## The effects of human disturbance on the seabirds and seals at Marion Island

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Animals undergo changes in behaviour or physiology when exposed to human disturbance[1]. Such responses can have population-level consequences[2,3]. The intensity of response may be site- and species-specific[4, 5]. Within species it may depend on the prior history of disturbance of individuals[6] and stage of the breeding cycle[7]. At Marion Island, animals may be disturbed by (a) biological research, (b) logistic activities and (c) incidentally by island personnel. (a) We found that the breeding success of a frequently-monitored Grey-headed Albatross study colony did not differ from that of non-study colonies. The maximum weight of Subantarctic Fur Seal pups that were weighed monthly did not differ from that of pups that were only weighed in July. (b) Grey-headed Albatross chicks were more likely to stand and to react in the presence of a Bell 212 helicopter than in its absence (both $p<0.001$). Brooding Gentoo Penguins were less likely to stand during flights by the Bell 212 helicopter than in the absence of a helicopter ($p=0.05$), while guarding penguins were more likely to stand on flight than on non-flight days ($p<0.001$). Birds of both phases were more vigilant when a helicopter was close to the colony than when no helicopter was present ($p<0.001$). No nest desertions were observed. (c) During single-person pedestrian approaches, breeding King Penguins were more likely to be anxious, but less likely to move away than non-breeders (both $p<0.001$). Wandering Albatross adults close to base and in a study colony were more likely to stand up ($p<0.05$) and had higher Overall Response ranks during approaches than birds that were seldom-visited ($p<0.01$). Frequency of approach did not influence the behavioural responses of seldom-visited birds, but breeding success was lowest for birds that were approached most times ($p<0.05$). We recommend the implementation of controls for potential effects of disturbance in studies investigating breeding success. Flights should not coincide with sensitive breeding stages but if this is unavoidable, helicopters should stay well clear of breeding colonies. Pedestrians should approach breeding birds with care. Subtle behavioural responses do not necessarily indicate lack of anxiety by animals.

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