Foreword

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An emphasis on defining 'habitat requirements' of species pervades modern conservation science. It lies at the heart of many wildlife management activities for rare, endangered, and game species: e.g. range management, management of release or translocation sites, reserve selection. Within New Zealand, defining habitat requirements is an explicit or implied activity in almost all threatened bird species recovery plans and is usually practised by enumerating how birds at one locality (or occasionally more than one) exploit their environment. Subsequent conservation actions are shaped by this 'picture' of habitat requirement or use. However, as Gray & Craig (1991) have noted, this approach needlessly restricts conservation options: by denying that the target species may already be restricted to 'sub-optimal' habitat as a result of the modern alteration of the New Zealand landscape, and by denying the possibility that it is far more plastic in its ability to exploit alternative habitats than its present (generally relict) distribution would indicate. The decade-long, and at times acrimonious, debate about whether conservation of takahe, *Porphyrio mantelli* should remain restricted to the alpine grassland environment of its sole remaining population is, perhaps, one of the more graphic examples of conservation thinking constrained by the 'what is, is best' approach (Jamieson & Ryan 2001).

In effect, the modern New Zealand landscape, so recently the result of extensive modification and fragmentation of the indigenous, bedevils any attempt to describe and interpret the distribution of its endemic avifauna in terms of 'habitat characteristics' by the impossibility of separating the effects of *preference* for particular habitats from those of *exclusion* by historic events. Furthermore, it frustrates attempts to define, from broad-scale survey of distribution and abundance, the relative quality of habitats occupied (Wiens & Rotenberry 1981; van Horne 1983). An example of this conundrum was the attempt by Collier et al. (1993) to define suitable habitat in which to concentrate conservation of blue duck, *Hymenolaimus malacorhynchos,* by comparing characteristics of sections of rivers in which the bird remained with those from which it had disappeared. This study identified birds present in places at 8–1050 m altitude, on rivers with gradients of 12–106 m/km, with channels 8–60 m wide, substrates comprising 1–95% boulders, banks clothed in 0–100% native riparian forest, and a broad range of aquatic invertebrate taxa. Some characteristics of occupied and unoccupied sites were considered significantly different but ranges of all overlapped; a more circumspect conclusion would have acknowledged the profound physical and biological diversity of occupied sites and the likelihood that a suite of site-specific historical reasons lay behind present-day absences. Presence is an uneasy surrogate for suitability!

The timely critique of Gray & Craig (1991) and a restatement of blue duck conservation objectives (Adams et al. 1996), to which the study of Collier et al. (1993) contributed, were instrumental in directing thought to alternative ways of evaluating habitat quality and identifying sites in which conservation efforts should be concentrated. Demographic measures such as breeding success, survival, and population density are popularly employed as indirect measures of habitat quality, but they are invariably time-consuming (multi-year and multi-site data are required), labour-intensive (many pairs or individuals monitored at each site) and expensive. Although these approaches had already demonstrated startling differences in the survival and productivity of blue ducks inhabiting the Manganuiateao River's headwaters and its middle reaches (K.Oates unpubl. data; Williams 1991; Williams & McKinney 1996) sufficient to suggest headwaters may be population sinks rather than sources, the challenge was to test this hypothesis elsewhere quickly and cheaply.

Optimal foraging theory holds that fitness is a function of foraging efficiency (Pyke et al. 1977; Krebs 1978); individuals maximising net energy gain when foraging should live longer and breed better than those whose foraging efficiency is less. Extending this concept to a consideration of avian habitat, it follows that 'optimal' habitat is that in which it is easiest to maximise net energy gain, i.e. costs of living are lowest. Thus, individuals living in optimal, or highest-quality, habitats are predicted to have the lowest daily energy expenditures. This characteristic ought to be most apparent outside of the breeding season and be detectable by direct measurement of daily energy expenditure (e.g. using the doubly labelled water technique) and be reflected in individual time budgets. If this hypothesis is correct, field measurement of daily energy expenditure may provide a single and instantaneous bird-centred measure of relative habitat quality.

Papers presented in this volume are the written outputs of a study, conducted between 1997 and 1999, designed to test the above hypothesis. Expressed retrospectively, the goal of the research was to appraise and demonstrate the usefulness of field measurements of energy expenditures of selected New Zealand birds to their conservation and management, and especially as a means of assessing the quality of their habitats.

The study was conducted as a collaborative research contract (managed by Murray Williams) between Science & Research Unit of the Department of Conservation, New Zealand, and Professor David M. Bryant of the Institute of Biological Sciences, University of Stirling, Scotland. Dr Jason Godfrey was employed as a Post-doctoral Fellow to enjoy five consecutive summers of alternating fieldwork in New Zealand and laboratory analysis in Scotland. The written reports rightly indicate Jason as principal author, reflecting his predominant operational and intellectual contribution to the project. Operational funding was provided by DOC and was supplemented by grants from the Natural Environment Research Council (UK), the Lottery Science Fund (NZ), and Genesis Power Ltd.

Objectives for the study were:

1. To measure the daily energy expenditure of individuals of selected threatened bird species in habitats with differing physical and biological characteristics;

2. To compare energetics measurements as indicators of habitat quality with any alternative measures of habitat quality or existing demographic data from the study sites; and
3. To demonstrate the use of energetics measurements to a conservation 'problem', e.g. whether changes of flow regime, induced by hydro-electric power generation on the Whakapapa River, changed 'living costs' of blue ducks residing there.

To address objectives 1 and 2 required selection of at least three species each with two or more populations being monitored and with quality demographic data available for each population. Somewhat surprisingly this proved a particularly difficult requirement to satisfy. An additional complication arose from the operational requirement to capture individual birds twice within 3–5 days; we were advised that some otherwise desirable target species (kokako, *Callaeas cinerea*; kaka, *Nestor meridionalis*) were too difficult to catch within specified time constraints.

Eventually, components of the project were:

1. An evaluation of the theoretical justification for the primary research hypothesis, and issues which may make the hypothesis difficult to evaluate.
2. Assessment of energy expenditures between populations of differing demography: in (i) blue ducks, a nationwide, multi-river appraisal; (ii) takahe, alpine grasslands v. offshore islands; and (iii) black robin, *Petroica traversi,* lowland v. upland sites on South-east Island (Rangatira), and South-east Island v. Mangere Island, Chatham Islands group.
3. Assessment of whether the presence of predators increased living costs in North Island robins, *Petroica australis*—a comparison of robin energy expenditures in forest plots with differing predator densities after aerial 1080 pest control operations.
4. Comparison of energy expenditures of blue ducks residing above and below a water diversion structure on Whakapapa River and under differing residual flow regimes.

Of the six intended project outcomes, three (1, 2(i), and 3) are reported here.

Study 4 (Whakapapa River blue ducks) failed because of our inability to capture ducks residing above the water diversion structure. Given the results of the multi-river blue duck study reported here, it is most likely that birds living above and below the diversion structure had differing daily energy expenditures. Whether those residing below the diversion structure found differing residual flows imposing different living costs remains a tantalising research question.

The black robin populations on Mangere and South-east Islands, the latter descended from the former and both tracing their origins to a single female of the 1970s (Butler & Merton 1992), have demonstrated differing survival–productivity trade-offs during the 1990s (E.Kennedy unpubl. data). Unfortunately, all blood samples from Mangere Island were damaged during transit to Scotland, preventing any between-island comparison. No significant differences in energy expenditures of robins living in upland and lowland sites on South-east Island were detected; readers requiring details of these energy expenditures should contact Professor Bryant at Stirling University directly

(d.m.bryant@stir.ac.uk). I thank Euan Kennedy and Mike Bell for their contributions to the black robin study.

The comparison of takahe living in alpine grassland and on islands was unable to proceed when the DOC takahe recovery group advised against the project, citing concerns about disturbance to the alpine population. They suggested that birds held at the Department's Burwood Bush takahe captive rearing facility near Te Anau be used instead. By not being a free-living population with an intrinsic demographic history, birds at Burwood Bush were unsuitable for the purposes of this project. When staff at Burwood Bush expressed interest in knowing the effects of radio transmitters being attached to their birds when returned to the wild, this identified a potential application of energetics research to a conservation management problem. This, then, is the origin of the study of energy cost to takahe of carrying radio transmitters and the review of 1990s radio-tracking studies, also reported in this volume.

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