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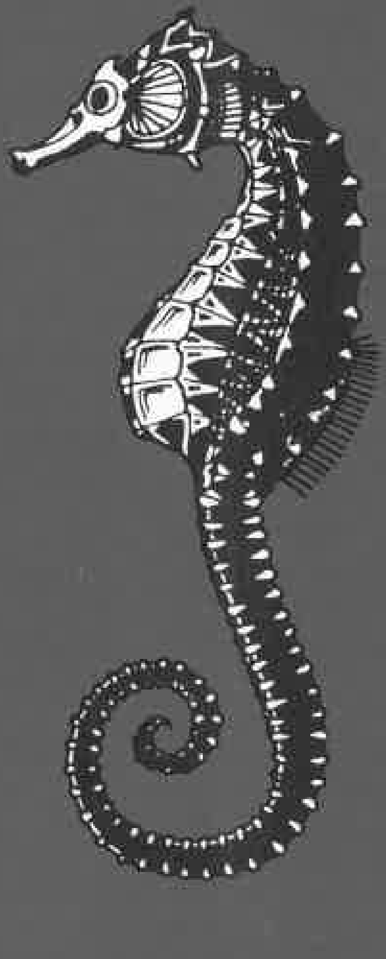
AUSTRALIAN MARINE SCIENCE BULLETIN



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EDITORIAL

More than 500 copies of the fiftieth issue of the Bulletin were distributed recently and now may be an appropriate time to consider whether the Bulletin is achieving what members expect of it.

Looking at twelve copies of the Bulletin published during the last fourteen years, I find that most are taken up with abstracts of papers and papers delivered at AMSA's Annual Conference and Minutes of Council Meetings. What else do members wish to find in the Bulletin? The twelve issues give little indication of members' opinions of the Bulletin's content and, in fact, little indication of members' opinions of the situation in Australian marine science. Is one to understand that members are perfectly satisfied with the Bulletin, with AMSA and with the situation in Australian marine science? How do members know who is doing what in marine science and where and why — the bush telegraph? But what of others, especially overseas members and non-members? Where are they going to find marine science issues discussed objectively and clearly? This is a part of the marine scientist's responsibility, but scientists are notoriously poor communicators. Unfortunately AMSA's members appear to be no exception.

AUSTRALIAN GOVERNMENT POLICY IN MARINE SCIENCE

by D. J. G. GRIFFIN

The Australian Museum, Sydney, N.S.W. 2000

On 17 January 1975 the Australian Government's Minister for Science, Mr W. L. Morrison, released a White Paper entitled 'Science and Technology in the Service of Society—The Framework for Australian Government Planning'.

A statutory body, the Australian Science and Technology Council (ASTEC), will advise the Government on the role of science and technology in the formulation and realisation of national objectives. The Minister announced the names of 11 of the 12 members of ASTEC on 18 May; the Chairman will be Dr J. A. L. Matheson, currently Vice-Chancellor of Monash University. Among the members are Professors G. J. V. Nossal (Walter and Eliza Hall Institute), R. O. Slatyer (Research School of Biological Sciences, A.N.U.) and R. Street (Chairman of the Australian Grants Committee). It is understood that one of ASTEC's earliest tasks will be to consider marine science policy in Australia. ASTEC will report to a Ministerial Committee. A Parliamentary Science and Technology Forum comprising members of both Government and Opposition parties and experts from the community will be established. This Forum will provide a means of informal discussion on issues of concern to the Parliament. Among the terms of reference of the Council will be the socio-economic implications of scientific and technological development, determination of priorities for research development and manpower policies (details of the proposal were included in the January Bulletin). In announcing details of the plan Mr Morrison stressed the importance of the potential contribution of science to the community. 'For too long, decisions on science policy have been taken behind closed doors. ASTEC will listen to the voices of the scientific community and the public, and will report back to them through reports to Parliament', he said.

The White Paper follows the extensive review of science in Australia carried out by the Organisation for Economic Co-operation and Development (OECD). The OECD Examiners published their report in August 1974 and their review was completed in Paris in October 1974. They defined science policy as 'a deliberate and coherent basis for National decisions influencing the investment, institutional structures, creativity and utilisation of scientific research'. There are two aspects to policy—the broad management of the national science system and the application of science to other elements of national policy.

The establishment of an overviewing body which would draw up policy guidelines for science in Australia has been sought by many scientists for a number of years. No doubt many see the establishment of such a Council, and of a policy, as leading to ways in which society might support science for its own sake. The Government, however, takes the alternative view: science policy means science assisting in the formulation of policies in the furtherance of society's ambitions—whatever these might be. These, perhaps opposing, alternatives have recently been discussed by Sir Hugh Ennor, Secretary, Department of Science. Ennor noted that the strong and almost unqualified support for science which characterised the 1950s and lasted through to the late 1960s has now weakened. During the last decade there had developed a wide feeling (says Ennor) that while science, pure and applied, and technology should be supported, some part, at least, of the scientific and technological effort should be orientated towards the needs of society. The United States has achieved a marked restructuring of its scientific effort during the past three or four years, the most obvious manifestation of which has been substantial reduction of the funds available to various agencies. Whether this reduction in funds might be causally related in some way to the disbanding of the President's Science Advisory Council and whether maintenance of such a body would have led to a less drastic reduction in spending are matters which those interested in the further development of science policy in Australian might consider.

The latest available figures for overall expenditure on science and technology in Australia refer to the 1968-69 year. (The Department of Science is likely to release more up-to-date figures for the year 1973-74 by the end of 1975.) These figures show that gross expenditure on research and development (GERD) in Australia was 1.1% of the gross national product (GNP). Countries with higher proportions of expenditure in this area include Canada, France, Germany (FRG), Japan, Netherlands, Sweden, United Kingdom and the U.S.A. In 1968-69, 1.35 million dollars was spent on oceanography. There would undoubtedly be many who would consider this far too low a figure for Australia.

The Report of the Interim Council of the Australian Institute of Marine Science (the Day Report) made strong recommendations for a much greater degree of support for marine science in Australia, and to this end recommended the establishment of a Council having responsibility for Australian marine science as a whole. Interestingly, the OECD Examiners' report makes the same kind of comments as did the Day Committee. They state, 'the practical possibilities of Australia's marine resources have not been fully explored . . . The need for a considerable increase in Australian research and development facilities in the basic and applied marine science is great . . . There seems to be a need for a fundamental review of fishery potential, marine biology and related fields, and considerable increase in effort'.

To date the Australian Government has not made substantial moves in accordance with the Day Report's recommendations. The point has been made that various initiatives, such as the inclusion within the funds available to ARGC of a special amount for stimulating research in marine science, have not had the expected results. In this respect again, the comments by the OECD Examiners are of special interest. They state that the ARGC, by special care and concentrated financing, could contribute decisively to the development of those fields of science which need the most support. Research in marine science remains fragmented and uncoordinated.

The Australian Government has, in the last few years, established the Council of the Australian Institute of Marine Science and the Institute itself at a site near Townsville and inaugurated the Queen's Fellowships in marine science. Increased support for the CSIRO Division of Fisheries and Oceanography, including, in particular, the implementation of plans to construct a modern oceanographic vessel for that Division's use, has been welcomed by many marine scientists.

The way in which the various disciplines will be dealt with as part of that Committee's operations have yet to be announced. The Association has made representations to the Minister for Science suggesting that it is still appropriate that a Committee be set up to overview marine science; possibly this Committee might report to ASTEC. Whether clarification of the Government's policy on science will carry with it the benefits seen as desirable by the Day Report and the OECD Examiners is a matter that remains to be seen. It will also be important to see whether ASTEC stimulates the development of science or whether it controls and directs research effort (an approach not widely favoured). Certainly, marine scientists in Australia will look forward with interest to further developments.

MARINE POLLUTION AND APPLIED MATHEMATICS

by J. NOYE

Applied Mathematics Dept, University of Adelaide

It is no understatement to say that we are facing the destruction of life in the oceans by the action of man, by his pollution of the marine environment and his overexploitation of marine resources—animal, vegetable and mineral. Until recently man treated the world's oceans as an infinite source of food and an infinite sink for his wastes. Only lately has he become aware that the seas are finite after all. In addition to the waste materials he pours directly into the seas, man pollutes the world's oceans indirectly because he also pollutes the world's atmosphere, its land and its rivers. The oceans are the final recipient of most atmospheric deposits and riverflows—it is 'the Ultimate Dustbin' for all human and industrial waste.

If too much of the wrong sort of materials is poured into the oceans the constancy of the marine environment, to which marine life has adapted itself over millions of years, is upset. One might not expect the occasional release of, say, soluble lead salts into the seas to have much effect, there is so much in the seas in their natural state. Yet it is now known that the cumulative effect of man's releases in the last century has nearly trebled the amount of lead in the world's oceans. The marine environment is geared to relaxed cycles of thousands of years, not to the frantic pace of present industrial expansion. Chemical compounds which are bio-degraded in a matter of years in rivers and lakes can survive for thousands of years in oxygen-depleted oceanic deeps. Marine organisms, accustomed to a very stable environment, are not readily adaptable to rapid change, being especially vulnerable because of their porosity which allows them to absorb pollutants through their surface.

We are told: 'So what! What if all the fish die, the world's fish catch represents only a few per cent of the world's calorie intake. We can soon cultivate a few more acres of land to compensate for that loss!' In fact, however, fifty per cent of the world's population get half its protein from fish. When one considers the area of land which must be cultivated to replace the quantity of protein presently extracted from the seas it is clear that sea-fish are essential to human survival and can only become more so as human numbers increase. If Japan were forced to abandon fish as a source of protein, it would require double its present area of arable land to replace fish with land-produced animal protein.

Most people equate marine pollution with the oil pollution caused by tanker disasters. Oil pollution, although very widespread, as found by Thor Heyerdahl in his crossing of the Atlantic Ocean in the reed boats *Ra I* and *Ra II*, is only one aspect of marine pollution. Also, accidental spills from oil tankers represent less than ten per cent of the two million metric tons of oil that man introduces directly into the world's ocean each year from refineries, blowouts at offshore oil wells, disposal of industrial oils, and so on. In addition, man introduces another ten million tons of oil indirectly to the sea via the rivers and the atmosphere. A survey carried out by the Massachusetts Institute of Technology in 1970 showed that spent crankcase oil in the United States was a greater source of ocean pollution than all direct forms of marine pollution.

Organic Wastes

It is somewhat surprising to learn that the first large scale introduction of pollutants into the marine environment occurred before the industrial revolution. It came with the agricultural revolution and the establishment of the first permanent settlements. As these settlements grew larger, less human and animal waste was returned to the land; this broke the natural cycle which maintained soil fertility and friability. Instead, the people living in these early settlements began to pipe off their wastes to the nearest body of water. While the quantities of waste remained low this did little damage to aquatic life; in the beginning it may even have helped to increase the number of fish available for food in bays and estuaries, as the fertility of the wastes would have nourished the water plants which are the basis of fish life.

It is probable that most early civilisations felt the impact of the loss of soil fertility long before their rivers, lakes and estuaries displayed any of the signs of ecological imbalance which result from over fertility. The Minoan, Rome, Greek and Aztec civilisations all experienced crippling famines when their crops failed because the soil had become infertile. The Chinese civilisation is one of the few based on the careful conservation of soil fertility; for two thousand years it has returned its animal and vegetable wastes to the land.

Modern man has exaggerated the tendencies of earlier civilisations by concentrating his industries in expanding cities and by increasing the amount of fertility he removes from the soil. Instead of converting human waste into suitable fertiliser and returning this to the land, we take the extraordinary measure of using enormous quantities of our rapidly diminishing energy and material resources to artificially produce inorganic fertilisers to replace lost fertility. The annual consumption of inorganic nitrogen fertilisers in the United States has increased fourteen-fold in the past twenty-five years, while agricultural crop production has not even doubled in the same time. To add to our marine problems, as much as half the inorganic nitrogen fertiliser applied to the land never reaches the plants; it is washed out into neighbouring bodies of water and then to the sea. Today we find many natural waterways, which were strong flowing streams a decade ago, choked with the resulting prolific growth of waterweed.

The world-wide process of urbanisation has increased the quantity and concentrations of organic wastes introduced by man into rivers and streams, and ultimately into the world's oceans into which they flow. Sophisticated sewage treatment plants have added to, rather than subtracted from, the problem.

Everyone is aware of the dangers of running sewage straight into a waterway without any prior treatment. Yet this occurs in Corio Bay, on which Geelong is situated. Surplus sewage from the Melbourne and Metropolitan Board of Works farm at Werribee, the biggest sewage farm in the world, is poured into lakes which drain into the Bay. In an attempt to understand the nature of the problem in this Bay, a mathematical model of the movements of these waters is being prepared by Dr Easton of the Caulfield Institute of Technology. Also, at the University of Adelaide, Brenton Webber and I are using the latest techniques I learnt while at the Institute of Oceanographic Sciences in the U.K. in 1974 to develop a computer model of the water-circulation in the Port Phillip Bay-Bass Strait system so that the dispersion of pollutants in this area can be determined.

There has also been a vast increase in the output of organic wastes which eventually find their way into the seas from industrial processes associated with slaughterhouses, laundries, breweries, dairies, sugar refineries, fruit canneries and other food-processing plants. The pollution load from large food-processing factories is of the same order of magnitude as that of domestic sewage from small cities. For instance, one fruit cannery in Australia has a discharge equal to that of a community of 350,000 persons.

Both freshwater and seawater ecosystems cope naturally with organic wastes by decomposing them and breaking them down to inorganic materials with the aid of oxygen dissolved in the water. In a balanced system the removal of oxygen is compensated for by the oxygen produced by aquatic plants which in turn are fertilised by the products of decomposition. This cycle is broken if excessively large quantities of material ready for decomposition are introduced. Too much oxygen is removed from the water and the fish and other organisms which eat the plants die. Once these animals die in large numbers they merely add to the wastes and to the decomposition taking place. In such a way, it is possible that all aquatic or marine life can be eliminated from waters into which too much organic material has been deposited.

Few people realise that sewage treatment plants merely convert the organic materials in the sewage to a dilute solution of inorganic chemicals which, when released into the sea, can have a far greater impact than even the untreated organic wastes. They act as inorganic fertilisers and cause massive increases in the population and productivity of plant life which, because of a lack of dissolved carbon dioxide, chokes itself to death. The biological oxygen demand of such a large mass of dead plants is many times greater than that of the sewage if it had been discharged untreated.

The complete process from over-fertilisation to excessive decomposition is known as eutrophication and was first observed in lakes which had built up high concentrations of dissolved artificial fertilisers. The greatest shock came when it was found that most semi-enclosed seas with little circulation, such as the Baltic Sea, the Black Sea, and the Mediterranean, were all showing signs of de-oxygenation, a reduction in the diversity of species living there and eutrophication caused by waste disposals. For instance, the Baltic Sea is the ultimate recipient of gigantic discharges of all types of wastes from the six industrialised nations which line its shores. Evidence gathered during the 'Baltic Year' of 1969, during which this sea became one of the most studied in the world, shows that the wastes referred to above are of critical importance as they accentuate any natural processes of stagnation in such poorly circulated bodies of water. The entire deep-water area of the Baltic Sea is becoming a biological desert without any form of visible life, except the anaerobic bacteria responsible for decomposition.

Evidence is accumulating that less enclosed bodies of seawater are being similarly affected. The continental shelves of the more highly industrialised countries are showing symptoms of decay. The nursery grounds of many commercial species of fish are being destroyed and highly productive ecosystems, such as the kelp seaweed forests found on the continental shelves of much of the temperate zone, are being simplified or destroyed. It is also unfortunate that estuaries, the spawning ground of most of the fish we eat, are the first part of the sea affected by the highly polluted river waters.

Recent United Nations statistics indicate a world-wide process of rapid urbanisation concentrated in coastal zones with five per cent of the world's population already living in the world's ten largest cities, all but one being situated on the coast. These future coastal populations will have their health put at hazard if we have an unhealthy marine ecosystem. One can only imagine the acceleration in the quantity of decomposing dead matter on our beaches and in our shallow coastal waters if some sort of control is not established. Besides those permanently living on the coast, there are those who spend their holidays and other recreation time by the sea, using it for swimming, diving, fishing and sailing. Their health is also put at risk by a polluted ocean.

Most mathematical studies of marine pollution have been to model tidal and river flows to predict the movement of pollutants in estuaries and other coastal waters. A pollutant moves through an estuary by water transport (induced by river flow or tidal streams) and convection; it disperses by means of molecular diffusion and turbulent mixing. As it travels from its source to the mouth of the estuary it may be converted to other forms by chemical, biological, and physical processes. The totality of these processes must be thoroughly understood if the estuarine environment is to be managed soundly.

Many numerical models of varying degrees of refinement have been developed to describe the transport processes in rivers and estuaries. Also, many advances have been made in developing mathematical descriptions of the physical processes of dispersion in streams and coastal waters. The major area for progress lies in the development of mathematical descriptions of the various degradation processes. The chemical and biological complexity of these processes requires that research in this area be highly interdisciplinary, involving scientists from such fields as chemical oceanography, marine biology and ecology, as well as the applied mathematician.

For instance, the problem of predicting the extent of nitrification of ammonia contained in waste waters which are being run into estuaries is of considerable importance. Estuaries are a home for many coastal fish as well as a nursery for many offshore fish. Ammonia is toxic to fish but its oxidation to nitrites and nitrates, while lowering the ammonia content to a safe level, may consume a significant amount of the dissolved oxygen required by the fish. This process was originally assumed to be according to a simple first-order process at a rate proportional to the concentration of ammonia. However, recent research indicates that it also depends on the quantity of the nitrifying bacteria *Nitrosomonas* and *Nitrobacter* which are present. If the process is assumed to be independent of the growth of these bacteria, mathematical analysis shows that the concentration of dissolved oxygen decreases with increase in the degree of nitrification of the effluent; if bacterial kinetics are included in the model the minimum quantity of dissolved oxygen occurs when the effluent is half nitrified, since the bacterial content is proportional to the nitrification.

The treatment of municipal waste waters can be controlled to a very fine degree, to avoid such problems. Treatment in several works under the control of the United States Department of Interior is monitored by means of a digital computer program which models preliminary treatment, primary settling, activated sludge treatment, sludge thickening, digestion and washing, vacuum filtration and sludge incineration. The model relates the influent and effluent streams in terms of flow rate, temperature, and the concentrations of up to twenty species of contaminants. This model assumes that the overall rate at which the biological processes remove organic material from waste water is controlled only by the rates of the biochemical reactions involved. However, the overall rate also depends on mass transfer mechanisms and the rate at which the organic materials diffuse to the organisms which convert the organic waste to inorganic chemicals. A new model incorporating these ideas is now being prepared to improve the control of the treatment process.

Pollution in an Australian Gulf

Australia is a very young country. Surely the deterioration which has occurred to the seas adjacent to Europe and North America is not occurring to the marine environment in our estuaries and gulfs and on our continental shelf? Unfortunately, the colonisation of Australia coincided with the mushrooming of industrialisation in western countries. If we contrast the requirements of man, European or Aboriginal, as a biological organism with those of present day industrial man's water and power consumption, we find that the energy consumption per person in Australia today is more than one hundred times the energy equivalent of the food he eats, while the present water consumption per head is more than one thousand times the quantity he drinks. We must then take into account the fact that a much greater number of people lives in Australia today, compared with the number who lived here two centuries ago. This dramatic change has occurred in a period of time which is infinitesimal compared with the normal period of oceanic cycles. If we represent the time from the beginning of the Cambrian—which was marked by the sudden appearance of most of the shelled invertebrates in the sea—until now as one year, the period of man's industrial activity in Australia amounts to only a few seconds. During these few seconds we have driven the fish from many Australian rivers, lakes and estuaries, and many species of birds and animals have become extinct.

As an example, let us consider Spencer Gulf, which appears to be a clean, open stretch of water, a most attractive place to sail on or swim in if we are to believe the advertising of the South Australian Government Tourist Bureau. This Gulf is a large region of relatively shallow seawater. Its shores, consisting of wide sand or mud flats covered at high tides and exposed at low water, were first settled by white man 139 years ago.

Today at its northern reach is the industrial complex consisting of Whyalla, Port Augusta and Port Pirie. Port Lincoln, the centre of the Southern Australian tuna fishing industry, lies on the coast at the south-west corner of the Gulf. South of Port Pirie on the eastern side of the Gulf are numerous small settlements, the resorts of holiday-makers and weekend fishermen.

Sixty per cent of the houses in Port Lincoln are serviced by a sewage system which discharges two and one-half million gallons of untreated effluent into the sea each week. Nearby, the Government Produce Department kills about 2,000 lambs, 60 pigs and 30 cattle per day and runs blood-stained water from the works into the sea. Waste water from two SAFCOL factories is also poured into the sea at the same point, a discharge of some 3,000 gallons of water and blood being emptied into the Gulf two or three times a day. When the wind is from the north-east, this effluent is blown on to a nearby bathing beach at Tulka.

At Whyalla treated effluent from the sewage processing plant south of the city is run into mangrove swamps and thence finds its way into the sea. Also, the Broken Hill Proprietary steel and shipbuilding complex to the north of Whyalla pours a number of liquid effluents into the sea at various points. The monthly volume of seawater pumped through the complex and then returned to the sea contaminated in various ways is 3,000 million gallons.

The Playford Power Station, controlled by the Electricity Trust of South Australia, is located three miles south of Port Augusta at the northern extremity of the Gulf. Seawater for cooling the condensers is pumped in at the rate of 17 million gallons per hour and then run back into the sea. This effluent enters the sea at a temperature approximately 7°C above that of seawater, with a pH increase of about 0.4 because of the addition of chlorine used to inhibit biological growth in the pipes. All toilet and ablution blocks are connected to septic tanks, excess effluent from soakage pits being discharged to the sea.

It is proposed that a $300 million petrochemical plant be built at Red Cliff on the north-eastern coast of the Gulf, in the not so distant future. The Gulf here is very shallow and is only a few hundred yards wide in places. The waters remain unchanged over long periods of time because of the lack of tidal movement; this must present difficulties if any industrial complex were to discharge waste into the area. There is also a real danger that the close proximity of the Playford Power Station could result in significant thermal pollution of the northern reach of Spencer Gulf.

The main potential source of pollution in this area is the possibility of an oil spill. The waters of northern Spencer Gulf are effectively land-locked with little water deep enough for the passage of large vessels. If the proposed petrochemical complex were proceeded with, very large tankers will start sailing into the Gulf and the possibility of a major oil disaster will become much greater. As the headwaters of the Gulf with its shallow flats and mangrove swamps is considered by marine biologists to be the spawning grounds of many species of South Australian fish, the whole of the marine life in Spencer Gulf could be exterminated by one large tanker running aground and spilling its cargo.

At Port Pirie the lowlying ground presents complex drainage problems and a large number of separate drains convey various effluents into Port Pirie Creek which runs into the Gulf. The residential area is partly sewered, the effluent being pumped to a treatment works and then discharged into a nearby mangrove swamp.

The Broken Hill Associated Smelters in Port Pirie, the largest zinc and lead smelters in the world, pours more than half a million gallons of waste water into the sea every hour. This includes the entire flow of water used in the metallurgical processes along with much of the effluent from the ablution blocks and general washwaters. The quantity of zinc which finds its way into the waters of the Gulf from this plant amounts to more than ten thousand metric tons per year.

The disposal of sewage and other rubbish from ships in the Gulf is a matter for concern. Once outside the three mile limit, sewage and rubbish, stored while a ship is in port, are permitted to be discharged into the sea. Because the Gulf waters are so restricted and shallow, this is a completely unrealistic limit, since most of the waste material ends up being blown ashore.

A number of mathematical models which emphasise different aspects of the movement and other properties of the waters in Spencer Gulf have been developed during the last two years. Andrew Bullock produced a model for its general circulation while he was at Flinders University; Dr Kim Tronson and I have produced a model for the tidal streams and wind-induced currents in the Gulf, and Professor Green of the University of Adelaide has made a study of the exchange of waters near the head of the Gulf, with particular application to the dispersion of effluents which will run into its waters from the proposed Red Cliff petrochemical scheme.

Thermal Pollution

Temperature is one of the most important environmental factors which control a given ecological system. Its effect is of primary importance to marine and estuarine organisms, in whose life cycle temperature variations play a large part. When heated water is added to such a system, it will affect it in a variety of ways, and it generally dramatically alters the ecology of the region.

Power stations, whether nuclear or conventionally fuelled, require a heat sink for their condensers to operate efficiently. They are therefore located near a plentiful supply of water which is pumped to the station to cool the condensers and then discharged at a temperature of up to 4°C above ambient in the United States, or to almost any figure in Australia. Both Power Stations in South Australia are located on the coast in regions of very shallow water having restricted tidal movements. The Thomas Playford Power Station is at the headwater of Spencer Gulf and the Torrens Island Power Station is located on one of the islands in the Port River 17 km north of Adelaide. Both areas have extensive regions of mangroves growing on mudflats which are exposed at low tide.

Some of the effects of such heated water discharged into a marine environment are immediately obvious; others are not so clear. The main ways in which higher temperature can affect different organisms are:

(i) The temperature rise may be large enough to kill marine organisms.

(ii) A rise in temperature generally leads to an increase in the rate of metabolism. If food and oxygen are plentiful within the environment, this increased rate can be accommodated. One problem which must arise, however, is a possible shortage of oxygen, since an increase in temperature results in a decrease in the amount of dissolved oxygen within the water. Also, the food chain which had become stabilised within the environment could well be upset to a point where a shortage of food results.

(iii) The range of temperatures over which organisms can reproduce is less than the range they can tolerate. An artificial increase in temperature may prevent breeding, even though the organisms may still survive.

(iv) Behaviour may be affected. Some marine animals move from inshore to offshore areas in response to a temperature increase near shore.

(v) The whole ecology will be altered if, by accident or design, a new organism is introduced that is better suited to living at the higher temperature.

In 1972, after the completion of the first stage of the Torrens Island Power Station, Paul Zed, a research student in the Zoology Department at Adelaide University, found that the heated discharge was having a detrimental effect on the environment in nearby Angas Inlet in a number of ways. He found a lower distribution of some shellfish near the outfall in the Inlet, compared with the distributions found in the North Arm of the Port River and he discovered that there were fewer mangrove shoots in Angas Inlet than in the rest of the Port River generally. He also found many other changes in animal and plant distributions. The discovery of the jellyfish *Cassiopea*, which has only a tropical distribution, in the heated waters of Angas Inlet in 1972 is an illustration of the way in which the ecology of the Inlet is changing.

Angas Inlet is a rather small channel of water, about 2.5 km long and having an average depth of about 6 m, which was originally a section of the Port River, separating Torrens and Garden Islands. With the construction of the Torrens Island Power Station, a solid causeway was built across the south-western end of the Inlet to prevent hot water discharged from the Power Station mixing with intake water in the North Arm of the Port River.

This Power Station is being built in three stages. Stage A was completed in 1971, Stage B was recently completed and Stage C will come into operation in the early 1980s. Stage A consisted of four 120 Megawatt generating units served by water pumps which extracted water from the North Arm at the rate of eighty thousand cubic metres per hour and passed it through the power station to cool the condensers. This warm water was discharged into Angas Inlet at a temperature 8°C higher than that of the intake. The volume of water in the Inlet is estimated at 2.5 million cubic metres at high tide and at the above rate of discharge, nearly the same amount of heated water is run into it from the Power Station each day. During last summer the temperature in the vicinity of the outfall rose as high as 34°C, when the ambient seawater temperature in these shallow waters was near 26°C.

When all stages are complete, the amount of heated water pouring into Angas Inlet from the Power Station is expected to be up to four times the present amount at a temperature as great as 11°C above ambient.

During the period when Stage A was operating alone, the temperatures in Angas Inlet remained at an acceptable level for most of the year, the temperature of the water dropping quickly as it moved along the Inlet. However, with the completion of all the remaining stages a much greater volume of water will enter Angas Inlet from the Power Station than from tidal movement and water will remain at a higher temperature much further along the Inlet and connected channels than at present. Heated water could possibly extend all the way around Garden Island to the intake pipes, which would greatly reduce the efficiency of the station since greater quantities of water will need to pass through it to produce the necessary cooling. It is also possible that recirculation of warm water could lead to a continuing increase of temperature of the water in Angas Inlet and connected channels, with certain death for nearly all aquatic life in the region.

A numerical model of the tidal flow and heat transport in the network of inlets around Torrens Island is being developed by Mike Teubner and me at the University of Adelaide. The model will be checked against available data on tide heights, current speeds and temperature distributions while Stages A and B are operating, and then will be used to predict the temperature increases in the waters of Angas Inlet and North Arm which should follow the completion of Stage C. The results will indicate whether an ecological or economic problem would result without consideration being given to cooling the heated effluent in ponds or towers before it is run into Angas Inlet. One obvious use for any waste heat in cooling ponds would be to use it to assist fish farming as is done in Great Britain.

Toxic Chemicals

In addition to pollution of the seas by the addition of excessive quantities of nutrients and of heated water, the world's oceans are being contaminated by toxic chemical materials of various kinds. These include various chlorinated hydrocarbons, the best known being the pesticide DDT, and the heavy metals, in particular lead, mercury and cadmium.

Recent calculations indicate that as much as one quarter of the DDT compounds used by man ends up in the world's oceans, most being precipitated from the atmosphere. DDT residues are distributed throughout the entire surface layer of the ocean and have been found in every kind of creature investigated from Antarctic penguins to Arctic krill. The fat-soluble DDT residues enter plankton through their porous cell walls and can build up in their fatty parts to thousands of times the concentration in the surrounding seawater. This concentration increases in organisms further up the food chain and man, unfortunately, is at the top.

DDT residues are known to cause reproductive failure in commercial stocks of fish, crustacea and molluscs and to possibly cause disruption of sex hormones, interference with the nervous system and changes in the function of the liver in humans.

One group of toxic chemicals, orginally throught to be a residue of DDT, and detected in organisms throughout the world's oceans, is the poly-chlorinated biphenyls (PCBs). These are not pesticides and are not deliberately released into the environment as is DDT. They are used in a wide range of industrial applications such as the manufacture of paints, plastics, adhesives, and cardboard packaging made from recycled paper, and somehow they are accidentally escaping and dispersing. The PCBs owe their industrial usefulness to their chemical stability, which means they persist in the environment for a long time after the disposal of the products of which they form a part. Again, marine food chains concentrate the PCBs as effectively as they do the DDT residues.

Although world DDT consumption has fallen by half since 1965 and PCB releases to the environment are no longer increasing, there is no room for complacency. It if took twenty years for scientists to discover that PCBs were contaminating all the world's oceans, what other toxic chlorinated hydrocarbons are still being released to pollute our seas?

The natural balance which developed over hundreds of millions of years and kept the composition of seawater constant has been upset by a sudden massive input of toxic heavy metals such as lead, mercury and cadmium. Sufficient of the annual world production of lead (about four million metric tons) has entered the seas to treble the average lead concentration of ocean waters. Much of this is due to precipitation of lead from the atmosphere. The atmospheric contamination is caused by combustion of petrol containing 'anti-knock' compounds. Since lead tetra-ethyl was introduced into gasoline in 1925, lead concentrations in some regions of the Pacific Ocean have increased tenfold. Again, marine organisms have an unfortunate knack for concentrating lead in their bodies.

Mercury is concentrated by marine organisms more effectively than other heavy metals: much sea life contains concentrations thousands of times higher than the surrounding seawater. It is highly toxic to man in very low concentrations and can build up in shellfish and fish to levels which are non-lethal to them but highly dangerous to man. The worst case of mercury poisoning in humans occurred in 1956 at Minamata Bay in Japan. Methyl mercury, a compound formed when mercury comes in contact with organic wastes, killed 43 people, and another 73 people suffered numbness, defective vision and atoxia as a result of damage to the central nervous system. Closer to home, we find that Victoria has banned the sale to fish-shops of school shark caught in the south-eastern waters of South Australia, because the mercury level in this shark is twice the maximum permitted by the Public Health Department.

As much as one-third of the annual global consumption of ten thousand metric tons of mercury finds its way into the environment. Most of this is released to the atmosphere when fossil fuels, such as coal and oil, are burnt; some escapes into rivers, in pulp mill effluents, and some is released in mercury based pesticides.

Copper is a heavy metal which has a dramatic effect on marine life if released in high concentration. In March 1965, a large quantity of industrial copper sulphate solution was poured into the sea off the Dutch coast. At the point of release it increased the natural concentration of copper in the sea over one hundred times. Instead of quickly dispersing, as the dumpers had hoped it would, the copper enriched waters travelled in a coherent mass which wrought havoc as it moved along the coast. Beaches were littered with the decaying bodies of thousands of dead fish; whole mussel beds were killed and some species of plankton were wiped out.

Cadmium is the heavy metal which promises to be the biggest future threat to marine life. In Japan as many as five-hundred people have died of *itai-itai* (cadmium poisoning). In Corio Bay, Victoria, fishing for mussels is now prohibited by the Public Health Department because of excessively high levels of cadmium, the source of which is effluent from one of the many industries near Geelong.

Filter feeders, such as oysters, living in estuaries build up some of the highest concentrations of heavy metals, as most of the river-borne lead, mercury, cadmium and so on is deposited at the bottom when the fresh water meets seawater. If we were to collect and eat oysters from the rocks lining Sydney cove in the same way as our grandfathers did, we would very quickly find ourselves in hospital.

The heavy metals represent only a small fraction of the half a million substances released by industry into the environment. Dumping of industrial wastes into the ocean from ships specially chartered for that purpose is growing and menaces life in the coastal areas of industrialised regions.

Some Governments consider that it is safe to dump contained wastes in oceans more than a kilometre deep on the assumption that currents at that depth are so sluggish that it could take centuries for any escaped pollutant to reach the upper water layers where it would be directly dangerous to man. But this is only conjecture. Discoveries such as the counter current under the Gulf Stream contradict the idea that all deep water motions are negligible.

Some of the questions that mathematicians interested in marine science hope to answer include: where and how quickly will a pollutant spread if introduced into a certain part of the world's oceans? How long does it remain in the sea before being removed by marine organisms or by adsorption in the sediments? In what proportions does it move through the cycles of marine life? One day, through their efforts we may know enough about the movements of the ocean waters to confidently predict when and where it will be safe to dump certain wastes and in what fashion, but that day has yet to come. The mind boggles at figures such as those released by the U.S. Government, concerning dumping of wastes in the ocean around that country; in 1968, 48 million tons of waste were dumped in the ocean and 29 million dollars was spent on that dumping.

Positive thinking about pouring wastes into the sea is long overdue. It must be remembered that every bit of industrial material which pollutes the sea is a loss of some kind. The Chinese, as well as returning their organic wastes to the soil, carefully conserve every scrap of material produced as a by-product of industrial processes. In China, one finds fertilisers being made from nitrogenous wastes from chemical factories. If mercury could be recovered from the gases produced by the combustion of fossil fuel, not only would our seas be less polluted but our rapidly diminishing mercury resources might last until the end of the century.

Oil Pollution

The seas are also at risk, with the possibility of untold damage to marine life, if one of the new half million ton supertankers were to be involved in an accident. The calamitous grounding of the 123,000-ton *Torrey Canyon* in the English Channel would pale into insignificance before the mayhem that would ensue if the 476,000-ton *Globtik Tokyo* were to discharge its cargo of crude oil into the sea.

The immediate widespread killing of fish, bird and plant life which followed the *Torrey Canyon* disaster was largely caused by a film of oil which smothered them, although the detergents used to disperse the oil seemed to be just as lethal. Long-term chemical effects of crude oil pollution also occur, although they are less obvious. For instance, the presence of oil interferes with the transmission of chemical messages which assist fish in their search for prey, sexual partners and spawning areas.

By improving the estimates of wave forces, of the stresses produced in the structure of such supertankers, and of their behaviour at sea, the naval architect and the marine engineer contribute toward preventing such disasters. Such ships, because of their excessive draught, are particularly vulnerable to running aground, then breaking up and releasing their cargo of oil into the marine environment. The amount of underkeel clearance is therefore of vital importance. Improved methods of calculating ship motions, such as pitching and heaving, or of 'squat', in which the ship settles deeper in the water as the speed increases, give better ideas of when it is safe for such tankers to sail through shallow seas. Results of mathematical studies of ship motions by Professor Tuck of the University of Adelaide have contributed greatly to the safety of tankers moving through shallow channels such as those in the Torres Strait which connects the Gulf of Carpentaria with the Coral Sea. An analytical study of tidal propagation into the Gulf of Carpentaria by Professor Buchwald and Dr Williams of the University of New South Wales has given us an insight into the physics of the behaviour of the waters in this sea. This study is being extended by Michele Rienecker, under my supervision, at the University of Adelaide. Studies of meteorological effects in tide heights in these shallow seas gives further information which can be used to determine the time of safe passage for tankers. A numerical model of the hydrodynamics of the combined Carpentaria-Coral Sea region is also being developed by Grieg McArthur and myself, one of the aims being to predict the effect of strong winds on the tidal streams in Torres Strait.

To strike at the heart of oil pollution one has to reduce our excessive oil consumption. Unfortunately, the principal economic forces in the world today are the multinational petrochemical industries and the car manufacturers who are dependent on them. The idea that we ought to curtail our consumption and gradually move over to technology not based on petroleum to conserve our oil supplies which will start to run out before the end of the century at our present rate of consumption has received little consideration in the past. Perhaps the rapid escalation in the cost of petroleum will produce action that commonsense could not do in the past.

Radioactive Wastes

One alternative to the use of fossil fuel as a source of energy is the use of nuclear power. It is estimated that the production of electricity by nuclear plants will increase ten fold in the next five years. This adds to the risk of polluting our environment because of the danger of an accident, when most of the radioactive material which escapes will ultimately find its way to the world ocean, and the disposal of highly radioactive wastes by enclosure in containers of limited life and dumping them in the sea. This source of radioactive pollution of the seas is in addition to radioactive fallout which reaches the oceans from the testing of nuclear weapons in the upper atmosphere.

The resultant increase in radioactivity above the natural background radiation could have a disastrous effect on life in the world's oceans. Living beings which have adapted over millions of years to a fairly narrow range of radioactivity are now being subjected to much higher levels of radiation. Marine organisms are more susceptible than terrestial organisms because they are shielded by seawater from most natural radiation, and the odds of a dangerous dose are much greater because their food chains are longer and more concentrative.

Because radioactive wastes are not susceptible to biological degradation or oxidation, radioactivity introduced into the sea takes many years, sometimes thousands of years, to decay to safe levels. Knowledge of ocean currents is therefore vital to those disposing of radioactive waste, since radioactivity spread by strong currents would be a global menace. Using currents measured by physical oceanographers to calibrate their numerical models, mathematicians are modelling oceanic circulations produced by combinations of forces such as gravity, the earth's rotation, surface wind stress, internal friction, and so on. One such study is well underway as a joint venture between Drs Bye and Sag of Flinders University and myself. Monthly mean ocean surface wind stresses have been computed from monthly charts of wind roses compiled by the United States Navy and used to produce the mean monthly global oceanic circulations. The real time for the model to reach steady state for a typical monthly change of wind stress is approximately one week so the resulting monthly circulations give considerable insight into seasonal variations of current, such as the movement of the eddies in the East Australian Current.

Besides the indirect hazard to humans because of the concentration of radioactive wastes by marine organisms and their subsequent use as food, there is an ecological hazard since radioactivity may produce unpredictable changes in the biological communities in the world's oceans. The effect of excessive radioactivity on shellfish and fish include a reduction in their ability to tolerate changes in the temperature and salinity of seawater. This could result in the extinction of estuarine fish which must withstand conditions ranging from almost freshwater to seawater.

There is a need for a transfer of electricity production from the environmentally damaging power stations run on nuclear reactors or fossil fuels to ones using gravitational, magnetic, solar and tidal energy. For the last decade, a tidal power plant has been operating at the mouth of the River Rance near Saint Malo in France. This plant yields as much electrical energy as can be generated by a steam plant using half a million metric tons of coal each year, without producing any form of pollution, thermal or otherwise.

A study to determine the feasibility of harnessing the tidal power in the Bay of Fundy, which lies between Nova Scotia and New Brunswick, is presently under way. Due to resonance in this Bay, the tide has a range of 15 metres, that is, about the height of a four storey building. The electricity produced in this way would be sufficient to supply much of Canada's present needs. A mathematical model of the ocean flow in these waters is being developed at the Institute of Oceanographic Sciences in England to determine the best position to place a dam across the Bay; electrical generators will be installed in openings in this dam.

There are many regions of large tidal range on the north coast of Australia which are eminently suitable for the harnessing of tidal power. Unfortunately they are located long distances from the large centres of population in the east and south of this country. There is one place in South Australia where a tidal power station is within the realms of possibility. A study is being undertaken by Peter Bills and myself at the University of Adelaide on the feasibility of floating caissons, containing the generators and associated wiring, into position to dam off part of the upper end of Spencer Gulf to produce electrical power. In addition, we are studying possible complications arising from the discharge of thermal and other effluents from shore based industrial plants. It would be ironical to find that the harnessing of tidal power was an economical proposition, but that it could not be realised because it restricted circulation necessary to disperse effluent from a poorly sited petrochemical plant.

Only by continued efforts by scientists to develop new methods of combating or managing the pollution already occurring and of informing the politicians and the general public of better ways of ridding ourselves of waste than pouring it into our seas will there be any improvement in the present situation.

There is formidable opposition to altering the *status-quo* in the form of public lethargy and vested interests. Statements like that made in 1970 by the ex-Premier of Victoria, Sir Henry Bolte, characterise the sentiments of many of our politicians and industrialists: 'We care about water pollution, but it is not more important than a one hundred million dollar industry'. Unless we can prevent further pollution and can control present pollution of our air, our rivers and coastal waters, Australia is well on the way to becoming—with apologies to Shakespeare —'A septic isle in a sewage sea'.

DESIGN OF NEW RESEARCH VESSEL FOR CSIRO

by R. H. AUSTIN

CSIRO, Division of Fisheries and Oceanography
Cronulla, N.S.W. 2230

Advice on and criticism of the design of their new research vessel were sought by CSIRO Division of Fisheries and Oceanography at a meeting held at the Division on 11 February 1975.

Possible users of the vessel and other interested people and organisations were invited to attend. These included representatives of State fisheries departments, universities, museums, the Royal Australian Navy, Australian Institute of Marine Science, other CSIRO Divisions, and many Australian Government organisations with oceanic interests.

Dr K. Radway Allen opened the meeting and welcomed the distinguished visitors on the historic occasion. 'Historic', he said 'because this is Australia's first serious research vessel'.

Dr Allen gave a brief account of the development of the vessel so far. He said that an interdepartmental committee had been set up to advise the Government on research vessel needs. They recommended to Cabinet that a major research vessel be built for CSIRO. At that stage, Mr Geoffrey Trout from the U.K. Ministry of Agriculture, Fisheries and Food came to Australia to assist with the planning of the ship. He was directly responsible for the planning and design of R.V. *Cirolana*, a vessel similar to the present one. He worked with the scientists of the Division and the Shipbuilding Division of the Department of Transport who are responsible for the design of the ship. Preliminary estimates of cost were made and these went to the Minister for Science and then to Cabinet in November 1973. They remained on the table of the House until November 1974, when permission was given to go ahead. 'The time has now come' he said 'to talk to other people in Australia; people with a general interest in research vessels and people who might wish to make use of such a vessel'.

Dr Allen went on to say that on present plans the vessel's available sea time will be fully used for cruises by the Division, but that on many of these cruises ship time and berths will be available for other users. He pointed out that while all suggestions would be welcome, it should be borne in mind that it would not be possible to make design modifications which would compromise the vessel's suitability for its main purpose, namely the fulfilling of the Division's responsibilities for marine resources, fisheries and oceanographic activities in deep waters.

The general arrangement plans were then displayed to the meeting and Mr B. V. Hamon, who is responsible for liaison between the Division and the designers at the Department of Transport, gave an account of these in terms of the work for which the vessel is intended.

The initial discussion centred on questions of fact in relation to sizes, capacities, materials of construction and so on, but shortly it settled down to the possibility of making allowance for additional facilities for various purposes.

Several changes resulted from the meeting.

The Bureau of Meteorology wish to affix instruments to the mast, and special wiring will be incorporated for these.

There were several requests for portable container-type laboratories to be carried, and an endeavour is being made to keep sufficient clear deck space in appropriate positions for these. Pipes, cables and drainage will have to be allowed for. It is anticipated that a standard container size (4.9 x 2.4 x 2.4 m) will be used.

A request for a balloon filling shelter will probably be met by a similar portable container.

Geology and geophysical interests in universities asked that space be made available for a gravimeter and for a permanent berth for a technician. A room 3 m^2 near the centre of the ship's motion has been incorporated for the instrument.

The main features of the design of the vessel as at June 1975 are given in the following paragraphs.

Dimensions and General Characteristics

The vessel is being designed to carry out a wide variety of biological, chemical and physical investigations in weather conditions up to Beaufort wind force 8 and from the tropics to 50° latitude.

Passive anti-roll stabilising tanks will be fitted.

The vessel is to be a stern trawler with following dimensions and general characteristics:

Length overall	76.00 m
Length between perpendiculars	67.00 m
Breadth moulded	15.25 m
Depth moulded	8.05 m
Designed load draught	5.00 m
Gross tonnage, about	1850
Speed, service	14½ knots
Propulsion motor	2240 BkW
Range	10,000 miles
Endurance, port-to-port	30 days
Endurance, stores	90 days
Officers	10
Crew	24
Scientists	19

The propulsion will be single-screw diesel-electric, with steerable Kort nozzle. There will also be a retractable bow propeller to assist in manoeuvring and station keeping.

Deck Working Areas

The two deck working areas are the forecastle deck (approximately 24 m long) and the aft part of the upper deck (approximately 23 m long on the starboard side and 14 m long on the port side). There is an additional deck working area for the main oceanographic winch approximately midships on the forecastle deck.

Deck Equipment (Winches, Cranes, 'A' Frames etc.)

The forecastle deck (6-6.8 m above water line) is to be used mainly for the laying of medium moorings (anchor weights to 1 tonne) and the launching of buoys. It carries an 'A' frame, a winch to handle the mooring ropes and a rewind winch to accept the mooring ropes when a mooring is being recovered.

The main oceanographic winch is approximately midships, on the starboard side of the forecastle deck. It will operate in conjunction with an 'A' frame. It will be a double-drum winch with 10,000 m of 6 mm diameter steel wire rope on one drum, and an armoured electric cable on the second drum. Equipment, such as samplers, to be used with this winch will be handled from the deck below.

On the after part of the forecastle deck are the main trawl winch (main trawl warps each 3100 m of 28 mm diameter); an auxiliary oceanographic double-drum winch (mainly for sampling to depths of about 500 m) with slip-rings provided on one drum and a net towing winch with 3600 m of 12 mm diameter wire.

The after part of the upper deck (3.2-4 m above water line) carries the fixed inner bulwarks and arena, for use in bottom and midwater trawling. Within the arena is a net drum winch for convenient handling of the large midwater trawl.

Other light winches will be provided: details are still under discussion.

The after part of the upper deck has two goalpost masts with derricks, and a small stern 'A' frame.

There is a stern ramp about 3.4 m wide and 7.6 m long for use in trawling.

Laboratories

The main laboratory space (total area approximately 150 m^2) is situated amidships on the upper deck. This space is presently divided into four laboratories (chemistry lab, wet lab, biology lab, physics lab) and a dark room. As far as possible the fittings in each laboratory will be of modular design to make it easy to accommodate workers in different disciplines.

On the same deck there are a wet deck laboratory (port side, aft), and a blast freezer and storage room.

On the forecastle deck, slightly aft of the midships position are a computer room, plotting room and an electronic workshop. The total area of these is approximately 56 m^2.

Noise Reduction

An appreciable effort is being put into reduction of noise at all frequencies up to several hundred kHz. In particular, the main diesel motor generator sets and some auxiliaries will be resiliently mounted on a large steel raft and covered by an acoustic hood. The raft itself will be isolated from its supporting members by resilient rubber mounts.

Navigation and Scientific Equipment

The following items are to be provided:

Satellite navigation system
Two-component electromagnetic log
Precision depth recorder
Fishing echo-sounders
Surface thermograph-salinograph
Wind velocity and direction detectors
Air temperature and humidity detectors
Acoustic trawl monitoring equipment
Computer network
Data logging system

COUNCIL MEETINGS

Council Meetings were held at the Australian Museum, Sydney, on 11 March and 6 May 1975. Some of the topics discussed are reported briefly.

Constitution

Mr S. Bourke is currently looking at the Constitution and preparing the way for Incorporation. When a final draft is ready, the new Constitution will be circulated to members for comment. Members will then be asked to vote in a postal ballot to be arranged later this year.

Proxy Voting

Dr Baker has enquired about the proxy system of voting used by the Royal Australian Chemical Institute. The Institute has found that the system does not work well and Council has decided not to pursue the matter further.

Subscriptions

Council resolved that State officials may collect subscriptions and may issue an interim receipt, but the full subscriptions together with the members' names and addresses must be sent to AMSA's Hon. Treasurer who will issue an official receipt. In future official receipts of the Association will be marked 'This is the only official receipt of the Association'.

Funds for State Branches

Limited funds are available to the State Branches for approved activities. In general, approval should be sought from Council before the expense is incurred.

AMSA Meeting 1977

Professor Burdon-Jones has written to the President suggesting that Townsville could host AMSA's meeting in 1977. The President has acknowledged Professor Burdon-Jones's letter and Council will discuss the matter at a later date.

Government Policy in Marine Science

Dr Griffin has written to the Minister for Science pointing out that it is still AMSA's opinion that the Government should set up a council to overview marine science in Australia. The Minister has referred this matter to the Department of Science.

AMSA is also of the opinion that the establishment of marine facilities by one organisation for their exclusive use is not in the best interests of marine science and views with concern the possible establishment of such facilities in N.S.W. and Victoria. The President is to ask Dr Gilmour to report on the situation in Victoria and is to arrange a meeting with Professor Phillip to discuss the possible establishment of a marine facility by the University of Sydney.

Working Groups

It was decided that 'working groups' in aspects of marine science, as suggested at the General Meeting in Canberra, should be

(a) set up by Council to meet a need,

(b) charged with a specific task, and

(c) disbanded when the task is accomplished.

Council has decided to set up working groups to follow developments in

(a) The Law of the Sea (Drs Griffin and Allen and Mr D. Rochford). This group is to prepare a report which is to be sent to the Australian Government.

(b) Australian Tidal Institute. Dr Noye has agreed to work with Dr Easton on this matter.

(c) Preservation of Wetlands and Estuaries. Mr. Collett has tabled a draft document 'Guidelines for the Protection of Estuarine Wetlands'. It was decided that this document should be circulated to Councillors and other interested persons for comment. Dr Hutchings reported on difficulties in obtaining information about the Wetland Survey. Dr Allen explained that it had been decided at a Government level that a comprehensive survey of the wetlands should be undertaken and that CSIRO had decided to carry it out. Funds were made available by the Department of Environment. The responsibility for the survey is shared by three Divisions of the CSIRO, viz. Wildlife; Fisheries and Oceanography; and Land Usage. The first stage of the survey, which is now coming to an end, was to find out the state of the existing knowledge of the wetlands. It is envisaged that stages 2 and 3 of the survey will include more detailed studies. Dr H. Frith of the Division of Wildlife is convenor of the Interdivisional Committee.

(d) Dr Hutchings tabled a document which she had prepared on 'Diving Standards in Australia'. It was decided that opinions should be sought from Councillors, other interested persons and Mr Malnish of the Australian Underwater Federation before it is published in the Bulletin.

(e) Availability of Research Facilities. Dr Baker reported that he had had many favourable replies to his requests for help in drawing up a list of facilities for marine research and that he hoped to have a report ready in August.

Correspondence

Dr Griffin reported that he had written to Dr M. White requesting a copy of a document, prepared for the Australian Academy of Science by Drs P. Mather and F. Talbot, on the state of knowledge of the marine fauna in Australia.

A copy of the document on Marine National Parks has been sent to the Senate Select Committee on Development and Urbanisation of Botany Bay.

Correspondence has been received from:

(a) the Australian Academy of Science, which requested AMSA to nominate a representative for the National Committee for Oceanic Research. Council resolved that Dr Griffin should represent the Association.

(b) the Friends of the S.A. Museum. Council decided to refer the question of location of the new S.A. Museum to AMSA's S.A. Branch, which should obtain the opinions of the management of the S.A. Museum before any action is taken.

(c) Guiness Superlatives on the updating of information about marine waters around Australia. The Hon. Secretary reported that Mr D. Rochford of CSIRO Division of Fisheries and Oceanography had agreed to deal with this report.

(d) Dr Peter Sanger of the Australian Underwater Federation. He informed the Association of an International Symposium on Mangroves in Hawaii and commented on the draft document on Marine National Parks.

(e) Mr S. Shepherd who forwarded a draft of the rules which had been adopted at AMSA's General Meeting in January 1975 for the John Mitchell Photographic Award. Council agreed in principle with the rules as presented by the S.A. Branch.

Financial Matters

Council decided that the signatories on the cheques should be the President, Immediate Past President, the Hon. Treasurer and the Hon. Secretary.

Council gave approval for

(a) the transfer of the Association's Bank Account to the Cronulla Branch of the Bank of N.S.W. at the end of the financial year.

(b) the withdrawal of the Association's investments with the St. George Permanent Building Society on 1 June and the opening of a Savings Investment Account at the Cronulla Branch of the Bank of N.S.W. with these funds.

(c) the appointment of Mr P. Menzies as Auditor for the Association for 1974-75.

Statement of Accounts

The financial statement as presented by the Hon. Treasurer was accepted.

The Hon. Treasurer explained that $30 petty cash had been required for urgent payments and had been approved by the President.

SUMMARY OF STATEMENT

Balance at 10 March 1975		40.77
Receipts: Subscriptions	95.00	
Handbooks, postage, etc.	17.80	
		112.80
		153.57
Payments: Petty Cash		30.00
Balance (at Bank and in hand) at 5 May, 1975		123.57

Investments remain unchanged at $1,584.68.

MEETINGS AND CONFERENCES

Coastal Management Workshop. Peter Cullen from the Canberra College of Advanced Education, Eric Bird from the University of Melbourne and Jens Sorenson from the University of California will run a Workshop on Coastal Management at the Jervis Bay Field Station of the Canberra College of Advanced Education from 15-24 November 1975. Jens Sorenson, who is coming to Australia specially for the Workshop, is best known for his work on identification of conflicts in coastal use, but has also worked on arrangements for managing the coast and on techniques for environmental impact assessments. He is also Associate Editor of the new Coastal Zone Management Journal. The Workshop is designed for experienced coastal managers, and relevant Government agencies are being given priority for the 30 places available. The Workshop will cover resource inventories, demand assessment, capability assessment and coastal planning. Sessions on recreational vehicles and evaluating coastal surveys should be of special interest. There will also be sessions on coastal legislation in America and Britain as well as Australian requirements. Further details: Peter Cullen, School of Applied Science, Canberra College of Advanced Education, P.O. Box 381, Canberra, A.S.T. 2601.