MANAGEMENT OF SANDY BEACHES TO BALANCE CONSERVATION AND HUMAN USES: A CASE STUDY FROM NORTH STRADBROKE ISLAND.

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ABSTRACT

Sandy beaches are Southern Queensland's most significant recreational resource in the coastal zone: more people use sandy beaches for hedonistic and leisure activities than any other type of shore. Burgeoning population growth is placing escalating pressures on this ecosystem through sharply increasing levels of beach usage. This has the potential to create conflict between the need to conserve the ecological integrity of beaches and dunes juxtaposed against the socio-cultural demands of unbridled access to beaches. North Stradbroke Island is a poignant example where such potential conflicts might occur. The island's beaches are one of the prime recreational areas in the region and support multiple uses such as dune camping and 4WD driving – both activities that can be environmentally harmful. The local authority, Redland Shire Council, is charged with managing beaches on the island and is increasingly required to react to mounting public concerns (particularly after peak periods such as Easter and Christmas) about the perceived ecological impacts of beach uses, especially the driving of vehicles on the shore and in the dunes. Management interventions are, however, highly problematic to develop or implement chiefly because robust data about the putative ecological consequences of recreational activities are very limited. This situation is now being addressed through a research partnership with a University; this partnership provides information on the ecological ramifications of high-intensity uses of beaches and dunes to underpin management decisions. Preliminary findings support some of the public perceptions about detrimental effects of 4WD vehicles: i) large areas of faunal habitat are being substantially modified by vehicles, ii) most traffic overlaps directly with the distribution of benthic species on the beach, and iii) vehicle traffic (particularly at night) can contribute to observed declines in population sizes of ghost crabs on the beaches. It also provides an opportunity to measure whether newly trialled options of visitor management (i.e. restrictions of driving around the time of high water) translate to measurable, positive outcomes for the environment. Notwithstanding the efficiency of such management interventions in terms of conservation outcomes, comprehensive visitor management on beaches requires a political commitment. This is presently embryonic in the local/regional situation, but examples from other parts of the world show that it can be achieved. For example, beach traffic has been reduced along much of the South African coastline based on a comprehensive assessment of ecological, social, cultural and historic demands supported by a political will to conserve sandy beach ecosystems nationwide. Regionally, beach management must be built more strongly on collaborate working arrangements between multiple tiers of government to achieve conservation outcomes that provide for a balanced approach between human resource utilization and environmental protection.

INTRODUCTION

Sandy beaches are the prime sites for human recreation. Arguably, beaches underpin coastal economies and support commercial developments, tourism, and population shifts to coastal areas (Klein et al. 2004). The emergence of distinct 'beach cultures' denotes the pre-eminence of sandy beaches for hedonistic pursuits, and beaches have acquired icon status in Australia (James 2000; Jones et al. 2004).

Beaches are under threat worldwide from a plethora of human pressures ranging from coastal armouring to the effects of global climate change (Schlacher et al. 2006). The chief cause of the escalating pressures on beaches is the rapid growth of coastal populations, coupled with increased availability of leisure time (Schlacher et al. 2007). For example, 85% of Australians live within 50 km of the coast and coastal populations are growing significantly faster than elsewhere, particularly in Southern Queensland (Australian Bureau of Statistics 2004).

North Stradbroke Island is Australia's second largest (271 km^2) barrier, sand island. The island has been occupied for possibly 40,000 years by aboriginal people and continues to have one of the strongest aboriginal communities in the region, with many important archaeological sites of great cultural significance. The island's eastern shores abut Moreton Bay which is habitat to several endangered species, and supports large numbers of migratory shorebirds, while the western shores are exposed ocean beaches. While the resident population of the island is small at 2508 people (census 2001), the population increases over ten-fold to ~ 30,000 during holiday periods. Recent 2006 Census data has a resident population of 2010 people. Much of this transient influx is concentrated on the sandy beaches that are the prime focus of recreational pursuits on the island.

The island's beaches are an important and highly popular camping and recreational area for many residents of South East Queensland. The natural values of the island have made it attractive to family holidays with many being long–term repeat visitors. Tourism operators are increasing and through coordinated tourism strategies both domestic and international visitation to the island has increased in recent years. Commercial fishing is another economic activity derived from the beaches. Fortunately fishing seasons tend not to conflict with high visitation periods on the island. Recreational fishing along the beaches is the most significant activity and contributor economically with both local and tourists spending many hours and dollars of bait and tackle.

Residents and tourists alike are concerned about the escalating human pressure and its impact on environmental and aesthetic values. A management plan for the island's second largest beach, Flinders Beach, highlighted that impacts on fauna and vegetation and the maintenance of cultural values without diminishing the social and economic benefits rank highly as public concerns (Carter 2005). Detrimental effects of 4WD traffic are a key issue particularly threats to public safety and ecological consequence for the beach fauna (Carter 2005). The issue of public safety was tragically brought to the wider community's attention in April 2006 when a child was hit by a 4WD vehicle on the Noosa North Shore, and there have been several "near misses" on North Stradbroke Island.

Recreational beach use encompasses a wide spectrum of pursuits including walking, swimming, surfing, beach-camping, fishing, sun-bathing, nature-based tourism, and adventure activities (Priskin 2001). Driving of 4WD vehicles on beaches is mostly for

leisure activities and is highly popular on many Queensland's beaches. The use of 4WD vehicles is, however, not without controversy with respect to environmental impacts and potential conflicts amongst beach user groups. Most tourism has some undesirable environmental consequences, but it is environmental degradation attributed to beach traffic – whether putative or real – that is more readily perceived by the public (Priskin 2003).

There is evidence from overseas studies that 4WD vehicles cause substantial environmental harm on beaches. Some of the ecological impacts reported include: changes to sediment properties and erosion dynamics (Anders and Leatherman 1987), destruction of dune vegetation (Rickard et al. 1994) and injuries, disturbance and kills of wildlife such as turtles (Hosier et al. 1981), birds (Williams et al. 2004), and invertebrates (Wolcott and Wolcott 1984; van der Merwe and van der Merwe 1991; Moss and McPhee 2006).

However, this information is generally not available for beaches in Southern Queensland with the exception of a few studies recently conducted by the authors at North Stradbroke Island (Schlacher et al. 2007; Schlacher and Thompson in press; Schlacher and Thompson in press); this paper summarises some of the key findings from the assessments of 4WD impacts on the island's beaches and outlines recent advances in developing management strategies for beach uses.

STUDY SITE

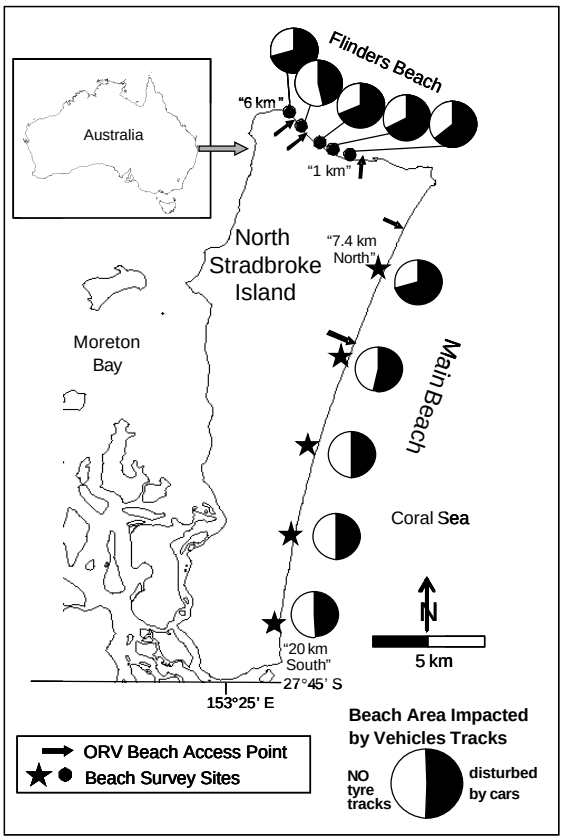


Figure 1 Map of North Stradbroke Island showing beach sites surveyed for physical damage caused by 4WDs. Pie-charts show the percentage of the surface area that was

North Stradbroke Island is a sand barrier island forming the south-eastern rim of Moreton Bay off the coast of Brisbane, Queensland, Australia (Fig. 1). The island is a popular tourist destination and receives large amounts of 4WD beach traffic, especially during peak holiday periods (Carter 2005). Of the 46 km of open, oceanic beaches on the eastern and northern side of the island, 40 km (89%) are open to cars. This traffic is concentrated on Flinders Beach (8.4 km) and Main Beach (34.5 km); only small sections (< 1.2 km) on the northern end of these two beaches are closed to traffic.

Flinders and Main Beach have camping areas in the dunes, but there is only a single back road to reach the campgrounds. Thus, majority of campers must travel in vehicles along the beach. Access points for 4WDs are located on the northern, central and southern end of Flinders Beach, and at the northern end and central part of Main Beach (Fig. 1). The locations of 4WD access points necessitates extensive

travel along the beach to reach the majority of campsites that are located in the central sector of Flinders Beach and the southern part of Main Beach. Fishermen also rely on 4WDs to reach 'optimum' fishing spots along the beach. Another form of beach traffic is by 'day-trippers' who travel on the beach to reach preferred swimming spots or simply for 'scenic drives' on the shore, and commercial tour operators. Beach traffic from local residents travelling from and to the townships of Dunwich, Flinders, Amity and Point Lookout occurs regularly for similar reasons as that of tourists.

HISTORY OF 4WD MANAGEMENT ON THE NORTH STRADBROKE ISLAND

Government Gazettes 13/10/1977; 14/08/1975; 15/12/1938 and 28/11/1912 provided council jurisdiction in the shire down to the mean low water spring tide. Access onto the beaches was done with no controls or management until:

- 1995 April 19th: Redland Shire Council adopted a vehicle access permit system which applied to all vehicles accessing the beaches of North Stradbroke Island. Prior to this, no active controls were undertaken. Funds derived were to be used to employment of beach rangers and better management of the beach;
- 1995 November 15th: introduction of a 50% discount to rate–paying residents of the shire for annual 4WD beach access permits only;
- 1998 September: Mary Maher and Associates with Tim Low produced the Flinders Beach Management Plan. The plan was financed by Coast Care funds but never adopted by Council;
- 2003 January: a public meeting was held following serious storm erosion on Flinders Beach, restricting access at Adder Rock. Many tourists took it upon themselves to carve a track through the Flinders Swamp. The Community raised the issue of a perceived lack of management for the beach;
- 2003 February 15th: Community workshop held to obtain local community input into the development of a Land Management Plan for Flinders Beach in accordance the Land Act 1994; a Land Management Reference group was formed;
- 2004 December 17th: Council resolved to allow the Draft Flinders Beach Land Management Plan to go out for public consultation;
- 2005 June 22nd: Council resolved to adopt the Flinders Beach Land Management Plan 2005-2009.

RESULTS

BEACH TRAFFIC VOLUMES

Volumes of beach traffic on the island are substantial (Fig. 2). In the financial year 2005-2006, 7,987 annual vehicle permits were sold to access both Flinders and Main Beach, providing an income of $255,584 for Redland Shire Council to fund general administration and management with further funds from General revenue to balance the costs. The average number of vehicles entering Flinders Beach per day is 352, equating to 128,845 cars per year (averaged over the period 01 Apr 1999 to 04 Jan 2003 for which continuous traffic recordings are available). Peak traffic reached 3,168 vehicles in a single day. Although 4WDs drive on beaches throughout the year, peaks are evident during holidays and fishing competitions when mean volumes reach 687 cars per day (range: 126 – 2,934). About 8% of all beach traffic occurs at night, and this proportion is relatively stable irrespective of weekends or

other peak periods. Night traffic shows the same peaks in traffic volumes and can reach up to 247 vehicles per night. Interestingly, during peak periods, there is no large difference in night traffic between weekdays (2 – 239 cars day^{-1}) and weekends (2 – 247 cars day^{-1}), indicating that impacts are likely to be continuous. On average, 28 cars access the beach at night, or 10,220 annually. 4WDs drive on the beach almost every night of the year: out of 977 recording days over 4 years, only 13 nights (1.2%) registered no night traffic.

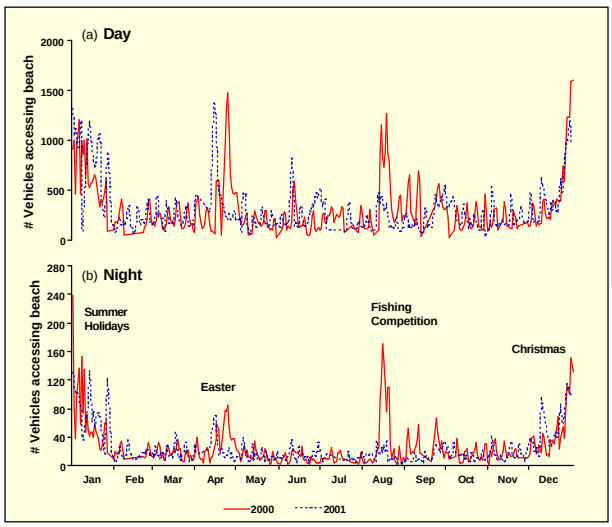


Figure 2 Daily traffic volumes on Flinders Beach, North Stradbroke Island, Australia. Data source is automatic traffic counters that recorded vehicles accessing the beach at hourly intervals, with traffic occurring between 07:00-19:00 classified

HABITAT DISTURBANCE

Surveys during the peak holiday period around late December and early January 2005/06, showed that 4WDs had disturbed substantial areas of the intertidal beach causing large volumes of sediment to be dislodged. Substantial areas (61-54%) of each beach were covered withy tyre tracks up to a maximum of 90% in some areas and 4WDs corrugated the sand as deep as 28 cm (mean depth: 5.86 ± 4.72 cm); the deepest rutting occurred between the foredunes and the drift line. On a volume basis, vehicles disrupted 5.8% (Main Beach) and 9.4% (Flinders Beach) of the available faunal habitat matrix (top 30 cm of the sand) in a single day. Although traffic densities were generally higher on the lower parts of the beach, ruts were significantly deeper in the soft sand of the upper shore. Thus, 50–55% the sand displaced by vehicles originated from the upper shore, although this section represents only 13–36% of beach width.

EXPOSURE OF FAUNA TO TRAFFIC

Beach traffic overlapped to a large extent with the distribution of the invertebrate infauna, and vehicles frequently disturbed the drift line and the base of the foredunes.

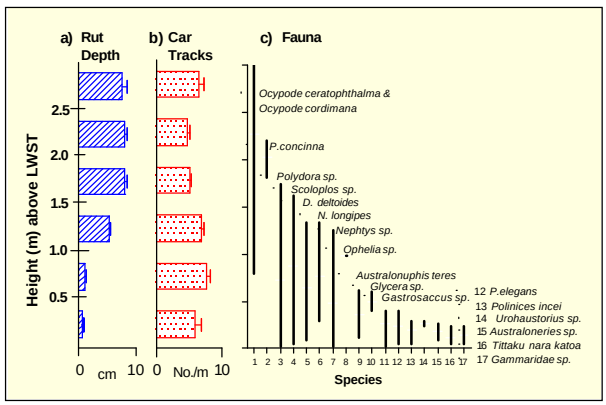


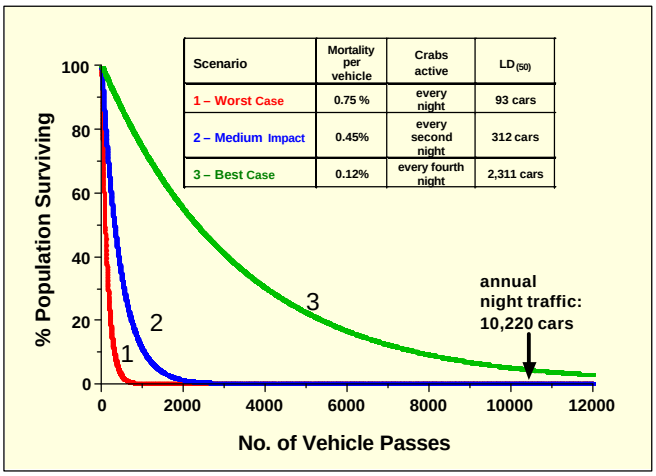
Figure 3 Distribution of vehicle disturbance in terms of (a) depth of vehicle ruts and (b) the number of car tracks per metre of beach in relation to (c) the intertidal distribution of invertebrate

Notwithstanding education campaigns for beach drivers, vehicles were found to routinely (16–67 % of traffic) cross the soft upper shore near the dunes where physical habitat damage is greatest. The majority of species overlap in their distribution with that of beach traffic and are thus potentially vulnerable to direct impacts (Fig. 3). In fact, recent work on the Noosa North Shore indicates that

beaches open to 4WD traffic harbour significantly less species at much reduced numbers (Schlacher unpubl. data).

ECOLOGICAL IMPACTS – GHOST CRAB MORTALITIES

We measured the direct impact of 4WDs on beach fauna using ghost crabs as indicator organisms. Ghost crabs are generally active on the beach surface at night and remain mostly hidden inside their burrows during the day. Two species of ghost crabs (*Ocypode cordimanus* and *Ocypode ceratophthalma)* are common on beaches in the region. Surveys on North Stradbroke Island showed that crab densities were significantly lower in areas subjected to heavy beach traffic, suggesting direct crushing by vehicles.



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It has been suggested that the burrows of crabs provide an effective means of protection against the physical impacts of vehicles. We tested this assertion via a series of controlled impact experiments in which crabs were subjected to a range of traffic volumes at different depths in the sediment. Burrows only partially protect crabs against cars: all individuals buried shallow (5 cm) are killed by 10 vehicle passes. Mortality declines with depth of burrows, but remains considerable (10-30% killed) at 20 cm and only those crabs buried at least 30 cm are not killed by 4WDs: these "deep-living" crabs represent only half of the population. After crabs emerge at dusk they are killed in large numbers on the beach surface. A single vehicle travelling at night on the beach can crush up to 0.75 % of the intertidal population. Therefore, the fossorial life habits of sandy beach animals cannot off-set the impacts caused by 4WDs and direct kills by 4WDs (particularly those at night) can contribute to population declines of sandy beach fauna (Fig. 4).

DISCUSSION

Recreational Values vs. Ecological Damage by 4WDs

Balancing environmental, economic and social demands in the management of beach traffic is a formidable challenge. The conflicting demands and constraints of regulating the use of vehicles on beaches are poignantly summarised by Godfrey & Godfrey (1980) *"There can be no doubt that 4WDs do environmental damage in just about any ecological setting. The problem is to decide where the least damage will occur, and how much, if any is acceptable".* Our data from North Stradbroke Island clearly show that beach traffic has ecological consequences, but whether the current level and extend of the damage is "acceptable" requires a broader set of criteria.

Irrespective of the social judgement or what constitutes an "acceptable" level of damage, the data obtained undoubtedly are an important step forward to derive better traffic management, including limiting or banning the use of 4WDs on the island's beaches.

Indeed, ecological damage caused by 4WDs is an argument for much stricter control of beach traffic, but counterarguments do exist. People have an inalienable right to outdoor leisure activities (Celliers et al. 2004) and this is particularly relevant for Stradbroke Island which is one of the closest ocean beaches for the people of the larger Brisbane Metropolitan area. If beaches, campgrounds and fishing spots can only be accessed by 4WDs driven on the beach, such recreational "demands" would favour beach traffic. Conversely, people also need opportunities to escape from motor vehicles and beach traffic severely curtails the rights of "non–motorised" users when 4WDs severely tarnish or exterminate the wilderness character of a beach (Wilkinson 2001). Redland Shire Council over the following three financial years intends to expand off beach parking which will – hopefully – encourage more people to walk, instead of drive, on the beaches.

It is frequently argued that local communities derive economic benefits from 4WD-based tourism. Any such gains could be lost when other visitor segments stay away from beaches with 4WD traffic. Currently we have no objective data on the actual economic costs and benefits of beach traffic. Neither do we have quantitative information about the social values of unbridled vehicle access to beaches or the level of social acceptance of this activity in the wider community including "non–motorised" beach users. This lack of socio–economic information on 4WDs on beaches is a major impediment to the development of a balanced "triple–bottom–line" approach for managing beach traffic.

MANAGEMENT IMPLICATIONS

Suggested measures to reduce the multitude of ecological impacts caused by 4WDs usually comprise the following, either as individual interventions or in combination: 1) limited access during times of high water to reduce impacts to the backshore, 2) a ban (partial or total) on night–driving to reduce mortalities of beach fauna that is surface-active at night, 3) no-go areas above the high water mark, 4) exclusion zones for beach sections to act as conservation areas, 5) temporary closure of beaches during ecologically sensitive times (e.g. bird and turtle nesting seasons), 6) capping the total number of vehicles driving on beaches ('maximum allowable pressure'), 7) provision of off– beach parking and facilities to reduce the need to drive on the beaches, and 8) improved driver education focusing on appropriate driving techniques and ways to limit ecological damage.

In practice, a balance is currently difficult to achieve given the popularity of beach driving and the economic values of tourism on the island. Nevertheless, based on data obtained in this study (i.e. level of use, impacts on beach habitats and fauna) on the 27th of June 2007 to Redland Shire Council introduced a new condition for beach driving permits that stipulates: "*access onto the beach or driving of a vehicle on the beach 1 hour before and 1 hour after high tide is not permitted*". Furthermore, Council identified that research must continue to evaluate the efficacy of the new regulations. Although this measure was generally well received by the public, any discussion of banning or restricting the number of cars would be less palatable given political fears of a public outcry. The recent public objections to increase the area of no fishing zones as part of the review of the Moreton Bay Marine Park zoning made this apparent to environmental managers. Although this attracts lots of media and

community attention considerable level of consultation is required with the general public to get a whole–of–community view and understanding of the issue and the management actions required for a more sustainable management in the long term.

However, beach traffic management must recognise the multi-faceted nature of 4WD uses on beaches that include ecological, social, historical, cultural, and economic dimensions (Celliers et al. 2004). A broad spectrum of people use beaches for different purposes. Therefore, the contrasting expectations and demands of different user groups should be accommodated to reduce conflict. One should not underestimate the social value of allowing people to drive along beaches. Values they gain from utilising the beaches may provide them with life experiences and/or appreciation of an area, making them more willing to put pressure on governments for the protection and management of our natural areas. This has been observed on the island with many long–term visitors identifying a steady deterioration of the environment and requesting better management of the island. Recent tightening of the enforcement of conditions for the driving on beaches has gained broad support from the wider community. For example, from June 2005 to June 2007, 310 Public Infringement Notices (PIN) were issued by council officers on Flinders– and Main Beach; at $375 per fine, this equates to total revenue of $116,250. Of these, 254 notices were issued for driving on the beach without permit and 66 were for undertaking a prohibited activity such as driving on vegetation and in prohibited areas.

While negative ecological impacts of 4WDs have been demonstrated for a limited number of physical and biotic components of local and regional beach ecosystems (this study), the information base for Southern Queensland is in several instances not adequate to comprehensively address the broader ecological risks of beach traffic across the entire spectrum of ecosystem components and functions. Thus further work is required within the region to gain a better understanding and ensure rigorous, robust and objective debates about the management actions required.

Finally, it is crucial that the efficacy of beach traffic management interventions implemented at local, regional and national scales is measured in a scientifically robust way to produce defensible assessments. For example, in South Africa, access of 4WDs to beaches has been severely restricted, and the ecological benefits of these bans have been immediate (Williams et al. 2004). Such policy and management interventions (Celliers et al. 2004) present a valuable opportunity to learn lessons for developing and implementing corresponding conservation measures for Queensland's beaches.

The Environmental Protection Agency through the State Coastal Management Plan – Qld Coastal Policy section 2.3.4 Vehicle use of Beaches – states that *"plans that address vehicle use on beaches, including regional plans, will determine long–term levels of use that provide for public access and safety while ensuring that the coastal resources and their values are protected"*. Unfortunately, the South East Coastal Management Plan only refers you to the State Coastal Management Plan on this issue. Redland Shire Council has undertaken the work which provides important new information on the impacts on coastal resources. Unfortunately, support from the EPA to undertake this work in a collaborative manner was limited. Redland Shire is also committed to pursue a Memorandum of Understanding between all Coastal managers of South–East Queensland to provide for a more cooperative and coordinated management approach of sandy beaches.

TAKE HOME MESSAGE

Sandy beaches present a unique and complex coastal management challenge because of a multitude of different uses (e.g. fishing, recreation, shoreline protection) that may have the potential to impair the ecological integrity of the ecosystem. One example is the widespread practice of driving 4WD vehicles on beaches which we show can cause environmental harm. However, management of beaches must be broadly encompassing of not only conservation needs but equally the socio–cultural demands and economic constraints. This principle is currently difficult to translate into on–ground management actions because objective and quantitative data on the key parameters are rudimentary at best. A regional approach is paramount given the burgeoning population of South–East Queensland and because beach management decision by one coastal management authority will have knock–on effects on other areas. For example, the intention to close two beaches to 4WDs and to cap the number of campers on Moreton Island is likely to have spill–on effects on areas that remain open to 4WDs (Williams 2007). While such conservation measures are very valuable for one area, they need a coordinated approach across the region. Similarly, discussions are being held to limit camping numbers between Noosa and Double Island Point (Odgers 2007), again emphasizing the need for strong regional cooperation on the issue of beach conservation.

In fact, fresh and pro-active approaches to managing sandy beaches must involve all tiers of government in a truly collaborative, progressive and responsive way. To this end, partnerships with research providers are an important management tool to deliver information on values, impacts and the efficacy of management interventions; ultimately, management actions must be underpinned by defensible data. This paper demonstrates that on a local scale, progress can be made when management approaches are proactively developed that begin to address the balance between human uses and environmental protection to achieve sustainable outcomes for the future of sandy beach systems.

Plate 1. Examples of damage caused by 4WD vehicles on sandy beaches. a & b – vehicle tracks in the dunes including the highly sensitive foredune areas (b); c & d – high volumes of recreational traffic on beaches with most of the intertidal area covered by tracks except a small "sandcastle" exclusion zone (d); e & f – deep rutting of the upper shore caused by beach traffic extending into the foredune areas (f); g & h – beach invertebrates crushed by vehicles both in the dunes (g – ghost crab, *Ocypode cordimanus*) and in the intertidal zone (pipi, *Donax deltoides*) with clearly visible tyre tracks after the overpass. (All photos: Thomas Schlacher at North Stradbroke Island).

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