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DEVELOPING ECOTOURISM FOR THE SURVIVAL OF SEA TURTLES

Abstract

Discusses generally why humans should bother to conserve sea turtles. In doing so, it considers both economic and non-economic reasons and outlines threats to the existence of sea turtles and ways in which tourism may either contribute to the conservation or decline of their populations. Turtle-based ecotourism at Mon Repos in southern Queensland is described. As a result of a survey conducted by the authors, it is shown that turtle-based ecotourism at Mon Repos has positive social (indirect) consequences for the conservation of sea turtles. Furthermore, it is argued that ecotourism operations at Mon Repos have positive direct impacts on the sustainability of populations of sea turtles. However, using a simple model, it is demonstrated that this impact is limited because turtles are migratory. A model is also developed to capture the possible relationship between turtle populations and the sustainability of ecotourism dependent on turtle populations. It is argued that significant interdependence exists between the sustainability of these two variables.

Key words: Biodiversity, Economics, Ecotourism, Sea Turtles, Sustainable Tourism, Wildlife Conservation.

DEVELOPING ECOTOURISM FOR THE SURVIVAL OF SEA TURTLES

1. Introduction

All species of sea turtles are listed by the IUCN as being endangered and the Hawksbill *Eretmochelys imbricata*, is listed as critically endangered (IUCN 1998). Sea turtles have become endangered as a result of the adverse consequences of human activities. Positive human action is required to ensure the survival of most species of marine turtles.

In this article, the potential of tourism development based on turtle-watching to contribute to the sustainability of populations of sea turtles is explored. Empirical results are based on findings from a survey of tourists visiting Mon Repos Conservation Park in south-eastern Queensland in order to observe turtles. Analysis is developed to specify likely interactions between turtle-watching and the conservation of turtle populations. The sustainability of tourism based on turtle-watching and that of turtle populations is shown to be interdependent for a variety of factors involving both direct and indirect impacts from tourism based on turtle watching.

This subject will be explored by considering the following matters sequentially

- 1) threats to marine turtles and turtle-based tourism in a general context;
- 2) turtle-based ecotourism at Mon Repos beach in Queensland – background description;
- 3) economic, political, communal, educational and indirect conservational consequences of turtle-based tourism at Mon Repos as revealed by a survey of visitors;
- 4) analysis of direct positive impacts of ecotourism operations in sustaining population of sea turtles as suggested by experience at Mon Repos; and
- 5) analysis of the sustainability of ecotourism dependent on turtle watching, followed by
- 6) concluding observations.

2. Why Should Humans Bother to Conserve Marine Turtles?

Before discussing these points, it is, however, relevant to consider why humankind should make a special effort to save sea turtles from extinction. Different social groups may give different reasons.

For economists, the desirability of special action to save sea turtles can usually be expected to hinge on whether market failure is present and whether a Kaldor-Hicks or a potential Paretian improvement would be achievable as a result of intervention to conserve turtles. Taking a man-centred approach, economists, in order to justify intervention, will usually search for evidence of market failure in terms of the presence of such factors as the presence of externalities and public good characteristics. Given the migratory behaviour of turtles, often transboundary or international, these fugitive resources give rise to economic externalities. Furthermore, public good characteristics are present. For instance, many individuals in society value the pure existence of these animals (existence value) and may collectively desire their conservation for the benefit of future generations (bequest value). Option values are also likely to be present. Some individuals may wish to keep open the option of seeing turtles in the future and this option value may not be fully taken account of in the marketplace. Furthermore, wild turtles in the future could provide or contribute to products e.g. medicine, inputs to turtle farming, as yet uncertain or unknown. This uncertainty-option element may provide an additional reason for conserving (Krutilla 1967) at least minimal viable populations of turtles, that is relatively safe minimum populations (Krutilla 1967; Ciriacy-Wantrup 1968; Bishop 1978; Hohl and Tisdell 1993).

For some philosophers, however, the desirability of conserving species is not purely to be determined by reference to the desires of mankind – values independent of human wishes are recognized. For example, Leopold (1996) argued in favour of preserving ecosystems as a whole because of their intrinsic value as expressed in his land ethic. Passmore (1974) sees Man as having responsibility to provide stewardship for nature and Sagoff (1988, 1994) argues in favour of the rights of animals and their rights to continue to exist.

In modern times also, the conservation of species, or more widely of biodiversity, has been linked to the possibility of achieving sustainable development. Sometimes it is argued that conservation of biodiversity is necessary to achieve ecologically sustainable development or even sustainable economic development.

In relation to ecologically sustainable development, it is useful to distinguish between at least two possible objectives:

- (a) the achievement of economic development or economic growth subject to a specified degree of ecological conservation and
- (b) the maintenance of ecological conservation to the extent necessary to ensure sustainable economic development.

Conservation of all species is unlikely to be required to achieve (b), and objective (a) may involve a greater degree of biodiversity than (b).

It is not apparent that the conservation of sea turtles is needed to achieve (b) because none seem to be keystone species. Or, at least given this perspective, it would be important to show that turtle species do have a keystone role in the maintenance of ecosystems of economic significance to mankind or to show that they could have. However, economic support for conservation of a species does not necessarily depend on its consumptive value nor on whether it is a keystone species in an ecosystem of economic value to mankind. Thus, because sea turtles have economic value in themselves, it may still be socially worthwhile conserving them even if they are not keystone species. With this background in mind, let us turn to more specific aspects of conservation of sea turtles.

3. Threats to Marine Turtles and the General Role of Tourism in the Conservation and Decline of their Populations

Although marine turtles face many natural threats to their existence, they have primarily become endangered due to human activities. Some indigenous communities continue to hunt sea turtles for meat and collect their eggs for consumption. Turtle shells may be used for jewellery and tortoiseshell items. Their leather can also be utilised and tourist souvenirs and curios can be produced from these items. Turtles are subject to damage by power boat

strikes, especially if struck by propellers, and may be caught in crab pots or fishing nets and die particularly in prawn trawl nets. Furthermore, they can become entangled in plastic ropes and other debris floating at sea and drown, and some species which eat jelly fish are prone to ingest plastic bags and bottles which they apparently mistake for jellyfish and this can result in their death. Pollution e.g. of water by oil spills, poses a risk. In many parts of the world seagrass (*Sargassum*) beds are being threatened by human impacts and this reduces available sources of food for the Green turtle, *Chelonia mydas*. In several countries, urban development along the foreshores of beaches where turtles nest creates major problems for the conservation of turtles. Urban residents may disturb nesting turtles and be tempted to collect their eggs. But more significantly turtle hatchlings are likely to be disoriented by light from land-based development. On hatching, they are attracted towards the most powerful source of light. In a natural setting, this is usually the sea, but artificial light from land may attract them inland after hatching, where they perish.

Depending upon the way in which turtle-based tourism is developed, it can either be a positive force supporting the conservation of turtles or a destructive force.

Destructive-type tourism occurs when turtles are utilized unsustainably as a part of such tourism e.g. when they are used to supply specialty turtle-based goods, produce curios, souvenirs and other specialty items for tourists. While the Convention on International Trade in Endangered Species (CITES) helps to reduce the demand from international tourists for turtle-based souvenirs and other durable items made from turtles, it has not completely eliminated this trade or other forms of international trade in turtle-based products. For example, tortoiseshell still finds its way to Japan for the bekko trade even though Japan is a signatory to CITES.

Tourism can also be destructive of turtles when it does not have proper regard to their ecological needs (cf. Heng and Chark 1991, pp.33-36). For example, if tourist development results in light distracting to turtle hatchlings or if tall tourist or other buildings shade beaches so that turtle eggs receive insufficient heat to incubate, the turtle sub population

nesting on the beach concerned will eventually be eliminated. Similarly if tourists cause distress to turtles attempting to nest, they may fail to do so.

Tourist attractions merely based on captive turtles held in aquaria may also have a negative impact on turtle populations, if such turtles are captured from the wild, if they act as a substitute for ecotourism based on the presence of real turtles, and if they provide little or no conservation message. Much depends on how aquaria-based turtle tourism is developed, and whether or not it is seen as a substitute locally for conserving the rookeries of sea turtles.

Aquaria do have the advantage, from a commercial point of view, that they enable turtle-based tourism to take place during the day and operations are much less labour-intensive than those associated with ecotourism reliant on the nesting of wild turtles. Furthermore, captive sea turtle-watching has the advantage that it is not seasonal, as the watching of wild turtles often is, and the tourist is sure to see turtles which is not the case for ecotourism based on the viewing of wild turtles.

Ecotourism which makes direct use of the viewing of wild turtles is a night-time activity and is seasonal as a rule. It requires considerable care to be taken by tourists guides in crowd control and a good deal of patience. But for most individuals seeing wild turtles, and even touching the carapace of nesting females (a hands-on experience), in vital parts of their life-cycle, it is a special experience building a degree of empathy with turtles that can not be replicated by a visit to an aquarium holding sea turtles. It is ecotourism of this type which has been developed at Mon Repos beach in southern Queensland.

Sometimes turtles in aquaria are also combined with night-watching of turtles as has now happened at Praia do Forte in Brazil. But in Reunion, turtle-watching is entirely reliant on sea turtles in aquaria, whereas at Mon Repos sea turtle-watching is entirely of an ecotouristic nature depending only on the viewing of wild marine turtles.

4. Turtle-Based Ecotourism at Mon Repos Beach: Background Description

Ecotourism is a form of tourism which is usually wildlife-based and careful of the environment. It is therefore likely to be sustainable. Many writers also suggest that ecological/biological education should be an important part of an ecotouristic experience. The whole experience is likely to leave tourists with a positive attitude towards the conservation of nature.

Turtle-watching at Mon Repos beach near Bundaberg in south-eastern Queensland (see Figure 1) satisfies the required conditions for ecotourism. Turtle-watching at this beach is managed by the Queensland Parks and Wildlife Service (QPWS). Turtles may be seen here in the period mid-November to the end of March of each year, the hottest period of the year in Australia. Mostly loggerhead turtles, *Caretta caretta*, nest on this beach.

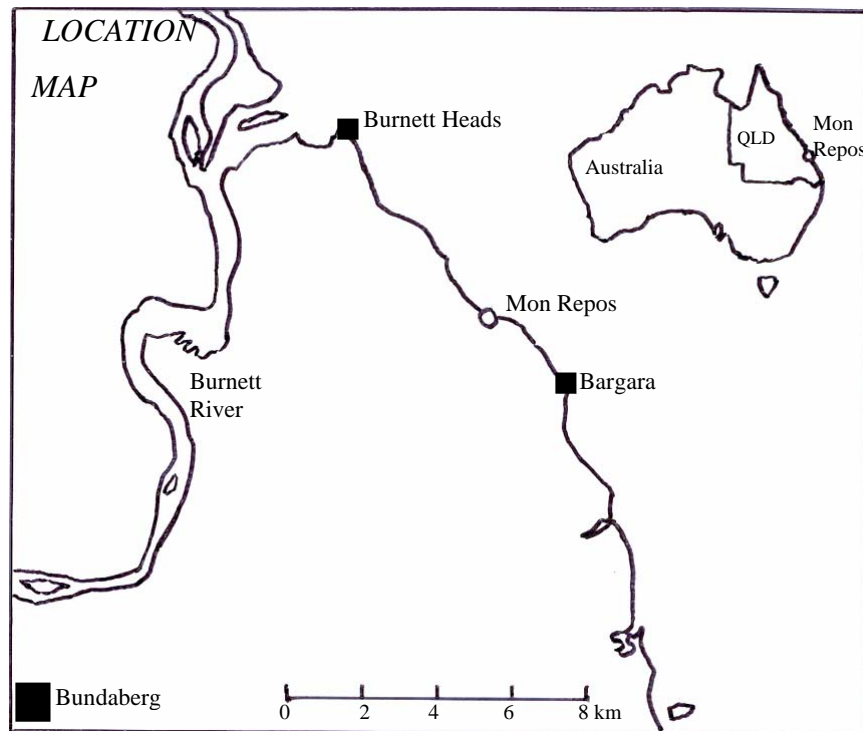


Figure 1: Map showing the general location of Mon Repos (after Kay,1995, p.1).

Turtle watching takes place at night under the guidance of QPWS rangers and volunteers. During the turtle season, evening visitors to Mon Repos Conservation Park pay a small fee

for entry (see Table 1). The fee enables visitors to see the display on sea turtles at the information centre, participate in the presentation at the outdoor amphitheatre and join a group of up to 70 persons to be guided to the beach to see turtles nesting, if they appear, or to see hatchlings emerging at times when this occurs. QPWS rangers assisted by volunteers explain what is being observed and undertake crowd control. At the same time, they collect scientific data on nesting turtles and hatchlings.

Table 1.
Nightly Entrance Fees to Mon Repos During the Turtle Season (Mid-November to end of March inclusive) 1999/2000

Single visit ticket	Aus \$	Season ticket	Aus \$
Child (5-15)	2	Child (5-15)	5
Pensioner	2	Pensioner	5
Adult	4	Adult	10
Family	10	Family	25
School Groups	1 per student		

Source: Queensland Department of Environment and Heritage, 1999, p.3.

Turtles about to nest usually come ashore in the evening on the high tide and make their way up the beach to find a suitable site to nest. Once a turtle has been noticed by personnel of QPWS, and has found a suitable spot to nest and has become settled at that spot, a group of visitors is brought from the information centre to witness the nesting process. After egg-laying is completed and the eggs are covered by the female turtle, visitors accompany it on its return to the sea. Similarly, visitors watch hatchlings emerge and accompany them to the sea.

However, visitors are not assured of seeing turtles and the entry fee is payable whether or not turtles are seen. Furthermore, the time of arrival of any nesting turtles is variable. Visitors may have to wait until quite late before a nesting sea turtle is available for viewing. Tourist operations are combined with collection of data about turtles which is used for scientific purposes.

The Queensland state government began the process of creating Mon Repos Conservation Park for the conservation of sea turtles in 1981 by its acquisition of an initial parcel of private land. However, turtle research at Mon Repos beach had already commenced in 1968 as part of the Queensland Turtle Research Programme. In 1985, research staff at Mon Repos commenced formal turtle-watching programmes in order to manage growing crowds of visitors. In 1993, an Information Centre and Amphitheatre were constructed at Mon Repos and in the following 1994/95 turtle season, ecotourism involving turtle watching was formalized with an entry fee being charged. In 1991, Woongarra Marine Park was established in order to protect turtles offshore from Mon Repos and nearby beaches during their breeding season.

Although Mon Repos Conservation Park is only 45 ha. in size, it protects the leeward side of Mon Repos beach for a distance of about one kilometre, and has prevented urban development of this foreshore area which was mooted in the late 1970s and early 1980s. This, combined with a tree planting programme to reduce light from onshore provides effective protection to turtles at Mon Repos, a major Australian rookery for loggerhead turtles.

The number of visitors to Mon Repos Conservation Park in recent years for the purpose of turtle-watching are shown on Table 2. It can be seen that in the 1994/95 season the number of visitors fell considerably compared to the 1993/94 season. This may have been due to an initial adverse reaction to the introduction of fees. However, during the 1999/2000 turtle season, the number of visitors was over 23,000 and had returned almost to its 1993/94 level.

Table 2.
Annual Number of Visitors to Mon Repos Conservation Park for Turtle-Watching
1993/94 to 1999/2000 Season

Year	Visitor Numbers
1993/94	23,580
1994/95	14,868
1995/96	19,962
1996/97	18,284
1997/98	17,394
1998/99	18,421
1999/2000	23,485

Source: Queensland National Parks and Wildlife Service, 2000 (unpublished data)

5. Turtle-based Tourism at Mon Repos: Its Economic Impacts and Social Consequences for the Conservation of Sea Turtles

Ecotourism can have directly beneficial consequences for the conservation of nature as well as indirect benefits. Direct benefits for sea turtles from ecotourism at Mon Repos are specified in the next section. This section concentrates on indirect benefits. These may occur because tourists, as a result of their turtle experience, become more aware of threats to populations of marine turtles, show greater appreciation of the value of turtles and develop greater empathy for them and learn of ways in which they can foster the conservation of turtles.

A survey of visitors to Mon Repos turtle rookery undertaken by the authors in the period December 1999 to end of March 2000 with the assistance of QPWS staff and volunteers revealed that the turtle-experience which tourists had at Mon Repos has a strong positive impact on their support for conservation of sea turtles.

A total of 1,200 survey forms were distributed to visitors to Mon Repos Conservation Park intending to see turtles. A total of 519 usable complete forms were obtained. About 15 questionnaires per day were randomly distributed either with sales of entrance tickets or to

visitors waiting to view sea turtles. Completed survey forms were either left with rangers or volunteers at Mon Repos or returned to us in a pre-paid envelope.

Nearly all respondents (99%) said that they found turtle-watching at Mon Repos Conservation Park informative. About a third of respondents learnt about threats to sea turtles for the first time, and 54% said they learnt more about such threats as a result of their visit. So about 87% of respondents were better informed about threats to marine turtles as a result of their visit.

It was also revealing that the visit convinced the majority of individuals to adopt personal behaviours that would support the conservation of sea turtles. After their visit, 62% of respondents said they would be more careful of disposing of plastics and 47% said this in relation to fishing gear. Most said they would exercise greater care in switching off lights near beaches (68%), avoiding the purchase of tortoiseshell products and turtle eggs, meat and soup (73%) and in using beaches where turtles nest (75%). Furthermore, after their turtle experience at Mon Repos, two-thirds of respondents said that they are likely to report the sighting of sick or injured sea turtles, and 88% said they would report the poaching or mistreatment of sea turtles.

After their visit, 87% of respondent said they were convinced of the urgency of protecting/taking action to conserve sea turtles, and 98% were convinced that more action should be taken to minimize threats to sea turtles.

A considerable percentage of responding visitors (40%) said that their visit to Mon Repos will influence them to contribute more money for sea turtle conservation than before. 27% said they would contribute the same amount as prior to their visit to Mon Repos, whereas only 1% said they would contribute less. However, 32% did not answer this question. Just over a half of the respondents (268 out of 517) indicated that they would be willing to contribute an average of Aus\$2.49 per week to protect turtles in Australia that is over Aus\$125 per year per person willing to contribute to the conservation of turtles. This was in response to the following question (8.4). “In order to protect sea turtles that come to nest

in Australia what is the maximum amount you would be willing to pay per week for the next ten years? (Please bear in mind that this is only one of the many environmental issues which may cost you money and that this may have to come from your family budget).” It can be inferred that the visitors to Mon Repos for the 1999/2000 season involved in turtle watching would be prepared to pay at least Aus\$250,000 per year to protect Australian sea turtles. When this is combined with the willingness to pay by turtle watchers from previous years plus the willingness of some non-visitors to pay for protection of turtles, considerable collective economic value is clearly placed on the conservation of Australian marine turtles. This can also be expected to translate into political support for state programmes for the conservation of marine turtles.

Political support for ecotourism and conservation of turtles at Mon Repos can also be expected from other quarters. To the extent that turtle watching at Mon Repos attracts tourists to the Bundaberg region, it has positive local economic impact. From our survey, it was found that 40% of respondents would not have visited the Bundaberg region had turtle-watching not been possible (at Mon Repos) and that a further 19% would have reduced their length of stay in the Bundaberg region. This would have resulted in a fall in initial tourism expenditure in the Bundaberg region by about Aus\$1m in the 1999/2000 turtle season.

Furthermore, support for turtle conservation and ecotourism at Mon Repos can be expected from community involvement in these activities. A significant number of community volunteers (36 volunteers contributing 4 hours per week for 5 months) help guide visitors to see turtles at Mon Repos, assist with scientific data collection, and in other ways. Such communal help fosters community support for the conservation of marine turtles.

Respondents to our survey on average showed a high degree of consumers’ surplus after the turtle-watching experience. From responses, it can be inferred that on average the consumers’ surplus of individuals was more than double their entry fee. This surplus indicates a high degree of economic satisfaction with the turtle-watching experience, and is likely to add to political support for the ecotourism programme at Mon Repos. The fact

also that a large proportion of respondents (98%) intended to share their experiences at Mon Repos with friends and relatives would provide an additional avenue of support for conservation of sea turtles.

All in all, the turtle-watching experience at Mon Repos fosters major support, social and economic, for the conservation of marine turtles. This indirect effect via humankind may be as important or more important for turtle conservation than the direct consequences of turtle-watching for the conservation of sea turtles. Consider now the direct impacts.

6. Analysis of Direct Positive Impacts of Ecotourism Operations in Sustaining the Population of Sea Turtles

Ecotourism (of the type practiced at Mon Repos) can be very effective in protecting the breeding grounds (rookeries) of turtles. This is particularly so when the rookeries are concentrated in a small area as is so at Mon Repos beach.

During the breeding seasons for turtles at Mon Repos from mid-November to the end of March, the hotter part of the year in Australia, turtle-watching visitors are catered for at Mon Repos Conservation Park. This means that the beach is under almost constant surveillance by Queensland Parks and Wildlife Service rangers and associated volunteers from dusk until past midnight when most female turtles come ashore to nest. Turtles come ashore at night to nest. During the nighttime unauthorised entry to this beach is prohibited.

Park rangers and volunteers guiding ecotourists to watch turtles at Mon Repos have the indirect effect of guarding turtles against illegal human intrusion. Furthermore, predators are kept at bay during nesting of turtles because most female turtles are watched during the whole of their nesting activities and accompanied by turtle-watchers until they return to the sea. Moreover, emerging baby turtles are likely to be under protective surveillance for much of the night because of the presence of turtle-watchers. So large batches of young turtles on land at night are given some extra protection before they enter the sea as a result of the presence of turtle-watchers.

So it can be argued that the development of turtle-based ecotourism has a positive direct impact on rookeries such as that at Mon Repos in protecting turtle populations. This is so apart from any indirect impact e.g. through increased political support for turtle conservation.

Also turtle-ecotourism at Mon Repos has led to some investments which help to increase the likely survival of baby turtles. For example, there has been planting of casuarinas (she-oaks) along the leeward side of the beach to reduce light emissions from land. Light from the land disorients hatched turtles. They are photosensitive and move towards the area emitting the greatest amount of light. In normal circumstances, this is the sea. But artificial light from the land may cause baby turtles to move inland where they meet their death.

Scientific data collection such as that obtained by tagging of turtles, egg counts and so on are combined with turtle-watching at Mon Repos. Because of the presence of visitors a greater number of volunteers may be available to help with collection of scientific data. In the long-term, this data could assist in the development of improved policies for managing turtle populations. Scientific data collection and research involve an investment likely to enable more effective strategies to be developed to sustain turtle populations.

Furthermore, it is possible that the presence of ecotourism at Mon Repos provides some stimulus to programmes to control predators of turtles eggs. The fox, *Vulpes vulpes*, introduced to Australia from Britain is, for example, a significant predator of turtle eggs. Baiting programmes to reduce the population of foxes in the vicinity of Mon Repos beach have been introduced.

However, even if the number of turtle hatchlings reaching the ocean is increased by ecotourism activities at Mon Repos, it will take a long time before this is translated into a larger number of female loggerhead turtles coming ashore at Mon Repos to nest. This is because it takes 30-50 years before females are mature and lay their first clutch of eggs (Queensland Turtle Research, 1994, p.27). Conservation in this case requires a long-term perspective to be taken.

Like salmon returning to their stream of birth, turtles usually return to nest on the beach where they were born. It is suggested that they are able to do this because of geomagnetic sensitivity and memory. This raises an interesting ‘property-rights’ or appropriation perspective. If the distribution of mortality of turtle hatchlings entering the sea at the rookery is constant and in particular if the relative frequency distribution of turtles reaching adulthood is constant and is positive, in the long-term the population of adults nesting at a rookery will rise if the population of hatchlings from the rookery entering the sea increases.

Ignoring overlapping generations, then roughly the population of nesting turtles at a rookery in period $t + n$ (where n is the period required for turtles to reach maturity and t represents the time of birth of turtles) might be represented as

$$y_{t+n} = f(x_t) \quad \text{where} \quad f' > 0 \quad (1)$$

and y represents the population of nesting turtles and x_t the number of female hatchlings entering the sea at time t .

Consider the simple linear case

$$y_{t+n} = ax_t \quad (2)$$

where a is the coefficient of survival of female hatchlings to adulthood.

It might be noted that only females come ashore to nest, and different beaches have different ratios of females to males in their population of turtle hatchlings. The sex composition of hatchling populations is temperature dependent. Warmer beaches tend to produce a higher proportion of females, and the proportion of female hatchlings at Mon Repos is high. If X_t represents all hatchlings entering the sea and Θ represents the proportion of females, then equation (2) could be rewritten as

$$y_{t+n} = a\Theta X_t \quad (3)$$

If the ‘appropriation’ of ecotourism benefits from conservation of sea turtles at the rookery is dependent on the long-term return of females, this benefit will be greater, other than

things unchanged, the easier it is to increase or maintain x_t and the higher is a , the survival coefficient.

Note that the coefficient a depends on two elements, the natural rate of mortality (b_1), and mortality due to anthropogenic factors (b_2), that is

$$a = 1 - (b_1 + b_2) \quad (4)$$

While it may be impossible or considered undesirable to try to vary b_1 , there may be scope to reduce b_2 . In Australia, measures to reduce b_2 include limitations on the speed of boats in the neighbourhood of turtles, turtle-excluding devices on prawn trawlers, and trawler exclusion zones such as that during the turtle-breeding season at Woongarra Marine Park abutting Mon Repos and surrounding beaches. But additional reductions in b_2 are possible, for instance, by avoiding disposal of plastic bags and containers into marine areas when some species of turtles ingest those, they die. Moreover mortality can be further reduced by ensuring that plastic ropes and nets are not left at sea for turtles to entangle themselves.

However, because sea turtles are international transboundary resources (they migrate over long distances and between countries) the countries where they nest do not have complete control over b_2 , because of their mortality in international waters and in the exclusive economic marine zone of other countries. In these circumstances, reducing b_2 , or preventing it from rising, is likely to depend significantly on international cooperation.

7. Analysis of the Sustainability of Ecotourism Dependent on Turtle Watching

Judging from the responses to the survey of visitors to Mon Repos for the purpose of seeing turtles, ecotourism can be very effective in building community support for programmes to conserve turtles, as reported earlier. However, it seems likely that the demand for the opportunity to watch turtles nesting or hatching at a locality will depend on the probability of seeing them.

Other things equal, the probability of seeing turtles on a beach will depend on their population. As the population of turtles declines on a beach, the demand to engage in turtle-watching there can be expected to decline. The sustainability of tourist visits,

therefore depends on the extent to which turtle populations visiting a beach are maintained. In turn, given that community support for turtle conservation programmes is to a considerable extent experiential (that is dependent on human interaction with turtles), political and private support might vary in a similar way to the frequency function for visits by tourists.

The frequency function (total number of visits for turtle watching) might take a form of logistic type as shown in Figure 2. As drawn, this suggests that there may be a threshold at which the demand for visits by turtle-watchers to a rookery declines precipitously as the population of (female) turtles visiting the rookery during the breeding season declines. Thus unless turtle populations visiting a rookery can be saved early enough from significant collapse, tourist visitor numbers and communal support for turtle conservation may crash, thereby compounding the problem of reversing the unfavourable downward trend in sea turtle populations. In the most extreme case, mathematical catosphere theory would apply because a discontinuous decline or 'jump' in social support for conservation of turtles may occur, and the situation may become irreversible from a social or political viewpoint as well as biologically if programmes to conserve turtles are subsequently scaled back.

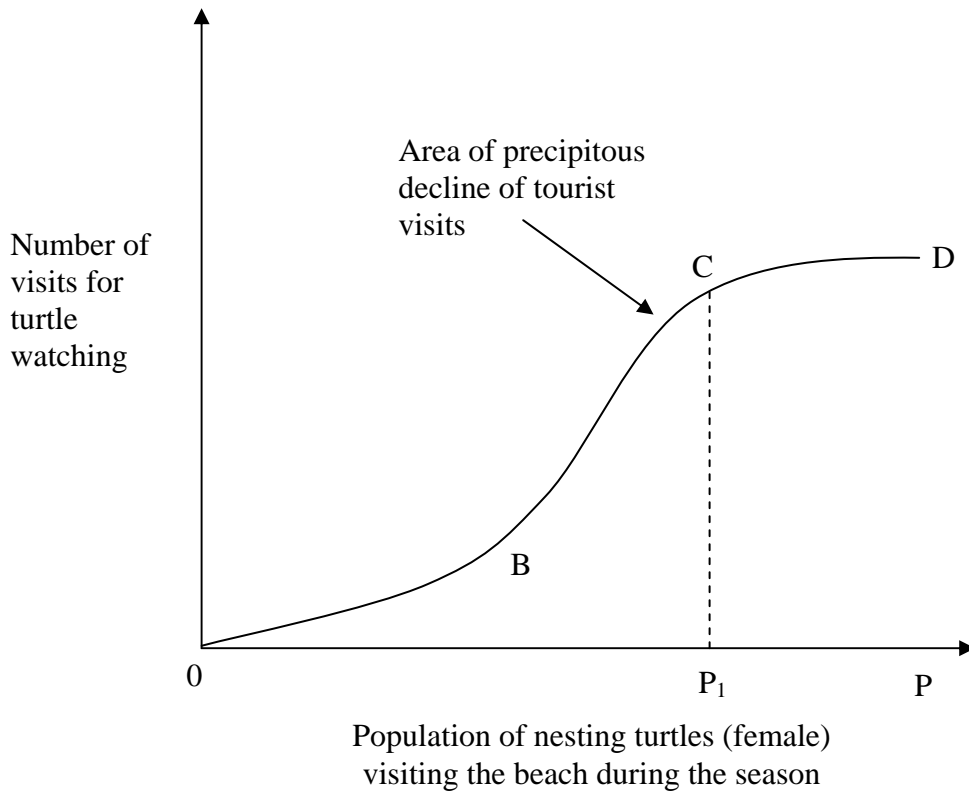


Figure 2. Sustainable ecotourism and sustainability of populations of turtles are interrelated

This interesting sustainability phenomena is not, however, confined to ecotourism based on turtle-watching. It is likely to occur for ecotourism and recreation involving the viewing of most wild animals. It may also be present for the recreational hunting of wildlife, given that hunters are often strong supporters of conservation of their hunting stock.

8. Concluding Comments

The type of ecotourism developed at Mon Repos Conservation Park based on turtle watching has both, as outlined, positive indirect and direct consequences for the conservation of loggerhead sea turtles. The population of nesting sea turtles at Mon Repos beach has not fallen below the critical level (see Figure 2) for sustaining support from tourists for sea turtle conservation. In the four turtle seasons, 1996/97 to 1999/2000, a seasonal average of 183 loggerheads, 6 flatbacks and 2 green turtles were recorded as nesting at Mon Repos. This may be just above the critical tourist threshold in Figure 2. So from this point of view, the conservation position at Mon Repos seems precarious: any

significant decline in numbers of turtles currently nesting at Mon Repos may result in a major decline in its visitors to watch turtles.

While turtle-based tourism at Mon Repos appears to fulfil the ideal conditions for ecotourism, this is not true of all turtle-based programmes. Whether or not aquaria-based turtle tourism helps to conserve populations of turtles depends upon how such attractions are managed and their programmes generally. Some appear to be purely captive facilities without breeding programmes for turtles, and without significant educational or other programmes to support the conservation of sea turtles. Others are associated with programmes to purchase turtle eggs from local people, hatch them under protection and release them, provide education about the conservation of sea turtles as well as to provide local employment. This is the case at the Kosgoda Turtle Hatchery in Sri Lanka (Gampbell 1999) and at Praia de Forte in Brazil (Vieitas *et al.* 1999, see also Marcovaldi *et al.* 1999). There has also been development of ecotourism based on non-captive populations in less developed countries, for example in Costa Rica (Place 1999; Lee and Snepenger 1992). How successful that has been compared to the programme at Mon Repos has yet to be assessed.

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