Science to support the ecologically sustainable use of marine ecosystems

Marine ecosystems have supported human communities and economies for thousands of years. The human benefits of marine ecosystems, historically and now, are hard to over-state. The oceans and its ecosystems provide raw materials for industry and food. They assimilate, transform and purify waste nutrients, pathogens and contaminants from human activities. They regulate climate and the composition of atmosphere. They provide the basis for increasing levels of marine-based tourism and recreation. And the coasts and ocean continue to be a source of inspiration for people.

But what is really going on in the sea? We are land animals and we usually just look at the surface of the sea. It all looks much the same and it all looks fine on the surface. But beneath the surface:

- Far too many fish stocks have been overfished; about 25% of assessed stocks world-wide and in some cases more than 90% of the stock has been removed.
- Fishing is extending further down the marine food-chain and using ever more effective technology, but in the last decade the world catch has at best remained about constant and more likely has decreased.
- Direct harvesting and by-catch in fisheries has endangered many species of marine mammals, seabirds, and turtles.
- Coastal development, sedimentation, pollution and fishing have modified or reduced many vital habitats, including mangroves, seagrasses, wetlands, corals and seabed sponges.
- Nutrients and other chemicals are modifying many marine ecosystems, and in some regions are causing huge areas to become oxygen deficient.
- There are increasing numbers of introduced marine pests in many locations.

There is an urgent need to change how we use and manage the oceans if we are to achieve the goal of sustainable development — that is meeting present needs without compromising future generations the opportunity to meet theirs.

But there are grounds for cautious optimism. As yet there have been relatively few global extinctions of marine species. And experience has shown that recovery of depleted populations and habitats is possible — although it requires focused action and takes time. But, perhaps the main reason for optimism is that many people do care about the ocean, and they do want its use to be sustainable.

How do we ensure that our use of marine ecosystems is sustainable? Science is only one part of the answer but it is fundamental for two reasons. Firstly, science provides basic understanding about marine ecosystems and the impacts of human activities on them. Secondly, science provides advice about management measures and strategies to achieve sustainable development. It is this second role that I want to emphasise here today.

A fundamental feature of predictions about marine resources and ecosystems is that they are highly uncertain. The challenge is to provide scientific recommendations that have a good chance of succeeding despite the uncertainties, to make the risks and trade-offs clear, and to identify ways to detect and correct departures from desired outcomes in time to avoid failures.

The methodology that I and others have

developed and used for this is Management Strategy Evaluation (MSE). MSE includes risk assessment and the evaluation of risk management strategies. It uses computer simulation models to test and compare strategies. To ensure realistic testing the models include all reasonable interpretations of the ecological system and available data.

MSE is commonly used to identify what to monitor, how to respond, and the expected outcomes of management. This can include environmental, economic and social outcomes. MSE also allows calculation of the value of additional information that reduces uncertainty. Different additional information may have very different cost and value to the management system.

The following four real examples illustrate application of the MSE approach.

1. The North West Shelf of Australia was intensively trawled during the1970s and undesirable changes occurred in the species composition of the ecosystem. Models were used to evaluate different management strategies. A strategy was adopted that included closing some areas to trawling and continued trawling in others. This demonstrated that habitat modification by trawling caused the changes in fish community, and that this was reversible. The fishery is now sustainably managed using a strategy that includes restricted trawling zones.

2. There was concern about the ecological impacts of line fishing on the Australian Great Barrier Reef. In collaboration with Prof Carl Walters we developed a model of the reef ecosystem based on a range of hypotheses. We used it to develop a large scale experiment to determine the effects of line fishing on the target species and reef ecology. The experiment has operated for the past10y. It has demonstrated that the target species is sustainably harvested and that line fishing is not causing indirect effects on prey species or biodiversity.

3. Fisheries for toothfish recently developed around Macquarie Island in the subantarctic. This is an area of high conservation value, including marine mammals, seabirds and penguins. The impacts of fishing on the target species, by-catch, habitats and food-webs were studied and modelled to test management strategies. A strategy was developed, accepted and implemented by both fisheries and environmental management agencies. It included establishing a large Marine Protected Area and proscribed methods for determining the allowable catches.

4. A study was established on the North West Shelf of Australia to develop and demonstrate scientific methods to support integrated management of ocean uses there — including petrochemical industries, shipping, aquaculture, fishing and coastal development. A detailed model of the ecosystem, industries, and management regulation was developed. It was used to test management strategies for the separate industries and for the region as a whole. It has demonstrated that regional management strategies can be scientifically tested, despite the complexity and uncertainty of coupled ecological and socioeconomic systems.

These and other examples show that scientific methods exist to deliver reliable strategies for ecologically sustainable use of marine fisheries and ecosystems. They can deal with the wide range of ecological impacts and

situations that occur, and they do not necessarily require everything to be known. But they do require that management systems place priority on achieving ecologically sustainable use. This means using management approaches that are sufficiently precautionary for the level of understanding. We have the scientific tools to design strategies to deliver sustainable and integrated management of the world's marine ecosystems. Now we need to get on with using them.