RECENT ADVANCES IN MARINE SCIENCE AND TECHNOLOGY '94

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PREFACE

Recent Advance in Marine Science and Technology '94 contains some 76 papers on a wide range of marine topics which were given at the Sixth Pacific Congress on Marine Science and Technology (PACON 94) held at James Cook University, Townsville, Australia July 4-8 1994. This was the largest PACON congress to date with 577 participants from 28 countries attending. More than 300 technical papers were presented under 38 technical sessions and 2 workshops and in addition 5 plenary papers were given at the start of proceedings each day. Unfortunately, it has not been possible to publish the large number of papers which were offered and many presentations of very high quality are therefore omitted from this volume. The review process was carried out through the chairmen of the sessions and workshops and to them both, myself and the editorial board would like to express our thanks. The 76 papers published in this volume therefore represent only a relatively small part of the total proceedings, but they reflect both the very wide range of marine interests of the PACON organisation and the national spread of delegates. An index giving the alphabetical listing of authors is presented at the end of the volume. Plenary papers are presented first followed by papers presented in the Ocean Science and Technology sessions and finally those from the Marine Resource Management sessions.

As organiser of the Local Organising Committee, I have the opportunity to permanently record my thanks and appreciation to all of those who helped to make the PACON 94 conference such a success. Our sponsors are listed elsewhere in this volume and to them in particular we are grateful for their support. I would also like to express my thanks to the editorial board whose hard work in the nine months since PACON 94 has helped to make these reviewed proceedings such a valuable addition to the marine science, technology, management and policy literature. Narendra Saxena in Hawaii and Howard Choat in Townsville have provided valuable leadership in producing this volume, but particular thanks go to Ms. Orpha Bellwood for her perseverance and efforts which have been continuous since the end of the conference.

Townsville
April 11th 1995

Professor David Hopley
Sir George Fisher Centre
James Cook University
Chairman
Local Organising Committee
PACON 94

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THE PACIFIC BASIN: HUMANS IN A COMPLEX SYSTEM

Prof. Graeme Kelleher

Chairman, Great Barrier Marine Park Authority
P.O. Box 1379, Townsville 4810, Australia

"All things are connected like the blood which unites one family" Chief Seattle - 1854

The principal goal of PACON International is to provide information to all participating nations to promote the environmentally sound utilisation of ocean resources and to advance knowledge in the various disciplines. In this Congress, special attention will be paid to the impact of marine technology on the quality of life of the Pacific Islanders.

The developed world is at last recognising the truth behind Chief Seattle's words. It is no longer sensible to consider any area of human endeavour in isolation. Let us look at some of the problems facing the Pacific Basin and the causes of them, so that we can together act in ways which reflect our dependence on the health and continued productivity of natural ecosystems

THE STATE OF THE BASIN'S SEAS

In the Pacific Basin, a large proportion of the human population lives either on islands or in the narrow strip of land which borders the sea. This situation and the likelihood that it will only develop further with time are central to the present state of the marine environment, to many of the threats to its integrity and to the strategic directions that we should take in achieving economic development while protecting ecological processes and states.

Much of the Pacific Basin's marine coastal environment is suffering from a number of stresses caused by human activity They can be considered under the headings of pollution, overfishing, physical alteration of the seabed or coastline, introduction of exotic species and climate change.

Before considering these stresses, it should be emphasized that our knowledge of the state of the marine environment is inadequate. As yet there is no adequate international system to assess its present state and we are a long way from having monitoring systems which will reveal adverse trends and their causes.

Therefore, it is not possible for anyone to state unequivocally what is the state of many parts of the Pacific, how serious are the threats and what specifically (as opposed to generally) should be done about them. Generally, of course, we should be establishing and maintaining comprehensive long-term research and monitoring programs covering the coastal waters, and we should be managing coastal environments in an integrated way, so that the costs of actions by one industry (eg. agriculture) are not borne by other industries (eg. fishing and tourism).

Pollution and its sources

By far the greatest source of pollution of the sea is land-based human activity. Not surprisingly, the degree of marine pollution at different parts of a coastline is often closely related to the size of the adjacent human population. There are exceptions to this where, for example, a major river system discharges pollutants arising inland pollutants arising inland into the sea.

Forms of human-induced pollution include nutrients (mainly nitrogen and phosphorus), herbicides and pesticides and their derivatives and toxic chemicals and heavy metals, most of which are created in industrial processes including mining. Outfall sewers cause local eutrophication, loss of seagrass beds, build up of toxic metal levels in sediments and organisms and loss of public amenity. Stormwater drains also contribute pollutants.

Nutrients in sewage, combined with contribution of nutrients from other sources, particularly affect coral reef ecosystems adversely, resulting in reductions in strength of calcium carbonate skeletons and smothering of corals by algae. However, in some circumstances, addition of nutrients to marine areas may be seen as beneficial. For instance, deep outfall sewers can contribute to the nutrient budget, which may result in larger fish catches. Even in these circumstances, there is the ever present risk of toxic substances entering the food chain. In coral reef environments, tertiary treatment (ie., the removal of nitrogen and phosphorus) of sewage is essential if long term degradation is to be avoided.

Mainland environmental problems, are usually reflected in marine problems. Soil erosion results in suspended sediments being conveyed to the sea. Nutrients in the form of ions are often attached to the soil particles, leading to nutrient enrichment. This is usually greatly increased where the clearing of native forests is followed by agricultural activities which involve the application of fertilizers. The effects can include degradation of coral reefs and the destruction (or in some cases the creation) of seagrass beds.

Fortunately, the interests of farmers coincide with those of people who depend on healthy marine ecosystems. Farmers do not wish to see their lands eroded and are not happy to pay for the application of expensive fertilizers which end up in the sea. An approach which has been started here in Queensland, is the establishment of joint research programs, involving farmer organisations, governments, research institutions and management agencies, aimed at defining the marine problems and their causes and formulating solutions which benefit all sectors of the community as well as the natural environment. It is probable that this process is working in Australia only because of the existence of a government agency which is responsible to all sectors of the community for the overall management of a large marine ecosystem.

Great amounts of oil are carried in tankers around the world's coastlines. There is the ever present risk of a major oil spill with potentially disastrous ecological consequences. No country in the world has the capacity to combat adequately a major oil spill.

There are two major deficiencies in our scientific and administrative systems, which place in jeopardy the attainment of ecologically sustainable development of our coastal waters. The first is the absence of comprehensive, long term monitoring programs covering each of the large marine ecosystems which impinge on the coastline. This deficiency prevents us from defining the extent of pollution that exists now and the trends in water quality parameters. The second is the lack of integration of planning, management and research in the coastal zone. Without integrated programs, there is little chance that nations will be able to take the actions, on both land and sea, that will be necessary to prevent insidious increases in pollution of the marine environment.

Fishing

Virtually every marine fishery is considered by most experts to be inadequately managed for ecological sustainability. The evidence of inadequate management is decreasing catch/effort ratios followed by stock collapse. Input/Output controls by themselves have usually not worked because pressure from the industry prevents imposition of sufficiently stringent controls until after the point of no return in the process of stock collapse has been passed.

Much of the shallow water seabed is trawled regularly. What is the ecological effect on a large marine ecosystem of dragging boards, nets and chains across the seabed regularly, recovering virtually all the sedentary organisms and then discarding five- sixths of the catch? The answer is that nobody knows. Nowhere in the world have there been adequate experimental research programs into the effects of trawling. Such a major, long term research project has been commenced for the Great Barrier Reef, involving the commercial fishing industry, amateur fishers, Australian and international marine scientists and the Queensland and Federal Governments. About AUD$lm have been provided by the Federal Government for each year of the project, which is also investigating the ecological effects of line fishing.

Most of the research related to fisheries has concentrated on the target species rather than on the whole ecosystem. A shift in emphasis to ecosystem-focussed research will be necessary to obtain the scientific information necessary to achieve ecologically sustainable fishing practices.

A possible answer to the problems of over-fishing and destruction of habitat is to combine multiple use protected area management processes with traditional fishery management practices. Such an integrated process would allow the various interest groups to agree on what areas and levels of protection should be provided to critical habitat and to areas that are representative of major habitat types which occur within each large marine ecosystem. Such protected areas fulfil the multiple roles of providing baselines against which to measure ecological changes caused by human activity, protecting critical life stages in commercially or recreationally fished species (such as nursery or refuge areas), providing sites in which to carry out ecological research and allowing tourists and the public to appreciate and enjoy relatively undisturbed marine environments.

I believe that this sort of integrated management is unlikely to be achieved in the absence of a single agency in each country (or, in the case of countries with federal systems of government, each state or province) with the responsibility of coordinating all government actions and programs with the primary aim of achieving ecologically sustainable development of the coastal zone. In the absence of such an agency, it is unlikely that any agency, whether its principal function is research or management, will design and carry out the sort of multi-disciplinary, ecosystem-focussed research necessary to answer management questions.

Physical alteration of the seabed or coastline

Destruction of coastal wetlands, removal of mangrove areas and alteration of the coastline for coastal development continue to occur in a largely unplanned, uncoordinated and disintegrated fashion. Decisions are made without taking into account adverse ecological and economic consequences of destruction of natural coastal environments. Activities such as dredging, harbour construction etc change water patterns and sediment regimes, often with ecologically undesirable results.

Mangroves play vital roles in retaining sediments eroded from the mainland and islands, taking up toxic chemicals, preventing erosion and providing vital habitat to various marine species. Wetlands are important areas for the preservation of biological diversity and as habitats for many migratory and domestic species. These and other coastal features are commonly sacrificed for tourist developments, mariculture and agriculture. The ecological and economic costs of these piecemeal decisions are rarely taken into account in government approval processes. There is a vital need for coordinated, integrated long term planning of the coastal environment in order to achieve both ecologically sustainable development and economically rational use of coastal resources. This planning must be based on information provided by integrated, multi-disciplinary, ecological research, which defines the interdependencies of the various parts of the marine ecosystem and the coastal zone.

Introduction of exotic organisms

The implications of the introduction of exotic species are very serious, both ecologically and economically. Evidence of the introduction of exotic marine organisms around the world is mounting. For instance, it is known that at least ten such organisms have been introduced around Australian waters, probably in ballast water. The potentially disastrous effects of such introductions on local shellfish and other industries have been illustrated. It is probable that other introductions will continue to occur unless very stringent controls are placed on the discharge of ballast waters. Probably the most effective mechanism will be sterilization of ballast water before discharge.

Research is urgently needed on the most cost-effective means of preventing the inadvertent introduction of exotic organisms.

Climate change

Recent advances in the study of this world-wide issue indicate that it is unlikely that there will be catastrophic problems relating to most of the world's coastal areas for the next fifty years. There has been much concern expressed about the effects of rising sea level on coral reefs. Far from destroying coral reefs, it is likely that projected increases in sea level will lead to accelerated coral growth, particularly over mature algal flats. Drowning of coral reefs is unlikely to occur for at least 300 years, if ever. It is likely that most of the world's coastal communities will be able to adapt to the projected rates of sea level rise in a measured and economical way. However, localized increases in sea temperature, such as in areas where tidal changes and currents are small, might well increase the incidence of coral bleaching and death.

In making these statements, I do not imply that rising sea levels may not cause drastic problems for some countries, such as the Maldives or Bangladesh. Climate change may grossly affect agriculture in many countries.

MAKING SCIENCE RELEVANT TO MANAGEMENT

In most countries of the world, including in the Pacific, there has been a long history of lack of communication between scientists and managers. There are two sides to this coin. On the one hand, scientists are largely unaware of the informational needs of managers. They often do not understand the constraints under which managers operate or their decision making processes. For instance, scientists are often reluctant to admit that managers must make decisions, whether or not the necessary research has been carried out to ensure that those decisions are based on sound science. Scientists rarely ask managers to define the questions they most need answered and they equally rarely ask the managers to help them to design research projects and programs which address those questions.

The other side of that coin is that managers rarely make the time to involve the scientific community in an assessment of what management questions can be meaningfully addressed by silence and they equally rarely ask scientists to interpret for them the results of research.

The consequences of this lack of communication are serious. Often, scientists have known the causes and effects of pollution, fisheries mismanagement, physical alteration of the environment etc for a number of decades - but the message has not been absorbed by economic and other policy managers. At least, if it has been absorbed, this has not been demonstrated by policy actions. Because of this difficulty, the analysis and interpretation of current scientific information may be a more urgent need than the derivation of new scientific information. To provide for the future, long term monitoring is essential if environmental trends are to be detected and management responses implemented.

Fortunately, the situation is improving. In more and more cases, scientists and managers are becoming involved in the joint identification of management related questions which can be addressed by science and in the design of research projects and programs which address those questions explicitly.

PACON offers an opportunity for these problems to be addressed by both managers and scientists. It is therefore hoped that both groups will ensure that they attend workshops in other than their own explicit area of expertise, so that this communication can be improved.

THE NEED FOR INTEGRATED PLANNING, MANAGEMENT AND RESEARCH

Many of the problems that I have mentioned in this address have been exacerbated by the general absence in the Pacific of integrated coastal management and research systems. One of the few exceptions to this is the Great Barrier Reef Marine Park, which is managed as a large marine ecosystem covering both islands and water. Even the Great Barrier Reef administrative system does not adequately address mainland/marine linkages in a formal way. However, specific research programs involving all levels of government have been and are being established to assess the effects on that ecosystem of mainland based activities, including agriculture.

I believe that there should be formal integrated management of each country's coastal waters. One option to which consideration could be given is the establishment in each country, state or province of a Marine Management Authority, with representatives of state and federal governments as well as a small number of representatives of local government and community interests, with the specific function of achieving integrated planning, research and management of the marine coastal zone in accordance with the principles of ecologically sustainable development.

Because of the proven difficulty that organisations and individuals have in simultaneously attempting to achieve two goals - in this case, economic development and ecological protection- I am inclined to think that these Authorities should not be responsible for detailed management of individual sectoral activities, such as tourism or fisheries. Such activities should, I think, continue to be managed by specialist agencies. However, the Authorities could have the following responsibilities and functions:

- development, in association with interest groups and the community generally, of a strategic plan for the marine coastal zone;
- ensuring that sectoral agencies operate in a manner consistent with the strategic plan
- oversight of coastal development to ensure that it is ecologically sustainable;
- design and management of comprehensive monitoring programs which will define the state of the marine coastal environments and the trends in environmental parameters;
- design and management of contracted, multi-disciplinary, ecological research programs aimed at solving environmental problems;
- design and implementation of comprehensive community involvement and education programs designed to achieve voluntary acceptance by the community of policies, programs and actions which will lead to ecologically sustainable development. Particular emphasis should be placed on educating the young.

I think that, to the maximum extent practicable, specific management programs and actions should continue to be carried out by existing agencies, with the Authorities concentrating on policy, strategy, planning, design and supervision of research programs and coordination. The enabling legislation should override conflicting provisions of existing legislation.

I believe that such a systems-based organisational framework provides the best hope for a country to achieve ecologically sustainable development of the marine coastal zone. Without it, the energies of people and governments will continue to be dissipated in intersectoral conflicts, incompatible activities, economically inefficient developments, and research that is not relevant to ensuring that the economic development of the Pacific is ecologically sustainable.

CONCLUSION

PACON offers a rare opportunity for scientists and managers to consider together the opportunities for improvements in economic development, human welfare and environmental management in the Pacific. I look forward to working with the participants in contributing to the development of a framework in which ecologically sustainable development of this important region can occur.

THE FUTURE OF MARINE SCIENCE AND TECHNOLOGY IN JAPAN

Dr. Shin-ichi Ishii

Executive Director, Japan Marine Science and Technology Center (JAMSTEC)

INTRODUCTION

Life on earth has had close relationship with the ocean since time immemorial. About 1.9 billion years ago there appeared, below the surface of the sea, some forms of life with photosynthesis function, while on land, no life could live because of ultraviolet rays that were too strong to permit their survival. During ages that followed, life in the sea kept releasing oxygen on to the atmosphere, which eventually formed a ozone layer that reduced the volume of ultraviolet rays reaching the ground, making it possible at long last about 400 million years ago for some life in the sea to come out of the sea and live on land. In other words, all living things on land today, including humans, owe what they are to the ocean that kept providing shelter to their ancestors until then.

It appears that today, we are finding it increasingly hard to continue our stabilized growth, or even our very existence, without the help of the ocean since we now face such present-day issues as population increase, shortage in food and other resources and problems of environment deterioration represented by global warming. To address these issues it is first of all necessary, in my opinion, that we increase our understanding of the ocean, which in turn largely depends on what we can do to promote relevant science and technology.

Humans have utilized the ocean for fishing and transportation since ancient times. Remarkable progress made in science and technology in recent years has generated new opportunities for utilization of the space and resources that the ocean has, and as a result, there has been a dramatic increase in the level of contribution that our ocean development and utilization effort can make in bringing man's social and economic progress overall. Moreover sports and other leisure-type activities utilizing the sea have also been on a rise as a response to people's changing life style to seek more spiritual as well as physical satisfaction.

Lately, however, it has come to our attention that the ocean has a great deal to do with such widely talked-about environment issues as global warming, and the climate change like abnormal weathers experienced in different parts of the world lately. There has been a growing recognition also that there is a certain limit to the ocean's ability to rejuvenate itself. Given the continued expansion of world population and social and economic activity, and taking into account the earth's environment into the 21st century, I think we must do the following two things first of all among many: First, we come to grips with the processes of the ocean on a global scale to obtain a correct understanding as to the role of the ocean in the global environment change. Second, we devote ourselves to the development of technologies capable of meeting such scientific and engineering challenges.

PRESENT STATUS OF OCEAN DEVELOPMENT

I. Utilization of ocean resources

Marine biological resources

(a). Marine fisheries

Regarding Fishery resources, it is important for Japan to know how much is available for Japan and how best we can manage the available resources to ensure stabilized supply to consumers. A structural change is taking place in Japanese coastal fisheries right now: The conventional "depredatory" way of fishing is rapidly giving way to a new "cultured and farming" type fisheries. Active research and development work is going on in all areas of technology with government support: For increased production, new culture and farming methods, and related facilities and equipment. Cultured and farm fishing currently represents roughly 13% of the total fish production in Japan.

An outlook for the future: The ocean holds the possibility of becoming a huge and priceless "food storage" to cope with serious food shortage that might come as a result of continuing world population increase by providing high-quality animal protein from fishes and shells, and large quantities of phytoplanktons and zooplanktons to be made available through our development of technologies for large-scale collection and processing for our consumption.

(b). Marine microbiological resources

Much remains to be known about marine microorganisms. They adapt themselves to the extreme environments of the deep sea with high water pressures, sightlessness, and low-temperatures, or in some cases, high temperatures. It has been known that certain deep-sea microorganisms have truly exotic biological systems in that they do not rely on solar energy, giving us promise of an entirely new type of bioscience being developed by studying these organisms to the genetic level.

JAMSTEC (the Japan Marine Science and Technology Center), to which I belong, has been engaged in this phase of science since 3 years ago, and we have discovered some interesting deep-sea microorganisms that might lead to the development of new useful pharmaceuticals or chemicals eventually. Experiments, including isolation and culture of these organisms, are under way in our laboratories.

Off-shore petroleum and other mineral resources

(a). Off-shore petroleum and natural gas

The world's major petroleum and gas resources developed in recent year exist mostly off-shore. Off-shore petroleum represents 25% of the world's total oil produced today. The shift that is currently taking place in production sites from shallow seas to increasingly deeper seas and to arctic seas calls for new technologies that will be responsive to these harsher environments. There appears an ease at moment in the energy supply and demand position, resulting in a world-wide lull in new oil and natural gas resources development. Taking a long-range view of the world energy resources, however, I think we should continue our effort to prepare for future production, notwithstanding short-term market trends of the time.

(b). Ocean mineral resources, other

Millions of tons of mineral ore deposits: manganese, cobalt, nickel, and the like exist on the ocean floor. Manganese nodules are found on the ocean bed at depths between 4,000 meters and 6,000 meters. Cobalt-rich crust is found on slopes at depths ranging from 800 meters to 2,000 meters. Ocean water also contains uranium and many other minerals as solutions. Although their concentration is low, their total amount is huge. Demand for rare metals for high-technology industry use has been on a marked increase in recent years, so that the establishment of technologies for mining and refining these mineral resources, while aware that we are still far away from realization, is what we would like to bring about as soon as possible. The ever-increasing world population and a continued rise expected in per-capita water consumption appear to dictate further advance in seawater desalination technology.

Ocean energy utilization

The ocean makes us available reusable and clean natural sources of energy in varied forms: Those based on the solar energy are waves, the temperature difference between surface and deep sea waters, the tide, the water current. Other energy sources available include the difference in salinity, or geothermal energy available underneath the sea floor. Energy density in these energy sources is usually small in comparison to fossil fuels and nuclear energy, so that economic aspects must be studied carefully in developing these sources. However, in the main, the energy conversion unit required for these sources can be small in size and simple in system construction. By taking advantage of these strong points, these forms of energy may find uses in remote islands or peninsular tips where power is not available from utilities.

In Japan a number of experiments on power generation using wave energy have been made. Demonstration models for practical use have been designed, manufactured, and installed, or tried at sea, proving their worthiness. Cost considerations still hamper commercial production. But continued effort is being made by interested circles even today.

Research on power generation through ocean thermal energy conversion (OTEC) is under way in certain countries, including Japan. The major problem of cost effectiveness regarding this generation method may be overcome, we hope, while we make effort to develop a multi-purpose deep sea water utilization technology, in which JAMSTEC is currently engaged.

In some regions, the tide or the water current can be a source of power generation depending upon the circumstances. We need to give continued encouragement to research in this area, too.

II. Utilization of ocean space

Shipping and shipbuilding

Shipping has helped people bring in new cultures and goods from overseas and has thus played an important role in history. And, without shipbuilding technology, there has been no shipping service. I think we can say that shipbuilding was "the very pioneer" to all ocean development technologies that followed.

Ocean space utilization

A number of mega-size civil engineering projects involving ocean development have come, or are coming about, in close heels in Japan lately, ie., Honshu-Shikoku connecting bridges spanning the Inland Sea, the Tokyo Bay Crossing Road that is part underwater tunnel and part open-air bridge, the Haneda Airport expansion into the Tokyo Bay, and the New Osaka International Airport built on a man-made island are examples of large transport and highway projects; while the Kobe-Rokko Island and the Yokohama Minato Mirai 21 are instances of developments to use ocean and coastal space for multipurpose business, culture and residential use. I expect there will be more of similar large projects in Japan as we continue to need integration of resources for distribution and information to keep up with the ever-rising quality of the people's living, although dependent, to a large measure, on the business trend of the time. Research on ocean space utilization involving structures of the floating type is presently carried on in certain countries. Utilization of space at greater depths underwater may also be realized as it becomes necessary.

Underwater ocean space has potential for storage of high pressured gases using its high pressure environment, and of foodstuff using its cool and dark environment. Study is presently carried on in this area as well.

Coastal utilization

Coastal areas, which have long provided an important base of human activity in terms of fishing and shipping, have present-day needs for development: To further strengthen the economic base of those living along the coast by carrying out area development appropriate to each coastal region. Promotion of effective use of the coast is also important as a way to ease population concentration pressure in cities.

Science that will respond to these needs involves studying the environment of the particular coastal area in question, finding suitable methods for developing and utilizing the region, and establishing technologies for utilization that take into account the special characteristics each region has.

Also important is research and development concerning the coast, ports and harbors, and structures for protection of people's life and property from erosion, storm wave surge, and tsunami, and there has been progress in these research areas.

Concerning coastal fishing promotion, effort is also being made to improve fishing grounds and their surroundings, encourage cultured and farm fishing, including resource-management-type fisheries.

In the future we need to do more research that would support creation of more places along the coast or off the coast where more people can enjoy their leisurely life - their interest being rapidly diversifying - safely and at reasonable cost.

III. Addressing issues on the Earth's environment

The oceans occupy roughly 70% of the earth's surface and provide storage and transport media for heat in the earth's environment. The oceans also have functions to absorb and keep within carbon dioxide gas which is said to be a major factor in global warming phenomena. We can see that the oceans, through interaction with the atmosphere, give a tremendous impact upon the earth's environment. The ocean has 1,000 times as much heat capacity as the atmosphere does, and stores carbon dioxide 60 times more than the air does. Also, natural disasters such as earthquakes, volcano eruptions, and "Tsunami" tidal waves have their origins in the ocean or sea-floor movements. "Red tide", or plankton bloom, that occurs in closed bays, and other similar water and sea bottom pollution and the erosion of coast lines are now witnessed everyday and give us no small concern.

It is our urgent call to develop correct understanding of the varied processes that are taking place in the ocean and that are changing all the time, and devise effective methods to predict and control natural and man-made hazards as mentioned above.

IV. Oceanographic research and technology development

People have been studying the ocean out of pure scientific interest or as something closely related to utilization of its resources. To these conventional ideas on the study of the ocean we must now add a new purpose: To take part in mankind's effort to preserve and improve the earth's environment, in which the ocean accounts very heavily, by developing our global-scale understanding of the varied processes of the ocean.

The ocean, indeed, is wide and deep. As you go deep in the sea, a world develops which is impervious to light and has an enormous water pressure. And we know very little about it, the main reason being that we have not had appropriate tools developed for its observation. Over the years, however, thanks to the recent progress in science and technology, such as satellites, deep-sea submersibles, and acoustics-applied technologies, we have come to know more and more about the ocean and now we have every reason to believe that we are on the threshold of a real breakthrough in all aspects of ocean science and technology.

My discussion today will touch on some aspects of technological developments we have had in deep sea research and ocean observation work with an outlook for the future.

TECHNOLOGY DEVELOPMENT TO SUPPORT OCEANOGRAPHIC RESEARCH AND DEVELOPMENT

I. Deep-sea technology

Eighty-four percent (84%) of the ocean has depths over 2,000 meters, with the average ocean depth worldwide being 3,729 meters. The world's deepest point is found somewhere in the Mariana Trench of the Western Pacific near Guam Island that has a depth of 10,920 meters. Unlike on land where sediments tend to be washed away by rain or wind, the sediments on the sea bottom are preserved over ages and provide records of the history of the environment changes that the Earth experienced through geological times. The ocean bottom has active earthquake and volcanic activities generated in connection with oceanic plate movements. I have already mentioned that deep-sea also provides a huge storage of gases like carbon dioxide reportedly a major cause of global warming. It has also become known recently that carbon dioxide and methane is liquefied under high pressures and stored in great quantities beneath the ocean floor.

Deep sea also provides home to exotic microorganisms and other life giving ample hopes for a new science of deep sea biotechnology centering on these organisms.

As mentioned above, exploration of deep sea is indispensable to understanding the origin and distribution of many resources there and to promoting science to predict global environment changes and earthquakes that are to come. For this purpose, we need to have more manned submersibles, and unmanned explorers, or ROVS, as tools for deep-sea observation, sample collection and analysis, and for long-term environment change monitoring.

Manned research submersibles

JAMSTEC completed a 2,000m class manned submersible Shinkai 2000 in 1981, and a 6,500 meter depth manned submersible Shinkai 6500 in 1989. Shinkai 2000 have made 725 dives to date, and Shinkai 6500, 196 dives, The reason, by the way, for setting the maximum depth at 6500 meters was that the capability of this depth makes it possible to cover as much as 98% of the area of the world oceans. Using Shinkai 2000, a colony of "calyptogena" giant white clam was discovered in 1985 for the first time in the Japanese coastal waters off Hatsushima Island, Shizuoka Prefecture. Calyptogena is a special bivalve found only at deep sea bottom where there is water seepage due to active crust movement nearby, making this deep sea clam an interesting object of study for both biologists and those studying earth's crustal movements.

On a Shinkai 6500 dive made in 1991, a fresh crack believed to have resulted from an earthquake was found off north-eastern coast of Japans on the oceanic side of the Japan Trench, providing another proof, it is believed, of subduction of the Pacific Plate according to the plate tectonics theory.

Unmanned explorers

There are two kinds of unmanned explorers, the tethered type and the untethered type. Both are controlled by the operating staff aboard the mother boat stationed on the sea above, and their TV cameras send images of the sea bottom on to the screen on the mother boat and the remotely-operated manipulators collect samples from the sea floor. Tethered explorers vary in size, from small to large, depending on what uses they are put to. Three representative tethered explorers in Japan are DOLPHIN 3K, KAIKO, and MARCAS 2500. DOLPHIN 3K built in 1987, is a 3,000 meter class explorer owned by JAMSTEC. KAIKO, under development by JAMSTEC, is a 10,000 meter class, or the world's greatest depth capability, expected for completion in 1995. MARCAS 2500 is a 2,500 meter class explorer built in 1987 and owned by KDD (Japan's International Telephone and Telegraph Corporation).

Untethered deep-sea explorers are still under development and none has been placed to regular use. But there is a definite need for developing such untethered, unmanned explorers, in other words, "deep sea robots" that will make it possible to conduct continued long-term observation of deep sea bottoms without the help from the mother boat. This requires integration of electronics and other modem cutting-edge technologies of today.

Deep-sea long-term monitoring stations

Under development at moment are underwater long-term monitoring stations for deployment at selected positions on the sea floor that are capable of taking measurements on various ocean and sea-floor processes and transmitting, real-time or near real-time, the data to land. A small such station, developed recently by JAMSTEC, is currently at work on a relatively shallow sea floor known as a nest of earthquake swarms.

Data transmission would be greatly facilitated when submarine cables laid for international telecommunications use are connected with these stations.

The "Deep-sea microorganism experiment system"

This system, completed by JAMSTEC in 1993, is currently the world's only system available of its kind enabling separation, culture, and research on land of live deep-sea microorganisms while preserving the same deep-sea pressure and temperature in which the sample was taken.

II. Ocean observation technology

To correctly understand the role of the ocean in global environment change, we need to develop technologies capable of global-scale ocean observations. We also need to take an approach in which ocean processes are studied comprehensively and under international collaboration. Urgently called for, in particular, is the development of technologies that make wide-area, 3-dimensional, and real-time observations of the ocean possible.

Ocean observation vessels

It goes without saying that we need a number of state-of-the-art research vessels for effective ocean studies. In this connection, we strongly feel that we need a large-size modern research vessel capable of observation and buoy deployment and recovery under harsh weather conditions, or of long-duration cruises with a wide range of modern equipment on board. JAMSTEC has plans to convert the former Japanese unclear-powered vessel, Mutsu, into a new large ocean research vessel for studying ocean thermal and material fluxes, changing ecosystems and ocean plate dynamics, and others. The vessel's completion is expected in 1997.

There is also a need to develop vessels for science areas which have not been covered well, such as ice-breaker research vessels capable of detailed observation of polar seas, and submarines for shallow and mid-depth underwater observation.

Ocean observation buoy

Ocean buoys that continue to give us data on fixed positions at sea on a long term basis play an important role in understanding changes in ocean parameters. A number of buoys are currently deployed in tropical seas for TOGA Program led by the United States, and Japan is an active participant in the program taking care of part of these buoys. Japan Meteorological Agency, meanwhile, has a number of buoys deployed around the seas of Japan for purposes of weather forecasting. There must be much more buoys to be deployed in the future not only in the low-latitude Tropical Pacific, but also in high-latitude Pacific and other oceans, such as Eastern Pacific and Indian Oceans, to help obtain environment change data in the world oceans. In this connection, the development of buoys fit for use in high-latitude, coarse or frigid weather seas is also an urgent call upon us.

For observation of ice-seas, JAMSTEC has been engaged in a cooperative project with Woods Hole Oceanographic Institution of the United States that involves use of "Ice-Ocean Environmental Buoys" (IOEB's) presently installed on chunks of ice drifting in the Arctic Ocean.

Satellite remote sensing

Satellite remote sensing offers a new and very effective means of observation of the ocean because the technology makes real-time, and otherwise impossible huge sea-area observation possible, although observation is limited to the sea surface, and not for the ocean interior. Such items as sea surface temperature, water color, surface wind, surface elevation can be observed by satellites using sensors. We need to develop programs that will make effective use of this new technology.

The Marine Observation Satellite-I (MOS-1) was orbited in 1987 as Japan's first earth observing satellite, followed by JERS-1 (Japan Earth Resources Satellite) orbited in 1992, the year dubbed the International Space Year (ISY). The radar equipment mounted on JERS-1 is capable of conducting observation regardless of weather conditions, giving a great promise to ice sea observation in the polar region normally harassed by bad weather.

Japan plans to orbit the Advanced Earth Observing Satellite (ADEOS) in 1996, and the Tropical Rainfall Measuring Mission (TRMM) in 1997. Both satellites will be equipped with high-resolution sensors for water color, temperature, and rainfall on the sea, and expectations are high among scientists not only in Japan but also the world over.

Ocean acoustic tomography

This technology, currently under development, uses a low-frequency sound wave that travels underwater a long distance across the ocean to enable us to obtain 3-dimensional and near real-time measurements of water temperature and density structure covering a wide sea area, much as a CT scan in medicine does for us.

JAMSTEC is presently engaged in the development of a system capable of gauging a sea area of 1,000 km by 1,000 km using a 200 Hz sound wave for source.

Ocean observation laser

Ocean observation laser is a technology under development as an effective means to gauge wide-area distribution in the sea of phytoplankton in horizontal and vertical directions, and phytoplankton provide important index to material fluxes in the ocean.

JAMSTEC has been engaged in R&D of this technology and recently succeeded in developing a system of the vessel-mounted type, its effectiveness having been demonstrated in experiments conducted in the Tropical Pacific and the East China Sea where phytoplankton distribution was measured while running a ship mounting this laser system.

Other equipment for ocean observation

Automation has fairly well advanced now with observation of such conventional items as water temperature, salinity, and current direction and velocity. Automation has yet to be seen, however, in areas such as analysis of dissolved carbon dioxide and trace elements, or quality and volume analysis of phytoplanktons and zooplanktons, waiting for enhanced research and development effort in these fields. Observation equipment, meanwhile, needs to be subjected to a unified method of calibration so that the data obtained by different types of gauges can be compared with each other. Systems, facilities, and equipment to satisfy this need to realize uniform calibration must also be developed.

III. Ocean development and utilization technology

A wide range of new technologies, both basic and applied, are being developed by different institutes and organizations for development and utilization of coastal seas, ocean space, and ocean energy and resources. Today, I will touch on those whose development is under way at JAMSTEC:

"Mighty Whale"

A multi-purpose experimental wave-energy generation and aeration system called "Mighty Whale" is a floating device placed at the entrance of a bay where the device, while generating energy utilizing wave power, helps calm the water in the bay interior creating an environment suitable for fish farming. The compressed air may be converted to electric power through a turbine or used for aeration for cleansing effect where the air is forced to reach the sea bottom that is polluted because of fish farming.

Technology for underwater work carried on by divers

Sea areas with depths no more than that of the continental shelf have a high productivity where underwater work by divers becomes necessary for exploration and production of resources there. Under study is the application use of deep-sea diving technology which has been developed for off-shore petroleum production to resource development in those shallower seas.

JAMSTEC has also established a saturation diving technology for depths up to 300 meters. Our current research involves utilization of this technology to establish a saturation diving technology in seas of lesser depths to support studies of coastal ecology.

IV. Other technology

Underwater acoustic telecommunications

Modern equipment such as multi-narrow beams, side scanners, etc., to study ocean floor topography, geology, and earth's crust structure, and equipment for underwater telecommunications, image transmissions, and for ocean acoustic tomography - all work on the principle of sound. Technology development for higher capability gauging and for better quality telecommunications must continue for years to come.

Underwater power source

Finding an appropriate power source poses the greatest barrier to long-term and continuos observation under the sea. Fuel cell and Stirling engine offer hopes for overcoming this difficulty. The need to push this phase of study is obvious.

Simulation study of ocean environments

Estimates of ocean processes impacting on the earth's environment or those of man-made coastal structures affecting the coastal environments must depend on simulation models developed for mathematical calculation of those processes or simulation technology developed for simulation experiments, and this is a new area of study becoming increasingly important in the future.

Analysis, processing, collection, and utilization of oceanic data

Gaining correct understanding of ocean processes on a world-wide scale requires the development of common methods and systems for analyzing and processing the data obtained by different agencies and researchers. The development of data processing systems for wide dissemination and easy use by au is also important.

Ocean environment preservation

Technology development is urgently needed for preventing sea water pollution caused by wastes flowing into the sea from land, and spills of petroleum and heavy metals in the sea. New technologies are also sought for purification of polluted seas and restoration of the ocean's ability to rejuvenate itself.

CONCLUSION

Thirty (30) years ago, the late John F. Kennedy said: "The space and the oceans are the last frontiers left for us on earth." NASA has lately been pushing its earth observing program under a slogan: "Mission To Planet Earth".

Sally Ride, the first American woman astronaut who coined this NASA slogan, said: "We have undertaken highly sophisticated planetary studies by sending spacecraft around Mars and Venus; yet we have not used the same techniques to improve our understanding of our own planet which we desperately need." And the oceans indeed represent as much as 70% of the planet's surface, as I referred to earlier.

We are concerned that the oceans, once thought to have infinite purification power, are becoming increasingly polluted, and the fisheries resources, once believed to be inexhaustible, are coming close to extinction in a number of species. We at the same time have come to know that the ocean contains resources and life which are truly divergent beyond our imagination. It is our responsibility that we preserve this irreplaceable environment as the legacy to our offspring. Modern oceanographic research and development seeks a new state of coexistence between man and the ocean that would lead to the creation of a new way of life and a new form of culture for us human beings.

AUSTRALIA'S MARINE INDUSTRY: REFLECTIONS ON EMERGING POLICY

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We are all here at the 6th PACON because we share a desire to exchange knowledge and information on the latest developments in ocean sciences and technologies. Our knowledge about the oceans is changing quite quickly as a consequence of the advances in marine sciences and technologies, some of which will be reported upon at this Conference. Despite such advances the oceans remain vast frontiers with all the challenges and opportunities to human beings that frontiers tend to provide.

As participants at PACON 6 we are, if you like, frontiers-men and women with a shared vision. Our collective belief is that the world's oceans will play an ever increasing role in the destiny of all maritime nations. We see marine science and technology as central to this future.

PACON plays a particularly important role in facilitating exchange of knowledge and information amongst scientists and engineers around this vision. It will also play an enormously important role in raising consciousness among the general community, and perhaps even the policy makers, who, regrettably, still need to grasp fully the significance of the developments now taking place in marine science and technologies and their significance for marine industries. Maybe through important gatherings such as PACON the world's policy makers may eventually come to share our vision.

Indeed, PACON's charter recognises the important link between marine sciences and engineering and policy development. This important message is slow to get through. We must do more to make them aware of the connection between future human progress and development and the role of oceans and marine-based science and industry in the future.

In the time available to me this morning I want to reflect briefly on the implications of my experience as a reviewer of Australia's marine science and technology some years ago, with a further look in 1993 at its organisational base. There isn't enough time for me to go into marine science and technology matters in detail so I will confine the thrust of my comments to the way in which policy is emerging on the Australian scene, or, to be more precise, the way in which it is not emerging, in short, to disappointment about lack of policy development.

Those of us who have had any association with Australia's marine science effort and, indeed, some in government, firmly believe that Australia should be leading the world in innovative thinking about oceans policy. After all, our coastline is some 37,000 kilometres long, our Exclusive Economic Zone when it is formally declared later this year will be the third largest in the world - some 11 million square kilometres.

We are in close proximity to a rapidly developing and dynamic region to our north. All of these Asian countries depend upon the sea for foodstuffs, for trade and longer term economic prosperity. Many are investing heavily in offshore resource developments, particularly in oil and gas. The growing importance of the sea to regional nations is reflected in their expanded merchant shipping fleets, the emphasis on maritime capabilities in the development of their military forces, and the attention now paid to claims on offshore territories, particularly in the South China Sea. Maritime issues are likely to assume even greater importance in the future as economic growth proceeds and countries become more interdependent and more conscious of both the importance of maritime resources and the need for effective management of the maritime areas they share with their neighbours-

The maritime environment is a particularly fertile field for both cooperation and competition. Countries can rarely take a truly independent national view of the problems that can arise from their uses of the sea. They have to talk about and agree on issues such as the principles for the law of the sea, the prevention of marine pollution, the conservation of fish stocks, the safety and security of shipping, the delimitation of maritime boundaries, the monitoring of sea levels and the responsible development of the mineral resources which may lie on or under the seabed.

Australia has a range of marine industries producing goods and services which have considerable potential for development for export. The companies involved in these industries range from large multi-national conglomerates to small firms with specialist expertise and a few staff. A comparison of the growth of the marine industry in Australia in the five years 1987/1988 to 1992/93 (Table 1) shows the vitality of Australian marine industries and the way in which those industries have grown in presence in export markets over that period.

Table 1. Output Value of some Australian Marine Industries 1987/88 and 1992/93 (in current dollars)

INDUSTRY		***Value* $m**			***Exports* $m**	
	87/88	**92/93**	**% increase**	**87/88**	**92/93**	**% increase**
Fishing[a]	828	1,374	66	621[j]	1,085	75
Aquaculture	105[b]	258[ck]	146	116[i]	159	37
Offshore Oil & Gas[d]	4,971	6,979[P]	40	1,460	3,258	123
Marine Tourism[e]						
• foreign visitors	600	1,463[k]	144	600	1,463	144
• domestic	4,100		7,360[k]	80	-	-
Civil Shipbuilding[f]	132	237	80	12	195	1525
Naval Shipbuilding[g]	434	1,233	184	-	-	-
Boat building[f]	278	2941	6	78	258	231
Shipping: Coastal[h]	505	647	28	-	-	-
Shipping: International[h]	832	1,158[k]	39	-	-	-

Sources and notes

a Oceans of Wealth? and Australian Bureau of Agricultural and Resource Economics (ABARE); figures include aquaculture production.
b Oceans of Wealth?.
c Dos O'Sullivan (National Key Centre for Teaching and Research in Aquaculture.
d Australian Bureau of Agricultural and Resource Economics; value is based on export prices; exports include refined products.
e Bureau of Tourism Research; proportion of total tourism attributed to marine is as calculated using factors in Oceans of Wealth?: 19% of foreign total and 40% of domestic total.
f Ships are vessels of over 50 tonnes displacement; civil shipbuilding data are from Oceans of Wealth? (87/88), and Shipbuilding Bounty completions (92/93).
g Department of Defence.
h Estimates by International Business Information Services for the Australian component of the industry only; for coastal shipping, the industry is essentially 100% Australian; for international shipping, Australian shipping firms control only 6.6% and 3% respectively of inward and outward business.
i ReviewEstimate for 1989/90, based on ABARE data
j 1986/87
k 199V92
l estimated for 1992/93
p preliminary
\- not applicable

Australia's marine science and technology capability is quite substantial. In 1991/92 overall spending from all public sources was $211 million with 1400 equivalent full time staff conducting marine research. This represents about 7% of Australia's $3 billion worth of publicly funded R&D in 1991 and 1992. As far as can be ascertained, the growth over the last five years in this effort has been of the order of 30% real, although the figures are somewhat distorted by the fact that new vessels have been purchased for fisheries in the Antarctic program.

Table 2 shows the sources and recipients of funds for marine research in 1991/92.

Table 2. Sources and Recipients of Funding for Marine Research, 1991/92 ($ millions)

	RECIPIENTS			
SOURCE	***Commonwealth***	***State***	***University***	***Other***
Direct Appropriations (C'wealth & State)	109.70	34.65	5.57	0.04
Commonwealth Competitive Grants	16.25	4.92	3.57	0.18
State/Territory Competitive Grants	0.56	2.46	0.16	0.38
Other Government Grants	4.01	7.78	2.91	1.43
Industry Levies	0	5.31	0.55	1.50
Private Funds	3.47	1.39	1.74	0.80
Totals	**133.99**	**56.51**	**14.50**	**4.33**

Source: HOMA (1993) (with adjusted totals)

Admirable as these figures are, it has to be said that to date policy making for marine and ocean affairs in Australia, as in other nations, has been characterised by sectoral approaches, that is, administration of separate and individual functional responsibilities by specialised marine related agencies, without formal coordination or reference within and between them.

Typically, individual agencies carry out their responsibilities with effectiveness and efficiency, but do not relish others trespassing in their territory. "Repel all boarders", the cry carried over from pirate days, has modern applicability. The losers are those, including states and the nation, who need coordinated advice and action.

Currently, responsibilities for marine and ocean affairs are divided among several Federal Ministries. Similarly, at State Government level, responsibilities are divided among ministries. States take special responsibility for coastal waters and the coastal zone. In both of the reviews that I was involved in, it was clear that individual agencies carry out their responsibilities reasonably well, certainly professionally, but there was little coordination of effort between the two levels of government or within each of the State and Federal levels of government. Moreover, cooperation between scientific and government agencies, while improving, partly as a consequence of new funding mechanisms and partly as a function of the high level skills of the individuals involved, is still at too low a level to yield results which always solve the problems.

The evidence presented to the reviews pointed inexorably to the strong need for a more comprehensive approach, a national approach, to the management of Australian oceans.

The time has come for the development of an "Oceans Policy".

Obviously, the apparent administrative complexities of formulation or administration of a national oceans policy have discouraged policy makers from sufficient examination of the potential benefits. Afterall, it is well known that in the Federal Government any expression of interest in another department's sphere of interest stirs up a hornet's nest and aggressive, defensive behaviour. In these times of budgetary restraint, protection of an agency's policy patch has been easier than usual because the focus has been on restraint of cost, so new initiatives or better coordination could always be rejected on the grounds, real or spurious, of additional costs.

Comprehensive approaches to policy on ocean affairs (an Oceans Policy) need not impose excessive financial burdens on Australia or the governments of any maritime nations. Quite the contrary, for there are substantial administrative costs associated with fragmented and sectoral approaches to oceans policy. In economic terms fragmentation involves opportunity costs which in part, at least, would be overcome by a national policy. Strengthened coordination of the myriad government bodies typically involved in oceans management would bring about considerable efficiencies, real savings.

A national oceans policy must be fundamentally a statement of a national vision, and of associated goals and strategies. The approach suggested by some, that of ratification of international treaties and conventions, would not I suggest, be enough to guarantee that maritime nations could achieve best uses of their ocean territories.

I have time only to give three examples of the savings and benefits which could be the outcome of a national oceans policy.

The first concerns efficiencies attendant upon there being national long term data sets relating to tides, waves, storm surges and other physical parameters. The absence of such coordinated information leads to unnecessary costs, because coastal engineering installations have to be over-engineered against the possibility of the I in 100 years unexpected ocean event.

The consequences can be shown in another way. Last year Woodside Petroleum reported that it had to spend $80 million in six weeks because sediment movement had left its pipeline hanging over a huge hole in the ocean bed, a situation which might have been planned for, or averted, if there had been better knowledge of the seabed characteristics. The problem was averted by quick action but the potential cost of this lack of adequate data could have been even higher if the pipeline had actually broken.

On the same point, evidence is accumulating that tidal data accumulated in the Southern Oceans is extremely important and has linkages to the El Nino effect. Professor Lemon of Flinders University believes the data can be used to give an indication of the likely occurrence of such events a year ahead of any other data. The droughts or flooding rains attendant upon the presence or absence of El Nino, are obviously of huge economic importance to Australia.

The second example is drawn from the evidence brought to the attention of the most recent review, of the increasing difficulty of coastal zone management, except for isolated examples. It is true that in the management of the Great Barrier Reef, there is successful utilisation of the information provided by marine science and technology. Indeed, a recent Cooperative Research Centre for the Ecologically Sustainable Development of the Great Barrier Reef, has linked not only the Great Barrier Reef Marine Park Authority, the Australian Institute of Marine Science and James Cook University, but also the tourism operators, to ensure that the ecology of the area is sustained while providing adequately for visitors to this natural wonder. But this example is an exception rather than the rule.

Elsewhere in Australia, urban authorities are less sanguine about the prospects for good management of their adjacent marine ecosystems. They speak of the extreme difficulty of coordinating State and Federal agencies and the science agencies, freely admitting the deficiencies in their management plans.

The third example arises in civil shipbuilding. Australia is a world leader in innovative shipbuilding. The industry concentrates on high speed, highly fuel efficient aluminium ferries and large luxury motor yachts. It has been a highly successful export industry. For example, Australian builders provided one-third of the world market for fast ferries in 1992. That success is attributed to a number of technologies, notably innovative design and highly efficient fabrication aided by numerical cutting and other manufacturing technologies which are not specifically marine.

But greater cooperation and accelerated adoption of innovation in design and manufacturing will be essential to retain this competitive edge and may well require coordinated government encouragement and assistance. This could include state-of-the-art national facilities for understanding and testing the hydrodynamics of craft, use of advanced materials, new construction technologies and efforts to encourage greater interest in naval architecture.

There are numerous other examples one could adduce to show how the lack of cooperation and effective policies linking scientific knowledge with industry management has decimated particular wild fisheries or, conversely, failed to develop quickly a national aquaculture industry. In the case of the latter, efforts are being made to bridge the gap through a draft national aquaculture strategy, but the needs are substantial. For instance, as far as can be ascertained, Australia imports virtually all of the food used in aquaculture (fishmeal pellets mainly from Thailand).

In the esoteric areas of marine biotechnology where CSIRO is working on genetic engineering of prawns or pharmaceuticals where AIMS has recently succeeded in attracting significant private funding, individual efforts are being made, but without the advantage of common understandings and cooperative efforts to get the best results from the available resources.

What I have been saying is not to deny that in the individual Federal and State agencies there are some excellent scientists and public servants, skilled and professional, who work consistently in the national interest and cooperate well. I have been impressed with the effectiveness of those who work in the Commonwealth Department of Industry, Science and Technology, for instance, despite the meagre resources available to them, or of those facilitating aquaculture in Queensland, or of those concerned with protecting wild fisheries in New South Wales or of those who have built up the rock lobster industry in Western Australia. Notwithstanding these lighthouse efforts, the national policy picture is much less rosy than we would like.

Australia does have problems in the marine environment. The state of some of our wild fisheries is of growing concern. We are not immune to marine pollution problems such as oil spills, ballast water contamination and eutrophication. Despite the fact that our coastline is vast and our population sparse, there is evidence, especially on the eastern seaboard, of increasing signs of stress caused by human impact. We can also expect in the not too distant future, that use conflicts will be increasingly evident in offshore regions.

In summary, what I have been saying is that Australia, despite its strong marine scientific and marine industrial capabilities, lacks the political will to take a proactive and comprehensive approach to oceans policy. We have no shortage of urgent marine problems to tackle. We have competent professionals.. We are simply finding it too hard to overcome the political paralysis surrounding effective national policy making in relation to oceans.

Some of you may know that the Australian Government, following the most recent review in which I was involved, announced the formation of an Australian Marine Industries and Sciences Council (AMISC). It did not at the same time announce any budget allocation, so you can imagine how minimal the potency of such a body will be. It will have to beg for even the necessary travel funds for meetings from other parts of the Department of Industry, Science and Technology. It will not be able to take any initiatives whatsoever. There is no evidence that it will have a secretariat.

In any case, some months after the announcement that there would be such a Council, the Government has not done anything about establishing it. It cannot be a high priority on the Government's agenda if it doesn't get the attention of a Minister sufficient even to establish the membership of the Council.

The establishment of such a Council with adequate resourcing and servicing would have provided the Federal Government with a means by which it could develop a far sighted framework and strategy for the long term management of its oceans. Regrettably, this seems not to be the agenda. As far as I can ascertain, the proposed Council is to be confined to addressing the more limited task of developing a marine industries development strategy. Undeniably, such a strategy will serve a useful purpose; I believe it would be one of the key components of a national oceans policy. But alone it is not enough. A better response from government is needed.

Two Science Ministers have come and gone, both enthusiastic to take up the challenge provided by our oceans and the increased sovereignty which will come with the proclamation of an Exclusive Economic Zone. They were aware of the world concern that would be attendant upon neglect of the development of such a policy, quite apart from the consequences in the long term for Australia's living standards. But they were not successful.

Ladies and Gentlemen, a national oceans policy, as I said at the outset, is an idea for which the time has come. Canada at least has such a policy. Other national governments with ocean responsibilities need to put in place well developed national policies as a matter of urgency. The time is right for governments, including the Australian government, to be truly forward looking and put policy in place before the problems of the oceans become intractable, before missed opportunities become serious costs to national economies.

I hope you will play your part in building up a healthy debate on the future of the world's oceans, and the elements of the policies which would need to be put in place to ensure the wise use and protection of our common heritage, the oceans.