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Submission Three

to

Senate Environment, Communications, Information Technology and the Arts
Committee

**Inquiry into Australia's national parks, conservation reserves and
marine protected areas**

*Submission Three addresses terms of reference (a), and focusses on MARINE
PROTECTED AREAS.*

Ethics, fisheries, and marine protected areas

Abstract

Fishing (including illegal fishing and the associated effects of gear-related habitat damage and bycatch) is the single most important threat to marine biodiversity worldwide. Marine ecosystems are in urgent need of protection. The creation of marine protected areas is usually justified in terms of utilitarian needs relating to the conservation of biodiversity or the protection and enhancement of fish stocks. Could they also be justified in terms of ethics? In spite of the general absence of discussion of ethics within areas of marine science or fisheries management, a substantial and long-standing literature exists from which an ethical basis for the establishment of protected areas could be drawn. This paper briefly reviews some of the landmarks within this literature, and – without apology for an explicit ethical position – recommends increased discussion and use of environmental ethics within the marine community. My simple message is that humans are gradually but inexorably killing the other living inhabitants of our planet, and destroying the places in which they live. The time to adopt a new ethical position has already passed with much talk but no action. The matter is now so urgent that it demands the attention of every marine scientist.

Introduction

Australia has declared its entire Exclusive Economic Zone (EEZ) to be a whale sanctuary, and has proposed the creation of a South Pacific Whale Sanctuary at meetings of the International Whaling Commission (IWC). The Australian Government and Australian scientists have also criticised Japan's scientific whaling program (Gales et al. 2005). Interviewed in a Australian Broadcasting Commission (ABC) 'Four Corners' program screened in July 2005, a Japanese government spokesman asked: "Australians eat cows, pigs and sheep. Why shouldn't we eat whales?". Although this question was tangential to the immediate discussion, I found it interesting that it remained without discussion or reply. An implicit ethical position underlies the Australian point of view, yet Australians seem reluctant to talk about it. In discussing the issue later with a colleague (a marine scientist) I asked: "have you ever heard a marine scientist talk about environmental ethics?" The reply was negative.

In this paper I examine the reluctance of marine scientists to involve themselves with questions of ethics. I suggest that many marine scientists may be ignorant of the extensive

environmental ethics literature, or see it as irrelevant. I argue that, while this is entirely understandable, it is now counter-productive. It is not un-scientific to adopt an explicitly ethical position, and I argue that discussion of ethics within the community involved in the management of marine resources should be strongly promoted until it seeps through to the level of the general community and thus to political decision-making.

Justifying the creation of marine protected areas

As a fairly typical example of a marine scientist arguing for the creation of marine protected areas, Professor Terry Hughes argued that a substantial proportion (around 30%) of coral reef ecosystems need to be protected from harvesting pressures in order to ensure ecosystem stability. According to Hughes (2004) (my emphasis): “Our final recommendation, the most challenging, is for the creation of institutional frameworks that align the marketplace and economic self-interest with environmental conservation. *The ultimate aim is to secure future options for social and economic development*”. It should be noted, however, that Professor Hughes has discussed the ethics of protected areas elsewhere, unlike most marine scientists – who assiduously avoid discussing the issue.

The reliance on utilitarian arguments is of course not restricted to discussions of marine protected areas. Alfred Duda and Kenneth Sherman, in calling for urgent changes to existing fishery management strategies, state (my emphasis): “Fragmentation amongst institutions, international agencies, and disciplines, lack of cooperation among nations sharing marine ecosystems, and weak national policies, legislation and enforcement all contribute to the need for a new imperative for adopting ecosystem-based approaches to managing human activities in these systems *in order to avoid serious social and economic disruption*” (Duda & Sherman 2002).

Verity et al. 2002, in a review of both the status of pelagic ecosystems and the scientific and political paradigms underpinning resource exploitation, conclude that “use of resources for the benefit of humanity” is the prime driver. In spite of finding the paradigms of resource exploitation unsustainable, Verity et al., in recommending paradigm changes, do not attempt to expand this narrow ethic (2002:226).

Sissenwine and Mace (2001) in defining ‘responsible fisheries’ state: “...we believe ‘responsible’ means sustainable production of human benefits, distributed fairly, without causing unacceptable changes in marine ecosystems.”

These are eminent and well-respected scientists, and their reliance on utilitarian motives, and their avoidance of any discussion of ethical motives is typical of the approach of marine scientists generally.

Returning to the issue of whale sanctuaries, it is interesting to note that, in successfully arguing for the creation of the Southern Ocean Whale Sanctuary, and in unsuccessfully arguing for the creation of the South Pacific Whale Sanctuary, Australia has been constrained by the mandate of the IWC to argue in terms of rebuilding whale stocks (Gales, pers. comm. 2005). The mandate of the International Whaling Commission, as the name suggests, revolves around the central concept of sustainable harvesting. The IWC is not the International Whale Protection Commission, as the Japanese IWC delegation have correctly pointed out. So – although the Australian position on whale conservation *appears* to be underpinned by a wider ethic of protection of species for their own sake, the actual arguments used to establish protective measures are in fact based on traditional harvesting paradigms.

Environmental ethics and the development of an ecological conscience

Many religions contain concepts of care which extend beyond responsibilities to other humans. Buddhism, for example, combines a core ‘ecological’ concept, the ‘inter-connectedness of all things’ with an admonition to avoid causing suffering to any sentient being (BDK 1966). Hill (2000:161) has argued that Judeo-Christian teaching contains the concept that “nature serves something beyond human purposes, and as such it must be

respected and honoured". The recently-developed Baha'i faith advocates responsibilities relating to maintaining the health of the planet, while Pantheism is more explicit in its 'unity of all life' teaching (refer www.comparative-religion.com). These concepts have appeared in popular western literature for well over 100 years (see for example Tolstoy 1903), without significant influence on government or corporate decision-making, which are pervaded (globally) by John Stuart Mills' anthropocentric 'enlightened self-interest' (Mills 1863).

In a classic essay "The historical roots of our ecologic crisis" Lynn White (1967) argues that modern technology and its application, the immediate cause for the twentieth century's environmental problems, emerged from an anthropocentric culture of thought which rests in large part on Judaism. The particular passage cited is the 'dominion' passage of the Book of Genesis 1:26,28):

Then God said "Let us make man in our image, in our likeness, and let them rule over the fish of the sea and the birds of the air, over the livestock, over all the earth, and over all the creatures that move along the ground". So God created man in his own image, in the image of God he created him: male and female he created them. God blessed them and said to them, "Be fruitful and increase in number; fill the earth and subdue it. Rule over the fish of the sea and the birds of the air and over every living creature that moves along the ground.

White's essay continues to create discussion and controversy. Many support his basic contention (eg: McKibben 1989). Christian writers (eg: Birch 1993, Hill 2000) inheriting in part a Judaic foundation, have argued for the expansion of Christian philosophy to encompass strong environmental stewardship ethics. However, such arguments appear to have limited sway over the bulk of the Christian churches or their leaders. Consider, for example, the Christian 'Cornwall Declaration on Environmental Stewardship' 2000, which criticises "*unfounded and undue concerns [including] fears of destructive manmade global warming, overpopulation, and rampant species loss*". The evidence suggests that these three issues are in fact three of the most important facing the immediate future of our planet (MEA 2005, Novacek & Cleland 2001). It is also noticeable that modern Buddhist leaders, in spite of the inherent environmental concepts within their philosophy, do not speak strongly for comprehensive environmental stewardship concepts (see for example The Dalai Lama 1995 and other works by the same author). For a detailed discussion of various religious positions on the environment, see Nash (1990).

Henry James Thoreau, John Muir and Aldo Leopold (referred to by Callicott 2003 as "the three giants of American environmental philosophy) all advocated a reverence for nature, and argued the need to set aside large areas away from human impact (wilderness areas) in order to preserve intrinsic natural values.

Aldo Leopold's "land ethic"

Of the writings of these three, Aldo Leopold's 'Land ethic' (Leopold 1948) has made a lasting impression, and continues to be extensively quoted. I consider his views to be powerful and coherent, and warrant examination in more detail.

Suppose no law prevented you from killing your neighbour and taking his land – would you do it? Hopefully not. Suppose your 'neighbour' belonged to a different racial or cultural group, and lived in another land. Would you kill him and take his land? Would you enslave him? Again, hopefully not. Yet that is exactly what our forefathers did – and what they did seemed 'right' within the moral framework of the time. In certain parts of the modern world, slavery still continues (www.antislavery.org). These questions are not far-fetched. If you discovered an uncharted island, populated only by a forest and its animals, would you take possession, clear the land, kill the animals, build a house and plant crops? Maybe you would. If everyone else acted in the same way, where would it end? With increasing human domination of the planet's ecosystems (Vitousek et al. 1997) that end is now in sight.

I agree with Balint (2003:14) when he states: “Scientists often do not recognize or hesitate to raise relevant ethical issues when participating in environmental policy debates, relying instead on scientific theories, models, and data.”

As Balint also points out, Leopold urges humanity to undergo a change of heart towards the environment and extend society’s ethical structure to include the natural world. He reminds us that slavery, including the killing of slaves as property, was once considered normal and right. Leopold equates movement towards a “land ethic” with previous cultural changes that led, for example, to abolishing slavery and recognizing the rights of women. In contrast to anthropocentric utilitarian views of nature, in which morally right acts are those that protect or increase human well-being, Leopold offers the following recommendation:

...quit thinking about decent land-use as solely an economic problem. Examine each question in terms of what is ethically and esthetically right, as well as what is economically expedient. A thing is right when it tends to preserve the integrity, stability and beauty of the biotic community. It is wrong when it tends otherwise (Leopold 1948:240).

Leopold wrote, “There is as yet no ethic dealing with man’s relation to the land and to the animals and plants which grow upon it ... The land-relation is still strictly economic, entailing privileges but not obligations.” Movement toward such an ethic, he suggested, is “...an evolutionary possibility and an ecological necessity ... Individual thinkers since the days of Ezekiel and Isaiah have asserted that the despoliation of land is not only inexpedient but wrong. Society, however, has not yet affirmed their belief. I regard the present conservation movement as the embryo of such an affirmation.” (1948:218)

Apart from the immediate issue of technological capability, the planet’s environmental crisis stems from the way humans act as if they own the planet – dubbed by Ehrenfeld (1981) the “arrogance of humanism”. Balint concludes (2003:22) “Leopold argued that the unlimited prerogative to own nature – defined to include ‘soils, waters, plants, and animals, or collectively: the land’ – that humans have bestowed upon themselves should be replaced by a constrained set of rights and an expanded set of responsibilities founded on principles of membership and citizenship in – rather than domination and exploitation of – the community of nature.”

It is this concept of mankind as part of a ‘community of nature’ which provides the essential basis for the ethic we now so badly need.

Contemporary environmental ethics

Why are contemporary biologists and ecologists generally unwilling to engage in discussions of ethics? There are, of course, exceptions. According to Balint (2003:21): “Michael Soule’ has listed the postulate “Biodiversity has intrinsic value,” as one of four key tenets in the field of conservation biology, which he helped found, giving the idea that all life has intrinsic value the status of a first principle.”

Like White, David Ehrenfeld, in his critique of humanism (1981) argues that management of the planet’s resources is almost universally founded on the idea that the features and objects of the natural world were created primarily for the benefit of humanity, and that it is the responsibility of humanity to accept this gift and accept stewardship of the natural world. Stanley (1995) in applying Ehrenfeld’s arguments to ecosystem-based management, finds ample evidence that humanity’s belief that effective ecosystem management is both possible and necessary lacks a strong factual basis – the history of such management being paved with failures. Stanley suggests that such failures will continue without a change in underlying ethics: “Humanity must begin to view itself as part of nature rather than the master of nature. It must reject the belief that nature is ours to use and control” (1995).

Arne Naess and George Sessions are often seen as the founding fathers of ‘deep ecology’ – an ecology explicitly based on ethics which acknowledge the intrinsic value of non-human life forms. According to Naess & Rothenburg (1989:c1) “The inability of the science of ecology to denounce such processes as the washing away of the soil of rainforests suggests

that we need another approach which involves the inescapable role of announcing values, not only 'facts'." Deep ecology is based on a 'deep' consideration of the values behind human use and abuse of the natural environment.

James Lovelock proposed the 'Gaia hypothesis' which sees the entire planet as resembling a single organism in the inter-connection of its biological components: "the self-regulation of climate and chemical composition is a process that emerges from the tightly coupled evolution of rocks, air, and ocean - in addition to that of organisms. Such interlocking self-regulation, while rarely optimal - consider the cold and hot places of the earth, the wet and the dry - nevertheless keeps the Earth a fit place for life" (Lovelock 1995). The ethical extension of this concept involves care of the planet as a living organism – with, Lovelock argues, reverence, humility and caution.

These ethical positions are broadly termed "biocentric". Those opposing the extension of such ethics to the management and protection of planetary ecosystems are apt to highlight extreme versions as manifestly unworkable. For example, according to Hill (2000:161):

[T]he effort to move beyond an anthropocentric to a biocentric view neither fits with our moral sensibilities nor yields useful policy prescriptions. First of all, the various attempts to derive a biocentric theology have been stymied in determining agreed-upon stopping points for the rights of nature. Although early efforts concentrated on the concept of sentience, philosophers and theologians have been unable to present a workable definition of what sentience includes. Edward Abbey, a leading deep ecologist, has said, "unless the need were urgent, I could no more sink the blade of an axe into the tissues of a living tree than I could drive it into the flesh of a fellow human." Rene Dubos, a prominent bacteriologist, believes that just as people and wolves should coexist, so should people and germs. Philosopher Paul Taylor argues, "The killing of a wildflower, then, when taken in and of itself, is just as much a wrong, other-things-being-equal, as the killing of a human." But even granting rights to living creatures does not solve the problem, since several leading figures in the environmental movement now argue, in the words of Michael J. Cohen, that "rocks and mountains, sand, clouds, wind, and rain, all are alive. Nothing is dead..."

Most environmental philosophers, however, take more defensible, moderate positions. Stone (1987, 1996) in addressing questions relating to the standing of those without voices, argues for increasing weight to be placed on intrinsic biological values in reducing further erosion of natural ecosystems, as well as the need (Stone 1995) to develop institutional protection for the rights of future generations of humans. Chen (2005) argues within a traditional but precautionary ethical framework for the development of stronger legal mechanisms to protect global biodiversity. The modern philosopher Peter Singer (1993) echoes the earlier approach by Passmore (1974) in grounding his ethical framework largely on enlightened self-interest informed by long-term and precautionary ecological science, with a generally accepted need to reduce suffering of sentient beings. Such views are anything but radical.

Ethics in international and government policy instruments

However, with a few environmental philosophers expressing apparently extreme views, perhaps the reluctance of marine scientists and managers to adopt explicit ethical positions is entirely understandable. The university courses in marine biology that I am familiar with contain little or no formal exposure to issues of environmental ethics – which seem generally left within social science faculties. Keeping up with current science, past graduation, is a demanding task, and practising scientists mostly have little time to explore ethical issues. Where a scientist holds an ethical position (as many, perhaps most probably do) it will often seem more useful to couch arguments about ecosystem protection in terms which are clearly understandable within the utilitarian framework of politics and economics. I argue, however, that this approach is now unnecessarily conservative. We can, in fact, look to international agreements and documents to legitimise an explicit ethical position.

The *World Charter for Nature* 1982 (a resolution of the United Nations General Assembly) was supported by the Australian Government in its development through the UN. Although without compliance provisions, and thus non-binding, the Charter nevertheless represents an

important commitment. Commitment obligations apply not only to government agencies, but, through article 24, to corporations and individuals.

In the preamble, the Charter notes that “civilization is rooted in nature... and living in harmony with nature gives man the best opportunities for the development of his creativity, and for rest and relaxation”. Importantly, the Charter also notes “*Every form of life is unique, warranting respect regardless of its worth to man, and, to accord other organisms such recognition, man must be guided by a moral code of action*”.

Foreshadowing the Convention on Biological Diversity which was to develop a decade later, Article 1 of the Charter requires that “Nature shall be respected, and its essential processes shall not be impaired. Article 2 focuses on the protection of genetic diversity, and article 3 requires that “all areas of the earth, both land and sea, shall be subject to these principles of conservation; special protection shall be given to unique areas, to representative samples of all the different types of ecosystems, and to the habitat of rare or endangered species.” Article 10, perhaps particularly relevant to fishery management, states in part: “Living resources shall not be utilized in excess of their natural capacity for regeneration”. I suggest that flagrant violation of these principles has become such common practice that we now think of it as ‘normal’.

The *Earth Charter* was developed to extend the World Charter for Nature by adding social objectives, including the eradication of poverty and the universal adoption of democracy. The Earth Charter was developed over many years following a 1987 initiative of the United Nations. An *Earth Charter Commission* was formed in 1997 with help from influential UN figures and funds from the Dutch Government. The Charter was endorsed by the Commission in 2000, and was put to the 2002 World Summit on Sustainable Development in Johannesburg - with a view to it being endorsed by the United Nations General Assembly. The Earth Charter is important, as it embodies an explicit ethic of respect for the planet. The preamble states: “The protection of Earth’s vitality, diversity and beauty is a sacred trust”.

Article 1 advocated the recognition “that all beings are independent, and every form of life has value regardless of its worth to human beings”, and article 15 requires that “all living beings” be treated with respect and consideration. Many fishery practices flagrantly violate these requirements – consider, for example, the habitat damage routinely caused by trawling operations, or the incidental kill caused by prawn fisheries.

Although it is a conservative document, shying away from important issues such as the need to reduce the human population of the planet, and the need to reform democratic governance, the Earth Charter has nevertheless failed – so far – to get widespread government endorsement. It has, however, wide support amongst the community (including the scientific community) within many nations, and remains open for public endorsement (www.earthcharter.org).

Writing shortly before the UN Johannesburg summit, J. Baird Callicott (an influential American environmental philosopher) had high hopes for the Earth Charter: “The prospective adoption of the Earth Charter by the General Assembly of the United Nations may have an impact on governmental environmental policy and performance similar to the impact on governmental social policy and behaviour of the adoption by the same body in 1948 of the Universal Declaration of Human Rights.” (Callicott 2002). It is to be hoped that Callicott’s expectations in this regard will ultimately be fulfilled – however for this to happen there will need to be a growing awareness, particularly within agencies which provide direct advice to politicians, of the need to articulate the policy implications of ethical positions.

Australia’s *National Strategy for the Conservation of Australia’s Biological Diversity* (DEH 1996:2) underwent wide agency consultation prior to publication, and, in its final form, was endorsed by the Australian (Commonwealth) Government, all State and Territory Governments, and by Local Government’s peak body. In it we find an articulate ethical statement:

There is in the community a view that the conservation of biological diversity also has an ethical basis. We share the earth with many other life forms which warrant our respect, whether or not they are of benefit to us. Earth belongs to the future as well as the present; no single species or generation can claim it as its own.

This clear expression (in a widely-endorsed government policy document) of the beginnings of a 'land ethic' provided Australian scientists with an opportunity to build discussion and use of deeper ethical positions, yet almost nothing has happened, and nearly a decade has passed now since this statement was published.

Oceans in crisis

Global trends

Driven by the demands of an expanding human population combined with increasing per capita resource consumption, global ecological assets and processes are now being eroded. Outside protected areas (IUCN categories I-VI) which cover about 10% of the planet's total surface (Carey et al. 2000) humans have already modified and damaged almost all terrestrial and freshwater habitats (Cracraft & Grifo 1999, Wilson 2002). About half of all natural terrestrial ecosystems have been destroyed, with this percentage escalating (Vitousek et al. 1997). Most of the remaining natural habitat is significantly degraded (MEA 2005a, 2005b), and major degradation is occurring inside some protected areas, particularly in underdeveloped countries (Carey et al. 2000). About one-quarter of the Earth's bird species have already been driven to extinction (Vitousek et al. 1997), with notable marine species such as albatrosses currently on extinction trajectories (Baker et al. 2002, Dulvy et al. 2003). Considerable uncertainty surrounds estimates of threatened terrestrial plants, as poor data exists for the tropical regions where the bulk of plant species reside. Estimates by Pitman and Jorgensen (2002) suggest that "as many as half of the world's plant species may qualify as threatened with extinction under the IUCN classification scheme". Recent anthropogenic changes to the earth's atmosphere may not produce smooth changes in the earth's major ecosystems or the processes which underpin climate itself (such as global thermohaline circulation). The resilience of the planet is being undermined; abrupt changes could occur and could prove to be both damaging and effectively irreversible (Steffen 2004).

The oceans as well as the planet's terrestrial areas are being severely damaged. According to a United Nations advisory committee (GESAMP 2001):

The state of the world's seas and oceans is deteriorating. Most of the problems identified decades ago have not been resolved, and many are worsening. New threats keep emerging. The traditional uses of the seas and coasts – and the benefits that humanity gets from them – have been widely undermined.

Overfishing

Overfishing is one of the greatest threats to the marine environment (GESAMP 2001:1).

Overfishing, far from being a modern phenomenon, has been occurring in certain regions for a considerable time. Overfishing has been the rule rather than the exception, even in artisanal fisheries. As Jackson (2001) points out: "Untold millions of large fishes, sharks, sea turtles and manatees were removed from the Caribbean in the 17th to 19th centuries. Recent collapses of reef corals and seagrasses are due ultimately to the losses of these large consumers as much as to more recent changes in climate, eutrophication, or outbreaks of disease." According to Pauly et al. 2002: "Fisheries have rarely been 'sustainable'. Rather, fishing has induced serial depletions, long masked by improved technology, geographic expansion and exploitation of previously spurned species lower in the food web".

Populations of ocean fishes have been hugely reduced over the last two centuries. Evidence suggests that earlier stocks may have been an order of magnitude greater than stocks in the last half-century (Steele and Schumacher 2000). The last few decades have witnessed accelerating inroads into marine habitats, which in many instances are now broadly approaching ecological collapse. Many coastal ecosystems have already passed the point of collapse when compared with their pristine state. The dramatic decline of coastal fisheries is the signal we see (Jackson et al. 2001).

According to Jackson (2001): "Ecological extinction caused by overfishing precedes all other pervasive human disturbance to coastal ecosystems, including pollution, degradation of water quality, and anthropogenic climate change". Duda & Sherman (2002) express similar concerns: "Continued over-fishing in the face of scientific warnings, fishing down food webs, destruction of habitat, and accelerated pollution loading – especially nitrogen export – have resulted in significant degradation to coastal and marine ecosystems of both rich and poor nations."

Subsidization of national fishing fleets continues, in spite of warnings by scientists (eg: Pauly 1995) and the FAO (FAO xx) that excessive fishing pressures are the primary cause of fisheries collapse. Global fishing fleets are two or three times the size necessary to harvest the approximate reported annual global catch of around 90 million tonnes. Many fisheries have "staggering levels of discarded bycatch" which, when combined with unreported, unregulated and illegal fishing, pushes the true global annual catch to around 150 million tonnes (Pauly 1995). Pauly's figures, although a decade old, are still roughly accurate if Chinese reports of fishing take are excluded. This estimate does not include 'ghost fishing' – the take by lost or abandoned fishing gear. While difficult to estimate, ghost fishing may be causing significant damage. The plastics used in many nets, once removed from the effects of UV radiation in sunlight, last virtually indefinitely.

Many marine animals have suffered dramatic declines due to over-fishing. Roman & Palumbi (2003) estimate that "pre-whaling populations [of fin and humpback whales in the northern Atlantic] [were] 6 to 20 times higher than present-day population estimates". Jennings and Blanchard (2004) in their study applying macroecological theory to the North Sea, suggest that the current biomass of large fishes is over 97% lower than in the absence of fisheries exploitation.

Dayton et al. (1998) describing the kelp forest communities of western USA, state: "...fisheries have had huge effects on the abundances, size-frequencies, and/or spatial distributions of sheephead, kelp bass, rays, flatfish, rock fish, spiny lobsters and red sea urchins. Now even sea cucumbers, crabs and small snails are subject to unregulated fishing. ...most of the megafauna have been removed with very little documentation or historical understanding of what the natural community was like."

Studies by Myers and Worm (2003) have estimated "that large predatory fish biomass today is only about 10% of pre-industrial levels". This decline may have caused serious damage to ocean ecosystems, and species extinction is a real possibility (Malakoff 1997). Baum and Myers (2004) estimate that oceanic whitetip and silky sharks, formerly the most commonly caught shark species in the Gulf of Mexico, "have declined by over 99% and 90% respectively". Worm et al. (2005) confirms the generality of declines in large predators across the world's oceans.

As Botsford et al. (1997) point out, it is abundantly clear that, at a global level, "[fishery] management has failed to achieve a principal goal, sustainability".

Habitat damage

In spite of the admonitions of many international agreements and national policies aimed at the protection of habitats and ecosystems, trawling continues to cause massive damage to fragile benthic communities (Dayton 1998, Koslow et al. 2000, NRC 2002). The advent of recent technologies in navigation, sonar and deep fishing gear have permitted damaging fishing of the deep sea (Roberts 2002). Due to very slow recovery times in deep sea ecosystems, damage already caused by deep sea trawling is likely to take many hundreds of years to repair, if recovery is possible at all.

Coral, global warming and biogeochemistry

Coral reef ecosystems have been declining globally for many decades (Wilkinson 2004, Pandolfi et al. 2003, Jackson 1997). Average coral cover in the Caribbean region has declined from about 50% to 10% in the last 30 years (Gardner et al. 2003), and similar

declines are common in heavily fished reef ecosystems globally. Even given these dramatic declines, for coral ecosystems the worse is yet to come.

The concentration of carbon dioxide in the Earth's atmosphere has increased by about 30% since the beginning of the industrial revolution (Vitousek et al. 1997) with a continued massive increase effectively unavoidable over the coming decades. Carbon dioxide levels are now higher than any time in the last 400,000 years, and possibly the last 50 million years (xx reference?).

According to the Royal Society (2005) many marine organisms dependent on calcium carbonate structures, including corals, are unlikely to survive increases in ocean acidity predicted at the close of the next century, if global emission rates of carbon dioxide continue along current trajectories. Coral reefs are already degrading under the effects of overfishing, increasing sea surface temperatures, and nutrient-laden runoff from the agricultural and urban development of nearby coasts (Bellwood et al. 2004, Hughes et al. 2003). According to Pandolfi et al. (2003): "[Coral] reefs will not survive without immediate protection from human exploitation over large spatial scales."

Pollution

Excessive anthropogenic nitrogen inputs to coastal marine ecosystems are causing 'dead zones' (oxygen-depleted zones) of substantial size. Moffat (1998) reported a zone "the size of the State of New Jersey, expanding westward from the coast of Louisiana into Texas waters". Since then other similar zones have been identified (reference? xx). As mentioned above, shallow coral ecosystems are readily damaged by nutrients (Harrison & Ward 2001) sediment and pesticides in runoff from adjacent agricultural land (reference xx). Studies indicate trace metal pollution may also be important; copper for example has been found to inhibit coral spawning even at very low concentrations (reference xx). Pollution from plastic litter has reached epidemic proportions (reference xx) and does not degrade once removed from UV radiation.

Trophic cascades: catastrophic shifts in ecosystems

The Millennium Ecosystem Assessment biodiversity synthesis (2005:25) highlights damage which can occur to ecosystems by removing species which supply local services critical to key ecosystem processes, such as grazing in coral reefs, or pollination in terrestrial ecosystems. Examples of damaging trophic cascades in the marine environment listed in MEA include overharvesting of Californian sea otters, Alaskan sea lions, Kenyan trigger fish, and Caribbean reef fish (MEA 2005:27).

STILL TO COME:

Tyranny of small decisions; shifting baselines. Scientists are amongst the few residents of the Earth who can appreciate the gravity of the changes which are taking place.

Conclusion

The single most important issue the world faces is the need to develop an ethic of planetary stewardship, based on notions of participation in the community of nature rather than domination of it. Such ethics need to be underpinned by a reverence for the beauty and complexity of our "water planet" and its diversity of life forms. Without this ethic, the forces behind our industrial-consumer society are pushing global resource consumption to higher and higher levels, eroding the essential life support systems of the planet. The expansion of 'human habitats' is now so pervasive that it is quite simply destroying the homes of other inhabitants of our planet on a massive scale.

Much is at stake. The human onslaught on the marine environment has, until the last few decades, been concentrated in estuaries and coastal oceans – through overfishing, habitat damage, pollution and the introduction of invasive species. This has, however, changed dramatically in recent times. While coastal marine areas continue to suffer, massive damage is now being inflicted over oceanic environments, primarily by industrial over-fishing.

As Ludwig et al. (1993:17) pointed out: "There are currently many plans for sustainable use or sustainable development that are founded upon scientific information and consensus. Such ideas reflect ignorance of the history of resource exploitation and misunderstanding of the possibility of achieving scientific consensus concerning resources and the environment. Although there is considerable variation in detail, there is remarkable consistency in the history of resource exploitation: resources are inevitably over-exploited, often to the point of collapse or extinction." In the decade since Ludwig wrote, evidence is still accumulating that over-exploitation of marine resources remains the rule rather than the exception (Verity et al. 2002; Wilson 2002; Kieves 2005).

There is a desperate need to protect marine environments. While utilitarian arguments must continue to be used, I believe it is now essential that scientists and policy-makers enter into ethical debate. My simple message is that our species is gradually but inexorably killing the other living inhabitants of our planet, and destroying the places in which they live. The time to adopt a new ethical position has already passed with much talk but no action. The matter is now so urgent that it demands the attention of every marine scientist.

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