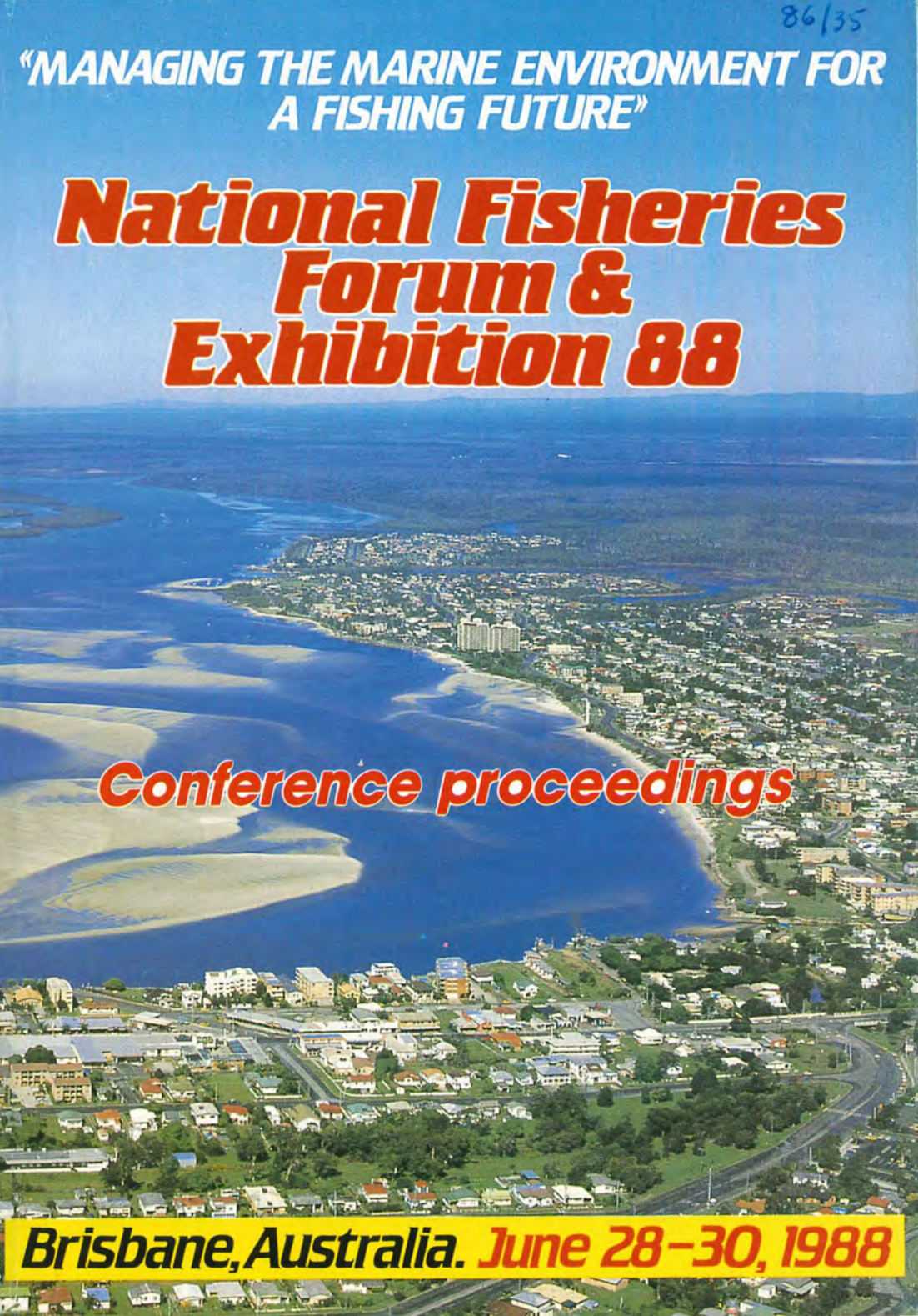
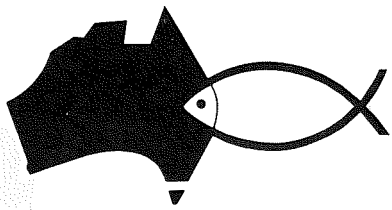
"MANAGING THE MARINE ENVIRONMENT FOR A FISHING FUTURE"

National Fisheries Forum & Exhibition 88



Conference proceedings

Brisbane, Australia. June 28–30, 1988



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FORUM SPEAKERS

DR JOE BAKER, Australian Institute of Marine Science — Segment 1: "The Fishing Resource".

MRS SUE BARKER, Queensland Consumer Affairs Bureau — Segment 3: "A Youth Perspective of the Fishing Industry".

GEOFF BURCHILL, Burchill Bate Parker and Partners Pty Ltd — Segment 2: "Development and the Fishing Industry".

PETER CONATY, Queensland Commercial Fishermens Organisation — Segment 2: (b) "Development of the Fishing Industry".

GRAHAME DENOVAN, Townsville Seafoods Pty Ltd — Segment 3: "A Youth Perspective of the Fishing Industry".

DR FABIAN FAY, Seaworld — Segment 2: (a) "Tourism and the Fishing Industry".

PROF. ALISTAIR GILMOUR, Macquarie University — Segment 1: "The Fishing Resource".

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DENIS GRIFFITH, Queensland Sport and Recreational Fishing Council — Segment 2: (c) "Recreational and Commercial Fisheries".

PAUL LEACH, National Marine Fisheries Service, Florida — Segment 1: "The Fishing Resource".

KEN McGILL, Queensland Tourist and Travel Corporation — Segment 2: (a) "Tourism and the Fishing Industry".

PETER McKENZIE, Commercial Fisherman — Segment 1: "The Fishing Resource".

BILL ORD, Journalist — Segment 4: (a) "Managing the Marine Environment for a Fishing Future — What To Do".

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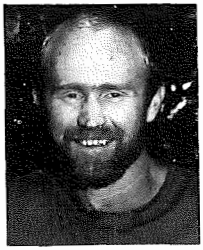

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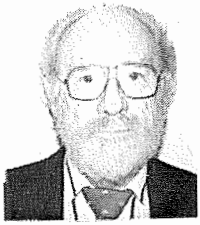

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FORUM SPEAKERS

ALD MIKE REYNOLDS, Townsville City Council — Segment 2: (b) "Development and the Fishing Industry".

LEN STOLK, Escott Station — Segment 4: (a) "Managing the Marine Environment for a Fishing Future — What To Do".

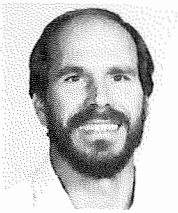
PROF. JIM THOMSON, Northern Territory University College — Segment 4: (a) "Managing the Marine Environment for a Fishing Future — What To Do".

DR IAN POINER, CSIRO Marine Laboratories, Cleveland.

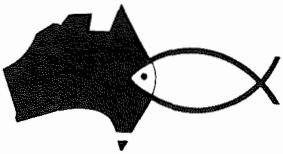
SALLY RICHARDSON, CSIRO Division of Atmospheric Research, Vic.

Technical Speakers

DR CARL SULLIVAN, American Fisheries Society — Segment 2: (b) "Development and the Fishing Industry".



DR WILLEM J. BOUMA, CSIRO Division of Atmospheric Research, Vic.



SCIENTIFIC RESEARCH CONTRIBUTION TO THE DEVELOPMENT OF WISE MANAGEMENT OF AUSTRALIA'S TROPICAL MARINE RESOURCES

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Introduction

Australia's tropical marine environment has in the past five years come under much more significant human pressure by reason of the emphasis of tourism in the region and the consequent development of major hotels, marinas and even offshore structures, such as hotels and very large pontoons.

In these circumstances all marine resources are exposed to an intensity of human pressure which has not been evident in the past. The traditional concept that commercial fisheries were the most significant economic factors to consider may well be challenged in northern Australia where tourism and an increasing population result in much greater recreational fishing activity and improvements in methods of transport give access to areas which previously were effectively protected from human presence.

Tropical marine research is several decades behind other areas of marine research with respect to the time factor but in Australia the developments in Queensland and more recently in the Northern Territory have resulted in a much greater commitment to research relevant to Australia's tropical marine resources and to management agencies with the specific responsibility for parts of Australia's marine tropics.

The scientific contribution to management is important because so little is understood of the physical and biological factors which affect recruitment and stability of tropical marine populations.

In this area of Australia the predominant coastal feature is of mangroves and the majority of the rivers enter the sea through mangrove lined waterways. Offshore there are significant reefs, particularly on the east coast. Other notable features in some areas of tropical Australia are seagrass beds, extensive shallow water mud flats and extreme

tidal ranges. Research has recently concentrated on developing knowledge on the links between the mangrove areas, the seagrass areas and the coral reefs and the relationships of those links to the fisheries resources both inshore and on the reefs themselves. The research conducted has implications not only for Australia but also for a large number of countries in the Asia/Pacific region.

The paper does not attempt to address studies on fish catch statistics but concentrates on the relevance of the predominant coastal and offshore features of the tropics to long term stability of coastal and reef fisheries.

In Townsville the close collaborations between the Australian Institute of Marine Science as an Institute committed to marine science research, James Cook University as an educational and research institution and the Great Barrier Reef Marine Park Authority as a management agency, provide a system of interaction which has never previously been apparent in any tropical region of the world. Additionally the close involvement of the Queensland National Parks and Wildlife Service, the Queensland Department of Primary Industries and the CSIRO together provide an effective network between research and management agencies at the State and Federal level.

Mangrove Areas

Mangroves have been traditionally respected by scientists as important sites for juvenile fish and crustaceans. However despite research conducted over a very large number of years, the nursery ground value of mangroves remains unclear. Robertson and Duke (1987) identified the fact that few studies have been conducted which took advantage of balanced sampling strategies capable of providing concurrent data on the densities of fish and crustaceans in mangroves and in comparative control areas e.g. seagrass beds, rocky shores etc.

Mangroves in Australia provide an excellent study site because in comparison with other countries, direct human usage of mangroves (apart from modification in concentrated areas to develop cane farms, marinas, port facilities and tourist resorts) has been very limited. The majority of the developments instanced above have been intensified in recent times but do not impact on a very large percentage of the total mangrove dominated coastline of tropical Australia. Whereas one must be concerned at the potential for increasing modification of mangrove areas by such use, without significant recognition of recent scientific research on mangroves and their productivity, tropical

Australia is still regarded as largely in an undisturbed state by comparisons with South-east Asian countries. In South-east Asia mangrove forests represent a highly significant, although sometimes poorly managed, resource through forestry, silviculture and mariculture. Robertson (1987) has stated that mangrove forests are probably among the few large scale, virtually pristine, tropical mangrove systems remaining in the world.

In the research that has been conducted at the Australian Institute of Marine Science since 1974 and in studies which have been conducted in Queensland, Northern Territory and Western Australia by scientists from several Australian institutions, significant advances have been achieved in our knowledge of mangrove forest types throughout tropical Australia. The increased understanding includes the factors which affect mangrove tree distributions, large and local scale distributions of mangrove species, species diversity, and forest photosynthetic production rates. Additionally long term data are available about litter fall in mangrove forests. The relevance of litter fall to overall mangrove productivity has only recently become evident.

Recent research has demonstrated the importance of mangroves as nursery grounds for juvenile fish and prawns. Studies on fish recruitment, growth rates and fish production within mangrove waterways have been conducted. Access to this information by managers is essential in defining strategies which recognise the long term importance of undisturbed mangrove stands to fisheries resources.

It is important to note that mangrove forests are not constant in species distribution and there is significant wide spread and local distinction between mangrove forests. In work conducted by Tom Smith (1986/87) comparison of species diversity patterns were made between forests on the eastern and western Australian coastlines: for both regions it was found that the temperature range had a similar influence, increasing temperatures being associated with greater species diversity. Tidal amplitude was also positively related to diversity in both regions. Factors such as estuary length, catchment size, rainfall variation and cyclone frequency were found to influence only the eastern mangroves. On the other hand western mangroves appeared to be more influenced by the degree of fresh water run-off, a factor of no significant influence on the east coast forests.

Predation of mangrove propagules was found to be an important factor in determining forest types and other factors which have been previously suggested as having strong influences on local scale distributions e.g. light availability (through gaps in the forests), tidal inundation, propagule size, and soil salinity have been shown to have far less effect than the predation factor. The work of Boto and Wellington (1983) has shown that the

potential primary production of mangrove forests is limited in the long term by nutrient status of mangrove soils, notably phosphorous and nitrogen deficiencies.

The Significance of Mangrove Litter

Litter fall comprises between 30-60% of overall mangrove forest production.

The studies of Boto and Bunt suggested that in the dynamic tidal areas up to 90% of the litter fall is exported by the tide. More recently Robertson has shown that this figure needs to be revised downwards to take into account the surprisingly high rate of direct litter consumption by Sesarmid crabs which inhabit mangroves. It is estimated that 60-70% of litter fall is still exported from mangroves to nearby coastal waters, in situations where there is significant tidal action.

This organic export is more significant than most people may at first think. AIMS has an experimental site at Missionary Bay on Hinchinbrook Island. In this area it is estimated that each year more than 35,000 tonne of mangrove derived organic matter is exported to the surrounding coastal waters from the forest system which itself covers an area of approximately 60 km^2.

The ultimate fate of this exported material is the subject of ongoing study and we cannot at this stage provide information to managers on what is really a very large contribution of organic material. Recognising the richness of mangrove forests on a tropical coast this is an area of study which managers should support as being of high priority.

Robertson has found that virtually all the litter fall during low tide periods is consumed by Sesarmid crabs. Throughout the year he estimated that 25-30% of total leaf litter fall is consumed by these crabs. He has also demonstrated some selectivity for different types of leaves and propagules among crabs. The work of Tom Smith has shown that more than 75% of the mangrove propagules are consumed by Sesarmid crabs, when this is averaged over all the species that he has examined.

This greater understanding of the fate of mangrove litter and the ongoing work on the role of microorganisms such as bacteria and microalgae provide information which must be effectively communicated to decision-makers because mangroves themselves are of such variety that different types of mangrove forests may demand different types of management strategies.

Robertson and Duke (1987) have shown the importance of mangrove habitats as a nursery ground for many species of juvenile fish and prawns. Their studies compared the populations of juveniles and adults in mangroves and in nearby seagrass beds and/or sandflats at a number of widely spread and diverse locations along the north-east Australian coastline.

It was found that mangrove waterways consistently contained higher numbers of juveniles than non-mangrove areas. On the other hand there were no consistent differences in adult populations between the habitats. Additional studies are continuing, to determine whether the complex mangrove root structures are preferred by juveniles because they afford a greater amount of protection or whether the higher incidence of juveniles in mangroves relate to the possibility of a better food source within the mangrove areas. It is conceivable that both factors are important. Robertson and Duke (1987) in their fish production studies regularly sampled mangrove waterways with seine and trap nets over a 13 month period and from these studies they obtained reliable information on recruitment of juvenile fish and crustaceans, their rates of growth while in the mangrove habitat and their population densities.

Relevance to Management

Managers of Australia's tropical marine resources should take note of these ongoing studies and should take the opportunity of frequent collaboration with the research institutions which certainly have now adopted an "open door" approach to developers and to managers, including the public and private sector. One of the reasons for this increased collaboration between scientists and manager is the recognition that in some countries, notably in South-east Asia, increasing human populations, and the internationally determined shift towards exploitative western style cultures, has meant that mangrove and seagrass habitats have been very rapidly degraded. For instance it has been estimated that the area of mangrove forest in the Philippines has been halved in the last forty years (Zamora 1984). In the South Pacific region mangrove forests are often heavily exploited for timber and firewood and they face an increasing threat from a variety of pollution sources (Baines 1981). Robertson (1988) has recently produced an excellent overview paper for the South Pacific Commission Workshop on Inshore Fisheries on the "Links between inshore fisheries resources and mangrove in tropical Australia: implications for coastal zone management in the South Pacific".

This detailed paper not only covers the experimental work that has been conducted but outlines sampling techniques which are important for reliability of data and to allow comparison of data from different areas.

Robertson and Duke (1987) conducted seasonal analyses of the stomach contents of the 40 dominant fish species found in the east coast tropical mangroves. They found that during most of the year zooplankton-feeding fish are the major trophic group in terms of both total numbers and biomass of fish captured. Other important trophic groups were found to be benthic micro- and macro-faunal fish feeders. Copepods were found to be the most important prey of the majority of fish in the period between April and August while crab zoea were more important in supporting fish between December and February.

With reference to the earlier question as to the importance of mangrove habitat versus food source in mangroves. Robertson and Duke (1987) noted that the period December/February is the major period of recruitment of post larvae for the majority of fish species. Differences in prey-abundance may be an important factor, and the studies continue.

From the viewpoint of management the most significant single factor is that the work shows that there is a major link between juvenile fish and mangroves. A large proportion of litter fall in the forests is consumed by Sesarmid crabs and crab larvae are a particularly important prey item of fish during the crucial recruitment period of the majority of the fish species. During the remainder of the year copepods and other zooplankton are a vital food resource, and current research is aimed at identifying the food sources of copepods to determine their link to mangrove forests.

The Importance of Hydrology Studies in Understanding Mangrove Systems

Several models have been developed for water flow in coastal systems. Wolanski (1980) developed a water flow model for a mangrove forest subject only to tidal influence. Use of this model has allowed the AIMS group to make estimates of tidal export of particulate organic matter (POM) and dissolved organic and inorganic nutrients from such a forest. The model shows that ebb tide flow rates are much greater than flood tide flow rates because the complex matrix of mangrove trunks and prop roots act as a barrier to water flow during the early phase of the ebb tide. When water does flow out of the forest it is at an increased velocity because of the gradient that has been set up between

forest and channel. A major effect of the greater ebb tide currents is scouring of the channels within mangrove forests. Again this is a factor which should be taken into account in all planned developments involving mangrove areas.

Mangroves as Nursery Areas

The AIMS data have shown that in tropical Australia distinct fish communities inhabit mangrove lined estuaries and total fish densities are markedly higher in mangrove systems than in any other type of adjacent habitat. The data, for the first time, provide a solid scientific justification for the long term belief of the nursery value of mangroves and also for the conservation of mangrove habitats.

In extending these studies to different areas and to determine the importance of different mangrove communities it is important to consider (i) the presence or absence of estuarine conditions (ii) the patch size of mangrove forest and (iii) the proximity to other habitats.

Previous work in countries with large riverine mangrove swamps (Papua New Guinea, Fiji) (e.g. Haines 1979; Collette 1983; Quinn & Kojis 1985; Lal et al 1984) have shown that there is great similarity in the fish and crustacean faunas among mangrove forests of Australia and Papua New Guinea and to a lesser extent, of Fiji. The current results would indicate that there is a strong likelihood that mangroves serve a similar nursery ground function in these different countries.

Disruptions to food chain links will obviously impact on fisheries resources which depend on mangroves. Our research indicates that practices like clear felling of timber and land reclamation, which lead to reduction of mangrove forest area, and overall forest primary production, will probably have a direct influence on consumer production.

This is because the established sequence from mangrove litter to adult crabs to larval crabs to juvenile fish as a food chain, links the fish populations directly to the mangrove detritus.

Another important factor to consider is that although mangrove trees themselves can withstand loadings of nutrient (e.g. from sewage) the increased biological oxygen demand created by bacterial respiration in mangrove waterways in response to high

organic matter loads may cause the death of the essential zooplankton. In tropical Australia at least this would result in decreased survivorship of juvenile fish.

The question of the importance of outwelling from mangrove swamps is one of continuing research. In the purely tidal mangrove forest of Missionary Bay in North Queensland there is little evidence of export of dissolved nutrients; in fact for phosphorous there was a net import to the forest. These results appear to indicate that the claims about the dissolved nutrient subsidy available to other inshore systems from mangrove forests (e.g. David 1985) may require reanalysis. We would point out that the situation may be quite different in countries with large riverine mangrove forests (e.g. Papua New Guinea) although dissolved nutrients exported from such systems may be purely of terrestrial origin.

One should again draw attention to the contrast between the dissolved nutrients and the particulate organic matter (POM) export from mangrove forests.

The factors that are important to take into account with respect to the impact of the mangroves on adjacent systems is the size of the mangrove forest relative to the body of water it feeds into, the nutritive quality of the particulate organic carbon (POC), and the magnitude of other sources of primary production. Boto and Wellington (1987) have shown that most of the POC has a very high carbon to nitrogen ratio and this material may play only a minor role in food chain dynamics outside the mangrove system.

Implications for Management

The results of research in Australia and elsewhere clearly indicate that no clearance of mangrove areas or large scale exploitation for clear felling, or timber production, or for aquaculture pond development should take place without consultation with scientists involved in the research. Preferably there should be no large scale modification of mangrove areas until the current research of forest and fisheries resources of mangrove swamps are completed.

In contrast to what developers may claim this is not an irresponsible statement. It is a recognition of fact and when one compares the impact of a delay of a few years in a projected development to allow better scientific understanding of a local system compared with the largely irreversible changes that will result from a major development, it is in fact a responsible situation to be taken by the scientists and an

irresponsible situation to be taken by management if they bow to the immediate economic pressures which may well have only short term benefit.

Additionally the destruction of the mangrove area may also destroy the very features which attract the development in the first place. We believe that a combination of ground truthing and remote sensing is essential to allow a reliable estimate of the extent of mangrove forests and their associated fisheries resources. We also believe that greater care must be given to the design of studies associated with environmental impact studies on mangrove areas - particularly comparisons of the fishery resources of mangroves and adjacent habitats should be undertaken. The research needed must take into account the greater definition on food chains for different mangrove types and comparisons must be made between mangroves in different geographical areas. This implies the need for the research scientists to work closely together and to adopt and accept standard methods of assessment of mangrove ecosystems.

In the long term we believe that it will be possible to recommend on controlled use of mangrove areas, identification of key areas which must not be disturbed. We can expect, in Australia, exploitation of mangrove timber products on a sustained yield basis and also the identification of areas which may be applicable for different types of mariculture.

Coral Reefs

The other major distinctive feature of the tropical marine environment of Australia is the different reefs on the north-west shelf to the north of Australia and, most significantly, along the north-east coast of Australia as represented by the Great Barrier Reef. The Great Barrier Reef may be at first thought to be a single structure but in fact it is a complex of many different types of reefs with the recognition now that there are some 2,900 individual coral reefs as well as the different mainland type islands and different coral reef islands. Williams, Russ and Doherty (1986) have estimated that there are approximately 1,500 different species of fish throughout this Great Barrier Reef complex. The reefs vary enormously in size and range from near inshore to the outer edge of the continental shelf.

Throughout the vast area of the Great Barrier Reef region scientific research is revealing significant differences between individual reefs, between different types of current flows in different areas, different tidal regimes and differences in reefs from those located

nearshore to mid-shelf and to outer shelf. Williams, Russ and Doherty (1986) have stated that the species composition of reef fish communities vary significantly from reef to reef and also from one time period to the next. They attribute part of this variation to the chance replenishment of benthic populations by pelagic larvae but recognise that this factor cannot explain all or even most of the variation observed among coral reefs. Their recent surveys have shown that at certain scales of both space and time there are consistent patterns in fish communities which reflect the influence of certain specific factors such as cross shelf (longitudinal) gradients in the physicochemical and biological environment.

In general the waters of the coral reefs are clear and visual analyses have often been practiced. (These are generally not suitable for the waters associated with the coastal region and particularly with mangrove areas which have such a high sediment load). Again it is important to recognise that the studies of tropical reef fish, beyond the simple description of individual species, has not been conducted on an integrated long term scientific basis. Very few studies of the distribution and abundance of coral reef fishes pre-date 1970 (Ehrlich 1975). Consequently there have been little data available to allow comparison of population changes or recruitment changes over a scale of decades. At this stage most of the work being reported is comparing interannual variability.

The work at the Australian Institute of Marine Science has been conducted principally by Dr David Williams who has worked in close collaboration with Professor Peter Sale (formerly University of Sydney), Dr Peter Doherty (Griffith University), Dr Garry Russ (formerly AIMS, then Sydney University, now James Cook University) and more recently with Professor Howard Choat (formerly University of Auckland and now James Cook University). Over the past seven to eight years these studies have concentrated on determining natural variations in fish species composition and abundance between different reefs in the study areas.

Obviously all reefs cannot be studied and it will be necessary to construct models to extrapolate findings in local areas to a more general projection of the way in which different areas of the reef can be expected to function. Equally obviously the work could not study all the different types of fish that are found on the reef. The work has therefore concentrated on more than 100 common species representing a wide range of ecological types. These include coral feeders, algal grazers, plankton feeders, carnivores, species with short larval lives, species with long larval lives, species associated with nearshore habitats and species associated with the reefs in the areas most remote from the land.

The Importance of an Understanding of Natural Variation of Fish Abundance

The importance of this area of study relates to the need to provide a reliable base line against which to compare the human impact on the fish population of "the reef". Without such a baseline, erroneous implications could be made with respect to observations of differences of abundance of species from one reef to another. For example if there is a great abundance of a particular species, say Red Emperor, at a particular reef and an almost complete absence of that same species on another reef, the first suggestion may be that the second reef has been overfished. However the preliminary results of research appear to indicate that it is quite possible that even when reefs are un-fished, significant differences in abundance may occur for natural reasons.

Additional information about natural variation of abundances both over time and geographical distance, allows scientists to formulate and test hypotheses in the search to discover the factors which will determine distribution and abundance of fishes. The initial work conducted from AIMS involved reefs along a transect running from inshore to well offshore from Townsville. Two nearshore reefs were selected; three midshelf reefs and three outer shelf reefs were studied and, in addition, three reefs in the Flinders Reef complex which is outside the Great Barrier Reef region and well within the Coral Sea, were added to the study transect. The results of this work have certainly shown that the abundance of fish species often varies between reefs but the differences between neighbouring reefs are small compared with the differences one finds between nearshore, midshelf and outer shelf reefs. The repeated censuses of fishes on the reef of the transect have shown that the natural abundances of some species on a reef may undergo a five fold change in numbers over only three years.

In all eight transects across the Great Barrier region have been surveyed. Latitudinally these range from the tip of Cape York Peninsula to the southern extremity of the Great Barrier Reef and the principal geographic features which identify the location of the transects are:-

Raine Island
Lizard Island
Cairns
Townsville
Whitsunday Island
Pompey complex of reefs
Swain complex of reefs
Capricorn-Bunker groups of reefs

As previously indicated the Townsville transect showed a significant difference in the abundances of different fishes as one moved from the nearshore through the midshelf to the outer shelf reefs. The results of the surveys over the latitudinal area reveal that the distribution and abundance of reef fishes varies significantly from north to south. However the variation observed north-south is not nearly as great as that from the nearshore to offshore regions. The research which has followed these basic investigations has concentrated on investigating the causes of the patterns of fish distribution that have been observed. The studies include investigations on the relationships between the availability of food and the abundance of fishes and the significance of the pelagic larval phase to the eventual distribution of adult reef fishes.

Recruitment as a Limiting Factor

It has been widely assumed that the supply of larvae competent to settle on coral reefs is in excess of resources available to those larvae after settlement (Sale 1980). The abundance of fish in a given area has generally been thought to be space limited and determined by competitive interactions among individuals. Debate has centred on the constancy of relative abundances of species given space limitation. Sale (1980) has argued that the total density of ecologically similar species is limited by space but that the relative abundances of species within the ecologically similar species is determined by chance processes. Vacant space is filled on a first come, first served basis and the specific identify of the first arrival is not predictable (Sale 1974; 1977; 1978; 1979; 1982). Others have suggested that relative and absolute abundances will be relatively constant and determined by competitive interaction between species (Smith and Tyler 1972; 1973a; 1973b; 1975; Ehrlich 1975; Gladfelter and Gladfelter 1979; Gladfelter al 1980; Anderson al 1981; Ogden & Ebersole 1981; Shulman al 1984).

More recently it has been suggested that competent larvae may not be in excess supply and densities of reef fishes may frequently be recruitment limited i.e. insufficient larvae survived to saturate the resource available to fishes in the reef environment (Munro et al 1973; Williams 1980; Doherty 1982a, 1983a; Victor 1983). If this is true it would have profound implications for those assessing and managing coral reef fisheries because (i) densities of fish will vary in space (among reefs) depending on spatial variation and recruitment but independent of fishing pressure (ii) densities of fish on a given reef will vary in time, depending on temporal variation and recruitment but independent of fishing pressure (iii) the availability of fish may be determined largely by factors outside the local reef environment and beyond the control of local reef manager (e.g. if reefs are

not self recruiting) (iv) greater care will be required in the interpretation and use of fishery models that assume recruitment is constant and/or not limiting.

Changes with time

It is known that several coral reef fishes have extended breeding seasons (Sale 1977; Johannes 1978a). Seasonal peaks in recruitment or larval abundance have been observed on the Great Barrier Reef (e.g. Williams and Sale 1981; Williams 1983; Leis & Goldman 1983) as well as in the Philippines, Jamaica, Japan, Guam, and the Gulf of California.

Most species in an area tend to recruit during the same season, but important exceptions may occur. For example although most species in the Great Barrier Reef spawn in late spring or summer (November to February) two species of major commercial importance, Lethrinus chrysostomus and L. nebulosus spawn primarily in mid-Winter (June to August) (Walker 1975). Because the limited data which is available do not suggest an exceptionally long larval life for L. nebulosus, peak recruitment of this important species may precede that of others by some months. The possible causes and adaptive values of this seasonality have been reviewed by several authors e.g. Johannes 1978.

Recruitment during seasonal peaks is believed to be not uniform but to tend to occur in a pulsing fashion. At the current level of knowledge there appears to be no general relationship between these pulses and the timing of spawning and/or lunar cycles. In the study conducted by Williams in the One Tree reef lagoon the timing of this pulse was found to be remarkably consistent from year to year but there was no clear relationship with time of the lunar month (Williams 1983). A number of studies on the Great Barrier Reef have suggested that the periodicity of recruitment is uniform on a spatial scale of kilometres but not tens of kilometres (Doherty 1983b; Eckert 1984; Sale al 1984).

Recent work by Doherty, Sale and Williams (1988) in research funded by the Marine Science and Technology Grant Scheme was conducted on variations in replenishment of reef fish populations at five different regions of the Great Barrier Reef spread over a length of 1100 km. This work was deliberately planned to be relevant to the needs of management of the Great Barrier Reef Marine Park. Natural replenishment of reef fish stocks depleted by human-induced or natural occurrences can occur only through recruitment of juveniles. The work by Williams, Doherty and Sale (1988) has emphasised the spatial and temporal variability of this recruitment process, and it's

significance, at scales of up to 10's of kilometres. Their study represented the first attempt in reef fish studies to determine whether such variation extends to scales of 100's of kms. Preliminary analysis suggests that there are major species - specific differences in rates of replenishment among the five regions (Cairns, Townsville, Whitsundays, Swain, Capricornia Bunker group) and that a "good" or "bad" year in one region is not necessarily "good" or "bad" in another. Their current research suggests that even under natural conditions without any major human or natural influencing event, annual replenishment of a specific species can occur over a distance in excess of 1000 kms.

Because adults of most species on a reef comprise individuals from a number of different year classes, the effect of annual variations in recruitment on variation in total numbers is not immediately obvious.

However it is of significance to long term successful management and to interpretation of human and natural influences to have reliable data on the frequency with which successful or unsuccessful replenishment is achieved under natural conditions.

At this stage in the investigation there is no evidence that the degree of annual variation recruitment is any greater, or less in any one species than in any other.

Detailed Spatial Variation

Spatial variation recruitment has been examined over a number of scales from adjacent patch reefs, coral heads and artificial reefs, to widely separated sites within a reef zone, to differences among zones and to differences among reefs separated by tens of kilometres. The smaller scale studies have emphasised the inconsistent variation in recruitment among apparently similar habitats. Williams and Sale (1981) suggested that at the scale of different sites within a reef zone, patterns of recruitment of some taxa are consistently more variable than those of other taxa.

Significance of Biological Interaction

Patterns of recruitment may, to a large extent, determine the abundance of fishes on a reef but the growth of individuals and hence the total biomass and fecundity of a stock may be modified by interactions between individuals. Intraspecific density-dependent growth has been widely demonstrated in fishes and is assumed in many fisheries models.

Many reef fishes are amenable to direct experiments of density-dependent growth but few data are available. Doherty (1982b, 1983a) has demonstrated the growth rate of juvenile Pomacentrus wardi is dependent on the densities of both adult and juvenile conspecifics. Much of the control of growth appeared due to social interactions rather than to an absolute shortage of food. Over a range of densities, including densities far higher than found naturally in the field, total biomass at the end of the first year did not reach an asymptotic value which might have indicated an absolute shortage of food (Doherty 1982b). The growth rate of juvenile Pomacentrus amboinensis has also been demonstrated to be dependent on the density of juvenile conspecifics and the presence or absence of adults. The effects of intraspecific interactions on growth rates are not yet clear.

The study of the fisheries within the Great Barrier Reef is extremely complex and there are ongoing studies on stock densities and structures, on environmental effects such as the difference between the reefs around low islands and high islands, the differences between nearshore reefs and shelf edge reefs, and on latitudinal variation: in the near future scientists will be able to provide additional information to management.

Effects of Exploitation

It is known that significant fishing pressure can change the age/size structure of a fish population, decrease the stock size and ultimately lead to fundamental changes in community structure. However few detailed descriptions of such changes in the populations of coral reef fish have been published. Russ (1985) compared the abundance of preferred target species on the reef slope of one island in the Philippines, protected from any fishing, and two other reefs open to fishing in the Philippines. He found that significantly more of the highly favoured target species, including a significantly higher biomass of groupers, were found within the protected site. While the differences between sites could not be attributed solely to the protective management. Russ (1985) concluded that the protective management has been very important in maintaining the high abundance of many of the species in the face of fishing pressure.

The Challenges of Management of Coral Reef Fisheries Based on Scientific Evidence

The Great Barrier Reef Marine Park Authority has established a zoning system which allows for different levels of use of different reefs within the Great Barrier Reef region. The zones including those offering the highest protection have been developed on the basis of available scientific evidence and on current use patterns. Recreational and commercial fishing on the Great Barrier Reef region have been one of the great drawcards of the reef for tourism and for general recreation. The Great Barrier Reef Marine Park Authority recognises that the scientific base on which the zoning was first developed, was very inadequate and has adopted a procedure whereby the zoning plans for the different sections of the Great Barrier Reef Marine Park will be reviewed in approximately five yearly intervals. This process of continual review allows the Great Barrier Reef Marine Park Authority to progressively take note of scientific developments and to consider their contribution to the planning process for the wise use of the Great Barrier Reef Marine Park.

The planning for the Great Barrier Reef region and specifically for the Great Barrier Reef Marine Park has fortunately been in advance of the excessive human pressures which have caused destruction of large reef areas in other countries. However it has also been well in advance of the detailed scientific knowledge which managers would like to have available in developing their management strategy. On the basis of work conducted to date it is clear that the conservation of the reef environment itself is an essential prerequisite to an ongoing successful fishery. If degradation of reefs occurs or if pollution of the waters around reefs is significantly increased there will be changes in biota which, on the basis of present knowledge can be expected to have an impact on the species distribution and biomass of fish associated with the reef. Our best examples of these impacts come not from Australia but from other countries e.g. the Philippines.

In Australia we have a limited knowledge of traditional management practices of fisheries by the Australian aboriginals.

Many of the practices adopted in fisheries outside the Great Barrier Reef region and outside of Australia will continue to attract the concern of the people responsible for fisheries management and for the Great Barrier Reef Marine Park. As scientific knowledge develops there will be continual analysis of the success of the seasonal closures which the Great Barrier Reef Marine Park Authority has adopted, or the system of establishing a limited number of permanent reserves (conservation areas), determination of whether these should be extended or reduced, the complex question of

whether patch quotas can be justified on the basis of scientific evidence and of catch statistics, the question of whether the size limits on fishes that have been adopted over several generations are still correct and whether even in the richness of the 2900 reefs of the Great Barrier Reef region there is a need for the construction of artificial reefs for specific purposes e.g. protection of juveniles or to allow increase of fish species in areas which do not have natural reefs.

The research priorities must relate to a better understanding of the complex multispecies fishery which the Great Barrier Reef represents: to an understanding of the effects of environmental changes on the different life stages of the fish species; and particularly to an enhanced interaction between biologists, ecologists, chemists, biochemists and oceanographers to ensure that all the different parameters that must be taken into account in a system coming under increased human pressure, can be properly understood. It is my belief that oceanography has a key role to play, particularly in analysis within the different regions of the Great Barrier Reef as to the importance of self seeding of reefs by larval distribution, or determination of whether reefs are interconnected by reason of the transport of larvae from one reef to another. There are many related fields of study which must be undertaken not only on the biology and ecology of the fishes themselves but also on the nature of the human activities which exploit the fish resource.

Recently there has been established an Advisory Committee on research into the effects of fishing in the Great Barrier Reef region. The membership of this Committee comprises the Great Barrier Reef Marine Park Authority, Queensland Department of Primary Industries, Queensland Fish Management Authority, Queensland Commercial Fisheries Organisation, CSIRO, Queensland National Parks & Wildlife Service and the Australian Institute of Marine Science. This group will be particularly concerned with the important question of the effect of fishing and I would imagine that the group would take into account the methods of fishing for different species, their selectivity for the target species and many other factors associated with the human pressures which cause us continually to assess the impact of increased human activity on the stability and viability of the different species which comprise the Great Barrier Reef fishery.

Acknowledgments

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Institute of Marine Science comprising Dr Kevin Boto, Dr Alistar Robertson, Dr Barry Clough, Dr Dan Alongi and Dr David Williams and their experimental scientists. Previously Dr Tom Smith (now in Florida) was a member of this group and part of his work has been used. Additionally I have used information from a special seminar on "Assessment and management of coral reef fisheries: biological, environmental and socioeconomic aspects" which was part of the proceedings of the Fifth International Coral Reef Congress held in Tahiti in 1985. At that special seminar, Dr David Williams, Dr John Munro and Dr Peter Sale were principal participants.

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BUILDING PUBLIC SUPPORT TO ENSURE A FISHING FUTURE

PAUL J. LEACH
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Introduction

It gives me great pleasure to be a part of the National Fisheries Forum and to make my first visit to your country. Australia and the United States have always been great friends, but I believe the warmth towards Australia has never been more intense than at the present, due in large measure to "Crocodile Dundee". This colourful, fun-loving, beer-drinking, down-to-earth character has captured the hearts of all Americans. I promised my wife that she would meet Crocodile Dundee during our visit, and she has--a hundred times over. It seems the entire country is made up of Dundee's, which is making our visit so pleasurable.

I would like to express my sincere wishes for a successful Forum, and look forward to sharing views with you during the next few days. So please, don't hesitate to seek me out for a lively discussion at any time. It would provide a good opportunity for me to brush up on my Australian.

My favourite outdoor recreational pursuit is fishing. I buy fish from the market whenever my piscatorial skills fail me or when my job cuts into my free time. I once operated a gillnet for salmon in Alaska. I order fish regularly in restaurants. My occupation is in fisheries. I'll bet you guessed already--my wife and three daughters are also into buying, cooking and catching fish. I can't imaging life without the enjoyment and rewards associated with fishing. Thus, I share deeply the concern about our fishing future. I want future generations to have the opportunity to pursue fishing and its related activities.

Let me pose a few questions about our fishing future that may help put this problem into perspective:

1. If the world population doubles in the next 40 years, as expected, will seafood production be able to keep pace and feed an additional 5 billion people?

2. Can the lid be kept on many of the problems that plague the fishing industry, such as overfishing, overcapitalization, pollution, user conflicts, product quality and safety, and effective management?

3. Will coastal development continue to march to its own tune irrespective of the importance of habitats to fisheries and other forms of wildlife?

4. Will budgetary support for fisheries programs falter when matched against other priorities such as education, defense, social welfare and public transportation?

5. Will the public care if the fishing industry is in shambles or economically distressed?

If the answer to these questions creates some nervousness, then perhaps we as leaders and managers may not be on the best course possible to remove this gloom from the horizon.

In looking at the fisheries picture in the U.S.A., I am not overly optimistic. We have the fourth largest coastline and the third largest continental shelf in the world. Presently, we are home to almost 7 percent of the world's population and have within 200 miles of our coastline (our exclusive economic zone) approximately 20 percent of the world's fisheries resources. Yet, we have a trade imbalance of almost $6 billion a year. Virtually all of the species sought by both commercial and recreational fishermen are in trouble. While many management actions are being taken to correct these problems through the efforts of our Regional Fishery Management Councils, the individual states and industry, I am fearful that won't make a significant difference in the long run. The deadliest enemy facing us is the loss of critical estuarine habitat. Vegetated coastal wetlands, the nation's most productive fisheries habitat constitutes less than .003 percent of the nation's land surface (excluding Alaska). In 1950, this amounted to 4.4 million acres. According to statistics, we are losing some 50 000 acres of our precious coastal wetlands annually. This is devastating, inasmuch as 70 percent of all of recreational species and 80

percent of all commercial species are estuarine dependent. In Tampa Bay, a 400-square mile estuary near my home, some 88 percent of the sea grasses and 46 percent of the mangroves already have been lost, and a good part of the bay has been filled-in. Urbanization is the chief culprit, and I suspect greed is the motivating factor underlying infringement into the bay and surrounding environs.

Fish are now becoming increasingly important as food in the U.S. because of their healthful attributes. We are still considered a meat-eating nation, consuming 150 pounds of red meat per capita annually; fish consumption amounts to 15 pounds per capita annually.

Australia and the U.S. are roughly the same size, yet our populations are enormously different. Australia's population is pushing 17 million while that of the U.S. is nearing 267 million. In 1840, 148 years ago, the U.S. population equalled that of Australia today. Every 14 seconds one more person is added to the U.S. population which translates into a growth of over 2 million yearly. That is probably more people than live in the Brisbane metropolitan area. Over 50 percent of the people in the U.S. live along the coasts, while the vast majority of Australia's population is located along the coasts. I believe Australia's population doubles about every 40 years. I live in the State of Florida in the U.S. Florida is a 400-mile-long peninsula that protrudes off the southeastern corner of the country and borders the Atlantic Ocean and Gulf of Mexico. Florida has 8426 miles of tidal shoreline and has a climate much like Queensland. Florida's population is nearing 12 million. Some 900 people are moving to Florida daily and 85 percent are settling into the coastal areas contributing additional pressures to an already over-stressed coastal system. Some 45 million people also visit the State annually. About a third of Florida's marine wetlands have already disappeared and another 30 percent are expected to be lost during the next 25 years, as a result of "people pressure". We have not learned how to live in harmony with nature. We have the potential to ring the entire State with hotels, condominiums and other people-oriented developments.

Population growth and resultant coastal habitat losses are not unique to Florida or the U.S. We just happen to have gotten started a little earlier than Australia.

Let's face it--water is magic! People like to live, work and pay at the water's edge, and particularly where the climate does not hinder use and enjoyment. Thus, Australia's major stresses still lie ahead, and hopefully, there is sufficient time for effectively planning. That is one reason why the environmental overtones to this Forum are so meaningful and so timely.

Since people, with all their attendant needs, are the underlying source of environmental problems; it is only befitting that people should be the long-term solution to the problems. It is my perception that fisheries interests alone cannot safeguard the coastal environments. They can, however, serve as a catalyst to help protect this valuable resource. The best weapon to ensure a fishing future appears to be broad public support for a clean, healthy and productive coastal and marine environment. Fishing is but one use, and the fishing industry (commercial and recreational) but one user-group that can benefit from the attainment of that goal.

A clean, healthy and productive environment means different things to different people--particularly when man's survival and economic prosperity depend on the manipulation of the physical characteristics of land and water bodies. We can't "lock-up" everything, nor can we allow total and unrestrained development. The answer seems to fall within yet another area that one might refer to as "balanced growth, use and development". I have concluded that finding the balance must be left to parliamentarians, planners, and government officials involved in the decision process. Our role is to ensure that the decision-makers are aware of the consequences of their action on the environment.

And this is where we can play a catalytic role. We collectively, as fisheries managers, biologists, social-scientists, fishermen and business leaders must make those who impact our lives knowledgeable of our concerns through education. We must respectfully seek the help of the "framers of public opinion" to achieve this end. I refer to professional educators and communicators who are instrumental in the awareness process.

It is critical that every man, woman and child be aware enough to adopt a "conservation ethic"--or "environmental state-of-mind". Everyone, be they a housewife, student, business leader, developer, government official or

politician has a responsibility as a steward of the environment--each doing what they do best for the benefit of all.

It behooves us to ensure that there is a systematic and comprehensive approach to producing a steady flow of timely and accurate information regarding our precious natural resources. The approach, to be most effective, must be as inclusive as possible. Television, radio, newspapers, billboards, the podium, classrooms, fairs and festivals are the obvious communication channels. Our most influential and respected people should be encouraged to lend support in the education process. Paul Hogan, Greg Norman, and Pat Cash come to mind. Again, I stress that our teachers, newscastors, outdoor writers and others who are continuously in contact with the public hold the key to successful education of the masses. Their help must be enlisted by us. An information network would be a logical extension to the awareness process. Perhaps a toll-free, computer-assisted reference service might be made available to anyone seeking information on turtles, environmental legislation, estuaries or any other pertinent subject. Awareness, through knowledge and understanding, is the first step towards involvement in the decision-making process.

The coastal and marine environment educational effort should start in the formative years--much like teaching arithmetic and spelling. Children must be taught early that natural resources are a precious and fragile gift. With use and enjoyment comes responsibility and respect. Our youth must comprehend that life is no free-ride and they have obligations to the welfare of the environment. The future will take care of itself if we can instill the proper ideals and information before they are called upon to be decision-makers. Make no mistake, our youth is our future. They will become the parliamentarians, business leaders, government officials and parents.

The Marine Information Network, or simply MARINE, which I serve as Executive Director, has implemented a successful youth education program that I would like to share with you. First, however, I should point out that I am a federal employee, serving as an Assistant Regional Director of the National Marine Fisheries Service. I have been "loaned" to MARINE under a unique law (Intergovernmental Personnel Act) for a two-year period. The federal

government's interest is that if MARINE is successful, the program can serve as a national prototype--and a major need will be satisfied without a massive infusion of federal dollars.

MARINE is a non-profit, educational corporation whose principal mission is best described by its motto--"The health of Florida's coastal and marine environment depends on an informed public". For quite some time we worked diligently, but without much success, to make the public aware of the State's problems and opportunities-- and to get them involved. Even our fund raising efforts were a dismal failure. At one point we wrote to the top 250 companies in Florida seeking corporate membership/contributions of $100. Despite follow-up telephone calls and letters we received a total of $50.00. We were appalled at the apathy. Perhaps many were concerned that their profit margins might be reduced if the public were awakened and demanded greater controls. My perception was that as long as people were making money and the quality of life was not noticeably being down-graded environmental matters were not overly important. And this is a key point, I doubt that many would notice any deterioration on a monthly or even a yearly basis. However, changes occur continuously and subtly; and collectively, over a longer span of time can be staggering. Each generation of lawmakers imposes additional constraints, but the desired results seem to be smothered by the impacts of normal growth.

MARINE then adopted a new tack--concentrating on the youth. Foremost in this regard was the creation of the MARINE GANG--eight costumed characters whose role it is to captivate children and then deliver lessons on marine life and the need to conserve Florida's coastal and marine resources. The premise upon which the MARINE GANG operates is that if we can reach children early enough, they will become caring and responsible adults.

Each member of the MARINE GANG has their own story to tell through Captain NOAH, the leader and spokesman of the GANG:

> Sally Shrimp talks about estuaries and wetlands--how they work, why they are important and what's happening to them. Sally explains that we must do three things: 1) Conserve habitats that are left, 2) restore habitats that have been degraded, and 3) create new habitats. She describes how this is achieved.

- Lefty Lobster explains that heart disease is the number one killer of man, and if 2-3 meals of seafood are consumer weekly you will live longer (lower cholesterol and blood pressure). Also, that it will reduce the risk of cancer. Lefty talks about uses of fish and seaweed such as for aspirin, candy, ice cream, paints and pet food. Humour is also interwoven in the messages to increase the attention span. For instance, girls and teachers are asked if they use lipstick. After their positive nods they are told that it is made out of fish oil and they are putting fish oil on their faces. Boys tend to find that hilarious until they are told that someday they will be kissing that fish oil. If that isn't enough, we also explain that a product known as Preparation H, to reduce haemorrhoid problems, is made of sharks oil (usually, no explanation is necessary as to where the preparation is applied).

- Grumpy Grouper tells how fish will die naturally and be wasted at the bottom of the sea unless they are caught and eaten. Kids are urged to go fishing, and to learn about the exciting world of fishes. They are told how fish are managed, and above all to be a good sportsman and respect size and bag limits (and report violators).

- Captain NOAH, the "old salt of the sea" explains through interesting facts why earth is the water planet, and how the oceans are important to man--including the production of the oxygen we breathe.

- Daisy Dolphin tells what it is to be a mammal along with manatees, seals and whales. The interrelationship of tuna swimming beneath dolphins in quest of food, and fishermen encircling dolphins with their nets to catch the tuna provides a good example of nature and man interacting--including the net design to allow dolphins to escape.

- Tony Turtle explains that he is a reptile and endangered, and may become extinct if precautions are not taken to save them. And, if good conservation and management is practiced, populations will be increased and man can again use turtle meat for food, skin for purses and boots, and their shell for jewelry. Plastic bags and other plastics dumped in the oceans can be mistaken for jelly fish, often trapping turtles and suffocating them.

- Pete Pelican opens young eyes to the world of sea birds--how they live, what they eat and their dangers. Automobiles kill about one million animals in the U.S. daily, of which 600 000 are birds. Abandoned fishing lines, and plastic six-pack holders are deadly to birds as well.

- Drats, the ugly globule of pollution is an arrogant, despicable character who spews trash from his mouth. His hat says, "I love pollution". Children hate him, and I have seen them kick him and jab him with a chair. Drats talks about air, water, solid waste, visual and noise pollution and how they are the end product of man. Drats explains what can be done to overcome this engulfing menace.

The MARINE GANG is an informal supplement to the formal classroom science curriculum. They have made almost 150 appearances in the last year. Approximately 30 000 children have been reached in the classrooms. The program has been endorsed by federal, state and local government agencies; educational institutions; and the private sector. Children have been the greatest supporters as attested by thousands of letters and pictures they have mailed to MARINE. The MARINE GANG also has participated in civic and social functions, fairs and festivals--reaching upwards of one-half million people. The MARINE GANG also has been an effective teaching tool to older youth and adults. The use of mascots in colleges and professional sports, and the use of animated characters associated with advertising on TV have proven very popular and effective. Mickey Mouse could possibly be the most recognizable critter on the face of the earth, and is appreciated by adults as well as children. I am always amused to watch a husband take a picture of his wife along side someone like Drats. I would guess that picture is "shown-off" far more than the one taken with their husband or best friend.

As part of the MARINE GANG program we have recently provided a membership for children with quarterly messages from Captain NOAH with important information and a suggested list of family and individual activities.

It is MARINE's intent to streamline its youth education program by developing a 50-foot-long "MARINE MOBILE". This mobile education unit would not only provide for MARINE GANG stage presentations but house extensive "hands-on" exhibits. Sounds, music, touching and film would add to the

learning experience--teachers too would be provided class and field trip educational material to further the learning process. Each MARINE GANG character would have his or her own exhibit. Lefty Lobster is a five-foot model of a "pumping hear" that teaches children how the heart works and why seafood is "heart food". Grumpy Grouper features a fighting chair that you can sit in and push a button to fight a 10-pound grouper or a 70-pound sailfish. The pull matches the actual strength of the fish. A video screen allows the fisherman to see the fish they are fighting. The MARINE MOBILE will allow us to greatly enlarge the number of people that can be reached.

MARINE has formed a 21-member, prestigious Board of Governors to help promote awareness and involvement. Persons like Burt Reynolds, Lloyd Bridges, Paul Newman and Chris Evert are concerned about the future and have loaned the use of their names to further our educational goals. As funds permit, several will participate in a T.V. public service campaign to bring important messages to the masses.

There is no reason why the fishing community cannot be instrumental in developing a program that promotes a holistic approach to environmental education; a program that reaches out to user groups beyond the fishing industry. We all have heard the expression, "you scratch my back and I'll scratch yours". Will our future be brighter if we get others more involved in fisheries problems and aspirations, and if we become more responsive to the needs of others? There is some very positive "image building" that can be achieved by the fishing industry with its partners, constituents and the public by taking a strong lead role. All too often the industry is perceived as taking and not giving. Let us give the public more reasons to embrace the fishing industry.

We have all seen a fair share of successes in fisheries. We are continually improving our knowledge base and management techniques that help guarantee our future. We try new and innovative concepts for addressing opportunities or resolving problems--these too help our future. However, perhaps nothing will help more than broad public support for what we do, or intend to do. From the halls of parliament to the halls of schools, our present leaders and future leaders must be made aware of what is at stake relative to fisheries and other marine resources. This is our challenge, this is our future, and I know we are up to it.

MANAGING WHAT?

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Introduction

The paper reviews some definitions of the Australian marine environment derived from different perspectives. It then draws attention to some of the types of variability in the physical environment and notes other causes of uncertainty that can be identified in the social environment. It takes for granted variability and uncertainty in the biology of the resources which are sought by the fishing industry, and on which we spend most of our research effort. It is clear that the majority of the causes of uncertainty are not amenable to direct control and this has important implications for any management strategy to be adopted.

Thus the paper poses the question - "What are we attempting to manage?" and I suggest that the answer is mainly people, not just the resource. If we are managing the people involved in the industry and, at the same time, attempting to protect the sustainable use of resources, then we should develop a better set of mechanisms to establish and review our objectives and to develop our management plans.

The people who work in the industry should be involved in all aspects of the management of their industry. A broad definition, however, is required when canvassing the scope of that involvement as the industry encompasses many groups such as fishermen involved in various fisheries, processors, wholesalers, retailers, industry managers, government managers, export groups, promotional and marketing groups, and many others. How do we set the limits? The paper argues for a systems approach to management and one that is more experimental, and less dogmatic, than has been to norm to date.

The paper also argues that while we may have the technical skills, we may not have the communication skills, nor the will to cooperate,

that will allow us to learn from our collective mistakes.

The Australian Marine Environment

A definition of the Australian marine environment, based on legal considerations, is that it consists of the seas and oceans surrounding the continent stretching to 200 nautical miles offshore, which is the outer limit of the Australian Fishing Zone. The AFZ includes the waters of the sea on the landward side of the 1983 Australian baselines and the submerged lands beneath those waters. This area of sea, 8.94 billion square kilometres, is a significant extension of Australian responsibilities as it almost doubles the area of jurisdiction. It also increases management requirements dramatically.

Four major divisions of the marine environment around Australia can be identified from a fisheries perspective. These are the waters of the oceanic areas, of the continental shelf slope, of the continental shelf itself, and the inshore and estuarine waters of the coastal zone. The general ocean circulation pattern which influences the Australian region are the large, basin wide gyres, of the Pacific, Indian and Southern Oceans, which have a counterclockwise circulation in the Southern Hemisphere. This circulation, which can take of the order of 10 years, produces a variability in environmental conditions, particularly at the margins on the continental shelves. Upwellings, which bring nutrient rich waters up the continental shelf slope on to the shelf may persist for some months at a time. Areas where the shelf waters flow away from the coast may also be regions where surface materials, including eggs and larval fish, are moved offshore into the less productive waters of the open ocean. The fluctuations in these systems introduce an element of variability on a seasonal time scale.

The Continental Shelf extends from the shore to the 200m isobath, which marks the edge of the continental slope. The shelf, 52% of which is less than 50m deep, has a surface area of approximately 2.3 million square kilometres. In recent years, research workers have developed a more detailed understanding of the currents that affect the shelf environment; for example the south flowing East Australian Current and the north flowing West Australian current. These are one

of the major elements which give rise to variability on the Shelf. The tendency of these current systems to form meso-scale gyres or vortices, which may take three months or more to progress along the shelf, adds another element of variability to the system in those areas. A number of current systems, notably the Leewin Current in the south west and the currents through Bass Strait, are pulsed by the progression of high and low pressure systems as they sweep across the continent which gives rise to variability in the system on about a three to five day time scale.

The Coastal Zone is a narrow strip extending both landward and seaward of the shore. The marine environment includes the seaward part of the coastal zone, termed coastal waters. These are defined as all waters from high water level extending seaward to the outer extent of the territorial sea (3 nautical miles from the baselines) thus including all harbours, bays, entrances and river mouths. Here systems are driven by local weather events such as rain storms which may flush out an estuary in a wet season, although increasing damming, and other forms of water diversion, are significantly altering these patterns. The time scale for these events is very closely linked to the local weather patterns. Such small scale variations are often called "noise in the system" using an analogy drawn from information or communications theory.

Some 70% of the Australian population lives in 11 cities of 100,000 people or more and only one of these, Canberra the Federal capital, is not on the coast. The 6 state capitals, which are all on the coast, are the largest cities in Australia and contain 55% of the population. Yapp (1986)has shown that 85% of the population of Australia lives in cities, towns and municipalities abutting the coast. Coastal lands are important to the fishing industry by providing locations for support facilities and for aquaculture installations. There are various definitions of coastal lands utilised by various authorities and that of Galloway et al (1984) is used here; i.e. land within 3 kilometres of highwater, or the inner boundary of recent marine sediments where they extend more than 3 kilometres inshore. Their data gives an estimate of about 2 percent of Australia as coastal land and of this only about 6 percent is used for industries, cities and agriculture.

This suggests that the effects of pollution will be quite local, of most significance in estuaries and other depositional areas which receive runoff from land. Where the by-products are toxic, and particularly where they are capable of being accumulated by biological processes, the receiving environment may be altered over quite long time scales. Materials that accumulate in the food chain can be moved over wide areas by currents and by migrating marine animals. Time scales relevant to pollution impacts may vary from hours to decades.

Two examples of processes of long term change are the phenomena known as EL NINO and the GREENHOUSE effect. In the first case, the fishermen of Peru call a change in the sea, that heralds poor fishing, El Nino, meaning the Christ Child, because it usually begins to take effect in December. Normally, trade winds blow off-shore towards a low pressure system located over Indonesia. The winds induce a west flowing current which, as it leaves the coast, draws up cold, nutrient rich waters from the deep sea. The nutrients support plankton that in turn provides a rich and abundant food source for the anchoveta. Periodically, a high pressure cell develops over Indonesia and the low pressure system is established in the mid Pacific region. This reduces the westerly blowing trades and, as a result, decreases the influx of deep nutrient rich water along the South American Pacific coast. Low plankton densities result and fewer juvenile anchoveta survive. Fishing boats are laid up and fishing families go hungry.

What triggers this movement has not been established, as the interactions between the atmosphere and the oceans are closely interlinked. In the intervals between El Nino events, water levels and temperatures are higher in the region to the north of Australia. In the periods preceding the El Nino-Southern Oscillation (ENSO) phenomenon water temperatures in the seas to the north appear to drop a degree or two.

The potential impacts of the Greenhouse effect are on a much longer time-scale. Sea levels have varied considerably over the last 1-2 million years but have been stable for the past 6000 years. Changes to the composition of the atmosphere of the earth by human activities

such as burning fossil fuels, eliminating forests, and releasing chemical gases, are causing concern to scientists and managers around the world. It is proposed that, as a result of their accumulation in the upper atmosphere, a warming, estimated to be between 1.5 and 4.5°C at the surface of the earth, will lead to thermal expansion of the surface waters of the oceans over the next century (Pearman 1986). On a longer time scale it may also cause the melting of the accumulated ice and snow at the poles. Current knowledge is inadequate to make precise predictions on a regional scale of the rate and height of future sea level rises. It is sufficient to predict the broad picture, however, and it is suggested that an increase in sealevel in the range of 0.2 to 1.4 meters may occur, possibly as early as the 2030s.

The expected sea level rise could increase coastal erosion and flooding, raise groundwater tables and result in saltwater intrusion into rivers, bays and aquifers. Many of the major coastal cities of the world could be seriously disrupted, although many of the adverse economic impacts of sea level rise can be avoided if timely action is taken in anticipation of these effects. Policy makers and coastal managers need to assess the vulnerability the existing and proposed infrastructure to the predicted rise. Infrastructure related to the fishing industry includes ports, aquaculture facilities and land based processing facilities.

This brief review shows that physical processes in the sea operate at a range of scales. The variability and frequency distribution of extreme events such as cyclones and other low pressure systems are key elements in significant pertubations of environmental quality, and therefor stability, for living organisms. Other physical processes such as internal waves moving on to the shelf and large scale ocean basin phenomena also bring about changes in environmental conditions which, in turn, affect larval survival and growth rate, adult growth rates and reproductive success. Uncertainty results, for both fishermen and managers, from a lack of knowledge of the mechanisms governing the variability of the marine environment. Management in such circumstances involves the development of a wide variety of contingency plans.

The Resource

Commercial fishing ranks about seventh in order of value of primary industries to Australia. The Gross Value of Production in 1983-4 was $445m, placing it ahead of horticulture, intensive live stock and small cropping industries (Bain 1985). Approximately 25,000 people work in the catching sector of the industry which operates about 10,000 boats.

Although Australia has a large fishing zone, annual output is only about 0.2 percent of total world production which compares unfavourably with 4.1 percent obtained from the comparably sized US Fishing Zone. Bain (1985) and other observers have attributed this to a combination of factors:

- low nutrient levels in the shelf waters surrounding Australia,

- the large proportion of the shelf waters that lie within the tropics; tropical waters are characterised by high species diversity and, relative to colder waters, low numbers of any particular species,

- and the Australian tradition of reliance on landbased primary industries.

The major fisheries, which are significant export earners, can be classified from a number of different perspectives. They may be based in the ocean regions offshore, in the waters of the continental slope and shelf. although none are based on operations in the nearshore or estuarine areas. From a biological perspective the classification may be based on living zones - pelagic or demersal, taxonomy - crustacea or mollusca, or feeding type - plankton or detrital. A fisherman may class them according to the gear used to capture them, as might a manager, while the consumer wants to know the taste sensation class - to say nothing of the price class! Consumer preference is yet another uncertainty that the industry must grapple with in its planning and operations. With a significant proportion of the catch going to overseas markets, the traditional perception of consumer fickleness is compounded and uncertainties increased.

The economic and biological dimensions of most stocks in the AFZ, with the possible exception of Southern Bluefin Tuna, are inadequately researched to allow Australia to manage effectively its AFZ resources. While the biology of some stocks is understood, in outline at least, after decades of research we are still not able to predict with any degree of certainty the outcome of any particular management strategy for most of our stocks. This is because we are not able to predict the environmental variables, nor their impact on the biology of the target species, with any useful degree of reliability.

The one clear message which can be derived from this review of the marine environment and its resources is that there are many levels and scales of uncertainty in the system. While this may not be a new idea to most fishermen, the implications of the nature and magnitude of the inherent variability do require some further thought and discussion. There are the obvious areas of uncertainty such as the weather, the variability of the currents that determine the availability of stocks, the differences in recruitment patterns of various stocks, and the variation in prices at the market. There are some less direct, and therefor less obvious, variabilities. These, for example, may lie in in overseas markets, in the international price of fuel, the exchange rate and its effects on imported gear, in the rule of law in respect of international fishing rights and in the changes in bureaucratic and political personnel.

The Australian fishing industry is already developing coping mechanisms for some of the international causes of uncertainty. Firms, and individual fishermen, have developed coping mechanisms for some of the more immediate causes of uncertainty. One approach to coping with uncertainty is to identify the aspects of the total operating environment that are susceptible to management and to develop strategies for anticipating the effects of the more predictable components of uncertainty.

Management

In a scientific or operational definition, management is a process of organised activity which serves to bring about a coordinated effort of many individuals to achieve an agreed outcome. It must, therefor,

have an agreed objective or set of objectives, towards which the activities are directed. Such a definition may seem fairly obvious to some, however, there are a number of elements that need to be emphasised. In the present context, the way in which an agreement on objectives should be achieved, and who should be involved in the coordination of effort, are not immediately clear.

Another aspect of an operational definition of management is the requirement that goal orientated activity is brought about by establishing relationships among the available resources, which include supplies, equipment, funds, information and people. The organisation of goal orientated activity implies that many people will be involved at many different levels, and that the manager, whether it is a single individual or a committee, must gain, and keep, the support of most of those who are involved in that activity. Finally, agreements and decisions on a wide range of points need to be developed over a long period. The need for a widely based consensus is is particularly crucial in the selection and evaluation of alternatives in a complex environment which is invariably fraught with uncertainty and risk. In such an environment it is important that as many of the players as possible understand the risks involved.

The application of such a definition to fisheries management in Australia raises a number of interesting issues. Clearly, the old dichotomy between the managers and industry is already in the process of being discarded. The advent of industry participation in advisory and decision-making committees, and the cooperative development of fisheries management plans for specific fisheries are clear evidence of progress. The goals are being cooperatively established and the need for enforcement of the provisions of the management plans is receiving growing support.

There is some question, however, as to the extent that industry might participate in the information gathering component of the management system and in the enforcement activities, which unfortunately are essential to the success of most human activities. The provision of adequate catch and effort data are essential to the successful management of any self-adjusting system. Management committees must have an efficient feedback mechanism in place to provide the basis

for the evaluation of the efficacy of the management provisions. There is no point in wasting time and resources in developing, and putting into place, any management strategy if its effects cannot be evaluated because of a lack of an adequate monitoring program. In the absence of such an effective monitoring program all who are contributing to the costs of management are making a bad investment decision.

There are so many areas of uncertainty, however, it may not make sense to maintain perfunctory long term monitoring programs aimed at all areas of uncertainty. There are some areas of uncertainty in each system that it will be essential to monitored and methods of identifying them must be developed. The identification of the real target of a monitoring program is a difficult task in technical terms and that task is further complicated by very different perceptions of the system that are held by the different participants.

A Systems Approach to Management

One approach to effective management is the so-called Systems Approach which attempts, in a systematic and repeatable way, to break a problem down into manageable elements. The first step is to develop a classification of a system to establish the inherent operational rules; is it a static, unchanging system or is it dynamic and driven by internal forces? An homeostatic system is one that tends, after some changing external condition, to return to some level of equilibrium which will not necessarily be the same level as before. A cybernetic system, on the other hand, is one that responds to environmental changes using internal control devices to maintain some degree of constancy. It is important in problem solving to clearly identify the type of system as different management strategies will be required depending upon the nature of the inherent control mechanisms of the system.

The second step is to identify the composition of the system to determine the components, the boundaries, the environment outside those boundaries and the interfaces with subsystems. A precise definition of a problem requires all these parts to be identified. The third step is to identify the relationships important in system under review. In management systems it is very important to identify

the "chief decisionmaker" and to define the connections with, and between, other players in the system. A fourth step is to consider the intent of the system; what are the objectives, what purposes are served by the parts of the system, and what tradeoffs can he identified at various stages in the system. This leads to the fifth step which is to consider the overall context of the system. This is a model of how the system is put together and how it operates. The model can vary from an idea for a very simple system relating only to that one person, to a computer model simulating a very complex system. In many situations a diagram is used to portray the system so that a number of people can discuss it and contribute to the problem solving exercise - a computer model is merely a working diagram.

The development of a systems view is a very effective management strategy to deal with uncertainty in real life situations. It encourages a clear identification of the parts of the system, it helps establish priorities for the attention of managers, and it can assist in developing plans to cope with various different outcomes resulting from uncertainty in the system. It can be particularly helpful in the development of solutions to problems or dysfunctions that may develop from time to time. Diagnosis of problems and the definition of symptoms, causes and of potential solutions, is made easier by reducing complexity in a logical series of steps, and by providing a clearly identified strategy for dealing with the uncertainty inherent in any system. An important characteristic of effective management is that it should be adaptable to changing conditions in the environment of the system that it sets out to manage. Managements that do not adapt to changing circumstances go out of business.

Adaptive Management

There are two particular approaches to management of the environment and of natural resources in a climate of uncertainty developed in North America which may be useful in the Australian situation. These are the techniques of environmental mediation and an approach to environmental management termed 'Adaptive Environmental Assessment and Management'. Both aim to involve a wide spectrum of view points and concerned groups in the processes of developing environmental management strategies.

Environmental mediation has evolved in North America where endless rounds of court battles have ground major projects, and the development and implementation of many management plans, to a standstill. The concept is simple. An independent mediator, or team, is proposed that is acceptable to, and must be explicitly accepted by, all parties to a dispute. Mediators have no powers other than those agreed to by the participants, and all parties understand that they can resort to the courts, or to previous strategies, if the process fails. The mediators assist each of the parties to sort out the facts, to identify and clarify the real issues and to arrange for independent, agreed assessments of disputed facts. They then facilitate the negotiation processes between the parties. Once agreement is reached, each of the parties is expected to follow through with the agreed strategies - to keep faith with each other in effect! It is important to note, however, that not all situations are capable of being resolved by mediation.

The literature on environmental mediation has developed rapidly in the last decade (Bingham et al 1981) but it has yet to make much of an impact in Australia. Although Australia is a much less litigious arena than North America, there are clear advantages to providing such opportunities in our system. It is interesting to note that both New South Wales and Victoria have introduced neighbourhood conflict resolution, or community justice centres, to resolve minor inter-neighbour disputes without going to court. Such experience could well be of interest to environmental and natural resource management in Australia.

A major problem in environmental management is the "all or nothing" syndrome which seems to have evolved as an essential part of the twentieth century administrative machine, whether it is public or private. This approach can best be exemplified in the phrase "make a decision and stick to it!" which may have been a good approach in stable times but no longer seems appropriate in what are euphemistically termed "dynamic" times. The point to be made is that new environmental management strategies are required to cope with modern, rapidly changing, or uncertain, conditions.

One new approach has been developed by a group at the University of British Columbia, in Vancouver Canada, which has been termed

"Adaptive Environmental Assessment and Management" (Holling 1978). They argue that the available data and theories will always be inadequate for the particular task at hand, and that conditions change rapidly and unpredictably. In this uncertain environment it is best to take an incremental and experimental approach to problem solving - a program of continuous monitoring and readjustment. Some sixty applications worldwide have been reviewed by a workshop reported by Environment Canada (1982) but none have been in Australia to date. The following description of the process is taken from that Report.

Adaptive Environmental Assessment and Management (AEAM) is a collection of concepts, techniques and procedures intended for the design of creative resource management and policy alternatives. New methods for dealing with resource management problems are required to bridge the gaps between knowledge and disciplines. The AEAM methodology recognizes that it is equally important to bridge gaps between the various players that are part of the problem. The players include not only the people who utilize the system and the technical experts, but also the managers who are charged with operating a management scheme and the policy people who may serve in either advisory or decision making roles. Technical experts are basically driven by scientific goals and the users, in this case fishermen, are driven by the necessity to survive to the next season. If these two groups alone are involved, a way of life and livelihoods on the one hand, and management constraints and longer term goals on the other, may be lost.

The AEAM methodology uses a workshop procedure to bridge both the knowledge and people gaps. A simulation model is used as a focus to develop links between people and to synthesize existing information. Key gaps in information are identified in workshops and priorities for filling these gaps are structured from both scientific and policy perspectives.

AEAM's key features are as follows:

1. Ecological and environmental knowledge is incorporated with economic and social concerns at the beginning of a strategic analysis rather than at the end of a design process.

2. Since linked resource/social systems involve numerous feedback loops and are cybernetic rather than static and linear, techniques of simulation modelling, qualitative modelling and policy design and evaluation are chosen to reflect these features.

3. Scientists, managers, and policy people are involved and interact from the beginning and throughout the process of synthesis, analysis, and design so that learning becomes as much of a product as does problem solving.

4. Direction, design, and understanding are in the hands of those from the region who analyse, select and endure policies rather than in the hands of a separate group of analysts who lack the knowledge of needs, the responsibility and the accountability.

5. Although prediction can be improved, the uncertain and unexpected lie in the future of every design. Hence policies are designed both to explore opportunities and pitfalls as well as to fulfil immediate social needs.

Over the past decade the AEAM process has been applied to a wide variety of environmental and resource issues with varying degrees of success. Features which make AEAM an attractive and useful methodology for tackling complex environmental problems are:

- it provides an unfamiliar mix of expertise and interests which brings together different approaches and views of the world;
- it provides a forum within which people with different roles (e.g., scientists, managers, policy advisors, key constituents, users, etc.) can interact;
- it draws from experiences in other areas and issues that relate to the problem at hand; and
- it promotes understanding of the behaviour of complex, dynamic systems.

The application of AEAM has been a mixture of successes and failures. Remembering that a key tenet of AEAM is learning and adaptability comes from failure, a critical examination of failures

is thus valuable and necessary for tailoring and adapting the procedures in the future. Hopefully, by recognizing failure, a management strategy can evolve into something more useable, more credible, and ultimately, more successful.

Criteria for success in environmental and natural resource management are difficult to define. Policies are often ill-defined or poorly articulated. Even when policies and plans are well-defined, it is still difficult to measure success. Probably the most significant products of AEAM are the intangible ones; development of a common understanding, better communication, and clarification of uncertainties.

Conclusions

This paper may have painted a rather bleak picture of the chances of success in managing such an uncertain resource as a fishery. Clearly, from experience in Australia, and from a review of fisheries management overseas, it is at best an very uncertain business. There are strategies, however, that can be adopted which will at least improve our understanding of the systems and their variability, and may even improve our management of them.

Fisheries management in Australia has begun to be more broadly based in its approach. There are, however, further steps that need to be taken. Some joint industry - government experimental fishing to evaluate stocks has already been undertaken in Australia and we need to build on those experiences to further develop a cooperative approach to management.

Environmental mediation techniques should be reviewed in an Australian fisheries management context to evaluate the benefits of their possible introduction into the development of resource management plans.

The AEAM methodology should also be evaluated, as it is ideally suited to overcoming institutional inertia, both public and private, and has been successfully applied to fisheries problems (Walters 1986). As it is based on a series of workshop sessions, it brings together individuals from the different technical and managerial

areas of the various institutions whether they are in a government agency, a fishermen's association or a firm. They can get together to produce a set of alternative development scenes and alternative management strategies and they can examine each set of strategies in the light of the possible system responses. The likely outcomes, in the sense of risk assessment, can then be discussed amongst the players. A particular strategy is decided upon, and evaluation criteria for success or failure are agreed. A timeframe for review, and conditions for continuation are also decided. It is in effect a kind of a "contract: between the interested parties to pursue a workable, and mutually satisfactory solution.

The introduction of the AEAM techniques into Australia has already begun and decision makers in both private and public institutions need to become involved. The extent of the uncertainties in both the technical and social spheres of fisheries management make such an innovation essential.

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MANAGING THE MARINE ENVIRONMENT - CONSULTATION THE KEY -

A COMMERCIAL FISHERMAN'S PERSPECTIVE

P. MCKENZIE
COMMERCIAL FISHERMAN

Abstract

Commercial fishermen as a group recognise the importance of conservation. Our livelihoods depend upon it. Without continued maintenance of natural resources in the marine environment our source of employment, the well being of our families and in fact the fishing industry are at risk. Individual users of the marine environment may maximise their own benefits without consideration of the costs they impose on others. For example the real estate developer reclaiming fish habitat or the government instrumentality allowing spraying of insect pests in marine ecosystems. Thus a conservation policy aimed at maintenance of natural resources in the marine environment is necessary. Government is the body charged with this responsibility for the benefit of society as a whole. Commercial fishermen respect this responsibility and are often the leaders in pursuing this goal.

Once the conservation of the natural resources are ensured, their rational allocation between (often) competing users is also subject to government control. The degree and type of control depends largely on the characteristics of the resource under consideration, markets for the resource, method of capture and the management structure in place. Natural resources can be considered in terms of renewable and non-renewable resources. It is the allocation of these resources that most concern commercial fishermen and it is the subject of this paper.

TOURISM AND THE FISHING INDUSTRY (SUMMARY POINTS)

KEN MCGILL
GENERAL MANAGER, QUEENSLAND TOURIST & TRAVEL CORPORATION

Role of Queensland Tourist & Travel Corporation (QTTC)

QTTC set up under act of Parliament in 1979 charged with responsibility to:

* develop and market the tourism industry to maximise the economic benefit to Queensland.

Major Goals are:

* encourage and assist development of Queensland and South Pacific tourism industry and its environment
* make the South Pacific the leading tourist region in the world

To achieve this purpose:

* encourage growth of investment
* developing and promoting diversity and quality of product
* identifying and capitalising on market opportunities

* QTTC influences the market by leadership

Market Segmentation

The tradition of a holiday at the beach is changing. More tourists are demanding "experimental" holidays.

QTTC research 3 years ago showed 3 most popular special interest activities:

* Fishing
* Scuba Diving
* Golfing

As supplement to Queensland book, QTTC produced three booklets on those areas.

QTTC distributes them through overseas offices.

Potential of Fishing to Tourism Industry

* Few places in the world can equal what Queensland has to offer in area of fishing.

Possibilities:

Marlin Fishing ..... Lizard Island
Reef Fishing ..... Great Barrier Reef
Surf Fishing ..... Fraser Island
Dam Fishing ..... Outback
River Fishing ..... Statewide

* Queensland internationally recognised as safe tourism destination, up to date transport, good climate, excellent scenery

* Waters noted for large range of species
* Large untapped fishing market, both domestic and international
* Accessibility...3 international airports Brisbane, Cairns, Townsville
* In most outdoor activities, participation declines with age...but not fishing
* Fishing and underwater recreation ... one of Australia's most popular activities *4.5 million people or one-third of population do it
* About 100 000 internationals

QTTC Catalyst to Industry Organisation

QTTC has acted as a catalyst in the dive tourism industry to form the Queensland Dive Tourism Association

* self regulatory body set up 3 years ago
* 50 members, representative of Queensland industry
* in conjunction with QTTC have co-ordinated a major research project into the industry
* Association has a vested interest in and is keenly aware of the environment
* National Parks, Marine Park Authority representative as ex-officio member of executive

Because of proliferation of fishing tour operators and guides in Queensland in recent times next step for QTTC is to help set up a Fishing tourism industry association similar to Dive Tourism.

QTTC Markets Queensland as Fishing Destination

- Apart from few resorts (Escott Barramundi Lodge, (Gulf), Bloomfield River Resort, Orchid Beach Fraser Island) Industry has done little to market State as fishing destination ... QTTC accepted that challenge.

Famils

Organised visits from international fishing journalists.

One of most recent led to 20 colour pages in Japanese fishing mag. "TAILING" Circ. 120 000. Presently organising crew from "FISHING MAGAZINE" Japan to visit Cairns, Whitsundays, Fraser Island, Moreton Bay.

Sunlover

1988-89 Sunlover Programme

3 fishing packages in CRUISE, DIVE AND SAIL

Monitor reaction for possible future inclusion of more fishing tour packages.

QTTC in Role of Third Party Advocate

QTTC campaigns for environmental/marine development balance.

No point destroying the environment if that's the basis of the tourism industry.

Many of the marine coastal tourism developments in Queensland are around fish habitats.

QTTC often approached for advice, opinions on tourism benefits of marine projects.

Moreton Bay Strategy Plan

Now Queensland has investor confidence, leadership, great projects established, can turn attention to aspects of Queensland which make our tourism product unique.

Commissioned Moreton bay Strategy Plan which will be released soon. World tourism planning expert : Larry Helber.

A vision of excellence for the region to the year 2000.

Purpose is to strike a balance between
commercial and charter fishing, transport
conservation, development, recreational fishing

NOW rather than AFTER development of the area takes place.

Provides for ares of conservation, recreation and development

FINDINGS INCLUDE

Moreton Bay Region has major significance: tourism and employment opportunities

Recreational fishing in Moreton Bay worth $70 million in 1986. By year 2000....$220 million.

Commercial fishing is worth about $28 million and it's limited to that.

QTTC opinion: Should preserve, improve and promote the recreational fishing opportunities.

As State's tourism body, QTTC is concerned to see a balance between tourism and the marine industry to ensure the preservation of natural habitats for the enjoyment and livelihood of future generations.

SUMMARY

Role of QTTC
Market Segmentation/Experimental Holidays
Fishing Potential to Tourism Industry
QTTC Catalyst
QTTC Marketing Fishing/Famils/Sunlover
QTTC Third Party Advocate Role
Moreton Bay Strategy Plan

TOURISM AND THE FISHING INDUSTRY

FABIAN FAY

SEA WORLD AUSTRALIA LIMITED

GOLD COAST, QUEENSLAND

Sea World is a Marine and Theme Park which in 1986 won the Australian Tourism Award for the best attraction, and in 1987 was the winner of the Queensland Award. Sea World is a complex of 24.6 hectares situated on the Broadwater at The Spit, Gold Coast, Queensland.

Sea World is the synthesis of two imaginative ideas. Firstly to present Marine Life in a series of spectacular shows and secondly to provide an interesting and education marine orientated park for families enjoying more and more leisure time. From a somewhat humble beginning in 1971, Sea World has continually lived up to its ideals of developing "new" shows, facilities, exhibits and rides to such an extent that it now boasts a full day's entertainment package unparalleled in Australia.

On December 5th, 1984 Sea World's original owner Keith Williams sold the complex. Sea World's current owner, Peter Laurance of Pivot Group Limited, said he pledged to follow on with a most successful formula of continually developing the park. Sea World has an important role to play in Queenslands Tourist Industry and intends to stay Australia's Number One Tourist Attraction. Sea World was floated on the stock market and was over-subscribed.

The park is a combination of Marine Animal Shows and exhibits which includes Whale & Dolphin Shows, Sea Lion Shows, Aquariums and a unique 'live' dive show. The rides include Helicopter Joy Flights, Gondola Sky Way, Trains, Corkscrew Rollercoaster, Flume Ride, FLooded Mine Ride, Monorail and Water Park.

Besides the above attractions Sea World operates Gifts Shops and a full Catering Department. The Park also plays host to social functions and weddings. It is also a much sought after venue on the itinerary of the many Conferences held on the Gold Coast. Sea World is a large classroom for students who visit on the Educational Programme - "Project Neptune". The per capita visitation has risen steadily from 600 000 in 1984 to 1 000 000 in 1987. The Park has a staff of 300 which increases to 450 in the Peak Christmas/New Year Period.

In July 1988 the Sea World Nara Resort Hotel of 402 rooms is due to open at the Northern end of the Park, and will provide accommodation for families as well as individual visitors. The Park functions under the guidance of many departments. The everyday running is covered by the Park Management, Marketing, Public Relations, Accounting and Cleaning Departments. Maintenance and Construction Departments ensure all goes well, and the grounds are kept in first class order by the Gardening Department. Attractions are operated by the Marine Mammal, Diving and Aquarium, Aviation and Rides Departments. While the Gifts and Catering Departments cover the souvenir and culinary needs of the visitor.

Approximately 35% of all International Tourists to the Gold Coast visit Sea World, which is 6% of all International Visitors to Australia.

INTERNATIONAL VISITORS

COUNTRY	PERCENTAGE
JAPAN	21%
NEW ZEALAND	20%
U.S.A.	15%
GREAT BRITAIN	11%
OTHER EUROPEAN AREAS	12%
ASIA	10%
CANADA	7%
OTHERS	4%

DOMESTIC VISITORS

AREA	PERCENTAGE
BRISBANE	30%
OTHER QUEENSLAND AREAS	15%
SYDNEY	19%
NSW COUNTRY	8%
MELBOURNE	16%
VICTORIAN COUNTRY	8%
SOUTH AUSTRALIA	2%
TASMANIA & OTHERS	2%

The annual turnover of Sea World is $28 million.

Contacts with the Tourist Industry are both International and Local, and include such organisations as:-

1. Japanese Association of Tourist Associations (JATA)
2. Australian Federation of Travel Agents (AFTA)
3. Gold Coast Visitors & Convention Bureau (GCVCB)

Sea World is the home of twenty-one Bottle Nose Dolphins (Tursiops truncatus) the latest addition being born in April of this year. One Indo-Pacific Humpback Dolphin (Sousa chinensis) is the only one of her kind in captivity in the Southern Hemisphere and is over 40 years old. Three False Killer Whales (Pseudorca crassidens). Twenty-two Sea Lions of various species and three North American Harbour Seals are also included in our complement of marine mammals.

Grey Nurse, Whale, Wobbigong, Leopard and Port Jackson Sharks. Eagle, Leopard, Rays, Groper, Cod and many other species of fish are present as well as Penguins and Pelicans.

The Park also operates as a hospital treating injured marine animals, rehabilitating and freeing them if possible. The extensive Educational Programme, "Project Neptune" offers 35 projects for students from Grade 3 to Grade 12. During the visit the students are given talks by the Marine Mammal and Diving Departments. In conjunction with the Gold Coast T.A.F.E. College and their enrichment programme, a once weekly course on "The Sea and some of its Animals" is offered.

What does this have to do with the FIshing Industry and a Symposium of this kind? Sea World is closely tied to the Industry as all the animals in the park must be fed.

The Fish Room is a small area whose efficient, smooth operation is vital to the functioning of the Park.

The animals consume 3 500 kg/week of mullet, whiting, yellow tail, biddies, goat fish, tailor, razor gut, tuna, tommy ruff and octopus. Fresh fish is collected from local fishermen, brought to the park, sorted, put in trays, snap frozen, packaged and stored. The second source of food is frozen fish from areas as far away as Adelaide and Cairns. Only premium quality fish is

fed. The fish fed to the animals could just as easily be eaten by humans. Frozen fish is rotated and kept for a maximum of 3 months. To compensate for the changes which occur during the freezing process, vitamins and mineral supplements are added daily. Fish are the primary medium for medication.

Early in the afternoon fish breakout occurs. Frozen fish for the next day is placed in three stainless steel tanks and thawed during the afternoon and night. In the morning the trainers from the Marine Mammal Department make up each animals individual bucket. Each bucket of fish is weighed. The menu of the fish is made to suit each animal. The food is then distributed around the park to fridges and cool boxes where it is iced down.

It is vital to the functioning of the Animal Husbandry System that the exact food intake of each animal is known. As the temperature of water rises, food intake must be dropped and vice versa.

There are live whiting, bream and flathead in the pools. These fish have established themselves over the years. The animals very rarely eat these fish but will occasionally chase and catch them in play. The fish are well aware of the territory they occupy and know the safety areas.

Not only are the animals fed, but also the visitors to the park. There are 3 main restaurants and seafood is prominent on their menu. Although the free living fish are not utilized as a direct food source for the animals Sea World has been, for a number of years, the natural laboratory for researchers from the Queensland Institute of Technology (QIT) and the University of Queensland for their work on reproduction.

On the surface a theme park like Sea World would appear to have little to do with the Fishing Industry. However, catering for the needs of both animals and humans is a major part of the behind the scenes operations. The science and technology of the Fishing Industry is going through rapid change and advancement. It is vital that the needs of facilities such as Sea World, an end user of the products of the Fishing Industry be considered and catered for.

MANAGING THE MARINE ENVIRONMENT - THE U.S. EXPERIENCE

CARL R. SULLIVAN
EXECUTIVE DIRECTOR
AMERICAN FISHERIES SOCIETY

Ladies and gentlemen, in my prepared remarks today I will begin by describing many of the multiple-use demands placed on the coastal waters of the U.S. I will then address the impacts of these multiple uses on fisheries resources. Next, I'll talk about how things would be changed if I were king and had it all to do over again. Lastly, I'll review the multiple-use circumstances as they exist today and talk about how we can make the best of a bad situation.

1. Multiple Uses of U.S. Coastal Waters

For my purposes today, coastal waters include bays, estuaries, harbours, saltwater marshes, river mouths, river segments influenced by tides. In fact, it includes all coastal waters and wetlands inside the twelve-mile territorial limit. I doubt that there is anything unique about the way Americans have grown accustomed to using their coastal waters but for the record let's take a look at them.

The transportation of virtually every commodity known to man is perhaps the most prominent use. Associated with transportation use is dredging, filling, pile driving, paving, harbour development, breakwater construction, bilge water purging, bridge building and much more. Costal waters are increasingly being used for oil and gas production and mineral extraction. In the U.S. waters of the Gulf of Mexico there are approximately 4 000 offshore structures associated with oil and gas development. These activities extend from coastal marshes to deep-water areas where wells are being drilled in more than a mile of water. Off Alaska, giant dredges are scooping up and processing bottom sediments in search of the gold that was carried there by ancient rivers. In many areas of the Pacific, mineral interests are assessing the economic potential of mining manganese nodules and cobalt crusts from the ocean floor. Off the southeastern U.S. coasts lie great deposits of minable phosphates needed for agricultural fertilizers, and the giant sand and gravel industry is poised to move offshore in search of unlimited quantities of these two essential construction commodities.

Beginning in the earliest days, when America's resources seemed unlimited, it was common practice to discard everything we didn't want into the rivers and hence to the oceans. This was particularly true of raw industrial and municipal waste. As our society has grown more technical and "sophisticated" our wastes have grown more varied, our chemicals have become more toxic, our pesticides more deadly, and our trash more plastic and less biodegradable. Although giant steps have been made in sanitary landfills and primary and secondary treatment of waste, the problem is by no means solved. This is particularly true of wastes generated on ships.

Mariculture is a new and growing use of coastal waters. In the U.S. the emphasis is on rearing salmon in floating pens but controlled shellfish culture is expanding and the industry is expected to experience exponential growth in the years ahead.

Other prominent uses of coastal waters include the activities of recreational and commercial fishermen who spear, hook, net, dredge, trawl, trap, tong, dig and seine the renewable fin-fish and shellfish resources. Agricultural interests are making increasing use of river water for irrigation. Power generators "swallow" great quantities oat ambient temperatures and spit it back at much higher temperatures. Pipeline and communications companies dredge and jet ocean floor troughs in which to install their cables and pipelines. Cities and industries ingest vast quantities of water to make possible the life styles we've grown accustomed to. Ill-advised barrier island developments require continuing sand dredging for beach nourishment. Coast lines are blanketed with prostrate sun worshippers and our near-shore waters are congested with sailboats and every other kind of floating recreational conveyance that one can imagine. Even the Defense Department is in on the act with practice bombing ranges, strategically located surveillance devices and who knows what else.

What has been done to coastal habitats is not a pretty thing. More than 70 percent of the fisheries resources harvested off America's shores are directly dependent upon coastal wetlands for some phase of their life cycle, yet we have subjected this incredibly productive and valuable habitat to every conceivable stress as if there were no tomorrow. But there is a tomorrow, in fact, it's here today and if we are to preserve and enhance the fisheries resources which are left we must adopt and implement new ethical standards in our use of coastal resources. It is not too late to begin.

2. Impact of Multiple Coastal Use on Fisheries Resources

The recreational fisheries resources of the U.S. have an estimated value of 28.2 billion dollars per year and support 800 000 full time jobs. Commercial fisheries are worth 16 billion dollars annually and provide employment for 500 000 persons.

The wages of excessive, reckless, and unregulated use of coastal waters are great losses in fisheries resource value. Many enormous and valuable fish stocks have all but disappeared. Some shellfish beds have become too contaminated to be used, acid water poison juvenile forms, toxic substances render fish flesh unsuitable for human consumption, channeling disrupts critical freshwater/saltwater balance and unregulated harvest leads to virtual disappearance of some species. There is growing evidence that the large fin-fish mortality associated with shrimp trawling bycatch is a serous problem.

More than half of the coastal wetlands which existed in America a hundred years ago have been lost to dredging, filling, erosion and sedimentation. These losses continue today with some estimates as high as 450 000 acres lost per year. Combine this loss with a decline in water quality and the resultant loss of spawning and nursery habitats is staggering. Soil erosion, agricultural run-off, coastal dredging, heavy shipping and even trawling have reduced water clarity and lowered the basic photosynthetic productivity that is the basis of all food chains.

Deteriorated water quality and man-caused physical disturbances have destroyed food organisms, changed historic migration patterns, prevented spawning, slowed growth, poisoned juvenile forms and, in some instances, created vast areas of aquatic biological desert. Toxic wastes have accumulated in fish flesh with sometimes serious consequences for human health. Fish from many areas have been declared unsafe and off limits for public consumption. Dredging and filling has led to great destruction of benthic organisms. This is particularly true where enormous quantities of shells have ben dredged for road building and construction aggregate. Power and navigation dams and flood control structures have destroyed or reduced anadromous fish runs. Excessive harvest and unregulated access have devastated major fish populations and changed the biological balance. Major spills and other accidental or deliberate discharges have poisoned areas. Upstream flooding and flood control structures have vastly altered coastal

depositional patterns with corresponding changes in fisheries habitat.

Our overall fishery status today features an essentially unregulated fishing industry with a growing appetite for product and a sophisticated harvest technology that improves its proficiency each year. Early AMerican history is replete with references to the limitless and inexhaustible fish and wildlife resources. Increased attention to the "good health" benefits of eating fish have raised the annual consumption from 12.3 pounds per person in 1982 to 15.4 pounds in 1987. Fish, beneath their blanket of water, would appear to be less vulnerable than the vast wildlife resources that populated the land when America was young, but given unlimited access and an insatiable search for a so-called "better life," man has been equally successful in fouling the land and the sea.

3. If I Were King And Could Do It All Over Again

We all know the old expression that "hindsight is 20-20". Obviously, even the most environmentally insensitive among us would do things differently if we could do them over again. Though we cannot change what is past, perhaps there is something to be learned from fantasizing a bit about how we might do it over.

As king, my very first step would be to document and formally recognize the value of the fisheries resource. Historically, we took fish for granted like clean air and pure water and now we've learned the folly of our ways in every instance. With each new mouth to feed, with every new finding about the health dangers of animal fat, with every additional hour of leisure time, and with every ring of the enormous recreational fishing cash register comes increased recognition of the irreplaceable importance of our fisheries resource. As king I would decree that the fisheries resource is vital to our national welfare. I would require every school child to learn the basic facts about renewable aquatic resource values and every citizen would be frequently reminded about his or her responsibility in defending our fisheries legacy.

Secondly, I would do everything "kingly" possible to see that major ports were developed only in natural deep-water areas, where little, if any, dredging was required. In shore side construction there would, or\f course, be some necessary channeling, but I would permit no filling of wetlands. Sewage processing would not end with primary or secondary treatment, but

wherever possible would be continued through tertiary treatment. There would be no residential construction and little commercial or transportational development in floodplains or on barrier island and thus little need for massive flood and beach control efforts. No storm sewers could discharge directly into our waters, and no waste disposal at sea would be permitted unless the discharge met the same strict criteria imposed for land disposal.

Every multiple use activity in our coastal waters has its environmental costs, whether it's cooling water, channel dredging, road construction, harbour development, sand and gravel dredging, ballast water exchange, bridge building, clam dredging, fish trawling, recreational angling, well drilling, levy construction, breakwater installation, ship building or marina operation. In my kingdom nothing would be more important than building these environmental losses or costs into the price and value of the product. All of these developer- and user-paid dollars would be collected and placed in a Fisheries Resource Trust Fund to be used exclusively to mitigate for the fisheries resource losses. If a power plant discharged heated water or blocked migrating streams the price of its electricity would be slightly more to mitigate the losses. If ocean commerce required dredging, then the product transported would cost slightly more to mitigate the biological damage. Dredged sand and gravel prices would reflect an environmental cost and even the commercial fishermen would add an increment to their fish prices to cover the environmental damage caused by their activities. Roads built through wetlands would mitigate their environmental damage through tolls or slightly higher gasoline taxes. All ballast water would be treated, boats would have facilities for storing wastes and .... I'm sure you get the picture. The Fisheries Resource Trust Fund would be used to buy, create, enhance and protect wetlands. It would be used to repair flood damage to riparian habitat, to build artificial reefs, to fund essential fisheries related research, to create impoundments in strategic areas, to support waste treatment and to provide access to public waters so that the public could better enjoy its natural heritage.

If I were king, there would be carefully regulated commercial and recreational fishing access to the fisheries resource and every licensed user would pay a fee to cover loss of a public value and the cost of management. Coastal area developments would be carefully zoned and property tax structures would reward people for protecting wetlands rather than force

them to sell to pay the taxes.

To cover situations where environmental damage is unavoidable, I would create a system of mitigation banking. Under this system a public or private developer could earn banking credits through special bonus environmental initiatives. Once a mitigation account was built up it could be drawn upon to compensate for the sometimes unavoidable environmental losses necessary for societal growth.

All told, I believe the cost of protecting the environment and the fisheries resources in my kingdom would be far less than the real-world cost of repairing or rebuilding the resources and the indirect but, nonetheless, real cost of fisheries opportunities foregone.

4. Making The Most Of a Bad Situation

Since it is too late to start over what are our options? We could preserve a few fish specimens in a museum and then abandon the resource as a lost cause. We could intensify confrontation among user and protection groups by being totally inflexible and then go down fighting. Or we can assess the circumstances in a very objective and scientific way and develop future strategies of genuine co-operation and compromise with other legitimate resource users. Our only real choice is to make the most of a bad situation. We cannot shut the valve on the city's sewage treatment plant, we cannot sink our fleet or end maritime activities by halting dredging of ship channels, we cannot close the power plant, and, of course, we cannot turn back the clock. Just as we will not destroy the institutions that compete with fisheries resources in the coastal waters we will not turn belly up and float away.

Our goal should be to replace competition and confrontation with co-operation. We must defend fisheries with sound scientific information and the zeal of a missionary, but we must not shoot ourselves in the foot.

- If we are firm and persuasive we can convince dredging operators to time and scope their activities for minimum fisheries impact.
- If we are inventive we will find ways to have abandoned oil production platforms left in place as artificial reefs.
- If we are smart enough we will manage biodegradable wastes so that they enrich the environment without polluting it.

- If we a persistent we can sell the concept and management practice of permitting no more net losses of fisheries habitat.
- If we are vigilant and determined we can achieve great fisheries resource enhancement by effective enforcement of existing laws.
- If we are resourceful we will find ways to mitigate wetland losses by enhancing existing wetlands and creating new ones.
- If provide aggressive, involved leadership from the top down through all levels of government we can do something about solid waste pollution abatement and clean-up.
- If we cite the consequences we can persuade cities to do effective street cleaning and to screen and maintain all storm drains.
- With effective political efforts we can mandate sanitation devices on all vessels and require all marinas to have adequate sanitation pumping and disposal facilities.
- If we publicize the damage we can end the practice of waste disposal at sea.
- If we are determined not to poison the oceans we can require that nothing be dumped that does not fit land disposal criteria.
- If we better understand the consequences we will see that strict controls are exercised over the indiscriminate discharge of ballast and bilge waters.
- If we are imaginative and inventive enough we can create "containment islands" for spoil disposal.
- If (and when) we run out of space for trash disposal we will see mandatory recycling of all solid wastes.
- If our best efforts cannot prevent fisheries resource damage we can negotiate appropriate mitigation.
- If we document the excesses of open-entry fish harvest, a limited-entry solution will evolve.
- If tax structures encourage fisheries abuse, we can change them.
- If we co-operate with educators and communication media we can instill a public recognition and support of fisheries resource values and;
- we might even be able to persuade the military that every ocean target range or other "pre-empted" area does not have to be an order of magnitude larger than the space actually used.

There is no denying that much of our bountiful shellfish and fin-fish resource has been sacrificed for so-called economic growth and development. The ecosystem on which our fisheries resource depends extends to the very headwaters of the tributary streams. Unfortunately, ever segment of that system is vulnerable. Our defenses have been too limited and while we struggle with ocean dredgers, a tanker discharges oily ballast water. While we defend against draining and filling wetlands, a nonfunctioning municipal waste treatment facility goes un-repaired for weeks on end and while we press for toxic waste incineration we see more and more such material barged to ocean dump sites. Perhaps the problem is that our fisheries resource belongs to everyone and what belongs to everyone belongs to no one. If that's the case, then it's time to do something about it.

If we are to be successful in managing the marine environment to provide for a fishing future we must begin by making the public understand what is at risk. In America, it's worth $44 billion dollars per year and it impacts every single citizen in some way. Those of us concerned and responsible for fisheries resources have taken all the backward steps we must ever take. This and similar national fisheries forums can put us on the offense and if we keep our guard up while we keep on searching for compromise there will be a future for fishing.

DEVELOPMENT & THE FISHING INDUSTRY - LOOKING TO A NEW ERA OF DEVELOPMENT OPPORTUNITIES, ATTITUDES & TECHNOLOGY

G.H. BURCHILL, Dip.C.E., M.I.E. Aust.

Market Factors:

Waterfrontage living and ready access to waterways for recreation are some of the most **sought after features** in real estate and resort markets throughout the world. In prime locations, there is often no ceiling on price for waterfront properties.

Servicing this demand is a legitimate objective for the development industry as it is equally legitimate for authorities and for people concerned with the environment and natural resources such as fisheries to question how the development is to take place.

On the water itself, along the Queensland Coastline from Southport to Port Douglas, we are also seeing the formation of a marina chain which will add a new dimension to large boat markets and activities on the East Coast of Australia.

For the commercial fishing and boat building and servicing industries, this market pressure reflects on values of traditional waterfrontage operating sites and will eventually force operators to find new locations. This can give the opportunity for some foresighted thinking and investment which allows not only for relocation itself but also for long term expansion of these operations and the introduction of efficiencies in operation in the design of new sites.

New Era Forces and Attitudes for the Development Industry:

Whilst there is nothing new about these market issues, the rapid rates at which the world is changing towards global tourism and financial and cultural internationalisation with universally increased leisure time, greater affluence and less dependence on major city job locations for significant parts of the world's workforce, are bringing a different scale of investor and development interest in preferred areas of the world. High

on the list of these preferred areas are Turkey and Spain for example and Australia and particularly Queensland, but other relatively undeveloped places such as Darwin and Perth are new frontiers for attention.

For those places, this interest represents huge potential for economic growth if harnessed.

The same world wide factors that are producing accelerated demand for property in these more climatically, politically and environmentally attractive locations are accompanied by three key features:

(i) by greater public and business awareness of the dangers of rapid change and of the need to balance development with organised conservation of the natural assets that provide the attraction and

(ii) by greater access to international capital and technology resources.

(iii) by premium in sales prices due to scarcity of waterfront properties particularly.

International investors are providing not only new levels of funding and technology, but they bring from their developed countries, an acute awareness of the lifestyle disasters that come with insensitive and excessive urban development and over population and over usage of favoured places.

In Queensland, the Integrated Resort legislation is providing a mechanism to allow projects to be less site dependant or clinging to existing centres and to be able to select sites for their capacity to allow for creative planning approaches.

The Multifunction Polis initiative by the Japanese Government which has been proposed to be carried out jointly with Australian authorities, is an example of a new era approach to co-operation in planning for new living and working environments on an internationally derived set of input and objectives.

I won't suggest that development in the past hasn't deserved a lot of criticism or that all developers in the future will have these nobler and stronger characteristics, but by and large, future development projects will be fewer and larger and more capable of supporting professional inputs to their site selection and strategies, rather than the many undercapitalised and ill planned schemes of the past.

Being larger and of much greater financial consequence and with this greater awareness of the need for longer term concern for total environments, developers will be more responsive to the need to look outside of their own boundaries for the effects of their activities, and to invest capital in beneficial works for environmental enhancement.

In the case of developments involving waterfrontage, support for regional waterways planning and natural resource enhancement will be forthcoming in the form of financial assistance and co-operation in developing desirable networks of active waterways facilities and acceptance of the need for zones for special care and enhancement.

This can be helpful to new Government initiatives for Marine Parks and other formal designations in the ocean and waterways if the two groups work together to face the growth opportunities.

As well as the impact of new development locally, world progress in technology and the `civilisation' of developing countries will bring us other new era problems, such as the Greenhouse Effect.

This effect will not lessen the basic attraction of waterways recreation and living but it will place new demands on development technology.

On this, developers, authorities and the community must together face up to problems that may arise at the foreshore interface with the sea and an even greater framework for co-operation must be formed between the development industry at large and the other parties involved in foreshores and waterways.

Developers often can play a leading role in this approach, initiating regional schemes jointly together.

Underatanding Growth:

One of the problems that has got in the way of this new era kind of thinking in the past in Australia is that most people haven't been able to appreciate the relative enormity of the potential growth that has to be accommodated. Unless we can find a way to say no more new residents, no more new tourists and no more new boats, we have to accept a lot more growth pressure in popular areas and to plan well in advance for the development that is needed to accommodate it.

The scale of innovative major new development schemes are understandably, at times, beyond belief. I am quite used to this reaction over the years, for example at Sanctuary Cove and Bayview Harbour.

The likely scale of future growth can be seen from data recently assembled for the Gold Coast, as part of research by consultants for the Gold Coast Waterways Authority.

This area, with its microclimate, its range of natural waterways and attractions and its massive level of existing tourist and lifestyle investments and infrastructure is a prime target for attraction of new era growth. The recent development of the Gold Coast Seaway and Sanctuary Cove are the first major initiatives for the large boat community particularly as a special new area for accelerated growth in large boat sales and usage.

All other resort centres are similarly receiving attention, with major new large boat marinas being mooted at Burnett Heads, Airlie Beach, Mackay, Cardwell and Cairns, to add to recent new marina developments at Port Douglas, Townsville, Mooloolaba and the Gold Coast.

Gold Coast population growth for example, foreshadows a huge demand for new properties.

Existing resident population will grow from 200,000 in 1988 to between 325,000 and 500,000 by 2000, in only 12 years and will add somewhere between 125,000 to 300,000 people, possibly doubling the need for housing over what we have today, and correspondingly the need for recreation facilities.

Tourism Growth is even more spectacular:

At June, 1987, an annual number of 2.3 million visits were made to the Gold Coast.

Forecasts for 1989/90 are for 3 million visitors, i.e. 700,000 more in 2 years.

The International Component grew from 53,000 to 127,000 per year in 6 years up to 1985, average 16% pa. increase. In 1987, estimated foreign visitors were 187,000.

880,000 international visits are expected by 1995 and by aggressive marketing and greater investment in facilities and air services, this could rise to as high as 1.4 million per year, from 93,000 in 1979.

Obviously waterways usage will be one major area of the tourist operators portfolio of entertainments and will be critical in the location of new destination resorts.

For Boat Ownership:

Today, Queensland boat ownership is almost totally related to resident population and their leisure habits.

Small boat registrations at 1987 on the Gold Coast were 10,020, out of 93,148 in Queensland with a growth rate of 10.6% pa. since 1971. Of these numbers only about 4% were above 10 metres and only 2% for the whole of Queensland.

It can fairly be said that if small boat ownership grows at only 8% pa. for the next 10 years, we have to accommodate another 9,000 new boats for storage, fuelling, service, launching, waterways traffic and perhaps construction on the Gold Coast. This is almost as many more new boats as we have now after 40 years of modern postwar development. At only 4%, the 400 boats larger than 10 metres at present do not give a true measure of potential future number of sea going pleasure boats, once a chain of marina ports is available at a day's journey intervals along the Coast towards Cairns.

The Gold Coast has never before had a facility like the Sea Way. Initiatives are under way to promote an international yacht racing programme and to ascertain the facilities that would be needed for this, and why not for a place like the Gold Coast in the longer term as a world tourist centre?

Finite Resources:

Well advanced local Authority and Government investigation indicates that the Gold Coast has finite capability for ultimate land and waterways development, and today it is becoming much harder for the development industry to locate long term development opportunities.

Checks and Balances and Decision Making in the Future:

Fortunately in real life situations, there are checks and balances that will redirect excessive growth pressures and provide essential limits on ultimate development and demand absorption.

Conferences such as this National Fisheries Forum and current public debate on Foreign Land Ownership are important public checkpoints in the process of growth and development.

Single interest groups, and these include authorities, developers, commercial fishermen and environmentalists in the narrow minded sense that "we're here now and we like it as it is, so no more development", often have not been inclined to look past immediate problems and their own anxious perceptions about particular interests.

However, authorities in high growth zones, including local authorities and others such as the Gold Coast Waterways Authority, are now recognising the need to take a wider and longer term view of the constraints and needs of areas under their potential influence, and are employing regional scale strategy and management planning that acknowledges growth although not necessarily defining solutions to absorbing growth. It is the private development industry, with its special skills and its market focus that will have to offer the development initiatives that find ways to live with those limits that are imposed by conservation and other land use priorities.

For the future, with visionary and balanced leadership coming from Governments, and professionalism and access to hard data coming from well organised interest groups on both sides of development and conservation, and with common sense all round, it is very likely that the new era being opened up in 1988 by Expo, of "Technology in the Age of Leisure", will lead on to very successful regional concepts and individual developments for man to live with and enjoy sustained high quality marine waterways environments as an important part of future life style options.

A Working Case Study - The Gold Coast and Green Meadows

- Proposed Regional Harbour and Integrated Resort Development - Gold Coast

The Gold Coast area has all the ingredients for modelling new era situations; high population and resort industry growth, a large high technology potential industry growth as well, massive capital attraction, a complex waterways situation, advanced regional strategy and management data sources, an innovative development industry, and strong community awareness and interest in the whole spectrum of development and conservation.

Commercial fishing is a very important element of the Gold Coast providing the famous Queensland seafood in plentiful variety and adding to the areas visual environment and economy.

The port of Southport has 83 of the total Queensland fleet of 2,200 primary commercial fishing vessels registered with the QFMA, of which 625 are in the Brisbane and Moreton Region. A total of 236 fishermen are employed and an estimated $13.89m of fleet capital investment is located at Southport, with replacement value of $18.27m.

With processing and trade, there are significant flow on, multiplier factors, of about 1.5 persons to one fisherman.

Operations of the fleet base on the Spit and allied construction and servicing of large commercial boats are far from ideal due to the inadequacy of water frontage land for industries within the Gold Coast.

Pressure is on the fleet to relocate due more to the problems of working where it is in conflict with intensive tourism activities, than any deliberate actions by others, although the current site occupied is obviously extremely valuable for redevelopment under commercial lease arrangements.

My organisation has spent some two and a half years in negotiating approval for zoning of a large waterfront industry zone at Coomera, to try to service some of the needs of this group.

There are well developed public attitudes and some considerable competition between favoured theories of the two local authorities and the Gold Coast Waterways Authority about the priorities for use, development and conservation within and adjacent to the Broadwater and waterways northwards to Jumpin Pin.

The State Government has, over the top of any other official planning policies, acted to acquire large areas of freehold land on islands, for conservation, and is currently looking at firming up policies for use of South Stradbroke Island. This initiative has done a lot to clarify the position for future development and conservation.

It can be said that neither local authority is very keen to have development in the Broadwater System, even for boating facilities, and that the Gold Coast Waterways Authority is grappling with its obligations to plan ahead for recreational and commercial fishing operations, the rapidly growing sport of boating and the many other recreational uses sought on the areas waterways as an important sector of the Gold Coast's role as Australia's largest tourist operator and 6th largest residential region.

In amongst all of this, I and my colleagues as entrepreneurs and suppliers of facilities and development, are working at the day to day frontier, in the creation of the future master planned projects that will cater for new growth demand, and as you know all such development inevitably must impact on the existing land condition and waterways if these are close by.

It won't work simply if anti development attitudes prevail to stop development. Neither will it work if development overrides caution and care of a conservationist nature.

There are techniques whereby the whole picture can be seen, especially the likely ways in which growth is to be absorbed.

My organisation, as consultant to many of the major developments in the Gold Coast area has developed a logical approach based on researched hard data and has a position of being able to influence project planning and strategies towards accepting huge open space areas and exgratia contributions to local and regional works and services.

Because high premiums are available to successful developers in the waterways projects, they are capable of being generous.

Green Meadows:

I would like to use a proposed new Integrated Resort style development, **Green Meadows**, as our example.

As shown on the enclosed plan series, this project site is located on the south and eastern banks of the Pimpama River, occupying almost 2,000 acres of run down nursery and farmland.

Three separately owned parcels have been taken under control by contracts and options at considerable cost, to allow proper investigations, also at great cost, by myself and a joint venture partner, to secure approvals prior to a final commitment to the land purchase. Originally owned by the well known Queensland Muntz family, we have retained their name for the property at this time at least.

Green Meadows proximity to the main waterways, its large area and its close relationship to Brisbane, the Gold Coast and to existing and proposed major tourist and urban developments at Coomera, Oxenford and Hope Island, are the ingredients for an innovative future Integrated Resort Development which will add to the capacity of the Gold Coast to service forecast growth in an efficient manner, in a period from three to ten years ahead.

We can prove by analytical means that this project will be needed within that time frame. What will have to be justified however is that its development is acceptable in a regional environmental context.

This project strategy envisages a built out cost of about $700m and certainly has those new era characteristics referred to earlier, that is its success long term will rely on presentation and enhancement of its regional waterways facility, its cost is huge and will justify highest quality marketing research, long term investment attitudes and financial contribution to waterways and fish management research and improvement works.

The project details in table form indicate a massive contribution of 52% open space and protection of significant natural waterfrontages.

It draws on the experience of Sanctuary Cove in selection of real estate products but amplifies many community and conservation aspects.

It provides for a large new harbour area of almost 4 times the total of all the Sanctuary Cove Phase 1 harbours and canals, in a centralised form of great width.

It proposes a mini Freemantle town and marine centre for ultimate servicing of a long term potential 850 marine berths, as the only such single major facility in the Gold Coast, if and when an America's Cup and anticipated huge growth in large boat usage occur.

Boat travel time from the Sea Way will be about the same as to Sanctuary Cove after speed limits are taken into account.

The project is not aimed at competing with Sanctuary Cove but rather recognises the excellence and the prior marketing and sell out programme of that project, and hopes to add to the initiative given to the Coomera Region from a man made tourism appeal point of view.

Its key environmental advantages are -

* with the exception of some essential "Heads" image creation developments on the existing denuded river front section, all development is contained within the property, behind significant buffers to the river system.

* The project provides an ideal siting for a long term barge based channel dredging operation allowing a permanent cost effective spoil disposal means of avoiding the serious and objectionable disposal of dredging spoil within the waterways.

* Channel dredging access is relatively short to the main Broadwater, through a quite wide natural waterway system.

* The development provides for an excellent northern areas port to the waterways system for public recreation but also for commercial and administrative servicing of projects and activities on South Stradbroke Island.

* This project size, together with co-operation of other major landowners in the region will permit a scheme to introduce a development control plan for Resort Integrated (high open space) development over about 3,500 acres and an infrastructure of roads and services, including a bridge link to Hope Island, to allow more convenient public access to this waterway access point

* A financial contribution is proposed to be negotiated with the relevant Authorities towards a worthwhile research and management programme in the waterways system.

  The basis of this contribution will be argued on both the negative impact cost of the development itself and on the merits of specific work that would benefit the local or wider waterways. Consultants are assessing these factors now for us.

- Development in this location will complement the huge open space zones acquired and/or set aside by the State Government for future community and tourist benefit as the regions population and industry grows.

How does the Green Meadows Project fit into the wider Gold Coast Picture of Needs, Constraints and Opportunities for Development:

Key factors for the waterways are -

In the area of future boating needs, **The Gold Coast Seaway** has cost $50m to build, $6m per year for debt servicing, and about $1m per year to operate the sand by pass system. Its primary function was to give a reasonable deep water ocean access to large craft capable of safe navigation at sea. Other benefits were the sewerage effluent disposal system and the stabilising of South Stradbroke Island.

Recovery of the costs of the Seaway must substantially be from community use derived from it as an economic benefit and this is likely to come largely from recreational boating activities.

Today, Seaway boat use numbers are very few relative to capacity of the entrance, and this is due in no small way to the inadequacy of channels and moorings and berths within the waterways and also to lack of destinations up and down the coast for amateur skippers.

Special event usage as for off shore sailing spectaculars are similarly limited by lack of internal facilities and organised promotion as yet.

Increased larger boat activity therefore is a desirable feature to promote in the Gold Coast and plans for say another 2,000 boats over 10 metres by year 2000 would not seem an unreasonable objective, to add to the 400 currently registered, and the total of 10,200 of all sizes now. This could readily happen with improved inside facilities and a chain of Coastal Marinas as destinations and sanctuary.

Not all of these boats will require permanent marina moorings as canal homes provide many berths.

However, say 1,000 new marina berths by 2000 AD, to allow also for increased visitor numbers especially with Point of Entry Status, seems not unreasonable.

As well as berths, large boat activity in greater numbers will require very substantial channel improvements. This is being promoted by me, by use of barging to on shore storages in only two likely available locations, one at Jabiru Island and one at Green Meadows.

Foreshore Land Ownership and Constraints and Opportunities for new Marinas Capacity:

Almost all foreshore land in Gold Coast City is Council or Crown controlled. It is fair to say that only say up to 600 new marina berths are likely to be added to the Gold Coast City Council Waterway area, because of public and Council attitudes.

North of Paradise Point, plans are well defined for the long term, of almost all waterfrontages, except for Green Meadows.

Coomera, Woogoompah and Kangaroo Islands are now Council controlled for conservation, as is South Stradbroke Island.

All of Hope Island and Salt Water Creek foreshores are defined for particular developments but, apart from Sanctuary Cove which is in the current marina berth count of 2,200, these are not for major marinas.

A small marina is proposed on the Pimpama River upstream from Green Meadows, however this is not supported by substantial real estate development and is likely therefore to suffer problems with economic viability.

Only marinas which are allied to major projects appear to offer the level of return that warrants large berth numbers and what goes with a modern marina facility.

To provide 1,000 new berths would require a single major project with say 400 berths, and Green Meadows seems the only such opportunity in reasonable proximity to the Seaway.

The ultimate number of berths at Green Meadows is drawn on the master plan at over 800, however this is by no means a necessary target.

Fewer berths would allow less waterways congestion and may also allow greater use of floating homes or other activities in the harbour.

Within Green Meadows, we have the mandatory large destination Resort Hotel and two golf courses, and associated with these is about 350 lettable condominium units with harbour or golf course frontage, intended to supplement the hotel for tourist accommodation. This follows the Port Douglas Mirage model rather than Sanctuary Cove.

The project has about 1,100 residential units for its workforce, and to give access to normal permanent residency which is an element lacking in Sanctuary Cove; plus two schools and a high technology zone plus also our mini Freemantle town centre and shipyard.

We have only been able to put all of this together because of -

(a) High potential growth in tourism and resident population by job creation within the local area.

(b) Large land area aggregated by temporary negotiations with land owners, at a costly premium.

(c) Because of its huge financial scale, a capacity exists within the project to give away generous open space and financial contributions towards physical works in the waterways and appropriate research into fisheries.

This approach is where the future lies for the development industry to work with, not only conservation in waterways but to participate in pioneering of effective research and practical improvements to fisheries environments.

TABLE 1

DEVELOPMENT DENSITY / YIELD ASSESSMENT

LANDUSE (RESIDENTIAL)	AREA (Ha)	* % OF SITE	YIELD
Hillside Single Dwelling Sites	34.7	4.5	164
Harbour Front Single Dwelling Sites	11.6	1.6	85
Elevated Mansion Sites	38.2	4.9	161
Golf Course Villas	23.0	3.0	245
Quay Duplex Sites (Sequester Quays)	8.1	1.0	64
Harbour Front Villas	16.9	2.2	378
Hillside Villas	4.1	0.5	43
River Front VIllas	2.7	0.3	64
Village Residential Units (30/nett Ha)	11.6	1.5	348
Special Residential Units (12/nett Ha)	47.3	6.1	568
Contingency Factor (10%) for Approval Purposes	TO BE DETERMINED		210
SUB TOTAL	198.2	25.5	2330

LANDUSE (NON-RESIDENTIAL)	AREA (Ha)	* % OF SITE
Port Town Centre	10.5	1.3
Shipyard	10.0	1.3
High Technology & Service Industry Park	34.7	4.6
5 Star Resort Hotel	7.2	0.9
Mixed Motel/Residential Club	4.0	0.5
Yacht Club	1.7	0.2
Private Marina Club	0.4	0.1
Public Recreation Centre	10.0	1.3
Golf Course and Clubhouse	211.1	27.1
Park	44.6	5.7
Public Open Space	19.4	2.5
Harbour	136.7	17.6
Public School	10.5	1.3
Private School	16.5	2.1
Road Reserves	62.5	8.1
SUB TOTAL	579.8	74.5

MARINA BERTHS	
Shipyard	485
Private	365
TOTAL	855

TOTAL LANDUSE AREA 778.0

A DEVELOPMENT SITE INCLUDES 6.7 ha. OF NON-FREEHOLD PIMPAMA RIVER FRINGE LAND COMPRISING 4.5 ha. OF RESIDENTIAL DEVELOPMENT AND 2.2 ha. OF HARBOUR

TABLE 2

COMPARISON WITH SANCTUARY COVE STAGE
LAND USE SUMMARY

DESCRIPTION	PIMPAMA AREA Ha	PIMPAMA % OF SITE	SANCTUARY COVE ST. 1 AREA Ha	SANCTUARY COVE ST. 1 % OF SITE
Residential (Incl. Road Reserves)	253.6	32.6	106.1	45.1
Recreation	221.1	28.5	73.2	31.1
Village	10.5	1.3	7.3	3.2
Hotel	7.2	0.9	9.4	4.0
SUB TOTAL	492.4	63.3	196.0	83.4
Shipyards	10.0	1.3	-	-
Service Industry	34.7	4.5	-	-
Mixed Motel/ Residential Club	4.0	0.5	-	-
Yacht Club	1.7	0.2	-	-
Private Marina Club	0.4	0.1	-	-
Park	44.6	5.7	-	-
Public Open Space	19.4	2.5	-	-
Public School	10.5	1.3	-	-
Private School	15.5	2.1	-	-
Road Reserves (Non-residential)	7.1	0.9	-	-
TOTAL LAND	641.3	82.4	196.0	83.4
Harbour	136.7	17.6	39.0	16.6
Total Site	778.0	100.0	235.0	100.0

YIELD SUMMARY

SITE	AREA OF RESIDENTIAL	NO. OF UNITS	YIELD
Pimpama	253.6 ha	2120	8.4 units/Ha
Sanctuary Cove St.1	106.1 ha	900	8.5 units/Ha

May 10, 1988

MANAGING THE MARINE ENVIRONMENT - THE LOCAL GOVERNMENT PERSPECTIVE

ALDERMAN MIKE REYNOLDS, AM
MAYOR OF TOWNSVILLE
TOWNSVILLE, QUEENSLAND

Introduction

Local Government Authorities in Queensland have delegated power from the State under the Local Government Act. Local authority jurisdiction generally extends to high water mark, and may include rivers and streams seawards to the limit of their tidal influence, offshore islands and reclaimed or dredged areas. To the extent that the State Government does not intervene, local authorities thus have fairly broad powers to make by-laws relating to a wide range of matters; those which may be of relevance in this context are roads, culverts, resorts, reserves, sewerage, stormwater drainage, abattoirs, flood gates and flood prevention, town planning, subdivision of land use, construction and alteration of roads, eradication and destruction of noxious weeds and pests, agricultural drainage, reclamation of land, wharves, quays, jetties, landing places.

Under S32 of the Act, Local Authorities when considering applications .... "shall take into consideration whether any deleterious effect on the environment would be occasioned by the implementation of the proposal", and they can require environmental impact statements in relation to applications. Local Authorities thus can have quite far reaching powers in relation to matters affecting fisheries.

The Townsville City Council has jurisdiction over an area of 285 sq km. This area covers Townsville City, Magnetic Island and the Palm Island Group. Its area of responsibility extends out across the Central Section of the Great Barrier Reef Marine Park to the outer edge of the outer Great Barrier Reef. Although the Townsville City Council has not had a direct role in fisheries decisions, its decisions in relation to planning and development can have direct consequences for recreational and commercial fishing and the environment generally.

In this paper I would like to discuss several different types of issues in which we as a Council, have been involved, in which environmental consequences, of some relevance to fisheries, have had to be considered in relation to the costs and benefits of the proposal.

Before discussing specific issues, I believe it would be valuable to provide an idea of the Townsville City Council's philosophy. My Council believes in balanced development while ensuring that the needs of the community and environmental considerations are met. The Townsville City Council is an entrepreneurial council, and has undertaken a number of initiatives to attract development to Townsville, e.g. the Victoria Street Bridge redevelopment, the Rockpool on The Strand redevelopment and the Woolcock Street Lakes redevelopment. In doing so, the Council has been mindful of both the direct commercial benefits of redevelopment, but has also been concerned to ensure that environmental matters and community concerns are properly addressed.

Environmental Consultative Committee

The Townsville City Council has recognised the importance of environmental matters, with the establishment of an Environmental Consultative Committee. The role of the Committee is

1. To provide advice on environmental matters to Council;

2. To facilitate more public input into decision-making on environmental matters;

3. To play an educational role in helping to promote environmental awareness within Council departments and the community at large; and

4. To discuss environmental problems presented by the Council and by any members of the Committee and to seek solutions where appropriate;

5. To have power to form, direct and dis-band sub-committees, with approval of Council, in order to pursue issues of particular relevance.

The Committee comprises representatives of the National Trust, the Wildlife Preservation Society, the Queensland Conservation Council and 5 members of the public appointed by the Council on a staggered term basis.

The Committee has considered such matters as

- recycling and the operations of the new household waste dump
- potential beach erosion problems at Rowes Bay
- a report on declining barramundi numbers in coastal streams
- a proposed Magnetic Island Management plan.

The Committee thus is an avenue of expert outside advice to the Council and is thus a valuable resource.

New Dump Site

Townsville City Council has been looking for an alternative dump site for household waster for some years. The site originally proposed was eventually deemed to be hazardous by the Department of Defence because of likely bird strike, thus a new site near the Cluden Racecourse in Townsville was suggested for consideration.

The 41 ha site was on low lying land and it was believed that only about 30 ha of the site was suitable for use for landfill because of flooding of the salt pan area. It was proposed to construct a bund wall across the low lying salt pan area to exclude flood and tidal water and it was anticipated that this bund would exclude ground water penetration in from estuarine areas. It was believed that operation of the dump could be managed in such a way that excavation of refill areas would not create reservoirs in the underlying clay effectively sealing the area and limiting subsoil penetration of leachate and ground water.

Council received many objections to the proposal (including representations from commercial fishermen) based on increased traffic, reduced amenity of the nearby residential area and environmental grounds. In this context I will only raise the environmental objections. They include

- the suggestion that the area is a "wetland" and drains into the mangroves and Cleveland Bay; hence the risk of toxic chemicals entering the food web

- the suggestion that the area is a breeding ground for fish and prawns

- the influence of dumps sited in "wetlands" on flora and fauna is unknown

- the importance of this "wetland" area had not been evaluated

- the lack of evidence that mangroves can absorb leachates without detriment (as the Council's consulting engineers suggested)

- concern that almost the entire area could be subject to tidal influence, including possible raising of the water table.

Given these environmental objections, and the objections relating to traffic and amenity, the Council decided that it should investigate alternative locations without the same potential for problems.

The Council Therefore investigated another dump site, and succeeded in finding a location without such problems. The new dump site opened early this year.

Thus, through consideration of both the information directly obtained by Council and that obtained through public consultation, a potential environmental problem was resolved to the satisfaction of all parties.

Bolger Bay Quarry

Bolger Bay, on Magnetic Island, was the site of an application to conduct a quarrying operation (involving site clearing, extraction, crushing and stockpiling of rock prior to transporting it). The area is zoned non-urban and the proposed quarrying site is on a sloping site on the catchment area of Duck Creek, which runs into the sea a short distance away. Objections to the quarry were raised on a number of grounds and an initial application for the quarry was refused largely on environmental grounds - one of which was concern about transported sediment affecting commercial oyster leases and possibly affecting mangroves in the area.

A subsequent application accompanied by an Environmental Impact Statement addressed many of the grounds of the initial refusal by proposing mitigating environmental measures. In the case of the oyster leases and mangroves in Bolger Bay, the Water Quality Council of Queensland provided its requirements for controlling quarry operations to minimise suspended solids in water. It was felt that these limitations would be sufficient to prevent siltation of Bolger Bay as a result of the quarry operations. The quarry site is some distance from the creek mouth along the creek bed.

The proposal was subsequently approved, subject to a considerable number of environmental conditions.

The relevant conditions applied here were:

1. The washwater stream is to be operated as a closed circuit incorporating a number of settling basins or other means of removing suspended matter. Provision is to be made for removing suspended matter. Provision is to be made for removing accumulated solids (tailings) without need to discharge from the circuit, and for proper disposal of tailings. Accumulated tailings are to be removed twice annually from each pond.

2. Stormwaters are to be diverted around work areas and disturbed surfaces.

3. Disturbed areas including the quarry proper are to be managed so as to facilitate collection of silt-laden stormwater.

4. Silt-laden stormwater is to be directed to settling dams located so as to receive as little uncontaminated runoff as possible and sited according to Water Quality Council guidelines.

5. Excavations and embankments are to be constructed with stable slopes. "Permanent" works such as settling dams are to be revegetated if in erodible material.

6. The re-instated creek beds through the worked phases must connect into the original creek locations at both the upstream and downstream boundaries of the site.

7. Should creek bed and/or bank scouring immediately downstream of the boundary of Portion 44V result in part or in whole from increased flow velocities, the Council may require the installation of energy dissipation devices to prevent further scouring.

Thus, the Council approved the application subject to fairly stringent conditions, in the belief that the development was beneficial and its environmental impact would not be significantly adverse in that area. Again, I stress that the Council attempts to consider all the interests of relevant parties and to reach mutually beneficial conclusions.

Mariculture

To date, the Townsville City Council has not been involved with many mariculture proposals. However, planning approvals are required for developments on local authority property; this is one of the requirements of the Queensland Department of Primary Industries which handles approvals for mariculture activities.

With the advent of assured water in the Townsville area with the completion of Stage 11 of the Ross River Dam and the pipeline from the Burdekin, we anticipate that more mariculture operations will be attracted to Townsville. In fact, there may be active seeking of mariculture operations for the Townsville region through the recently established Townsville Regional Economic Task Force, another Council initiative to attract new industry to Townsville now that we have an assured water supply.

In the single mariculture application considered to date by Council, the Council approved the proposed mariculture lease, provided that

- town planning consent for annual husbandry (prawn aquaculture) and a caretakers residence be obtained

- Water Quality Council approval be obtained

- no processing of seafood take place without Council approval.

As far as Council is concerned, questions of water supply and outfall, buildings, access roads, processing, power, sewerage, landscaping and environmental matters are relevant.

Four Seasons Barrier Reef Floating Hotel

The arrival of large on and offshore tourism developments have potentially significant impacts for recreational fisheries in particular.

Local government's role in offshore developments is quite limited except where they are island based, thereby requiring planning approval. The Council strongly supports environmentally sound tourism developments which will enhance the tourism attractions of the region and bring tourists to Townsville.

The Townsville City Council has expressed strong support for the Four Seasons Floating Hotel at John Brewer Reef. The Council reviewed the EIS for the Floating Hotel and commended the developer for the sensitive approach shown to the environment. Council's concerns related largely to onshore matters. These included

- arrangements for the temporary care (i.e. support and accommodation) of 350 people evacuated from the resort in the event of an emergency e.g. a cyclone

- shore based car parking arrangements - for daytrippers, hotel guests and employees of the Hotel

- onshore dispersal on non-toxic ash which would be shipped ashore in drums

- increased boat traffic in the Townsville Harbour as a result of the development would result in increased demand for boat trailer launching facilities and mooring facilities.

In matters such as these, where bodies such as the Great Barrier Reef Marine Park have major responsibilities for environmental matters, the Council attempts to support their activities. The Council is aware, for instance, that GBRMPA has approved a stringent monitoring program for the Hotel: this should ensure that the environment that the tourist comes to see is maintained so that tourists will continue to want to see it and use it.

Magnetic Keys and Florence Bay Resorts

The proposed Magnetic Keys development at Nelly Bay and the proposed resort at Florence Bay have both been the subject of considerable controversy as you will be aware.

The Magnetic Keys proposal involves an international standard resort hotel, apartments, budget accommodation, commercial centre, a marina, public boat ramp and trailer park.

The proposal is yet to be finalised, but the Townsville City Council has supported the proposal in principle, subject to a few major concerns. These are that Bright Point, the location for part of the resort is sensitively treated, the fair exchange in terms of quality of open space and high level of public accessibility to water front; and control of the Gustav Creek outfall. These concerns have been taken into account in the detailed designing of the resort and the Council is satisfied that while not all resident of Nelly Bay are behind the decision, the best decision in terms of the options available has been made.

Senator Graham Richardson, Federal Minister for the Environment recently called for a Public Environment Report (PER) on the development. The PER is being prepared by the proponent and describes the proposal, examines the environmental implications and describes environmental safeguards to be implemented. When the report is released, there will be at least 28 days for the public to comment on the report.

The Florence Bay proposal (i.e. for a resort at Florence Bay on Magnetic Island) is one which the Council cannot prevent, but which, subject to appropriate developmental and environmental controls, the Council does not oppose. The development may have no direct effects on fisheries but it is important to ensure that there are no deleterious effects on the general marine environment.

While I agree with conservationists that the Bay is a site of unusual attractiveness, development need not be environmentally incompatible and if it is undertaken in a balanced manner, can enhance the attractions of the natural environment.

Conclusion

While Councils may differ in their view on the role of local authorities in large scale development which has potential to affect the environment in general, an fisheries in particular, the Townsville City Council has firmly taken the view that it should encourage balanced and environmentally sensitive development which will be beneficial to the city. The Council believes its role is not necessarily limited to encouragement and assistance in the planning and approval process, but if necessary and desirable, being a partner in the development itself. The Council encourages prospective developers to approach them at an early stage with concept proposals, so

that Council requirements can be addressed in the development of the proposal. In this way, developers can more easily meet environmental (and other) concerns. Periods for public review of developments as required in rezoning applications are also essential to the balanced planning process.

Furthermore the Council is careful not to extend its interests beyond its powers; the Council attempts to co-operate closely with other agencies which have interests and responsibilities in developmental proposals which might affect the marine environment.

In my view the Townsville City Council through adopting this approach has been able to successfully encourage and foster balanced development.

The Council believes that through a co-operative and consultative approach in which adequate planning, public consultation, and governmental liaison occurs, that the marine environment can be used and developed to our advantage; with the resource potential and massive tourist attraction of the Great Barrier Reef on our doorstep it is imperative that we encourage balanced development in such a way as to ensure that the Great Barrier Reef will continue to provide fisheries resources and tourist attractions for generations to come.

MANAGING THE MARINE ENVIRONMENT
COMPENSATION AND REHABILITATION

DENIS GRIFFITH
CHAIRMAN
QUEENSLAND SPORT AND RECREATIONAL FISHING COUNCIL

Introduction

Although this paper generally relates to and interprets the situation in Queensland, the problems outlined and the remedial measures suggested are applicable throughout Australia.

As part of our marine environment, coastal wetlands have an integral role with respect to our quality of life because of their effect on the economy, the food supply, flood and cyclonic surge mitigation, water quality and fish and wildlife resources. By coastal wetlands I refer not only to mangroves but to seagrasses, intertidal mudflats, fringing communities, paperbark, sedge and reed swamp. Each habitat type plays an important role in maintaining the health and vitality of our recreational and commercial fisheries.

Wetlands and the fish that are dependent on them are the source of significant recreational and commercial benefits, including

(i) A commercial marine harvest with an annual value approaching 200 million dollars.

(ii) Recreational fishing and boating that is enjoyed by some 600,000 people (ABS 1985), generating 800 million dollars annually (PA Management 1984).

Destruction of coastal wetlands has occurred in Queensland on a large scale, for a variety of purposes and by a variety of agencies. Changes in land usage of the wetlands themselves and of surrounding catchment areas are major causes of destruction (Saenger 1987). Flood mitigation and drainage works are actively encouraged adding a further continuing threat to wetlands.

Responsibility for Management

The root cause of such environmental degradation has been a system where legislative responsibility for coastal wetland management is vested in a diversity of government departments and authorities. To cite the Queensland example, responsibility for management of coastal wetlands is shared amongst eight separate State and Commonwealth Acts. These are

(i) Great Barrier Reef Marine Park Act (1975).
(ii) Fisheries Act (1976-84).
(iii) Beach Protection Act (1968-84).
(iv) Canals Act (1958-84).
(v) Harbours Act (1955-82).
(vi) Marine Parks Act (1982).
(vii) Local Government Act (1936-86).
(viii) Land Act (1962-85).

A similar situation exists in New South Wales and in other States to a lesser degree. Given this fragmentation of responsibility it is doubtful whether meaningful policies of wetland management can be devised (Saenger 1987).

The fragmentation of legislative responsibility outlined above has at least enabled public comment on development projects to be heard and considered in terms of fisheries, wildlife and other conservation concerns. In this regard, recreational and commercial fishing interests are given opportunity by the Fisheries Management Branch (QDPI) to comment on development proposals in terms of anticipated adverse impacts on fish and other marine life.

Recently, however, there has been a trend towards so called "fast track" legislation in a number of states. Examples include the Integrated Resort Act 1987 (Queensland), Environment Planning and Assessment Act 1979-86 (New South Wales) and the Economic Development Act 1981 (Victoria). Such legislation overrides normal planning and environmental controls and is heavily development-oriented rather than environment-oriented.

The ad hoc and fragmented nature of decision making in relation to coastal wetlands - what is often referred to as the "Tyranny of the Small Decision" (Odum 1982) - has allowed groups pursuing their own (legitimate) objectives to maximise those objectives while not recognizing that such a course of action is quite counter to the objectives of other groups.

The problem, particularly in Queensland, is compounded by a lack of resources and, more importantly, a lack of will to enforce habitat legislation. Illegal destruction of mangroves (ie without a permit) attracts a maximum penalty of $400, a penalty comparable to that for possession of undersized or female mudcrabs. The irony of the situation has not been appreciated by those responsible for such legislation.

On a more positive note, the idea that tidal wetlands are non-productive and unsightly wastelands, suitable only for reclamation and development, seems to be passing. Evidence of this can be seen in the recent local government elections in Queensland, where two local authorities (Cairns and Mackay) which firmly supported tourist developments involving major habitat disturbance were defeated. The community would appear to be more aware of the value of wetlands and more vocal in its support of their protection.

Notwithstanding the above, it is obvious that there is an increasing demand for coastal land for urban, industrial, port and tourist developments. Other threats include mining and extractive industry, the dumping of solid wastes, chemical pollution from industry and agriculture and changes to water flow patterns from so-called agricultural improvements - salt water intrusion dikes, clearing of riverside vegetation etc. ponded pastures

Current Management Practices

In Queensland, to date, coastal wetland management in relation to fisheries has consisted of two measures:

(i) The identification and classification of what are considered to be key habitat areas into Fish Habitat and Wetland Reserves and Fish Sanctuaries. These offer varying degrees of protection and their complete retention and indeed their expansion is strongly supported by the recreational fishing sector.

political intervention

(ii) Involvement by the Fisheries Management Branch (Department of Primary Industries) in the planning phase of coastal developments. The requirement that the Queensland Sport and Recreational Fishing Council and the Queensland Commercial Fishermen's Organization be given opportunity to comment on proposals and that fisheries questions be addressed in Environmental Impact Statements has led to most coastal developments becoming less damaging in terms of fisheries resource loss. In most cases, however, losses are unavoidable and intervention in the planning phase cannot be relied upon to preserve, in the long term, our coastal wetland resources (Ashe 1982).

Future Management Directions

It is the opinion of this State's recreational fishing sector that two important management measures need to be urgently adopted if wetlands and the fisheries that rely on them are to be maintained for the future.

Firstly, the decision-making process should be changed from one of small decisions to a management concept that encompasses all aspects of community usage with adequate community input and, hence, acceptance. Such a management concept is the theme of a paper presented by the Commercial fishing sector and I do not intend to pursue that issue further save to express the support of recreational and sport fishermen for the ideas expressed in that paper.

The second requirement, which is the central theme of this paper, is a system which accounts and compensates for those unavoidable habitat losses associated with coastal wetlands developments.

Environmental Compensation

This paper proposes that where coastal developments involve unavoidable anticipated adverse impacts on wetlands that developers be required to compensate those sections of the public adversely affected by habitat loss by contributing to a fund to be known as the Fisheries Habitat Research and Restoration Fund. The fund and its associated activities would be administered by the Minister for Primary Industries advised by a committee

consisting of representatives of the Fisheries Management Branch, Fisheries Research Branch, Fish Management Authority, Harbours and Marine Department and the recreational and commercial fishing sectors.

The major problem which will have to be addressed involves the determination of the charge to be levied on developers. How much are 10 hectares of mangrove or seagrass worth in dollar terms? The simplest solution is to apply an arbitrary charge to each project; however, this is unlikely to be representative of the actual value of the public resources lost (Wessel 1986).

What is required is the development by the Fisheries Management Branch of a set of criteria which would be used in determining the remuneration required. At this point in time there are no accepted standardized methods for quantifying wetland habitat values. Compounding the problem is the multitude of diverse and complex coastal ecosystems (Wessel 1986) and the subsequent need for a substantial data base. An inventory of Australia's estuarine areas has been commissioned by the Australian Recreational and Sport Fishing Confederation and when completed will be a useful tool in determining relative habitat values. It is suggested that the policies of the United States Fisheries and Wildlife Service regarding the measurement of habitat values be investigated and evaluated with a view to their possible adaptation to the Queensland situation.

In imposing a compensatory levy on developers there are two methods which should be considered: a one-off initial payment or an annual levy. In relation to products derived from coastal wetlands which are infinitely renewable an annual impost would seem appropriate; however, in terms of administration, a single cost to be determined in the planning phase is perhaps more acceptable to both the developers and fisheries managers.

The payment of a levy should not be seen as payment for a licence to destroy habitat, nor as the Fisheries Management Branch auctioning off this State's natural resources, criticisms which are likely to come from the more extreme elements of the environmental lobby. Whilst recreational fishermen would prefer a situation of zero habitat loss, we are realistic and pragmatic enough to recognize that option to be a pipe dream.

Compensation for habitat loss is seen as a means of generating funds for the following purposes:

(i) Fisheries Research

Fisheries Research in Queensland has been hampered by an acute lack of funds. Research has been overwhelmingly oriented towards those species of importance to the commercial fishing industry, hardly surprising given the major contribution the commercial fishermen make to research funding.

Funds generated through a system of habitat compensation would be made available to the Fisheries Research Branch (QDPI) and other research organizations on the recommendation of the Minister for Primary Industries.

To date, research (and management) have tended to be on a species-specific basis and there is still much to be done in this field, particularly concerning species of importance to sport and recreational fishermen. Increased emphasis should be given to research into the habitat requirements of fish and other marine life and their response to manipulation (Russell and Saenger 1981). Management-oriented research relating to both the actual fishery and the environment that sustains it is also necessary. Such research would encompass investigation into foreshore usage with a view to forward planning and streamlining of habitat legislation.

(ii) Habitat Restoration - the repair of damage caused by past activities and developments.

Habitat restoration has, to date, been rarely used in coastal management in Queensland, the only known example being that associated with the Brisbane Airport redevelopment. Precedent exists, however, for habitat restoration elsewhere in this country. Under the New South Wales Environmental Planning and Assessment Act (1979) successful restoration of mangrove wetlands has taken place in the Parramatta, Georges and Hawkesbury rivers. In the United States, Federal and State environmental legislation enacted in the 1970's has enabled a large number of restoration or mitigation projects to proceed in areas such as Tampa and Biscayne Bays, (Florida) San Pedro Bay and Long Beach, (California) and Tacoma, (Washington) (Wessel 1986).

Habitat Restoration may involve:

(a) The removal of a damaging or inhibiting structure e.g. culvert, saltwater intrusion dike etc.

(b) Active revegetation.

(c) Remedial Engineering (Ashe 1982) which may include
- Depth adjustment
- Substrate alteration
- Increased intertidal habitat diversity
- Shoreline adjustment
- Circulatory enhancement

(d) Passive revegetation following (a) or (c) above.

(iii) Resource Enhancement

Effective management of this State's fisheries resources should consist of three broad objectives - protecting partitioning and enhancing the resource (Russell and Saenger 1981). A system of environment compensation can be a source of funds for resource enhancement, which may include:

(a) Artificial Reef Construction

Such reefs have been constructed in Moreton and Hervey Bays and have been successful in terms of the quantity and variety of fish taken. Their construction has been left, however, to community groups such as boating, fishing and diving clubs. Increased government involvement and initiative in this area would seem appropriate.

(b) Fish Aggregation Devices (FADs)

Pioneering work by the Queensland Sport and Recreational Fishing Council has shown these devices to be of benefit in concentrating pelagic species in readily identifiable locations. Significant government involvement, however, is required if FADs are to become a valued addition to the options available to recreational fishermen.

(c) Impoundment Stocking

Stocking of a selection of Queensland's numerous freshwater dams with a variety of native fish species has been carried out as a part of the Queensland Government's Recreational Fishing Enhancement Program. As the species chosen will not readily breed in dams a "put and take" fishery will be developed, necessitating a regular infusion of funds for restocking purposes. A viable freshwater fishery will tend to reduce pressure on already hard-pressed marine fish resources.

Conclusion

It is obvious that coastal estuarine systems will continue to function as centres for man's economic and recreational activity. The accommodation of economic growth with the continued functioning of our coastal wetlands in terms of fisheries production will require more innovative management than at present. A system of compensation is seen by the recreational fishing sector as creating the potential for a "win - win" situation in which necessary development proceeds, the overall productivity of wetland resources is maintained and our fisheries are protected for the enjoyment of future generations. As we approach the last decade of the twentieth century it is imperative that the hard decisions be taken immediately. History will surely condemn us if the destruction of one of our most important resources leads to a future where fishing is a dim memory of the past.

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MANAGING THE MARINE ENVIRONMENT - A COMMERCIAL FISHING PERSPECTIVE

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Introduction

The value of production from the Australian Fishing Industry this year 1987/88 will be approximately $900 million. The value of exports will be approximately $300 million. The industry directly employs some 20,000 people and at least as many more in service industries and processing, retailing and related areas.

The commercial fishing industry makes a vital contribution to the Australian economy. But it all depends on protection of our fisheries habitat - on our ability to manage the marine environment for a fishing future.

Our commercial fisheries - which within a couple of years will be worth one billion dollars remember - all depend on the maintenance of fisheries habitats. Many of our high value species, prawns in particular, depend on inshore areas. It is these inshore areas that appear most at risk.

The thrust of fisheries legislation is to protect fish from over-fishing. Of course if it is found that numbers of a particular species have been fished down, then further restrictions on fishing would generally see those numbers bounce back. But if we lose habitat then the fish that depended on that habitat are lost with it - and they are lost forever.

There is a simple analogy: 100 hectares of kikuya grass pasture can carry 100 dairy cows. If you take away, let's say for a new shopping centre, 50 hectares of that pasture the farmer in future would be able to graze only 50 cows.

It is the same with our marine pastures: mangroves, seagrass beds, sand-and-mud bait banks. It is no good saying "this development is only going to take a small part of the habitat available." Any loss of habitat will reduce the fish and other seafood species available to be caught. It is simply a matter of degree: the more destruction, the more reduction.

Of course this is not a new problem. There is an old English proverb that covers this situation. It says: "The law goes hard on man or woman, Who steals the goose from off the common, But lets the greater sinner loose, Who steals the common from the goose". To put this another way, you can be fined up to $1000 for taking a single female or undersized male mud crab in Queensland. You can be fined in fact $5000 and/or jailed for 6 months for taking ten or more illegal mud crabs. But illegally knock down hundreds of acres of mangroves, and so destroy the habitat of thousands of mud crabs, and the maximum fine you can face is a paltry $400.

National Problem

Now this of course is a national seminar and certainly maintenance of the environment for a fishing future, managing the environment for a fishing future, is a national problem.

I hope that as our national fisheries organizations such as NFIC and NFA mature and gain confidence and expertise they will begin to co-ordinate common approaches to these common problems.

I will concentrate here today on issues in Queensland, because it is those that I know best. Nonetheless, I believe they are relevant to other areas of Australia and certainly I hope that the solutions we are searching for in Queensland can be applied throughout Australia.

Certainly we would look to the national fishermen's organizations becoming more involved in environmental issues in the future. In the meantime the QCFO is putting an increasing proportion of its resources into environmental issues.

You would hardly call us greenies or raving preservationists but this action by the QCFO is in response to direct demands from its members. These have come from Branches up and down the State. It was interesting to note also that in a Queensland Department of Primary Industries survey on fisheries research priorities, which independently canvassed the opinions of fishermen throughout the State, the number one research priority for fishermen was habitat research: ie, protection of the environment.

We cannot ignore the concerns of our members. They have accepted a wide range of restrictions on their activities so as to conserve fish stocks. But increasingly they are concerned about the loss of fish stocks in other ways, particularly through the loss of fish habitat. Thus environmental protection becomes an area of legitimate concern and involvement for QCFO.

The reasons for fishermen's concerns are obvious. They see the problems every day. They see the direct result of pollution and loss of habitat: fish kills from farm residues, process effluent from sugar refineries, and simple soil erosion into the rivers worry our fishermen.

Then there are other ways of if not destroying, then certainly denying access for fish to large sections of their natural environment. The most obvious perhaps are dams. An example that Queensland fishermen will be familiar with is the Fitzroy Barrage, where one concrete wall effectively shut-out barramundi from hundreds, if not thousands, of kilometres of habitat, and so reduce by a massive amount the production of barramundi from the Fitzroy River system.

We now find in the same area the spectre of "ponded pastures", where a form of passive irrigation will trap water behind levy banks, and trap with it juvenile barramundi and other commercial/recreational fish species. Unfortunately, of course as the pond dries out so the fish will be killed.

There has to be a better way of satisfying both the understandable desire of graziers to improve their pastures but at the same time the equally genuine, legitimate demands of commercial and amateur fishermen in regards to the protection of one of our most valuable fish species.

We don't want to halt progress, but...

We don't want to halt progress, but some of the basic assumptions in the development of coastal land should be questioned. We come here to the area that concerns commercial fishermen the most and that is "development".

Development of coastal lands, particularly conversion of wetlands, into marinas, real estate, industrial land, etc. has the potential to destroy a significant proportion of Queensland's valuable and vital fisheries habitat.

We believe that some of the basic assumptions in the development of coastal land should be questioned.

I find myself in agreement with the recent comments of Bob Bryan, President of the Queensland Chamber of Mines. Despite the glamour of space ports, high-tech industries and international tourism, he believes, as I do, that Queensland's primary industries will continue for the forseeable future to be the backbone of our economy.

The same can be said of Australia at large, where the primary sector of our economy currently accounts for 80% of the nation's exports. For the sake of the Queensland and indeed the national economy it is vitally important that our environment be managed for a fishing future.

I believe fisheries is often undervalued by planners. As you will gather, this is a popular theme with many of the leading spokesmen of our primary industries. Recently the Executive Director of the National Association of Forest Industries, Brian Gibson, commented that the fortunes of the forest-based industries have been adversely affected in recent times through a failure to adequately represent their economic and social importance to the nation. Of course how easily you could insert "fisheries-based industries" in that comment.

Fisheries creates wealth, it takes a latent natural resource and converts it into money. By contrast I believe many competing projects or competing uses of our coastal resources simply recirculate money made elsewhere. Domestic tourism is one example, unless the alternative to a local holiday is a trip overseas.

Commercial fishing plays a vital role in both generating export income and increasingly in replacing imports. Therefore on both sides of the ledger it plays a vital role, reducing Australia's trade deficit and improving our balance of payments accounts. As they say that has to be good for all Australians.

We fishermen are suspicious of fast talk about big money. That sort of flash talk creates a mood, an illusion of "progress". To oppose it becomes unfashionable, even heretic.

Fights with Developers

For fishermen here in Queensland fights with developers seem never ending. I don't simply mean real estate or marina developers. Other groups include local councils and, in particular, Port Authorities who obviously have the ability to have a major impact on our fisheries habitats but with whom environmental considerations, indeed commercial and recreational fishing considerations, seem to hold little sway.

For us these environmental battles are costly in time and in money. Yet they are vital to the conservation of fish stocks and so to the continuation of the commercial fishing industry. Just consider the changes to our coastal environments in the last 20 years and project 20 years ahead, then I am sure you will understand the basis for our concern.

These fights involve us in delegations to Ministers, submissions to Cabinet, calls to local councils, holding port meetings to canvass fishermen's opinions. They are certainly costly in time and money. They must be just as costly, perhaps more so, for developers. I think it is a cost that is largely unnecessary for both groups, for reasons I will explain shortly.

There seems to be a new development proposed every week. Typically the plan is for a marina and a golf course. Usually they want to make the marina by dredging up seagrass banks and dumping the spoil on the adjacent mangroves to create a golf course. Precious little fisheries habitat that leaves, but it is okay, they say. "It is still natural - just look at all that green grass." Well perhaps a golf course is the natural environment of some of our developers but it is certainly not a natural environment for fish or for fishermen.

To us many of the tourist, residential, port and similar developments often demonstrate an exploitive, antagonistic attitude towards the environment. Indeed developers seem to feel almost as though they are performing a community service by getting rid of smelly mangroves and biting insects (as well as smelly, irritating fishermen). With the present system it is hard to predict anything other than increasing, evermore costly, perhaps more bitter battles with developers over the use of coastal land. At the same time we commercial and amateur fishermen will be squabbling over access to a diminishing fisheries resource.

A Better Way

There is a better way. It involves planning and consultation to replace the present ad hockery and conflict.

We understand the Queensland Government is considering five or ten year plans for economic development. We certainly would welcome the opportunity to discuss with other users five, ten, indeed fifty-year plans for development of coastal land. Now fifty years might seem a long way down the track but, given the greenhouse effect and consequent rising sea levels, Federal and State Government and other authorities are already beginning to look that far ahead.

The greenhouse phenomena will certainly affect the environment on a grand scale, and just as certainly affect the lives of our children, many of whom we fondly hope will follow us into the fishing industry. Remember the saying that we don't inherit the world from our parents we borrow it from our children. Long-range planning seems not only sensible but essential.

It is our belief in the QCFO and I am sure other fishermen's representatives from throughout Australia would concur, that proper coastal-use planning is essential.

This type of planning is necessary for rational management of all our natural resources. Earlier this year I was interested to hear David Bills, General Manager of APPM Forest Products, tell the National Agricultural Outlook Conference in Canberra, that in regard to forest lands better techniques aimed at assessing social or intangible values need to be refined so that the real costs and benefits of resource allocations can be made.

We are looking for meaningful discussion, debate, consultation with Government and with other users of coastal lands. It is a common mistake to view the fishing industry as simply anti-development. Let me make it clear that this is completely wrong. We oppose development of the kind that is careless and leads to wanton destruction of the marine environment. But the fishing industry totally supports the concept of sensible rational development.

There has been at least some small recognition of the fishing industry's concerns over the use of the environment. Some developers have come forward to talk to fishermen through the QCFO about their development plans. But often this is far beyond the concept stage, frankly at a stage where there is little chance of even altering, let alone halting, the particular development. That makes a mockery of consultation and wastes the time of both the QCFO and developers.

We believe coastal planning is vital in Queensland so that everyone knows the rules and can plan accordingly, developers as well as fishermen. We do not want a continuation of the present conflict situation. We believe coastal planning is one way to overcome it.

Mitigation of Harmful Effects

Mitigation of harmful effects could be part of a coastal-planning and consultation programme, or at least one of its outcomes. By "mitigation" I mean avoiding, minimising, rectifing, reducing and compensating for project induced resource losses. Now this is clearly not something new. It has been applied in the United States. How successfully it has been applied, and how it might be adapted here in Australia, I look forward to discussing with our American visitors.

In theory this mitigation process has the ability to allow resource exchanges as an alternative to simply denying Government permits for a particular development. Such a system appears to provide the potential for both sides to win rather than having inevitably one winner and one loser.

A development may be able to go ahead, but the overall amount of wetland may remain the same. In theory it means that if wetlands are destroyed by a development in one place they must be created in an adjacent area. This of course is conducted within a management plan that would see some unique and genuinely irreplaceable natural features preserved. It is important that developers consider the preservation of public amenities such as fish, birds and other wildlife, clean air and water, access to the waterfront and even new projection for local residents.

But Won't It Cost Extra?

Mitigation or habitat restoration won't cost any more than projects cost now. But it may redistribute the costs already being paid. That may be confusing. What I mean is that if developers in future are requested to pay either a direct sum of money or devote resources to reconstructing elsewhere habitat consumed in their projects, this will cost money. But they will be paying then in cash no more than the cost the community is paying now in kind. The equivalent cost is being paid now in lost fisheries habitat and natural environment but it is being paid for by the general public and by fishermen in particular. It seems some developers in this sense are able to privatise the profits but socialise the costs. I should add this does already involve a heavy financial cost for fishermen whose catch, and so income, is reduced by loss of fisheries habitat.

As I said earlier development is talked about with almost a religious fervour. The benefits are discussed in glowing terms, but I think some of the developers read only from one side of the ledger. They confuse income with profit but perhaps it is the case that in many of the projects significant costs appear in someone else's ledger, certainly the cost of lost fisheries habitat.

Make no mistake, development in coastal areas by converting coastal wetlands is expensive. But we cannot afford to have developers who only want to put in cheap developments, that is those built with a public subsidy, where the public pays the cost of lost public amenities.

Now the idea of mitigation, compensation, reconstruction, needs a great deal more thought. I don't pretend that commercial fishermen have all the answers. But we certainly are aware of many of the problems, and are searching for workable solutions.

Can Australia Do It?

Can Australia do it? Do we have the ability to develop rational coastal management plans? I'm sure we do. Considering the demonstrated skills of our biologists and engineers I believe they could find ways to catalogue and protect, preserve and recreate our coastal wetlands and adjacent offshore areas and so conserve our fish and other resources for the future.

We need an inventory of fisheries resources and we need to develop the skills to repair or preserve the environment. I am sure that is not beyond the biologists and engineers of Australia.

Growth is Good

We are not arguing for negative growth or even zero growth in the economy. We are in favour of continued strong growth in our economy. It's good for Queensland, it's good for Australia, and it may even be good for the Australian fishing industry. We really do support tourism, space ports, high-tech industries and associated developments provided they are rationally managed. But an existing, lucrative, self-replenishing primary industry such as fishing should not be needlessly sacrificed to them.

If we can find ways to manage our marine environment through sensitive, sensible planning I believe Australia will be a far richer nation as a result.

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CONSUMERS: HOW TO NET A GOOD CATCH

SUSAN BARKER
CONSUMER AFFAIRS BUREAU

Introduction

The 1988 National Fisheries Forum has as its theme "Managing the Marine Environment for a Fishing Future". This is a most admirable objective, both economically and ecologically, but there is one important factor which can be all too easily overlooked by those involved in the fishing industry and its management. The end user of the product - the everyday consumer - has no input into and probably no interest in fisheries management or conservation; yet without the goodwill and purchasing power of consumers, the most innovative and productive management plans can all be to no avail. There is, after all, no point in maximising seafood production, increasing the number of species generally available or bringing in out-of-season varieties from other ares if consumers are not going to make the effort worthwhile with increased purchases. Oversupply and wasted products make as little economic and environmental sense as undersupply and poor management.

Matching production capabilities to consumers' needs is rather like deciding which comes first - the roe or the fish? Initially it may be best to tailor production and supply to known buying and consumption patterns, but a sharp eye should always be kept on changing consumer behaviour. At the same time every effort should be made to help modify consumer demands to match desirable supply patterns.

This would of course be an ideal situation, and very few of those exist in any industry. A fair approximation is often possible, however, and this paper will concern itself with areas which deserve consideration in attempting to rationalise supply and demand.

Seafood Consumption Patterns

Assuming that consumption patterns for the Moreton (South-East Queensland) region are fairly representative of similar urban/suburban coastal ares which contain a large proportion of the population, seafood would appear to be a significantly under-utilized resource.

Figures available for the Moreton region (Bandaranike et al, 1984) indicate comparatively infrequent use of seafood, on an average of only 102 days per

month. At the same time, the average for poultry was 3-4 days per month, and meat 15-20. While the majority of seafood eaters ate fresh seafood at least part of the time (77.6%), canned and frozen seafood products also had a significant following (72.4% and 41.1% respectively). At least some of this processed seafood would originate from a country other than Australia, further reducing consumption of the local product.

Persuading the public to eat more seafood to a certain extent required "brand changing" techniques rather than "new product: ones. Everyone has to eat, but as the number of meals per day is not likely to change, it follows that seafood will have to replace some other item/s in the diet. As changing established habits can be even more difficult than introducing new ones, this may well require skillful and prolonged effort.

Seafood has a certain guaranteed regular following - those who eat it for religious reasons, for dietary/health reasons, or simply for love of the product.

It is the occasional user - the great majority of consumers - who has to be courted and convinced of the advantages of increased usage in terms of both quantity and variety. The study cited above found consumers to be "extremely restricted" in their choice of seafood; even fresh seafood users limited themselves to an average of only 4 species out of over 50 available for home consumption, and the majority of restaurant patrons showed a similarly unadventurous spirit.

The availability of seafood to consumers is affected not only by the size and nature of the catch, but by the presence - or absence - in their area of retail or wholesale outlets. Fresh seafood will not appear regularly on shopping lists if a trip to another area is necessary to buy it.

While the decision to open a seafood outlet, or to include seafood in the range of products to be offered (in delicatessens and supermarkets, for example) is an individual one, the industry should make every effort to encourage traders to provide this service in presently under-catered-for areas. If a new shop is being established, or seafood lines being incorporated in an existing one, careful attention should be given to its locality to ensure that it is within the reach of consumers who previously had no local source of supply. Ideally it should be in a previously

unserviced/underserviced area; convenient for users of public transport; associated with other food outlets filling the regular food needs of an area (large shopping complexes can be included in this category) or incorporated in an established outlet.

Wholesale outlets and markets are not usually in convenient localities, but domestic consumers could perhaps be persuaded to make more use of them if the comparatively low price of bulk seafood, whole fish etc. was promoted widely enough. At the same time, however, consumers would have to be adequately educated in the handling of seafood, as its perishable nature tends to make many people wary of handling and storing it in quantity or in its natural state.

Handling problems, real or imagined, can easily prejudice consumers against an otherwise desirable product. Many people think twice about buying and using seafood through lack of confidence in their ability to choose quality, transport it quickly, store it safely or bone/shell and prepare it correctly. These objections could perhaps be overcome by practical advice offered at the point of sale, and advice/education made available in the cookery sections of newspapers or magazines, cooking/home economics classes, and so on.

Convenience is becoming a major consideration in food purchasing as many women return to or continue to work outside the home, and have less time to spend on meal preparation. As a comparatively quick-cooking product fish is an excellent food choice, and its convenience should be actively promoted. The meat industry has already hopped on this bandwagon with its "Short Cuts" campaign, and a similar approach could well be considered by the fishing industry. As microwave ovens are now quite a common appliance, especially for two-income families, particular emphasis could be placed on the suitability of seafood for microwave cooking.

Health and good nutrition are now well-established criteria for meal planning and food purchasing in many families. Seafood has a distinct advantage in this area, being high in protein and mostly very low in fat. Emphasis should be placed on cooking methods other than the traditional, high-fat batter or egg and breadcrumbs, accompanied with deep fired chips. Grilled or microwaved fish with a salad, for example, meets the most exacting standards of healthy eating.

Persuading consumers to try new cooking methods or combinations of foods can be a slow task, and a long term campaign may be necessary on several fronts: information and recipes at the point of sale; demonstrations/samples in larger stores or shopping complexes; materials available for home economics and cooking classes; incentives for restaurants (and even take-aways) to offer new or different varieties of seafood cooked in innovative ways which the consumer could duplicate at home.

Just over 8% of households in the region consumed no seafood, and this does represent a potential new market. Whether the gains to be made by attempting to tap this market would justify the effort and expense necessary to convert its members to even occasional use of seafood is open to question, and should be the subject of careful study before any action is taken. As there will necessarily be constraints upon the finances available for market research, education and advertising by the fishing industry, these resources may be better employed in persuading existing consumers to increase and diversify their use of an already accepted and familiar product.

Increasing Seafood Consumption

Consumers will not increase their use of seafood without good reason/s, and some attractive form of encouragement from the fishing industry. Without this, the only increase in consumption will be the natural one brought about by an increased population. If seafood resources are to be managed to the industry's best advantage, as well as their own, natural increase will not be enough to keep demand in step with supply.

What will persuade the consumer to buy more seafood, especially if the decision to buy seafood also requires a decision to buy less of some other product? Quite simply, it has to appear to be a practical and desirable decision, preferable for some reason to its alternatives. To achieve this, it is necessary to have some idea of what motivates consumers to buy in the first place.

With food products, this is easy - we buy to eat to live. Food has a universal market, and the only variables present are national/regional/individual food preferences. These are what must be modified to increase the market share of any given food.

Not all preferences are dictated by personal taste (where taste equals taste buds). Many foods are used at ceratin times and in certain ways for a whole variety of reasons - custom, association, religion, availability, convenience, cost, lack of alternatives, health. Christmas dinner is a classic example of custom and association determining food choices. Many families still sit down to huge, hot meals of turkey and plum pudding because this is the traditional Christmas fare of their country of origin, when it would be far more sensible to serve a seafood platter, salad and fruit.

To persuade consumers to make more use of seafood it will first be necessary to understand existing reasons for buying or not buying it, and then determining which or these can be exploited or overcome. To do this properly would require an extensive, professionally-conducted study, and this paper naturally cannot match the results of such a study in specific recommendations. What can e considered are some of the purchasing incentives which operate in varying degrees in most consumer decisions.

Factors Influencing Consumer Behaviour

A major factor in many consumer decisions is price. There may be a wish or intention to purchase a certain product which will not be translated into action if the price is not suitable.

Any primary producer is acutely aware of how production costs can vary from time to time, and how the size and cost of the resulting harvest (be it wheat, tomatoes, cattle or fish) can be influenced by environmental factors entirely beyond his control. To a certain extent the cost of any natural food product is beyond control. However once the product has been harvested (or caught, in the case of seafood) it is possible to exercise some control over processing, handling and transport costs, and every effort will undoubtedly be made to keep these to minimum reasonable levels.

Most consumers are interested not only in the actual price of an item but in its comparative price - is it better value than the possible alternatives? The consumer needs to be convinced of two things - firstly that seafood is good value for money (nutritious, little or not waste if fillets or steaks are used, makes a filling meal); and secondly that it is as good as or better than alternative protein sources (less waste, less fat, less

cholesterol, less needed to feed a family, quicker/easier to prepare and cook). If seafood prices can be kept favorably competitive with those of meat and poultry it would be easier to persuade consumers to increase their use of it as a protein source.

Price is of course also influenced by availability. Where consumers have only a limited range of favoured brands, there will inevitably be times when these will be out of season locally and thus more expensive, if available at all. Rather than lose the money normally spent on familiar seafood, the industry should be looking at ways of introducing consumers to different varieties which are in season and reasonably priced. If "old favorites" must be brought in from other areas where they are in season, every effort should be made to streamline processing, packaging, storage and transport to keep costs competitive with less variable alternatives.

Some types of seafood are traditionally regarded as luxury items, bought only for special occasions or ordered in restaurants. The higher cost of crab, lobster, prawns, bugs etc. removes them, in consumer minds, from consideration as every-day foods. While every effort should be made to keep their prices as reasonable as possible, consideration should also be given to showing consumers how to "stretch" these luxuries. For example, if the price per kilo is likely to scare away all but wealthy shoppers, emphasis should be placed on the smaller, more reasonably-priced amount necessary for the average meal if properly used.

Achieving Change

Before any commitment is made to consumer education/information programs, or to increased retail trading, there should be as clear an understanding as possible not only of consumer buying patterns and motivations, but of the composition and growth of the population in possible target areas. Growth areas, or areas with a high proportion of resident from an ethnic group that makes extensive use of seafood, are examples of desirable locations for good seafood outlets.

This type of study can only be effectively carried out if it is done professionally and thoroughly, and if the results are carefully analyzed to identify the most effective and cost-efficient strategies for change.

The time and costs involved in this type of study naturally put it beyond

The time and costs involved in this type of study naturally put it beyond the resources of individuals within the fishing industry, and it any case in the interests of uniformity it is one which should be undertaken by the industry at a national level. Recommendations for action would also have to be adopted and implemented on a national level if they were to achieve maximum impact.

The fishing industry has an excellent product, one which is currently under-utilized by consumers, and which offers tangible benefits if taken full advantage of. Nothing is ever ceratin in the marketplace, but effective and sustained promotion can have positive effects on consumers' buying and eating habits, and the time and money spent on promoting a natural, beneficial, Australian product would be justified in any terms.

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MANAGING THE MARINE ENVIRONMENT FOR A FISHING FUTURE

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TOWNSVILLE SEAFOODS, TOWNSVILLE, QUEENSLAND

General

There is a need for all of us to appreciate that whilst the marine resource has been, is being and will be used by many diverse groups of people with differing attitudes and interests, it is essential that each group understand that other groups have to share the resource and inevitably compromises will be necessary.

Common Objective of Resource Users

There is no doubt that users of the resource have one common objective and that is not to "over exploit" the resource but to ensure its retention for future generations.

Whilst the hard line conservation view point would be to maintain the status quo it is very evident that the resource needs to be allocated among the various users.

Management must formulate methods of retaining a usable resource for the future. However it must be recognized that the "future use" may vary considerably from today's use. Man will not stop progressing and therefore changes for the better or worse will continue.

Despite the inevitable changes which will occur it is important that we appreciate that if nature is changed then there automatically will follow other changes which may not be as desirous or as easily overcome as the initial change.

Management - is it needed - and at what cost?

Whilst we may all recognize and appreciate the common objective of retaining the resource for future generations, there is no doubt that without some form of management that greed will come to the fore.

There are numerous examples where if management action had not been undertaken, then certain sectors of those interested in the resource or maybe individuals within that sector would be guilty of exploiting the resource for their own benefit.

Therefore in a conservation sense management is necessary. The concern I have is that if we adopt an over zealous management attitude then we will have prevented a lot of people from using the resource.

Management must consider the marketing of the edible produce of the marine resource. With an input from marketers, the consumer's interest should be well protected. In taking on board the marketers' needs in a management plan then both short and long term marketing objectives and needs must be addressed.

In summary management is necessary. However we must recognize the cost of management and with the "user pays" principle being portrayed by most Governments then we must curtail unnecessary costs.

Marketing

Marketing was once defined by the American Marketing Association as "the performance of business activities that direct the flow of goods and services from producer to consumer or user".

Whilst the definition is probably over simplistic it discloses the marketer as a responsible link from our producers - or fishermen, and the end user or consumer. Whilst the marketer is the link from producer to consumer his priority must be to demonstrate the needs of the consumer.

It is industry today and not individuals that catch our product - and the marketers play a very important part in highlighting the market and the needs of same.

Needs of consumer

In todays marketing environment consumers are demanding:-

- High quality
- Good packaging
- Availability on a regular basis
- Cheap prices

The consumer today has a very sophisticated approach as to his needs and also to the effect his needs have on the environment. However we still see many consumers whilst not "one eyed" are often "blinkered". They so often support the emotional whimperings of the often negative conservationist yet demand the high quality, well packaged and cheap products as disclosed earlier.

Consumption Levels

Demand by consumers for seafood products is increasing at an alarming rate due to a number of factors including the consumer's awareness of regular availability and the tremendous health push for sea based products in recent times.

Various charts etc. will be available as handouts to support this statement.

Price - Component of Marketing Mix

I mentioned earlier that the definition as taken from the American Marketing Association was probably over simplistic. There are a great number of functions in the marketing mix but here I would like to address "price". It is something to which we can all relate.

As marketers we were taught in the first days of any economic study that the demand for any product moved in relation to cost (or price).

Today the prices for seafood, as with many other products, is not simply effected by supply/demand curves based locally. In fact we can so often become blinkered to believe that when there is a glut of a particular product in an area then the prices should fall. This is not the case. Seafoods today can be held and stored for lengthy periods at temperatures around minus 25 degrees centigrade - or in fact can be placed in a fresh form onto international aircraft for overseas markets. Our modern marketer must recognize this opportunity - and the consumer must appreciate that the marketer will source out the best market.

We are often in reality when it comes to price, dealing with a world market and the only difference in the price of a product in say Paris, Los Angeles or in fact Brisbane is the cost of transportation.

This of course can in many instances bring further pressure on the resource which is not simply being attacked by the local users but more pressure is being asserted from a market many thousands of kilometers away.

Demand for the product is obviously closely associated with price. If a producer (fisherman) can obtain from the marketer a better price for his product by having it consigned to a distant market then obviously we cannot expect him to sell his products for "local consumption" at a lower price.

The other point I would like to make in relation to price of seafoods is that related to the cost of "a serve". So often consumers are heard to say "the price of that fish is too high". Consumers need to realize that with so many of our seafoods - particularly fillets - there is no waste. The real cost to the consumer is the cost per serve. In other words how much it costs to serve each person the required quantity. So many other products that compete with our seafood in the market place have a great deal of fat, bone etc. which has to be discarded and the cheaper prices for these products is not realistic.

The Marketer - Other Functions

Apart from recognizing price, the marketer becomes involved in a great number of other activities - some of which are cost related and others are purely related to the marketers time.

These includes:-

- Value-adding
- Packaging and Presentation
- Storage
- Exchange Rates
- Interest Rates

Value-adding

- This can include cooking, breading, filleting, heading etc.

Packaging and Presentation

- I feel it is very relevant when considering presentation and consumerism to consider frozen versus fresh product. Consumers often feel that the only seafood to buy is that which is fresh.

I come from North Queensland - where temperatures are on the whole a lot higher than southern areas. Water temperatures are higher and ice melts much faster. Fishing grounds are often a long distance from unloading ports.

Wet - or fresh products - have often been held in ice or a brine solution for 5-6 days on boats and then it may take a further 5 days for the product to reach the consumer.

I believe that in many cases a seafood product which has been processed on board a fishing boat - it may have been filleted or whatever - and then frozen quickly on board - will end up in the consumers hands a much enhanced product than the previous so called fresh product.

So don't disregard the frozen product - it is very often excellent quality - and better than fresh.

Storage

- Frozen storage enhances the availability of a product to consumers over a much longer period and to some extent overrides seasonality - gluts and famine - and yet leaves the consumer with a consistent high quality product available over an extended period.

Exchange Rates and Interest Charges

- Other costs not often appreciated by consumers are those associated with exchange rates, interest charges etc. Whilst "world markets" have certainly broadened the opportunities for the movements of various seafoods from one part of the world to another, they have brought to the marketer a number of added worries. Exchange rates and interest charges can change so quickly and when dealing with products that attract such slight marketing margins then the marketers today have to keep abreast of world affairs.

Future of Seafood Marketing

Aquaculture and Mariculture are going to favourably effect the availability and supply of a number of seafoods in the future. However in this country at the moment very little of our product at consumer level originates from an aquaculture source.

There is need in the future for further value-adding to the produce from our marine resource and in many cases utilizing marine products which are currently caught but discarded by the producer due principally to poor acceptability in the market place.

It has been demonstrated that a degree of management is certainly necessary if we are to retain our resource for all users in the future. However we must all realize that with management comes an additional cost and that is often borne by the consumer.

Whilst appreciating the needs of the other users of the marine environment we should never lose sight of the discriminating consumer who is demanding to be healthier and better fed - and a balanced use of our marine environment will assist this objective - with a greater consumption of our ever popular marine products.

PUBLIC GOODWILL: THE MOST IMPORTANT RESOURCE OF THEM ALL

BILL ORD

Introduction

My paper has little to do with the specifics of fisheries-resource management principles and practice. I will, thankfully, leave these to the experts: the fishermen themselves, both professional and recreational, the marine scientists and the management teams at governmental and industry levels. I simply do not have the technical expertise, or even the cheek, to comment on what they may suggest are the best physical courses of action to harvest our seas, estuaries and other waterways as an always-renewable and, hopefully, self-renewable and, hopefully, self-renewing resource that must provide not only for man's sustenance and pleasure but also for the maintenance of the health of the marine habitat on which man's own greatly depends.

Instead, I will address myself to the task of suggesting some ways in which the fishing industry, its advisors and supervisors may get "on side" with the many individuals, groups and organizations whose good opinion of the industry, its objectives and its methods is vital to the industry's well-being and progress for the greater good of the community which, in the large sense, it serves and it which it must operate.

I will do this within the framework of a simple principle of communications: what people do not know, they cannot understand; what they cannot understand, they mistrust; what they mistrust, they reject.

How to seek and receive that trust -- and deserve it -- is the thrust of this paper.

A new fisheries resource: a climate of goodwill

Goodwill towards an individual or organization is an asset both tangible and intangible. It is tangible in that it exists in some measure or other, and the larger the better. No human enterprise can exist without it, however small it may be or however restricted the source. It is intangible because it is difficult to quantify, hard to create and all-too-easily dispersed by

rash statements and actions, particularly those which indicate a lofty disdain for what people may think of you, your organization, your methods and objectives.

In a word, goodwill is friendship. It is the oil that lubricates the machinery of change. And change is largely what this conference is about.

In this context, I will state quite categorically that you will be aided or retarded in making this change -- the change, as I understand it, towards a more conservation-based management of the marine environment and resource-- in direct proportion to the amount of goodwill you can generate on the broadest possible front for your philosophies, methods and, of course, product.

This, in turn, will depend largely on what you tell people about what you're doing, where you're heading and why.

If you do that in sufficient and persuasive enough measure, and if you maintain that friendly attitude and keep the friendship -- that is, the goodwill -- in good repair, as all friendships must be if they are to remain close and based on mutual respect, then you will have created a new type of fisheries resource or, rather, a resource of infinite value to the fishery and the fisherman. (Fisherwomen, too: where, for example, would our northern prawn fishery be without them!)

The who, what and why of public relations

It is the truism of public relations that there is no such thing as <u>the</u> public. Instead, there are many publics, each separate, each individually identifiable, each with its own characteristics, each with a need for specific kinds of information, each with a capacity to help or hinder those who seek its understanding and support, and yet each part of a whole which is greater than the sum of its parts.

As far as the fishing industry is concerned and insofar as it may be represented by a National or State association or master-fishermen, the following is a by-no-means exhaustive list of its publics:

1. The Government of the day, in both the State and Federal areas, which imposed the legal, regulatory and other frameworks within which the fisherman must go about his calling.

2. The ruling political party within whose policy guidelines Governments are generally required to act in legislative matters.

3. The Opposition MPs and their parties who may be persuaded to agree with or oppose legislative proposals with which fishermen themselves agree or disagree. (It is surprising just how much legislation passes through our Parliaments on a bipartisan nod or with only cursory or token opposition).

4. Parliamentary committees with cross-party memberships which frequently initiate or moderate legislative proposals.

5. Departmental officers who frequently propose legislation to their political masters, always have and advisory say in legislative matters, and are responsible for policing the various laws and regulations. (The legislative-initiatory power and function of the "mandarins" is generally imperfectly understood outside government).

6. Local authorities and other statutory bodies whose adoption and policing of their own rules and regulations may have a considerable bearing on how the fisherman goes about his business.

7. Marine and other research institutions whose scientific investigations and findings are of direct relevance to the operations, directions and economic wellbeing of the fishing industry, to say nothing of the maintenance and hopeful improvement of the fishing resource itself.

8. The education system through which it might be hoped to teach future citizens about the community value of the industry and the necessity for protecting the fishing resource.

9. The financial community whose good opinion of the industry's economic merits is necessary to ensure an adequate flow of capital and carry-on cash and credit.

10. The carriers and marketers of your own product for the most obvious of reasons.

11. The millions of recreational fishermen with whom you share your resource and to whom you must, in your own best interests, get the resource-management philosophy across in the clearest of terms. This has to be done not only for the conservation and enhancement of the resource itself but also to encourage huge numbers of people to be your allies in bringing pressure to bear on your other publics -- the politicians, for example -- to listen to what you have to say.

12. The media -- newspapers, magazines, radio and television -- which must be encouraged to regard commercial fishing as an interesting and newsworthy subject, accept the validity and worth of the industry's philosophies, objectives and methods, and, by doing so, help inform all of your other publics about what you're doing, where you're heading and why.

13. The members of your own industry who themselves need to be persuaded to maintain a particular course of outlook and action, and be prepared to defend and spread the work to everyone with whom they come in contact in their own local community scene. These members are, or should be, as it were, your front-line "defenders of the faith". You can talk as hard and persuasively as you like at upper organizational, political and other communication levels, but if your own members are confused, ignorant or apathetic about the industry's philosophies and practicalities, your communications program is hampered from the very beginning.

Getting the message across: a walk-up start

What we are talking about here, if I have not already made myself abundantly clear, is winning friends and influencing people. You are not only entitled

to do this; you also have a duty to do it for reasons which range from personal self-interest (and there's nothing wrong with that) to the greater economic, environmental, ecological, social and even aesthetic good of the local, state and even national community in which you live and work.

And here you have a walk-up start.

One reason is that hardly anyone, at whatever communication level you operate, will seriously dispute the community worth of the industry in which you are engaged. Criticisms may be levelled at such things as product price and availability, at what may be perceived as over-fishing a scarce resource, at the industry's apparent inability or lack of desire to compete successfully with other countries as far as exploitation of our outer-limit as opposed to off-shore or in-shore fisheries is concerned.

There may be, and certainly will be, other criticisms of which I am not aware or of which I have only a dim understanding. But the central fact is that the fisherman and his industry are accepted as being at the core of the Australian society's work-ethic, economic life-style and dietary convention and necessity. From man's very beginnings, fishing has been regarded as a worthy, even noble, calling conducted by hardy, resolute and intelligent people for the general public good as well as their own material good and the satisfaction of their own emotional and intellectual needs. At the community's heart, this belief still stands unchallenged. Put simply, fishing is a good thing -- not just for fishermen but for everyone.

Thus you have out there, in the community at large, a mass of people who want to believe the best of you and who, just as importantly, want to know more about you -- anything and everything that will justify their faith in the worth of what you do.

Another reason for your walk-up start in the field of communications is that you are deeply engaged in an issue that is securing the attention and sympathies of an ever-growing number of intelligent, articulate people whose own thinking and actions, political or otherwise, cannot fail to impact on other individuals and groups whose good opinion of your industry is essential not merely to its progress but perhaps even to its survival.

The issue is conservation. The people are those who believe we must practise conservation of natural resources or, failing in this, face sore perils in the totality of our very existence.

I am not referring here to the "greenies" as such: those paid-up, active members of specific conservation organizations who have done so much to arouse us to environmental-ecological truths in the face of a sometimes bull-headed and particularly politically-blinkered unwillingness to accept the facts.

The people I mean are those who may be described as "closet conservationists" and who belong to no conservation groups but who nevertheless hold both general and specific environmental concerns.

Until recently, I have been able only to work from a kind of journalistic instinct, honed in 40 years in the communications and media field not just here but all over the world, to guess at the numbers of these people and to get some appreciation of their concerns.

Now, however, and thanks to the Australian Bureau of Statistics, that worthy reader of the nation's arithmetical pulse, my instincts about the size and importance of this group are confirmed by recently-researched statistical fact.

And this is that:

* 47 percent of all Australian aged 15 and over have one or more specific environmental/ecological concerns.

* 52 percent of people between the ages of 25 and 45 have similar concerns.

It thus follows that anything that the fishing industry says or does that indicates its awareness of environmental responsibilities, anything it does to conserve and enhance our fisheries resources and values will have the approval of nearly half of the adult population of the country. What a weapon in your communications armoury that could be!

In Queensland, as in every other State and Territory, the top concern of conservation-oriented people was for the conservation of native flora and fauna. In this State, extrapolations of the Bureau's figures suggest that at least 509 000 people over the age of 15 are worried on that score. Second-most frequent concern was about pollution. This exercised the attention of 488 000 people. Third-ranked issue was deforestation (388 000). Others included nuclear and uranium fears (291 000 people), soil erosion (228 000), environmentally-destructive development and planning (214 000), and the destruction of historic buildings (185 000). Some people, of course, had more than one environmental/conservation concern.

These figures relate to about 2 million people in Queensland over the age of 15. The proportionate figures relating to specific concerns are similar in other States. You might care to work these out for yourselves. You will not, I think, fail to note their relevance to your communications task and, as I have categorised it, duty.

I will make this further important point: very obviously, conservation is not a passing fad or fancy. It will not go away. It has become, and will come increasingly to be, a major preoccupation and concern of the public at large. And anything the fishing industry says or does that harmonises with that concern cannot help but assist you in the attainment of your own objective of ensuring your own livelihood through the commonsense management of a precious but too-easily degraded natural resource.

The equation of knowledge with trust and acceptance

Earlier, I suggested that, in the field of communications with which this paper concerns itself, there is a simple principle at work: what people do not know, they cannot understand; what they cannot understand, they mistrust; what they mistrust, they reject. From this we can deduce an equally simple equation: knowledge=understanding=acceptance. Some logician semanticist might accuse me here of over-simplification or simplisticism but the equation will serve for the present purpose.

Now, some of you have probably noted with a possible sense of relief that the environmental concerns expressed to the Bureau of Statistics' researchers did not apparently include misgivings which might be laid at the door of the fishing industry. Watch that word "apparently"!

For my own research and discussions among the bell-wethers of the conservation movement from which the public-at-large will eventually and inevitably take their tune suggest that maritime conservation as it concerns all marine flora and fauna will become a matter of intense community interest, concern and apprehension.

Now is the time for the fishing industry to press harder and more publicly than in the past for resource-management policies and action that will safeguard their livelihoods, ensure the community's continued access to the products of their efforts, and build public goodwill for the fisherman's role in the genesis and application of those policies. In this, the fisherman's and the public's best interests are identical for more reasons than require enumeration here.

I don't know very much of what may be happening in other States but here in Queensland the Queensland Commercial Fishermen's Organization is already hard at work in this regard, particularly in the person of its able and articulate President, Peter Conaty.

Over the past couple of years, Conaty has been unremitting in his public, organizational and privately-political efforts to warn against everything from over-fishing to pollution and from habitat-destruction to ineffective management policies which degrades fishing resources.

The "knowledge" part of my equation is gaining ground. Understanding and acceptance must surely follow -- but not if Conaty appears to be a lone voice in the wilderness. Fortunately, this is not so but he and his cause could do with a great deal more help in getting the message across.

The voice must come from the QCFO's own people in whatever community they live and through whatever means of communication which may be available to them. It must come from the research people who are too often diffident about speaking out on the community or industry implications of their discoveries. It must come from MPs who represent fishing centres. It must come from those conservation leaders and groups who largely, sometimes even exclusively, are at present concerned with the terrestrial environment and who must be informed consistently and vigorously that they have a duty to

the marine scene as well. It must certainly come from the Government's own public service advisers in their dealings with Government Ministers and politicians who may not be attune to what resource-management is about but who know what a vote-favorable issue is when they see one.

As in one State, so it must be in all States. As it is at State level, so it must be in the Federal sphere.

Let our fishing resource, the marine environment as nature intended, not go the same way as our terrestrial farming resource in which 80 percent of or cropping lands and 50 percent of our grazing lands are suffering, some irretrievably, from erosion and other forms of land degradation because of ignorance, greed and apathy in the past and political and public indifference and inaction in the present. There, Australia is losing a greater value of productive soil annually than the gross return from the crops and livestock grown. There, over vast areas, nature's chain of life in which the links range from the tiniest bacterium and speck of trace element to the trees which moderate underground water levels and quality has been broken and may never be repaired. As the farmer and the land suffer, so do nature and the Nation.

We have not yet, I think, reached anything near the extent of degradation of our marine environment as we have in terrestrial terms. But, oh dear, nature's alarm bells are ringing.

Over-fishing in some areas has, I am told, put some species in precarious hazard of non-recovery in those habitats. In other areas, the very habitats themselves are being degraded, even destroyed, by dredging and land reclamation, by industrial and human wastes, by run-offs of agricultural fertilizers, pesticides, weedicides and other "suicides", and by other pollutants ranging from plastic bags to beer bottles.

In eastern Australia, it is estimated that 67 percent of the entire commercial catch of fish, crustaceans and shellfish is composed of species dependent upon mangrove estuarine areas which are, to put it bluntly, being brutalised, bashed and poisoned on an ever-growing scale.

Here, in Moreton Bay, the once-profitable mudcrab fishery is dead. Not a single fisherman makes his living from "muddies" any more: there aren't enough to make the game worthwhile. Fish catches are getting smaller despite, or perhaps because of, greater fishing effort. The ecosystem, which is virtually an enclosed one because Moreton Bay is not really a bay at all but is structured more like a large lagoon, is under attack from all manner of development and pollutant pressures that threaten to turn it into the nation's biggest septic tank.

Now let us return to our communications equation and add another factor. It now reads:

Knowledge = trust = acceptance = action

But what knowledge do people at large really have about the facts and imperatives of the nature and maintenance of a healthy marine ecosystem or the means by which it may be returned to health if it is already sick? Precious little, I would suggest.

So what chance does the fishing industry have at this moment of convincing people, other than its own members (and perhaps not all of them), of current degradation of the marine ecology and resource, of future probable or potential hazards, of the policies and actions which may repair present damages and guard against future dangers? Again, precious little so long as ignorance of even the most basic marine biological facts persists.

Trust in what the fishing industry wants in the way of sound maritime-management policies and practices? Acceptance of these demands? A welling-up of a demand on the broadest possible scale for action in the appropriate governmental, legislative and regulatory areas to bring in and enforce appropriate marine-environmental measures aimed at conserving the fishing resource while permitting harvesting on a resource-renewable basis?

Again, to these questions, the answers, as far as probability goes, are: not much in the light of what the broad mass of people knows about the biological mechanics of fish and fishing.

Here, in Moreton Region of Queensland which extends from the Sunshine Coast through Brisbane to the Gold Coast, more than 400 000 people from about 200 000 household go fishing. They own 50 000 boats and gear worth a total of more than $250 million -- four times more than the current capital value of the Moreton Bay commercial-fishing fleet -- and they spend $150 million a year in non-capital expenses on their recreation. (Compare this with the Moreton Bay commercial fishing industry's running costs of $27 million for a $33 million gross annual return).

How many of the 400 000 people, do you think, have even the vaguest idea of what fishery-resource management and the marine biological facts-of-life are and what they have to do with them?

Again, very few.

Here, then, and very obviously, is one of the major points from which should start the communications campaign without which, I contend, any effort by the fishing industry and its friends in government and elsewhere to get the necessary widespread acceptance of resource-management principles and action will be less effective than it should and must be.

Who is to pay for this campaign? Why not the boatowners themselves for a start? Commercial and recreational craft alike. In the Moreton Region alone, a licence-fee impost of, say, only $5 would provide more than $250 000-a-year for the purpose. Statewide, from about 100 000 craft, the figure would be $500 000. Other States can work out their own figures.

Conclusions

I am not here to work out the mechanics and costs of getting the resource-management message across to where it will do the most good for the fishing industry and the resource itself.

I am here to argue, as I said earlier, that an essential resource of the fishing-resource itself must be the informed and active goodwill of the people who have placed, whether they have thought of it in those terms or not, that resource in your hands.

I contend that the issue of marine conservation and resource management is too important to be left only to the scientists, the fishing industry and governments, just as war, as it has been said, is too important to be left to the Generals.

I suggest that this issue can be likened, in essence, to that of erosion and other forms of land degradation but that, unlike the terrestrial situation, we have the knowledge and the time in which to arrest and even repair the damage done and which continues to be done to the marine environment and ecology.

I submit, however, that unless the philosophies and practicalities of marine-resource management are placed squarely before the people as a whole, and in a fashion that will persuade them of the imperatives involved, much of the thrust of what you have discussed and agreed here will be vitiated, even nullified, by political, governmental, public and -- dare I say it?-- industry indifference and ignorance.

Knowledge of what is wrong and what needs to be done to right that wrong is not enough.

Unless that knowledge is spread through the community, unless the community itself is behind -- indeed, demands -- action to right the wrongs that are being done to the marine environment through stupidity, greed, apathy or incomprehension, then so will those wrongs continue in some measure or other in a situation that requires no wrong to be done at all.

I'll leave you with an old English adage:
Who steals a goose from the common is a thief, but much more a thief is the person who steals the common from the goose!

The marine environment is your common. The Nation's, too. Don't let anyone steal it. And let the Nation itself be your Neighbourhood Watch.

RECREATIONAL AND COMMERCIAL FISHING FOR BARRAMUNDI IN THE GULF OF CARPENTARIA

LEN STOLK
ESCOTT LODGE, VIA BURKETOWN, QUEENSLAND

I feel a little like a Christian in the Colosseum for I am going to talk about fishing from a recreational viewpoint, and just that in itself must pose another point of view to the subject of fish resource management. From the outset, please understand that I can only talk about the activities of fishing from the location of the Gulf of Carpentaria. I have not had any experience elsewhere but with respect to that location, I feel I can demand a certain credibility, having at one time operated a commercial fishing enterprise and for the past 12 years Escott Lodge just west of Burketown on the Nicholson River that has attracted amateur fishermen intent on catching the famous barramundi.

Escott is on a one thousand square mile cattle property that has the shores of the Gulf of Carpentaria as its northern boundary. In the 1960s we established the homestead as a resort, a resort we initially called Escott Barramundi Lodge. The emphasis in those days was fishing. Today, we have dropped the word barramundi from the name and we now call it Escott Lodge.

In those formative years we saw barramundi as a natural resource to help us subsidise our primary industry, grazing. Just as the barramundi fleet is doing today, we fished the estuaries from a converted landing barge and we sold accommodation to the recreational fishermen who wished to try their hand at barra. We were high users of the resource, although primitive because our commercial fishing technology was by no means sophisticated.

We also found most anglers who frequented the Lodge came with dreams rather than skills. There is an old saying that "the only certainty in life is change" and over a period of time things did begin to change. We fund the commercial operation to be marginally profitable and there was more potential in the tourist industry, for at that time you could almost guarantee and angler fish, assuming he knew what he was doing.

Today, as I have said, we have dropped barramundi from the resort's name. We still have the fishing lodge profile in a section of the community but basically we are now selling a new concept, an experience both educational and adventure-orientated. This shift has occurred because of the change in

the marine environment. In other words, from our experience fish stocks have diminished.

It is no longer an unspoilt Eldorado. Because authenticity and delivering the visitor's expectations are the keys to responsible tourism, we would be amiss to persist in marketing Escott as a barramundi fishing experience.

It is a fact that when we were engaged in commercial fishing we would have strenuously objected to any form of river closure for it eliminated potential harvesting areas. So that is one extreme. Now that we have viewed the ecology from the recreational point of view, it would be only too easy to take the opposite position and pursue river closure as a method of building up fish stocks. The reality is somewhere in between.

As Chairman of the Burke Shire Council, I am lobbied frequently and fairly heavily for closure of the Gregory/Nicholson River system. As representative of the Burke Shire Council on the Gulf Local Authorities Development Association, I know that there is concern within the Gulf Savannah for proper management of the fish resource. We have been waiting to view the wetlands management plan that is currently being compiled by the Fisheries Management Branch of the Department of Primary Industries and the Queensland Commercial Fishermen's Organization. It is hoped that such a rationalization of the current status of the GUlf waterways will solve most of the problems associated with fish stocks.

However, there are a few points I feel I should be identifying that possibly are not taken into consideration. Technology is a creature of mixed blessing. It is true that the advancement of technology over the past few years has increased the catch potential of the commercial operator. There are currently somewhere in the vicinity of 111 fishing licencees in the Gulf who are, to varying degrees, using this state-of-the-art technology and every year they unleash this sophisticated gathering method on a fish population that may vary from year to year, depending on the fickleness of the season. There does not seem to be judgement made annually as to whether the fish stock in the rivers can stand 111 licenced fishermen operating at maximum pitch.

In addition, the technology of today is not necessarily the technology of tomorrow. In the future the new improved methods of harvesting will no

doubt increase the catch rate of individual vessels. But what about the resource? Can it stand that ever-increasing sophistication, especially in bad years?

If one was to produce a graph showing the advancement of technology and its use against fish stock, the suggestion is that there would be an incline over a period of time with respect to the method of harvesting, and a decline with respect to fish population. The recreational fisherman does not harvest that many fish in the main and, as I have stated, most come with dreams. I should like to qualify that this industry is not the shamateur, but the legitimate recreational fisherman who has heard of the legendary barramundi and is prepared to spend his money and travel a distance to try his luck.

I believe there is room for both industries to function side by side. But there has to be a hard look at how we are using the basic resource. From a tourist industry point of view, it is always a concern that a region, through overuse, will become burnt out over a give period of time. Currently, the Gulf Local Authorities Development Association is working on a management plan for the tourist industry to manage and guarantee the longevity of that industry in the Gulf Savannah.

The premise here is that tourism does not have to be big to be good. It is more a matter of community satisfaction rather than visitor satisfaction because if the community is satisfied with the industry then the visitor's expectations will be fulfilled.

The entire premise of this type of management is a matter of scale. In other words,k how much impact can a community stand? Graziers do it all the time with regards to carrying capacity. The same basic consideration should apply to the marine resource. We are quite prepared to design some areas in the Gulf as "no go" areas for fishermen. We are quite prepared to allocate other areas for breeding grounds. The recreational fishing side of the Gulf tourism plant can be manipulated and I know there is enough concern to fall into line with fish management with regard to management of the wetlands.

There does need to be a plan put forward very soon that is conscious of:

(a) decreasing fish population;

(b) an increased technology commercially; and

(c) an increase in public pressure to temporarily, or on a semi-permanent basis, close some river systems and habitat areas to allow the numbers to build up again.

Quite frankly, I think we have overfished the resource. I think the days of a fished out Gulf are on the horizon if ewe continue on our current course. If this were to eventuate, then it would be devastating to the community from two standpoints. Firstly, it would eliminate to a large degree that section of the community that relies on and is engaged in commercial fish harvesting. And secondly, it would destroy the potential of the tourist dollar generated by the sale of the dream of catching barramundi.

There will be those who will say there is already river closure for commercial operators to a certain point in the river and this is true. In actual fact, however, such impositions s closures are not really effective unless either one entire river system is closed, or, more importantly, there is sufficient policing manpower on the ground to enforce the regulations.

Currently there are only two boating patrol officers in Karumba who are responsible for the enforcement of fishing regulations over thousands of miles of coastline. It is fair to say this is a totally intolerable situation. Because of the lack of enforcement, not only does this resource have to contend with ever increasing technology, but also with breaches of existing regulations from a wide range of sources. Shamateurs who skulk around backroads posing as amateur fishermen, but who in fact rip off the resource in a totally irresponsible fashion, are of great concern. This irresponsibility can also be laid at the door of some who live in the Gulf and, of course, although efforts are made by the commercial fisherman to self-regulate, there are commercial operators who have a tendency to break the rules.

This general disregard, in conjunction with lack of policing, places the resource even further behind the eight ball. Recreational fishermen have, in the past, been blamed for excessive harvesting and bag limits have been called for. Recently the Fisheries Management Branch, DPI, conducted a survey in the Gulf and, using various methods, compiled information from recreational fishermen to determine what degree of impact this user of the resource made on fish stocks. I believe that the recreational fishing was felt to be minimal. If this survey accomplished nothing else, it managed to

bring into perspective the various nature of groups who use the resource outside of the commercial fishing industry.

In this non-commercial group there are two definite elements;

(a) the recreational fishermen who come equipped with rods and dreams and, as the survey indicated, catch a very small percentage of fish and who in the main depart with shattered dreams;

(b) the shamateur who is a commercial fisherman in recreational fishermen's clothing. This group is irresponsible, unlawful and destructive in the extreme, and I am afraid only increased policing is going to eliminate this totally unwanted group. Both the commercial operators and the recreational fishermen can do without his presence in the Gulf Savannah.

The concept of bag limits, however, does give the appropriate authority, assuming it has a strong enough presence, a means of dealing with the shamateur group and it is hoped that such policing will increase in the near future.

The subject of bag limits is a very interesting one. I can appreciate its use in catching shamateurs and the recreational fishing group can live with this regulation for most would be happy if they caught one barramundi.

However, the question is, "what about the commercial fishing plant?" As I have indicated, the commercial fishermen are a group who use technologically advanced equipment, such as monofilament nets and who approach the harvesting of wild fish as an ever increasing science. If one takes it to the absolute extreme, the end product will be a fleet of technically sophisticated vessels pitting their technology against each other to catch the last barramundi.

You may feel I am talking in the extreme, but this does highlight the need to find suitable methods of management now. It is all very well to impose bag limits on non-commercial harvesters but how about the commercial operators themselves? With this legal use of technology does it not seem reasonable to consider such a ceiling of catch, or is the scarcity of stock going to be the discriminating factor of how many fish a sophisticated fishing unit is going to retrieve annually?

It is a very emotional issue and I do not wish to imply that the commercial fishing plant should be abandoned, but I do feel that with human nature being what it is, everyone is pushing their own wheelbarrow for their own vested interests without much regard for the longevity of the natural resource. Let us, for example, briefly examine the concept of fishing licences. It is true that, because of the increasing scarcity of fish stocks, catching technology has had to improve and this is a very costly business. But that goes with the territory, so to speak, and it is a symptom of the historic method.

I believe the commercial fishermen have bitten the bullet to some degree and accepted the fact that there are far too many units fishing the Gulf and that the size of the fleet has to be brought into proportion. On the surface this appears responsible with respect to the management of the resource, but is this really the case? Licences, as I understand it, are a method employed by the government to not only collect a user tax, but also to administer. In the case of the commercial fishing licence for catching barramundi in the Gulf such licences should only have as their function an entitlement to harvest the fish stock which belongs to the State. The number of licences, however, should be in proportion to the status of the natural resource.

By establishing a value on the licence it becomes not only an asset to the holder, guaranteeing him a negotiable value if he decides to sell, but it also places the management authority in a compromising position. Licences currently sell for around $30 000 so for an entitlement to fish the Gulf one would have to purchase not only the appropriate harvesting equipment, boats, nets, etc., but also a licence, and I can understand why fishermen would pursue such a situation.

To bring the fleet into proportion to the condition of the resource, however, this licence value poses a difficult problem. By establishing a licence value, the management authority has cut off their ability to quickly address the flexibility needed to keep the hunting process in balance with the resource. It appears the function of the licence has been corrupted and instead of its intention being to protect the resource, it now has as its main thrust protection of the commercial fishermen who harvest that resource.

If the numbers of fish was constant, then I suppose such a situation would not be critical. However, with the diminishing asset and the need to decrease the numbers of licencees who annually assault unknown fish stocks, who is going to pay the $30 000 to take them out of circulation? Certainly, there may be some sales along this line, but in the main this licence value has a tendency to stabilise the fleet size to some degree unless the government, who sanction such values, will accept the situation and buy back the appropriate number of licences as a management technique.

In essence, the status quo of the Gulf barramundi resource is depressing on examination. On its current course it is doomed to become extinct. There are those who suggest that the seeding of fry may hold the answer but it appears this science is far from exact, and although in the future such a process many restock rivers, between then and now, there is an escalating diminishing process taking place. Is it any wonder that concerned recreational fishermen have a tendency to polarize their opinion and harbour the attitude that commercial operators are destroying the resource? More importantly, there is a growing concern and frustration from within the Gulf Savannah that a natural resource that was once healthy is passing into history.

The time has come to be sincere about conserving the fish resource. If radical measures are needed, then so be it. For the sake of the future, we need to act now and approach the inadequacies for longevity of the resource fairly and squarely as the criteria for future decision making processes. It is only human to insist on gain now, but although some may make a living on the short term it is becoming obvious that no one will make an economic return from this industry in the long term unless we sit down now and positively approach actions that will bring the entire situation into some perspective.

If immediate increased policing was achievable to control the shamateur and illegal fishing techniques, then we would be taking the first step. POssibly the government could agree to community assistance in this area by using a system of community rangers, currently being developed in the Gulf Savannah, to identify illegal operations and then calling in the appropriate authorities.

The technology and its escalation should be examined to determine what sort of handicaps could be imposed on a fleet that was of a size commensurate with the ability of the resource to maintain a relatively stable status.

The abolition of fishing of any form should be examined in some river systems for a period of time in conjunction with the reproportioning of the commercial fleet and increased policing to cope with the misconception that it is an unwritten right to harvest regardless of management. Those days have gone in this country.

The value of licences is an issue the commercial fishermen have fought for and have won from government, and I do not see any way out but for the government to buy back a number of licences to reduce the fleet. If this needs to be approached a number of times to achieve a balance, then for the sake of the resource it must be considered logical.

The situation we find ourselves in now is not new. History is littered with similar scenarios, but somehow we never learn. Vested interests and immediate gain always seems to have precedence over the resource's balance and longevity. Recreational fishing in the Gulf is part of the tourist industry and the general direction of that industry is to develop a tourist plant that is proportionate to the status of the wilderness.

The intention is to ensure that the Gulf Savannah does not become a burnt out area in 10 to 15 years through overusage. This same principle needs to be taken on board by the government and commercial fishermen.

We are past the point of rationalising an already dubious position with respect to the current status. The time for action is now. So let us not repeat history yet once again. Let us collectively begin to consider that it is not too late, and devise radical solutions to turn around the demise of the barramundi and the livelihood of all those who rely on its numbers. If we don't, then the day will come when barramundi stocks, as we know it, will be a thing of the past and genetically different barramundi will be found only in aquaculture complexes.

MANAGEMENT AIMS AND STRATEGIES IN ENSURING A FISHING FUTURE

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Fisheries management suffers from two major problems: the lack of precision in defining the aims of fisheries management and the inability of scientists and economists to provide reliable data on which to base management practices.

Although the modern student may dismiss his perceptions as oversimplification, Russell (1931) initiated a long period in which the maximum sustainable yield was accepted as the preferred goal for fisheries management. It was not until economists starting taking an interest in fisheries that anyone questioned what the cost might be in aiming to attain the Maximum Sustainable Yield; and the subsequent demonstration that most fisheries became less and less profitable as the maximum sustainable yield was approached led to the concept of the Optimum Yield.

The optimum yield is attained when the fishery is at its most profitable, that is when the margin between costs and benefits is at its greatest. Figure 1 illustrates this. For simplification the line labelled total cost is constructed on the assumption that there is a constant marginal cost for every extra unit of effort expended; similarly the curve labelled "market price" is based on the assumption that the price per kilo is constant. The gap between costs and prices is greatest at the points C and R (costs and returns). This is the optimum yield or the efficient level of effort for at this point where the tangent parallel to the cost line touches the curve, the marginal benefit is equal to the marginal cost.

If at this stage extra effort is put in fishing, whether by an individual boat or by the fishery as a whole, the marginal costs between points E and M are greater than the marginal benefits. The total financial return to the fishery keeps increasing up to the maximum sustainable yield, but the cost per unit of effort increases without compensatory increases in the market price.

This of course is a simplified picture. In real life the market price could increase, but it is more likely to do so after the maximum sustainable yield has been attained than before, because then real scarcity is setting in and if the consumer choice is strong enough the market price may increase to compensate to some extent for the increasing cost per unit of fishing effort. Thus if the consumers are willing to pay enough to provide a profit a stock could be worked to extinction despite the general belief that a fishery would become uneconomic well before extinction threatened. However usually, because there are alternative choices in the market, customer resistance to the high prices sets in before the effect on the stocks is too drastic.

Not all fisheries work on the laws of supply and demand. For some countries the maximum sustainable yield remains more important that the optimum yield simply because the country needs the protein; then we find subsidy of the fisheries as in Japan and Russia. Australia has not yet reached that need for protein, but given time our immigration policies should provide for that. When the need for protein is desperate enough the subsidisation system could well tip the scales to extinction or uneconomic survival.

In a laissez-faire approach to fisheries one would expect that as the margin of profit became less individuals would drop out of the fishery, so that it would always tend back to the optimum yield where the profit margin is greatest. But usually this does not happen, for a number of reasons. People fail to drop out of the fishery despite falling profits because they have no other skills, or they like the life, or they have to pay off the loan on the boat or they think it is up to the other fellow to drop out.

If the degree of effort going in to the fishery is such that the catch is forced beyond the maximum sustainable yield then management has a role to play. Sometimes management acts to bring the fishery back to the optimum yield or sometimes, on the engineering theory of a safety margin in case of error, even below the optimum level. If one believes, as I do, that the role of a government agency is to conserve the stocks, then the only aim the fisheries manager should have is to maintain the stocks around the level of the maximum sustainable yield. To regulate the fishery in order to attain

the optimum yield is a socio-political or economic aim, not a conservation aim. Management agencies that regulate the profitability or on the basis of spreading the benefits should say so and not claim, as so many do, that they act in the cause of conservation.

In estimating the condition of fish stocks and in making judgements on what action to take to achieve management ends, the managers are dependent upon the scientists and statisticians. There are managers who disregard the scientists in the naive belief that commonsense is all that is required: the sort of commonsense which seems to have a resurgence, judging by some recent regulatory measures, and which says for example: every fish should have the chance to spawn once before being caught; despite the many many studies which have shown that only in the case of fishes with a very low fecundity is there any correlation between the number of spawners and the numbers in the subsequent generation.

The responsibility of scientists is to predict what will happen to the fish stocks if particular management measures are applied. But their predictions are only as accurate as the data on which they base their calculations. Too many people, including inadequately educated scientists, accept the notion that because numbers are used the calculations must be correct. They may be in mathematical terms, but far too often the margin of error is not calculated. The margin of error in most fishery calculations is large indeed, because of the sampling difficulties; for example: when population counts can only be made by electronic surveillance or by the lucky dip of fishing or of tagging experiments whose accuracy is plagued by many complexities, including the non-random dispersal of tagged fish in the population and the non-randomness of fishing effort. The cost of a sampling program which would reduce the margin of error down to an acceptable level is so great that not even the nations heavily dependent on fisheries will provide such costs.

The other major statistic whose precision may be doubted is the measure of effort. The measure used is usually the cheapest or the easiest to obtain. Days absent from port is easier to get than hours of fishing. Logs which show hours of fishing may be inaccurate because they are filled in long after the days' events are over or because the owner thinks it is none of

the government's business what the boat actually takes. The accuracy of catch figures are doubtful too. Not all catches have to pass through central depots. Processing firms object to their through-puts being published on the grounds that the information would be helpful to competitors. In some fishing towns unreported sales at the boat are by no means uncommon. And for a number of species the heavy angling catch is never taken into consideration, despite the evidence that inshore and estuarine anglers may take catches at least as great as those of the commercial fishermen (Thomson, 1959).

The means of managing the stocks are not necessarily those which a biologist would recommend, which has produced many a disgruntled biologist who sees his sage advice ignored in order not to disrupt the industry. The drastic measure of closing a fishery entirely in order to let it recover is seldom resorted to, although it undoubtedly would be the most effective action. But the socio-economic realities are that fishermen have to make a living and so do the fishing gear suppliers whose angling customers would complain loudly and long to their members of parliament if they were expected to contribute towards conservation by refraining from fishing.

Very often fisheries management has imposed inefficiencies on a fishery in order to control it. For example, the banning of more efficient dredges in scallop fisheries, banning of engines in boats in some fisheries; and the banning of monofilament nylon nets. Indeed, banning new technological advances, usually on the demands of fishermen used to the older gear has been a feature of fisheries. Some agencies ban the use of all gears except those whose specifications have been approved by regulation. Innovation and improved economy of operations are inevitably stifled by such an approach. But it does give the managers an easy way to exercise control.

Aquaculture is touted in some quarters as the answer to the problem of overfishing on wild stocks. Certainly a healthy future can be predicted for those species which lend themselves easily to aquacultural conditions: but not a perfectly healthy future, for where animal life is concentrated disease can run riot. After several thousand years of agriculture, primary industry is still plagued by plant and animal diseases and the vagaries of weather. It would be wishful thinking to believe that aquaculture will not be plagued by similar problems.

On the other hand aquaculture lends itself to the genetic improvement of stocks, so that in time desirable traits such as fast growth, flavour and disease resistance can be established. But the waters in which salt or brackish water fish flourish are those very waters which modern civilization is busy polluting. There are even scenarios in science fiction and in the lore of the Greenies that the whole ocean will become so polluted that fish life will become extinct. While the evidence does not suggest that total oceanic calamity is near, there are plenty of examples of rivers and estuaries which have been bereft of fishes. One has only to think of the Thames and the Humber or the Brisbane River. All three of these have been resuscitated; estuarine and diadromous fishes are back in the estuaries and rivers again, indicating that control of pollution can restore the fish-carrying capacity of rivers. But little is known about the long-term effect of sub-toxic doses of pollutant.

The management of fisheries is more difficult than control of most resources because of the fact that fish are regarded as a common property resource. Access to such resources is not restricted except to the extent that, increasingly, governments have taken the view that they, or they on behalf of the people, own the resources. But even so they seldom take the logical final step to provide individual persons or individual companies sole fishing rights over an area, as is done ashore by the provision of ownership over areas of agricultural land. Consequently competition is stimulated and there is no incentive to husband the resources. This type of ownership has its limitations. Fish take no notice of artificial boundaries and may wander from one owners paddock to another. Where the stocks move into international waters a further complication is added to the management scene.

An individual fisherman who has sole rights to an area would have an incentive to maintain the stocks at the most profitable level; but an individual company exploiting a common property resource has no such incentive because restraint on his part is negated by the exploitation by others. Government agencies attempt to control the inevitable overexploitation by restrictions on license numbers or on fishing practices, but these lead to economic absurdities as exemplified in the Pacific haddock industry where the entire permitted catch for the year can be taken in less

than a week. It needs to be emphasised that any concept of sole rights to exploit should be on the same basis as the right to exploit in agriculture or forestry, that is a right to an area. It would be deleterious to the community to confer sole rights on a species of fish, because monopolists in seeking maximum profits will price their fish at a level greater than is reasonable from the viewpoint of the consumer. Collusive agreement in producing selling rings can have the same effect of course. In both cases only government intervention will control economic exploitation of the ordinary citizen.

A logical alternative would be for the government to declare that common property resources belonged to the state and therefore the state would operate all fisheries. This is the Russian approach to all but small-scale fisheries. It is alien to the concepts of our capitalist society.

But the greatest disincentive to providing property rights over fish stocks is their use for recreational fishing. The owners of fishing rights would inevitably resent their potential profit being reduced by heavy angling pressures. Clearly little or no angling takes place on deep-sea fishing grounds, but even these can be affected by exploitation in the estuaries. King prawns, snapper and leatherjackets, all caught at sea, also use estuaries and coastal lakes as nursery grounds and some catch inevitably occurs there. There are no general patterns; each fishery has to be considered on its own characteristics.

To summarise my discursive discourse: Australia and its States need to clearly define their aims in fisheries management:

1. In each fishery are we seeking the Maximum Sustainable Yield or the Optimum Yield or are we merely trying to stop the possibility of extinction of species?

2. Should fisheries remain a common property resource or should exclusive rights be granted over large areas to provide an incentive to optimise the catch?

3. Are we seeking to maximise fishermen's profits or minimise the prices to the community?

4. Is it sensible policy to regulate for inefficiencies in order to spread the benefits to the maximum number of fishermen or should economic efficiency dictate that there be little, if any, restriction on exploitation methods, other than those designed for conservation of the species?

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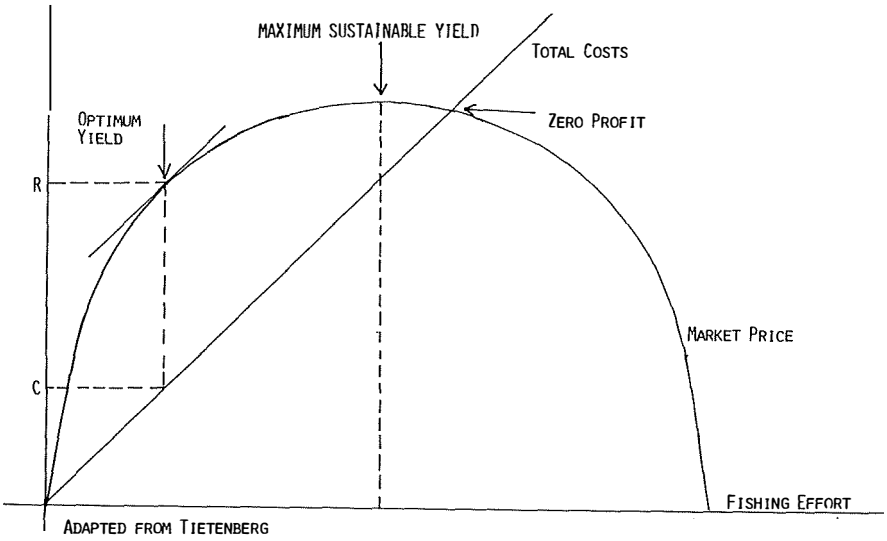

FIGURE 1. RELATIONSHIP OF MAXIMUM SUSTAINABLE AND OPTIMUM YIELD

EL NINO, THE GREENHOUSE EFFECT, AND THE ANTARCTIC OZONE HOLE: PERTURBATIONS OF THE ATMOSPHERE/OCEAN SYSTEM

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Introduction

In recent years there has grown an increasing awareness that the regional behaviour of atmosphere and oceans is intimately linked to global scale disturbances. In this paper one natural and two man-made phenomena are described which fall into this category, and which have or may have a significant impact on fisheries. The natural phenomenon which now is widely recognised as affecting the Pacific region and beyond is the El Nino: a disturbance of the atmosphere/ocean circulation in the Pacific which occurs every two to seven years. The two man-made phenomena are linked to the increase in certain trace gases in the global atmosphere as a result of human activities which appears to have reached a point where climate change and sea-level rise (the greenhouse effect) as well as increases in ultraviolet radiation (depletion of the ozone layer; the Antarctic ozone hole) are imminent.

El Nino

El Nino is the name commonly used to describe a major disturbance of the atmosphere/ocean circulation over the Pacific (Nicholls, 1987). The name (Spanish for 'the Christ-child') was used by people along the west coast of South America to describe a regular invasion of warm surface water which each Christmas flows south into the north-flowing cold coastal and oceanic currents, which bring nutrient rich water to this region. Once every few years the warm water invasion links up with more warm water flowing eastward in the Pacific and develops into a major disturbance which affects the biological productivity of the ocean off the South American coast. This has a dramatic effect on both the fishing and the guano industry which both rely on the normally abundant supply of fish in that region.

By the late 1960's it was realised that the El Nino phenomenon was part of a much wider disturbance and, in particular, was linked to a relatively regular see-saw in atmospheric pressure between the south-eastern Pacific

and the Indian Ocean, known as the Southern Oscillation. It is by now well-established that the two phenomena are part of one and the same atmospheric/ocean perturbation, which is therefore often referred to as the El Nino/Southern Oscillation (ENSO) phenomenon. (Nicholls, 1987; Wyrtki, 1982).

A full ENSO cycle runs as follows:

- Normally there is an atmospheric high-pressure system located over the eastern Pacific which maintains the trade winds blowing across the Pacific towards a low-pressure system over Indonesia. This induces an ocean current to flow in the same direction, piling up warm water in the western Pacific. The warm water flowing west is replaced by cold sub-surface water welling up off the South American coast.

- Every few years the pattern breaks down. The low-pressure system moves eastward and the high weakens, weakening the trade winds. The warm surface current reverses and warm water flows towards the eastern Pacific. Other changes in the warm surface layer of the ocean prevent the upwelling of cold water near South America reaching the surface.

- After about a year the position of the high and low pressure areas shifts back to normal, the trade winds start to re-establish themselves, and about 15-18 months after the El Nino event started conditions have returned to normal.

The ocean warming is illustrated in Figure 1, a more extensive description of the ENSO phenomenon can be found in Ramage (1986) and Nicholls (1987). The effects on the natural environment of an ENSO event are widespread. Such long-range effects are often referred to as teleconnections. Thus the most severe El Nino on record, the 1982/83 event, has been shown to be linked with drought in Australia (Allan and Heathcote, 1987), and Indonesia (Malingreau, 1987), and heavy rains and flooding in Ecuador and Peru, changes in tropical cyclone activity (Nicholls, 1984), while suggestions have been made that the other climatic anomalies further afield in the USA, India and Africa were also connected with El Nino (Canby, 1984).

One area of impact which deserves special mention in the context of this Meeting is the effect of El Nino on fisheries. The most dramatic impact

occurs off the coast of South America, where the upwelling of cold nutrient-laden ocean water from beneath the thermocline normally supports a rich marine ecosystem (the thermocline separates the warm, mixed layer from the colder, deeper ocean). ENSO events suppress the cold upwelling, and replace it with an upwelling of nutrient-poor water from the bottom of the mixed layer. The sardine fishery in northern Peru is significantly affected by the sardines moving to greater depths and southward from its normal distribution, while the overall numbers decline. Jack mackerel did not enter its normal fishing areas along the Chilean coast, and appeared to have moved further north, while the third major fishery, based on anchoveta, was significantly down for both Peru and Ecuador (Serra B., 1987). There is a further, less well-understood effect of El Nino, in that it has a long-term impact on the fisheries by generating overall changes in the population dynamics: the overall fitness as well as the survival of embryos, larvae and post-larvae may be severely affected.

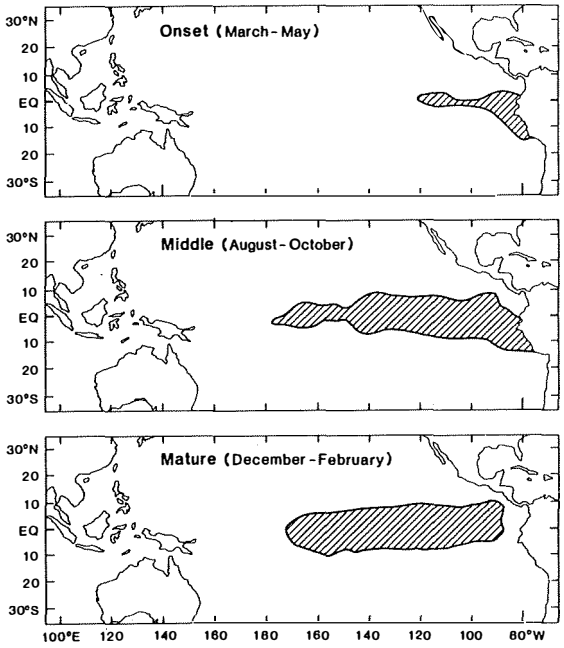

Figure 1. The different phases of an El Nino event, showing the regions of the Pacific where the sea-surface temperature is more than 0.8°C above normal (After Philander, 1983).

While the concomitant changes in the western Pacific (cooler surface waters and a raising of the thermocline) might be expected to influence fisheries there (Tranter, 1984), only little evidence of a significant impact of El Nino has been reported to date (Harris et al., 1987). In this respect it is interesting to note the occurrences of ENSO events in recent times (Table 1), most of which have been linked with significant changes in land-based primary productivity in Australia (Nicholls, 1985a).

With ENSO events having such a widespread impact in and around the Pacific and beyond, there is, of course, great interest in attempts to understand and predict them (Nicholls, 1985b; Enfield, 1987). While the Pacific is now being monitored constantly to detect signs of the onset of El Nino as a warning service of impending disruptions to weather and climate over the Pacific region and beyond, the task of forecasting the events is still incomplete (Kerr, 1986; 1987a).

Table 1. El Nino/Southern Oscillation events
(Compiled by Fu et al., 1986)*

1930	1940	1951	1963	1972	1982
1932(?)	1941	1953	1965	1976	1987
1939	1946	1957	1969		

* Major Australian droughts over the same period were from 1939-1945, 1965-1967, in 1972 and in 1982-1983.

The greenhouse effect

The Earth's atmosphere of oxygen (O_2) and nitrogen (N_2) is transparent to (visible) solar radiation, which warms the Earth. Much of the heat absorbed by the Earth is radiated out again (as infrared radiation) and would be lost to space if it were not absorbed by water vapour and a number of other gases which exist in very small quantities in the atmosphere. Such gases are often referred to as 'trace' gases, and the trapping of outgoing infrared radiation by some of these trace gases is known as the 'greenhouse effect'. This warming effect keeps the temperature of the Earth's surface and lower atmosphere at its present value, but could be altered if the total amount of trace gases in the Earth's atmosphere were to change. The best-known trace gas which contributes to the greenhouse effect is carbon dioxide (CO_2), and

it was suggested years ago that man, by burning fossil fuels and through the cutting down of forests might be adding CO_2 to the atmosphere, and possibly changing the amount of CO_2 present there (see Tucker, 1981).

These suggestions were found to be correct when atmospheric scientists first started to measure the concentration of atmospheric CO_2 in the mid-1950's (Keeling et al., 1982). Since then an ever-increasing amount of research has shown that atmospheric CO_2 is increasing at a rate of 0.4% per year (Pearman, 1982; Figure 2) and an analysis of air trapped in Antarctic ice has shown that the increase in CO_2 was coincident with the onset of the industrial revolution in the mid-nineteenth century (Pearman et al., 1986). Thus we know now that the concentration has increased from about 280 ppm (parts per million) then to 348 ppm today.

Thus, the term 'greenhouse effect' has become a general reference to the warming effect that an increase in carbon dioxide would have on the lower atmosphere by its action of trapping outgoing infrared radiation. In terms of what effect this warming might have on the Earth's weather and climate, scientists usually refer to what would happen if the concentration of CO_2 were to double. The most recent estimates, obtained from calculations using mathematical models of the Earth's general circulation, point towards an average surface warming of 2-4°C, a warming which would have a significant impact on weather and climate.

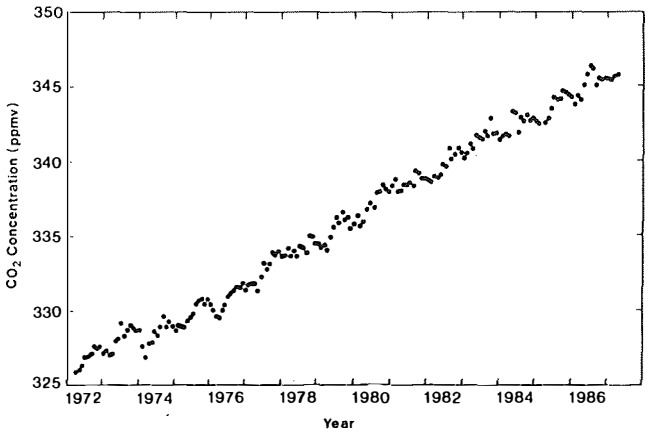

Figure 2. The monthly mean carbon dioxide concentration measured from aircraft flights over south-eastern Australia (Pearman, 1988).

The last few years a number of factors have led to a much greater interest in the greenhouse effect and its possible consequences for our environment. These are (Pittock, 1987):

- A growing consensus amongst scientists that increased infrared absorption by the atmosphere will lead to appreciable surface warming, despite possible feedback effects (Dickenson and Cicerone, 1986).

- The realization that increases in infrared absorbing gases other than CO_2 will cause an 'equivalent doubling' of CO_2 to occur on a much shorter time-scale than due to CO_2 alone (Ramanathan et al., 1985).

- The new evidence from ice cores that pre-industrial levels of CO_2 and some of the other infrared absorbing trace gases (notably methane) were much lower than present concentrations (Pearman et al., 1986).

- A growing realization of the many ways in which the greenhouse warming might impact on human society (Bolin et al., 1986).

- There is some evidence that the global mean surface-air and sea-surface temperatures have risen by about 0.5°C over the last 100 years (Jones et al., 1986) while a rise of the global mean sea level of 10 cm has been suggested for the same period (Bolin et al., 1986; Figure 3).

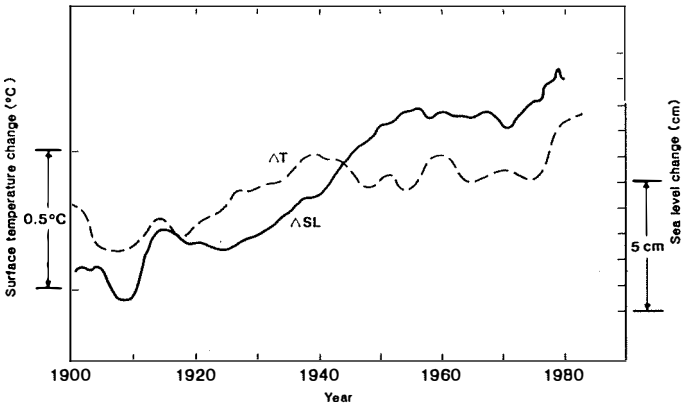

Figure 3. Graph of globally averaged changes in mean sea level (ΔSL) and mean surface temperature (ΔT) since 1900.

In 1985 an international meeting of scientists was convened in Villach, Austria, and considered these points. They agreed that, if present trends continue, the combined effect of all the greenhouse gases (Table 2) would be equivalent to a doubling of CO_2 concentrations as early as the 2030's, with a resulting equilibrium surface warming of between 1.5 and 4.5°C. The scientists also concluded that the warming might lead to a rise in global sea level of 20 to 140 cm, due to thermal expansion of the oceans as surface waters warm up, and due to the melting of land-based ice (Bolin et. al., 1986). Any sea level rise due to a melting of polar ice sheets is not expected for many hundreds of years (Budd, in Pearman, 1988).

Table 2. Current and estimated future levels (2050) of the most significant greenhouse gases (Dickenson and Cicerone, 1986).

Gas	Current level*	Year 2050 level
Carbon dioxide (CO_2)	345 ppmv	400-600 ppmv
Methane (CH_4)	1604 ppbv	2100-4000 ppbv
Nitrous oxide (N_2O)	304 ppbv	350-450 ppbv
CFC-11	0.2 ppbv	0.7-3.0 ppbv
CFC-12	0.4 ppbv	2.0-4.8 ppbv

* ppmv: parts per million by volume; ppbv: parts per billion by volume.

As there are still major uncertainties in the actual temperature changes expected and the time it would take for the changes to take effect; it is impossible at this stage to provide detailed estimates of what climate change is to be expected for Australia and its surrounding oceans.

Some preliminary estimates have been put forward (Pittock, 1987; Pittock, in Pearman, 1988) in order to give an idea of the type of changes to be expected and to enable other scientists, engineers and planners to make a first assessment of the likely impact of any impending climate change. This was the basis for a major national conference, GREENHOUSE 87, held in Melbourne late in 1987. The proceedings contain the assessments of the effect of climate change due to the greenhouse effect on Australia for a wide range of impact areas (Pearman, 1988).

Some of the conclusions relevant to fisheries were:

- The potential warming of 2-4°C in the Australian region could lead to correspondingly higher sea-surface temperatures (SSTs). Details would depend not only on the atmospheric warming, but also on the response of coastal and ocean currents to the warming. The timing of the SST rise would lag significantly behind the atmospheric warming due to the higher thermal capacity of the oceans (Pittock, in Pearman, 1988).

- While higher sea-surface temperatures generally lead to more intense tropical cyclones, and while it is known that if the 27°C SST isotherm moves further south tropical cyclones would move further south too, much would again depend on the response of coastal and ocean currents to the warming (Holland et al., in Pearman, 1988).

- However, any change in sea-level as well as changes in tropical cyclone intensity and frequency would significantly affect the coastal zone, with implications for marine ecosystems and hence fisheries (Titus, 1986; Rothlisberg et al., in Pearman, 1988).

Much research is needed to provide more detailed prognoses of regional climate change, as well as concomitant research on how the global atmosphere/ocean system will respond. Suggestions have been put forward that the Pacific Ocean might be induced into a 'permanent' El Nino mode (Holland et al., in Pearman, 1988), and that climate change might not be gradual at all if the circulation of the deep ocean were to switch from one mode to another, as it apparently has done in the past (Broecker, 1987).

The Antarctic ozone hole

Ozone (O_3) is a gas which is present in very small quantities in the upper atmosphere (the stratosphere), between altitudes of 10 and 50 km. Taken down to sea level all the ozone would form a layer of only a few mm thick. This small amount of ozone screens the Earth from harmful ultraviolet (UV) radiation, and is commonly known as the ozone layer.

The ozone in the stratosphere is in a continual state of flux: it is produced from oxygen (O_2) under the influence of sunlight, and destroyed by reactions involving naturally occurring reactive chemicals in the

stratosphere as well as by sunlight. Most of the ozone is produced over the equatorial regions, and dispersed throughout the stratosphere by atmospheric transport. The ozone accumulates in the lower stratosphere at about 60-70° in both hemispheres.

In the mid-1970's it was first suggested that chlorofluorocarbons (CFCs) when released into the atmosphere, could, upon reaching the stratosphere, degrade under the influence of sunlight and produce chlorine radicals which would contribute to the processes destroying ozone, and thus disturb the natural balance (Molina and Rowland, 1974). Since that time more has been learned about the behaviour and quantities of these CFCs in the global atmosphere, and it is now widely recognised that these man-made substances could indeed lead to a depletion of the Earth's ozone layer. If initial concern was tempered by the fact that no evidence of damage to the ozone layer had been observed, the most recent developments have altered that perspective dramatically:

- Much more is now known about the concentrations and behaviour of CFCs in the atmosphere, and scientists are better able to forecast the impact of current and future releases of CFCs on global ozone (Cunnold et al., 1986, Cicerone, 1987).

- Evidence has emerged of a small decrease in global ozone, a decrease which is not attributable to natural geophysical variability (Kerr, 1988).

- Recently, a dramatic seasonal depletion of ozone over Antarctic (the so-called Antarctic ozone hole) has been recorded (Farman et al., 1985; Bell, 1987; Lindley, 1987).

- It has been established beyond doubt that this Antarctic depletion is due to chemical processes involving atmospheric chlorine (hence CFCs) (Kerr, 1987b; Bell, 1988).

The Antarctic ozone hole appears each year in September/October, at the end of the polar night. Scientists have found that it is due to a combination of the presence of CFCs and the special meteorological conditions which are established during winter over Antarctica.

In winter the air mass over Antarctica becomes isolated from the rest of the southern hemisphere and circles the pole (hence called the polar vortex). In the absence of sunlight, the air in the polar vortex becomes extremely cold, and crystals of ice and inorganic acids form. It appears that the presence of these ice crystals leads to the right chemical environment for rapid depletion of ozone when the spring sunshine returns. At the end of spring the polar vortex breaks up, and the air over Antarctica mixes with the rest of the southern hemisphere stratosphere.

First reported in 1985 from ground based observations (Farman et al., 1985), satellite and ground based measurements trace the ozone hole back to 1979, with the depletion of 1987 the worst on record, having lost more than 50% of ozone in October, when compared with pre-1979 conditions (Figure 4). There are plans afoot to have all developed nations first freeze at 1986 levels and next cut back by 50% their use of CFCs over the next ten years while the use of halons (fire fighting chemicals which give rise to stratospheric chlorine and bromine) is to be frozen at 1986 levels by 1993 (the Montreal Protocol; Johnston, 1987; Bell, 1988).

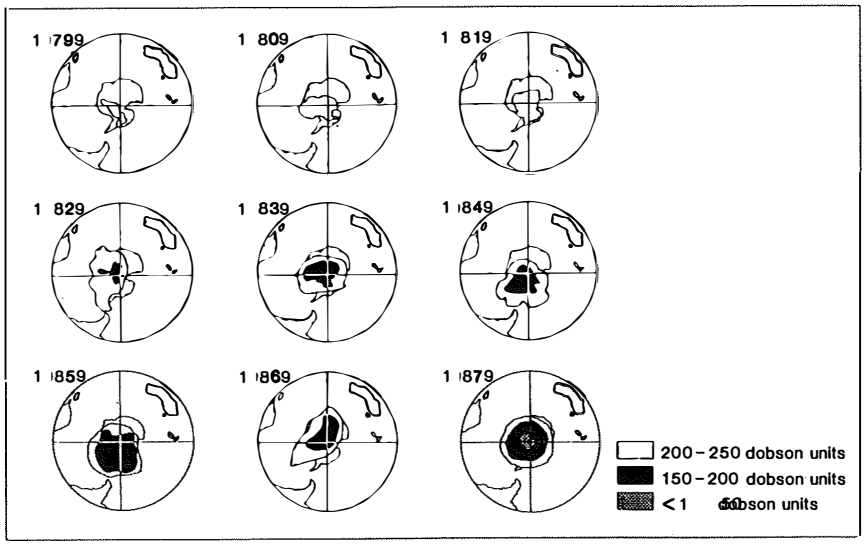

Figure 4. The October ozone concentration over Antarctica from satellite observations from 1979 to 1987. The concentration is given in Dobson units (100 Dobson units = 1 mm of ozone at sea level).

The chemicals covered by the Montreal Protocol, and their uses, are listed in Table 3. Strategies on how to replace these chemicals are not discussed here, see, however, MacKenzie (1987) and Joyce (1988).

While the Protocol is expected to prevent any serious depletion of the global ozone layer, it is not expected to prevent the Antarctic ozone hole from recurring and perhaps even getting worse. As the formation of the hole is linked to the polar vortex, it is expected to remain in the Antarctic region (south of 60°S). However, as a consequence of the ozone-depleted air spreading over the southern hemisphere each year as the polar vortex breaks up, the southern hemisphere may still be affected, and suffer ozone depletion as a result (Kerr, 1988).

Table 3. Ozone depleting substances (CFCs and halons) covered by the Montreal Protocol.

Name	Chemical name	Formula	Uses
CFC-11	trichlorofluoro-methane	CCl_3F	refrigeration, air-conditioning, foam blowing, aerosol propellants
CFC-12	dichlorodifluoro-methane	CCl_2F_2	refrigeration, air-conditioning, foam blowing, aerosol propellants
CFC-113	1,1,2-trichloro-trifluoroethane	$CCl_2F\text{-}CF_3$	electronics industry, drycleaning industry
CFC-114	1,1-dichloro-tetrafluoroethane	$CCl_2F\text{-}CF_3$	aerosol propellant (special applications)
CFC-115	1-monochloro-pentafluoroethane	$CClF_2\text{-}CF_3$	low-temperature refrigeration
halon-1211	dibromochloro-fluoromethane	CBr_2ClF	fire fighting
halon-1301	tribromofluoro-methane	CBr_3F	fire fighting
halon-2402	1,1,2,2-tetrabromo-difluoroethane	$CBr_2F\text{-}CBr_2F$	fire fighting (?)

Of course the reason for concern about ozone depletion is the effect it would have on the natural environment. Over the Australian region, every 1% loss of ozone would mean a 2% increase in UV radiation. Perhaps the impact which speaks most to the imagination would be the rise in skin cancer which is expected if the amount of UV radiation were to increase (Hughes and Beggs, 1986; Emmett, 1986). But a more general, and more significant impact would be on the world's food crops and the marine biosphere. Experiments have shown that most food crops (wheat, rice, corn and soy beans) would have lower productivity under increased UV radiation (Teramura, 1986). The major effect on the marine biosphere would be to phytoplankton and zooplankton, which form the base of the aquatic food chain (Calkins and Thordardottir, 1980), but other marine organisms may also be affected: fish, shrimp and crab larvae are easily damaged by UV radiation (Calkins, 1982; Worrest, 1986). With the very productive Southern Ocean being so close to the Antarctic ozone hole, there is good reason for concern on how the seasonal reduction in ozone, and concomitant increase in UV radiation might affect the marine foodchain. From what is known of how the disruption to this foodchain off South America by El Nino is affecting the fisheries is it not difficult to imagine the consequences of any disruption of the marine ecosystem in the Southern Ocean.

Summary

Three major perturbations of the atmosphere and atmosphere/ocean system have been discussed. The nature of those perturbations (El Nino, the greenhouse effect, and the Antarctic ozone hole) has been explained, and the implications for fisheries have been briefly touched upon. Clearly, with such important ramifications for Australia in general, and for primary industry in particular, the need for more research on understanding the atmosphere/ocean environment and any potential changes to it is urgent.

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POSSIBLE IMPACT OF CLIMATE AND SEALEVEL CHANGE ON COMMERCIAL PRAWN POPULATIONS IN THE GULF OF CARPENTARIA

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Introduction

The fishery

Penaeid prawns are Australia's most important fisheries resource. They form approximately 55% of Australia's crustacean landings, which in turn account for approximately 60% of the total fisheries production, currently valued at $731 million. In the Gulf of Carpentaria nine prawn species are commercially important, three of which represent about 90% of the catch (Somers, 1988). The fishery is divided into a banana prawn fishery and a tiger prawn fishery based on species caught, area fished, season and mode of fishing.

The banana prawn (Penaeus merguiensis) fishery is monospecific and is concentrated in the eastern and southern Gulf of Carpentaria. The fishing season is restricted to a few weeks in April and May and it operates during daylight hours, with large amounts of time spent searching for very dense schools. Over the past five years the catch has averaged approximately 3900 tonnes valued at about $40 million.

In contrast, the tiger prawn fisheries is a multispecies fishery (primarily P. esculentus and P. semisulcatus with smaller amounts of endeavour prawns Metapenaeus endeavouri and M. ensis). The fishing grounds are relatively distinct from the banana prawn grounds, generally in the southern and western Gulf. This fishery operates at night; it begins at the end of the banana prawn season in May; and peaks in August - September. The present status of the tiger prawn fishery is less well understood than the banana prawn fishery because two closely related species are involved and are not differentiated in commercial catch data. However, recent studies in the western Gulf have allowed higher resolution of the fishery logbook information (Somers et al., 1987; Somers, 1987). The tiger prawn catch over the past five years has averaged about 4250 tonnes valued at about $90 million.

Penaeid prawn life history

Penaeid prawns utilize a wide variety of habitats during their life history (Kutkuhn, 1966; Kirkegaard, 1975). While some are holo-marine and others estuarine, most commercial species in the genera Penaeus and Metapenaeus have a marine-estuarine dependency (Gunther, 1980). This involves spawning offshore, a 2 to 3 week planktonic larval phase, followed by settlement of postlarvae in coastal or estuarine nursery ground. After several months in this habitat the juveniles migrate offshore to complete the life cycle. While this is the general scheme there are significant differences between species, for example in adult habitat preferences, reproductive dynamics, larval transport trajectories, postlarval and juvenile nursery ground requirements and emigration cues.

This discussion paper reviews the impact of the Greenhouse effect on commercial prawn populations in the Gulf of Carpentaria. That is, the environmental shifts associated with climate and sea level change and potential impacts on each life history stage of three commercial prawn species (P.merguiensis, P.semisulcatus and P.esculentus). Potential changes considered are a sea level rise of 20 to 140 cm, a temperature increase of 2 to 4°C with a 10 to 20 year lag for ocean temperatures, a rainfall increase in the order of 40 to 50% for monsoonal areas with associated changes in coastal salinity regimes, and changes in frequency and intensity of tropical cyclones (Pittock, 1988). We have used a simplistic approach in which each effect is considered in isolation, ignoring complex ecological processes such as changes in predator/prey relationships and nutrient dynamics. Furthermore, changes in management, fishing methods and marketing strategies due to the Greenhouse effect have been ignored.

Gulf of Carpentaria

The Gulf of Carpentaria (Fig.1) is a large rectangular (approx. 3.7 x 106km^2), shallow (<70m), tropical embayment between 11-17.5°S and 136-142°E (Rothlisberg and Jackson, 1982). Its abiotic environment has been described by Forbes (1984), Jones (1987), Newell (1973), Staples (1983) and Vance et al. (1985). The area has marked seasonality in temperature, salinity, rainfall and wind regimes. Rainfall is restricted to the northwest monsoon in summer (1971-1986 average: 1400mm) with a very dry period during the winter southeast trades. Most seasonal variation in hydrometeorological

conditions is in coastal waters with a seasonal temperature range of 21°C to 31°C and salinity range of 20 to 36$^{0}/_{00}$, largely influenced by evaporation and runoff from coastal rivers. Tidal periodicities and amplitudes in the Gulf are variable with a semi-diurnal tide (3.3 m range) in the northeast; a diurnal tide (5.1 m range) in the south and semi-diurnal tide (0.5 m range) at Groote Eylandt in the northwest (Anon. 1987). Mean sea level varies seasonally by up to 1 m due to annual variations in wind, atmospheric pressure and river runoff (Forbes and Church, 1983). The Gulf circulation is forced by local winds and by sea level fluctuations at all frequencies, including tidal ones, at the two open boundaries, Torres Strait and the Arafura Sea (Webb, 1981; Reinecker, 1979; Church and Forbes, 1981, 1983).

The banana prawn (Penaeus merguiensis)

Penaeus merguiensis has a wide Indo-west Pacific distribution extending east-west from New Caledonia to the Persian Gulf and north-south from southern China to the northern half of Australia (Grey et al., 1983). In the Gulf of Carpentaria the largest commercial abundances are found in discrete areas in the eastern Gulf in Albatross Bay, off Cape Keerweer and east of Mornington Island (Fig. 1). In spite of the tropical latitudes, reproductive output is bimodal with peaks in spring and autumn (Crocos and Kerr, 1983). The relative heights of the two seasonal peaks vary geographically and occur near both extremes of seasonal water temperatures (Rothlisberg and Jackson, 1987). The mean temperature and salinity for P.merguiensis larvae is 29.2°C and 32.3$^{0}/_{00}$, near the upper end of the range of conditions in which they were found (Rothlisberg and Jackson, 1987). The timing and magnitude of larval abundances mirror the peaks in egg production in the southeastern Gulf (Rothlisberg et al., 1985, 1987). However the highest, most consistent, peak in postlarval recruitment to adjacent nursery grounds is in October-November, corresponding to the lower peak in reproductive output (Staples, 1979; Stales and Vance, 1985, 1987; Rothlisberg et al., 1985). This disparity is explained by seasonal differences in larval advection trajectories caused by the interaction between tidally dominated residual currents of the Gulf and diurnal vertical migratory behaviour of the larvae (Rothlisberg et al., 1983).

The timing and magnitude of postlarval immigration varies from one nursery ground to another and from year to year (Staples, 1979; Staples and Vance, 1985, 1987). The nursery ground for P.merguiensis is exclusively estuarine mudflats with a mangrove fringe (Fig.2).

Juvenile prawns stay in the nursery grounds for a few months and start to emigrate with the onset of the rainy season (Staples, 1980, Staples and Vance, 1986). The dynamics are complex with larger prawns leaving the estuary first. As rain and runoff increase the smaller members of the population follow with the total amount of emigration of juvenile prawns directly related to the amount of rainfall. Annual regional rainfall is significantly correlated with annual regional catch in three areas in the southern Gulf: Karumba, Mornington Island and Limmen Bight (Fig.3) (Vance et al., 1985). These three areas account for one half of the Gulf catch. In the northern Gulf the relationship between catch and rainfall is not significant and causal mechanisms are less well understood. Vance et al. (1985) found multiple regressions were significant when seasonal rainfall, temperatures and winds were considered.

Greenhouse scenario - Banana prawn

A 2 to 3°C warming in seawater temperature should have little effect on reproductive seasonality or larval survival. There is no clear indication that either changes in wind regimes or sea level will affect the current regimes which are responsible for larval transport from offshore spawning grounds to estuarine nursery grounds. Over the past 5500 years sea level in the southern Gulf has fall 2.5 m due to isostatic warping (Rhodes, 1980; Chappell et al., 1982). If however, a 1 m rise in sea level was to eventuate this could change the estuaries in the south-east Gulf of Carpentaria. The tidal inundation frequency of the salt flats surrounding the estuaries would be altered from one to two times per year to all winter spring tides and nearly all summer tides. At present in the southeastern Gulf, mangrove swamps occupy 400km^2 but are surrounded by 4000 km^2 of salt flats (Dowling and MacDonald, 1982). With increasing sea levels, the salt flats have the potential to become tidally inundated mangrove swamps. Increased mangrove swamps in turn would probably result in increased yields of banana prawns. Martosubroto and Naamin (1977) demonstrated a positive relationship between

mangrove area and penaeid prawn production in Indonesia, while Staples et al. (1985) also showed that banana prawn catches were related to the extent of mangroves in the Gulf of Carpentaria. In the case of the Gulf, it was felt, however, that the critical factor was the linear length of the creeks and rivers lined by mangroves, not the area per se. On the assumption that increased mangrove area will result in increased creek and river frontage, an increase in mangrove area will result in increased nursery areas and catches. A doubling of mangrove area has the potential to increase fisheries catches by 75%.

While the increased rainfall stated in the scenario is likely to be minimal in the tropics (Pittock, 1988), any increase would again have an attendant affect on river runoff and coastal salinities. A lowering of salinity in the coastal zone in unlikely to affect P.merguiensis larval survival. But any increase in rainfall would increase emigration from nursery areas with a consequent likely increase in catch, at least in the southern Gulf. If rainfall increased 40% there would be the potential for an additional 45% increase in catch above that caused by sea level rises. With uncertainty about localized sea level changes and latitudinal gradients in rainfall, there could be expected a 0 to 60% increase in banana prawn catch overall.

The tiger prawns, Penaeus semisulcatus and P. esculentus

The geographic distributions of the two species of tiger prawns are very different. Penaeus semisulcatus occurs from southeast Africa and the Red Sea through Malaysia and Indonesia to tropical northern Australia and north to Japan and Korea. Further it has colonized the eastern Mediterranean following a lessepian migration through the Suez Canal. In contrast, P.esculentus is endemic to northern Australia (Grey et al., 1983). In the Gulf of Carpentaria the largest concentrations of tiger prawns are from west of Mornington Island, around the Sir Edward Pellew Group, up to north of Groote Eylandt almost to Cape Arnhem (Fig.1). The catches are mixed but P.esculentus dominates south of Groote Eylandt and P.semisulcatus is more predominant in the deeper water north of Groote Eylandt. There is also a small mixed population in the Albatross Bay region.

Table 1. Seagrass habitats of the Gulf of Carpentaria (data from Poiner et al., 1987)

Habitat	Species Composition	Area Covered (km2)	Percent
Shallow intertidal	Halodule uninervis Halophila ovalis	246	28
Sheltered embayment	Enhalus acoroides	33	4
Reef flat	Thalassia hemprichii Cymodocea serrulata Enhalus acoroides Cymodocea rotundata	99	10
Subtidal	Syringodium isoetifolium Cymodocea serrulata Halodule uninervis Halophila spinulosa Halophila ovalis	530	58
Total		908	100

Reproduction of P.semisulcatus is bimodal with the largest peak in autumn (August-September) and a smaller one in January-February; while P.esculentus breeds more continuously (Crocos, 1987a,b). There seems to be little effect of temperature on reproduction as the peaks of activity appear at both extremes of the annual temperature range. Spawning of P.semisulcatus occurs in deeper water (up to 50 m), in the western Gulf, (Crocos, 1987a; Rothlisberg et al., 1987). Mean temperature and salinity at which larvae occurred was 27.9°C and 33.2$^{0}/_{00}$ for P.semisulcatus and 28.4°C and 33.1$^{0}/_{00}$ for P. esculentus; somewhat lower in temperature and higher in salinity than P.merguiensis (Rothlisberg and Jackson, 1987). As for banana prawns only a small portion of tiger prawn egg and larval production seems to contribute to the fishery. Postlarvae and juveniles arrive in nursery grounds in large numbers only after the September spawning (Staples, unpublished data). Postlarvae of both species require seagrass and algal habitats for settlement and/or survival (Fig.2) (Staples et al., 1985). The seagrass, Enhalus acoroides, found in sheltered embayments, supports the highest densities of juvenile tiger prawns (Fig.4). However, it comprises only 4% of the seagrass habitat in the western Gulf (Table 1). The most extensive

habitat is a subtidal community, dominated by Syringodium isoetifolium and Cymodocea serrulata (58%). While not supporting high juvenile densities it is an extremely important habitat because of its extent. After three to four months juveniles move offshore; the cue for this migration is unknown. The adult tiger prawn distribution is associated with both sediment type offshore (Somers, 1987) and proximity to the seagrass nursery areas (Staples et al., 1985).

Table 2. The intensity, maximum wind strengths and impacts on seagrasses of tropical cyclones that have impacted the western Gulf of Carpentaria (1984 - 1987).

Date	Cyclone	Intensity (hPa)	Max. Wind Strength (km/h)	Effect
March, 1984	Kathy	940	280	None
March, 1985	Sandy	953	220	Significant,>2yr
January, 1987	Irma	980	130	None
February, 1987	Jason	970	74	Significant,<6mo

Greenhouse scenario - Tiger prawn

The 2 to 3°C warming in seawater temperatures should have very little effect on the reproductive seasonality or larval survival of either species. While increased rainfall and lowered coastal salinities might have an effect on larval survival, most spawning, of P.semisulcatus in particular, is further offshore and outside the freshwater plumes entrained in coastal jets (Wolanski, unpublished data). Not enough is known about larval transport trajectories of these species to speculate on changes brought about by sea level rise and altered wing regimes. Increased rainfall and resultant runoff could be sufficient to increase turbidity and cause a decrease in available seagrass habitat. Seagrasses could also be affected by sea level rises. We would expect a landward migration with the rise and probably little change in extent, depending on local topography. Some changes in species composition may occur and could be important, given the complex relationships between juvenile densities and individual species of seagrass.

Probably the most dramatic change to tiger prawn populations could be brought about by increased frequency and intensity of cyclones. On average, five cyclones impact the Australian coastline each year with one or two

entering the Gulf of Carpentaria. On-going studies have been monitoring the effects of cyclones on the extensive seagrass communities of the western Gulf of Carpentaria since 1984. Since the onset of investigations four cycles of varying intensities have impacted the study area (Table 2, Fig.5). There is no noticeable relationship between the strength of a cyclone and impact on seagrass beds. Two cyclones (high intensity Kathy and low intensity Irma) had no significant effects on either area or above-ground biomass of seagrass. In contrast, the high intensity Cyclone Sandy and the low intensity Cyclone Jason had significant impact.

Cyclone Sandy neared the coast at the Sir Edward Pellew Group, and unlike many cyclones, travelled parallel to before crossing the coast (Fig.5). The cyclone's 220 km/h winds produced huge seas (12 m swell) and a significant storm surge (Poiner et al. in press). A survey 21 days after the cyclones showed only 18% of seagrass cover remained and above-ground biomass was decreased but appeared to be recovering. A dramatic longer-term effect was found in a second survey, carried out one year later (March, 1986). The impacted beds were completely removed (all 183 km^2) due to scouring of the remaining shallow beds and smothering of deep-water beds by fine mud. Complete destruction of the beds represents an estimated 20% reduction of the entire Gulf of Carpentaria seagrass beds. Associated with this decline was a 30% decrease in the tiger prawn catch for the area.

The low intensity Cyclone Jason decreased the above-ground biomass of a small area (<10 hect) of shallow water seagrass on the west coast of Groote Eylandt (Fig.5) but had no significant effect on the extent of seagrass in the area. Almost total loss of above-ground parts and rhizome burying in deep-water occurred although root systems were left intact and no wash-outs were evident. Regrowth was noted less than three weeks after the cyclone.

The significance of cyclones in the ecology of seagrass systems depends on the frequency of cyclonic events like Cyclone Sandy and recovery time of seagrass communities after such events. The rate of recovery of seagrass communities following cyclone damage on the scale observed for Sandy is unknown but present indications suggest it will be a long-term process over several years. Following Sandy, initial recolonization of seagrass occurred between 1 to 2 years after the event and was restricted to patchy inshore distribution in areas adjacent to the recolonization stock.

An increase in the intensity and frequency of cyclones could have a significant effect on the overall area of seagrass and species composition of beds. If the Greenhouse effect causes the periodicity of severe cyclones to be shorter than the recovery time for seagrass communities then significant decreases in the area of seagrasses with a shift to low biomass intertidal communities may occur. This in turn will lower the amount of high quality tiger prawn nursery ground habitat. Recovery of the seagrasses, impact on juvenile prawns and the subsequent offshore catch is currently being monitored.

Conclusions

Overall, the Greenhouse scenario as presented, could be expected to increase banana prawn catches and decrease tiger prawn catches. Both instances would be caused by environmental changes to nursery ground habitats.

The rise in sea level and the increase in rainfall would increase the size of the banana prawn nursery ground habitat (mangroves) and strengthen the environmental cue for emigration. The magnitude of these additive effects is hard to predict given the localised deviation from the scenario; namely the sea level rise would have to be large to overcome the current sea level drop in the Gulf, and the conflicting predictions of rainfall trends in the tropical latitudes would have to be resolved.

For tiger prawns the most significant impact could be the increased frequency and intensity of cyclones. Here too the magnitude of the impact is difficult to predict. With increased cyclone frequency there is an increased likelihood of cyclones which destroy significant areas of seagrass. This could be coupled to the inability of the nursery ground habitats to regenerate between these events.

Summary

The population sizes, and related commercial catches, of penaeid prawns in northern Australia are dependent on a large number of environmental factors which interact with the prawns' relatively complex life history. Physical factors including currents, tides, rainfall and runoff, affect larval dispersal from the offshore spawning grounds to the nursery grounds. They also affect the immigration and emigration of postlarvae and juveniles to

and from the nursery grounds. Biotic factors such as mangrove extent and seagrass extent, species composition and density will affect the carrying capacity of these nursery grounds, the population size of subsequent stages and hence the ultimate catches. If the Greenhouse effect leads to higher sea levels, higher rainfall and increased cyclone activity we would expect an increase in banana prawn (Penaeus merguiensis) catches and a decrease in tiger prawn (P. esculentus and P. semisulcatus) catches largely due to alterations in nursery grounds. The magnitude of these is hard to predict given the uncertainty of both the localised Greenhouse effects and their direct relationship to prawn populations.

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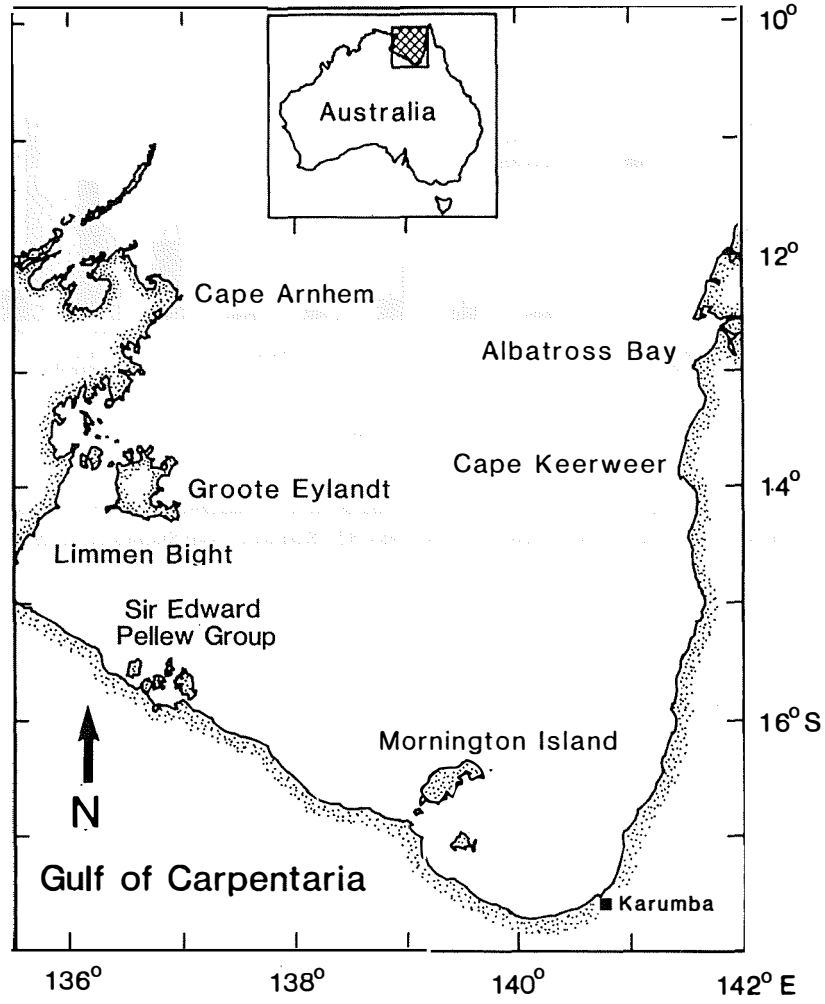

Figure 1. Gulf of Carpentaria, Australia

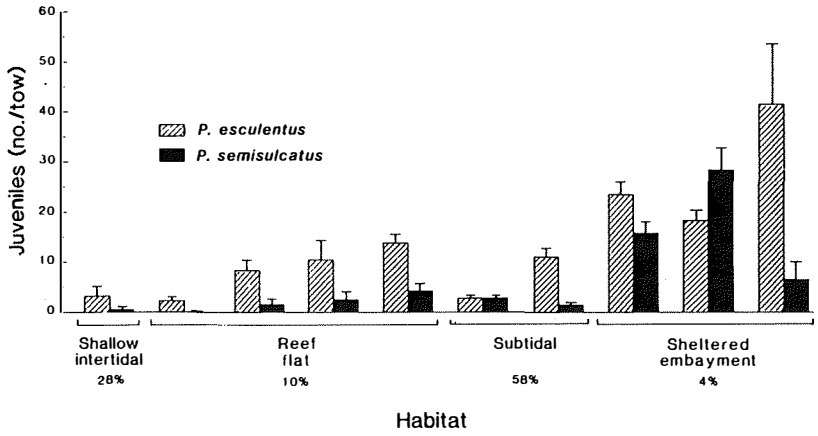

Figure 2. Percentage of juveniles of Penaeus merguiensis, P. semisulcatus and P. esculentus in each of five habitats in the Embley estuary, 1981-82. Redrawn from Staples et al.(1985).

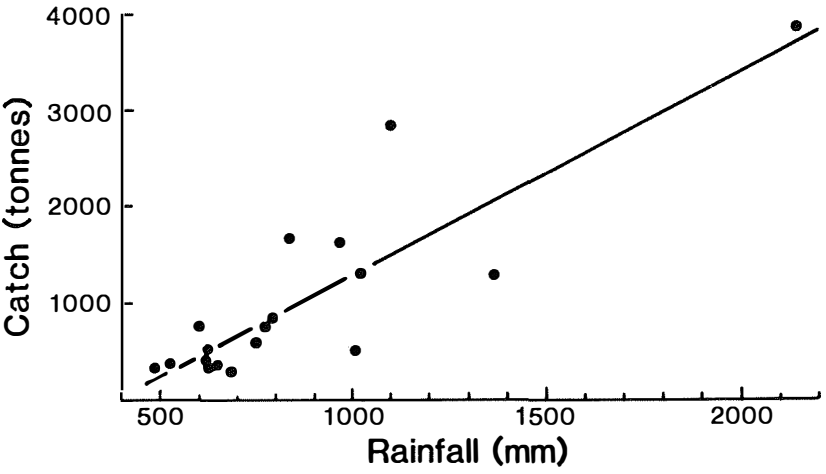

Figure 3. Banana prawn catch (tonnes) and rainfall (mm) for the Karumba Region, southeastern Gulf of Carpentaria.

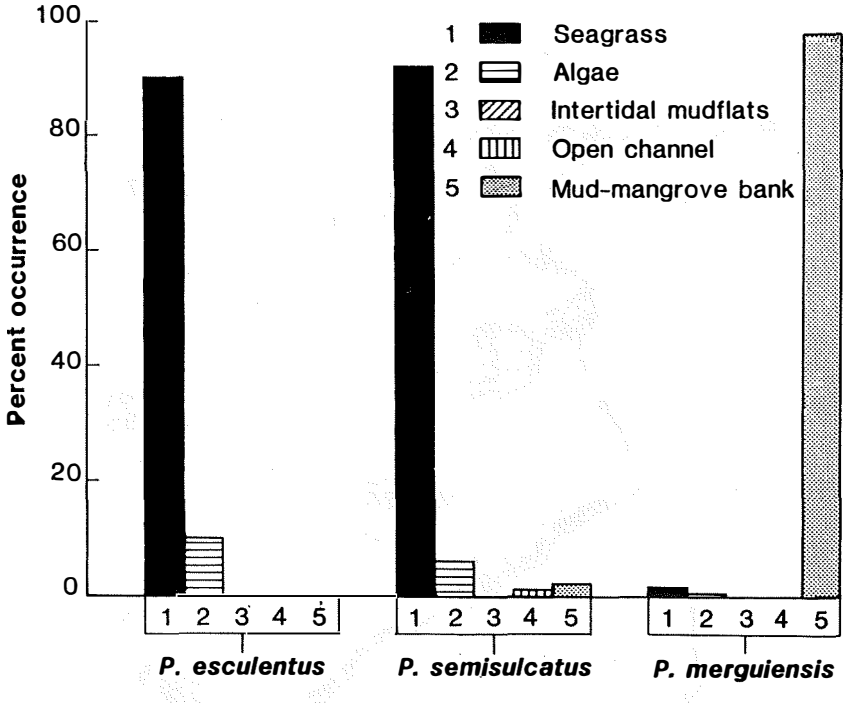

Figure 4. Comparative catch rates of the juveniles of two tiger prawns, Penaeus esculentus and P.semisulcatus in four seagrass habitats around Groote Eylandt. Percentages indicate the proportion of these habitat types over the entire Gulf of Carpentaria. Vertical bars indicate one standard error. See Table 1 for seagrass species composition in each habitat type. Redrawn from Staples (1987).

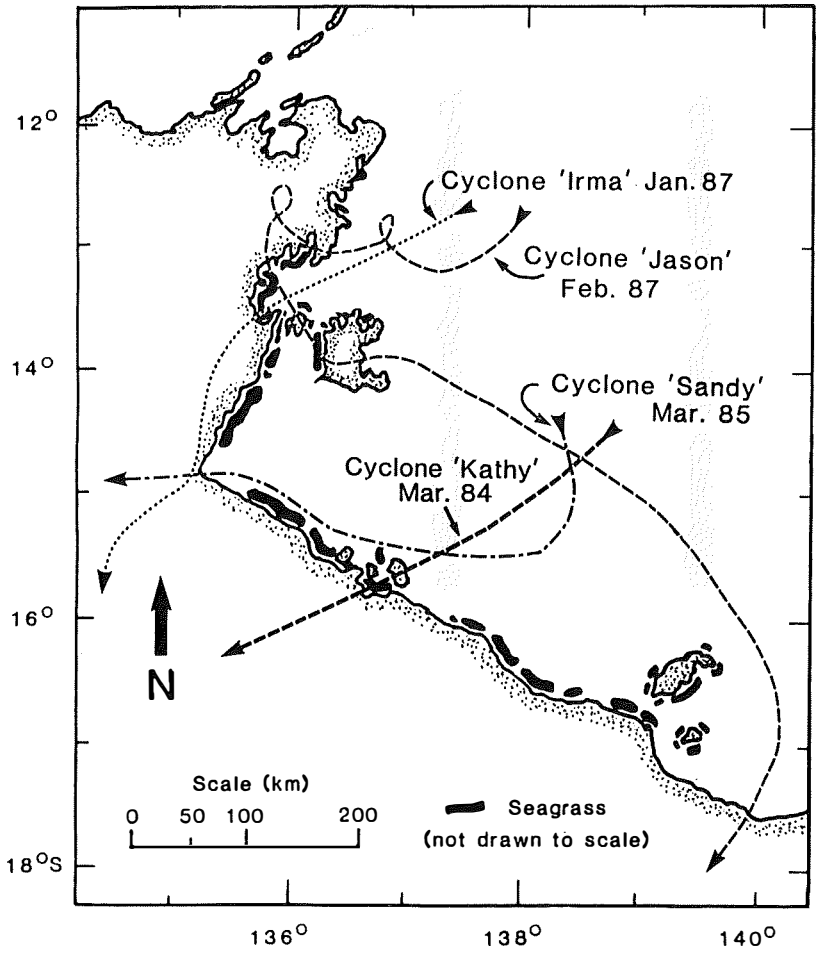

Figure 5. Tracks for the four cyclones in the western Gulf of Carpentaria (1984-1987). Redrawn from Poiner et al. (in press).

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