

THE FRINGING REEF PARADOX: OPPORTUNITIES AND CONSTRAINTS

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ABSTRACT

The fringing reefs of the Great Barrier Reef Region are amongst the most biologically diverse of any of the reefs of the Great Barrier Reef Region. That diversity and other attributes, particularly the accessibility of these reefs provides many opportunities for human use, and yet, paradoxically, also imposes many constraints on use. This paper discusses the attributes of fringing reefs, their uses and how these interact in terms of development constraints and opportunities. The paper concludes that with further vertical and horizontal integration of existing approaches to planning and development of fringing reefs, the opportunities they afford for a wide range of uses, could be optimised.

INTRODUCTION

"Among many who visited a "Great Barrier Reef" island resort, the Reef's image waned when they were confronted with the practical difficulties of getting to see or learn something about the reef Unless they had the good fortune to choose Green or Heron Island they found that the Reef could be up to 40 arduous miles by boat, if the **tide was right. If it wasn't, they had** to 'be satisfied with a glimpse of a "fringing reef" near their resort from a glass boat."

(W. Franklin, in an address to the workshop on Tourism and the Great Barrier Reef, Mackay, 1979)

Fringing reefs are seemingly among the more enigmatic natural features of the Great Barrier Reef Region. For example, some scientists have noted (e.g. Steers and Stoddart, 1977) that they are the simplest of the three main reef types while others (e.g. Veron and Pichon, 1976). have recorded their benthic fauna as being the most diverse anywhere in the Region. Similarly, fringing reefs may be highly attractive, although in many cases (e.g. Cape Tribulation reefs) the prevalence of turbid conditions may restrict reef viewing. Many other contrasts could be drawn.

The distribution of fringing reefs within the Region is much less anomalous, with two principal areas of distribution described by Hopley (1982) - mainland fringing reefs and island fringing reefs. The mainland fringing reefs occur intermittently along the coast between Cape Conway (near Proserpine) and the Daintree River. North of the Daintree, they are more continuous, although there are still significant areas of coastline (particularly near river mouths) where no reefal development has occurred. The island fringing reefs display similar variation both geographically and in terms of local development.

The fringing reefs of the Great Barrier Reef Region are used extensively for a range of activities. The predominant uses are those associated with recreation and tourism. This is reflected by the historical development of tourism infrastructure in the Region, where the accessibility of fringing reefs made them ideal **focii** for offshore tourist development.

In recent, years, particularly since the advent of high speed catamaran services to the outer reefs, the range of reef oriented recreational opportunities offered have been greatly increased, possibly resulting in a decline, in the recreational significance of fringing reefs to tourists. As later sections of this paper point out, however, fringing reefs remain a very important setting for a range of uses. A challenge facing both managers and operators, is to ensure that the opportunities afforded by fringing reefs are maximised while ensuring that those uses do not diminish the qualities of the resource on which they are based.

ATTRIBUTES OF FRINGING REEFS

Fringing reefs occupy a particular niche within the broader spectrum of Great Barrier Reef resources. Their wide distribution, high level of accessibility and diverse biophysical attributes combine to facilitate a wide range of potential uses. However, unlike many of the mid-shelf platform reefs, fringing reefs tend to exhibit marked local variation in terms of their in-situ attributes. Thus in any assessment of the development potential of a given fringing reef, or section of fringing reef, some assessment should be made of the relative significance of key attributes such as:

- (a) Geological Structure - the variable evolution of many fringing reefs as noted by Hopley (1982) may be an important factor in terms of influencing:
 - the topography of the reef - e.g. steep windward slope,
 - the composition of the reef - e.g. depth to rock, and
 - the geological history of the reef - e.g. influence of sea-level variations.
- (b) Geomorphological Processes - many factors combine to affect the ongoing growth of fringing reefs. Important geomorphological processes include:
 - erosion - e.g. stability of the reef structures,
 - sedimentation - e.g. infill/burial of surface features, and
 - zonation - e.g. variations in processes in different areas of a fringing reef.
- (c) Meteorological - climatic conditions and processes are fundamental influences in the development, maintenance and attractiveness of fringing reefs. Important elements include:
 - temperature - e.g. the limiting effects of low temperatures on some coral species,
 - rainfall - e.g. effects on reef flat biota of intense downfalls (and subsequent lowered salinity), and
 - cyclones - e.g. potential for disturbance/past influence.
- (d) Oceanographic - oceanographic processes are 'another, fundamental, influence on fringing reef development, maintenance and use. Important elements include:
 - currents - e.g. speed and direction,
 - tides - e.g. height and variability, and
 - waves - e.g., height, period and variability, relative to aspect/exposure.

- (e) Biological - the ecological patterns and processes prevalent on fringing reefs are often quite distinct from those associated with other reef types. This in turn affects their development, functioning and relative attractiveness. Major elements to be considered include:
- . biological community - e.g. algal/coral cover,
 - . productivity - e.g. growth rate and seasonality, and
 - . dynamics - e.g. variability in recruitment.
- (f) Resilience - the ability of an ecosystem to recover from impact or perturbation is a complex question, but one which may be vital to management of an activity in a particular setting. Various studies have shown fringing reefs to be resilient to the extent that their communities are capable of adjustment to highly variable environmental conditions. In considering the resilience of any fringing reef community, the major question faced by management is whether a proposed activity will affect the ability of the community to recover. Account should also be taken of the time scale(s) for recovery.
- (g) Accessibility - Accessibility is regarded as an important distinguishing feature of fringing reefs. Pigram (1984) notes, however, that recreational access implies much more than mere mobility or a tourist's technical capacity to reach a desired site. It is related to that space which the potential visitor perceives as available or attractive for recreational use. Factors influencing visitor perception include:
- . comfort/safety
 - . attitudes/past experiences,
 - . information levels/awareness, and,
 - . social/legal conventions.
- Other important factors for both recreational and other uses include:
- . the setting of the fringing reef (see (i) below),
 - . proximity to centres of demand, and
 - . ease/convenience and cost of access.
- (h) Management - the management regime for fringing reefs in the Great Barrier Reef Marine Park is complex. Nearly all of the fringing reefs are included in the Great Barrier Reef Marine Park. These reefs lie within both Commonwealth and State Government jurisdiction. The predominant management technique currently applied by both Commonwealth and State agencies (or under development) is zoning. This involves a "strategic" scale planning approach, supplemented as necessary by other development controls (e.g. permitting of activities)
- (i) Hinterland - the nature of land use adjacent to fringing reefs, or uses in catchments which may affect fringing reefs may be important influences on the development, maintenance and use of those reefs.

'Some important considerations include:

the physio-chemical pathways for influence, e.g. point/non-point source run off;
the land use setting of the fringing reef, e.g. whether the fringing reef is a barrier to a mainland/island site, or whether e.g., a coastal land use affects the relative attractiveness of the reef, and
the level of demand for fringing reef-based or oriented, activities from adjacent areas (e.g. tourist resort).

- (j) Competition between uses - fringing reefs are characterised by a range of resources and thus, are attractive for a range of uses. The ability of potential uses to coexist and/or separately exploit particular resources depends on considerations such as:

the resource requirements of, the use - e.g. temporal aspects especially,
the "sustainability" of the use - e.g. level of extraction/consumption, and
the intrinsic requirements of a use - e.g. ability to tolerate other uses.

'USES OF FRINGING REEFS

The ten attributes discussed above are indicative of the complexity of factors which must be considered in any assessment of the suitability of fringing reefs for a range of uses. That same complexity also serves to explain the wide diversity of uses of fringing reefs. Data on demand for most uses is limited. However, the following are regarded as major historical or present uses of fringing reefs in the Great Barrier Reef Region:

- fishing, both recreational and commercial, is widespread on fringing reefs in the GBR region, particularly those that are highly accessible from major mainland island centres (e.g. Geoffrey Bay, Magnetic Island).
- coral, shell and aquarium fish collecting occurs on a range of fringing reefs, although data on historic/present levels is limited.
- mariculture - in recent years increasing attention has been paid to, the potential for mariculture in some fringing reef locations. The principal species of interest at present are three species of giant clams (Tridacna gigas, T. derasa and Hippopus hippopus).
- mining and the recovery of minerals, which is prohibited within the Marine Park, although historically, a range of developments involving removal of reefal materials for construction purposes has occurred.
- dredging in the immediate area of fringing reefs is limited in extent, and now subject to permission. Permission is now also required to dump dredge spoil, although it is claimed that historically, spoil dumping may have adversely affected some fringing reefs (e.g. Smith, 1978).

- recreation and tourism use of fringing reefs in the Region is extensive and includes both active and passive uses. There is considerable variation in the extent to which tourism operations make use of fringing reefs. Some reefs form an important component of the recreational attraction of particular tourist operations (e.g. Fitzroy Island), while other reefs provide an incidental setting to tourist activities (e.g. Dunk Island). The increased accessibility of offshore platform and barrier reefs in recent years may also have led to a decrease in recreational attractiveness and hence usage of some fringing reefs, although inadequate data exists to assess the extent of that change.
- conservation of fringing reefs in the Region in terms of habitat protection/preservation is now provided for in the context of the zoning plans for the Great Barrier Reef Marine Park and through complementary State Marine Park zoning plans.
- use of fringing reefs for educational purposes is extensive, although, like tourism and fishing, data on use characteristics and levels is limited. Educational uses include occasional and regular excursions to selected reefs (principally near major mainland centres) and in the case of Orpheus Island, permanent facilities have been established for educational/research activities.
- ~~research use of fringing reefs~~ tends to be highly variable. This is highlighted by the lack of data on fringing reefs in the Great Barrier Reef Region generally. In recent years, research effort on some island and mainland fringing reefs (e.g. Cape Tribulation) has increased in response to perceived threats from hinterland activities.
- waste disposal is a minor activity impacting fringing reefs which may be locally important, and consists predominantly of outfall releases of sewage and plant/process wastes, and of dumping of wastes such as kitchen scraps. These activities are subject to permission under the Great Barrier Reef Marine Park Regulations.
- use of fringing reefs for anchorages is extensive, and includes random anchoring, set moorings and limited boat channels and harbour works. These activities often prevail where fringing reefs are an attractive setting for cruising activities (e.g. Butterfly Bay) or to facilitate access to island/mainland locations.
- "aesthetic" uses of fringing reefs include protection/reservation of areas for amenity purposes. They are rarely overt, although care is often taken in siting facilities to take account of the value of protecting/enhancing the visual amenity of a fringing reef setting (e.g. Hayman Island resort development).

Table 1

Table 1: Assessment of Fringing Reef Suitability*

POTENTIAL USE	SELECTED ATTRIBUTES									
	Geological	Geomorphological	Meteorological	Oceanographic	Ecological	Resilience	Accessibility	Management	Hinterland	Competition
Fishing										
Collecting										
Mariculture										
'Mining										
Dredging										
Recreation/ Tourism										
'Conservation										
Education										
Research										
Waste Disposal										
Anchorage										
Amenity										

KEY

Constraint		Opportunity
Nil		
Interaction		
Partial		
Interaction		
Major		
Interaction		

* See explanatory text

SUITABILITY OF FRINGING REEFS

As indicated above, the suitability of fringing reefs for particular **uses** is highly variable. There are many factors which need to be taken into account in assessing suitability. One method of **assessing** suitability is to define how resource attributes may affect a use in terms of whether those attributes represent a constraint or an opportunity.

Table 1 outlines a broadly-based matrix approach where some key attributes and uses discussed previously are assessed in terms of whether the interaction represents a constraint, or an opportunity, or a combination of both. The table reveals the varying extent of influence of various attributes on different uses. The table is too broad in scope to be applied to specific developments or reef settings, however, it serves as a broad guide to the types of considerations which must be taken into account in planning for use of fringing reefs. The table also indicates that, in many cases, an attribute **may** represent both a constraint and an opportunity. This apparent **paradox** is largely explained by the variable requirements of different uses and by the simplistic design of the matrix. The matrix thus has only limited practical application to development planning for fringing reefs as it does not identify specific aspects of an attribute which may influence the interaction, nor does it specify the relative strength/influence of any interaction.

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The matrix therefore underlines the need to apply appropriate development planning techniques to clearly elicit the type and strength of interaction.

Despite the above limitations, the matrix is a useful basis for comparison of use/resource interactions and provides a framework for more in-depth analysis by identifying **key** interactions and uncertainties. Kenchington and Hudson (1984) outline a range of further analytical techniques appropriate in this context.

RECREATION/TOURISM EXAMPLE

An illustration of how the matrix can be applied to assessment of recreation/tourism uses of fringing reefs is set out below. It is clear from this illustration how the ten factors which are constraints can also be opportunities.

1. As indicated by Hopley and Partain (this volume), there is a diversity of geologic structure in fringing reefs. This can provide a variety of recreation opportunities. A wide exposed reef flat may be appropriate for reef walking and shell collecting (such as on Middle Island reef near **Bowen**). However, the opportunity provided by that type of structure could be a constraint to a semi-submersible operation. A reef with a steep drop-off such as in the Palm Island group would provide a better opportunity for a semi-sub operation, providing excellent views of coral.

2. Certain geomorphological processes can provide constraints to long-term development or use of a fringing reef. If a fringing reef is prone to erosion or sedimentation, it may not be a reliable venue for a tourist operation.

3. A good example of the paradox of opportunity and constraint is revealed in meteorological conditions. The relative safety and shelter provided by many fringing reefs, also means that they are located in areas that are prone to cyclones and a rainy season that can limit the viability of a commercial operation.

4. Oceanographic processes such as tides, demonstrate the variation in opportunity available, for different activities, depending on the tide. On the same reef, one may enjoy snorkelling and water skiing during one part of the day, but reef walking during another, when it is low tide. However, the constraint is that because tides vary daily and seasonally, one cannot count on consistently being able to do certain activities at the same time every day.

In this respect, most successful tourist operations have found that they need to offer a variety of activities and to be flexible in scheduling activities. From a design point of view, floating pontoons and stinger nets may be more successful than more rigidly engineered structures.

5. Biological processes such as the type of algal/coral cover and seasonality of growth can have a major impact on recreational use. Most tourists have a greater appreciation for coral than for algae. If a massive algal bloom is anticipated at a certain time each year, this may be a constraint. On the other hand, as Colfelt (this volume) mentioned, through educating the public to appreciate algae or that "dead" reef flat, this could be turned into an opportunity.

6. The relative resilience (or ability to recover) of fringing reefs to variable environmental conditions means that they can offer a consistent opportunity in many ways. At reasonable levels, fringing reef corals can cope occasionally with lowered salinity which follows rainfall and the run-off from coastal streams. Similarly they can clear reasonable levels of silt which settles from coastal run-off. But when fringing reefs become covered with a blanket of silt, they provide a surface more suitable for plants than hard corals (Hopley, 1985). In this respect they are more susceptible to long-term or chronic "damage" from siltation or pollution. One could suggest, that they have adapted to cope with natural variation impacts rather than man-made impact.

7. An inherent characteristic of fringing reefs is their general accessibility to the coast and consequently, in many cases their proximity to centres of recreation demand. The ease and cost of access, perception of safety and other user requirements will determine the degree of use. With a trend in tourism of expanding into many places previously considered wilderness, accessibility may become less meaningful. The resort lodge recently constructed at the top of Cape York means that previously inaccessible fringing reefs are now more accessible. The zoning of fringing reefs off Cape Tribulation took account of the fact that it was the only sizeable mainland fringing reef in the Cairns Section that was inaccessible at the time.

8. To an average user, the system of management of the Great Barrier Reef Region is incredibly complex, involving a number of different agencies and possibly a number of different zonings. The complexity of management and necessary restrictions may be viewed as a constraint by tourists and recreational users. The opportunities that management provides, however, for interpretation, education and better conservation of the resource must outweigh the constraints. Management must be appropriate to the reefs and their use and to their users.

9. The hinterland offers physical support, to use of fringing reefs by the development of tourist infrastructure. It also places stress on the fringing reef environment, in different ways, from potential waste disposal to increased visitor impact.

10. Depending on the size of the fringing reef most tourist uses can coexist with other uses with little problem. **Conflicting uses** such as seaplane landings near areas used for snorkelling, can be resolved by proper management. Mariculture is an example of virtually exclusive use of a part of a fringing reef. This would not necessarily have to conflict with tourism however, as an opportunity could be provided for education/interpretation on some mariculture operations.

It can thus be seen how factors affecting the suitability of fringing reefs for tourism can be paradoxical.

RESOURCE OPTIMISATION

Other papers at this workshop will discuss resource-use interactions in more detail, and techniques for optimising those interactions. Many such techniques exist, at all planning levels. Appropriate to this discussion are those techniques which seek to maximise opportunities and minimise constraints.

Table 2 below sets out three categories of techniques within three planning levels as examples of methods for achieving optimal use while minimising potential disbenefits. Such techniques may be applied by government or industry or, ideally, both (according to factors such as location, nature of use, ability to control and motivation for involvement).

Table 2: EXAMPLES OF TECHNIQUES FOR OPTIMISING USE OF FRINGING REEFS

PLANNING LEVEL	TECHNIQUE		Site Management
	Direct Regulation	Indirect Regulation	
Strategic (Regional)	Zone Use	Inform Users	Restrict Activities
Developmental (Industry/Area)	Management Plan	Alter Setting	Restrict Use Density
Site (Local)	Control of facilities	Signage	Focus Use

Effective implementation of the techniques set out in Table 2 requires a consistency of approach between planning levels and the type of technique within each level. Horizontal integration is particularly important, as there is considerable interdependence between activities and fringing reef settings and hence, the types of opportunities provided to users. Pitts (1985) has discussed this **interdependence in terms of the recreational opportunity spectrum (ROS) concept..** The ROS concept is based on the premise that **there** is a continuum of opportunity states ranging from what Pitts terms 'modern' to 'primitive' setting. Figure 1 depicts the continuum, using appropriate reef **examples.**

While the ROS concept is not overtly used in planning for the conservation and development of the resources in the Great Barrier Reef Region at present, its rationale and framework appears to be highly appropriate to optimising recreation and tourist use of fringing reefs. The ROS concept is based on the premise that quality in outdoor recreation is best assured through provision of a diverse set of opportunities. Clark and Stankey (1979) note that to achieve this, the spectrum offers a framework within which to explicitly vary situational attributes (access, density, etc) to produce different settings. From these settings, recreationists participating in different kinds and styles of activities derive different satisfactions and, ultimately, benefits. The technique thus accepts and systematically provides for diversity, thereby mirroring the characteristics of fringing reefs, as discussed previously.

Table 2 also illustrates that vertical integration between planning levels is also desirable if the opportunities afforded by fringing reefs are to be realised. Achievement of this integration is complicated by factors such as the division of jurisdiction, the nature of the use(s) and the motivation/requirements of developers and users. It is, however, likely that as the strategic framework for planning of the resources of the Great Barrier Reef Region is completed through development and implementation of various zoning plans, then both managers and developers/operators will be able to "fine tune" other planning levels.

CONCLUSION

Fringing reefs are among the most diverse of the resources of the Great Barrier Reef Region. In seeking to maximise the potential benefits of the uses of any particular fringing reef, careful assessment needs to be made of the attributes which contribute to the overall use potential of that reef.

Current planning and management methods recognise this need in part, by taking account of relevant attributes in the preparation of zoning plan, in the formulation and review of development proposals and in the operation of existing ventures. It is suggested, however, that with further attention to vertical and 'horizontal' integration of planning and development, the opportunities afforded by fringing reefs could be further optimised.

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Setting

'PRIMITIVE'

'MODERN'

Overnighting on a
cruising yacht anchored
alone in an isolated
lagoon

Overnighting with 20 others
on a mother-ship moored in
a lagoon and serviced daily
by a seaplane from the
mainland

Overnighting with 400 others on
a floating hotel and casino
permanently moored in a
lagoon and rising six storeys
above the water

Description

Opportunities for self reliant
recreation in a natural
environment away from the
sights and sounds of people
and direct management
control. A high degree of
challenge and risk.

Opportunities for recreation in
the company of others but in an
environment that is still largely
isolated from the sights and
sounds of people and obvious
human intervention. Basic facilities
are provided and some on-site
management controls are
necessary.

Opportunities for organized
recreation in a 'resort'
environment. Although the
natural backdrop remains, use
levels are high, sophisticated
facilities are provided and obvious
on-site regulation of use is
necessary.

FIGURE 1: THE CONCEPT OF THE RECREATION OPPORTUNITY SPECTRUM

Source: Pitts (1985)