

6. HUMAN ACTIVITIES IN THE GREAT BARRIER REEF WORLD HERITAGE AREA

The following discussion is based on impacts and effects of human activities on marine turtles, documented both in the World Heritage Area and from other parts of the world. The lack of information about specific impacts and the regularity with which some of these impacts occur is an issue for management of all activities. Table 3 is a summary of the impacts of human activities on marine turtles.

A variety of human activities occurring in and around the World Heritage Area are known, or thought likely, to adversely affect turtles. It is important to consider not only the potential impacts of individual activities, but also the potential cumulative impact of activities that are likely to affect the populations of each species, over both the short and long terms.

There is insufficient scientific information to determine definitively for each marine turtle species whether adverse effects resulting from human activities are ecologically sustainable, or, in some cases, whether they are actually occurring. However, there is growing information of the impacts on loggerhead and green turtles. In the absence of information and because there is a risk of serious or irreversible damage to turtle populations, the precautionary principle should be employed in the World Heritage Area. Whilst the absence of scientific certainty is not a reason for failing to take prudent measures to conserve turtles, management measures must also allow for reasonable human use of the Marine Park.

6.1. Boats, Ships and Other Vessels

Vessels using the World Heritage Area range from surfskis and personal watercraft to ocean-going freighters and cruise ships. Vessels are operated in association with a variety of activities, including recreational use, commercial tours (including cruise ships), public transport (ferries), defence activities, commercial and recreational fishing, and commercial shipping (Great Barrier Reef Marine Park Authority 1998a). All vessels for charter hire, ferry service or for tourism require a permit from the Authority to operate in the Marine Park. Cruise ships require a permit from the Authority if they wish to anchor and conduct commercial activities in certain areas of the Marine Park.

The World Heritage Area includes several major shipping routes and reef passages used by commercial ships. In 1997/98, 1500 large ships transited the Inner Route of the Great Barrier Reef (Great Barrier Reef Marine Park Authority 1998b).

The Great Barrier Reef has been designated as the world's first Particularly Sensitive Sea Area by the International Maritime Organisation (IMO), thus providing special marine environmental protection measures for shipping activities. Some vessels are required to use licensed pilots in specified areas; the Australian Maritime Safety Authority (AMSA) strongly recommends that all ships' masters unfamiliar with routes and reef passages use licensed pilots. The IMO has also recommended a central portion of the Capricorn/Bunker Islands and Reefs (a key nesting and foraging area for loggerhead and green turtles) as an Area to be Avoided by ships over 500 tons gross tonnage (Australian Maritime Safety Authority 1997b).

With the advent of sophisticated navigational aids (e.g. Global Positioning Satellite – GPS - systems) and other technological advancements (e.g. Emergency Position Indicating Radio Beacons-EPIRBs), boaters can venture further from shore, operate under a wider variety of weather conditions, and stay at sea for longer periods of time (Great Barrier Reef Marine Park Authority 1998a).

A comparison of recreational boat fishing in 1980 and 1990 showed an increase of 89% in the numbers of vessels participating in this type of activity in some areas adjacent to the Marine Park

(Blamey and Hundloe 1993, Hundloe 1985). With an increasing Queensland population and advances in technology, the number of recreational and commercial vessels accessing the World Heritage Area will continue to increase in the foreseeable future.

6.1.1. Potential Impacts

All vessels can produce impacts that can affect turtles including:

- Deliberate or reckless killing or injuring
- Harassment
- Noise
- Physical displacement
- Physical habitat destruction or degradation
- Pollution
- Vessel strike

The behaviour and experience of operators can influence the impacts of vessels on marine turtles. For example, boaters may be unfamiliar with an area or with basic boat-handling practices and may also be unfamiliar with turtles and not realise the possibility of disturbance to them. Vessel operators who are unaware that turtles inhabit an area, do not know about the potential impacts of vessels on turtles or are unaware of practices to minimise such impacts will be a greater risk to turtles than those who are better informed. Thus education and licensing programs can be effective tools to minimise impacts on marine turtles.

The types and magnitudes of impacts generated by a vessel are largely determined by characteristics such as size, speed, hull composition and propulsion system. Large vessels can pose a greater risk of serious injury or death in the event of a strike on marine turtles, and can also produce higher levels of noise and pollution. Fast vessels generally are noisier, and may be more at risk of striking marine turtles than slower craft. Additionally, faster vessels allow people to travel greater distances in shorter time periods, thus increasing use of areas that were previously inaccessible and extending the geographic extent of human activities. Hull composition affects the amount of noise that is transmitted into the water; motorised aluminium skiffs or 'tinnies' typically produce very high levels of underwater noise (see section 5.3.9).

The potential effects of the above impacts on marine turtles include injury, death, and behavioural modification, such as displacement from areas of high traffic, and depend on factors such as the:

- numbers and types of vessels;
- routing of vessel traffic relative to key marine turtle habitats; and
- timing of vessel traffic and activity relative to migration/breeding patterns.

6.2. Coastal and Land-Based Actions

Coastal developments and land-use practices can have marked effects on marine ecosystems. Nutrient inflows, sediment transport, freshwater discharges and other fundamental ecological processes that strongly influence coastal ecosystems can be profoundly affected by land-based activities, such as farming, logging, and grazing. Additionally, some land-use practices result in the discharge of pollutants, such as fertilisers and biocides, or acid sulfate soil run-off into the marine environment and which may cause algal and other plankton blooms. Sewage discharge is also an issue, because it poses risks of disease outbreaks as well as disruption of natural nutrient balances.

Over 410,000 km² of land is contained within the catchments that drain into the Great Barrier Reef lagoon (Creighton et al. 1997). Within these catchments are some of Queensland's most extensive river systems, including the Burdekin and Fitzroy Rivers. An estimated 23,000,000 tonnes of sediment, 77,000 tonnes of nitrogen and 11,000 tonnes of phosphorus enter the inshore coastal waters of the Great Barrier Reef World Heritage Area annually (Great Barrier Reef Marine Park Authority 1998a). The Authority is strongly advocating actions by Queensland and local

governments, landowners and other stakeholders to reduce adverse impacts on the World Heritage Area resulting from land-use practices.

6.2.1. Potential Impacts

Coastal and land-based activities can pose direct and indirect impacts on marine turtles, including:

- Accidental ingestion of/ entrapment in marine debris
- Deliberate or reckless injury or mortality
- Disease
- Food depletion
- Harassment
- Physical habitat destruction or degradation
- Physical displacement
- Pollution
- Predation by feral animals

The magnitudes and types of impacts depend upon the type of activity and its location relative to the coast or within the catchment adjacent to the World Heritage Area.

6.3. Defence Activities

There are ten designated Defence Areas within the World Heritage Area. They were established in the interest of public safety to regulate public use of and entry into these areas while they are being used for Defence activities. Most areas are invoked for short periods. For example, the Defence Area over Flora, Coates, Gibson and part of Maori Reefs in the Cairns Section is invoked for weapons testing on an average of one day per month, and rarely for more than about three hours on that day.

Defence activities may include naval exercises, low-altitude flights, high-speed flights generating sonic booms, detonations of explosives for a variety of purposes, use of active sonar and other underwater acoustic devices, use of infra-red laser sighting devices, and firing of live munitions.

Many of these activities are conducted with dedicated shipboard and aerial observers. These personnel may be able to collect data on marine turtle sightings, as well as ensure activities are delayed if turtles are present.

In addition, there are areas of the World Heritage Area, often unknown, where unexploded ordnance from World War II and more recent activities, is located. Accidental or deliberate detonation of these devices could pose threats to turtles and other species.

Military vessels can operate at high speeds and operators may be unable to alter their course if turtles are observed. Naval exercises may involve large numbers of vessels operating intensively in a particular area for days or even weeks.

6.3.1. Potential Impacts

Direct and indirect impacts resulting from Defence exercises include:

- Accidental entanglement in/ ingestion of marine debris
- Explosions
- Food depletion
- Noise
- Physical displacement
- Physical habitat disturbance / degradation
- Pollution
- Vessel strikes

The Department of Defence has restricted the use of explosives and ordnance within the World Heritage Area to certain areas. The Department is also undertaking Environmental Impact Assessments for a number of training areas in Australia, including sites within the World Heritage Area. Environmental Management Plans are being prepared in order to identify the environmental impacts of Defence activities and to determine procedures to minimise and mitigate those impacts.

6.4. Feeding

Individuals may attempt to feed turtles in the World Heritage Area, for example by tossing them fish from vessels. Although there is little information on the prevalence of such activity, anecdotal reports are received infrequently. Turtles also may feed on the discards from commercial fishing vessels.

Deliberate feeding and attempted feeding of marine turtles within the World Heritage Area will be prohibited.

6.4.1. Potential Impacts

The potential impacts on turtles from feeding include:

- Disease
- Harassment
- Physical displacement
- Vessel strikes

Impacts by humans feeding turtles also arise from the type, quality, and amount of food, as well as the circumstances under which feeding occurs (e.g. whether feeding occurs in a high traffic or polluted area). Behaviour modification is always an effect of feeding, because animals that are coming to be fed are clearly not engaged in undisturbed behaviours, but the implications of this for the animals over the long term are unknown. Animals may become dependent on the food provided, and may therefore be at greater risk if the food supply is interrupted. Provisioned immature animals may not learn to forage for prey properly as they become accustomed to coming to the surface of the water for food (National Research Council 1990).

Feeding marine turtles also poses risks to humans because the animals may associate humans with food. For example, a loggerhead turtle resident at a popular dive site in Florida, USA harassed divers while looking for a food handout. This turtle has bitten dive equipment and divers and injured one person sufficiently to require hospitalisation (CTURTLE listserver September 1999).

6.5. Fishing, Shark Control Programs and Aquaculture

Fishing is a major activity in the World Heritage Area and is second only to tourism in economic importance (Tanzer and Russell 1999). Recreational, commercial and charter fishers use a wide range of gear types (mesh net, lines, trawl net) and target a variety of species (wide range of fish, prawns, scallops). The main fisheries operating in the Marine Park include the inshore and estuarine net fishery, reef line fishery and trawl fishery (principally ECOTF and the Scallop Otter Trawl Fishery). Reporting to the Queensland Fisheries Service of all bycatch in the trawl net fisheries is mandatory.

The Australian Fisheries Management Authority (AFMA) has responsibility under the Fisheries Management Act 1991 to ensure that fisheries under its control are conducted in an ecologically sustainable manner. They also must have regard to the impact of fishing activities on non-target species and the long-term sustainability of the marine environment. The only fishery managed by AFMA in the Marine Park is the Tuna and Billfish Fishery.

In the southwestern Pacific Ocean, pelagic longlines could pose a threat to young turtles that spend their developmental years in the open ocean before returning to the Marine Park to forage and breed (see section 4.1.1). There has been a decrease over the past six years in the number of young loggerhead turtles migrating from the pelagic zone to become resident at Heron Island Reef (Limpus and Limpus 1999). However, the relationship between pelagic longlines and the decrease in new resident turtles is unquantified.

Net fisheries operate along the Queensland coast in rivers, creeks, estuaries, foreshores and sheltered offshore waters. Although active forms of netting, (haul, ring and tunnel netting) are not thought to impact upon turtles as any that are captured can be released quickly, there has not been post-release studies to quantify this. Some fishers that use these methods deliberately avoid areas with turtles (Environment Australia 1998).

The Queensland Shark Control Program (QSCP) began in 1962 at many Queensland beaches for the protection of bathers from sharks. The QSCP is administered by the Queensland Department of Primary Industries (DPI) and makes use of mesh nets and drum lines to catch sharks that may pose a threat to humans. No nets or drumlines are set within the waters of the Marine Park, but ten nets operate seasonally in waters adjacent to the Marine Park, five each in the Cairns and Mackay regions. In addition, 154 drumlines are set in waters adjacent to or south of the World Heritage Area. Reporting of marine turtle by-catch in all shark control equipment is mandatory.

Since 1993, catches of marine turtles in QSCP gear have been significantly reduced because of changes to the program (eight deaths and 350 turtles released alive, Environmental Protection Agency 1999). However, there is little information on post-release survival. Mesh nets are associated with higher levels of by-catch of all non-target species (dugong, dolphins, whales, and turtles) than are drum lines and consequently have been replaced by drum lines in a number of places.

Aquaculture also occurs in and adjacent to the World Heritage Area. Operations vary significantly depending on the species being cultured. The most common types of aquaculture in the area are prawn and barramundi farming in land-based ponds with associated seawater intake/discharge, and sea-based long-line culture of pearl oysters. There is currently one barramundi sea cage that operates in Queensland waters and none in the Marine Park. Research and development of cage culture techniques for coral reef finfish species are currently in progress and may result in future pressure for the expansion of cage-culture operations.

Recreational fishers in the World Heritage Area must abide by restrictions contained in Queensland fisheries legislation in addition to complying with zoning plans declared under the Great Barrier Reef Marine Park Act.

6.5.1. Potential Impacts

Potential impacts from fishing, the QSCP and aquaculture operations include direct and indirect impacts:

- Accidental ingestion of/ entrapment in marine debris
- Disease
- Food depletion
- Incidental catch in fishing gear
- Physical habitat degradation and destruction
- Physical displacement
- Pollution
- Vessel strike

Considerable work is being undertaken by fisheries management agencies and scientists to ensure that fisheries in the World Heritage Area are ecologically sustainable. Included in this work are efforts to develop sustainability indicators, investigate possible effects of fishing on fish habitat and numbers, determine the effect of area closures on reef fish stocks, and minimise by-catch (catch of species other than target species).

Foreshore and offshore mesh net could pose more of a threat to turtles than the active forms of netting although the interaction between these types of nets and turtles is believed to be minimal and remains unquantified. A DPI/ Australian Institute of Marine Science project has examined the level of by-catch from inshore net fisheries in Queensland (Great Barrier Reef Marine Park Authority 1998a). The commercial netting industry is committed to modifying practices to minimise impacts on non-target by-catch, especially of protected species (including turtles). Recent regulations establishing Dugong Protection Areas and modifying netting practices are likely to benefit turtles inhabiting the same areas.

The Queensland trawl fishery has adopted 'Turtle Recovery Procedures' for turtles that are incidentally caught in trawls. In recent years, trawl fishers and scientists have developed and introduced TEDs and BRDs in trawl nets to exclude large animals and unwanted by-catch from the catch. A study of BRDs in the Northern Prawn Fishery showed that few or no turtles were caught or killed when these devices were used (Brewer et al. 1998), and trials of various TED designs along the east coast of Queensland suggest that large animals were significantly reduced in catches using the AUS TED II (Robins and McGilvray 1999).

TEDs are to be used in trawl nets throughout the World Heritage Area; however, implementation will be phased-in for certain fisheries (e.g. scallop, deep-water trawl) to allow for the TEDs to be modified to specific conditions for those fisheries. A review event specific to marine turtle capture has been set out in the Fisheries (East Coast Trawl) Management Plan 1999. It states that if capture or mortality for any species of marine turtles is in any year more than 5% of the average level of turtle capture or mortality for the species previously reported by Robins (1995), then the Plan will be reviewed.

If turtle populations are small, localised, or if they are threatened by other impacts, (e.g. Indigenous hunting, coastal development) then even minimal losses due to mortality in fishing, QSCP or aquaculture gear may be important, as in the case of the loggerhead turtle population in Queensland. It may become necessary to consider possible options to reduce the by-catch, such as modifications to equipment (e.g. use of pingers, hook design, TEDs, BRDs) or fishing practices (e.g. reduction in tow, trawl or set times, observer programs).

6.6. Indigenous hunting

Aboriginal and Torres Strait Islanders have hunted marine turtles for traditional food and medicines for thousands of years. Traditional hunting and the consumption of turtles, especially green turtles, serve important economic, cultural and social functions and forms part of the cultural and heritage values associated with the World Heritage Area. The Authority recognises the significant relationship Indigenous people have with turtles in the World Heritage Area.

Provided the Authority has granted a permit for the activity, traditional hunting can occur within all zones of the Marine Park, except Scientific Research Zones, Preservation ('pink') Zones and in the Central and Mackay/Capricorn Sections, Marine National Park 'B' Zones ('green').

Applications for traditional hunting are assessed against criteria set out in the Great Barrier Reef Marine Park Regulations sections 18[4(a-l)] and 18[5(a-g)]. Standard permit conditions include the collection of data (species, size, sex, capture location) about each turtle captured. However, there is little reliable quantitative data on the level of take by Indigenous hunting. This is a concern for Management Agencies.

The grant of a Marine Parks permit for traditional hunting is an important mechanism by which the Authority recognises and affirms the special relationship Indigenous people have with turtles. The Authority is committed to developing cooperative management arrangements with Indigenous communities for the sustainable take of turtles. In 1998, the Authority noted that *'For management to work in communities it must be compatible to the needs of individual communities and these needs have to be identified and understood. In general, community based management needs to ensure that turtles are hunted on a sustainable basis to fulfil community aspirations, expectations and the realistic*

ability to fulfil those expectations. It must maintain flexibility for the dynamics of Indigenous society and most importantly be initiated, monitored and maintained by the communities themselves thus empowering Indigenous communities' (Hunter and Williams 1998).

Of the six species of marine turtle inhabiting the World Heritage Area, the green turtle is the primary species hunted, while the eggs of all species nesting within the World Heritage Area may be taken from time to time. Adult female turtles are preferred over males and other size classes of green turtles because of their greater fat reserves. After consultation with the local Indigenous community, the capture of loggerhead turtles was prohibited in the Whitsundays Area through implementation of the Whitsundays Plan of Management.

Some green turtles migrate outside of the World Heritage Area to return to foraging or nesting sites (Table 2, Limpus et al. 1992). The levels of harvest in neighbouring countries to which these animals migrate are for the most part unknown; however, they are considered to be high (tens of thousands of turtles hunted annually) in areas such as Indonesia (Groombridge and Luxmoore 1989).

Tag recoveries from hunted turtles indicate that east coast Queensland Indigenous communities are hunting primarily sGBR green turtles (Limpus 1995).

6.6.1. Potential Impacts

The types of potential impacts that may occur from Indigenous hunting include the:

- deliberate killing or injuring;
- harassment of turtles that may be chased repeatedly while in a breeding or nesting area or from inhumane treatment following capture;
- live capture of non-target sizes/sizes of turtles that are released upon the capture of an adult female turtle; and
- physical displacement of turtles from foraging locations as a result of hunting practices (e.g. by frequent chasing by boats).

The early warning signs about the long-term survival of the sGBR green turtle population (see section 4.1.4) may mean that a population decline is underway because too many large (adult) female turtles are being lost from that population. The sGBR population can lose only a few hundred turtles from human-related causes each year for the population to remain viable (Limpus 1999).

The Authority is committed to ensuring that the number of turtles around for hunting by Indigenous people can be maintained in the long term for future generations. The Commonwealth Government, including the Authority, is concerned about threats to marine turtles and is trying to reduce the impact of each threat on the turtles through initiatives identified in the Draft *National Recovery Plan for Marine Turtles in Australia*.

6.7. Live Display, Headstarting, Ranching and Captive Breeding

The capture of live turtles from the Marine Park, whether for public display or other purposes, requires a permit under the Great Barrier Reef Marine Park Act, as does the release of turtles into the Marine Park. In Queensland waters, a permit under the Marine Parks Act is required to capture a turtle from a State Marine Park, and a permit under the Nature Conservation Act is required to hold turtles in captivity in Queensland.

Headstarting is the rearing of hatchlings (either from eggs incubated in a laboratory or from hatchlings collected from nesting beaches) for a period of time prior to their release. This technique developed because mortality is highest for young turtles during the first year of their life (see section 4.1.1). With headstarting, the turtles are larger when released and theoretically have a better chance of survival in the wild. However, management measures that look solely at improving the survivorship of turtles in their first year of life are unlikely to be effective for long-lived species, such as marine turtles (Heppell et al. 1996a).

The suitability (Reichert 1995) or unsuitability (Ehrenfeld 1995) of turtles for captive breeding programs has been debated for decades. Captive breeding programs involve maintaining adults who breed in captivity and whose offspring are raised for use (meat, shell) and ranching involves the collecting of turtles (usually as eggs) from wild populations which are then raised in captivity for use (Ross 1999). Three turtle captive breeding or ranching programs have been attempted. One program, in the Cayman Islands took nineteen years to return an operating profit; another, on Reunion Island, switched to fish aquaculture, research and education after attempts to apply for international trading privileges under CITES were unsuccessful; and a third, in Torres Strait, was discontinued due to problems associated with diseases and feeding turtles (Ross 1999).

The lack of success by these three programs highlights logistic and maintenance problems associated with keeping and rearing turtles in captivity (slow growth and maturation rates, and susceptibility to disease and parasites).

Although the concept of headstarting is appealing, there is insufficient evidence of success and hard evidence would not be available for many decades, when reared hatchlings return as breeding adults (Woody 1990). However, due to natal imprinting, it is uncertain where they would return to breed (Eckert et al. 1994, Huff 1989, Sato and Madriasau 1991).

6.7.1. Potential Impacts

The types of potential impacts that could result from capture of turtles for live display, headstarting, captive breeding or ranching include:

- disruption of normal life-history cycle, including migration patterns;
- displacement if headstarted turtles are released into habitats not normally inhabited by young turtles;
- introduction of different genetic stocks into an area;
- transfer or introduction of diseases as a result of captivity; and
- disruption of the imprinting process that hatchlings use to find their way back to their natal beaches.

Captive turtles, because they are in closed ecosystems, are more susceptible than wild turtles to disease and to nutritional deficiencies (see section 5.3.3). Therefore, regular health checks of animals kept in captivity are necessary, especially if an animal is to be released into the wild. This rule should also apply to animals brought into holding facilities for rehabilitation so that upon release, new pathogens are prevented from entering the sea and infecting healthy turtle populations.

Also, there is the possibility that over-harvesting of eggs or adults for stocking ranches or captive breeding programs could result unless controlled (Tisdell 1986).

6.8. Marine Construction

Marine construction includes building of wharves and piers, dredging, filling, and establishment of other offshore structures, such as artificial islands/reefs, jetties, etc. The construction and maintenance of any structure within the Marine Park is subject to environmental impact assessment and requires a permit issued by the Authority. Assessments of marine construction projects proposed for the Marine Park include, where appropriate, evaluation of potential adverse effects on marine turtles and key turtle habitats, and, where necessary, mitigative measures.

In Queensland, there is a lack of deepwater ports for commercial trade. Thus, there is a need to dredge (remove sediment from the seafloor) channels to allow large ships to access the mainland. To keep the channels sufficiently deep for these vessels, maintenance dredging occurs on a regular, semi-regular or infrequent basis, depending upon the characteristics of the channel. There are two main types of dredges utilised in Queensland: grab bucket dredges and suction dredges (Department of Primary Industries 1998).

Dredging has killed marine turtles where the activities have occurred in areas with high numbers of turtles (Lutcavage et al. 1997). There are anecdotal reports of marine turtles being injured or killed in dredges in Queensland. Turtles often inhabit nearshore areas where dredges operate and during the cooler months often seek the warmer waters of deepwater channels. At two shipping channel sites in Florida, USA, 149 turtles were confirmed caught in dredging operations between 1980 and 1990 (National Research Council 1990).

6.8.1. Potential Impacts

The most significant potential impacts to marine turtles from marine construction are likely to result from large-scale projects. The types of impacts depend upon the type of project, and may vary in magnitude and duration, but can include:

- Accidental ingestion of and entrapment in marine debris
- Deliberate or reckless killing or injuring
- Explosions
- Food depletion
- Harassment
- Noise
- Physical displacement
- Physical habitat degradation or destruction
- Pollution
- Vessel strikes

6.9. Photography and Filming

Photography and filming of marine turtles typically involves close approaches to animals by vessels, may involve placing people in the water close to animals to obtain underwater images, or may involve nesting turtles being approached.

The public interest in marine turtles is generally high, so this type of activity is likely to persist and perhaps increase. Additionally, technological improvements allow filming and photographing of marine turtles under an increasing variety of conditions, which may also lead to growth of the industry.

Photography and filming commonly occurs in the World Heritage Area. Photography and filming can require a Marine Parks permit, depending on the activities and locations proposed. Photography and filming for commercial purposes that is conducted on Island National Parks requires a permit from QPWS.

6.9.1. Potential Impacts

The potential impacts on turtles from filming and photography include:

- Deliberate or reckless injuring or killing
- Harassment
- Physical displacement
- Physical habitat degradation or destruction
- Vessel strikes

The impacts of filming and photography to turtles will vary depending upon factors such as the:

- type of activity (e.g. vessel type, whether in-water or on-land filming is involved)
- number of vessels/people involved;
- way in which vessels are operated/people act;
- number and species of animals involved;
- knowledge of marine turtle biology by persons involved; and
- number of close approaches required.

As a general rule, turtles should not be approached on a nesting beach until they have completed laying their eggs. At this time, the animal is less likely to be disturbed and if disturbed, the negative impact is lessened because the eggs have already been laid. Photographs may be taken at this time; however, care should be taken not to aim a flash directly at the turtle's head, as it may disorient the animal as it returns to the sea.

Nesting female turtles should not be disturbed from their nesting routine, nor should they or hatchlings be held back from returning to the sea to await suitable filming conditions (e.g. sunrise). Hatchlings need to enter the sea as quickly as possible so that they do not waste valuable yolk reserves.

6.10. Research and Monitoring

Marine research and monitoring includes not only biological studies, but also studies of physical and chemical oceanography, marine geology and geophysics, marine archaeology, underwater acoustics, and a host of other areas of investigations.

Studies that contribute to the understanding of marine systems may ultimately benefit turtles. Specific studies of marine turtles and their use of the marine environment, including estimates of relative and absolute abundance, distribution, ecology, and behaviour are needed to assess the conservation status of marine turtle species, support management, and allow evaluation of the effectiveness of conservation measures.

Depending on the activities and locations proposed, conducting research in the World Heritage Area might require a permit. Part of the permit assessment process involves an evaluation of whether the proposed research should be reviewed by the Authority's independent Environmental Research Ethics Advisory Committee (EREAC). Because all marine turtles within the World Heritage Area are listed as threatened, all research applications involving marine turtles are referred to the EREAC. All manipulative research proposed for the Marine Park is, when appropriate, evaluated for potential adverse impacts on marine turtles. Proposed research involving seismic exploration or other intense sound sources will be subject to particular scrutiny to balance the benefits of the research against the risks to marine turtles and other species.

For management to be effective over the long term, it must incorporate information on turtle population abundance and distribution within the World Heritage Area. Reliable information is needed on:

- the distribution and abundance of marine turtle species in the World Heritage Area;
- patterns of use of the World Heritage Area by marine turtle species (e.g. seasonal movements, long-term population trends); and
- locations of any key habitats for particular species.

Another source of information necessary for effective management is dedicated scientific monitoring. This is often the only way to answer definitively certain questions, such as those concerning genetics or population trends (Parmenter 1993). However, such monitoring studies are often expensive and securing funding can be difficult.

While scientific studies of marine turtles should be accorded high priority, supplementary sources of information are also needed. Tour operators, fishers, Indigenous people, Defence personnel, recreational boaters and government personnel spend significant amounts of time out on the water and thus are potentially useful sources of information about marine turtles. If data collection procedures and protocols are carefully developed in advance of data collection, and if the correct statistical analyses are performed, then the information can augment that gathered through formal scientific investigations. These kinds of data collection programs can also help build public awareness about marine turtles and the marine environment in general, as well as involve key stakeholders in management. The results of the data collection program are useful not only in formulating and evaluating management measures, but also should be fed back to the data collectors.

6.10.1. Potential Impacts

The types of impacts on marine turtles generated by research depend on the type of research but may include:

- Deliberate or reckless killing or injuring
- Harassment
- Live capture
- Noise
- Physical displacement
- Physical habitat degradation or destruction
- Pollution
- Vessel strikes

Vessels used for research pose similar threats to marine turtles as those used for other purposes (see section 6.1.1), but the level of risk depends on the type of craft used and the manner in which it is operated.

Marine turtle research often requires close approaches to or captures of animals, for example to take identifying photographs, or to obtain skin samples used for genetic analysis, stomach samples for feeding studies, and tissue samples for assessments of contaminant loads. Some research requires the temporary capture of animals, for example for taking of physical measurements or blood samples or to attach radio or satellite tags that allow animals to be tracked. These kinds of activities could be disruptive to the animals. The potential impacts of these activities depend on the species, its conservation status, age and sex, the number of animals involved, the duration of the study and importantly, the experience of the researcher. The kinds of information resulting from these studies can be useful for management.

6.11. Tourism and Recreation

Commercial tour operators undertake a wide variety of activities, including scenic cruises, island and reef trips, glass-bottomed boat rides, snorkel and diving trips, and marine thrill rides. Trips may last an hour or less, or extend for a few days, weeks, or even months. The sizes and types of vessels used similarly vary. Within the World Heritage Area, there are no known tourist operations focussing specifically on marine turtles (e.g. turtle watching tours); however, tourist permits focussing on turtles have been issued by QPWS in Moreton Bay Marine Park, near Brisbane.

Observing marine turtles underwater can provide better understanding of the animals, and can be a particularly exciting and rewarding experience for people. However, it provides increased incentive to get close to the animals in order to be able to see them underwater (see below), and there are additional potential risks posed by having people in the water in close proximity to turtles. It is likely that incidental swimming-with-turtles occurs, on both a commercial and recreational basis.

Tourism has the potential to educate large numbers of people about turtles and to encourage an appreciation of the marine environment as a whole. Tours can occur on nesting beaches and through interpretive talks for people visiting the World Heritage Area (Tisdell and Wilson 2000). The potential benefits of turtle watching include increased information about local turtle populations; increased awareness by tourists (Australian and overseas) of turtle conservation and management actions in the World Heritage Area, and greater potential for conservation initiatives through economic potential of wildlife-based eco-tours.

All tourist programs operating within the Marine Park require a permit from the Authority. Tourist operators accessing islands within the World Heritage Area require a permit under the Nature Conservation Act from QPWS if accessing a National Park or a permit from the Authority under the Great Barrier Reef Marine Park Act if accessing a Commonwealth island.

6.11.1. Potential Impacts

Potential impacts on marine turtles from tourism differ, depending on where the activities occur (e.g. in the water, on land), but may include:

- Accidental ingestion of or entrapment in marine debris
- Deliberate or reckless killing or injuring
- Disease
- Harassment
- Noise
- Physical displacement
- Physical habitat degradation or destruction
- Pollution
- Vessel strikes

The QPWS operates a guided tour of the Mon Repos nesting beach near Bundaberg from November to February and tourists visiting Heron Island often encounter researchers who explain the biology of marine turtles and the nesting process. However, without appropriate training even well meaning individuals and eco-tourist ventures may unknowingly disrupt turtles (e.g. through shining lights or driving on nesting beaches). Wilson and Tisdell (2000) estimate that the Mon Repos turtle watching season generates close to \$1,000,000 per year to the Bundaberg region. In some countries, the economic return obtained from taking tourists onto nesting beaches prevails over the previous requirement to harvest eggs and females (Tambiah 1991). The concern that large numbers of visiting tourists could impact key nesting habitats can be overcome with training, temporal or spatial closures, and compliance with permit conditions and guidelines.

Tourist programs do not necessarily have to focus their programs on turtles in order to have an impact on the animals. If a particular reef location is popular with tourists and is also a key habitat for turtles, there is the potential for turtles to be adversely affected.

As eco-tourism increases in popularity around the world, there is the possibility that operators will want to watch and possibly swim with turtles as part of a dedicated tour program. As with whales and dolphins, impacts from turtle watching are potentially much greater when swimming activities are involved. There are also potentially elevated risks of vessel strikes because vessels must operate in close proximity to the animals. Similarly, the effects of vessel noise, pollution, harassment and other impacts may be higher.

There are additional risks of swim interactions for both people and animals. If humans and marine turtles come into physical contact, there is the risk of physical injury to the animals and to humans. Turtles are wild animals, and have been known in rare instances to injure people in the water who were physically interacting with them (see section 6.4). It is also possible that diseases could be transferred from people to turtles or from turtles to humans (Herbst 1999).

The key management challenge for this activity, as with vessel-based turtle watching, is to ensure that the animals largely control the interactions. Deliberate attempts by people to swim with turtles are unlikely to be successful unless the animals choose to remain nearby or unless animals are trapped (e.g. in reefal lagoons) or entangled. Turtles are generally able to readily avoid people in the water. Nonetheless, repeated vessel approaches by people attempting to swim with turtles could be a serious source of disturbance to the animals and must be managed accordingly. Of particular concern are the cumulative effects of avoidance behaviour, if animals spend large amounts of time and energy avoiding vessels.

The Authority has developed the following Best Environmental Practices for Turtle-Watching:

The Great Barrier Reef is a critical breeding ground for four species of turtles. They come ashore at night to lay eggs. With care it is possible to watch the fascinating events of females laying eggs and hatchling emerging from the sand without disturbing the turtles.

- Keep the use of lighting (e.g. torches) to a minimum. Hint: put a red cloth or cellophane over the torch.
- Lights should be no more than a three-volt, two-cell, hand-held torch.
- Do not approach too close to turtles leaving the water and moving up the beach.
- Do not shine lights directly on turtles leaving the water, moving up the beach, building nests, or laying eggs.
- Avoid loud noise and sudden movements near turtles while they are laying their eggs.
- Do not touch the turtles, hatchlings or eggs.
- Keep dogs away.
- Do not light campfires on turtle nesting beaches.
- Report sick, injured, stranded or dead turtles to the Marine Animal Hotline phone: 1300 360 898 (24 hr)
- Learn about the habits and needs of turtles to increase your appreciation of them.

Codes of practice for swimming with large marine animals have been developed to minimise risks to the animals and humans from these types of activity (Arnold and Birtles 1998).

Observations to date suggest that practices, which promote safety also, lead to longer encounters with the animals.

6.12. Trade of Turtles and Turtle Products

Most parts of a turtle can be of economic value. Outside Australia, turtle eggs and meat are sold for food, the skin of flippers and the neck is made into leather articles, the oil is used in the production of cosmetics, the offal is used to make soup and the shell is used to make jewellery and ornaments (Mack et al. 1995). Young turtles are also stuffed and sold as ornaments.

Although the above products could be obtained from all turtle species, three species have been heavily exploited around the world: the green, olive ridley and hawksbill turtle. Green turtles are taken primarily for their meat and eggs; olive ridley turtles for their skin and secondarily for meat and oil and hawksbill turtles are the source of tortoiseshell because of the thick scutes covering their carapace, but are taken also for meat and eggs (Groombridge and Luxmoore 1989, Mack et al. 1995).

Food, souvenirs and tortoiseshell harvests in Australia and nearby countries currently pose a considerable threat to the region's turtle populations. Improvements in fishing technology and the growth of large-scale industries in which marine turtle products are sold for profit have meant that turtles, particularly green and hawksbill turtles, have become locally scarce in some parts of the world, including areas of the southwestern Pacific Ocean region (Groombridge and Luxmoore 1989). All marine turtle species in Australia are listed under Appendix I of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), which prohibits the commercial trade of turtle products by all signatories to CITES. Essentially this means that wild caught turtles or turtle products can not be exported or imported into Australia. Within Australia, turtles and products from turtles may not be sold and are protected against commercial take under Queensland's Nature Conservation Act and the Commonwealth's Environment Protection and Biodiversity Conservation Act.

Recently, trade of turtle products over the Internet has become a problem, with auction websites advertising tortoiseshell items for sale. Although the United States Fish and Wildlife Service, and the owners of the Internet site are addressing the issue, this type of occurrence will probably increase with increased use of the World Wide Web.

6.12.1. Potential Impacts

The potential impacts from the trade of turtle or turtle products include:

- Deliberate killing or injuring
- Harassment
- Live capture
- Noise
- Physical displacement
- Vessel strikes

The major effect of the trade in turtles or turtle products has been the subsequent population decline resulting from ecologically unsustainable trading practices.