COASTAL MANAGEMENT IN NORTHERN AUSTRALIA

Proceedings of a Workshop held in conjunction with the Conference on Coasts and Tidal Wetlands of the Australian Monsoon Region, Darwin, 4 — 11 November, 1984.

Edited by J.D.S. Davie, J.R. Hanley and B.C. Russell

Australian National University North Australia Research Unit
Mangrove Monograph No. 2
Darwin Australia

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PROCEEDINGS OF THE WORKSHOP ON COASTAL MANAGEMENT IN NORTHERN AUSTRALIA

Organised by the N.T. Branch of the
Australian Marine Sciences Association
and the North Australia Research Unit
of the Australian National University,
held at the Museum of Arts and Sciences,
Conacher Street, Bullocky Point, Darwin, N.T.
4 — 11 November, 1984.

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Front cover: Regenerating mangal, Ludmilla Creek, Darwin.
Photo - A. Howard, NT Museum.

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WELCOMING REMARKS

Barry Russell

President, N.T. Branch of AMSA

It is my pleasure as President of the Northern Territory Branch of the Australian Marine Sciences Association to welcome you to the Workshop section of the Conference.

The N.T. Branch of AMSA had its conception almost a year ago right here in this Museum building, and was formally constituted last February. We are the youngest and smallest AMSA branch but already among the most active.

One of the basic objects of the Australian Marine Sciences Association, embodied in its consitution, is to promote, develop and assist in the study of all branches of marine science and to provide for the exchange of information and ideas between marine scientists and related workers. It is in this latter area, of promoting the exchange of information and ideas, we feel our contribution to the community can be most useful.

In the last few years, as many of you will now be aware, there has been a dramatic increase in the amount of marine research in northern Australia. The Northern Territory Museum in particular has established a strong emphasis in marine taxonomic research, and the North Australia Research Unit of the Australian National University recently has expanded its activities to include a multidisiplinary study of mangrove coasts and wetlands. This latter program is being undertaken in co-operation with the Australian Institute of Marine Science and is being carried out in close association with scientists from the N.T. Museum, CSIRO, Fisheries Division of the N.T. Department of Ports and Fisheries, the Conservation Commission of the N.T. and the Australian National Parks and Wildlife Service.

Over the last two and a half days the Conference on Coasts and Tidal Wetlands of the Australian Monsoon Region has brought together much of the research which has been conducted in northern Australia in recent years. This afternoon and tomorrow morning the Workshop will shift the emphasis to the application of this new knowledge to the complex problems of management of Australia's northern coastal ecosystems. The speakers in the Workshop sessions have been carefully chosen for their experience and expertise in these areas. The speakers you are to hear represent a wide range of interests - biologists, developers, planners, engineers, consultants and conservationists.

In bringing together this diversity of experience and views it is our hope that a much more cohesive approach to the problem of coastal management than has previously existed in the Northern Territory will be developed. It is our intention as a Society to communicate the ideas which will emerge from this forum to the Northern Territory Government and to this end we value your input at this Workshop.

Without wishing to prejudge what will be said by the speakers in the Workshop or the discussion which might follow, I would like to recall the remarks made by Dr Colin Jack-Hinton in his welcoming address to the Conference where he emphasized the need to convince politicians that the work scientists are doing is of practical significance and that we can work together with government in a constructive way to achieve better solutions to the utilisation and conservation of natural resources.

In the Workshop we are not necessarily looking for a general concensus. Such an objective would be unrealistic in such a limited time and with the diversity of views represented here. The main objective is rather to identify the crucial issues of coastal management and to explore the way people from different backgrounds and with different management

objectives view these issues. What we are seeking is the emergence of general principles of management and of cross-disciplinary communication. This workshop can be a significant step in this direction.

Please bear these thoughts in mind and do not focus too closely on particular topical issues.

INTRODUCTION

Jim Davie

Coastal zone management is gaining prominance in government land use planning in Australia as well as overseas.

The reasons for this are clear to all of us who work with or are concerned by the wise use of scarce resources. Conservation of estuaries, unalienated shorelines, reefs and nearshore shallow seas, as well as the fertile lowlands of coastal water catchments depends upon a full appreciation of the pressures these ecosystems are under.

In northern Australia, problems of water pollution, alienation of land for residential and industrial purposes, and the over-exploitation of resources have not yet become severe. We still have relatively few people spread over a very large expanse of coastline. Nevertheless, a persistent 'frontier philosophy' linked to widespread unfamiliarity, or even unease, with the physical and biological environment of tropical Australia by the white population, creates a potential for incidents of ecological mismanagement. The likelihood of such incidents is exacerbated in the Northern Territory where there is also a strong imperative for rapid economic development.

Coastal zone management is primarily about conservation of resources. As an objective, conservation must be viewed not only as a way of retaining what we have but also for creating what we want. In the Northern Territory, coastal environments are for the most part still unspoilt and very often near to original, except in localised areas. There is, therefore, an opportunity not existing elsewhere in the tropical world, to assess what we wish to plan towards and to establish the infrastructure by which such plans can be achieved.

In his book on coastal zone management Dr. John Clark (1983) observed that environmental management is a form of art that prospers in direct proportion to the scientific knowledge on which it is based. A lack of detailed knowledge of tropical environments remains a serious constraint despite the increasing level of scientific attention now occurring. Recent advances in our understanding of the Australian wet-dry tropics and in the monsoon affected coastlines of our region have been documented in Ridpath & Corbett (in Press) and in the proceedings of the Conference on Coasts and Tidal Wetlands just held (Bardsley et al. 1985).

It is appropriate that this Workshop on Coastal Management in northern Australia should be held now to further develop the art to which Clark referred. The approach adopted by the Workshop convenors recognizes that the use of a resource depends upon how it is perceived by potential users, how society deems it should be used and how the use is carried out. These three elements we have paraphrased as:

- definitions and perceptions of the resource
- policy formulation, and
- implementation and monitoring in effective coastal management

and these are the headings of the three information discussion sessions of the Workshop.

It is intended that the Workshop will function along a well established formula within this structure. In each session discussion subjects will be introduced by three introductory papers dealing with diverse or controversial elements. General discussion is invited after the three principal speakers have finished their presentations in each session, and the results of this discussion will be summarised by the appointed Chairperson. In a final plenary session we expect that discussion will move to examine opportunities which exist to implement cross-disciplinary planning and administration of coastal resource utilisation.

The Workshop represents a rare opportunity for a wide range of professionally concerned people to come together in the Northern Territory to consider issues of very great importance to our future. By virtue of our location in tropical Australia, and because of the special problems we are seeing as a result of rapid urban expansion in Darwin it is inevitable that much of what is said will be of specific local content. It should be emphasized at the outset that while the locations are specific the issues are generic and what we are seeking above all is the emergence of principles and guidelines which may have widespread application. For this reason the experience and background of the participants from elsewhere in Australia and Southeast Asia is especially appreciated.

References

Bardsley, K.N., J.D.S. Davie and C.D. Woodroffe (eds.), (1985). Coasts and Tidal Wetlands of the Australian Monsoon Region. North Australia Research Unit Mangrove Monograph No.2.

Clark, J.R., (1983). Coastal Ecosystem Management. MaCabar, Florida: Robert E. Krieger Publishing Company.

Ridpath, M.G. and L.K. Corbett, (eds.), (in Press). Ecology of the Wet-Dry Tropics. Melbourne: Blackwell Scientific Publishers.

Session I - Definitions and Perceptions of the Mangrove Resource

Coasts and Tidal Wetlands of the Australian Monsoon Region: The Planner's View - Graham Bailey.

Definition and Perceptions of the Mangrove Resource: The Biological View - Peter Saenger.

Preservation of Mangroves: The Development View - David Veal.

Discussion Summary - Barry Russell.

COASTS AND TIDAL WETLANDS OF THE AUSTRALIAN MONSOON REGION: THE PLANNER'S VIEW

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Introduction

The task of providing 'The Planner's View' on Australian monsoonal coastlands is daunting to say the least. I should therefore, at the outset, emphasise that the views expressed are mine and should not necessarily be held against my fellow planners, or my employer.

It is also important to reflect that within the Australian Monsoon Region there is now, and has been in the past, very little opportunity for planners to form any specific view concerning the coast and tidal wetlands.

Most authorities consider that the Monsoon Region is confined to areas north of latitude 17S, for example Linacre and Hobbs (1977), and Lee and Neal (1984) who quote Ramage's definition of the Monsoon Region as the area north of a line between Port Hedland and Cairns. By my rough estimate there are more than 4,500 kilometres of coast between these two centres with less than 200,000 people resident.

It is clear that, within the defined Region, the development of urban communities has been (and still is) very limited. Where towns have developed they have typically been frontier outposts, not normally noted as strongholds for the planning profession! The rest of the Region (comprising pastoral holdings and Aboriginal lands) offers even fewer professional opportunities.

Darwin is by far the largest urban development area in the Region, and it is noteworthy that even here the first permanent resident planner arrived only 20 years ago. Previous involvement of planners had been by way of pioneering sojourn, such as the contributions of R.A. McInnis in the 1940's. These early contacts obviously provided a few planners with an opportunity to form views about the coastal areas of northern Australia. McInnis (1981), for example, recorded in his diary on September 6, 1940, some impressions gained on his flying-boat trip to Darwin: "The Gulf is fringed by miles of treeless arid, flat country with many small rivers (tidal) meandering through it - useless and repelling. Karumba is at the mouth of the Norman River - only the flight station and meatworks. They had shot a crocodile this morning. The ground is a bank of shell with a small covering of soil. Arr. about 9.45. Water of Gulf very muddy near shore. Wellesley islands flat and same structure of sea-bed as mainland. Saw nothing on Mornington. Groote Eylandt where we arrived at 1 p.m eastern time was better. It is sand. The flight station is on a lagoon. Only blacks on the island otherwise. Arnhem Land was an eyeopener to me. We circled the coast - on patrol duty. Of all the Godforsaken places I have seen, that coast is the worst. Absolutely flat, salt swamps and clay pans, and large areas of bare rocky outcrops".

Fortunately McInnis later had some kinder things to say about some of Darwin's coastal areas. His views, regardless of what they were, resulted from a brief association with the area. This 'working holiday' for planners is a phenomenon not necessarily yet extinct in Northern Australia, and seldom results in deep and abiding understanding of the Region.

The point to note is that the formation of the planner's view of the monsoon coastal areas of northern Australia is characterised by very limited chronological and locational boundaries. My own views are based on 15 years of planning work in the Territory. This would not be a

significant period of exposure in most climatic regions of Australia, but with so few planners in this country with long experience in monsoonal areas, I find myself in a surprisingly small company.

I believe I have accurately portrayed Darwin as unique in Australia's monsoon region as a centre for planning activity. If there is a place within the Region where the planner' view of coastlands has developed, Darwin must be foremost.

Yet it must be realised that in Darwin regional planning has, until very recently, considered only a few kilometres of coast in relatively close proximity to the developed urban areas. Consideration of the total Northern Territory coastal asset has commenced, with Departmental planners and Conservation Commission officers jointly preparing the groundwork for Government policy in this area. This marriage has yet to produce offspring although there is an air of expectancy!

The planner's bias

The fundamental difference between the planner's view of any coastal land and the view one would expect from (say) a biologist, is the underlying bias. I do not mean the word 'bias' to carry good or bad connotations in this instance. I am really referring to the standpoint from which one gains a perspective or perception of anything.

The planner will almost certainly be a 'developer' by nature, not a 'preservationist'. With a few exceptions, most coastal areas would be viewed by planners as areas of interest principally because of the experienced or potential demand for human use. Land-use, that is human land-use, is a plausible summary of the major element of interest to the planning profession.

Coastal areas which by their nature, location and availability are der pressure for human use are seen by planners as resources On the other hand, if an area is demonstrably significant (e.g. as a habitat, a unique example of flora under threat, or as essential to maintain a fragile ecosystem) to the extent that human use is damaging, a planner would perceive it to be a constraint.

Such a perspective does not of itself imply a lack of understanding of, or commitment to, the value of the constraint. Unfortunately, planner's reference to conservation areas as constraints is misunderstood by many to be a denigration of the worth of such an area. On the contrary, it is entirely consistent to assign to an area sufficient value to regard it as inviolate.

The planner's culture

Planner's, like other people within a vocational category, develop a professional culture. This is an often subtle (but nevertheless powerful) force which can direct or channel attitudes and responses in a manner identifiably characteristic of the group. Training, professional association and common interest provide the roots for this culture.

I hold the view that an individual planner's view should be a product not only of these factors, but also of an essential partial envelopment of the professional culture by the community culture. This results in a dynamic 'public participation' which enables the planner's view to be in harmony with community aspirations and expectations. Obviously a balance must be kept to avoid an unhealthy subservience to community pressures, regardless of facts or principles. However, the alternative extreme of a planner being aloof from the community culture results in either professional prostitution or a Messiah syndrome!

If this notion is correct, the planner's view of the coasts and tidal wetlands in the Australian Monsoon Region will directly reflect community views. As there will obviously be a wide spectrum of views in the community on such a subject, the planner is most likely to reflect the majority view. Presumably the planner can refine and clarify this view by virtue of the previlege of information availability, as well as training and experience in evaluation and interpretation of information.

I must, for consistency sake at least, assume that my own view of the coastal areas with which I am familiar will reflect the community culture.

It is worth noting in this context the importance of at least some degree of harmony between community perception and the planning product. The most heinous Philistine as a planner could not coerce informed and responsible citizens to conform to a planning solution which totally degraded the coastlands. Conversely, the most scientifically-supported plan which created a total preservation area on a coast where community aspiration and expectation was for recreational use would be similarly doomed.

Foreshore land-use imperatives

The planner's view of coastlands, together with everyone else's, must accept the existence of some land-use imperatives. These are likely to occur in direct proportion to the existence and growth of human habitation.

It is an exceptional coastal community indeed that has no need for port development, land for stormwater and sewage drainage outfalls (and treatment areas) and land on which to base marine activities related to commerce, research and recreation.

Foreshore land-use imperatives such as these cannot (by definition) be denied. Unless the response to their existence is positive recognition and adequate land provision, the activities will establish in an ad hoc, clandestine and usually unsuitable fashion.

An orderly provision of adequate land for uses which must locate in coastal lands is a blow for responsible conservation of a coastal zone. This provision may not be easily resolved, or achieved without some regretable damage to coastal features. This is particularly true where the nature of the coast offers limited economic opportunity to provide for the land-use concerned.

The only meaningful alternative to providing for these land-use imperatives is to deny the driving force behind them, namely, human habitation itself. This is seldom a realistic option in terms of economics, politics or community values.

Coastal land-use considerations

I have deliberately chosen to discuss the important considerations applying to coastlands in the context of land-use. This, as outlined previously, simply reflects the planner's bias.

Without wishing to labour the point, I want to emphasise again that in my view, there is no inconsistency in the planner's land-use perspective including conservation or preservation as a legitimate and desirable land-use.

In my experience, probably the three considerations which have most impact upon planning decisions related to land-use in coastal areas of the Darwin Region are drainage, insect breeding and storm surge.

No doubt it will be disappointing to some that in my view as a planner, environmental protection considerations do not loom larger. I suggest that it would be unfortunate if this were interpreted as strong evidence of inevitable conflict between a planner's view and the views of others whose principal interest is environmental protection.

In my experience the reality is that the constraints to development that arise from drainage, insect breeding and storm surge problems effectively defer much potential confrontation between development and conservation interests. This is the obvious result of the developer's losing interest in an area in the face of these constraints. It is noticeable that where conflicts do occur there is generally an absence of such constraints.

My choice of the word 'defer' was quite deliberate. It is my view that the potential for conflict remains, and actual conflict may well occur later. This will be when surrounding development sufficiently alters the economics associated with resolving the constraints, or when alternative more suitable land is exhausted. In these circumstances the planner's view will be focused on environmental considerations as much as any other. Probably the development bias will result in continued reservations between planner's and those with a preservation bias, but insurmountable conflict should not be inevitable if both parties are intelligent and responsible.

In new coastal development areas, the planner's preoccupation with drainage, insects and storm surge stems from essential and elemental concerns of public safety and economics. Quality of life issues loom close by, and are interwoven with safety and cost concerns.

To be more specific, in contemplating any proposed land-use in a coastal location, our view assigns great importance to ensuring people will not be subject to unreasonable risk of suffering drowning or property destruction in a cyclone event, contracting debilitating and perhaps fatal insect-borne diseases, or being driven mad by constant 'sandfly' (midge) attack. The existence in a study area of significant numbers of rare mangroves, or a colony of frilly-necked toads that sing like Joan Sutherland will be interesting but not vital considerations. Their welfare and continued existence in the subject area would be addressed after more basic human concerns had been laid to rest.

Probably the next most important consideration for a planner working in a coastal area would be the satisfaction of existing and anticipated foreshore land-use imperatives such as outlined previously. Le Corbusier, the noted architect, is reported to have described the house as 'a machine for living'. I contend that an area of urban development is the same thing at a macro-scale. It is primarily a utilitarian thing that simply must work, and if foreshore (or any other) land-use imperatives are not satisfied, it will fail.

Assessment of land-use proposals in coastal areas involves many other considerations which are common to evaluating proposals at most other locations. The condition of soils, ownership of land, aspect and outlook, drainage catchments, available services, access, administrative structures, mineral resources, flora and fauna, climatic factors, adjoining land-use and issues of culture and history are examples of considerations which apply to development proposals regardless of location.

The coast as a resource

Human history, from time immemorial, provides evidence of the pre-eminence of coastal land above all other in the perception of most peoples. The sea has provided the single most important frontier between races and nations for centuries. Voyages of conquest and exploration are recorded in events and ceremonies played out on the foreshores of the world. So often the coast is a boundary, the demarcation of areas which

assume specific characters with which the inhabitants identify.

Our culture is steeped in imagery which enhances the value of the coast. The anxious explorers' sighting a far-off coast, or the exhausted shipwreck victim reaching a beach, all speak of security and survival. Farewells and welcomes, now enacted more at airports than elsewhere, still linger in our cultural memory as a seafront occasion. The sea has always been a road to everywhere else, seductively calling the ambitious and venturesome. For many, the sea is the everlasting source of sustenance, the ultimate interface of life. If a coastland offered nothing else, it would still assume enormous importance as the stage on which these events have passed, offering opportunity for more in the future. In the face of this, the planner's view of the value of coastal areas must reflect that of the community.

Of course, the coast is often in its own right a major resource area, offering many attractive elements for human habitation. Coastlands are a source of raw materials (organic and inorganic), an area offering moderated climate, recreation opportunities and aesthetic surroundings for urban development. No continent or nation on earth demonstrates by practice these facts more than Australia. The concentration of people in urban developments at coastal locations is remarkable.

This concentration can, of course, bring severe pressure to bear on coastal resources. Indeed, countless examples of the damaging effects of such pressure can be found nation-wide. Such evidence results, understandably, in emotionally-charged confrontation between people whose bias differs.

It is fortunate for Australia that the isolation and sparse population of our monsoon region coastlands has meant we have seen very little damage through the pressure of human habitation. We should be able to benefit from the mistakes of our fellows in the more temperate regions of our country and perhaps overseas experience in monsoon coastal development, and avoid <u>unnecessary</u> disturbance of the northern Australian coastal resource. Adequate planning for the provision of suitable land for essential foreshore land-use should be the foundation of responsible coastal resource management.

Responsible planning and management of coastal resources depends very heavily on the available information concerning the coast being adequate for the task. Clearly, the lack of development in the northern Australian monsoon coastlands has resulted in little documented information being gathered. For this reason in the work I do (principally in forward or longer-term planning) we have given high priority to increasing our knowledge of the coasts which are subject now, or in the near future, to most pressure. The considerable expenditures of the last 3 or 4 years have expanded available information in the Darwin region in matters such as storm surge, land resources and capability, landform, insect breeding, and mangrove communities. No doubt the planner's bias I have mentioned earlier is reflected in the emphasis on information vital to decision-making related to land-use and public safety. Fortunately others with a different bias are contributing to information gathering on northern Australian coastlands.

The key issue I want to draw out is that we need to <u>understand</u> the coastal resource we have, regardless of whether our bias is towards preservation or development. It is sobering indeed to reflect on how much of the monsoon coastland we know very little about, even after the expenditure of hundreds of thousands of dollars.

Research and documentation of knowledge concerning the Australian monsoon coastlands should be a common objective which rests comfortably with people representing all views. I suspect that in this research we planners need to recognise, more than many of us now do, that the seaward half of the coastal environment deserves equal time with the landward side. Events such as this Conference/Workshop are a positive beginning in

widening understanding between people interested and involved in coastal policy-making and management.

Conclusion

So, in conclusion, I must admit that the planner's view of Australia's monsoon coastlands is not born of long association with the region. It is not a view that encompasses vast portions of the northern coast, nor is it based on any wealth of information specific to the area.

The planner's view shares the community perception of coastland as an unrivalled resource, one which feels the impact of human settlement largely because of its great attractions.

In the dynamics of human habitation, the planner's position is clearly on the side of development. In essence the profession seeks to match needs with resources in the ongoing development of a community. Whether the resources are derived from the coastlands or not, the planner's underlying objective is to responsibly meet the identified demands of the community.

It is difficult to measure how responsible any land-use decision may be. The degree of difficulty in this assessment is directly related to the quantity and quality of information available concerning the elements in the decision.

The 'need' element is usually expounded by the group or person in the community with the perceived need. It may be the specific attributes within a resource area are also located and defined by the need group. The nature of the total resource, and the importance to it of the subject area with the desired attributes, is not so easily identified. With increased knowledge of the resource in its totality, decision-makers will be able to realistically evaluate the responsibility (or otherwise) of land-use proposals associated with specific areas.

The lack of urban pressure in the coastal monsoon areas of Australia has allowed a generally ad hoc reactive decision-making process to apply in the past. The pressure of urban growth in a few coastal locations, notably the Darwin Region, makes it vital for responsible planners to have much more and improved information against which needs can be assessed. It is also imperative that essential foreshore land-use needs are anticipated and provision made for them (by evaluation of adequate information) before pressures are such that the decision is reactive and based on expediency.

In the foreseeable future, it is unlikely that the area of monsoon coast subject to development pressure will be a significant proportion of the whole. We need to have sound understanding of the whole however, with detailed research and documentation of information for areas that do experience pressure. This should be an attainable goal. It is also likely that persons with conflicting views on coastal land-use and management can agree on the areas requiring detailed study, and the specific information most likely to be needed.

It is my view that development of some kind in the Australian monsoon coastlands is inevitable, as is the resultant change to some coastal environments. It is unrealistic to adopt an objective of reaching full agreement between people with a development bias, and those with a preservation bias. It should be possible, however, to establish some agreement on the location and nature of development in monsoon coastal areas of Australia, provided it is based upon adequate knowledge of the resource and the probable impact of the proposed development.

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DEFINITION AND PERCEPTIONS OF THE MANGROVE RESOURCE: THE BIOLOGICAL VIEW

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Introduction

This paper focuses on the management of tidal wetlands which are one of the most important of the natural resources of northern Australia. Development pressures during the past two decades which have affected mangrove lands, and recent international attention directed towards the resolution of mangrove land-use decisions, provide a useful background to broader considerations of coastal resource management.

Broadly defined, tidal wetlands are those communities in which the hydrological regime reflects tidal forces. This definition, based on processes rather than components, is a useful one for understanding the dynamic relationships between various intertidal communities and for identifying their ecological sensitivities.

In the Australian monsoon region, tidal wetlands include the intertidal seagrass and algal communities, mangroves, saltmarshes and saltflats and the various fringing communities such as sedge swamps, reed swamps, paperbark swamps and on the east coast, swamp-oak communities. Although taxonomically distinct, each of these communities is linked by hydrological characteristics along gradients of tidal inundation, interstitial salt concentrations and degree of waterlogging. In this sense, these communities form an intertidal continuum on a graded series of habitats from seawards to landwards.

Mangroves are the most dominant of these tidal wetland communities in the monsoon regions; they not only dominate the habitat and characterise the ecosystem, but they also define an economic resource which has been widely and variously used by coastal people of the tropics (Saenger et al. 1983; Hamilton and Snedaker 1984). In contrast with other regions, the Australian mangrove resource is not under threat from a population at subsistence level; rather, misconceived perceptions and faulty valuations commonly form the basis of policy decisions concerning this Australian resource - a situation requiring urgent consideration and correction if rational management is to prevail. The role of the biologist in this process is best directed to the following questions.

What is the Mangrove Resource?

The Australian coastline supports approximately 1.1 x 106 ha of mangroves (Galloway 1982) and probably a similar area of saltmarshes and saltflats. Occurring throughout 34 of latitude and 41 of longitude, these communities extend from tropical to cool-temperate regions and possess a concomitant diversity of species and patterns. Maximum diversity, however, occurs in the northern monsoonal regions (Macnae 1966; Saenger et al. 1977; Mepham 1983), where over 30 species of mangroves occur, with an additional 20 or so associated species of mistletoes, ant plants and other epiphytes, and ferns.

The mangrove resource, however, encompasses more than the area occupied by mangrove plants. In addition to the plants, the resource consists of the associated and/or correlated biota - the terrestrial and marine animals, the lichens, fungi, algae and bacteria whether these are temporary, permanent, casual, incidental or exclusive occupants of the mangrove habitat or simply dependent on the sustained flow of materials from the mangroves.

In addition to the above components, it has been suggested (Saenger et al. 1983) that those processes essential for the maintainance of the mangrove resource are part of that resource whether they occur within the area occupied by the mangrove plants or outside it. Proper scientific management requires that these essential processes are viewed as part of the resource: lying at the land-sea interface, many of the processes that regulate the ecosystem occur outside it and are beyond its influence and consequently these external processes, governing water availability, the pool of available nutrients and the stability of the habitat, are often not seen as part of the ecosystem - or if they are, then the physical boundaries of the ecosystem become virtually impossible to delineate accurately. Despite this difficulty, failure to recognize the extended boundaries of mangrove systems considerably weakens the effectiveness of management and it has often resulted in unintended destruction of mangrove communities.

How is this resource perceived?

Around the world, the mangrove resource is perceived in a number of ways, often with a heavy utilitarian emphasis (Hamilton and Snedaker, 1984). In Australia, one of the few nations of European tradition with such a resource, the general perception of mangroves generally falls into one of the following four types: Fear/nuisance, Sinister mystique, Scientific curios and Utilitarian. Examples of these perceptive stances are given below.

Fear/Nuisance

Banks (1962): "May 24, 1770: Freshwater we saw none, but several swamps and bogs of salt water. In these and upon the sides of the lagoons, grew many mangrove trees, in the branches of which were many nests of ants, of which one sort were quite green. These, when the branches were disturbed, came out in large numbers and revenged themselves very sufficiently upon their disturbers, biting more sharply than any I have felt in Europe. The mangroves had also another trap which most of us fell into. This was a small kind of caterpillar, green and beset with many hairs, numbers of which sat together upon the leaves, ranged by the side of each other like soldiers drawn up, 20 or 30 perhaps on a leaf. If these wrathful militia were touched ever so gently they did not fail to make the person offending sensible of their anger, every hair on them stinging much as nettles do, but with a more acute though less lasting smart."

Sinister mystique

Wharton (1883): "As I have never seen the mangrove mentioned but as a conservative or productive agent as regards geological change, it may be interesting to readers of Nature to hear of its acting in a contrary direction. In several parts of eastern tropical Africa where the shores are mostly of upraised coral limestone, I have noticed the effect of mangrove in eating away this rock, but nowhere have I seen it so well as in the island of Aldabra .... which I surveyed in 1878 .... The mangrove has established itself on the edges of the lagoon .... and in all places where it has done so, tortuous creeks or little gorges run back into the coral, filled with mangrove trees (standing in deep mud of the adhesive and foetid nature so characteristic of mangrove swamps), which stretch out their roots to the coral walls around them, and, as it seemed indubitably to me, in some way decompose the softer parts and eat their way in."

Beale (1972) [writing about the explorer Kennedy]: "The great impediments at this stage, even worse than the tea-tree swamps, had been the positively evil mangrove swamps. It is the red mangrove that rules hereabouts; a greedy usurper which occupies the marshy no-man's land between dry land and water, a wide and flat space shunned by other plant life. This grasping tyrant seizes the unwanted, and consolidates its

position so as to become unassailable, surrounded by salt water at high tide and mud at low tide, when it is irrigated by ooze from sluggish backwaters. The entwining, revelling in the sludge; from its branches it drops aerial roots into the static convulsions below. And over all is a dense roof of glossy leafage which effectively excludes sunlight from the stinking, impenetrable chaos beneath. One can do nothing with mangroves but avoid them."

Cooper (1950): "In April 1948 HMAS Barcoo .... then anchored off Glenelg .... was caught in a fierce 80 mile an hour gale .... and was driven ashore .... As a small offset to the serious damage caused by this great gale, it provided a discovery of considerable scientific interest. The tremendous scour of sand from the Glenelg beach caused by the severity of the storm soon afterwards exposed an ancient mud swamp in which were imbedded stumps of large mangrove trees, dead for many ages (a type of vegetation no longer existing in the area) and containing the boreholes of teredos, still in a perfect state of preservation. There were also dead shells lying in the mud swamp exactly as they had lived some thousands of years ago before being overwhelmed and buried by the encroaching sand. Primitive stone hand axes and the burnt embers of the fires of those who had used them were lying nearby. Shortly afterwards sand began to accumulate again and this interesting feature is now obscured from view".

Utilitarian

McLaren (1926) [writing about the coastal people he lived with]: "These Cape York people all knew all there was to know of their surroundings - a circumstance due to the fact that being nomads who lived on what they could catch or find there was need to know where these things could be found, and be informed of their edible or non-edible qualities .... But this wide knowledge of theirs was in nowise ragged or untidy. It was systematized and regulated. For each department of animate and inanimate nature they had a system of nomenclature as comprehensively complete as that which any trained scientist could have devised; and they knew the relationships of the various departments, and the significance of the relationships one to another."

What are the values of the resource?

Four classes of values have been recognized in relation to natural resources and these can be readily applied to the mangrove resource.

Economic Values

These values can be readily recognized in the direct and indirect products forming part of the mangrove resource. Direct products, although not widely exploited in Australia, consists of various wood products and related materials such as tan-bark and oyster stakes. The indirect products are widely exploited in Australia although rarely perceived to be dependent on mangroves; these include fish, crustaceans, shellfish and honey.

The economic values of the mangrove resource can be easily quantified e.g. the annual value of the northern banana prawn fishery.

Usefulness Values (or 'free services')

Mangroves provide a range of these types of values (Saenger et al. 1983) including provision of habitat, shoreline protection, chemical buffering, water quality maintenance, recreational and educational opportunities and reservoirs of genetic materials.

Usefulness values are difficult to quantify in dollar terms but a

number of approaches have been used with varied success (Lugo and Brinson 1978).

Intrinsic Values

The acceptance of intrinsic values, i.e. the organisms, communities and ecosystems have an inherent right to exist independent of man's interest in them, is becoming more widespread. Acceptance of these values forms the basis of much of the rationale of the conservation and animal welfare movement. Because these types of values cannot be quantified (and perhaps should not be in any case), they are often ignored or dismissed by decision makers.

Symbolic Values

Some symbolic or totemic values are probably attached to the mangrove resources, at least by some coastal Aborigines. While these values may be rather difficult for the majority of Australians to understand, they should, nevertheless, neither be ignored in evaluating the resource nor in the decision-making process concerning its allocation.As with the intrinsic values, symbolic values cannot be quantified.

It is clear from this brief outline of the values of the mangrove resource that there are significant non-quantifiable components attached to this resource which make life for the decision-maker rather difficult. In view of this difficulty, it is probably easier to place a value on the benefits to be gained from planning and sound management of the mangrove resource and associated estuarine areas. These have been identified as including (AMSA 1977):

(a) the maintenance of attractive and readily accessible areas of high scenic and aesthetic value, suitable for both passive and active recreational pursuits by all members of the community;

(b) the conservation of important wetland and estuarine habitats and of breeding and nursery grounds of many marine organisms and water birds;

(c) retention of a 'drought refuge' habitat which can be used by inland water birds in dry years;

(d) the continuing profitability of shellfish cultivation and of inshore and estuarine prawning and fishing industries;

(e) the maintenance of a range of natural ecosystems which are suitable for teaching and research purposes; and

(f) the reduction of problems of sedimentation and erosion and consequently the need for expensive corrective engineering works.

From the benefits described above as emanating from the proper management of the resource, it is apparent that the management of the mangrove resource should aim at its use as a renewable resource providing fisheries products and possessing an inherent usefulness value based on its geomorphological, recreational and scientific characteristics. Only the most pressing and essential community demand should be considered to justify the treatment of the mangrove resource as non-renewable (Saenger et al. 1983).

How can the values be managed or optimised?

The various values and the various competing uses for the mangrove resource and the land it occupies, presents the decision maker with confusing options. Their task is made all the more difficult by:

(a) the strong emphasis placed by planners and decision makers on dollar valuations of alternatives in an ecosystem whose total values cannot be quantified and whose economic values are invariably underestimated;

(b) the need to resolve resource use conflicts in the long-term interests of the community which, by and large fails to appreciate the values of the resource; and

(c) the absence of a realistic ecological basis on which to evaluate and manage the various forms of resource utilization.

In spite of the above difficulties, mangrove resource utilization falls into three categories. Certain forms of utilization use the resource as a renewable system, e.g. the extraction of fuel, fish, honey and recreational opportunities. The conversion of mangrove areas by filling or dredging is a non-renewable use of the space occupied by the resource. Certain other activities such as mariculture, waste disposal, woodchipping and other forestry activities fall somewhere between these extremes, i.e. they are neither strictly operating on a renewable basis nor are they irreversibly occcupying the space at the expense of the mangrove system.

In theory, the ideal decision maker will manage a resource (or ecosystem) so as to leave open for the longest term possible as many resource use options and values as possible. In practice, the decision maker should emphasise the use options which rely on a renewable (or nearly renewable) approach to the system. To approach this state of optimization of the resource, scientists and particularly biologists have a major contribution to make. They must, first and foremost, work together with decision makers, to:

(a) develop and learn to apply a sound and relevant ecological framework for the mangrove resource;

(b) recognize and communicate the extended boundaries of the mangrove resource and the vital interrelationships between the various components of it;

(c) steer the decision-making process away from what Odum (1982) has termed the "tyranny of small decisions", i.e. adopting a holistic rather than a reductionist perspective so as to avoid the undesirable, cumulative effects of numerous small decisions; and

(d) seek to influence the community's values of the mangrove resource by enhanced appreciation through education.

In relation to the last point, it seems appropriate to conclude with the following passage from McLaren (1926) concerning community knowledge of coastal resources: "I think they thought me a most ignorant person ... Indeed, one man asked me how it was I knew so little of these things; and I told him that what to him were the simplest facts of life were to us matters for investigation by learned men. Whereupon he looked at me for some time as though doubting that such a state of affairs could really be, and at length remarked that he had not thought that among whites it was the fashion for the many to be ignorant and only the few to be wise, and opinioned decisively that there must be something wrong with the constitution and government of my tribe."

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PRESERVATION OF MANGROVES : THE DEVELOPMENT VIEW

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In recent years, the conservation pendulum has swung from 'develop at all cost' towards 'preserve at any cost'.

Both of these carry the problems inherent in any 'extreme'. More moderate approaches are necessary. My comments apply to the Mangrove stands around Darwin Harbour. They may or may not be pertinent to other places.

In the current circumstances only the most determined and courageous developer is likely to spend time and money sponsoring a project which interferes with mangrove stands.

This may seem to be a very good thing to those who have a strong belief in the importance of mangroves, but there are penalties which the community at large suffer in supporting this line.

For many years I have been reading statements such as: "Mangroves are a vital part of the eco-system and should be preserved" and ".... Mangrove stand is unique".

There are questions to be asked of both statements. As a layman I find it hard to believe that anything in Darwin Harbour pertaining to mangroves is unique. If I am to accept there are 'unique' species, I need to be convinced that sufficient field research has been carried out both in Darwin Harbour and along the Northern Territory coastline to justify this statement. I understand there are some 25,000 ha of mangroves in Port Darwin alone, and having spent some time on foot in mangroves I can gauge the difficulty of conducting effective surveys.

The value attributed to a commodity is usually related to its availability and the demand. The sheer size of the Darwin Harbour mangrove stand surely ensures a very low value being placed on this commodity.

Accepting that mangroves play a role in the ecosystem, how would marine life in Darwin Harbour be affected if, say 250 ha or 1% of the resource were removed?

Of course, the effective permanent removal of mangroves is costly, and the value of the land reclaimed will not be high unless additional measures are taken to protect it from tidal surge. Such factors will probably preserve the vast majority of the extensive mangrove stands in Darwin Harbour without artifical control, for as far ahead as one can see.

While many people support the preservation of mangroves, very few choose to live close to them. Currently the N.T. Department of Health discourages residential suburban development closer than 1.6 km to known mosquito breeding grounds. Less serious as a disease risk, but a more serious nuisance is the biting midge whose breeding grounds are found principally in mangroves. Constraints on land development in the Darwin area are numerous as can be seen from the Darwin regional strategy plan. The 1.6 km mosquito buffer drastically reduces the already severely limited area suitable for development.

There is a considerable cost in providing infrastructure to the 'spread out' developments currently planned which is, however, far outweighed by the massive transportation cost increases in the dispersed development now planned.

It is interesting to note what has occurred in the Gardens/Mindil

Beach area since World War II. I have copies of aerial photographs taken sometime in the 1940's and in 1983 which show how an area of what could be described as coastal waste land - very unattractive - was converted, largely by sanitary land fill, to become perhaps the most attractive part of Darwin, in areas such as Palmerston Park, the Botanic Gardens, The Gardens ovals and Mindil Beach. I wonder if this land reclamation would have been allowed to occur in the 1980's?

In conclusion I ask two basic questions:

(a) Is there really anything 'unique' about Darwin Harbour mangroves?

(b) In this harsh environment with relatively high-living costs, should the human needs for sea access and sea-side open space, reduction of biting insects and disease risk, cheaper land for housing, shorter transport distances etc. continue to be considerations subservient to hypotheses about the possible effects of a small percentage reduction of a vast resource of mangroves?

SESSION I DISCUSSION SUMMARY

Chair - Barry Russell

In the first session of the Workshop speakers examined definitions and perceptions of the coastal zone resource. Graham Bailey outlined the planner's view of coastal resources. He pointed out that much of the planners' experience in Australia relates to the southern part of our vast continent, and there are few planners with experience of coastal and tidal wetlands, and even fewer with specific knowledge of the Australian Monsoon region. Bailey discussed the way in which the planner's perception of the coastal resources differs from that of the biologist. He pointed out that the planner's role is one of balancing different views, the ultimate arbiter being the community. Peter Saenger broadly defined the mangrove resource from the biological viewpoint, and then examined the various ways in which people have perceived this resource. He then looked at the values of mangroves as a resource, and finally discussed ways in which these values can be maintained or optimised in the face of various competing uses. David Veal presented a quite different view - that of the developer faced with ever increasing human demands for industrial development, living and recreation space. He raised important questions such as should mangroves be preserved at all costs? Are there any significant effects arising from development of very small parts of our vast resource of mangroves? And should human needs always be subservient to ecological values of the resource?

The Discussion began with the Chairman suggesting that a common issue to emerge from all three speakers was the need to understand more about the coastal environment and its processes. Lyn Allen raised the question of energy flow from one area to another and the relatedness of different areas. Veal questioned the significance of this in relation to small scale development and commented on the desirability of obtaining some measurable or quantifiable evidence of any effect.

There was then some discussion of the Darwin Harbour Development Plan which had been presented earlier by Bailey. Allen commented that a very large area on the eastern side of the Harbour was proposed for industrial development and questioned Veal's statement that the developers were not really interested in encroaching on large areas of mangroves. In reply, Bailey stated that the Development Plan is very diagrammatic and at this stage is simply a document inviting comment, and that as yet there is no firm commitment to any particular scheme. He pointed to the urgent need, however, for expert information on which to base future planning decisions such as those prefaced by the Plan. Graham Wells took up the question of the suitability of mangrove swamp reclamation for development, pointing out the extreme vulnerability of such areas to storm surge and cyclone damage, especially when the buffering effect of mangroves has been interfered with. Veal also expressed surprise that the planners should consider mangrove-reclaimed land suitable for industrial development. He suggested the high cost of reclamation, possible tidal inundation, and the nuisance value of mosquitoes would naturally deter developers even in the absence of any other controls.

The Chairman commented on the need for some sort of orderly planning process but questioned how this might occur, particularly as there seems to be so little cross-contact between professionals in different areas of interest. Saenger endorsed the need for cross-fertilisation of ideas and gave the example of the Great Barrier Reef Marine Park planning process which involves widespread public and professional participation and has been hailed as a great success. Martin Jacob commented further that the planning process should be a continuing one and that because of our lack of knowledge any decision we make today will be piecemeal. He suggested that as a consequence, decisions should therefore be conservative and subject to future modification. Saenger then enlarged on his original discussion on the 'tyranny of small decisions'.

Keith Presnell made the point that our perceptions of mangroves very much influence any development decisions which are taken and that we should regard mangroves as a resource and not as a nuisance to be got rid of. He also pointed out that many decisions also are made for political reasons and that these may overide any careful planning considerations, for example the Mindil Beach Casino development. Jim Davie suggested that perhaps the values of professional planners and developers lags behind the forefront of evolving community values.

Brian Lee shifted the discussion in a different direction by reminding the audience of evidence brought out in the Conference that compared with 6000 years ago, there are only 1-5% of mangroves remaining today in the N.T. He suggested that perhaps the scale of natural changes may be so massive as to render man-induced changes insignificant. In reply, Saenger suggested that the important time scale for man is one of the order of only 50-60 years. The Chairman commented further that since we have only such a small fraction of mangroves remaining today perhaps this argues for even greater conservation of the remaining resource.

The Chairman then raised the problem referred to by the non-biologists of the need for a greater understanding of how our coastal ecosystems function, and of the necessity to provide answers to the many questions which relate to development. Saenger discussed the efficacy of a systems approach to this problem. He suggested that a fairly coarse level of predictability can be easily achieved by such an approach, even without detailed data, and that in most cases some sort of informed decision can usually be made. He agreed, however, that our ecological systems need to be better understood. Bailey pointed out to the audience the need to come up with answers quickly otherwise the decisions will be made regardless. Paul Broese also pointed out the need to properly document and build up information at the ecosystem level, well before questions of development arise.

Allen Kearns was invited by the Chairman to comment on the need for information in decision-making, from the consultant's point of view. He made the point that much detailed scientific information is being collected from areas other than those under pressure, and that a lot of scientific studies are trivial in the context of the sorts of questions faced by decision-makers. He felt scientists should address more practical problems and should not be so critical of coarse-grain decision making. Saenger agreed that it was unfortunate that scientists often failed to be interested in more applied areas of research, and he largely blamed the tertiary education system for this. Broese also pointed out that often there is political channeling of money into certain research areas, and neglect of others. He gave the example of the tremendous scientific effort in the Alligator Rivers region.

Session II - Policy Formulation

Coastal Management Policy Considerations - Barbara Singer and Peter Wright.

Some Sociological Considerations Relating to Human Perception and Recreational Use of Coastal Ecosystems - Phillip Pearce.

The Relationship between Coastal Engineering and Coastal Management - Martin Jacob.

Discussion Summary - Russell Hanley.

COASTAL MANAGEMENT POLICY CONSIDERATIONS

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Introduction

What is the 'coast'? Most of us have an intuitive feeling or conception for what we call the 'coast'. Sandy beaches, mangrove mud flats, sea cliffs usually come into consideration. But what about the seaward side? Does the coast also include the intertidal zone, estuary foreshores and margins, the seabed and offshore islands for instance? Are there other areas that should also be included?

Because of the complex interaction between land and sea and the number of factors that can impinge either directly or indirectly across the land-sea interface, it is extremely difficult to establish a precise definition of the coastal zone. Where this has been attempted elsewhere, there have invariably been problems because lines on maps do not recognise the dynamic inter-relationships between different elements of the coastal environment. The alternative is to consider a more flexible definition that allows a more practical approach to individual situations.

For this reason and for the purposes of this paper the coastal zone is seen as encompassing those areas of the sea, land and waterways in close proximity to the coastline, including offshore islands.

Coastal Resources

Given the above definition, the coastal zone offers a rich and diverse range of resources for the use and benefit of society. These include :

(a) waters - for navigation, industrial cooling, transport and recreation;

(b) fisheries - including important habitats and sources of nutrient in estuaries, wetlands and mangroves;

(c) port sites - including areas for marina facilities;

(d) land - for industrial complexes and residential development;

(e) minerals - including oil and gas, mineral sands and limestone;

(f) tourist sites - including aesthetic scenery, reef viewing and game fishing;

(g) recreation sites for the local community - including beaches and sheltered waterways;

(h) natural environments - including wildlife and conservation reserves and sanctuaries, areas of educational and scientific interest, and marine parks;

(i) archeological and anthropological sites.

There will always be differences of opinion as to which uses of these resources should take priority, and the way in which some areas should be managed. This will arise because of the overall impact of user pressure or because the particular resource for which users are competing is scarce.

Many of the resources which combine to create the coastal zone represent a fragile and sensitive environment which can be easily damaged

through mistreatment or ill-advised development. All too often, coastal resources are unnecessarily abused, and even lost, due to a lack of knowledge of the special characteristics of coastal systems, and insufficient care and attention to planning on the part of the user. For example, buildings being located on frontal dunes, poorly designed and located roads and stormwater outlets, mangroves unnecessarily isolated from tidal water, indiscriminate release of pollutants into coastal waters, uncontrolled use of off-road vehicles, and so on.

As a consequence the economic and social cost to the community can be considerable.

With careful planning and management, the coastal zone is capable of successfully accommodating a wide range of development and human activities, and many of the problems arising from the inherent sensitivity of the coastal elements and from user pressures and conflicts can be minimised.

Northern Territory Situation

In the Northern Territory, pressures on the coastal zone have not been as severe as elsewhere in Australia due to our smaller population and relatively sparse concentration of people along the coast, with the exception of Darwin, Nhulunbuy and a few other smaller settlements. Even so, serious problems and conflicts are emerging more frequently with the growth in our population, increasing industrial development, greater demands for coastal recreation areas and growing competition for coastal resources in general.

Recognising the problems faced elsewhere and wishing to avoid similar situations occurring here, the Northern Territory Government has announced its intention to introduce a coastal management policy to provide an effective approach for co-ordinating and guiding future decisions on the use and protection of the Territory's coastal resources.

The Conservation Commission has had a major input, along with the Department of Lands, in the development of a suitable policy proposal. This proposal is yet to be formally considered by the Government so that any comments addressed to the policy in this paper must be taken in that context.

Before examining the philosophies and directions of the proposed policy however, it is appropriate to make brief mention of the Commission's specific involvement in coastal management activities.

The Role of the Conservation Commission in Coastal Management

The Commission's areas of responsibility include a number of activities that have direct relevance to the coastal zone -management of parks and reserves, wildlife research and management, soil conservation and land resource appraisal, environmental assessment, forestry and urban park development.

Parks and Reserves

The value of and need for coastal protected areas received wide recognition at the 3rd World Parks Congress in Bali in 1983. In the face of ever-increasing competition for coastal land it was considered essential for specific coastal areas to be protected, preferably in a system of parks and reserves. Protection does not mean that such areas are locked away from the community or development, rather it is recognised that special precautions need to be taken to ensure that the ecological, historical or cultural values of these areas are not threatened by incompatible land uses.

The Commission has a number of parks and reserves under its control, management, or influence which border the coastline and serve to protect coastal features (beaches, wetlands, estuaries, coastal rainforests). These include the Vernon Islands, Indian Island and the Cobourg Peninsula.

Cobourg Peninsula contains two parks, the Gurig (Aboriginal) National Park and the Cobourg Peninsula Marine Park, the first marine park to be declared in the Northern Territory. Closer to Darwin the Commission has 'developed' and manages the popular Casuarina coastal reserve which provides a valuable coastal recreation opportunity for local residents and visitors.

Coastal Dune Conservation

The problem posed by mobile sand dunes, resulting from the destruction of dune stabilising vegetation, is a matter that has arisen in a few localities in the Northern Territory. Through action under the Soil Conservation and Land Utilisation Act the Commission can restrict entry to the damaged area and undertake works to restabilise the dunes. This action has been undertaken at Cox Peninsula and is being considered at Cape Arnhem near Gove, where unrestricted beach access is leading to serious erosion problems. Along Casuarina beach, part of which was rehabilitated by the Commission during the 1970's following sand mining operations, fences and specially constructed walkways have been used to reduce damage by trampling.

Marine Wildlife Research and Management

A significant component of the Commission's Wildlife research programme includes studies associated with aquatic fauna such as crocodiles, turtles, dugongs and marine birds. The information gathered on population distribution habits, harvesting effects, and so on, assists in the development of appropriate protection and management programmes for these species.

Coastal Resource Mapping

The land resources of much of the Northern Territory have been mapped over the past 20 years, however, only recently has specific attention been paid to the coastal resources, including land and sea. A rudimentary coastal resource data base has been prepared by the Commission and will be continually added to with information such as turtle breeding beaches, sea grass beds (for dugong habitat), crocodile nesting areas, mangrove distribution, historic shipwrecks and ruins. The uses of such an atlas are many, and an early use will be the identification of ecologically sensitive areas, of high conservation value, for planning in the event of serious oil spills. Ultimately the information will need to be computerised to enable efficient updating, data manipulation and modelling.

Environmental Assessment

The Commission also administers the Environmental Assessment Act which commenced operation on 4 July 1984. Although applicable to all developments in the Northern Territory which are likely to have a significant environmental impact, the Act has special application to developments in the coastal zone. The Act provides for the preparation and public review of Environmental Impact Statements, which will enable the community to examine relevant coastal development projects, their expected environmental impacts (both detrimental and beneficial) and safeguards proposed to ameliorate adverse impacts. The legislation therefore provides greater public participation in the planning process and enhances government decision making in this critical area.

The Commission's role in the coastal zone therefore ranges from resource assessment and planning at the very early stages, through management of select areas, to the restoration and rehabilitation of degraded areas. With its regional structure, research facilities geared to environmental management, and its role in the administration of legislation for soil conservation, environmental assessment and land and wildlife conservation, the Commission is well equipped to contribute to successful coastal management in the Territory.

Coastal Management - the Northern Territory Approach

As mentioned earlier, the Northern Territory coast has not been subjected to the same development pressures and land-use conflicts experienced elsewhere in Australia. Our coast is characterised by large expanses of tidal mangrove flats, relatively few accessible sandy beaches, few large coastal settlements, and restricted land access to the coast. At the same time, a great percentage of the coastline is located within Aboriginal land, remote from population centres, and is not freely available for development or recreation. Whereas southern coasts have been subjected to a long history of competing development activities, pressures on the Northern Territory coast have only recently reached this stage, and even now, most problems are restricted to localised areas close to Darwin.

Even so, since the mid-1970's there have been repeated calls for a more co-ordinated approach to coastal management in the Northern Territory to ensure more effective handling of the problems and conflicts that do arise.

The development of a coastal management policy has been underway for some time and has been the subject of many discussions, meetings and redrafts. It could be argued that the process of developing a coastal management policy has as many pitfalls in terms of the range of conflicts and differences of opinion, as have traditionally plagued the management of coastal lands and resources themselves.

The basic philosophy behind the proposed coastal management policy is that the coast is a particularly valuable economic and community asset which is finite, environmentally fragile, and vulnerable to misuse.

Management must therefore be geared to achieve sustainable use rather than short-term exploitation and unacceptable degradation of the resource base. The adoption of this philosophy is in accord with the Northern Territory Government's acceptance of the principles of the World and National Conservation Strategies.

The principal aim of the proposed policy is therefore to integrate conservation and development of the coastal zone to optimise the social and economic benefits for present and future generations.

The specific objectives needed to guide such a policy would be as follows:

(a) to ensure that all significant development proposals relevant to the coastal zone are subject to environmental assessment, including review by interested agencies and the public;

(b) to ensure that planning priority is given to those uses which depend on a coastal location;

(c) to protect areas of high conservation value through the establishment of marine and coastal parks and reserves;

(d) to identify and protect areas of cultural and historical importance;

(e) To promote rehabilitation and enhancement of damaged and degraded

areas within the coastal zone; and to encourage research into coastal processes and matters related to coastal zone planning and management.

Terms of Reference

The terms of reference for determining an appropriate policy approach for the Northern Territory essentially requires the development of a policy that would:

(a) assist in meeting the objectives outlined above;

(b) adequately recognise and accommodate existing administrative and legislative arrangements; and

(c) establish a mechanism that would provide for an overview of coastal planning and management, co-ordination of activities in the coastal zone and advice to Government on coastal matters.

Policy Approach

The management approach adopted in the Northern Territory must take into account existing administrative and legislative arrangements. More than 20 items of legislation apply to the coastal zone and a large number of Government bodies and various Councils have administrative responsibilities for coastal resources. This makes co-ordinated management and efficient planning of the coastal zone difficult and has resulted in a fragmented and somewhat ad hoc approach in the past.

The Northern Territory is in the fortunate position of being able to review the stategies adopted elsehwere in Australia and overseas and to assess their applicability to the Northern Territory situation. A common approach elsehwere in Australia has been the establishment of a separate coastal management authority, with or without relevant legislation. There have been a number of calls in the past for this approach to be adopted in the Northern Territory and there are some advantages in a permanent body with specific responsibilities and expertise which can co-ordinate the activities of departments and authorities with coastal zone responsibilities. At this stage, however, the Northern Territory situation does not warrant the establishment of a new body as this would unnecessarily duplicate existing resource planning and management functions and require considerable amendment to existing legislation and administrative arrangments.

Instead of a separate statutory coastal authority, a mechanism is needed that will enable more effective co-ordination of existing administrative responsibilities to impart an overall sense of direction to coastal management programmes and provide a basis for the determination of agreed priorities.

In this regard, it is considered that the Northern Territory's needs could best be met by the formation of an executive level co-ordinating committee; the development of management plans for key areas of the coastal zone; and preparation of a coastal resources inventory.

Coastal Management Committee

The formation of a Coastal Management Committee would ensure that decisions affecting coastal land uses are not made in isolation. Under the arrangements proposed, all Northern Territory government departments and authorities, and local governments, will be able to be involved in the planning of developments in the coastal zone.

Briefly, the Committee is seen as having the following functions:

(a) identify areas that should be subject to detailed examination through the preparation of Coastal Management Plans;

(b) advise Government on coastal planning and management issues and provide specific advice to the Northern Territory Planning Authority in relation to coastal development proposals;

(c) encourage co-ordinated planning for future use of the coastal zone and the involvement of interested parties and the public in that planning;

(d) encourage Departments and Authorities to review the adequacy of regulatory legislation relevant to coastal areas with particular emphasis on standards to mitigate pollution or degradation of the coastal environment;

(e) encourage research in relation to improved management and protection of the coast.

Coastal Management Plans

The principal mechanism for achieving the objectives of the Policy will be identification of parts of the coast under greatest pressure and the preparation of coastal management plans for these areas.

The concept of a coastal management plan is that of a document which can guide the application of a variety of different management tools - subdivision and development control; works programmes; construction of roads; regulation of off-road vehicles; declaration of soil conservation orders and water control districts; establishment of marine parks; and so on.

Plans would be prepared for areas of the coast that are:

(a) subject to or required for use or development that is likely to have a significant environmental effect;

(b) being degraded; or

(c) required for public use and enjoyment.

The purpose of coastal management plans would be to examine existing resources, specify management objectives and provide firm guidelines for the future management of each identified area.

Coastal Resource Inventory

One of the first tasks identified as being essential to the effective implementation of the proposed policy will be the compilation of a resource inventory of the Northern Territory coastal zone.

Preparation of management plans and coastal planning and management programmes in general, must be based on a sound understanding of the physical, social and economic resources available for use or requiring conservation, and of potential conflicts arising from competing demands for those resources.

Obviously, a detailed inventory of the resources along the entire Northern Territory coast would be an enormous task and is unlikely to be warranted in the present circumstances. Initially, such an inventory would aim to produce an overview of the Northern Territory's significant resources with a view to identifying priority areas requiring more detailed study for planning and management purposes. This data base would need to be continuously updated as more relevant information becomes available.

Much of the information to compile this initial inventory already exists in various quarters and the essential task involved is to put it all together in a practical and useful form. As mentioned earlier, the Conservation Commission has commenced this process and, in the event that a Coastal Management Committee is formed, it would be appropriate for this work to come under the Committee's area of responsibility.

To conclude, it is unlikely that any coastal management policy will provide universally acceptable solutions to all coastal zone issues and satisfy all the interests of the parties concerned. However, putting in place a policy that provides a common framework to enable improved consultation and information exchange on coastal issues, co-ordinated responses to coastal problems and a more systematic basis for arriving at decisions affecting the use of coastal resources, can be beneficial to all those concerned, irrespective of their philosphical viewpoint.

Implementation of such a policy has to be seen as an evolutionary process. The initial policy will need to have sufficient flexibility to allow for change and refinement in the light of experience. Its success will depend to a large degree on the enthusiasm, co-operation and commitment of those involved.

SOME SOCIOLOGICAL CONSIDERATIONS RELATING TO HUMAN PERCEPTION AND RECREATIONAL USE OF COASTAL ECOSYSTEMS

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Introduction

A useful point to emphasise at the beginning of any analysis of human impacts on delicate environments is the new directions and perspectives available within contemporary sociology and psychology. For many specialists outside of these disciplines the human sciences have rather a fuzzy image, a kind of amalgam of grand scale theories of human organizations as in traditional macro-sociology together with a study of human beings' unconscious desires, dreams and fantasies as in the old style Freudian psychology theories of per#onality. This confused image renders any paper or argument about the sociological considerations affecting resource development an unknown quantity.

In order to clarify the direction of this part of the workshop it is necessary to state that recent trends and developments in behavioural sciences offer concrete, empirically based, and conceptually developed approaches to human impacts. The developments have come from advances in evaluation work in sociology, particularly in terms of clearer research goals and better methods of analysis, and from a new applied environmental area within psychology where resource perception, resource use, and recreational behaviour have been studied in their own right. This research is being done in Australia as well as in the U.K. and U.S.A. and the plan for this Workshop is to document what is happening in the area of human impacts by focussing on three topics. Initially material will be presented which describes people's perceptions of coastal environments. This work will include a discussion of what the public thinks of natural environments, an analysis of public reaction to developments of different kinds and a study of tourists in coastal resorts in terms of their use of the environment.

Following this research work on human perception of coastal environments, the topic of human impacts on environments will be presented. In this discussion the different forms of impact will be mentioned, and a model of tourism/recreation impacts on coastal environments will be presented. It is not enough, however, just to describe and catalogue impacts. If sociological and psychological researchers and consultants are going to have anything to say to planners, developers and conservationists, then some form of insight or superior understanding must be produced in their studies. The third part of the present discussion will therefore attempt to show what is special or different about recent sociological and psychological studies of people in recreational and tourism environments. In particular, the need for interpretation of the environment will be emphasised. For reasons relating to time and space this paper concentrates on recreation/tourism/leisure considerations in relation to coastal resources rather than mining, agricultural and residential developments.

Perception of the Coastal Resource

Mark Fenton, now based at W.A.I.T. in Perth, has been looking at people's response to mangrove and coastal scenes. Using large wall-size sequences of slides he has asked people to rate hundreds of photographs of environments along dimensions of complexity, mystery, appeal and dangerousness. In one of the few systematic studies of how non-specialists see these Northern Australian coastal areas he has found that

five content dimensions are used by people to discriminate among scenes of mangrove environments. These dimensions are (a) open grassland -enclosed forest, (b) barren versus green and vegetated, (c) whether the scene is comprised mainly of land versus water, (d) natural versus man-influenced and (e) walking paths. Interestingly, these dimensions did not relate closely to the dimensions unearthed by American researchers for public perception of natural environments. More importantly, Fenton (1984) demonstrated in a series of studies that while individuals differed in the importance they attach to each of the above dimensions, overall 80% of subjects' aesthetic responses (i.e., liking for the environment, how interesting the environment was and the amount of time they would like to spend looking at it) were explained by the way subjects categorised the settings.

The implications of this kind of study for policy and planning is that people arrive at a setting with a crude category scheme for making sense of the visited world. Once an environment is categorised a certain way its aesthetic response is also determined. The challenge for environmental educators is to build on and expand the visitors' natural environmental categories, to demonstrate new and beautiful and mysterious aspects of places to advance people's understanding and hence to challenge their categorization and to heighten their appreciation.

A second study, conducted by Ros Stanley, one of my students, examined public reaction to different forms of coastal development. Although this work was based on a hypothetical set of coastal developments, it used as a starting point the premise that public comment on coastal development should be taken seriously. It can be suggested that our present means for eliciting public comment on new developments is poor. Few people, and then usually those with a vested interest, bother to comment on proposed developments. In Stanley's (1982) research she produced sketches and newspaper style releases of eight variants of the same development. Thus she was able to vary such factors as bush versus seaside, tourist versus residential development and a high versus low contrast between the development and its setting. She found that two sets of factors influence people's responses to different forms of coastal regions. The first set of factors related to aspects of the development itself. Tourist developments are evaluated more favourably than residential developments where there has been little previous development. Low contrast (not high rise) and small scale developments (less than 300 people) were preferred. There is a clear and probably accurate accompanying perception that such developments can have an acceptable level of ecological impact. The most useful attitudinal or value scale employed was one of Antiquarianism. It was found that the Townsville sample scoring high on this value perspective (indicating a liking for old fashioned buildings, furniture and objects) were most strongly opposed to all forms of development. A genuine detailed assessment of public reaction to development plans, almost to the extent of public voting for development proposals, is one direction for further development of this work.

A third study, one of my own (Pearce 1981), looked at how tourists visiting Queensland's offshore islands used the environment and how they were affected by it. The people involved included tourists both from Queensland and from southern States. (1-6 day package holidays.) It was clear from the results which were obtained from diaries and daily questionnaires that initially tourists were content with the planned, resort-initiated and not very environmentally conscious activities. After three days however, many tourists became disenchanted with the disco and bingo style activities and began to seek more self-initiated, environmentally involved activities. On both Hinchinbrook and Brampton Islands, tourists were the most negative in terms of dissatisfaction and low mood scores after three days, just before they began to get involved with the environment. It was also noted in the study that the negative impact of the environment on the tourist (in terms of sunburn, insect bites, etc.) was greatest on the third day as well (the phrase "third day blues" was used in relation to subsequent publicity of this work). It is possible to interpret the findings of this island based study in terms of a

need for environmental interpretation and education. The negative mood states and, even on the part of some tourists, a desire to leave the islands and cut their holiday short, represent a dissatisfaction with the more manufactured and synthetic tourist style of resorts. Some tourists are implicitly requesting something more. it is important to understand more about coastal resource developments, the forms of tourism which exist in a region and the kind of tourists who come to an area to appreciate fully when and how to develop the 'something extra' or missing component of such holidays.

The preceding section of human perception of the coastal environment suggests, from three different perspectives that public perception, involvement in decision making and use of the environment could benefit from greater public knowledge of the relevant ecosystems.

Impacts of People on the Resource

So far, I have been emphasising how people see the coastal environment.

A related behavioural science contribution to the study of coastal resources lies in assessing the impacts of people. A number of these impacts develop out of people's perception of the resource but there can be many indirect as well as direct impacts. For example, recreational fishing may change fish population numbers in a very direct way, but pollution resulting from new coastal industries and human habitation may have even more drastic indirect effects on several levels of the food chain. Specific coastal impacts that have been well documented in the overseas research as a consequence of increased recreational development and the use of recreational vehicles, include gross changes to vegetation patterns, sand and beach erosion, changes in fauna populations and aesthetic damage through the growth of architecturally foreign structures in the local settings. The loss of recreational settings for local people may also be a consequence of high priced tourist development.

It can be suggested that simply cataloguing impacts is insufficient; sociologists and others need to provide models of what is happening at various stages of development to assist planners and government bodies. It is worthwhile therefore to outline what may be called a succession model of recreational resource development. This model is based on a close examination of what has happened to natural environments in such places as Spain, Greece, Scotland, Mexico, Singapore, France and Southern Queensland. At the heart of the succession model is the idea that tourist destinations may be thought of as being in a particular stage or category of development.

An area is 'discovered' by an explorer/anthropologist and then by the 'very rich' who popularise the destination widely. They are followed by the upper middle-class. Later a broad range of middle and working class groups follow. At each stage the necessary facilities increase, as does environmental degradation, while positive social contact declines. As the location becomes broadly popular, the very rich and jet-setters either leave, or zone themselves within the setting in an extremely high priced ghetto. Large, well organised business interests make profits from this pattern. As succession unfolds, the quality of tourist experience declines and community hostility to tourism increases. In its final stage of massive hotel development, high tourist densities and often marked cultural differences between tourists and locals, this developmental cycle produces the worst sorts of social impacts. In addition, if the capital organisation is external to the local community, minimal economic benefits accrue to the region. This, however, is not the only sort of tourist development possible.

A second model is that of Alternative tourism. This model involves the economic recognition that certain economies of scale are inevitable, for example, air transport depends on full planes. It also accepts that

large numbers will come into a community at once. However, this model challenges the conventional big development, succession model of tourism on at least three important points. First, it is total profit to the region, rather than total tourism profit, which is what matters. Second, it accepts that social/environmental impacts are real factors to be considered in tourism development, and involves a cost which, moreover, goes beyond token efforts to placate lobby groups.

It is important to note that destinations in a particular category attract tourists who are themselves at a particular stage of their own travel career. The travel career notion holds that the motivation people have for visiting holiday environments may change during their life cycle. Travellers progress along a career path from fun and relaxation style holidays, through to family based holidays, through to holidays with a sense of status and then a deep concern for the environments and the uniqueness of places. As is the case with other applications of true concept of 'career', individuals need not start at the bottom but according to their education, interests and family background may start their careers at the status of even the environmentally concerned level.

The notion that people have a travel career relates closely to the proposal that environments or holiday destinations go through a set of different stages of development. The whole thrust of tourism advertising and marketing should be to get people to the places which suit their needs. That is, tourists at a physiological career level (drinking, eating and indulgence) are not those to attract to National Park settings. Similarly, the environmentally conscious career level tourist who is seeking special places is not suited to the Surfers Paradise context. It is necessary to research this process. Park managers, planners, interpretive staff need to know who is coming, not just in terms of visitor age and demographic status, but in terms of motivation and attitudes; the psychology of the visitor and his/her expectations. This information is important, as demonstrated in Fenton's (1984) study on the perception of mangrove environments, for building environmental education and hence limiting direct environmental damage through visitors' direct attack on sensitive ecosystems. The more indirect impacts also need control mechanisms. Here it is important to consider fully the model of tourism and the future of the tourist destination over the next 20-50 years. It is inappropriate to open up some environments to all comers. Advertising and marketing agencies should be screening the total tourist population and selecting the right people for the sensitive environments at risk.

In summary, direct and indirect people derived impacts need to be considered. I hope I have offered a small window to the recently growing world of behavioural science interest in environmental care, protection and education, particularly as it is facilitated by understanding tourists and recreational development.

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THE RELATIONSHIP BETWEEN COASTAL ENGINEERING AND COASTAL MANAGEMENT

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Coastal Engineering

Coastal Engineering may be defined as the interaction of man with the sea and the coastline.

The sea acts upon the coastline through waves and tides and its ability to transport solids. The effects of this action are normally slow but exceptional events such as storm surges and tsunami, can transform a coastline in hours which might otherwise have been stable for years.

The coastline is the terminating point for all rainfall run-off, and coastal areas often consist of alluvial deposits, generally in a saturated state. Where cliffs in sedimentary rocks occur, they indicate encroachment of the sea into what may have been land areas for millions of years. Volcanic activity has produced new islands and destroyed islands even in recent historical times. In general, coastlines are in a state of constant change.

Man, through his use of the sea for transport of people and goods, for disposal of waste products, and for residential and recreational purposes, interferes with the natural processes of erosion and accretion along the coastline. Too often man's interference occurs without consideration of the effects on the natural processes, many of which are complex and poorly understood.

The Sea

Waves

Waves on the surface of the sea have the same characteristics as other energy waves in nature. They are normally described in terms of height, wave length and period or velocity. Actual waves are made up of numerous wave trains all having different dimensions. For a given wind, the sizes of waves in deep water are reasonably predictable. For example, in Darwin Harbour during the dry season, the south-easterlies often blow with a mean velocity of 15 knots gusting to 24 knots, for a period of 3 or more hours in the morning. At the Darwin wharves the wind has a fetch of 4.5 miles across water. Empirical formulae estimate that a significant wave height of 0.2m will develop after 1.5 hours and remain at this figure for the remainder of the period. The significant wave height is defined as the average of the highest one third of all waves. The maximum wave height during the period will be about 0.35m. The dominant waves will have a length of 28m and a period of 4.25s.

Waves off the entrance to Darwin Harbour in the wet season with a 20 knot WNW wind blowing and unlimited fetch, would have a significant wave height of 1.5m after 6 hours and over 2m after 24 hours. The maximum wave height would be over 4m with a length of 60m and a period of 6s. These waves will already have breaking crests in deep water, but as they approach the shallow water off Casuarina Beach, they will become steeper and higher with the tops spilling continuously down the faces of the waves. At high water, the waves may not 'trip' until they reach the steeper part of the beach when they steepen rapidly and become plunging breakers with the top

curling over as in classic photographs of surfboard riding.

Due to the width and shallowness of the continental shelf surrounding the Northern Territory coastline, the true ocean swell generated by strong winds in deep water seldom reaches our coasts, although wave heights of 8m, with a period of 12s, have been predicted for cyclonic conditions. These waves could increase to 12m high in shallow water and cause considerable damage above the still water level.

The effect of waves on a coastline depends on the size of the waves and the material forming the foreshore area. Small waves on a sandy beach will produce a nett movement of material up the beach because water carrying sand particles up the beach soaks in and drains back to the sea through the sand. Large waves, on the other hand, have a nett seaward flow across the surface of the beach and thus cause erosion. This effect is quite noticeable on the Fannie Bay beaches which generally build up during the wet season, but if a strong on-shore wind occurs near high water the slow accretion gained during the period of gentle waves is removed in a matter of hours.

If waves strike a shoreline at an angle, particles will be moved up and down the beach in a zig-zag line, the nett movement being in a downwind direction. This is the main cause of littoral drift.

Waves impacting on a cliff face create pressures which are large enough to move large rocks and open up fissures in the face. Waves, of the size predicted for the entrace to Darwin Harbour during the wet season, have been shown to produce pressures of 100kPa on a vertical wall. A rubble breakwater with side slopes of 1 to 1.5 would need armouring with rock weighing 10 tonnes in order to prevent damage by such waves.

Tides

The gravitational pull of the moon and the sun on the oceans combined with the centrifugal forces of rotation, cause the surface of the oceans to take up a slightly elliptical shape around the parallels of latitude with a maximum elevation above mean sea level of about 0.5m in mid ocean.

As these humps approach shallow water near a coastline they are magnified. If the coastline includes gulfs, bays or tidal estuaries with natural hydraulic frequencies near to the tidal period of 12 hours 25 minutes, the tides in those areas will be greatly magnified. The Bay of Fundy between Nova Scotia and New Brunswick has a spring tide range of 15m and the Severn Estuary in England and the Raz du Seine in France have tides of 14m. Tidal velocities in these areas often exceed 6 knots and the turbulence created enables the sea to carry high silt loads. In the River Thames, for example, the silt load can be as high as 10,000 parts per million at the surface and 50,000 parts per million at the bed. Due to the geographic shape of many semi-enclosed seas, the ebb and flow velocities along a particular coastline may not be equal, thus leading to a nett transport of silt in one direction.

In a tidal estuary with a substantial fresh water inflow, the salinity balance is maintained by a nett seaward flow of fresh water on the surface and a nett landward flow of saline water near the bed. Because water near the bed carries a higher silt load, there is a nett movement of silt up an estuary. The deposition point of the silt will depend on the geography of the estuary and the ratio of fresh water flow to tidal flow. Some rivers, though tidal, may contain only fresh water right down to the mouth, and any silt will be deposited in an off-shore bar.

Storm Surges and Tsunami

The geographic factors which create large tidal ranges will also tend to magnify storm surges and tsunami. Tsunami, is the Japanese word for

tidal waves created by undersea earthquakes and volcanoes. The Territory coastline appears to be unaffected by tsunami, protected as it is by islands to the north and east. However, I am not aware of any records at the time Krakatoa erupted in August 1883.

Storm surges can have very significant effects on the Territory coastline. The highest authenticated storm surge ever recorded in Australia, occurred at Groote Eylandt in 1923 with a level of 6.6m above normal tide level. The Gulf of Carpentaria is susceptible to storm surges in that it provides the warm water necessary to maintain a cyclone, and its shallowness allows wind induced surface drift to build up the sea level on the downwind shoreline.

The storm surge in Darwin during cyclone Tracy was 1.6m. However, this occurred on a neap tide and the peak of the surge did not coincide with the high water. It is estimated that the storm surge at Casuarina Beach was about 4m due to the effect of wave set up in that area.

The Coastline

Changes in Mean Sea Level

In geological time there have been vast changes in sea level relative to different land areas. The theory of continental drift does not just involve the horizontal movement of land masses but also involves the raising and lowering of different parts of those land masses. This movement is still going on. For example, the south-eastern corner of England is sinking at the rate of 300mm a century.

The amount of water trapped in the ice caps has a very significant effect on sea level and appears to have varied very considerably over relatively recent geogological time. If all the ice in the ice caps melted, the level of the oceans would be raised by over 30m. The normally accepted view is that the Earth is still warming up from the last ice age which reached its peak some 15,000 years ago. The mean sea level is therefore rising although land previously covered by ice is also rising relative to the sea due to removal of the ice load.

To what extent movements of the land relative to the sea are slow and predictable and to what extent they are due to local or even global catastrophies, is difficult to determine. The still standing columns of the Temple of Jupiter Serapis on the Bay of Naples indicate that in the last two thousand years the relative land/sea level has varied by some 10m. An earthquake in New Zealand in 1931 reduced the depth in Napier Harbour by 2m. There is evidence that much greater catastrophes have occurred in relatively recent geological time.

Erosion and Accretion

If we apply the natural law which states that nature tends towards a minimum level of energy, then there would be no land, only a uniform surface covered by a uniform layer of water. In other words, erosion is a more normal state than accretion along the coastline. The considerable width of the continental shelf across the north of Australia indicates the extent of change that has taken place since Australia became an island.

The Northern Territory coastline consists mostly of sedimentary rocks from the Paleozoic or earlier ages sometimes overlain to varying depths by recent alluvial deposits, particularly near river mouths.

It can be divided generally into three main types: cliffs and rocky foreshore areas; beaches backed by sand dunes; and recent alluvial areas often supporting mangroves. The former two areas are generally eroding,

whilst the latter is accreting although local geographic conditions may change this pattern. The rates of accretion and erosion are generally unknown although locally structures such as the war time pill boxes on Casuarina Beach give some indication. As suggested earlier, rates of accretion and erosion are not constant and the actual long term processes may be reversed in the short term. Whilst knowledge of the wave climate, tidal flow, silt load, and fresh water flow may enable qualitative predictions to be made in relation to littoral drift, erosion and accretion, quantitative predictions can only be made by direct measurement over a period of time or by model simulation. However, any prediction of the quantitative effects of abnormal conditions is likely to be unreliable.

Wind

Apart from the wave producing effect of wind on the sea, the direct action of wind on sand dunes has a significant affect on shaping the coastline.

Onshore winds, unrestricted by hills or trees, tend to be stronger than offshore winds. Sand deposited on the upper beach at high water springs, dries out and is carried by wind into the foredune area. This is more a feature of the East Coast, where dunes 20 to 30m high are not uncommon, rather than the Northern Territory coastline which is less exposed to periods of strong onshore winds. If the dunes are covered by vegetation, sand will not be blown further inshore and the dunes will act as a reservoir of sand protecting the low lying areas behind during storm conditions. If the vegetation is destroyed by being trampled on by man or eaten by grazing animals, the sand will migrate inland allowing storm waves to penetrate further into the coastline.

Man

Transport Needs

Man's dependence on the sea is indicated by the fact that 85% of Australians live within 50km of the coast. Early European settlements were established near natural harbours or navigable rivers. As the size of ships increased, it became necessary to build jetties and breakwaters out into deeper water and to dredge rivers. The export of large quantities of bulk cargoes has necessitated the construction of wharves several kilometres out to sea. Solid structures cutting across a line of littoral drift, will cause accretion on the up-drift side and erosion on the down drift side. Attempts to stop erosion on beaches often only moves the area of erosion further down the line.

Deepening of rivers by dredging is usually only a short term solution leading to a continuing programme of maintenance dredging. The Brisbane River was progressively deepened from 4.6m at low water in 1893 to 11.6m at low water in 1976. The annual cost of maintenance dredging in that year was $2 million or $4 million at 1984 prices. Brisbane has partially overcome this problem by building a new port at the entrance to the River at a cost of $100 million, although some dredging is still required to service up river wharves and to reduce the probability of flooding in the city during periods of high fresh water flow.

Darwin Harbour, being a drowned estuary with little fresh water inflow and a large tidal range, has adequate deep water for present requirements. The entrance bar has a depth of 14m below mean sea level, sufficient for vessels up to 60,000 tonnes dead weight. Provided the tidal prism of the harbour is not reduced significantly by reclamation it is unlikely that there will be any reduction in depth over the bar. On the other hand, dredging of the bar is unlikely to be an economic operation as the sand movement in that area is fairly rapid and maintenance dredging

could be interrupted for lengthy periods due to rough water conditions in the wet season.

Residential Needs

Darwin and the Northern Territory have so far managed to avoid coastal ribbon development for residential purposes. Elsewhere in Australia, and particularly on the Gold Coast, mistakes discovered in the U.S.A. in places like Miami, have been repeated. One could go back to biblical times for warnings against building houses on sand, but in the last thirty to forty years not only homes, but multi-storey apartment buildings have been built on unstable foredunes. In Miami it is necessary to replenish the beach with one million cubic metres of sand every five or six years at a cost of $5 million. In 1974/75, the Gold Coast beach was replenished by dredging and pumping 1.4 million cubic metres of sand from the Broadwater at a cost of $1.8 million ($5 million at 1984 prices). Attempts to protect buildings and roads on the foredunes by building concrete walls or sheet piling, are often self defeating because they prevent the slow build-up of the beach during low wave periods. Beach replenishment by dredging offshore sand bars may also be self defeating in that it removes the only source of natural beach replenishment and increases the wave energy at the beach.

Coastal towns cause changes to the natural drainage, increasing and concentrating rainfall run-off. Sewer outfalls are laid across beaches and Darwin has its own monument to inexperience in this respect. The remains of the central zone sewer outfall can still be seen on the beach to the north of East Point.

Mining

Coastal sand deposits often form the most readily accessible deposits of heavy sands such as rutile, zircon and ilmenite. These have been mined extensively on the East Coast of Australia creating instability in some areas. The economics of mining in coastal areas should take account of the possible coastal engineering problems that might arise.

Recreational Use

Recreational use of coastal areas often creates a conflict between those who enjoy the coastline in its natural state and those who want easier access and other facilities. The provision of access itself can cause damage to sensitive sand dune areas as can be seen at Mindil Beach and to a lesser extent, at Casuarina Beach. Mindil Beach is already so altered from its natural state, and investment in facilities in the area so high, that beach replenishment at intervals is the only possible solution. The system of replenishment used in 1977, when scrapers hauled sand from the lower beach area to the foredune area during spring low waters, is probably the most cost effective. This was combined with a system of fencing the foredunes leaving narrow access paths to the beach. This had only limited effect due to the high density use of the beach on occasions such as the 'On the Beach Carnival'.

Fencing of the Casuarina Beach dunes has been more effective, but it is almost impossible to quantify the effect and thus apply an economic gain to the project in any cost-effectiveness analysis.

Coastal Management

The Northern Territory Coastline

The Northern Territory Coastline covers some 5,000km, the great majority of which has been unaffected by man. Well over half the coastline

is on Aboriginal Land although this does not mean that it may not be subject to development proposals in the future. The problems of erosion and accretion of coastal areas have only had significant impact, so far, on areas adjacent to Darwin, although minor problems do exist elsewhere.

Problems arise from the natural processes of erosion of cliff faces, the erosion/accretion cycles of beaches, the erosion of tidal swamps and marsh land, accretion in rivers and entrance bars and the high cost of attempting to stabilize the coastline.

Aims of Coastal Management

The aim of coastal management should be to ensure that the natural dynamic processes of the coastal zone and the planned use of that zone have minimal conflict. Where investment in structures on the coast is necessary or desirable, the cost of protecting that investment against possible changes to the coastline should be taken into account in the investment analysis and the cost borne by those making the investment. Too often, governments and private landholders see only the profit in developing coastal areas without being aware of the potential costs of protecting those areas.

One possible solution is to require a coastal environmental impact statement to be produced at the land allocation or zoning stage of planning or for any change of zoning.

Coastal Management Problems in Darwin

Two areas which have been subject to continuous development pressure over the last twenty years are Fannie Bay and the Frances Bay/Sadgroves Creek areas. They are very different geographically and worth looking at in detail.

Fannie Bay consists of a semi-enclosed area, 4km across the entrance and 2km wide with a gently sloping bed to a maximum depth of about 6m below M.S.L. The entrance is partly closed by a sand bar exposed shortly after half tide at its highest, southern point. Rocky cliffs of metamorphic phyllite with some siltstone, sandstone and ironstone, divide the Bay into four beach areas. Golf Club Beach and Mindil Beach are two sandy beaches originally backed by a foredune system which has long since been modified by Man. Vesteys Beach is largely a rocky foreshore with a thin covering of sand. Kahlin, or Cullen Beach, is a small sandy beach with the remains of a foredune system. Because of the prevailing northerly slant of onshore winds and the back eddy created by Emery Point on the ebb tide. there is a north to south littoral drift along the shoreline. This is noticeable adjacent to the lauching ramps of the Trailer Boat Club and Ski Club where sand has built up on the north sides. After periods of strong onshore winds, the excess sand at the southern end of Mindil Beach has been sufficient to block the outlet from the gully that discharges just south of the Casino. A more or less seasonal movement of sand up and down the beaches often obscures the effects of the littoral drift, but generally the quantity of sand at any cross section does not appear to vary greatly. The littoral drift movement must therefore be balanced by a system feeding sand to the northern beach. The most likely source of sand is the sand bar stretching north from Emery Point which is known to be fairly mobile. After cyclone Tracy the level of the bar was about 1.5m lower at the southern end and the area above low water springs extended further northwards. A rough estimate indicates that approximately 100,000m was moved 2km during the cyclone. It appears fairly safe to assume that the sand in Fannie Bay is circulating in a clockwise direction and that any dredging of the sand bar for reclamation purposes could affect the quantity of sand on the beaches. Comparisons of surveys of the sand bar taken in the 1930's and in 1970 suggest that the amount of sand in the bar is increasing. This could be due to sand entering the harbour from run-off in the wet season or some redistribution of sand in the Fannie Bay area.

In the long term, the cliff promontories are receding, perhaps as much as 5m per century, and this will increase the problems of stabilizing the beach front which has already been attempted in front of the Casino and the Darwin Sailing Club.

The Frances Bay/Sadgroves Creek area consisted originally of a mangrove lined creek discharging into a relatively sheltered bay. The bed and foreshore are largely recent alluvial deposits of mud varying from 1-8m deep with some rocky outcrops and beach areas, mainly formed of broken quartz. The western shore from the Stokes Hill Power Station to north of Dinah Beach has been totally changed. The breakwater for the Fishing Boat Harbour has reduced the cross-sectional area at mean tide level at the point by over 20%. In its natural state, the regime would have achieved a reasonably stable condition with the depth and width of each section being dependent only on the tidal volume. Silt washed down in the wet season would either be trapped in the mangrove swamps or carried out into the deeper parts of Frances Bay. Reclamation has two main effects; it reduces the tidal volume, thus decreasing velocities downstream and it reduces the cross-sectional area, thus increasing velocities at that section. Decreased velocities lead to siltation and increased velocities lead to scouring. The present regime consists of a narrow channel in Sadgroves Creek with depths up to 5m below L.W.S.T. but, as the Creek runs into Frances Bay, the depth reduces to less than 1m. Reclamation of the western shore should lead to an increase in depth in the lower channel because the reduction in cross section is much greater than the loss of tidal volume. Dredging a channel 3-4m deep, connecting the creek channel to the open harbour, may only be speeding up a natural process, although determining the natural line of such a channel might be difficult.

In general, the effect of changes to tidal estuaries with small fresh water flows and unaffected by wave action or littoral drift, can be predicted with economic limits.

SESSION II DISCUSSION SUMMARY

Chair - Russell Hanley

In the second session of the Workshop, participants addressed themselves to the problems of policy formulation. Barbara Singer presented a paper which detailed the Conservation Commission approach to the role of regulating the development of industrial and recreational facilities in coastal zones; their role being the assessment of likely environmental effects. Singer and Wright highlighted the problems encountered in the past by a lack of effective communication between government departments in the Northern Territory, but ended on an optimistic note with the suggestion of a committee which could be empowered to oversee all future planning in Darwin's coastal zones. Phillip Pearce's paper was concerned with the insights which can now be offered by sociologists and psychologists to planners, developers, and conservationists who are involved in determining resource use policies. The body of the paper dealt with peoples' perceptions of coastal environments, and tourism was used as a case topic of recent research into human impact. An interesting result of a study on tourists in Queensland suggested that, in general, people were sophisticated in their need to know more about the environment in which they were staying. Martin Jacobs' paper gave an audience composed largely of biologists, an insight into the difficulties faced by engineers responsible for the development of industrial and recreational facilities in a macro-tidal coastal environment of the kind found in Darwin.

Penny Figgis asked if all public demands for the use of coastal resources have to be met? Or are there some activities which should not be permitted in the coastal zone? As an example in the recreational area, dune buggies and trail bike riding were described as activities which had no tangible social benefit, yet were considered undesirable by many other people using coastal resources and were recognized as being ecologically destructive.

Jacob and Singer both replied that the ideal solution was to so divide the resources that all demands were met. It may not always be possible to do this, but when making decisions regarding land use the major criteria was to avoid siting incompatible activities side by side. Barbara felt that in some situations activities like trail bike riding and dune buggies could be permitted but would depend on an assessment of environmental impact considering scale of usage and the characteristics of the locality. It was also mentioned that examination of the appeal of coastal areas to trail bike riders and dune buggy enthusiasts might reveal a need for soft drift sand, which could be simulated elsewhere, disused quarries perhaps, without impingement on coastal resources.

Richard Phillips questioned the validity of the model of recreational development described by Pearce in which initial interest in a remote area comes from the wealthy few who have the personal resources and contacts to gain access to the region. They are then followed by an accretion of services and facilities leading to a rapid growth in tourism as other socio-economic groups discover they now have the resources to visit the region. Phillips put forward the example of the California desert where initial interest and use of the area came from the 'average working man', who drove his family out of the cities on the weekends and holidays to go camping in the desert. The result was a high incidence of recreational use and a significant environmental pressure on fragile desert habitats without the involvement of the wealthy, with no high-rise development or burgeoning infrastructure.

Pearce agreed that these were examples which did not fit his model but emphasized that the model did describe the development of places like Las Vegas and Florida very well. He stressed the importance of generalized models of recreational development when regional development plans are composed and felt that the Northern Territory could benefit greatly from observation of the mode of recreational development which had occurred

elsewhere.

The Chairman then asked Singer to comment on the likely size of any coastal management committee, given that there were many interested parties who would wish to provide information and comments on future development planning in the coastal zone.

In reply Singer considered a committee composed of all interested parties would be unwieldy as it would be too large. Therefore it was suggested a core group of four or five of the bigger departments would have executive level representation on the committee and there would be advisory groups made up from other interested parties who would be called upon as required.

Figgis asked if non-government bodies would also be given access to the committee. Singer agreed that this was necessary. Lyn Allen made the point that when non-government bodies are approached for their comments, the options have already been decided; clearly there was a need for greater involvement earlier in the decision-making process. Several people agreed it was often the case that consultation came after the decision to go ahead with a development project and that some government bodies as well as non-government bodies suffered in this way.

Peter Saenger came into the discussion at this point to suggest that large committees can sometimes be quite successful and provided the example of the Great Barrier Reef Marine Park Authority which has a consultative committee made up of State and Federal government departments plus non-government bodies; a total of 20 representatives.

Singer emphasized that no decisions have yet been made on the size, form, or powers of a coastal management committee.

Jim Davie asked if the committee would approach consultants (government and non-government) to conduct research identified by the committee as essential to the management process and stressed that careful consideration be given to the form of any research undertaken under the auspices of a coastal management committee, as the results of that research must provide a useful basis for management decisions. He also suggested it was therefore necessary for any committee of management to be provided with sound funding. Singer felt this approach was desirable and with respect to the research priorities noted that there is a sizable body of information on the mangroves of the region as evidenced by the papers presented at the conference. However, much of the information had been previously unavailable and much of it was in a form which excluded it from consideration in coastal management decisions. Singer indicated the Conservation Commission was undertaking a project to document the existing information on local mangroves and the location of that information.

John Brock asked if there was any intention to formulate a policy of floral protection in the coastal zone of the Northern Territory? Singer replied the Conservation Commission was examining the possibility of floral protection legislation.

Barry Russell questioned the effectiveness of the committee structure which had been proposed, saying there was little evidence to suggest itwould be able to exercise any influence in the decision-making process because it lacked legislative power. Singer felt it was a logical first step as it would formalise the cross-flow of information between interested parties. There were a number of informal groups or committees currently addressing the matters of importance in coastal planning. A formal committee would act as a focus, drawing on the information and recommendations of the informal groups and hopefully lead to a co-ordinated approach to the many problems facing those parties concerned with coastal management in the Darwin region.

Keith Presnell then suggested we examine the problem of the definition of a coastal resource. The general feeling was that there are serious

difficulties encountered in any attempt to delineate what is coastal and what is not. Consequently, it was felt that broad definitions were the best approach as they allowed greater flexibility. This was particularly so in the Northern Territory where much of the coastline is subject to macro-tidal systems. One of the examples given of where definitions can present problems is what to do when activities planned for catchment areas which may be hundreds of kilometres inland, are believed likely to effect downstream coastal resources? The general opinion was that in these cases, coastal management authorities should have the power to comment and make recommendations to the relevant bodies responsible for planning development in the hinterland.

Session III - The Implementation and Monitoring programmes in effective coastal management

Development Project Implementation and Environmental Monitoring Responsibilities of Government in the Northern Territory - Mike Bugler.

Practical Constraints on the Environmental Consultant in the Management of Coastal Zone Development - Allen Kearns.

Problems of Marine Ecological Monitoring in Northern Australia - Russell Hanley.

Discussion Summary - Jim Davie.

DEVELOPMENT PROJECT IMPLEMENTATION AND ENVIRONMENTAL MONITORING RESPONSIBILITIES OF GOVERNMENT IN THE NORTHERN TERRITORY

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Introduction

Government responsibilities for environmental management in the Northern Territory are carried out by the Conservation Commission of the Northern Territory (CCNT). The CCNT has two roles in coastal management: the implementation of policy; and the assessment and mitigation of environmental impacts.

The theory behind coastal management policy has been generally described in the paper by Singer and Wright. A brief reiteration of particular aspects is appropriate in relation to the present paper. It should be noted that the N.T. Government coastal management policy is still in draft form, so the following discussion must be considered theoretical.

If coastal management in the Northern Territory follows existing interstate models, the coastline will be split up into planning regions or districts. Each region will eventually be covered by a regional management plan that will, among other things, address the development potential and conservation value of the region. Particular regional attributes, in terms of renewable and non-renewable resources will be identified and the regional plan, which when complete will carry the endorsement of government, will become a blueprint for the management of the region.

All arms of government with an interest in coastal resources will contribute to the drafting of management plans and, since it is currently proposed that plans will be given the status of 'Planning Instruments' under the Planning Act administered by the Department of Lands, there will be opportunity for public input at the draft stage.

Each region of the coast will eventually therefore have a blueprint for development and conservation; these blueprints, will naturally have to be dynamic to take advantage of changes in resource status, but will provide the guiding framework within which the development of the coastal regions can take place. In practise, those segments of the coast already under pressure, such as the Darwin/Bynoe region and the Nhulunbuy Peninsula will need priority, but the actual pace and direction of implementing coastal management policy will depend to a great extent on the committee that is set up under the policy, the Coastal Management Committee, and the first role of the Conservation Commission in coastal management and the implementation of policy will be as a member of this Committee.

Once a development framework, or regional management plan, exists, a filter effect will be created whereby certain criteria will apply to the type of development acceptable within areas of the region. This is similar to the zoning structure already in place for Darwin itself, but there would be two major differences between the systems. Firstly, the framework identified by the Coastal Management Committee would be decided through a much wider community of contributors, and any alteration of the framework would require consideration by the same community; and secondly, the framework could cater for matters beyond zoning plans. An example here would be the development of Darwin harbour water quality criteria.

Any development proposal would have to meet the appropriate regional criteria, and these criteria would be taken into account when the environmental impact assessment (EIA) process is brought into the picture.

Administering the EIA process is the second role of the Conservation

Commission in coastal management. I propose to use a case study to illustrate this role because an explanation of the EIA process as it appears in the legislation, would require working through the aspects depicted as Figure 1. In practice, this apparently complex process can be reduced to a few key steps. A common task of the Conservation Commission in implementation is explaining this process to planners and developers. The simplified version is presented in Figure 2.

I do not propose to work through this whole process, and I refer anyone interested in the complete procedure to the booklet produced by the Environment Unit of the Conservation Commission where the legislation is explained (see CCNT 1984).

Case Study

Channel Island Powerhouse

The following case study illustrates some aspects of the process described above, and identifies a role CCNT can play in coastal management.

The Northern Territory Electricity Commission, NTEC, have determined a need for a new power station in the Darwin area. A proposal was developed, feasibility studies conducted on sites, fuels etc., and the preferred option, a coal-fired facility on Channel Island in Darwin Harbour selected (Figure 3). An EIS was drafted, following guidelines supplied by CCNT, reviewed according to the legislative procedure, and an assessment report (the Environmental Assessment Report or AR referred to in Figure 1) prepared by the Environment Unit, CCNT. The report contained recommendations for the conduct of the proposal identifying, among other things, how, and how often the surrounding harbour water quality was to be monitored.

The particular monitoring programme to be used was determined at meetings between NTEC, their biological consultants, representatives from the N.T. Museum, from N.T. Fisheries (Department of Primary Production), from Water Division (Department of Transport and Works) and from the Conservation Commission.

The programme was designed to firstly determine the status of the various estuarine communities around the site prior to the start of construction, and then to determine any perturbations of these communities during the construction and operation phase of the power station.

When the transects and sampling stations had been set up and the first ambient quantification performed, NTEC found itself with the unexpected problem that the construction method proposed for the ash pond bund wall, a simple infill technique, was determined to be structurally unsuitable. An alternative dredging programme, involving the removal of about 150,000 m of mud from the wall foundation area, was proposed and this generated a new set of environmental problems.

NTEC consultants produced a Preliminary Environmental Report (PER) (see Figure 1) on the dredging proposal at quite short notice in which it was determined that, due to a combination of economic and environmental factors, direct discharge of the spoil through a floating pipeline extending out into the main harbour channel was the best discharge option (Figure 3). The spread and settlement rate of the discharged material was modelled and the report offered for assessment.

At this stage, a Darwin Harbour management plan would have been most helpful. The Conservation Commission, in attempting to assess the impacts of the dredging proposal, was faced with conflicting views on its possible effects on harbour mangroves and reefs, and had very little information on the ecological or recreational importance of these resources. As an example of the difficulties that became apparent, the preferred discharge

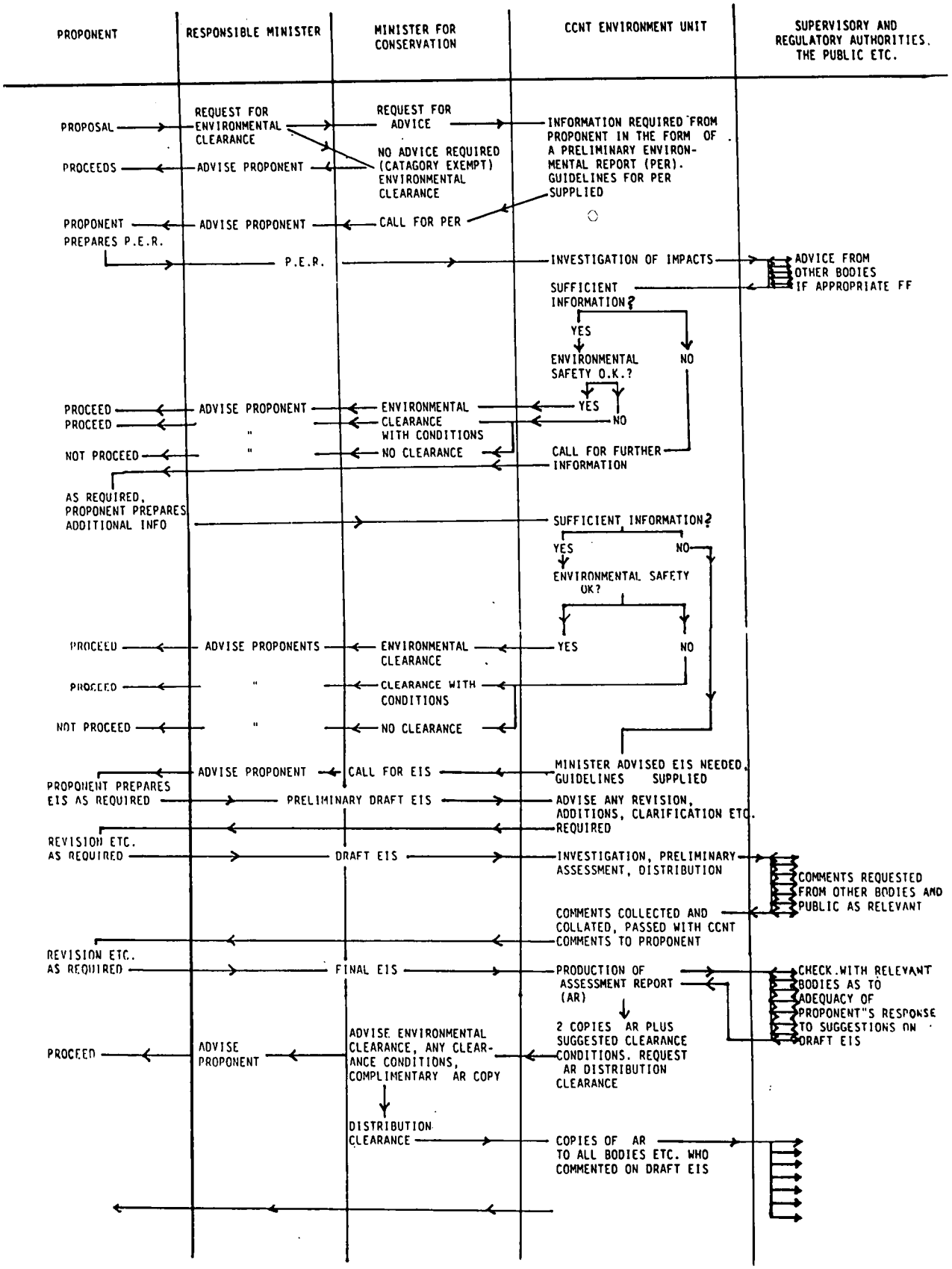

Figure 1. The Northern Territory impact assessment process.

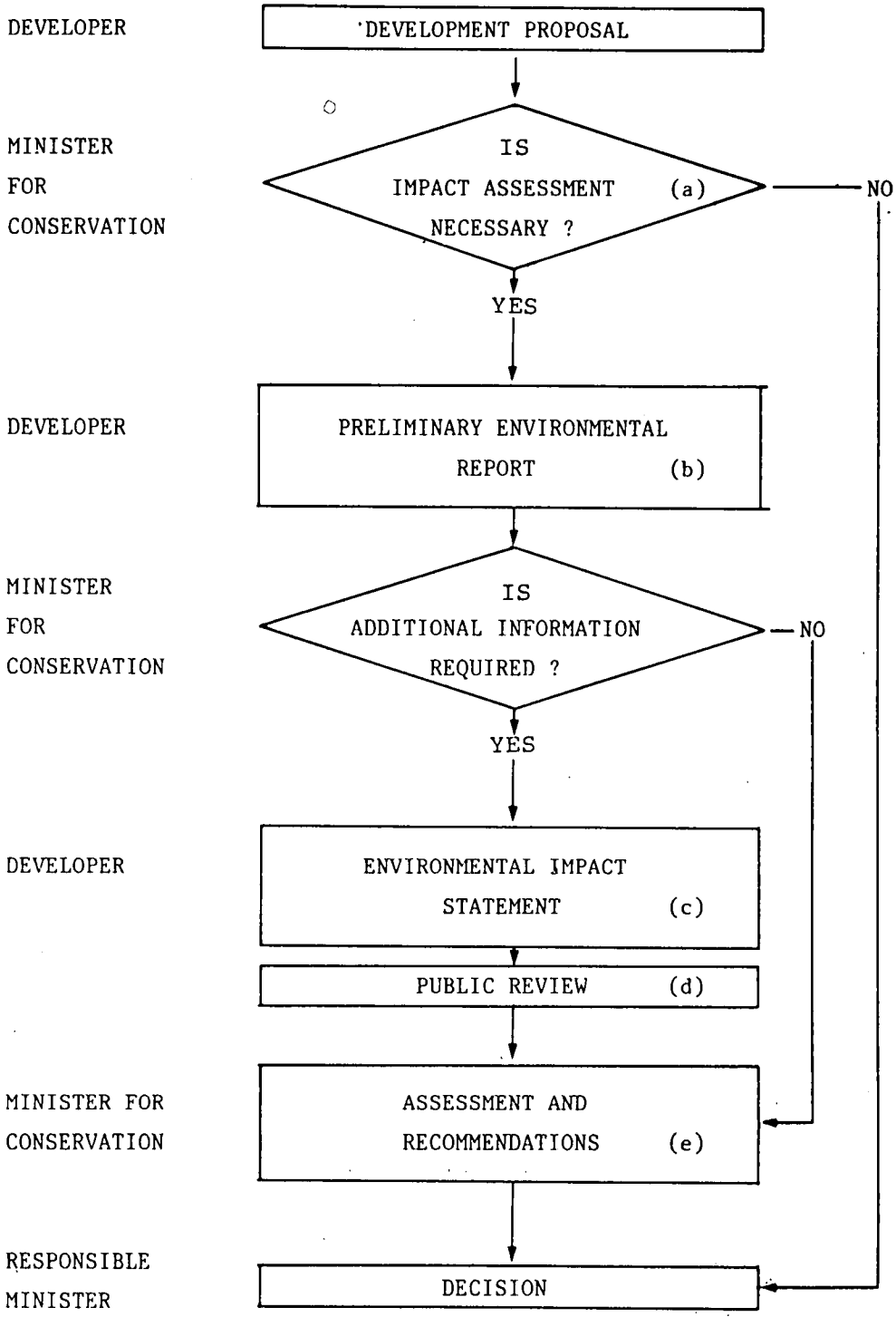

Figure 2. Simplified environmental assessment flow chart.

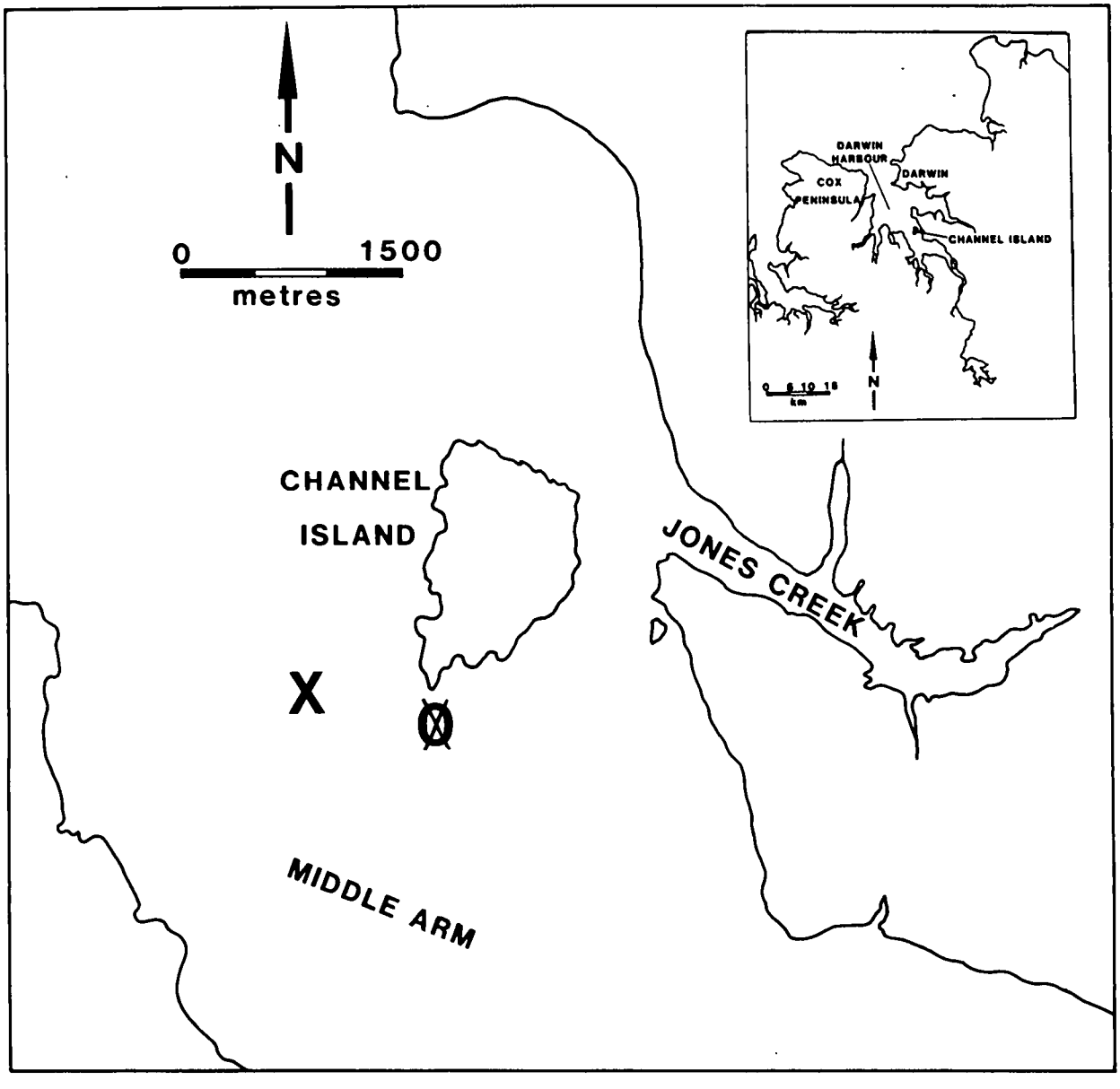

Figure 3. Channel Island showing proposed (x) and eventual discharge points (⊠) Inset shows regional setting.

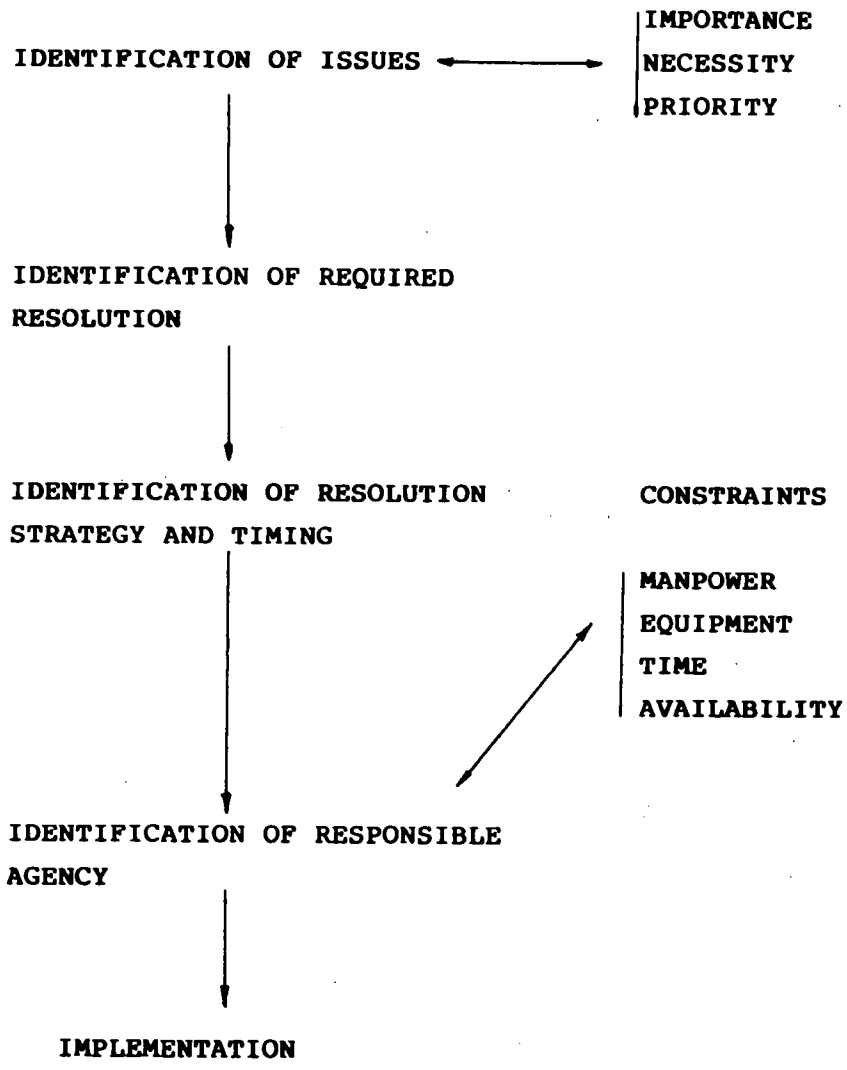

Figure 4. Scheme for decision making rationale.

point was almost right on top of a favourite local fishing spot, 'Town Hall Hole'. The questions raised over this included - what was so special about this spot that it had become a renowned recreational fishing spot? Would spoil settle in it or be flushed out by high velocity tides? Would settling spoil affect the spot as a recreational fishing area? What would be the long-term and the short-term effects?

The Consultant's environmental report on the dredging proposal seemed to raise as many questions as it answered. However, the dredge was already on-site and extensive delays were not acceptable because of the nature of the contract between NTEC and the dredging contractor, and the necessity to co-ordinate the dredging contract with other contracts already underway.

A quick series of meetings was held that involved NTEC, the Conservation Commission, expert representatives from other Government Departments and a variety of consultants. The meetings were carefully orchestrated so that issues of environmental concern were addressed as quickly and appropriately as possible. This was done following the rationale presented as Figure 4.

Two types of issue became apparent by using this process: the first type required an answer before dredging could commence, the second type could be most suitably addressed by more detailed knowledge of the in situ operation itself.

The major issue of the first type concerned the nature of the dredged material: while the PER had reported on some aspects of the material to be dredged, these related to the particle size of the spoil and distribution prediction models rather than the material's chemical properties. There was sufficient evidence available locally to determine that there was a possibility of significant heavy metal levels in the spoil and, if these were to be transported from passive deep mud to active surface sediments and the water column, a risk existed of damage to mangroves, the marine environment and possibly to humans.

It was decided that the chemical characteristics of the spoil needed. analysis. Some old mud cores from the area were available, but their method of storage, in copper/brass tubes, rendered them unsuitable and new cores were taken for analysis by contract. The results of this analysis showed that the sediments contained heavy metal loads within acceptable levels, and the issue was considered resolved.

While this priority action was underway, the second group of issues were closely considered by the various authorities, and it was determined that the required answers could only be provided by a trial dredging programme. The conflict was basically over the behaviour of the spoil within the harbour and the need to protect a number of specialized habitats there. These habitats, particularly the Channel Island channel reef, Town Hall Hole and Weed Reef (4 km north-west towards Darwin Harbour mouth), were either of recreational importance or scientific interest, and the expert group determined that on the basis of the material before it, there could be no guarantee that these features would not be adversely affected.

At this stage it was fortuitous that the dredge was experiencing difficulty setting up the discharge line and the breathing space was used to plan the monitoring of a two week long trial run. Eventually the discharge line was successfully laid at a point different from that used by the consultant when modelling the spoil settlement pattern (refer Figure 3). The distribution and settlement predictions were therefore no longer expected to be particularly accurate, although it was thought that the general behaviour of the discharge could still have been correctly predicted. There was no time to remodel the situation on the basis of the new discharge point due to the contractual constraints previously mentioned.

It was arranged for the dredge to operate for set periods at predetermined stages of the tidal cycle. It was also arranged that aerial

photographs would be taken to coincide with this activity and for water sampling to 'ground truth' and extend the aerial photography survey.

The predicted behaviour of the spoil on an outgoing tide relied on tidal velocity being sufficient to pick up the discharge and carry it towards the harbour mouth while it gradually settled, initially in the central channel and later over peripheral mudflats. This was seen to occur for some of the time. At other times the behaviour of the discharge was not as predicted with low tidal velocities unable to clear the material from the island's western gyre. Considerable deposition occurred on the reef in this area.

A similar situation was found with flood tides and it became clear from inspection of the transect lines and sampling points (surveyed for the original pre-construction biological monitoring programme) that the channel reef was going to receive a significant degree of sedimentation, and that uncontrolled discharge was not compatible with conservation of the reef. Some coral death was noted during the trial discharge period.

It was apparent that the different current velocities that occur in the vicinity of the discharge point over the tidal cycle, when tide ranges vary from less than 1 m to over 7 m had played havoc with the settlement models and that the discharge behaved as predicted only part of the time.It was clear from this, that if environmental impacts from the dredging programme were to be minimised, steps would be necessary to protect the reefs in the vicinity of the island from sedimentation.

It was determined by the group that since the discharge settlement and distribution predictions were based on a tide with an average range, and that for such conditions the prediction worked, discharge on tides of that size or greater would be acceptable. Tides of a smaller range, with reduced current velocities, led to heavy deposition on the surrounding reefs, and discharge at such times would lead to long-term detrimental environmental impacts.

The final meeting of the assessment group was called and a discharge strategy worked out that took tidal ranges into account, allowed dredging to proceed and minimised impacts on the areas determined as being of high conservation value. This strategy was recommended by the Conservation Commission to the Minister for Conservation, who administers the Environmental Assessment Act, and was subsequently passed via the Minister for Mines and Energy (the 'Responsible Minister' in Figure 1) to the Chairman of NTEC.

Since the recommendation carried the endorsement of all the contributing assessment authorities, and had been derived as the clear consequence of a process with which NTEC was fully conversant and to which NTEC had contributed, the Chairman of NTEC was prepared to accept the recommendation. At the time this decision was taken the possibility of an alternative gas-find power station came under renewed consideration and all previously contracts were then ceased. It was therefore not possible to test the recommended discharge strategy.

Conclusion

The Conservation Commission will play two roles in implementation and monitoring as it relates to coastal management. First, implementation of policy via its role on the Coastal Management Committee; and second, to identify and oversee monitoring programmes of coastal developments through the environmental impact assessment process.

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PRACTICAL CONSTRAINTS ON THE ENVIRONMENTAL CONSULTANT IN THE MANAGEMENT OF COASTAL ZONE DEVELOPMENT

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Background

Further development of the coastal zone of Northern Australia is inevitable given an expanding population and the Australian preference to live and recreate by the sea. One can expect increased demand upon coastal resources for tourism and recreational activities, for residential and industrial development and for subsequent waste disposal. Vacant land close to urban and industrial facilities will become less available with time. It can therefore be confidently predicted that mangroves and tidal wetlands, traditionally regarded by developers as less productive than their development plan, will come under increasing pressure through market forces to yield up their ecological role for the works of Man.

The decision to undertake a development is based on the Proponent's perception of fulfilling some social expectation while realising a profit on capital invested in the project. The success of the venture is obviously subject to political approval or pressure depending on the number of jobs created, the investment secured and the votes counted.

The public's first exposure to a development project may initially come through incomplete media reports or glowing press releases. Increasingly, a somewhat organised and unified conservation front, through a recognisable spokesperson, will pass early judgement on a project with sweeping generalisations about unmitigated environmental disasters and the destruction of whole ecosystems. The scientific community may venture the more cautious opinion that not enough is known about the response of the system to 'perturbations beyond the domain' and then call for detailed investigations of ecosystem dynamics before the development proceeds.

Government agencies charged with the responsibility for environmental control of coastal development have anticipated the need for project evaluation and public information by requiring the process of Environmental Impact Assessment (EIA). A major function of EIA includes resolving conflicts of interest and satisfying the need for public participation in decision-making by providing information on the project and the affected environment as well as the opportunity for public comment. On a more technical level the preparation of some form of EIA allows Government Departments to review the proposal and provide comment on their area of interest.

The final written result of the EIA process is frequently labelled as inadequate by specialist reviewers and recent papers in reputable journals question the performance and ethics of environmental consultants undertaking EIA (Moy 1983) and their uncritical acceptance of the scientific method as a procedure for generating prediction to legitimise their business interests (Bradbury et al. 1984). An analysis of this criticism from the viewpoint of an environmental consultant clearly indicates a lack of mutual understanding and agreement on the role of the environmental consultant and what can be expected from the Environmental Assessment process. One aim of this workshop paper is to briefly examine some of these complex issues and expectations by way of a practical illustration of the consultant's role in a hypothetical coastal development.

A Hypothetical Development in Darwin Harbour

A hypothetical oilfield has recently been discovered in the southern

reaches of Middle Arm, Darwin, NT. It is proposed to develop the oilfield from four off-shore platforms and to pipe the oil to a new refinery located on the adjacent mainland. Due to dwindling natural gas reserves the oilfield must be in production within 2 years to allow conversion of the nearby power station to an oil-fired facility. All reports and management plans must be completed within fifteen months for both the oilfield and the refinery sites.

Selecting an Environmental Consultant

The Proponent is aware from the exploratory drilling phase that the Conservation Commission of the Northern Territory (CCNT) will require an Environmental Impact Statement (EIS) to be completed before development proceeds. The Proponent had commissioned a well-known firm of consultant's with an office in Darwin to prepare a Preliminary Environmental Report (PER) for the exploration phase. The PER was supplemented by a separate Oil Spill Contingency Plan in case of well blow-outs during exploration as well as detailed plans for rehabilitating on-shore hardstand areas at the completion of drilling.

The Proponent held discussions with all relevant Government departments and signalled their intention to proceed with an oilfield development and mini-refinery on the adjacent mainland. The proposal was loudly proclaimed by the politicians and the expectations of the public were raised by media reports of 'jobs, jobs and more jobs', real estate booms and expansion into high technology sunrise industries.

The southern-based Proponent then decided to put the preparation of an EIS out for competitive tender. The local office of the consulting firm who prepared the PER ceases to be a trusted and professional adviser with valuable local knowledge and acquires the status of a 'competitive merchant of technical services' who must use his local knowledge to beat his competition (Moore 1983). This situation, in contrast to the fears of Moy (1983) about monopolisation of markets by consultants, actually reduces the level of confidence and trust between client and consultant and makes the process of effective environmental assessment for a controversial development more difficult.

The consultant in preparing a quote for services to prepare an EIS must gauge the 'level of effort' required to satisfy both the client's needs and budgetary constraints and a rigorous Government review process. Furthermore this 'level of effort' must successfully compete against the judgement of other consultants who are bidding for the preparation of the EIS. A consultant who lowers his bid to secure a commission, and a client who accepts it, run the risk of accepting a greater degree of uncertainty about critical issues or overlooking important considerations through lack of time and funds.

The end effect of inadequate EIS preparation can be costly delays and conflict before final approval of the development (Atkinson and Irvine 1983). Once commissioned, the successful consultant in the competitive bid process may find out during preliminary discussions with the Government and the client that a far greater scope of work is expected then was originally anticipated by their proposed 'level of effort'. This places pressure on both the consultant and the client to renegotiate the scope of the EIS and the budget, with consequent delays in commencing EIS studies.

Implementing the EIS Investigation

The consultant selected to undertake the preparation of an EIS will generally have visited the site during proposal preparation and identified the major environmental issues which are likely to be encountered during the development. The proposal will usually include an estimate of the hours required to conduct appropriate investigations to characterise the site as well as details on the experience of the study team who will

undertake the investigation. This early forecast of likely impacts and the 'level of effort' required to adequately assess significant environmental issues is based on the consultant's experience and judgement.

The EIA method used by consultants has come under recent scrutiny by Bradbury et al. (1984) who maintain that the scientific method provides explanation but does not necessarily generate prediction - which, they believe, is the basis of successful business and the contract upon which environmental consultants serve their clients. This simplistic approach by Bradbury et al. (1984) misinterprets the investigative process undertaken by environmental consultants which can be more realistically divided into four phases - description, explanation, prediction and assessment. The main features of each phase can be summarised as follows:

(a) Description - characterising the local environment in terms of physical, chemical, biological and social aspects.

(b) Explanation - interpreting the inter-relationships between the above processes as a way of understanding complex systems.

(c) Prediction - forecasting the behaviour of existing systems when perturbed by natural fluctuations or impacts from project development.

(d) Assessment - estimating the significance of developmental impacts on the local environment in terms of benefits gained against the expense of lost resources.

The four-phase investigative process undertaken by environmental consultants clearly recognises the complexity of environmental processes which to be completely understood theoretically would require detailed investigations from many scientific disciplines. However to be useful in the present and to develop into a more powerful investigative approach for the future, environmental consultants must pragmatically aim their investigations at generally assessing the whole system rather than concentrating on separate disciplines.

Prediction and assessment leading to sound management practices are therefore emphasised rather than description and explanation of complex interactions and processes. In this regard the environmental consultant more closely resembles the operational model of the consulting engineer who through empirical experience and judgement is able to make sound management decisions based on quite limited analysis and investigation.

Investigating the Hypothetical Development

A literature search of published and unpublished reports held by Government departments and private industry for the Darwin Harbour region indicates a limited amount of information for the study area. However there is a growing body of relevant descriptive and explanatory literature on the mangrove communities of Northern Australia (Clough 1982) and South-East Asia (Macnae 1968) on which to base predictions and assessment. The suitability of this non site-specific information may be questioned but in the absence of long-term studies it is invaluable for the practical purposes of this assessment. This is particularly true for seasonally variable parameters such as primary productivity where limited site data must be correlated against literature values to be meaningful.

Preliminary discussions between the Conservation Commission, the Proponent and the Consultant have highlighted the following broad areas of concern for the EIS investigations:

(a) Effects of oilspills from well-blowouts, pipeline rupture and shipping on the marine ecosystems of Darwin Harbour.

(b) Effects of discharge of the oilfield brine into Middle Arm and the

accidental release of refinery effluents or products.

(c) Effects of reclaiming a 300 - 400m wide corridor through the mangroves for the pipelines, access roads and wharf facilities.

(d) Effects of siting the refinery on Middle Arm in terms of air pollution, terrestrial ecology and altered drainage within the adjacent mangrove community.

(e) Effects of transportation and housing requirements on neighbouring Palmerston.

(f) Presence of sacred sites or sites of traditional and contemporary significance to Aboriginal people within the development area.

(g) Impact on recreational and commercial fishing and boating activities.

(h) Soil and coastal erosion caused by disturbance to the mangrove forest, dredging of sediments and disturbance to highly erodible soils.

Clearly, within the fifteen month period there is only a very limited amount of research investigations which can be undertaken to provide answers to some of these concerns. It is also evident that the effects of these identified concerns on the local environment depends to a large extent on how the oilfield and refinery operates. Therefore, environmental considerations in the early engineering design and in the management of operations becomes critical.

For example, construction and site disturbance can be controlled or avoided in sensitive or unique areas. Discharges of effluents and brines can be carried out with regard to the assimilative capacity of the receiving system. Furthermore, disturbed areas can be restored by revegetation and earthworks as part of a rehabilitation programme.

In this case, it makes practical common sense to recognise early in the study that the EIS investigations should lean heavily towards developing methods of mitigating environmental impacts. Unfortunately, this is not usually the case and there is a frequent over-emphasis on lengthy descriptions of the existing environment, which may or may not be relevant, and on attempts to characterise complex ecosystems by techniques such as community structure which may not be appropriate (Bradbury et al. 1984).

The development of a suitable monitoring programme to assess the impacts of the project should also be given high priority during the EIS preparation. This is also a difficult technical issue to resolve because it is often uncertain what impacts should be monitored, how frequently, where and in what detail. Furthermore, the costs of monitoring can be excessive and great care to calculate how much time and funds will be required for monitoring should be undertaken before agreement is reached between all parties. An interesting feature of monitoring programmes is how they reflect the professional bias of the consultant or Government agency involved in their preparation; and of what little value or great redundancy much of the data regularly collected in large monitoring programmes actually is in terms of detecting change.

The Assessment Process

The Assessment Process is more subjective and open to value judgement than the earlier investigative phases and can be separated into three stages briefly described as follows:

(a) Consultant Review - the potential impacts of the project are considered in terms of the existing environment and the managerial

capacity to minimise adverse effects; the Proponent is informed of his ongoing obligations to monitor, rehabilitate and manage his operation within the local environment; if this is economically and operationally viable then the EIS is submitted as a Draft document.

(b) Government Review - an Environment Unit (in the Conservation Commission in the N.T.) will review the Draft EIS and distribute it to other Government departments for comments.

(c) Public Review - the Draft EIS is advertised in newspapers, displayed in local libraries and available for purchase; the public is invited to comment by written submission or, in some cases, to attend a public meeting and personally question any aspect of the development.

This three stage review process is a fairly successful means of regulating both the effects of the proposed development on the environment and the performance of the consultant who has prepared the EIS. The EIS will be reviewed in detail by specialists covering a wide range of disciplines in perhaps ten or twelve Government departments and institutions.

Members of the public are not usually in the technical position to review a whole EIS document but individuals often comment on aspects which affect their personal interests. More detailed public responses are received from conservation groups and environment councils who usually take a strong interest in criticising any development project.

It is almost inevitable that the EIS will be seen as 'totally inadequate for impact assessment' by some specialist reviewers. The consultant will be criticised for example of practising 'vertebrate chauvinism' by failing to mention termites, or accused of 'cynical attempts to destroy features brought to your attention'. Some criticism will be warranted, some will be trivial and it is inevitable that some reviewers will uncover an important consideration which requires more attention. All these comments will be considered and acted upon in the preparation of the Final EIS.

Conclusion

Environmental Impact Assessment is a combination of science and art, experience and judgement. This is particularly true in poorly understood coastal environments where development pressures preclude long term studies. In this case, environmental management decisions must be made with the best information available and a certain level of risk will be inevitable.

Techniques of rapid assessment of complex systems need to be developed for characterising the resilience or assimilative capacity of the receiving system against change. Included in this conceptual technique development is the need for more useful approaches to monitoring the operational phase of a development.

A shortcoming of past management proposals for the coastal zone is that they are basically anti-development and preservation-oriented and do not address the critical issue of fitting a development into a coastal environment (Hegerl 1982).

An important area of future research lies in the development of techniques of restoration and rehabilitation of coastal zone ecosystems. The rehabilitation of mine sites, overburden dumps and coastal dunes provides a suitable model for developing a new environmental technology (Bradshaw and Chadwick 1980). Similar techniques have been applied to seagrass beds in Florida (Thorhaug 1983) and techniques for restoring or stabilising mangrove zones around a coastal development are likely to be

equally challenging but realistically achievable.

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PROBLEMS OF MARINE ECOLOGICAL MONITORING IN NORTHERN AUSTRALIA

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Introduction

In this era of large scale industrial and agricultural development, the effects of human activities on undisturbed ecosystems ranges from negligible to catastrophic. Fortunately, the severity of disturbance is diminishing as a function of public pressure, an increasing understanding of how ecosystems work, and a general willingness on the part of developers to attempt an assessment of the impact of their proposals.

Assessments in Australia usually take the form of an Environmental Impact Statement (EIS) and are recommended, if not legally required, in all States and Territories. In general, an EIS seeks to identify sensitive areas of a development proposal which could have undesirable environmental consequences. After the identification of areas of concern an attempt is made to assess the value of the development project against the cost of disturbance, followed by a recommended course of action designed to minimize detrimental effects.

Where there is a lack of information regarding the effects of changes by the development on the existing biological community a monitoring programme may be proposed. The aim of such a program is to allow development to proceed while checks are made from time to time on the status of the flora and fauna which may be affected by the project. Monitoring programmes have been associated with major activities, notably the Gladstone power station and Mt Isa Mines in Queensland, and Ranger Uranium mine in the Northern Territory.

Where development projects occur on the coast, the value of any EIS will be determined by the baseline data available. Baseline data may be derived from 'pure' research studies, or it may be the result of 'applied' studies, such as previous EIS reports for other development proposals in the region.

Given that marine biology in Australia is still relatively new, especially in northern Australia, there is often a lack of information on the community ecology of the region under investigation in the EIS. In such cases, data from similar regions elsewhere should be used and a biological monitoring programme devised. The lack of baseline data pertaining to the Australian monsoon region, and the lack of data from similar regions of the world, demands that in most cases where development projects are suspected of influencing coastal marine resources, a biological monitoring programme of one kind or another is essential. This consideration is therefore most important for the Northern Territory.

This discussion paper will demonstrate some of the difficulties involved with the design of monitoring programmes when baseline data are lacking, by examining a hypothetical biological monitoring programme for the Darwin Harbour region. The question is asked is it possible to design an effective monitoring programme to reflect significant ecological changes by a development project when no information is available on the community ecology of that area?

The Ecological Problems

The aims of a biological monitoring programme are first to detect changes in the community or population structure; and second to attribute observed changes to 'natural' causes or to aspects of the development process.

To detect changes, it is useful to have some information on the structure of the biotic community before the development project begins. Samples from sites likely to be affected by the development, collected before the project began, can be compared with subsequent samples from the same sites to determine if shifts in community structure or population structure are occurring.

To distinguish between changes brought about by the project and changes due to other factors not related to the development project, a series of control samples is required. In Figure 1, Site A is considered to be at risk from a nearby development project. Sites B & C are ecologically similar locations, but are not considered to be at risk from the development project. These can be used as control sites. A high correlation is expected between physical (e.g. sediment grain size, water salinity and temperature, and current velocity) and biotic characteristics (e.g. species composition, abundance and local distribution) at all three sites before the onset of the development project.

When the biotic character of a chosen site is determined, it is necessary to decide what is to be sampled and how often samples are to be taken. If the sample sites are in an area from which information has already been accummulated by past research in the form of species lists, records of associations between species, habitat requirements, abundance and distribution of species; and if this information has been collected over a time period which allows a reasonable estimation of the variability in species composition, abundance and distribution which occur with time, it is not necessary to undertake a rigorous sampling programme before the development project gets under way.

The presence of data on the relative abundances of species through time can be particularly useful. This information provides a choice of potential indicator species and may suggest a suitable sampling programme. Considering as an example, marine benthic invertebrate communities, the majority of species recorded are rare, occurring in low frequencies and often absent from one or more of a set of samples. The collecting, sorting and identification of this group of rare species is not cost- effective because they do not provide useful statistical information. Conversely, there may be several species which approach very high population densities. A polychaete worm Capitella capitata, for example has been recorded at densities of over 200,000 m^2 in some soft sedimentary habitats. These species represent a big increase in processing costs and also provide little diagnostic information.

However, in many tropical benthic environments there is a group of 10-12 species whose numbers are large enough in each sample to provide useful and cost-effective statistics on changes in abundance and distribution.

Once the group of species to be monitored is identified, the next step is to decide the sampling frequency. Most species show some annual variation in numbers, particularly just after reproduction or, in the case of many benthic species, the settlement of larvae. These fluctuations can be of great magnitude but are often of short duration as recruitment to the population is low. Therefore when taking samples, the period during which larvae are settling, or young appear in the population should be avoided. Sampling should occur several times in a year, however, to detect fluctuations in numbers due to environmental instability. For example, in response to changes in salinity, water temperature, turbidity, or at the community level, shifts in predator - prey or competitive relationships. Ideally, sampling should be timed to take account of variations in the value of each or all of these factors.

In tropical Australia, it is highly unlikely that any part of the marine environment has existing baseline data which allows simplification of the monitoring process to a concentration on that useful group of 10-12 species. An exception to this may be found where commercial species of fish or crustacea are involved.

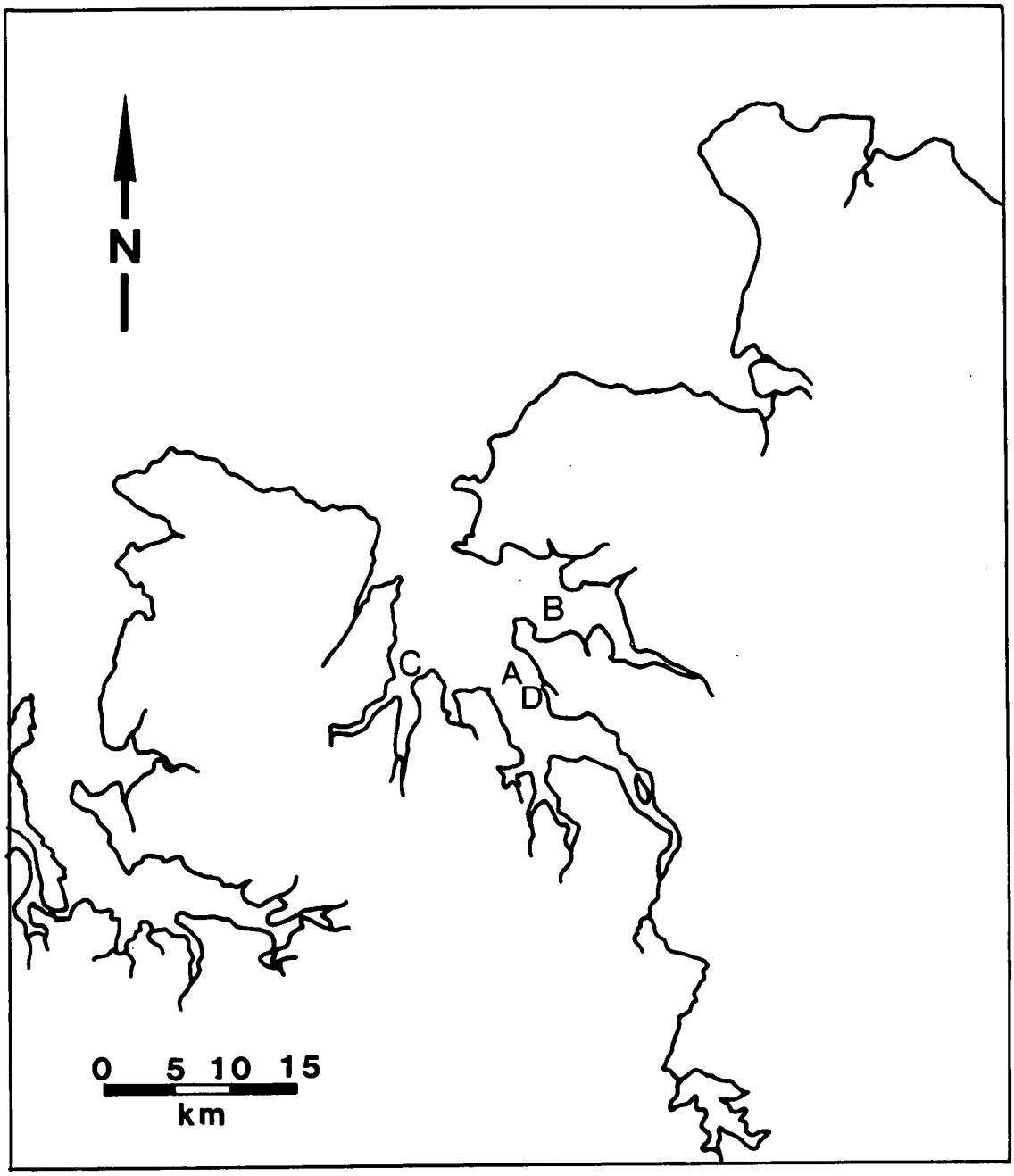

Figure 1. Hypothetical Development (D) in the Darwin Harbour. A is a site considered to be at risk from the Development. B & C are control sites, similar to A, yet not considered to be at risk.

In the absence of prior baseline data it should be the responsibility of the developing agency to provide some estimation of fluctuations in species composition, distribution and abundance before the development project begins. A failure to do this can render the monitoring programme ineffective, as it is then impossible to attribute shifts in community structure or population structure to the development project or to 'natural' processes in the environment.

A further problem is that development projects have often sought advice through the EIS too near the proposed date of commencement of the project. Where this has prevented the collection of some baseline data before project commencement, the second aim of a monitoring programme - to separate natural and human-induced environmental changes - cannot be met.

This problem may or may not be solved by using control sites which are by definition very similar to the development sites. If a significant departure from community structure is observed at the site considered at 'risk' while at the control sites no shift occurs, this may provide sufficient circumstantial evidence for the affect of the development project. This can of course be achieved only if there is sufficient information to establish the similarity of the control site to the development site. So for northern Australia especially, we are faced again with the consistent lack of baseline data which reflects not only spatial patterns but also patterns of change over several time scales.

For example, control and 'risk' sites may resemble each other at this point in time, but did they always do so? Initially this may not appear to be much of a problem. However, if there is an underlying instability in community structure at any of the control sites then, in the future, our two control sites B and C may differ from each other as much as they may differ from 'risk' site A. If we do not recognize the processes producing instability, it is not possible to assess the impact of the development project on the environment.

The long-term stability of faunal communities of marine benthic ecosystems in nearshore, tropical waters is still poorly understood. Recent work in temperate and boreal seas (see Gray, 1981 for a summary) indicates that community structure may exhibit cyclic patterns with periods of from one to seven years. In most cases, the factors producing these cycles are not yet identified. Patterns of change in community structure associated with long term cycles of several years duration may also occur in tropical, shallow water habitats. This might be the case in habitats composed of loosely consolidated sediments subject to reworking by fluctuating tidal currents, especially in macrotidal environments in the north and northwest of Australia where periodic high flood flows during the monsoonal wet season can also be expected.

Darwin Harbour has extensive deposits of sediments and community structure in these habitats may vary widely through time and space. The Harbour is a series of shallow, drowned river valleys, and large tidal range and high current velocities keep much of the incoming sediment from terrestrial sources in suspension. During the 'wet' from October to April/May, runoff can increase dramatically, bringing with it an increase in sediment load and depressing salinity in the Harbour arms. The increase in freshwater inflow and higher sediment load may produce extensive movements of previously deposited sediments which were primarily under the influence of the tidal currents dominant during the 'dry' season.

The invertebrate fauna of the Darwin harbour estuary is largely marine in origin. Many of the species are tolerant of wide variations in salinity, water temperature and turbidity. However, many of the sedentary, benthic species may experience such a rapid change in salinity or water temperature during the onset of the 'wet' that these species suffer mass mortalities and even local extinction. Many of the benthic species are osmo-conformers (e.g. many polychaete worms) and the rapid change in salinity immediately following the first heavy rains may well kill most of the animals exposed to it.

In addition to the damage caused by fluctuations in salinity is the physical damage created by reworking of the sediments. Many of the burrowing infauna may be killed when the substrate within which they live is resuspended at the beginning of the 'wet'. Much of the material resuspended is likely to be deposited elsewhere, changing the characteristics of the deposition site from those that were dominant during the dry, and eventually reproducing conditions encouraging colonization by benthic invertebrates. The new community of benthic invertebrates that becomes established is unlikely to resemble that before the onset of the 'wet'. Enough of the physical characteristics of the environment may be different, that a completely new community is established. These changes will be most dramatic.

In the past, it was considered by most researchers that tropical habitats possessed a greater species diversity than similar temperate habitats because they were less likely to experience physical disturbance. However, the effect of the marked seasonality of the climate in northern Australia is to produce a marine benthic community which exhibits a much lower diversity than might otherwise be predicted.

If the marine benthos of Darwin Harbour for example does follow an annual cycle governed by the change in seasons, it should present no problems to those concerned with the design of monitoring programmes. This would be the case if it were possible to predict at a particular site, the species composition, abundance and distribution, given the state of the season. It is probably not possible to do so.

It was once widely held that if a habitat was disturbed and the resident community of plants and animals eliminated, a series of successional invasions by different groups of plants and animals would occur until, in the absence of further disturbance, stability or equilibrium would be achieved and no further change in community structure or composition would occur. This equilibrium point would be reached when the community was composed of the same set of species that persisted before the disturbance. In marine invetebrate communities equilibrium can occur in a period as short as a few months.

While the concept of successional communities still holds, there is increasing awareness that in many cases there is more than one possible end-point or climax community. The factors governing which end point is reached are poorly understood, but appear to be complex and even stochastic. Both physical and biological factors occurring during succession may be involved and the influence of any one may be only ephemeral.

Consequently, it is possible that from year to year the composition of the community changes at a number of locations. For any area the species composition, abundance and distribution may differ in some dry seasons, and be similar in others. These different communities do not reflect different physical or biological factors acting on the end point community, but that a different end point was reached because of a transient physical or biological effect during the return to equilibrium conditions.

Interpretation of such ecological patterns is very difficult indeed and this will affect the capacity of any monitoring programme to determine the cause of observed variation in community composition between control and 'risk' sites over time.

Towards a Solution

Presently, there is very little information available on the composition, abundance and distribution of the marine soft sediment benthos of the sorts of environments represented in Darwin Harbour. Harbour. Some useful insights may be obtained by considering the polychaete fauna which has a high proportion of opportunist species with broad tolerances of physiological stress. These are found, often in large numbers, in the

absence of other species, in habitats ranging from mud to rock. Supporting evidence for the theory of local extinctions induced by the onset of the 'wet' season, followed by a different species composition when conditions return to equilibrium ('dry' season), is provided by some of the data collected from mangrove habitats (unpublished data). Within the Rhizophora zone there are usually two niches available for polychaete worm species. At every site which has been examined there was a nereid and a capitellid species present. At different sites there is a strong likelihood that different species will be found; but, one was always a nereid, and the other a capitellid. This might indicate that there is a fine partitioning of the niche between a lot of the species in these two families. However, all of the species involved have been collected from other habitat types in the Northern Territory and elsewhere. The implication is that the timing of local extinction during the wet season, rather than fine differences in niche dimension is responsible for the observed distribution.

These data suggest that many of the niches available in sediment deposits in Darwin Harbour may be defined at the family level, rather than the generic or species level. Therefore one would expect to find a variation in species composition, abundance and distribution at many of the areas in the Harbour where sediments predominate. Further, at any one of these sites, variation in species composition, abundance and distribution may occur annually, and fluctuations in species composition and distribution may occur from year to year.

If this is the case, then substantial variation in species composition between control sites can be expected during the course of monitoring periods. While variation in species composition may occur at the spatial and temporal scales being compared, the indications are that the carrying capacity of the habitat may not alter very much at all. Here perhaps lies a solution to the problem of detecting environmental change due to human influence, which circumvents taxonomic and community ecology problems associated with other forms of analysis. The carrying capacity of the habitat is defined as the maximum amount of living material that can be supported by that habitat and is obviously related to the amount of energy available for conversion into living systems.

Usually, the effect of human activities is to either increase the carrying capacity of the environment by increasing the supply of nutrients, or to decrease the carrying capacity through the input of toxic chemicals. The effect of the first is to increase abundance, often with a decrease in diversity: the effect of the second is to depress the abundance, again with a decrease in diversity.

Perhaps the way to measure the well-being of sites at risk is to measure two biological parameters. Firstly, the individual abundances of the species, to monitor for shifts between trophic levels, which can affect the overall carrying capacity, due to a poor energy conversion rate between trophic levels. Secondly, the total biomass of each sample. Such an approach would not be difficult to accomplish as most monitoring programmes do attempt to take quantitative samples.

Conclusion

Given the problems outlined above, it is currently difficult to design and implement useful and effective marine biological monitoring programmes in northern Australian monsoon environments. The difficulty lies with the absence of baseline data. This problem can only be overcome with time, and the co-operation of all involved with the future development of the region. Resources are limited, but a great deal of information can be collected by various agencies. Co-operation between all parties is necessary to minimise duplication of data collection, and to identify priorities for future investigation. In Darwin, there are encouraging signs that the agencies involved with the development of Darwin Harbour at least are aware of the difficulties and are willing to join in co-operative effort with the goal of establishing a Harbour management plan.

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SESSION III DISCUSSION SUMMARY

Chair - Jim Davie

The three papers which lead the discussion of implementation and monitoring of coastal development initiatives responded individually to a number of the special problems of northern Australia mentioned in the Introduction to this Workshop.

Michael Bugler discussed a model for environmental regulatory action being developed by the Northern Territory Government. He then proceeded to demonstrate in a case study of the Channel Island Power Station development in Darwin Harbour, how such a model can work to avert serious environmental consequences. Two points emerged from this paper which were particularly pertinent. The need to justify a programme of monitoring by having a demonstrable set of questions which need to be answered is of paramount importance. This question provided a major focus for the ensuing discussion. Also of importance is the need for government agencies to be informed and flexible in their operation, especially in a field like environmental management where the parameters of professional practice are still being defined, and the Channel Island example showed how this could work.

Allen Kearns demonstrated some of the elements of professional consulting practice in a stimulating paper which reacted to some theoretical stereotypes of environmental consulting that have appeared recently in the literature. Kearns made a number of very important points which marine scientists in more conventional practice need to consider carefully.

In order to respond to the EIA process within the severe time constraints typically imposed by development proposals Kearns proposed a framework for consulting investigations. This framework consists of four elements: (i) description (ii) explanation (iii) prediction and (iv) assessment. It was asserted that prediction and assessment are more valuable in consulting practice than description and explanation, these latter elements being the major areas of activity of more conventional marine sciences. In this sense professional practice follows that of the consulting engineer who traditionally depends upon empirical experience and judgement based on limited analysis and investigation. The dangers inherent in such an approach are regulated by a rigorous three stage review involving consultation with the proponent, the government and the public.

The EIA is widely seen as a means of resolving conflicts of interest in the use of resources. Kearns proposed that such investigations should concentrate on the mitigation of impacts by influencing development plans and implementation. For this reason, early consideration should be given to the design of monitoring programmes, with the caveat that there are difficulties in defining parameters to be monitored so that the programme can be contained and focused. In making this point he emphasized the role of the consultant in defending the interests of his client while also challenging more discipline-oriented scientists to think more broadly about the issues which industry consultants must address.

Consistent with the interest in mitigating the effects of development Kearns concluded his paper by pointing to the need for restoration and rehabilitation of development sites as complementary land management options. In making this proposal the Chair felt that Kearns was underscoring two points which scientists in northern Australia feel very acutely. In a general sense these points relate to a lack of knowledge about natural ecosystems in tropical Australia. Consequently (i) the importance of empirical knowledge of these environments by scientists who have experience working in them must be emphasized; and (ii) knowledge of the biology and ecology of natural ecosystems and the organisers which

comprise them must be encouraged.

Russell Hanley took up this second point in his paper which dealt with the potential importance of description and explanation, to use Kearns' terminology, in assessing impacts of coastal zone development.

Hanley's paper concentrated particularly on the difficulties which face marine biologists who are called upon to comment on the impact of developments or on impact statements sent to them for review. In this paper he emphasized the problems of interpreting change in coastal marine environments where the fauna is poorly known, and the natural environmental effects are unfamiliar in comparison to those in more equable and better known temperate environments.

It was asserted that biological monitoring programmes have two objectives in relation to impact assessment: to detect change in community or population structure; and to attribute observed changes to natural causes or to aspects of the development process. Following a consideration of a hypothetical case study in Darwin Harbour, Hanley concluded that the absence of baseline data is a major difficulty to progress and that this can only be overcome by concerted co-operative efforts from all interested parties.

Discussion of these papers pursued two main themes: the nature and role of the EIA process and the application of monitoring in environmental management.

Richard Phillips observed that the trend in the United States had been for the EIA to become a formal document with a major function in resolving public debate on development proposals in court. Consequently it was increasingly a legal document with a closely defined format with little potential for planning. Brian Lees indicated that legal requirements in NSW forced the consultant to be very careful in the preparation and expression of reports because legal implications may drag on for many years.

This tendancy appeared not to be occurring in the Northern Territory, where views expressed by environmental scientists Allen Kearns and Keith Presnell indicated that the EIA should not be seen as detailing an exact prescription on how to handle environmental problems but rather as a document which identifies these problems and proposes strategies and policies for handling them. Kearns made the point that in his practice clients were advised to treat the EIA as a useful planning document and not merely as a requirement of environmental legislation. He agreed with Penny Figgis that political approval for projects associated with economic or engineering feasibility studies frequently proceeded without, or prior to, an EIA. However, he felt strongly that communication was a most important part of the consultants' practice and that much can be gained by direct consultation, with advice and guidance to the client to proceed in an environmentally sensitive manner being in their best interests.

Pat Harbison pursued further the C.C.N.T. EIA guidelines described by Bugler and those for practising consultants proposed by Kearns. In their responses Bugler and Kearns emphasized the interactive process by which main concerns for a specific development are isolated from the guidelines to form the focus of the EIA that is eventually produced. It was agreed that the guidelines should constitute a format rather than a strict proforma.

The significance of the EIA outside the specific legal requirement associated with project approval varies widely from case to case. In application to planning, modification of design, or implementation, monitoring programmes may have an important place. Depending upon circumstances, two monitoring objectives emerged during discussion from the floor. These were the development of baseline (or archival data) as a

basis for prediction and assessment of specific impacts; and the identification of modifications for design or implementation of projects to mitigate environmental impact.

Presnell elaborated on the experience of the Channel Island Power Station investigation referred to by Bugler. Monitoring in this case was of fundamental importance in the implementation of the project and continued to be so because the programmes were flexible and responded to problems as they arose, or to additional knowledge. Monitoring was seen to be an important and continuing commitment through the construction phase and into the operational phase and of far greater value when managed in this way then if it had been restricted to the initial planning phase alone.

Peter Saenger referred to the 9-year monitoring project in Port Curtis in Queensland associated with the Gladstone Power Station. He emphasised the value of such long-term studies to the planning of large facilities and for regional studies. In cases such as these, monitoring studies can provide baseline information to meet applied and pure scientific needs and contribute to the solution of some of the dilemmas posed in Hanley's paper and raised in discussion by Paul Broese.

With respect to this problem Saenger noted that while the EIA approach is probably the best available at the moment it has the inherent weakness that it is project-based and usually site-specific. A desirable elaboration on the approach which could be managed by Government is to sponsor and coordinate regional studies in areas which are planned as development nodes. Despite criticisms which may be levelled against past studies of this kind at Westernport Bay and Port Phillip in Victoria, much needed information of broad significance came to light. Similar studies are especially warranted in northern Australia where the history of systematic study is so short.

Monitoring studies are not always the appropriate direction to go and this point was made by several speakers, notably Richard Phillips. There was general agreement that monitoring had to be directed towards answering specific questions (Bugler, Kearns, Broese). Only in this way could it be contained and directed. Kearns made the salutary point that in his experience monitoring projects demonstrated a professional bias rather than a problem focus. He was particularly conscious of the need to protect his clients from unnecessary costs of monitoring programmes over ill-defined time scales, or which sought answers to academic questions. Kearns emphasized in conclusion his belief that protection of habitat and ecological processes were of paramount importance.

Session IV- Plenary Session

Towards the Development of a Framework for Coastal Zone Resource Management Decisions in Northern Australia - Penny Figgis.

TOWARDS THE DEVELOPMENT OF A FRAMEWORK FOR COASTAL ZONE RESOURCE MANAGEMENT DECISIONS IN NORTHERN AUSTRALIA

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Introduction

The Conference preceeding this Workshop dealt with recent research on the physical and biological characteristics of the coastal ecosystems of the Australian monsoon region. It asked questions about the nature and status of knowledge of the coastal environment of this part of Australia. This Workshop has dealt with the policy implications and applicability of this substantive work to prescriptive questions of how to use the natural resources of the region to ensure they are wisely conserved. There is general agreement that knowledge has intrinsic value, but its fundamental social role is to enhance the lives of present and future generations by informed rational planning and decision-making.

The Conference canvassed subjects as diverse as 'Holocene statigraphy of the South Alligator River', the 'breeding patterns of Magpie Geese' and the 'paucity of polychaete species' in the region. The intention of the Conference organisers was that these reviews of research should act to inform and update fellow scientists, and by putting scientists in touch with decision makers, also contribute to better conservation and management of the coastal zone.

While there has been agreement that informed decision-making is the goal, formal and informal discussions throughout the Conference and Workshop have highlighted the numerous problems which are encountered in achieving this end. This paper attempts to draw out major points made during the Workshop which are impediments to good policy. It then summarises the plenary discussion which explored a way forward appropriate to the issues of coastal zone management in northern Australia.

The Present Status

Perception

Fundamental to most landuse or resource conflicts are differences in perception of the resource. Mangroves and wetlands provide a particularly good example of this problem. As the Workshop has made clear, one person's view of a complex and essential ecosystem, valuable for habitat, breeding ground, coastal stabilisation, water quality and other external values, is to another a smelly, mosquitoe-breeding obstruction to a beach view. These are two of a great many perceptions which range from spiritual reverence through to outright hostility. Inevitably, persons holding such disparate views will also differ on what would constitute sound and rational decision-making. It is our perceptions which shape our evaluation of the environment and hence our judgement of what should or should not be done with it.

Behind the different perceptions which were evidenced in the Workshop lies a fundamental philosophical dichotomy that underlies the problems which invariably afflict resource decision-making. The two philosophies can be termed 'utilitarian' and 'aesthetic ecological'.

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The utilitarian viewpoint holds that the primary value of land lies in its direct utility to humans, in particular its ability to produce a commodity of quantifiable value. In the case of coastal regions the holders of such views can principally see value in the ecoystem if it produces seafood or minerals, or land for industrial, residential or agricultural development, or tourist dollars. Frequently associated ideas are that man improves on nature, that environmental destruction, while regrettable is 'the price of progress', and that non-utilitarian land allocation (e.g. a nature reserve) is wasting land and 'locking up' resources. Another commonly held associated opinion in Australia is the 'big country syndrome'. Put simply "there's plenty of mangroves, wetlands, rainforests, beaches etc. in Australia and it doesn't really matter if we destroy this particular area." I would contend that this philosophy and its more subtle variants remain dominant in our society and shape most decisions in resource usage.

Struggling for equal recognition is the aesthetic-ecological viewpoint which holds that in addition to commodity uses of land there should be recognition of non-commodity or non-quantifiable values. The aesthetic argument is that some small percentage of the earth should be left in its natural state because unspoilt nature is a source of inspiration and pleasure, and in fact it is a psychological need for increasing numbers of people, and that the decisions of the present generation should not preempt those of the future. The ecological argument, which is frequently put by the same advocates, is that humans are but one species making up an intricate web of life, and that we continue to make dramatic changes to this relationship to our detriment and ultimately our peril. This viewpoint, frequently put by scientists, also emphasizes that there are many non-quantifiable benefits to be gained by maintaining an ecosystem in its natural state or at least using it in a cautious sustainable way.

Peter Saenger's paper highlighted the unnecessary destruction which has occurred from poor recognition of the non-quantifiable (external or indirect) benefits of mangroves, and the resultant loss of those benefits.

I have emphasized these perceptual problems because of their importance to both policy-making and implementation in all resource issues and no less, coastal management.

The utilitarian philosophy is so entrenched in our community, our bureaucracies and our politicians that it has achieved the status of 'just commonsense'. Contrary viewpoints are dismissed as 'airy-fairy' or 'emotional'. Until a much greater understanding and acceptance of the aesthetic-ecological philosophy is achieved, utilitarianism will remain a major obstacle to truely balanced decision-making in environmental policy.

The above generalisation may in fact be particularly true for the coasts and tidal wetlands of monsoonal Australia because with 85 cents in every dollar coming from Canberra the "desperation for development" ethic is particularly virulent and the major natural systems engender considerable hostility and little appreciation. A very small human population compared to land area also encourages an apathy to environmental degradation.

Policy Formulation

The Workshop on policy formulation raised numerous problems but also identified that there is general agreement as to the requirements of good policy-making. Some of the most important constraints identified were:

(a) the dominance of economic factors over ecological considerations. It was felt that a frequent result was a short-term decision to benefit a specific individual or group rather than long-term planning in the public interest. The chair raised the question whether the Northern Territory might have a

particular problem with political pork-barrelling to special interests because of the small size of N.T. electorates.

(b) the sheer number of issues which have to be addressed under the title 'coastal management' - to cite just a few : recreation, residential development, waste-disposal, navigation, fisheries, ports, tourism. The complexity of issues in turn means a morass of different government departments from all three levels of government and numerous pieces of legislation. The result is, inevitably, formidable problems of jurisdiction and coordination. This is a major difficulty for both policy formulation and implementation.

(c) the above problem is usually exacerbated by inter-governmental or inter-departmental rivalry. The Northern Territory, in common with other States remote from Canberra has a particular hostility to anything it perceives as 'interference' from the Commonwealth. Informal comments have also made it clear the Territory is not immune from the usual inter-bureaucracy jealousies.

(d) the lack of reliable data was emphasized by numerous speakers. In particular the difficulty of making accurate projections of likely results when both data and precedents were lacking. Inadequacy of research, although part of the liturgy of all scientists, may be especially applicable to northern Australia where research is only just beginning on whole ecosystems.

(e) the inadequacy of mechanisms to transfer research data to policy makers. Scientists in general feel isolated from the policy process and although in some cases this is voluntary there are many others who see communication as vital to improved policy formulation.

Implementation

Many of the above points also constitute problems in the implementation of what is judged to be good coastal management. However, further points which arose in the Workshop include:

(a) the gap between the needs of people like developers and planners for clear-cut answers in the short-term and the eternal plea from scientists that there is need for more research over the long-term before any answers can be given.

(b) the lack of rational mechanisms for resolving conflict over land management or allocation means that the more frequent determinant is political interest.

(c) the planning process often only involves ecologists and the public after decisions have been taken. This leads to a situation in which scientists have the potential to influence only <u>how</u> a development should go ahead but not <u>if</u>.

(d) the problems which arise because each proposal to substantially change the environment tends to be considered in isolation which can lead to what was dubbed in the discussions the 'tyranny of small decisions': the large-scale cumulative impact over time from many small decisions which may individually have seemed reasonable.

(e) the inevitable problem of lack of funds and competing priorities for what funds do exist. This was seen as a particular problem in the Northern Territory where distances are vast and infrastructure often lacking.

The Way Forward

Guidelines for Policy Formulation

Despite the truism that it is easier to identify problems than to come up with solutions, the Workshop discussions have achieved a degree of consensus on the basic requirements of sound policy-making. The following points were widely agreed:

(a) there needs to be a good information base. In the case of coastal planning a primary need is for a comprehensive inventory of resources.

(b) there should be agreement over the basic goals of coastal management. Territorians said there was little consensus at present on what people wanted from the coast. Some felt that regional goals should be determined within the framework of agreed National goals.

(c) priorities must be identified. The invariable inadequacy of both financial and human resources mean that the most pressing issues should be tackled first.

(d) decision-making mechanisms should facilitate communication between the scientist and the policy maker.

(e) complicated procedures and the proliferation of new bureaucracies should be avoided.

(f) all interested parties should be involved early in the policy process.

(g) rigidity in mechanisms or processes should be avoided, policy-making should be able to cope with changes in information or with changed societal needs or demands.

The Need for a National Policy

This question was raised by the Chair as a discussion focus. The question is whether there is a need for State or regional plans to be developed within the framework of National policies objectives or guidelines.

The Chair cited the example of the United States which in the 1972 Coastal Management Act asserted that there is "a National interest in the effective management, beneficial use, protection and development of the coastal zone." The U.S. Act is not coercive but requires States to follow detailed guidelines and go through certain procedures in developing coastal plans while providing major financial incentives to participating coastal states. The Chair also cited the major finding of the 1980 House of Representatives Standing Committee on Environment and Conservation Report on The Management of the Australian Coastal Zone, that "the Commonwealth Government, in consultation with the States, develop and promulgate National policies and objectives for the conservation and preservation of the Australian coastline". In addition to citing an existing National policy and a perceived need for one, the Chair also offered the even broader guidelines adopted by the OECD as a possible model (Appendix IV of House of Representatives Report).

While many participants agreed that a national approach might be ideal there was scepticism that it would eventuate. Speakers pointed to the profound suspicion and hostility felt by State and Territory governments over what they see as interference from Canberra. It wasnoted for example that the major State-Federal environment bodies: the Council for Natural Conservation Ministers (CONCOM) and the Australian Environment Council

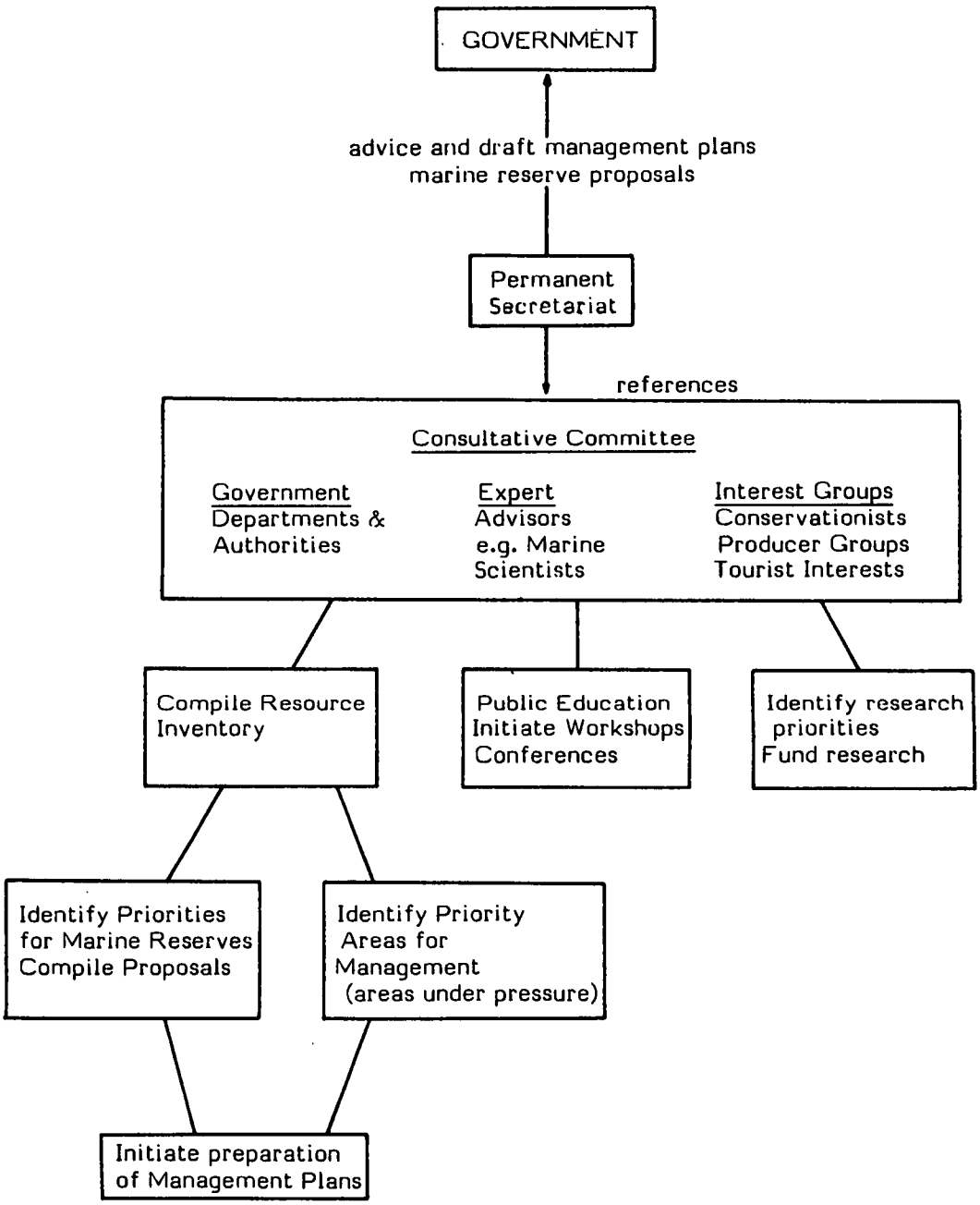

Figure 1. Composition and Functions of a coastal consultative committee. (This model should not be taken as an ideal but was drawn up after discussion with Territorians as a model which might meet their immediate needs.)

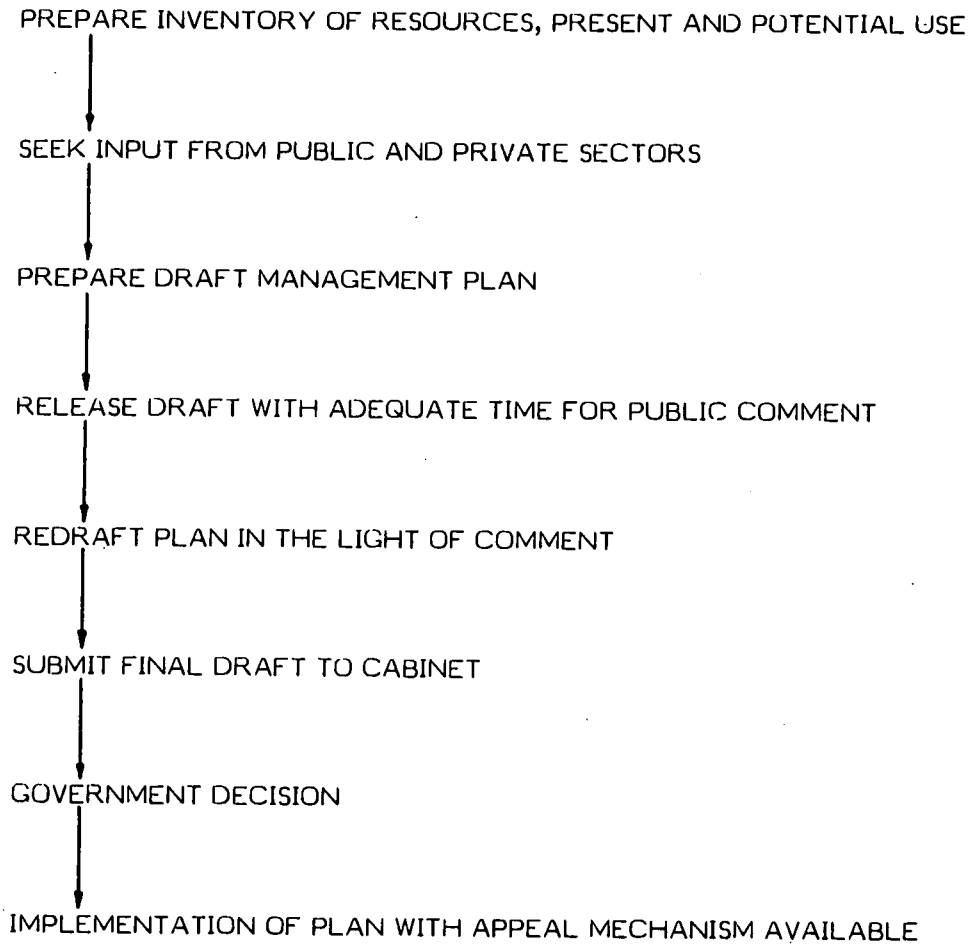

Figure 2. Management plan preparation for priority coastal areas.

(this model is derived from those used by the Great Barrier Reef Marine Park Authority in determining zoning plans for sections of the reef and the procedures followed by the Australian National Parks and Wildlife service in producing plans of management for Commonwealth National Parks.)

(AEC), have both had a National marine policy on their agendas for some years but little progress has been made, largely due to State fears. Others pointed to the confusion of Constitutional responsibilities as a major impediment to a National approach. Against this it was argued that as long as the Commonwealth's role was principally confined to financing, the States were unlikely to object and greater cooperation towards desired objectives might be possible. It was mentioned that in specific areas such as the operation of the prawn fishing industry the involvement of all three levels of government worked quite well.

Professor Richard Phillips described the Californian Coastal Commission as an interesting model of planning within guidelines. In this model the State authority gives generalized guidelines but the actual plan is developed from the 'bottom up'. Local plans are created then amalgamated into regional plans which in turn are combined to form the State plan. After checking that the composite plan complies with State and Federal guidelines it may be adopted through state legislation. At this stage local and regional coastal planning bodies are disbanded and the plan is administered by the State Coastal Commission. This model avoids the problem of proliferation of bureaucracies and Professor Phillips claimed that the system works fairly well.

There were varying opinions about the desirability of broad guidelines on the OECD model. Some speakers thought that such statements were useless 'motherhood' generalisations and would not in fact have any impact on real policy. Another opinion was that planning could only occur at a local or regional level when good information was available: guidelines applicable to Australia as a whole would be too generalised to be useful. However, Dr Ibrahim (Malaysia) supported the idea of generalised principles, within which much more specific policies can be determined. The Chair supported this, arguing that the realities of the Australian political scene meant that the more specific the Commonwealth tried to be the more likely they were to encounter resistance and therefore the development of sound principles and the provision of financial incentives was their most likely role.

A Mechanism for Rational Planning

The second question raised by the Chair for discussion was that given the numerous constraints on good policy-making which have been identified, what mechanism would best avoid these problems and in particular what mechanism would enable scientific data to inform decision-making?

A model for a standing consultative mechanism (Figure 1) and a model for public participation in planning (Figure 2) were proposed for discussion.

Most participants agreed that there was a need for a body which brought together various government and non-government interests. However, anxiety was expressed over composition of the body and the resolution of conflict. It was argued that if all interests were represented, conservation interests would be swamped. A comment in reply from a public servant who is centrally involved in determining such a committee for the Territory is that a great deal will depend on the attitudes and cooperativeness of individuals. Another remark was that conflict need not be seen as negative, that governments require alternatives. It was also proposed that conflicts between different interests would be easier to resolve if a coastal policy including agreed goals had been accepted by the parliament.

Peter Saenger told the conference of the success of the Great Barrier Reef Marine Park Authority (GBRMPA) model in both consultative and planning mechanisms. A Consultative Committee, representing Commonwealth and State departments plus conservation and producer interests advised the GBRMPA on the development of policy. Dr Saenger attributed much of its ability to reconcile diverse interests to the positive educational role of personal

interaction. He said that while representatives might start by 'pushing their own barrel', discussion frequently allowed them to see another point of view. Another reason for GBRMPA's success was that its charter allowed for flexibility as it was not against 'reasonable use'. Dr. Saenger and the Chair expressed their view that the model of public planning used by GBRMPA in determining the management of sections of the Marine Park was highly regarded across a wide range of interests.

Conclusion

The present state of policy relating to the Northern Australian coastline provides opportunities for creative input from the public and the scientific community. It was a strong feeling of the Workshop that scientists be urged to participate in the formulation of consultative structures to ensure that their views are incorporated in future coastal resource management. There was a general feeling that the Workshop constituted a step in this direction by bringing government and non-government interests together.

CLOSING REMARKS

Jim Davie

We have now come to the end of the Conference and Workshop activities. On behalf of the organisers I would like to say thank you and congratulations to you all for your persistent and active involvement through a most intensive week.

Many of the scientific technical and management questions which we have discussed in the Workshop have been local in their specific content. However it has been valuable to note from our overseas participants that these problems are part of a generic set of coastal zone management issues that are very widespread. It is important therefore that we continue to look for solutions through the experience of others elsewhere in Australia and also in our case, the tropical world. Coastal zone management meetings at the moment appear to be something of a growth industry and it is important that we here in the Northern Territory make the most of the information and experience which will flow from such meetings.

The NT Branch of the Australian Marine Sciences Association is concerned that Government and Industry in the Territory become aware of the range and depth of experience which can be tapped locally. The feeling we have had during this week is that a significant step has been taken in that direction. We have been impressed by the free ranging cross-disciplinary discussions which have marked the Workshop particularly. The frankness of the exchanges between members of the several Government agencies represented here, and their willingness to listen to those outside Government, indicate a real reason for optimism.

Thank you again for your participation.

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