FOOTWEAR TO ALLOW RESEARCHERS TO CROSS DENSELY BURROWED TERRAIN WITHOUT DAMAGE TO SEABIRD HABITAT

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SUMMARY

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Damage to breeding burrows is an inevitable consequence of human activities on densely populated seabird colonies. Few of the *ad hoc* mitigation measures reported in the literature offer means of working freely and effectively in such environments without collapsing burrows. This paper describes a simple snowshoe-like attachment to footwear that enables individuals to walk relatively comfortably across terrain heavily burrowed by smaller seabird species (≤ 300 mm body length). We outline the design principles for these versatile, easily made fittings and discuss their benefits and limitations.

Key words: petrels, habitat, disturbance, conservation, New Zealand

INTRODUCTION

Conservation managers, researchers and other visitors to oceanic seabird islands commonly experience difficulties of access and movement across densely burrowed terrain (Taylor 1995, Ussher 1999, Ryan 2005). Frequent burrow collapses tend to be unavoidable, especially if burrows are shallow or excavated in friable substrates (e.g. Fleming 1939, Campos & Granadeiro 1999, Scott *et al*. 2008). During the breeding season, full or partial collapsing of burrows may be fatal to burrow occupants or may result in desertion of eggs and chicks. The risk of damaging burrows also limits conservation effort and effectiveness. Island managers may be compelled to limit visits or visitor numbers and to impose codes of conduct for visitors (e.g. Great Barrier Reef Marine Park Authority 1997). Conservation work ashore can be curtailed by limiting the frequency of activities (Ryan *et al*. 2006) or their scope (West 1999, Souter *et al*. 2005, McGowan *et al*. 2007). Stopping constantly to excavate and rebuild burrows prevents fieldworkers from venturing from well-trodden tracks and reduces time for fieldwork.

Various methods of traversing fragile breeding terrain have been used on extensively burrowed islands. Baker *et al*. (2010) followed the practice of West & Nilsson (1994) in using narrow plywood boards laid ahead of researchers to reach study burrows. To improve study outcomes and reduce disturbance, Campos & Granadeiro (1999) constructed purpose-built research trails through a densely populated colony of White-faced Storm-petrels *Pelagodroma marina* on Selvagem Grande Island (northeast Atlantic). The authors above do not report on the relative efficiency of these methods.

The problems inherent in traversing heavily burrowed terrain are manifest in New Zealand, where many relict or translocated populations of threatened terrestrial birds are managed on islands also supporting large seabird colonies (Craig & Veitch 1990, Armstrong & McLean 1995, Atkinson 2001). The problem is acute on Rangatira (South East) Island (218 ha), one of the southern hemisphere's most important sanctuaries for threatened marine and terrestrial biota. The island, situated 800 km east of New Zealand in the Chatham Island archipelago (44°20'S, 176°10'W), supports the only substantial populations of four species of endangered endemic birds (terrestrial and marine), along with communities of at-risk endemic birds, invertebrates and plants (Miskelly 2008). The rare birds have been intensively managed since 1981 in habitats densely burrowed by penguins and seven breeding petrel species. Estimates of density for the latter average from 1.19 to 1.39 burrows/m^2 (West & Nilsson 1994, Roberts *et al*. 2007).

Conservation of critically threatened species such as Chatham Island Black Robins *Petroica traversi* (Butler & Merton 1992, Kennedy 2009) and Chatham Petrels *Pterodroma axillaris* (Sullivan & Wilson 2001) required observers to search for or follow birds through untracked areas of forest, or to make daily visits to burrows and nest-sites off arterial tracks formed previously by trampling burrows flat. Expanding populations of the managed species and daily census requirements intensified the need for a means of moving safely and quickly across burrowed ground. Without such a method, burrows were collapsed at almost every footfall. Seekers of Chatham Petrels risked damaging the very burrows they were looking for.

In 1991, Pachlatko and Kennedy experimented with various forms of boards strapped to their boots, adopting the principle of snowshoes to distribute the weight of each footfall over a surface area greater than a normal boot-print. Despite initial scepticism about the efficacy and practicality of these devices, they proved effective. On the feet of enterprising fieldworkers, these petrel boards have since evolved through numerous forms, each designed to improve effectiveness and comfort. An account of this development is available on request from the authors. Successive modifications focused primarily on board shape and bindings. In their most recent form described here, petrel boards have become relatively comfortable, easy to fit and wear, and absolutely necessary for the conduct of conservation projects on Rangatira Island. In this form, they are more appealing to fieldworkers otherwise disinclined to use them.

This paper describes the petrel boards currently in use on the island and the principles underpinning their design. Benefits and limitations are discussed. Since board character differs according to the preferences of each operator, we confine its description here to essential details.

DESIGN PRINCIPLES AND REQUIREMENTS

The function of petrel boards is to distribute the weight of a footfall over a broad area. To achieve this, petrel boards must balance mobility against weight-bearing and weight-distribution properties. Field testing showed that rectangular boards measuring approximately 380 mm long by 260 mm wide can convey a fieldworker and equipment of mass > 100 kg across heavily burrowed ground. Five-ply (9–10 mm) plywood sheeting (H4-treated for durability; New Zealand Timber Preservation Council 2004) is sufficient to bear this weight. Three-ply boards are lighter to wear and carry, but flexing of the thinner (4–5 mm) material results in counter-productive soil compression and eventual fracturing of the board itself. By contrast, five-ply boards do not flex.

Boards are strapped tightly to boots using commercially available snowboard bindings (Fig. 1). These are stronger and more durable than their wire-and-strap predecessors (Fig. 2) but are not so easily repaired in remote field locations. The bindings pass across the toe and over the arch of the foot in front of the ankle, holding the boot firmly against ankle-high heel restraints.

The bindings locate the foot in the centre of the board for even weight distribution. Adjustable fittings accommodate differing boot sizes and minimise lateral and fore-and-aft movement of the foot. Thus, wearers can negotiate soft ground and modest slopes confidently, even in muddy conditions. Bindings of this sort are better bolted than screwed to the boards (screws invariably work loose over time). The bottom edges of the boards are bevelled to minimise soil compression, a problem associated with foot rotation of the stiffer five-ply boards. Board undersides are customarily fitted with two wooden battens fixed laterally to provide grip on slopes, especially in wet conditions.

LIMITATIONS

Petrel boards are best suited for use on flat or gently sloping terrain on which ground cover and litter are minimal (see http://www.youtube.com/watch?v=9R4lNcEMcZw). They are not appropriate for steep or broken ground or for movement over tree roots, rock surfaces and boulders. Entanglement in lianas, bracken or dense fern can be a problem. Mud tends to accumulate on the undersides in wet conditions. Quick-release bindings have made it easier to remove boards to deal with these situations.

Petrel boards are not suitable for traversing ground burrowed by birds such as Blue Penguins *Eudyptula minor* and larger-bodied petrels such as Sooty Shearwaters *Puffinus griseus*. The boards cannot straddle the wider tunnels and nest chambers of such species; in terrain colonised by these birds, petrel boards increase rather than lessen the risk of wholesale collapse.

The rigid soles of petrel boards require a deliberate, slow action in lifting and placing each step (see http://www.youtube.com/watch?v=R3KdFLu5Sbs). Fieldworkers adjust quickly to this novel mode of locomotion, especially when the bindings are firm and comfortable. Board width also requires some abduction in leg movement so that opposing ankles and calf muscles are not bruised. Several modifications have been tried to minimise this discomfort (see below). The boards may not suit people with existing hip- or knee-joint problems.

MODIFICATIONS

The basic petrel board design has been modified in several ways in efforts to improve comfort and effectiveness.

Off-set bindings

Some fieldworkers shifted the bindings laterally from board centrelines so that they did not have to compensate for the width of the board. Practice showed that excessive adjustment towards the inner edge compromised weight distribution, causing more burrow collapses. The adjustment is a matter for experimentation, to determine the best compromise for each wearer's weight.

Fig. 1. Current petrel board design using commercial snowboard bindings to accommodate standard field footwear. *Photo: E. Kennedy*

Fig. 2. Early petrel board design using wire-and-strap bindings with a wooden instep locator. Many variations of these easily fashioned and relatively durable binding materials were tried. *Photo: E. Kennedy*

Rubber edges

Traction in slippery conditions and soil compression at the leading edges has been problematic for all forms of petrel boards. T. Pachlatko attempted to remedy these issues by fitting an oversized rubber sole to the board, cut from standard car-floor mats (Fig. 3). This softened the edges, but increased board weight significantly, and resulted in mud build-up between boards and soles. Ground vegetation tended to abrade the rubber excessively. This modification has not been adopted.

Board shape

Many boards in use today are kidney-shaped (Fig. 4). This modification has the benefit of reducing board contact with opposing ankles and calves and does not compromise weight distribution.

CONCLUSION

Since 1991, field experience on Rangatira Island in the Chatham Islands archipelago has shown that use of petrel boards to traverse heavily burrowed terrain radically reduces the incidence of seabird burrow collapse and thus improves the effectiveness of conservation and research activities. For this reason, the boards are now carried by all fieldworkers, and the New Zealand Department of Conservation requires them to be worn off formed tracks on Rangatira Island (Fig. 5).

The boards offer a superior, more versatile alternative to earlier means of moving over burrowed ground (planks, trampling of access routes). The principle of weight dispersal is sound when applied using the design described in this paper. The boards are cheaply made, easily maintained and safe for fieldworkers of all

Fig. 3. Rubber car mats trimmed to form soles for the petrel boards. This modification was not adopted. *Photo: T. Pachlatko*

Fig. 4. Alternative to the conventional rectangular petrel boards. This kidney shape improved mobility without affecting weight dispersal properties. *Photo: E. Kennedy*

Fig. 5. Petrel boards readily at hand outside the hut door on Rangatira Island (Chatham Islands). The boards are now standard equipment for fieldworkers and must be worn off tracks. *Photo: E. Kennedy*

statures and weights up to 100 kg or more. They are very effective year-round on terrain where soil is friable and densely burrowed. They are particularly suited to use on level terrain, gentle slopes (up to 20°) and reasonably open ground vegetation, but can be damaging on ground burrowed by larger-bodied seabirds (≥ 30 cm body length). Worker safety and confidence will be compromised if the boards are worn on steep, rocky terrain or in dense vegetation.

The current recommended design follows extensive experimentation and testing in the field. The board dimensions reported here are optimal, but further development of bindings is possible. Toe bindings, such as those used by cross-country skiers, may improve comfort and mobility; but alternative bindings are practical only if they accommodate the footwear worn normally by fieldworkers (boots, walking shoes).

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