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COASTAL CONFERENCE 2009

*Whose Coast Is It?
adapting for the future*

13A:

Analysis of
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A Knowledge Gap Analysis of the Coastal and Marine Environments for the Pilbara and Kimberley Regions

PRESENTER:

Dr Brett Human

Department of Fisheries

CONTACT DETAILS:

Phone: +61 (8) 92030155

Email: brett.human@fish.wa.gov.au

Postal Address: Department of Fisheries Research, PO Box 20, North Beach WA 6920

Introduction

The West Australian coastal and marine environment is a vast area with 20,800 km of coastline, including islands (Trewin, 2006) and vast expanses of state marine waters (commonly 3 nm from the coastline). A very large geographic gap exists in marine resource condition monitoring programs in Western Australia. With the exception of Ningaloo Marine Park, we know almost nothing of the condition of the marine resources of the arid-tropical Pilbara and Kimberley regions, yet the high marine biodiversity and recreational values of these areas are recognised at a national and international level.

The Pilbara is of great strategic and economic importance for the State and Commonwealth. The area supports a wealth of offshore oil and gas resources. The Pilbara has the country's largest export ports, some of which are currently expanding or have proposals to expand. There are also a number of new large-scale LNG and industrial activities proposed throughout the region, most of which will rely on large marine infrastructure to facilitate export. The region also has great tourism potential. It is also an area that supports some of the country's most unique and highly biodiverse marine habitats (e.g. nearshore coral reefs develop due to the limited run-off from the land, and arid-zone tropical mangrove communities are also present) (CALM, 2005; DoE, 2006; NWSJEMS, 2007; DEWHA, 2008; and Wood & Mills, 2008).

The Kimberley is one of the most remote and uninhabited stretches of the Australian coastline. Apart from a few indigenous communities, the only coastal settlements are the small ports of Derby and Wyndham. Despite this remoteness, the remarkable natural beauty of the coastal environment means that commercial tourism operations are already well established, and major development applications by oil and gas industries are currently being planned. Assessment of the potential impact of all of these activities is hampered by the paucity of baseline environmental data for any of the marine communities in the Kimberley. What little is known of these habitats indicates that they tend to be locally very complex and diverse, and frequently not found elsewhere in Western Australia (NWSJEMS, 2007; DEC, 2008; DEWHA, 2008; Fry *et al.*, 2008; NDT, 2008a,b; and Wood & Mills, 2008).

Habitat loss and its effects on biodiversity are a growing global concern. Loss of habitat is a major cause of the decline of coastal species. Changes in distribution, such as range extensions or reductions, are also of interest, especially during times of climate change, as they may be indicators of significant ecological changes underway. Some of the existing, imminent, and proposed threats to marine habitat integrity in these

areas are in close proximity or adjacent to existing and proposed marine conservation reserves, created to conserve important ecological and social values. If pressures or threats are left unchecked, serious damage or irreversible loss is likely to occur. However, we currently know little about the characteristics of key habitats or how they might respond to any stressors. State-wide, there is a significant lack of monitoring at unimpacted reference sites and a great need for this type of monitoring to gauge natural variability, inform target setting, and differentiate between the effects of human and natural influences. The need for this critical baseline information is growing daily.

The unique natural characteristics of the region and the ever developing industries located here, especially along the coastal fringe, creates the need for a long term monitoring strategy to ensure the future integrity of the marine and coastal environments of the Pilbara and Kimberley regions.

This literature review aims to identify gaps in our knowledge of the marine and coastal environments of the Pilbara and Kimberley.

Background

The Coastal and Marine Resource Condition Monitoring—Scoping Project is a one year project, which commenced in October 2008, and was developed in order to increase our understanding and develop a standardised long term monitoring protocol, for the marine and coastal environments of the Pilbara and Kimberley.

The project has three objectives, to:

- 1) Undertake a desktop study of the current coastal and marine resource condition monitoring programs being undertaken in the Pilbara and Kimberley;
- 2) develop standard monitoring protocols and test in two inter-tidal habitats; and
- 3) provide a coastal and marine Resource Condition Monitoring framework.

This paper addresses the first objective by undertaking a major literature search of research that has been conducted in the region. Knowledge gaps were identified from the literature review, ranging from very specific questions, perhaps relating to a particular species group, to very broad ecological and oceanographic questions.

Methodology

A systematic search of major scientific journals, government, and accessible consultant reports from 1900 to 2009 was used to analyse the literature. The search concentrated on studies centred on the coastal and marine environment of the Pilbara and/or Kimberley regions.

Using a combination of library searches, including interrogating online scientific research tools, such as SCIRUS (<http://www.scirus.com/>) and ScienceDirect (<http://www.sciencedirect.com/>); interrogating online metadatabases such as the Western Australian Marine Science Institute BlueNet Metadata Entry and Search Tool (WAMSI iMEST) (<http://mest.ivec.org/geonetwork/srv/en/main.home>) and the WA Department of Environment and Conservation (DEC) Biodiversity Audit of WA (<http://www.dec.wa.gov.au/science-and-research/biological-surveys/a-biodiversity-audit-of-wa.html>); as well as traditional library searches, resulted in over 2000 references concerning material on the coastal and marine systems of the Pilbara and Kimberley.

A project objective of the literature review was to identify knowledge gaps categorised by whether the knowledge gap related to the Pilbara region and/or the Kimberley region, and then further, into whether the knowledge gap was related to general marine, marine water and sediment quality, marine primary production, key marine vegetation communities, key marine invertebrate communities, key marine fish species, key marine reptile species, and/or key marine mammal species

Results

For the Pilbara region 1013 references were collated, however only 11% (115) were of direct relevance to the aims of this study. The same pattern was displayed for the Kimberley, with 1131 references, of which 11% (133) were of direct relevance, resulting in slightly more literature being available for the Kimberley compared to the Pilbara. Much of the excluded literature on the target regions were centred on detailed attributes of the regions geology, with very little or no relevance to the aims of this review.

Space does not allow for a detailed discussion of the actual literature review here, however, the points below were identified as the major gaps in our knowledge of the target regions based upon the literature review. The knowledge gaps are not identified in any order of priority, however, they are placed into themes that became apparent as the knowledge gaps were compiled.

Abbreviations at the end of each gap identifies how a particular gap relates to the Pilbara and/or Kimberley regions: P—Pilbara general marine; PW—Pilbara marine water and sediment quality; PP—Pilbara marine primary production; PV—Pilbara key marine vegetation communities; PI—Pilbara key marine invertebrate communities; PF—Pilbara key marine fish species; PR—Pilbara key marine reptile species; PM—Pilbara key marine mammal species; K—Kimberley general marine; KW—Kimberley marine water and sediment quality; KP—Kimberley marine primary production; KV—Kimberley key marine vegetation communities; KI—Kimberley key marine invertebrate communities; KF—Kimberley key marine fish species; KR—Kimberley key marine reptile species; KM—Kimberley key marine mammal species.

Endangered/Threatened Habitats

1. CALM (2005) highlighted the need to review and monitor the status of current threats to seagrasses in the Dampier Archipelago (currently no threats), however the need for a review and monitoring of threats to seagrasses applies throughout the Pilbara and Kimberley. [PV, KV]
2. Due to their apparent sensitivity to pollution and habitat loss/ modification, the use of invertebrate fauna as indicators of such impacts needs to be assessed. [P, PW, PP, PV, PI, K, KW, KP, KV, KI]
3. The impact of historical overfishing and bad fishing practices on benthic assemblages are unknown, and the recovery these habitats (specifically sponge gardens) are also unknown. [P, PP, PV, PI, PF, PR, PM, K, KP, KV, KI, KF, KR, KM]
4. Influence of large scale oceanographic features on inshore habitats of the Pilbara and Kimberley are mostly unknown (Wood & Mills, 2008). [P, PW, PP, K, KW, KP]

Endangered/Threatened Species

5. Knowledge of basic biological information is lacking for dugongs around the Dampier Archipelago, including population size, distribution, migratory habits, etc... (CALM, 2005), however, the same is true for the Pilbara and Kimberley region in general. [PM, KM]
6. The survivability of dolphins that have passed through a BRD escape hatch is unknown (Stephenson *et al.*, 2008). [PM, KM]
7. The misidentification frequency of threatened river sharks (genus *Glyphis*) for whaler sharks in the Kimberley Gillnet and Barramundi Fishery is unknown (Fletcher & Santoro, 2007) and applies to all areas where river sharks occur. [PF, KF]
8. A full understanding of habitat use by threatened fresh water sharks and rays, which apparently changes ontogenetically, is lacking. [PF, KF]
9. There is no mention of seabird catches in any of the fishery reports in Fletcher & Santoro (2007). Recording of seabird interactions has just begun for recreational charter boat fishing, however, no monitoring procedures are in place for the commercial fishery to the best of our knowledge. [P, K]
10. The impact of the Pilbara Demersal Finfish Fishery bycatch on pipefishes and seahorses is recorded but not assessed (Fletcher & Santoro, 2007). [PF, KF]
11. The survivability of bycatch released alive is presumed. There appears to be little to no available data on actual survivability. [PF, PR, PM, KF, KR, KM]
12. Will directing the effort from demersal long-lining to pelagic gill-netting in the WA North Coast Shark Fishery and the Joint Authority Northern Shark Fishery (Fletcher & Santoro, 2007) increase bycatch of threatened species such as river sharks, sawfishes, turtles, and mammals? [PF, PR, PM, KF, KR, KM]

Biodiversity

13. CALM (2005) highlighted the need for a thorough biodiversity survey of the invertebrate fauna of the Dampier Archipelago, however, the same is true for the Pilbara and Kimberley region in general. [PP, PI, KP, KI]
14. Biodiversity hotspots in the Pilbara, and in the Kimberley, for various flora and fauna groups, need to be reassessed and verified, or identified. [PV, PI, PF, PR, PM, KV, KI, KF, KR, KM]
15. The amount of genetic input from Indonesia into WA waters unknown (Wood & Mills, 2008). [P, PP, PV, PI, PF, PR, PM, K, KP, KV, KI, KF, KR, KM]
16. Species composition of the flora and fauna in the shallow coastal zone of the Kimberley is poorly surveyed (Wood & Mills, 2008), and the same is apparently true of the Pilbara. [PV, PI, PF, PR, PM, KV, KI, KF, KR, KM]

17. There are no published baseline data against which to measure or detect introduced species (Heyward *et al.*, 2006). [PP, PV, PI, PF, PR, PM, KP, KV, KI, KF, KR, KM]

Ecological/Oceanographic

18. There has been virtually no research conducted on the primary production for the Pilbara and Kimberley. Virtually nothing is known of the ecological significance and interactions of the phytoplankton and zooplankton of the area. [PP, KP]
19. The trophic links between plankton and benthos communities are poorly understood in both the Pilbara and Kimberley regions. [PP, PV, PI, PF, KP, KV, KI, KF]
20. The role of plankton in trophic dynamics and nutrient cycling, particularly in the near shore environment is poorly understood. [PP, PV, PI, PF, KP, KV, KI, KF]
21. Seasonal primary productivity is very poorly understood (Heyward *et al.*, 2006). [PP, KP]
22. The dynamic interactions between plankton and physical oceanography are poorly known, particularly for small scale processes (Heyward *et al.*, 2006). [PP, KP]
23. The establishment of a standard set of environmental quality indicators, criteria, and standard monitoring procedures appropriate to the tropical marine ecosystem to assess resource condition, provide early warning of change, and to trigger management responses where necessary is needed (DoE, 2006). [P, PW, PP, PV, PI, PF, PR, PM, K, KW, KP, KV, KI, KF, KR, KM]
24. What will be the effects of sea level rise? [P, PW, PP, PV, PI, PF, PR, PM, K, KW, KP, KV, KI, KF, KR, KM]
25. What will be the effects of climate change, with particular reference to sea temperature rise? [P, PW, PP, PV, PI, PF, PR, PM, K, KW, KP, KV, KI, KF, KR, KM]
26. Water movements in the commonwealth North-West Shelf Transition Bioregion (the Holloway Current) are not well understood and has implications for pollution and invasive pest dispersal (DEWHA, 2008) [P, PW, PP, K, KW, KP]
27. Large scale oceanographic features are only partially characterised for the Pilbara and Kimberley (Wood & Mills, 2008). [P, PW, PP, K, KW, KP]
28. Community composition of the trophic tiers immediately following the primary producers, are poorly known in the Kimberley (DEWHA, 2008) and in the Pilbara. [PW, PV, PI, PF, KW, KV, KI, KF]
29. The ecological processes within and between fringing reef and seagrass bed communities are virtually unknown (Wood & Mills, 2008). [PP, PV, PI, KP, KV, KI]
30. Long-term biological time series data are virtually non-existent for the Pilbara and the Kimberley, particularly for inshore environments. [P, PW, PP, PV, PI, PF, PR, PM, K, KW, KP, KV, KI, KF, KR, KM]
31. Health indicators of tropical marine communities are poorly known. [P, PW, PP, PV, PI, PF, PR, PM, K, KW, KP, KV, KI, KF, KR, KM]
32. Responses to stress by tropical marine communities are poorly known. [P, PW, PP, PV, PI, PF, PR, PM, K, KW, KP, KV, KI, KF, KR, KM]
33. There is a paucity of marine water and sediment quality testing and monitoring for the Kimberley region. [KW]

Fisheries/Aquaculture

34. There is a lack of information on non-target fishes of the Dampier Archipelago (CALM, 2005), and for the Pilbara and Kimberley fisheries in general. [PI, PF, KI, KF]
35. There have been no environmental impact assessments conducted to assess the impact of establishing various aquaculture activities around the Dampier Archipelago, and there have only been limited studies elsewhere in the Pilbara and Kimberley regions. [PW, PP, PV, PI, PF, PR, PM, KW, KP, KV, KI, KF, KR, KM]
36. There have been no stock assessments of target species other than barramundi in the Kimberley Gillnet and Barramundi Fishery (Fletcher & Santoro, 2007). [KF]
37. The impact of increased charter vessel operation for recreational fishing in the Northern Demersal Scalefish Fishery zone is unknown (Fletcher & Santoro, 2007). [KI, KF, KR, KM]
38. The occurrence and impact of ghost fishing from discarded fishing gear, both commercial and recreational, in the Pilbara and the Kimberley is unknown. [PI, PF, PR, PM, KI, KF, KR, KM]

39. Recreational fishing for Spanish mackerel is apparently high in both the Pilbara and Kimberley regions, the last survey for this fishery/region was conducted in 1999/2000 and is unpublished (Fletcher & Santoro, 2007). [PF, KF]
40. The recreational catch of sharks and rays has not been assessed in the Pilbara or Kimberley regions. [PF, KF]
41. Only the primary target species (*Carcharhinus plumbeus*, sandbar shark) has been adequately stock assessed in the WA North Coast and the Joint Authority Northern Shark Fisheries, with all other shark and ray species being inadequately assessed (Fletcher & Santoro, 2007). [PF, KF]
42. The impact of climate change on fisheries is unknown. [P, PI, PF, K, KI, KF]
43. The impacts of illegal foreign fishing vessels on shark, beche de mer, trochus shell, and other stocks, are unknown (Fletcher & Santoro, 2007). [PI, PF, PR?, PM?, KI, KF, KR?, KM?]
44. The last scientific surveys of recreational fishing in the Pilbara were conducted in 1999/2000 (Williamson *et al.*, 2006) and no recreational fishing surveys of the Kimberley have been conducted to the best of our knowledge. DoF (2005) recommended catch surveys to be undertaken every 3 years. [PI, PF, KI, KF]
45. It is estimated that recreational fishing pressure will be 14 million fishing days per year by 2012 (DoF, 2004), the impact of this on various habitats is unknown. [P, PW, PP, PV, PI, PF, K, KW, KP, KV, KI, KF]
46. No studies on the effectiveness of BRD's in any Kimberley trawl fisheries (Stephenson *et al.*, 2008), and only limited studies in Pilbara trawl fisheries (Stephenson & Chidlow, 2003; and Stephenson *et al.*, 2008). [PF, PR, PM, KF, KR, KM]

Performance Assessment

There was considerable bias found in the available literature as to the research that had been conducted in the Pilbara and Kimberley region, both in terms of the research group, and the focus of the research. Further bias was introduced into the knowledge gaps because of the easier access the author had to fisheries related literature, and the authors ichthyological background. It was also possible to identify more specific knowledge gaps when more literature was available for a particular topic.

A constraint to this literature review is that a significant portion of the research and monitoring that occurs in the Pilbara and Kimberley regions are conducted by private enterprises and consultancies. Therefore, this information is generally not publicly accessible and are not included in the current literature review. This constraint is common to a number of Resource Condition Monitoring programs that are currently underway in Western Australia and represents a significant impediment to progress in this field.

Conclusion

The relative amount of research and monitoring effort that has been invested in the marine and coastal environments of the Pilbara and Kimberley region is low compared to elsewhere in Australia.

There is a need for long-term resource condition monitoring of the marine and coastal environments of the Pilbara and Kimberley and there is a paucity of baseline data for resource condition monitoring of the marine and coastal environments of the Pilbara and Kimberley. This is compounded by the fact that a significant portion of the literature relating to research and monitoring of the marine and coastal environments of the Pilbara and Kimberley are largely inaccessible because they have been conducted by private enterprises.

Large knowledge gaps exist both in terms of research and monitoring in the marine and coastal environments of the Pilbara and Kimberley.

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