ECOLOGICAL IMPACTS OF VEHICLES ON THE SANDY BEACHES OF SOUTHERN ADELAIDE, SOUTH AUSTRALIA

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SUMMARY

This thesis reviews the impacts of vehicles on the physical environment of beaches and beach macro- and meiofaunal communities, identifying significant gaps in our understanding of the impacts of this activity on heavily-used beaches along metropolitan coastlines of large cities, such as the southern metropolitan beaches of Adelaide, South Australia. Beaches in this region are subject to intense summertime vehicle use, and, when compared to cases reported in the scientific literature, appear to be used by vehicles in a very different way (i.e. as space for parking, rather than merely as a roadway).

In 2005, the opportunity arose to conduct a quasi-experimental investigation of the impacts of vehicles on beaches and their inhabitants when the local council, responsible for managing this activity on beaches in southern metropolitan Adelaide, implemented a series of vehicle restrictions on one beach, Aldinga. Aldinga Bay Beach was subsequently divided into three sections, a seasonal closure, where vehicle access is only permitted in the summer months, a permanent vehicle closure section made possible by the erection of wooden bollards and a section where vehicle access is permitted year-round. Vehicle restrictions were also already in place on a second beach in the region, Moana Beach, where vehicles are only permitted on one section of the Bay, with closures at both the northern and southern ends. In addition, two nearby beaches, Maslin and Port Willunga Beaches, are permanently closed to vehicle traffic along their entire lengths, as is a third beach to the south of the study region, Normanville. Thus, a series of within- (e.g. among sections at Aldinga Bay) and between-beaches (e.g. between those beaches open and closed to vehicles) comparisons were possible to investigate the question of whether vehicle traffic on these beaches was having a negative ecological impact. Sampling was undertaken three times each year, with a sampling conducted during the Austral mid-winter (July) and then again before (November/December) and after (February/March) the peak vehicle usage period during the six-week South Australian school holidays. By using such a complex experimental design, sampling multiple seasons over three years, it was possible to separate

effects of vehicles from natural spatial and temporal variation inherent in sandy beach habitats.

Vehicle activity on these nine study beaches was assessed over a two year period, with each beach surveyed for vehicles and evidence of recent vehicle activity, specifically tyre tracks in the sand, in each of the high-, mid- and low-shore zones of the beach. Likewise, pedestrian activity on these beaches was also surveyed. Similar assessments were conducted on a number of additional beaches along the Adelaide metropolitan coast, as well as south of Adelaide along the Fleurieu Peninsula and the South East region of South Australia. By doing this, it was possible to place vehicle usage of the main study beaches into a regional context, and make comparisons to usage rates reported in the literature (Chapter 2). An understanding of the patterns and intensity of vehicle usage on the study beaches themselves also aided in the interpretation of the results of other chapters of this thesis.

Vehicle impacts on the beach face profile and sediments, on wrack and the wrack-associated macrofauna and on the interstitial habitat and meiofaunal community were assessed using the complex between- and within-beaches comparisons study design described in brief above. Strong temporal and spatial variation (i.e. among beaches and beach sections) overrode any differences in beach profile and sediment characteristics between- or within-beaches that may have been related to vehicle access (Chapter 3). This result suggests that, in the face of such a high degree of natural variation, vehicle use, at the levels experienced on these beaches during the study period, is not likely to have a detectable environmental impact on the variables measured. To determine if there was any disturbance to sediments as a direct result of the actions of vehicle tyres, displacement experiments, *sensu* Anders and Leatherman (1987), were conducted in each of the high-, mid- and low-shore zones of the intertidal beach at Aldinga (Chapter 4). Noticeable displacement of sediment only occurred in the high-shore zone. By this method, sediment displacement on Aldinga Beach was found to be much lower than that reported by Anders and Leatherman (1987) for a Fire Island beach but estimates of annual net displacement were found to be much greater, owing to a higher rate of vehicle usage at Aldinga.

Effects of vehicles on the wrack-associated macrofauna were more complex (Chapter 5). Macrofaunal communities on beaches with vehicles generally lacked semi-terrestrial isopods and terrestrial beetle species, indicating a potential disconnect between the intertidal beach and the back-beach and dune habitat. While there was no difference in the composition or amount of wrack deposited on beaches or beach sections with or without vehicles, macrofauna communities along the entire length of both Moana and Aldinga Bay beaches were generally depauperate in nature, regardless of vehicle closure types (i.e. permanent or seasonal) or duration of closure (i.e. 3 years at Aldinga versus at least 15 years at Moana), with low abundances and species richness. These results suggest that the spatial extent of vehicle effects on sandy beach macrofauna may extend beyond the actual area of impact, and that the spatial scale of closures on both Aldinga and Moana Beaches may be too small to encompass macrofaunal populations.

Few impacts of vehicles were detected on the interstitial habitat and meiofaunal communities (Chapter 6). Like beach profile and sediment characteristics (Chapter 3), the interstitial habitat and meiofaunal communities of the beaches studied appear to be subject to a high degree of temporal and spatial variability that overrode any negative effects of vehicles. There were some differences in meiofaunal community structure among sections of Bays with different vehicle access, indicating that although such closures may have been too small to protect macrofaunal populations from vehicle disturbance, closures may have acted as refugia for meiofauna.

Further research is needed to aid in the effective management of this activity on beaches in southern Adelaide, and around the world, especially if the purpose of management is to maintain (or reestablish) ecosystem function. Specifically, roles of the spatial extent of vehicle impacts on mobile macrofauna and the dispersive capacities of many key species remain unclear. Likewise, methods for reestablishing macrofaunal populations on disturbed beaches need to be developed, tested and then implemented on beaches that have previously subjected to vehicle activities. Understanding these aspects may prove critical when designing and implementing future closure sections on open beaches especially when deciding on the size of such closures.

DECLARATION

I certify that this thesis does not incorporate without acknowledgement any material previously submitted for a degree of diploma in any university; and, that to the best of my knowledge and belief it does not contain any material previously published or written by another person except where due reference is made in the text.

Tanith Ramsdale

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