Understanding the Cultural, Natural Heritage Values & Management Challenges of the Ashmore Region

Abstracts

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UNDERSTANDING THE CULTURAL & NATURAL HERITAGE VALUES & MANAGEMENT CHALLENGES OF THE ASHMORE REGION.

Convenor. Dr. Barry Russell,

Museum & Art Gallery of the Northern Territory

Sponsored by: Environment Australia, Museum & Art Gallery of the Northern Territory & the Australian Marine Sciences Association NT Branch.

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MARINE CONSERVATION & THE TRADITIONAL FISHERMEN IN INDONESIA

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Awaiting abstract

BALANCING THE CULTURAL AND NATURAL HERITAGE VALUES OF THE ASHMORE REGION

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Indonesian fishers have been harvesting marine resources along the northern coast of Australia for at least three centuries. Historical evidence suggests that the Bajua people were the first Indonesian fishermen to sail beyond Timor to Ashmore Reef and further to the coast of Australia. Indonesian fishermen continue to be very active in the region.

Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve lie within an area subject to a Memorandum of Understanding (MOU) signed between Indonesia and Australia in 1974 and reviewed in 1989. The MOU provides for continued Indonesian traditional fishing activities in an area known as the MOU74 Box.

While traditional Indonesian fishers have an historic and ongoing association with islands and reefs in the region and traditional fishing rights are incorporated into the MOU, Indonesia and Australia now face a common problem. Over the past two decades Indonesian fishing pressure in the region has increased significantly and recent studies indicate that unsustainable and illegal fishing practices are threatening marine biodiversity and population density. Additionally, the unchecked harvesting impacts negatively on traditional Indonesian fishing livelihoods.

Indonesian and Australian authorities today realise that the overexploitation of the marine resources in the MOU74 box is a shared problem which will only be resolved through a partnership approach. Resolution of the problem must take into account socio-economic needs of Indonesian fishers, development of sustainable traditional Indonesian fisheries and protection of the unique biodiversity of the Ashmore region. It is agreed that the development of alternative livelihoods such as aquaculture for traditional Indonesian fishers is critical.

With a pro active and collaborative approach from the Indonesian Ministry of Marine Affairs and Fisheries and Environment Australia developing and a desire to involve provincial and district governments as well as traditional fishing communities the opportunities for achieving common goals in the Ashmore region are promising.

ARCHAEOLOGY, MATERIAL CULTURE & A HISTORY OF VISITATION; EXAMPLES FROM ASHMORE & BROWSE ISLAND.

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The purpose of this paper is to contribute towards an understanding of the cultural heritage that exists in what one commentator has recently called Australia's the last frontier.

This maritime zone which lies at the edge of the Australian continental shelf on the boarder with Indonesia, includes an Australian external territory, a national nature reserve, a marine reserve and a significant oil and gas reserve. It is also subject to an international agreement regarding access to traditional fishing grounds.

This paper will discuss some of the historical sources, the archaeological evidence and the material culture currently available and provide direction for further research in the area of maritime resource use and a history of visitation.

WHO ARE THE 'TRADITIONAL' FISHERS OF THE MOU? A PRELIMINARY ANALYSIS OF SOME DATA COLLECTED AT ASHMORE REEF.

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In 1974 the Australian Government signed an agreement with the Government of the Republic Indonesian. The agreement, titled Memorandum of Understanding between the Government of Australia and the Government of the Republic of Indonesia regarding the operations of Indonesian traditional fisherman in area of the Australian exclusive fishing Zone and continental shelf. This historic document, which subsequently become known as the MOU has been described by some commentators as an act of compensation or a good will gesture on the part of the Australian authorities. Regardless of the political perspective one may have in regard to the MOU, it is interesting to note that it is one of the earliest official documents in the Australian context, which recognised traditional rights of access. The MOU was agreed to two years before *The Northern Territory Land Rights Act* was passed 1976 and ten years before the *Torres Strait Fisheries Act* in 1984.

Essentially the MOU does three things. Firstly it allows access to a defined area in the AFZ. Secondly it defines the type of access, i.e. 'by methods which have been the tradition over decades of time' and thirdly it defines who is allowed access, i.e. 'traditional fisherman' that is fishermen who have traditionally taken fish and sedentary organisms in Australian waters.

It is this last category, 'traditional fisherman' which is the focus of this paper. Since the mid 1980's the Australian National Parks and Wildlife Service, now known as Environment Australia has collected data on Indonesian fishing boat arrival at Ashmore Reef. This paper presents a preliminary evaluation of the data collected and its usefulness in answering the question 'who are the traditional fishers of the MOU'.

ASHMORE REEF & ITS PLACE IN INDONESIAN VOYAGING

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During research on Indonesian contact in the Kimberley region, I spent 5 days on perahus at Ashmore Reef in 1968, and subsequently visited the island of Ra'as in 1974. As a result of that experience, I was able to advise the Australian government on the development of the MoU which sought to protect traditional fishing in the off-shore region. I will argue that the intention of the MoU has been progressively eroded, that the provisions of the International Law of the Sea are being ignored, and that the repercussions of administrative actions, while unknown in detail, may be catastrophic in human terms. I call for professional anthropological assessments of these repercussions, and professional anthropological involvement in any future changes which may affect Indonesian usage of Ashmore, and the creation of a management structure which ensures that thieves of traditional fishermen are heard.

MANAGEMENT ARRANGEMENTS FOR THE ASHMORE REEF NATURE RESERVE & CARTIER ISLAND MARINE RESERVE .

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Ashmore Reef National Nature Reserve and Cartier Island Marine Reserve were declared in August 1983 and June 2000 respectively. Both have been identified as areas with high biodiversity values and are significantly threatened by overfishing, illegal fishing and illegal immigration.

Since the declaration of Ashmore Reef NNR there have been some crucial achievements in the management of this remote location. Environment Australia (EA) has chartered a vessel and crew to undertake on-site management since the late 1980's. This action proved highly effective in reducing illegal fishing effort and improving the protection of wildlife including sea birds, turtles and dugong. The result is that this reef is in significantly better ecological condition than others in the region. EA has encouraged and supported research on listed species including turtles, dugong, sea snakes, sea birds and migratory birds. Recently research has also included: coral health and distribution, and population surveys of the species targeted by traditional fishers. Since May 2000 the Australian Customs Service have provided increased on-site management services for EA.

A new Management Plan (the first for Cartier Island MR and second for Ashmore Reef NNR) has been released for public comment. Once accepted the new Management Plan will establish the management regime for these Reserves over the next 7 years. Overall the management proposed for Ashmore Reef NNR will be similar to that already in place. It is proposed a similar regime be set in place for managing Cartier Island MR. New directions include a move to greater consideration of the wider region and recognition of the need to be more involved in the compelling issues associated with traditional Indonesian fishing. A performance assessment framework to provide a basis for future research and to establish a basis for assessing management performance is proposed. Future management will see EA continue to work closely with other government agencies operating in the area, to provide a more consistent whole-of-government approach.

This paper will overview achievements at Ashmore Reef since 1983 and the recently released draft Management Plan.

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While Indonesian fishing activity in North Australian waters is an issue of continuing concern in both the management of resources and the policing of national boundaries the issues involved are poorly understood. Outlined here are the beginnings of Australian interest in, and claim to sovereignty over the area, together with an overview of the changing nature of Australian control. Records of the origins of Indonesian activity at Ashmore, and observations of recent Indonesian fishing enterprise in the area, will also be examined. Illegal actions, such as motorised poaching, and the crewing of vessels delivering refugees to areas where the fishers have recently been denied reasonable access, are seen as the desperate and almost unavoidable responses to the changing Australian regulations.

SEDIMENT CHARACTERISTICS OF ASHMORE REEF.

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Positioned at the transition zone of the Browse and Bonaparte Basins this reef experiences the seasonal oceanic influences of Indian Ocean upwelling and the Indonesian Through Flow. Presently, this tropical carbonate platform is characterised by high biotic diversity and extensive coral growth, broad sediment productive windward reef flats and three vegetated cays. Additionally, an extensive series of highly mobile and heavily bioturbated intertidal / sub-tidal sand sheets adjoin two lagoons within an pronounced ovoid reef rim. Major bioturbators include annelids, bivalves, Callianasssa shrimps, echinoderms, holothurians, dugongs, stingrays and turtles. The skeletal carbonate bioclasts of the sand sheet sediments are principally comprised of Halimeda sp, coral fragments, foraminiferids, molluscs, a range of coralline algae and echinoid spines. The cays are capped by thin, sub-economic deposits of guano; on East Island a soil profile also is evident. West and Middle Islands have skirts of beach rock, East Island is without beach rock and is markedly mobile. Coralline and igneous ballast rocks have been found in the islands swash zone and wash-over deposits of pumice, timber, shell and coral are found up to 10m behind the ~2m fore dune, on all three islands.

Variation in sediment texture around the islands indicates the presence of a hydrological sorting regime. Two distinct sand fractions are found, one a fine-grained lagoonal sand and the other, a coarse swash zone sand. The finer fraction contains aragonite from Halimeda that has broken down into needles, while the coarse fraction has lesser aragonite but is higher in calcite derived mainly from the robust foraminiferid, Calcarinidae Shlumbergerlla floresiana, and to a lesser extent from Marginopora vertebralis. Xray defraction analysis indicates that the lagoonal sands are approximately~75% aragonite and 25% calcite and the swash zone sediments are approximately~75% calcite and 25% aragonite.

The sediment contains a range of unrelated foraminiferal groups with strong morphological similarities. Robust benthic populations of rotalids Baculogypsina sphaerulata and Amphistegina sp., with calcarinids, Marginopora vertebralis and planktics Globigerinoides ruber, Globorotalia cultrata and Neogloboquadrina sp are all found on the reef flat within 1km of the northern margin of the reef. The asexual megalospheric Calcarinidae Shlumbergerella floresiana is most abundant in the intertidal sand sheets.

WATER PROPERTIES & PROFILES OF ASHMORE REEF, NW SHELF AUSTRALIA.

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This study reports on the water properties of temp and salinity of the lagoon and well water from Ashmore Reef, NW Shelf Australia. This marine protected area has three vegetated cays with fresh water lenses, two lagoons separated by a calcareous algal rise with two entrances each on the northern side of the reef (Figure #1). This region is subject to a 4.75m semi-diurnal tide and the evaporation potential is twice that of the precipitation. On a spring tide ~0.52km^3 of water is introduced onto the 152 km^2 reef whereas at neap tides the value is ~0.033 km^3 . A Yeo-kal multi-probe measuring Conductivity Temperature & Depth (CTD) deployed at 16 sites over the reef showed a temperature range from 19?C - 35.4 ?C

CTD profiles measured within the lagoon in November 2000 showed that the water column was generally well mixed with a temperature gradient from ~31?C at the surface to 29?C at 16.5m. Salinity ranged by <0.2 ‰. There were some noticeable exceptions with strong temperature stratification with hotter more saline bottom waters, temperature values ranged from 19 to 35.4 ?C . This stratification is believed to result from evaporation within the lagoon and particularly the shallow intertidal sand flats. This evaporation increases the water density and the shallow environment readily allows an increase in water temperature. The hot dense water has been noted in the shallow intertidal environments, it flows underneath the other lagoonal water and out the conduits to the open ocean. These conduits include the four main entrances to the lagoons and numerous channels across the reef flat.

The water in the well located in the middle of West Island was sampled in October 2000. The 49 samples averaged values of a pH of 7.64, temperature of 28 ?C. Dissolved Oxygen % saturation was at 51 %. Salinity of the well water is 3.94‰ or 3.94 grams per litre.

PHYSIOGRAPHY & CLIMATIC INFLUENCES AT ASHMORE REEF, NW SHELF AUSTRALIA.

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Ashmore Reef is an ovoid, shelf edge, platform reef located on the north west shelf of Australia (12? 20' S, 123? 00' E) at the north-western boundary of the Browse and Bonaparte basins. Founded on antecedent topography it is the largest emergent reef (>150 km2) with the highest biodiversity in the region. Geomorphological expressions of the carbonate platform include three vegetated cays with a fresh water lens and beach rock, two lagoons separated by an calcareous algal rise, extensive lineated reef flats, large scale inter-tidal and sub-tidal sand flats. Sedimentological analysis shows that the modern sand formations are primarily halimeda, foraminifera and mollusc fragments.

The reef is subject to a 4.75 m semi-diurnal tide and lagoonal water temperatures range between 19 and 35.4?C. The climate is tropical monsoonal, and warm/hot, with the annual mean temperature at 28.50C. Regional data indicates that rainfall exceeds 950 mm, evaporation potential is 1820 mm. Dominant SW trade winds assist Indian Ocean upwelling for most of the year and the reef is seasonally influenced by the southward moving Indonesian Though Flow. Thunderstorms occur on ~ 85 days in the wet season and regionally experiences 7% of the global annual total of cyclones.

ASHMORE REEF'S GEOLOGICAL DEVELOPMENT DURING THE HOLOCENE, NW SHELF AUSTRALIA.

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This initial study investigates the geological development over the past 11 thousand years of the Ashmore reef platform. Founded on what is thought to be Pleistocene antecedent topography this ovoid, shelf-edge reef is located in the transition zone between the major hydrocarbon provinces of the Browse and Bonaparte basins.

C14 dating was used to identify the recent changes in the lagoonal facies. A series of 8 algal-foraminiferal sand and coral (in life position) samples from vibro-cores across the heavily bioturbated platform yielded dates ranging from 970 to 2020.

A reef growth evolutionary model is presented using models derived from the Great Barrier Reef, with vertical reef growth indicating transgressive sea level (SL) phases, lateral growth representing SL still stands, an evolutionary model for the reef growth is presented. An initial vertical growth phase took place at ~8 – 6ka, with sub tidal reef growth inheriting the antecedent topography. At ~6- 4ka the reef underwent a transitional growth phase during which time reef growth began to catch up to the slower rising SL. Coral debris and calcareous algal from the intertidal zone is found deposited in the leeward side of the windward edge, where the reef growth enters the energetic intertidal zone. From ~4ka to present is the lateral extension phase. The C14 dates infer a change from coral to sand deposition 1.7 – 2 thousand years ago soon after SL stabilised. As sediment production on the reef flats became more extensive, Halimeda/foraminiferal sands became the major depositional component in the lagoon, with infill rates ranging from 0.73 to 0.3 cmy^{-1}. The high energy of the reef front is identified by 100's of coralline blocks, several up to 90 m^3 located on the northern reef flat 90 m from the reef front. Back reef deposition is prominent on the windward (southern) side of the reef. Here, three vegetated cays have formed, all have a fresh water lens which has inturn allowed the formation of a prominent beach rock apron on both West and Middle Island. East Island has no extensive exposure of beach rock and consequently is the most mobile. A photographic record from 1963 and maps from 1958 allow the tracking of the recent morphological changes to the islands. Wash over deposits on the three vegetated cays include coral cobbles, pumice gravel / cobbles along with plant material and plastic anthropogenic waste. Geochemical analysis of the igneous wash over material indicates a Sunda Arc origin. The three islands have been a major resting/nesting place for a range of migratory birds for centuries. On West Island, the resulting guano deposits formed an economic resource which was mined, this resource along with the calcium carbonate sands were again identified as potentially economic in the 1950's.

ESTIMATES OF THE SIZE & COMPOSITION OF SEA SNAKE POPULATIONS AT ASHMORE REEF, EASTERN INDIAN OCEAN.

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Population estimates and ecology of sea snakes (Hydrophiidae) inhabiting Ashmore Reef National Nature Reserve, Eastern Indian Ocean, were investigated from 1994 to 1999. Research was conducted in September and October each year. The surveys concentrated on the species that utilised the extensive reef flat. Of the 16 species of sea snake recorded from Ashmore Reef, the most prominent in this study were: *Emydocephalus annulatus*, *Aipysurus laevis*, *A. foliosquama*, *A. apraefrontalis* and *A. fuscus*. Opportunistic observations were made on other near shore species including *Acalyptophis peronii* and *Hydrophis coggeri* and *Astrotia stokesii*. Seven transects of variable length but known width, were used in estimating the population density of 228 snakes per square kilometre of reef flat at high water at that time of the year. Mark and recapture studies of *E. annulatus*, indicated that approximately 90 individuals utilised a coral patch approximately 15 m in diameter. An association between species and substrate appeared stronger than species and water depth for the inshore species. The sea snake assemblage at Ashore Reef is characterised by a large number of species, including three endemics, and large population sizes.

CONSIDERING ASHMORE REEF WITHIN A BIO-REGIONAL CONTEXT : INSIGHTS FROM RECENT AIMS RESEARCH & OPPORTUNITIES FOR THE FUTURE

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The Australian Institute of Marine Science has sustained research into a broad range of marine ecosystems between Exmouth and Darwin since 1993. During this period a significant area of focus has been the Ocean Shoals Bioregion (see IMCRA, 1997), which includes the Ashmore Reef area. Multiyear oceanographic and biological data sets have been collected from emergent reef systems such as the Rowley Shoals and Scott Reef, while additional research has focussed on shelf and shelf-break physical oceanography and biological surveys of numerous submerged shoals on the Sahul Shelf (eg, Heyward et al, 1997).

This research suggests that very significant coral reef type communities occur throughout the bioregion. Furthermore, consideration of recent work including surveys by AIMS, AGSO, CSIRO and the petroleum industry prompts our hypothesis that the emergent reef habitats in this bioregion surveyed by scientific divers, while of great importance, may not be the most significant areas of biodiversity and biomass accumulation. Aspects of AIMS biological and oceanographic data will be presented to elucidate the key facets of this hypothesis

AIMS has the capacity to further explore the biodiversity of this region and will be deploying a research vessel into the northwest again on a regular basis. AIMS scientists in the biological and oceanographic disciplines are developing proposals, both internally and with collaborating agencies and industry stakeholders such as Woodside Energy P/L, to lead a multidisciplinary research effort into exploration and conservation of biodiversity in the oceanic shoals bioregion. This workshop provides an excellent opportunity to further refine the research priorities and future collaborations for research into this bioregion.

TERRESTRIAL REPTILES OF ASHMORE REEF NATIONAL NATURE RESERVE

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Located in the Indian Ocean, 840 kilometres west of Darwin, Ashmore Reef National Nature Reserve (ARNR) is renowned for supporting large populations of marine reptiles (sea snakes and turtles). Protecting about 239 square kilometres of reef platform, the Reserve also includes three small islands with a combined surface area of about 112 hectares. This report presents results of a field survey, conducted late in the wet season (11-17 March) of 2001, aimed at determining species present and relative abundance of terrestrial reptiles on the islands of ARNR. Anecdotal reports have suggested that at least two lizard species occur in the Reserve, however, survey results indicate that only the Asian House Gecko *Hemidactylus frenatus* is present. *Hemidactylus frenatus* was recorded only on West Island, where it was locally abundant. It is postulated that the apparent depauperate lizard fauna of ARNR is due to an abundance of diurnal avian predators, rather than a lack of opportunities for colonization.

REPRODUCTIVE ECOLOGY & REVEGETATION OF *ARGUSIA ARGENTEA* ON ASHMORE REEF.

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The dominant shrub species on Ashmore's islands is *Argusia argentea*. Argusia typically grows as a shoreline fringing species and is highly adapted to the environmental conditions experienced in these habitats.

Little is known about *Argusia argentea* despite its importance to the ecology and stability of Ashmore Reef and islands throughout the Pacific and Indian Oceans. On Ashmore, Argusia is an important resource for nesting sea birds and turtles. In recent years, it appears that little or no recruitment of Argusia has occurred, and the species may be declining. To understand the reasons for this possible decline research focused on the ecological and environmental processes that affect Argusia recruitment, and determining the most effective methods of re-establishment.

Research found that Argusia maintains an extensive but low-germinability seed bank, with seedling recruitment also restricted by the environment. Seedling recruitment on West Island is minimal, though asexual recruitment is common in the inland regions of the island. No seedling recruitment was occurring on the other islands.

The primary factor in the successful propagation of Argusia from seed for re-establishment projects is the age of the fruit. Seed age has not previously been shown to be important in germination of Argusia, and the same can be said of asexual reproduction, despite its importance to recruitment in the interior of West Island.

Successfully establishing potted seedlings on West Island during trials shows that restoration of Argusia populations is possible. Middle and East Islands may require extensive revegetation, but the high impact of nesting birds on seedling recruitment remains a problem area requiring further research. The only successful method available to re-establish Argusia on Ashmore is via potted seedlings; with direct seeding trials still needed to test the recently acquired information on seed age. The knowledge gained through this research hopefully is sufficient to achieve successful revegetation on Ashmore's islands.

SUB-SEAFLOOR GEOLOGY, NATURAL HYDROCARBON SEEPAGE & EUSTATIC SEA LEVEL VARIATIONS AS KEY DETERMINERS OF CARBONATE BANK & REEF DEVELOPMENT ON THE ASHMORE PLATFORM, TIMOR SEA, AUSTRALIA.

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The Ashmore Platform-Timor Sea region of Australia's North-West Shelf is an area of significant petroleum exploration potential, with several large commercial oil fields present. Moreover, exploration activity seems likely to continue at current levels for the foreseeable future, and also extend into deeper water, driven by a combination of high oil prices and improved drilling technologies. The area is also one of high conservation value, with both the Cartier Marine Reserve and Ashmore Reef (a Category '1' marine park), as well as numerous other genetically rich carbonate "seed" bank systems, closely associated spatially with exploration activities. Balancing the conservation and resource values in this area will present a key challenge into the future.

The magnitude of this challenge has been highlighted by recent work by AGSO, which involved the acquisition and interpretation of assorted remote sensing data, such as high-resolution bathymetry (including side-scan sonar), satellite synthetic aperture radar (SAR), Landsat, water column geochemical sniffer, airborne laser fluorosensor, seismic data and sediment sampling. These studies have shown that at both a regional and local scale, the development of these important carbonate systems is directly related to the geological development of the area.

At a regional scale, the collision between the Australian and Eurasian crustal plates in the Pliocene (<5 MaBP) induced the formation of the Timor Trough. The rapid subsidence associated with the formation of the trough provided a range of ideal habitats within which rapidly growing carbonate communities could effectively "out-compete" other types of sediment deposition/accumulation processes on the continental shelf. Moreover, this trough focussed the location of (what would

become) the Indonesian Through Flow (ITF). The conjunction of the ITF with the Indian Ocean ultimately provided a range of diverse genetic opportunities which were fed by significant nutrient upwelling, a situation which reinforced the favourable growth scenario created by the rapid subsidence. As a result of these processes, reefal growth in the Timor Sea took place almost exclusively over the last 5 million years, with most occurring over the last three million years or so.

At a local scale, new data also strongly suggest that the majority of reefs and carbonate banks and build-ups in the area are associated both spatially and causally with active and palaeo-hydrocarbon seeps. These seeps are localised over either fault systems which tap the reservoir, along migration fairways, or at the pinch-out of the regional Cretaceous top seal. The data suggest that the reefs and the build-ups formed via a sequential process. Firstly, hydrocarbon seepage (induced by collision-related faulting) localised small seafloor (chemo-lithotrophic) biological carbonate communities, which ultimately formed topographically positive features. These higher relief features were subsequently preferentially colonised by an assortment of reef building biota, whose rapid growth progressively kept up with rising sea level (which was driven principally by collision related subsidence). It is probable that initial reef colonisation occurred preferentially during periods of relatively low sea level, when the areas around the reefs were located at much shallower water depths (<40m) than today.

Clearly, the fact that the genetically rich carbonate communities in this area are probably causally related to natural hydrocarbon seepage (and the attendant processes which drove that seepage) will present a series of almost unique exploration, development (especially engineering) and conservation challenges.

UNCERTAINTY & GIS:
A FLEXIBLE MANAGEMENT TOOL FOR THE ASHMORE REGION

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The Darwin Aquaculture Centre (a Division of the Department of Primary Industry and Fisheries of the NT) commissioned the Darwin office of AIRESEARCH Mapping Pty Ltd to create an Aquaculture GIS of the Tiwi Islands. The project, articulated around a GIS multicriteria decision making methodology developed in ArcView (a popular, low cost, readily available commercial software) demonstrates a strategy which has great potential in many domains of environmental management.

This multicriteria decision making tool incorporates fuzzy logic to accommodate often loosely defined processes which are not deterministic nor probabilistic. These models, formulated in linguistic terms, are well suited to the uncertain world of "soft sciences". The influence of the selected criteria on the model output (generally maps of suitability) can easily be "tuned" to changing conditions by altering their weightings. The semi automatic evaluation of these weightings is achieved by pairwise comparison spreadsheets which eliminate all tedious calculations.

The potential offered by this GIS modeling framework is demonstrated in the context of the Ashmore Region. This simple prototype identifies, around Ashmore Reef, the area(s) most vulnerable to illegal fishing based on three criteria:

- vulnerability to trochus fishermen
- vulnerability to trepang fishermen
- distance to anchorage (where authorities are based)

The weightings of the first two criteria are inferred from the estimated market value of trochus and trepang. As the market value of these commodities fluctuates, so do the weightings of the corresponding criteria and, ultimately, the location and extent of targetted fishing grounds displayed on the output maps.

The number of criteria in this prototype is deliberately limited to three as the purpose is merely to demonstrate the mechanisms of this visual decision support strategy.

FISHES OF REEFS OF THE SAHUL SHELF

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This paper reviews the fishes of Ashmore, Cartier and Hibernia Reefs, based on published records and on field collecting undertaken by the Museum and Art Gallery of the Northern Territory and the Western Australian Museum since 1983. A total of 932 species from 91 families is recorded from the Sahul Shelf reefs, including 756 species (81.1% of total) from Ashmore Reef, 411 species (44.3% of total) from Cartier Reef and 351 (37.9% of total) from Hibernia Reef. The differences in species richness between the reefs is due mainly to the much greater sampling effort at Ashmore Reef compared with Cartier and Hibernia Reefs, and further collecting effort at the latter localities will undoubtedly reveal more species. Compared with other northwestern Australian reefs, Ashmore Reef has the greatest diversity of marine fishes. Ashmore Reef's location near the Indonesian archipelago – which has the world's most diverse fish fauna – is probably responsible for this high diversity. The atolls and reefs to the south (Seringapatam Reef, Scott Reef, and Rowley Shoals) have progressively fewer species. Ashmore Reef's outer reef slope fishes are noticeably distinct from those inhabiting the Scott/Seringapatam Reefs and Rowley Shoals complex. However the lagoonal fauna of Ashmore Reef is more closely related to that of Scott/Seringapatam Reef than to the Rowley Shoals. Habitat differences between the three areas most likely contribute to these discrepancies.

THE MARINE RESOURCES OF THE REEFS & SHOALS OF THE MOU74 BOX.

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We surveyed the fishery resources of the shallow reefs (0–15 m deep) and shoals (15–50 m deep) in a 60,000 km^2 area off the Australian northwestern coast during September and October 1998. The study area contained seven shallow reef systems, including Ashmore and Scott reefs, totaling 560 km^2, and 1226 km^2 of shoals. On the shallow reefs, marine resources were quantified using diver transect surveys and visual censuses (finfish and shark). On the shoals, we used video camera transects and acoustics. GIS was used for designing efficient stratified sample strategies, for data analysis and reporting. Using data from the survey, we produced stock size estimates of the marine resources of the shallow reefs and shoals, including commercial holothurians, trochus, finfish and shark. By comparing these estimates to known catch and effort data, and to the density of these species on like reefs in Torres Strait and the northern GBR, we were able to assess stock status. Overall, the sedentary marine living resources on the shallow reefs were heavily depleted with the high-value species over-exploited and the lower value species probably either fully or over-exploited. The exception is Ashmore Reef, where there were significant populations of most target species. However, even here there is clear evidence of exploitation of at least the high-value resources.

RECENT CORAL MORTALITY ON THE REEFS OF THE MOU74 BOX.

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In 1998, there was a substantial mortality of hard corals on most of the shallow reefs of the MOU74 Box off the northwestern Australian coastline, with up to 76% mortality on the large southern reefs, Scott and Seringapatam. In contrast, Ashmore Reef, and Browse and Cartier Islands had low or no coral mortality (0–5%). Hibernia Reef was intermediate (15%). We estimate that there were 2290 ha (+/- 14%, 95% CI) of live hard coral, and 2570 ha (+/- 13.5%, 95% CI) of recently dead coral on the shallow reefs in the study area (down to 15 m depth); an overall mortality rate of almost 53%. The level of mortality was not the same for all corals in the study area: over 83% of branching coral, but only 22% of massive corals had died. The highest mortality rates were on the lagoon or protected reef edges; areas where branching Acropora corals flourish. The coral most likely died during April/May 1998 coinciding with widespread coral bleaching and mortality in the Indo-Pacific region caused by above-average sea surface temperatures. The different mortality rates between reefs is probably due to differences in maximum daily temperatures in the waters surrounding the two reefs during March 1998. The southern reefs including the Scott Reefs and Seringapatam Reef, were in a sea surface temperature hotspot that was hotter and lasted longer than the northern reefs. There were large areas of what appear to be live foliose corals, probably dominated by *Montipora* spp., in the large (289 km^2) deep lagoon (~50 m deep) associated with Scott Reef South. We estimate that there is over 5000 ha of live coral in the deep lagoon, with little evidence of mortality. This is over twice the amount of live coral estimated for the shallow reefs in the entire study area.

HABITAT MAPPING OF THE REEFS AND SHOALS OF THE MOU74 BOX.

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We used rapid broad-scale survey techniques to map the habitats of the shallow reefs (0–15 m deep) and shoals (15–50 m deep) of the 60,000 km2 area off the Australian north western coast called the MOU74 Box. The study area contained seven shallow reef systems, including Ashmore and Scott reefs, totaling 560 km2, and 1226 km2 of shoals. On the shallow reefs, we used diver transect surveys to collect field data, and remote sensing to map shallow reef habitats. On the shoals, we used video camera transects, acoustics and sediment grabs. The reefs in the study area show a wide variation in size and structure. Ashmore Reef differed markedly from the Scott and Seringapatam Reefs. Generally, it had more sandy habitats, and lacked the extensive shallow reef crest habitat of the southern reefs. It also lacked the deep lagoon and associated lagoon reef edge found on Scott and Seringapatam Reefs. The northern reef habitats were often characterized by having more sand and seagrass, and less dead coral. Many of these differences reflect the balance between shelf and oceanic influence, such as nutrient input from surrounding waters. The shoals in the northern part of the study area are mostly made up of *Halimeda* sand with small areas of reef mainly on the southern margins. In contrast, the deep lagoon associated with Scott Reef South had a high cover of hard substrate and live coral.

EMERGENT REEFS OF THE MOU74 BOX: PAST, PRESENT & FUTURE RESEARCH

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THE MOU74 Box in the Timor Sea encompasses the emergent reefs of Ashmore, Cartier, Browse, Seringapatam and Scott Reef. Comprehensive studies of the benthic communities for this report were carried out on Scott and Seringapatam Reefs. Spatial and temporal changes of coral communities were assessed and reproduction and recruitment patterns of the resident coral population quantified over a five-year period. Recently, holothurian and trochus (both part of a traditional fishery in the MOU74 Box) monitoring programs have been implemented at Ashmore Reef. This paper will present an overview of the findings and their implications in the management of both exploited and non-exploited species of the region. Furthermore, we discuss the potential for future work in the Ashmore region.

CROSSING BORDERS: IMPLICATIONS OF THE MEMORANDUM OF UNDERSTANDING ON BAJO FISHING ACTIVITY IN NORTHERN AUSTRALIAN WATERS.

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The 1974 Memorandum of Understanding between Australia and Indonesia was a goodwill attempt to recognise the long-standing interests of Indonesian fishermen in the northern Australian region. Bajo originating from the villages of Mola and Mantigola in the Tukang Besi Islands, Southeast Sulawesi, are one group of fishermen who have a historic interest in the region and currently operate in and around the MOU area.

This paper examines the effectiveness of the MOU in providing for recognition of indigenous Bajo fishing rights, sustainable marine resource conservation and management, and in curbing illegal Bajo fishing activity in the Australian Fishing Zone. An analysis of the key concept of "traditional" fishing encapsulated in the 1974 MOU shows it to be problematic with direct and far reaching consequences for Bajo fishermen.

It is argued that until the problems of the MOU are addressed, by way of new arrangements incorporating a more culturally informed inclusive approach with respect to traditional Indonesian fishermen, other Australian policy responses to address illegal activity and marine resource conservation in the AFZ will be undermined.

MECHANISMS IN THE INDONESIAN COMMUNITY OF PAPELA FOR EXERCISING TRADITIONAL FISHING RIGHTS

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A report on a 2 1/2 month field study conducted in 1997 in the Indonesian fishing community of Papela on the island of Roti. This community has traditional fished the reefs and water around the Ashmore and Cartier Islands. The focus of the study is on "customary" law and mechanisms in the fishing industry and community, although the study inevitably touches on the broader context of government regulation and economics. A brief assessment is made of the suitability of structures within the community for asserting such traditional resource rights as might be recognised under Australian and International law.

MARINE BIODIVERSITY ON OFFSHORE CORAL REEFS IN NORTHWESTERN AUSTRALIA

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Biogeographical relationships of corals, fish and molluscs on atolls off northwestern Australia are compared with the continental coast, the eastern Indian Ocean, and the coral triangle. Diversity is moderate on the offshore atolls: similar to or lower than along the continental mainland and higher than on Christmas Island and the Cocos (Keeling) Islands in the Indian Ocean. Diversity in the coral triangle was significantly greater for all three groups. Diversity tended to be greatest at Ashmore Reef, intermediate at Scott Reef, and least at Rowley Shoals. The reefs act as stepping stones from which planktonic larvae move from the high diversity region of Indonesia south along the outer continental shelf off northwestern Australia to the continental mainland. Species with lower dispersal abilities drop out along the way. A second reason for lower diversity on the offshore atolls is the restricted habitat diversity. There is a considerable difference between the fauna which occurs along the continental shoreline and that present on the offshore atolls. A substantial proportion of species recorded on the atolls were new records for northwestern Australia. The community composition is also different. Many species which are rare along the continental shoreline are abundant on the offshore atolls. No Indian Ocean species were found on the atolls.

DUGONGS OF ASHMORE REEF & THE SAHUL BANKS

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A small but significant population of dugongs (*Dugong dugon*) live on Ashmore Reef and may use some shallow shoals on the Sahul Banks. Aerial observations in 1996 confirmed the miscellaneous reports of Parks Australia North personnel of dugongs feeding on the reef flat of Ashmore Reef. Individuals representing all age classes were present, which indicated breeding and at least some short-term residency on the reef. A single dugong was located 130 km east of Ashmore Reef that indicated a wider area of utilisation including the Sahul Banks.

The oceanic coral reef habitat used by these dugongs is unusual when compared to the coastal habitat used by other Australian populations. Situated between Indonesia and the Australian mainland, Ashmore Reef supports a population of dugongs whose genetic identity is unknown. Few tissue samples have been collected and analysed to date, but more samples from Ashmore Reef and neighbouring areas in Indonesia and the Kimberley Region will determine their genetic pool.

The isolation of dugongs on Ashmore Reef may afford them protection against threats such as mesh nets and boast-strike, common to other Australian populations, but may make them more vulnerable to illegal hunting by Indonesian fishers and habitat loss due to increased oil and gas exploration and retrieval. In addition, human activity especially motor boat usage has increased in recent years at Ashmore Reef.

The dugongs at Ashmore Reef are one of the most isolated and least known populations in Australian waters. Future research at Ashmore Reef should be directed at determining their population size, movements, preferred habitats, genetic stock and the extent to which their requirements are met by the Ashmore Reef National Nature Reserve. A research and conservation strategy should be incorporated into the Plan of Management of the Ashmore Reef National Nature Reserve.

SEA TURTLES OF SAHUL BANKS – WORK COMPLETED & REQUIRED

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Ashmore Reef and the Sahul Banks represent an internationally important region for foraging and nesting sea turtles. Thousands of foraging green turtles (*Chelonia mydas*) with smaller numbers of loggerhead (*Caretta caretta*) and hawksbill (*Eretmochelys imbricata*) turtles live on Ashmore Reef. Green turtles are the dominant nesting species on most sandy and vegetated islands in the region including those at Ashmore and Scott Reefs and Cartier and Browse Islands.

Research has suffered from the lack of continuity since beginning in the early 1980's. Several groups, including the Bureau of Meteorology, the Department of Territories and Australian National Parks and Wildlife Service, have tagged green turtles on West Island at Ashmore Reef. Since 1994, the Sea Turtle Research Group from NTU has conducted both foraging and nesting studies at Ashmore Reef with some work on Cartier and Scott Reefs. These studies rely on a minimum of five consecutive years of research to estimate several population parameters, including population size. Unfortunately, lack of funds in 2000, prevented the program from reaching its fifth year.

A research and conservation strategy should be incorporated into the Ashmore Reef and Cartier Island Plan of Management. For sea turtles at Ashmore Reef, priority should be given to:

?? analysing all previous tagging data from West Island

?? converting old database records to a new system

?? setting long term goals for sea turtle conservation in the region

?? continuing foraging studies to monitor population trends continuing nesting studies on West Island

?? estimating population parameters for the turtle species in the eastern Indian Ocean.

For the conservation of sea turtles of the Sahul Shelf priority should be given to:

?? assessing the impact of potential threats such as oil and gas exploration

?? increasing surveillance of Cartier Island, Browse Island and Scott Reef to reduce the incidence of unlawful killing of nesting sea turtles.

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