

Using the Sorensen Network to Assess the Potential Effects of Ecotourism on Two Australian Marine Environments

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In the marine environment ecotourism, like any human activity, has effects. Identifying such effects is essential otherwise they cannot be minimised through management. This paper reports on the development and application of the Ecotourism Sorensen Network to identify potential effects of ecotourism activities in two marine environments of northwestern Australia — Ningaloo Reef and surrounds of Legendre Island, part of the Dampier Archipelago. Most of the effects identified could potentially occur in both study areas. More of these potential effects were negative than positive, with most of the latter being sociocultural and economic and the former predominantly biophysical. Those most likely to occur and to be the most significant were negative biophysical effects, especially damage to marine biota, and negative Aboriginal effects. For Ningaloo, overcrowding was also a significant negative effect while at Legendre possible future conflict with the planned industrial port was significant. The Ecotourism Sorensen Network provided a useful mechanism for describing the potential effects of ecotourism activities on marine environments. It also allowed analysis of the similarities and differences in effects between study areas, the likelihood of effects occurring and their significance. This analytic approach could be readily and usefully applied to marine-based ecotourism elsewhere in the world.

Introduction

Ecotourism in Australia is growing at three times the rate of other sectors of the tourism industry and is a \$AUD100 million a year industry (Boyer, 1994). As such, the effects of ecotourism activities on the surrounding environment need to be determined urgently, otherwise ecotourism may become a mere replica of conventional mass tourism with its associated effects and problems (Carter, 1992). Ecotourism activities are conducted in relatively pristine marine environments. Accordingly, the negative effects if not managed have the potential to affect adversely the natural resources on which the industry depends.

Environmental impact assessment can be used to identify the potential effects of ecotourism on the marine environment. Impact identification and summarisation methods can be divided into four broad categories: checklists, *ad hoc* methods, matrices and networks (Westman, 1985). Of these, networks allow diagrammatic linking of causes and effects, an essential assessment attribute when potential effects on complex, interrelated ecosystems such as marine environments are being considered. The Sorensen Network, which also addresses secondary and indirect effects and incorporates them in diagrammatic form (Bisset, 1987), was modified and used to determine the potential effects of ecotourism on the marine environment. Study sites were two marine environments of northwestern Australia — Ningaloo Reef and surrounds of Legendre

Island, part of the Dampier Archipelago. Northwestern Australia is experiencing rapidly growing tourism interest and activity. Also, little is known about the potential effects of ecotourism on northwestern Australia (Buckley & Ponnell, 1990).

Ningaloo Reef is the longest continental fringing reef in Australia (Wells, 1988), stretching 260 km along the Western Australian coastline (LaPlanche, 1995; Figure 1). It lies at the intersection of the Indo-West Pacific and temperate southern Australian regions resulting in a wealth of flora and fauna species including whale-sharks, whales, dugongs, green turtles and over 200 coral species (Department of Conservation and Land Management, 1990; Edwards, 1995). All of the reef is included within Ningaloo Marine Park (Department of Conservation and Land Management, 1989). A total of 14 registered Aboriginal sites lie within the boundaries of the Marine Park (Aboriginal Affairs Department, 1996).

Ningaloo Reef is a popular tourist destination with 91,000 visits to the Marine Park and hinterland in 1995/96 (L. Liddicoat, pers. comm., 1997). The majority of visitors use the coastal town of Exmouth as a gateway to the Marine Park. During the peak tourism season Exmouth's population more than doubles to 8–10 000 people of which 4–6000 are tourists (S. Pitmin, pers. comm., 1996). The town has an Aboriginal population of 30 people which is 1% of the town's population (Department of Local Government, 1995).

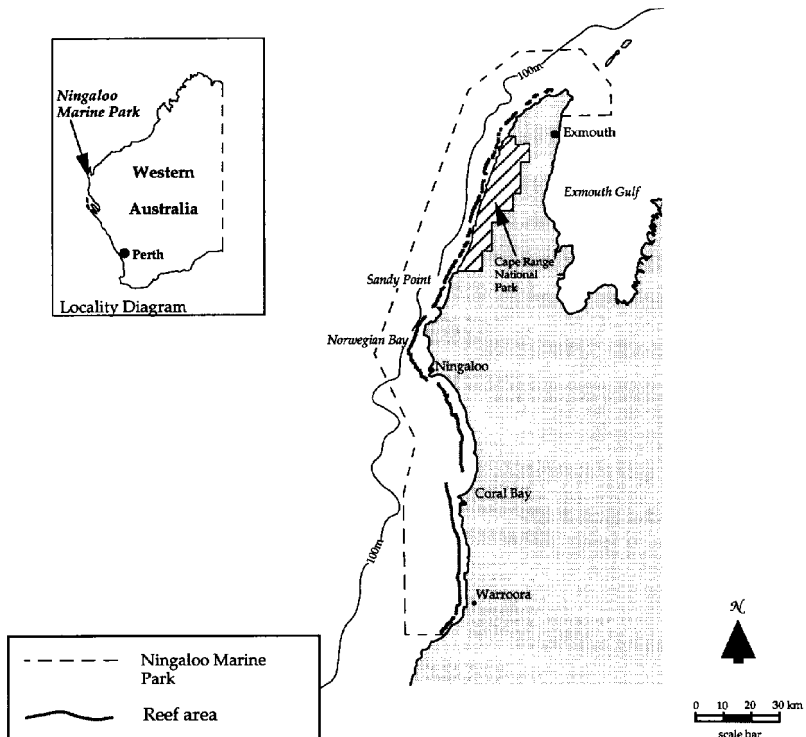


Figure 1 Location of Ningaloo Marine Park

Ecotourism activities based in Exmouth include coral viewing, scenic flights and cruises, touring shipwrecks, snorkelling with whale-sharks, whale watching and general snorkelling and diving. Twelve ecotourism companies reliant on the Reef are based in the town (S. Pitmin, pers. comm., 1996). Average daily expenditure of Exmouth tourists is \$AUD43.65 (Western Australian Tourism Commission, 1995a), equating to approximately \$AUD200,000 per day being injected into the economy during the peak tourist season.

The Dampier Archipelago contains 25 islands (Department of Conservation and Land Management, 1990), and lies off the Western Australian coastline 1200 km northwest of the state's capital Perth and 300 km northwest of Ningaloo Marine Park (Figure 2). The islands range in size from 1 to 3290 ha (Department of Conservation and Land Management, 1990), have no human habitation and little infrastructure (F. Stanley, pers. comm., 1996). They lie in the Indo-West Pacific region; fauna present includes turtles, humpback whales, seabirds and numerous fish and coral species (Department of Conservation and Land Management, 1990). The marine surrounds of Legendre Island were chosen because they are used by two commercial ecotourism operators based in Karratha. Legendre's marine environment contains seven registered Aboriginal sites (Aboriginal Affairs Department, 1996). Ecotourism activities, both commercial and individual and based in Karratha, include snorkelling and diving, scenic flights, and whale, turtle and seabird watching.

The mining town of Karratha, with a population of 10,000 (R. Haeren, pers.

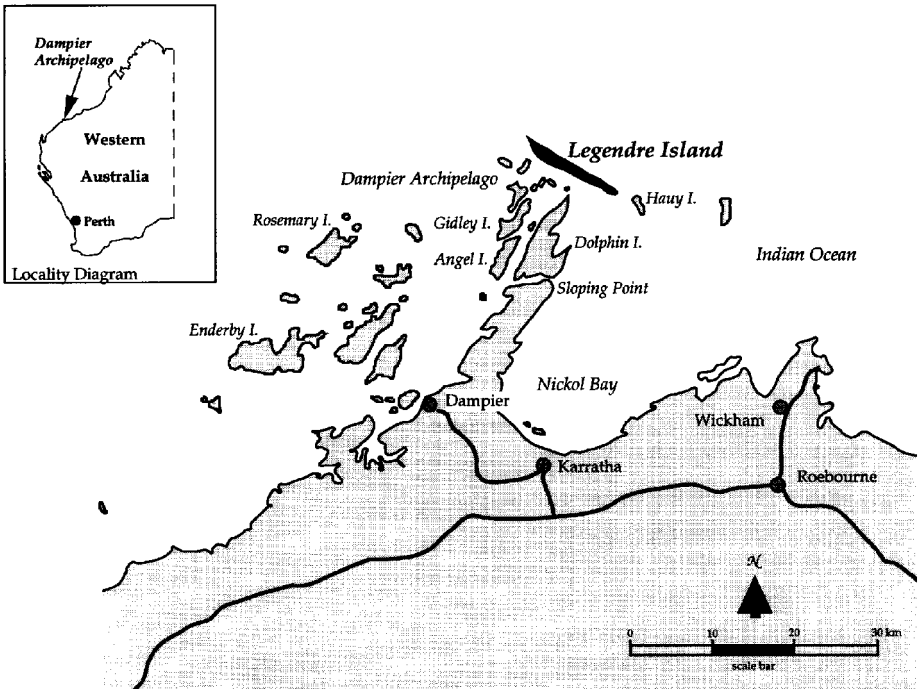


Figure 2 Location of Legendre Island, part of the Dampier Archipelago

comm., 1996), provides the base for tourist activities and associated businesses using the Legendre marine environment, although the nearby town of Dampier provides the harbour facilities. The Aboriginal population of Karratha is small (R. Haeren, pers. comm., 1996). During peak tourism season there are 3500 tourists in the Roebourne area which includes Karratha (Western Australia Tourism Commission, 1995b). An unknown proportion visits the Dampier Archipelago and Legendre Island; however, total numbers are lower than the numbers visiting Ningaloo Reef. Lack of commercial ecotourism activities is attributed to little investment in and limited enthusiasm by local people for ecotourism (R. Haeren, pers. comm., 1996). For Karratha the money generated from ecotourists is insignificant compared to that injected into the economy by mining-related activities.

Developing the Sorensen Ecotourism Network

Network approaches allow identification of direct and indirect environmental impacts as well as establishing 'causal chains' (Erickson, 1994). Such causal chains link activities, impacts and their consequences. As noted by Shopley and Fuggle (1984: 39) in their review paper, 'The objective of the network approach is to display, in an easily understood format, the intermediary links between a project and its ultimate impacts'. The Sorensen Network was developed around 1970 (Westman, 1985) to identify and control resource degradation and conflict in the coastal zone. As such, it had strong potential for application to the equally complex marine environments of northwestern Australia as they face increasing ecotourism use.

What are the strengths and weaknesses of a network approach, compared to other impact identification techniques such as checklists, *ad hoc* methods and matrices, for identifying and summarising the environmental impacts of marine-based ecotourism? Networks allow the illustration and exploration of links between impacts and their likely consequences. Their greatest weakness is visual complication (Canter, 1996). Checklists, although simple to construct, do not allow a linking of impacts and consequences. *Ad hoc* methods, which typically identify impacts by brainstorming, are a less organised version of the checklist approach and have similar strengths and weaknesses. In addition, they do not allow addressing of secondary impacts (Shopley & Fuggle, 1984). Matrices display the interactions between project actions and environmental characteristics, providing an easily understood summary of primary impacts, however, similarly to *ad hoc* methods they do not consider secondary impacts (Shopley & Fuggle, 1984).

Development of the 'Ecotourism Sorensen Network' (Figure 3), through application to the two study areas, was as follows. The *potential* effects of ecotourism activities at Ningaloo and Legendre were derived from known effects of marine-based ecotourism activities elsewhere in Australia and overseas and reviewing existing activities and environmental attributes in the two study areas. Review of existing activities in the study areas involved identifying the activities of the 14 ecotourism companies, 12 in Exmouth and 2 in Karratha. These activities and examples of companies involved in each activity are given in Part A of the Ecotourism Sorensen Network (Figure 3). The likely components or 'causes' of

each activity, for example ballast water as a component of coral viewing, are given in Part B. Causes are aspects of activities most likely to affect the marine environment.

Causes fall into one of four loosely-defined groups. The first group is potential effects due to the presence of something foreign to the environment, either ecotourists, boats, associated equipment or diver's flippers. The second group potentially results from pollution — oil or fuel, noise, ballast water, plane engine fallout or litter. The third group is possible removal of part of the marine environment such as flora, fauna, or part of shipwrecks. The last group is likely human interaction with fauna by feeding or touching animals.

Causes can then result in primary effects, determined from a knowledge of effects elsewhere, existing activities and the receiving marine environment. Part C of Figure 3 shows 32 potential primary effects in 5 broad categories — biophysical, sociocultural (general), Aboriginal, economic and political. Both positive and negative potential effects are included as well as consequent conditions associated with each effect (Part D). For example, a negative biophysical effect is displacement of fauna and the associated consequent condition is fauna occupying less desirable (i.e. less suitable) habitats. These effects have not been quantitatively determined; rather we have identified them as having the potential to occur.

Potential Effects of Ecotourism Activities on the Ningaloo and Legendre Marine Environments

The Ecotourism Sorensen Network was used to: (1) identify and analyse the possible positive and negative effects in common between the two study areas and explore the differences; (2) provide the base for recognising and grouping these effects according to the probability of their occurrence in each study area; and (3) discuss the likely significance of these potential effects for the marine environment.

Most impact identification techniques contain aspects of subjective judgement (Westman, 1985). In applying the Sorensen Network to ecotourism, subjective judgements were made by the authors and authors of work cited. Classification of an impact as positive or negative was a value judgement. For example, listing 'change in the pace of life' as a negative effect of ecotourism is a value judgement by the authors. The decision to weight equally all impacts, providing a simple and transparent approach for comparing impacts, was also a value judgment. Comments regarding significance of impacts made later in this paper also involved and reflected the judgements of the authors and others in this field.

Possible positive and negative effects of ecotourism activities

The majority of possible effects, 28 of the 32 listed in Figure 3, were identified for ecotourism activities at both Ningaloo and Legendre. Of these, 12 were positive effects and 16 were negative effects. Most of the potential positive effects were sociocultural and economic, for example improvements in infrastructure, better services and increased money in the economy. Most of the potential negative effects were biophysical, such as decrease in abundance and diversity of flora, aesthetics and water and air quality. The effects on Aboriginal people

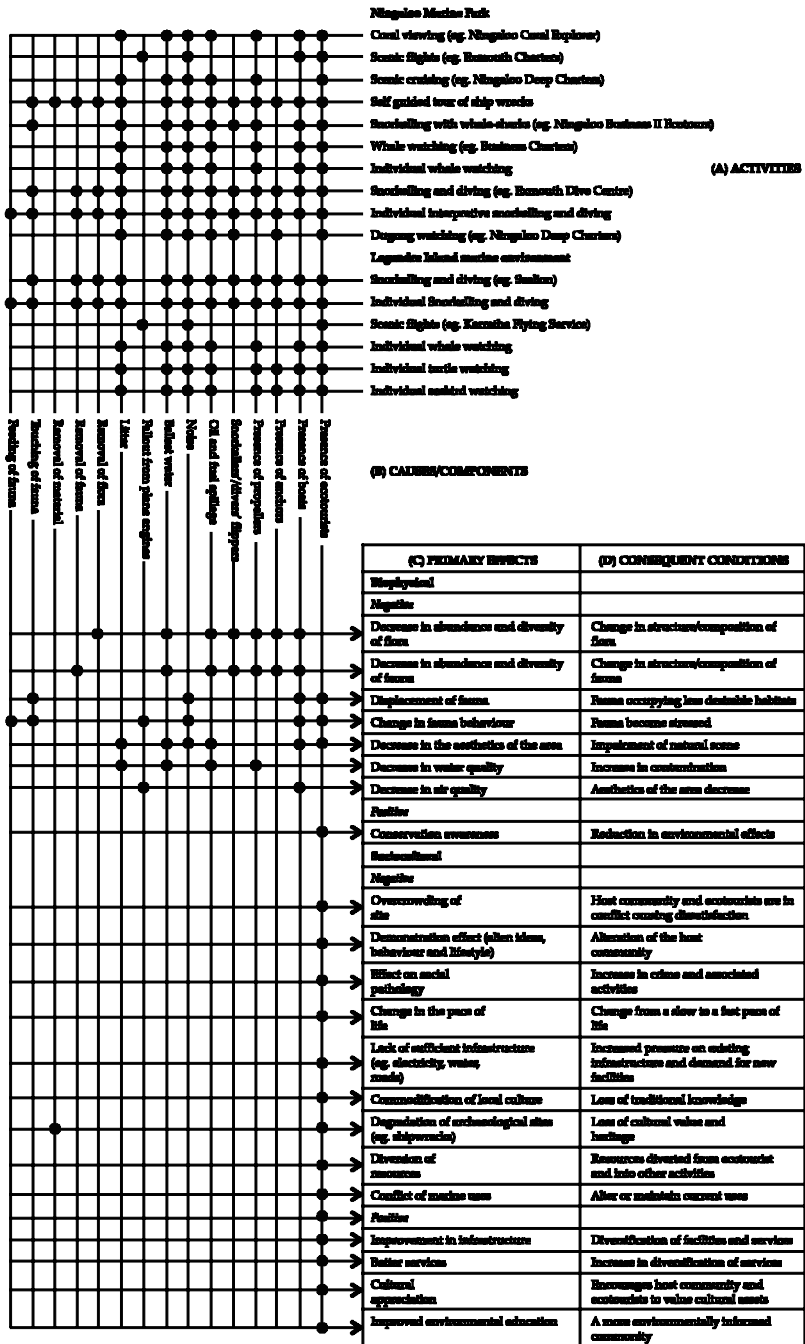


Figure 3 Ecotourism Sorensen Network developed for ecotourism activities and effects on Ningaloo and Legendre marine environments
 (Sources: Australian Conservation Foundation, 1994; Boo, 1990; Buckley & Ponnell, 1990; Burns & Associates, 1989; Commonwealth Department of Tourism, 1993; Dowling & Alder, 1996; Hall, 1995; United States Congress Office of Technology Assessment 1993; Westman, 1985.)

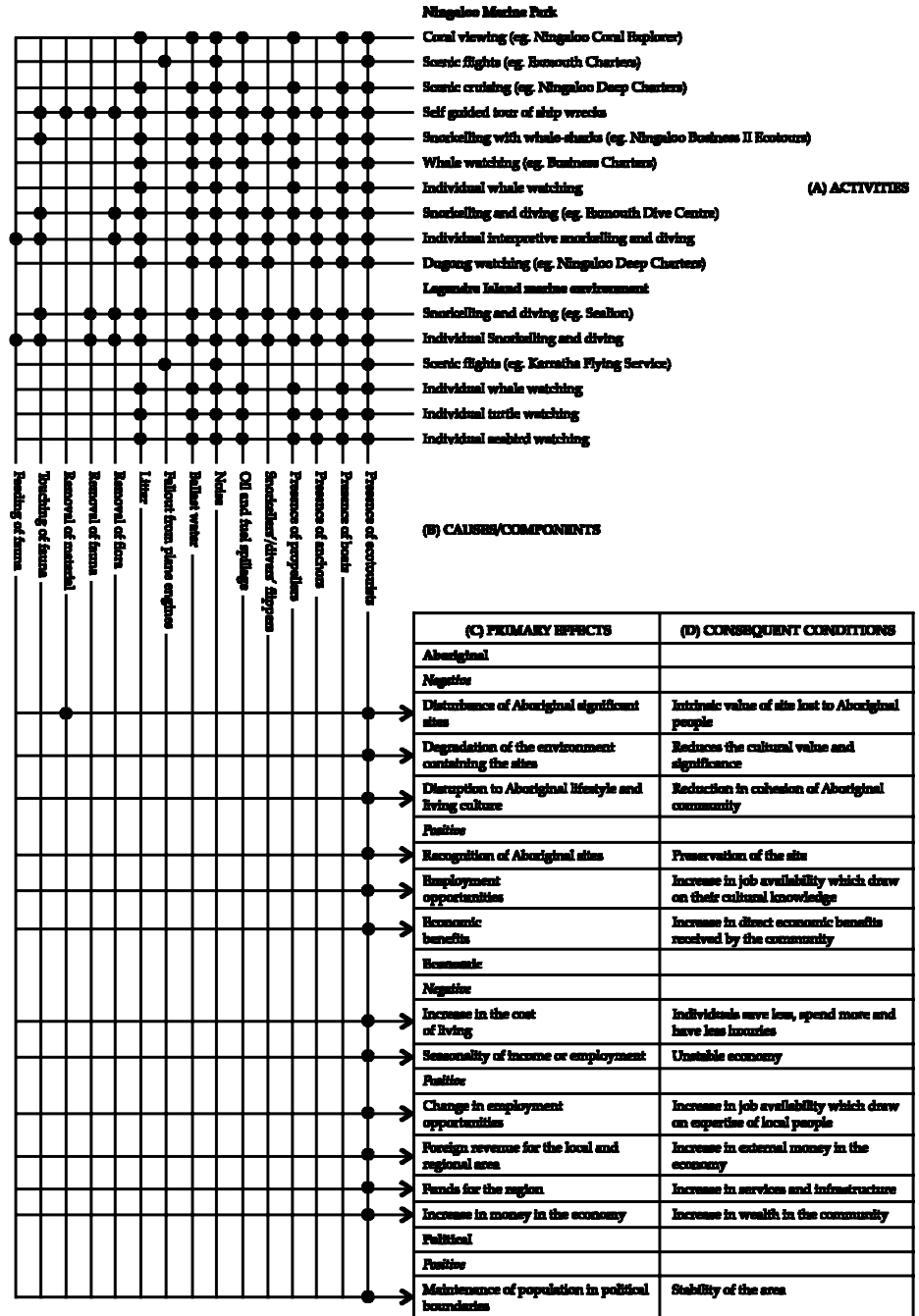


Figure 3 cont.

and communities were mixed, with both positive and negative effects; positive being employment and economic opportunities and negative including disturbance of sites, lifestyle and living culture.

Although an effect such as decrease in water quality may occur at both Ningaloo and Legendre, its nature and extent may vary. Although declining water quality is potentially a concern in both environments, poorer circulation in the lagoons of Ningaloo Reef means this effect could be more serious here than at Legendre. Similarly, changes in fauna behaviour were suggested as a possibility in both marine environments; however, because of the whale-sharks at Ningaloo and ecotourism activities based on swimming with them, this effect is potentially more serious in nature and likely at Ningaloo (Thomson & Stevens, 1994; Taylor, 1996; Davis *et al.*, 1997).

The nature of certain sociocultural effects may also vary between the two areas. For example, conflict between ecotourism and other uses was a possibility at both Ningaloo and Legendre. However, at Ningaloo potentially conflicting uses include fishing and hydrocarbon production, while at Legendre these include possible port and causeway development linking Legendre and the peninsula (Figure 2). Similarly, marine infrastructure concerns typify both environments, but its nature differs between the study sites. At Legendre much-needed marine infrastructure such as mooring facilities or jetties is absent although boat launching facilities at Karratha are adequate. In contrast, ecotourism pressure in large part resulted in the construction of the Exmouth Boat Harbour, opened in October 1997.

A small number of effects (four) could potentially occur at Ningaloo but not Legendre: degradation of archaeological sites, site overcrowding, the demonstration effect and inadequate land infrastructure. The numerous shipwrecks at Ningaloo and the absence of such wrecks at Legendre mean that site degradation is only a concern in the former environment. Legendre has far lower visitor levels and thus is unlikely to be faced with overcrowding. Ningaloo and the support town of Exmouth are well-known tourist destinations and overcrowding already occurs during peak season. For similar reasons, Exmouth experiences the demonstration effect, where the local culture is susceptible to change through the presence of tourists. On the other hand, Karratha, experiencing smaller tourist numbers and low numbers relative to the mining community and culture, is unlikely to be subject to any demonstration effects. Lastly, Exmouth will soon face infrastructure limitations in terms of potable water, with the Cape Range borefields reaching their maximum capacity (Muir Environmental, 1995). Karratha faces no such infrastructure limitations.

Probability of occurrence of potential effects

The Ecotourism Sorensen Network, through the information and links it contains, provides a basis for recognising and grouping potential effects according to the probability of their occurrence. In both study areas some potential effects are more likely to occur than others. Effects most likely to occur are negative biophysical and negative Aboriginal effects. The former is likely and unavoidable given that most ecotourism activities interact directly with the marine, biophysical environment. The latter effect is highly likely to occur

because of the Aboriginal significance of both study areas, although ecotourism may improve the recognition afforded or protect sites of spiritual significance. The other likely negative effect is on Aboriginal lifestyle and cultural disruption. In Broome, another northwestern town and major tourism/ecotourism destination and gateway, tourism has disrupted the Aboriginal community (Hall, 1995).

Effects most unlikely to occur were positive effects for Aboriginal people. To date there has been little involvement of Aboriginals in ecotourism activities and if this trend continues then positive benefits such as employment opportunities and economic benefits will not be realised.

No matter what the activities and associated potential effects, the probability of effects occurring is higher at Ningaloo because of its greater numbers of ecotourists and established ecotourism industry. Therefore, although Ningaloo and Legendre may experience similar effects (Figure 3, Part C), the likelihood of both positive and negative effects occurring is greater at Ningaloo than Legendre.

The Ecotourism Sorensen Network also allows identification of activities which potentially have the greatest number of associated effects. Activities associated with boats have the greatest potential to physically affect these marine environments through anchors, propellers and pollution risks. Other effects caused by boats include decrease in the abundance of flora and fauna, displacement of fauna and change in fauna behaviour. Activities leading to these potential effects include coral viewing, scenic cruising, and snorkelling and diving. The ecotourism activity least likely to affect the environment is scenic flights. The only associated potential effects include noise and fallout from plane engines.

Significance of potential effects to the marine environments

The last component of analysis of ecotourism effects using the Ecotourism Sorensen Network was estimations of the 'significance' of potential effects for the marine environment. This estimation was based on the susceptibility of each study area to damage and the probability of effects occurring as detailed previously. Other researchers, such as Canter and Canty (1993), have similarly based significance determination on the project location, especially the fragility and importance of the resources likely to be affected.

For Ningaloo, the most significant effects potentially result from the inevitable interactions of ecotourists with the biophysical environment, infrastructure and overcrowding concerns because of rapidly increasing ecotourist numbers, and disruption to Aboriginal peoples' lifestyles and sites. Adverse effects to the biophysical environment and Aboriginals were also noted earlier as being the effects most likely to occur in both study areas. The only positive effect of any significance would be increased money spent in the local economy, with about \$AUD200,000 per day being spent in Exmouth by ecotourists during peak season (Western Australian Tourism Commission, 1995a).

Of the 12 Exmouth-based ecotourism businesses, seven facilitate direct interaction with the marine environment which houses dugongs, whale-sharks, humpback whales, seabirds, and green, hawksbill and flatback turtles. The effects of human contact on whale-sharks are poorly known (Davis *et al.* 1997), while

numbers of ecotourists swimming with them are increasing by 60–70% per year (Anonymous, 1996).

Exmouth is growing and will continue to grow as a tourist destination and gateway to Ningaloo. Potable water sources have reached their limit, as previously mentioned. Overcrowding has been experienced by snorkellers swimming with whale-sharks (Birtles *et al.*, 1995). Other ecotourism activities may also become overcrowded with time.

Disruption of Aboriginal peoples is a potential effect significant to both the Ningaloo and Legendre study areas. Both areas contain sites of significance — Ningaloo has 14 registered sites and Legendre has seven. This large number of sites emphasises the importance of these marine environments to Aboriginal people. There are also probably other sites yet to be registered. Registration protects sites in law; however, once a site is registered there is an increased likelihood of tampering. The original Aboriginal custodians of the Ningaloo sites were killed and therefore site registration depends on the awareness of other tribal groups (E. Davis, pers. comm., 1996). Archaeological sites can be ascertained from analysis of found objects but the spiritual meaning of the objects and site cannot. The original custodianship of the Dampier Archipelago is in dispute but the area is clearly of significance to local Aboriginals (D. Meckarl, pers. comm., 1996). As mentioned previously, not only are negative effects on Aboriginal lifestyle likely, they are also potentially significant, with negative effects from tourism noted in Broome (Hall, 1995).

For Legendre, two of the most significant potential effects, anchoring of boats and conflict with other marine uses, are different to those identified for Ningaloo. Anchors at Legendre are of concern because of potential damage to rock-based coral communities. This is of lesser concern at Ningaloo where sandy-bottomed lagoons are less susceptible to anchor damage. In terms of conflicting marine use, the proposed establishment of a deep-water port and causeway at Legendre will conflict directly with ecotourism. The marine environment on which the ecotourism activities are based will be altered and in some areas destroyed.

Conclusion

The Ecotourism Sorensen Network is a useful mechanism for describing and analysing the causes and effects of ecotourism activities on marine environments. The two study areas selected were Australian but this analytic, network approach could be easily applied to marine-based ecotourism elsewhere in the world. The Ecotourism Sorensen Network, as an impact assessment tool, allows the integration of qualitative data from the biophysical and socioeconomic environments, for both potential and existing impacts. The Network then provides a basis for further analysis, as in this article, of the similarities and differences in potential effects between study areas, the likelihood of effects occurring and their significance for various environmental components if they do occur. It also provides a mechanism for managers to identify the causes of environmental effects and the links between activities, causes and effects.

The majority of potential ecotourism effects occurred in both the Ningaloo and Legendre marine environments. More of these potential effects were negative than positive, with most of the latter being sociocultural and economic and the

former predominantly biophysical. The likely effects on Aboriginal peoples and communities were mixed, being both positive and negative. Effects most likely to occur are negative biophysical and Aboriginal effects. Biophysical influences are unavoidable given the direct interaction between most ecotourism activity and the natural environment. Aboriginal effects are also highly likely given the significance of the areas to these people. No matter what the activities and associated potential effects, probabilities of occurrence are higher at Ningaloo because of the greater numbers of ecotourists and established ecotourism industries.

The Ecotourism Sorensen Network can also be used to explore the significance of potential effects based on the susceptibility of an area to damage and levels of ecotourist use. For Ningaloo significant negative effects could result from interactions with the biophysical environment and overcrowding. A significant positive effect is increased money spent in the local economy. For Legendre the most significant potential effects, both negative, are boat anchors damaging the marine biota and possible future conflict between ecotourism and industrial port activities. A significant effect for both study areas is potentially negative effects on Aboriginal people and communities.

To conclude, marine-based ecotourism has effects which can be described and clearly linked to associated activities using the Ecotourism Sorensen Network. This network and the information it contains can be used by managers and policy-makers to prevent or minimise ecotourism impacts through active management.

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References

- Aboriginal Affairs Department (1996) Aboriginal sites. Division of Heritage and Culture (Unpublished). Perth, Western Australia.
- Anonymous (1996) Ningaloo's giant the focus of forefront research. *Murdoch News* 23 (1), 8.
- Australian Conservation Foundation (1994) *Tourism and Ecologically Sustainable Development in Australia*. Fitzroy, Victoria: Australian Conservation Foundation.
- Birtles, A., Cuthill, M., Valentine, P. and Davis, D. (1995) Incorporating research on visitor experience into ecologically sustainable management of whale shark tourism. In H. Richens, J. Richardson and A. Crabre (eds) *Ecotourism and Nature-based Tourism: Taking the Next Steps* (pp. 195–202). Brisbane, Queensland: Flash Printing.
- Bisset, R. (1987) Methods for environmental impact assessment: A selective survey with case studies. In A.K. Biswas and Qu Geping (eds) *Environmental Impact Assessment for Developing Countries* Chapter 1. London: Tycolly International.
- Boyer, A. (1994) Nice and neat niches: A look at a special interest travel abstract. *NPA Bulletin*, March, 11–15.

- Boo, E. (1990) *Ecotourism: The Potential and Pitfalls* (Vol.1). Washington, DC: World Wildlife Fund.
- Buckley, R. and Ponnell, J. (1990) Environmental impacts of tourism and recreation in national parks and conservation reserves. *The Journal of Tourism Studies* 1 (1), 24–32.
- Burns, M. and Associates (1989) *Paper and Proceedings of a Seminar on the Environmental Impacts of Travel and Tourism*. Canberra: Australian Government Publishing Service.
- Canter, L.W. and Canty, G.A. (1993) Impact significance determination — Basic considerations and a sequenced approach. *Environmental Impact Assessment Review* 13, 275–97.
- Canter, L.W. (1996) *Environmental Impact Assessment*. New York: McGraw-Hill.
- Carter, E. (1992) Profit from paradise. *Geographical Magazine*, March, 17–20.
- Commonwealth Department of Tourism (1993) *Draft National Ecotourism Strategy*. Canberra: Commonwealth of Australia.
- Davis, D., Banks, S., Birtles, A., Valentine, P. and Cuthill, M. (1997) Whale Sharks in Ningaloo Marine Park: Managing tourism in an Australian marine protected area. *Tourism Management* 18 (5), 259–71.
- Department of Conservation and Land Management (1989) *Ningaloo Marine Park: Management Plan 1989–1999*. Perth, Western Australia: Department of Conservation and Land Management.
- Department of Conservation and Land Management (1990) *Dampier Archipelago Nature Reserve: Management Plan 1990–2000*. Perth, Western Australia: Department of Conservation and Land Management.
- Department of Local Government (1995) *Local Government Summary Statistics (7): Central Statistical Division*. Perth, Western Australia: Department of Local Government.
- Dowling, R. and Alder, J. (1996) Shark Bay Western Australia: Managing a coastal world heritage area. *Coastal Management* March, 17–21.
- Edwards, G. (1995) *First Report of the Legislative Council Select Committee on the Cape Range National Park and Ningaloo Marine Park*. Perth, Western Australia: Legislative Council of Western Australia.
- Erickson, P. (1994) *A Practical Guide to Environmental Impact Assessment*. San Diego: Academic Press.
- Hall, C.M. (1995) *Introduction to Tourism in Australia*. Melbourne, Victoria: Longman.
- LaPlanche, S. (1995) *Stepping Lightly on Australia*. Melbourne, Australia: Angus and Robertson.
- Muir Environmental (1995) *Extensions to Exmouth Water Supply Borefields*. Perth, Western Australia: Water Authority of Western Australia.
- Shopley, J.B. and Fuggle, R.F. (1984) A comprehensive review of current environmental impact assessment methods and techniques. *Journal of Environmental Management* 18, 25–47.
- Taylor, J.G. (1996) Seasonal occurrence, distribution and movements of the whale shark, *Rhincodon typus*, at Ningaloo Reef, Western Australia. *Marine and Freshwater Research* 47 (4), 637–42.
- Thomson, C. and Stevens, J. (1994) A whale of a shark. *Landscape* 10 (2), 28–34.
- United States Congress Office of Technology Assessment (1993) Science and technology issues in coastal ecotourism. *Tourism Management*, August, 307–15.
- Wells, S.M. (1988) *Coral Reefs of the World, Volume 2: Indian Ocean, Red Sea and Gulf*. Nairobi, Kenya: IUCN and Gland; Switzerland: UNEP.
- Western Australian Tourism Commission (1995a) *Pilbara Region Summary of Key Findings of Western Australian Travel Survey*. Perth, Western Australia: Western Australian Tourism Commission.
- Western Australian Tourism Commission (1995b) *Roebourne Area: Tourism Research Overview*. Perth, Western Australia: Western Australian Tourism Commission.
- Westman, W.E. (1985) *Ecology, Impact Assessment, and Environmental Planning*. New York: John Wiley.