

special issue:

Feathers to Fur

The ecological transformation of Aotearoa/New Zealand



Feathers to Fur: the status of New Zealand ecological research in 2009

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Abstract: We outline the scope of this special issue of *New Zealand Journal of Ecology*, which reviews progress in New Zealand ecology to 2009, based on a symposium in 2007. Both the issue and symposium update a 1986 conference and 1989 special issue of *NZ J Ecol* called “Moas, Mammals and Climate” which has been influential and widely cited. This issue revisits several themes featured in 1989, including the extent of recent and prehistoric extinctions in the New Zealand fauna; effects of introduced mammalian herbivores replacing now-extinct browsing birds such as moa; the impacts of introduced mammalian predators on native birds (hence the *Feathers to Fur* title); the role of islands as refuges and opportunities for restoration; and the status of bird-plant mutualisms like pollination and fruit dispersal. Several topics not discussed in 1989 are raised, including the unusual size and functional composition of New Zealand’s tree flora, and several taxonomic groups (invertebrates, fungi) and habitats (fresh waters) that received little attention in 1989. We summarise four symposium talks which are not included elsewhere in this issue. New Zealand leads the world in ways both unenviable (e.g. levels of impact of introduced species) and enviable (e.g. predator eradication, translocations, rare species management). The recent advances reviewed in this issues have relevance well beyond New Zealand.

Keywords: conservation, disturbance, eradication, extinction, fish, fungi, herbivory, invasions, *Rattus exulans*, trees

Introduction

In the 1980s, progress in ecology in New Zealand was reviewed by a conference symposium (at the 1986 annual conference of the New Zealand Ecological Society) and subsequent special issue of the *New Zealand Journal of Ecology* (1989, volume 12 supplement), both entitled “Moas, mammals, and climate in the ecological history of New Zealand”. These were landmark events, and the 1989 special issue has become the most cited in the history of the journal (see below). A generation later we decided it was time to once again take stock and produce a synthesis of ecological research into important drivers of ecological change, including the implications of this for New Zealand and for global ecology. This special issue and the 2007 conference, again both sharing a single title, “Feathers to fur: the ecological transformation of Aotearoa”, reflect on 20 years of progress in New Zealand ecological research. For “Feathers to Fur”, we expanded the scope of the 1986 conference to encompass past and present changes to New Zealand’s flora, fauna, and fungi in general, and our understanding of the processes driving these changes. While the conference title was suitably alliterative, it was never intended to imply a focus solely on birds and mammals; McIntosh et al. (2010) suggested “mucous to scales” would be a better summary of the fish changes.

More than almost any other land mass, New Zealand’s biota has experienced substantial, almost schizophrenic, rates and amounts of ecological change. New Zealand’s natural environment has been through the freeze-thaw pendulum swings of the Quaternary glacial-interglacial cycles, mountain building and erosion, frequent massive earthquakes, and some of the largest volcanic eruptions documented. The last 20 years of ecological research have greatly improved our understanding of how these disturbances shaped the New Zealand biota, including surprises such as the extent of maximum marine transgression in the Oligocene when it has been seriously suggested that all of Zealandia might have been underwater (Landis et al. 2008, but c.f. Tennyson 2010, McDowall 2010), accumulating evidence against the ancient Gondwanan ancestry of many New Zealand taxa (McGlone 2005), and the discovery of a fossil mammal from the Miocene (long after New Zealand’s separation from Gondwana) (Worthy et al. 2006; Tennyson 2010).

While the New Zealand biota was well used to environmental change, the recent arrival of people with their associated species and fire has caused an unprecedented ecological transformation. Hugh Wilson (2008) likened it to a harpoon hitting a whale. The transition of the vertebrate fauna from feathers to fur, with at least 58 bird extinctions and 31 mammalian introductions since human arrival (Tennyson

This special issue reviews the current status of New Zealand ecology, updating the 1989 *Moas Mammals and Climate* special issue (*NZJ Ecol* 12 supplement). Both issues are available at www.newzealandecology.org/nzje/.

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2010), is just one of the most visible of a great number of interrelated changes. Because people arrived in New Zealand so very recently (c. 1280 AD: Wilmshurst et al. 2008), and because so many novel taxa arrived with them, New Zealand is one of the most detailed examples in the world of the ecological changes caused by humans, both indigenous and European, to naive biotas (e.g., Worthy & Holdaway 2002; Wilson 2004; Allen & Lee 2006). Similar changes probably occurred in all other areas invaded by humans, but the record has either been largely lost through the passage of time, or is only now being uncovered as in the case of bird losses throughout the Pacific (Steadman 1995, 2006).

The “Feathers to Fur” conference and this special issue review how much we’ve learned about these changes to New Zealand, and look to the many challenges ahead. In this preface to the issue, we briefly summarise the history of these two milestone conferences, and outline additional contributions to the 2007 conference which are not represented as papers in this issue.

A Brief History

The 1986 conference and 1989 journal issue stand as a milestone in New Zealand ecology. The conference, held in Lincoln College (now Lincoln University) on 2–5 September, included a two day symposium and two days of contributed papers. Sixteen of these papers were published in the 1989 special issue of the *New Zealand Journal of Ecology* (issue 12 supplement), which includes four of the journal’s ten most cited papers based on ISI Web of Science (McGlone 1989; Holdaway 1989; Clout & Hay 1989; Atkinson & Greenwood 1989). Eight of the issue’s 16 papers are among the top 100

most downloaded articles from the journal website since 2003, more than from any other single issue of *New Zealand Journal of Ecology* or its predecessor the *Proceedings of the New Zealand Ecological Society*, and including four of the top ten most downloaded papers (McGlone 1989; Holdaway 1989; Clout & Hay 1989; Anderson 1989). Jared Diamond (1990) wrote an overview of the special issue in *Nature*.

The common themes running through the symposium and special issue were ecological changes brought about by human hunting, burning and grazing, the extinction of moa and other birds, and the invasion of predatory and herbivorous mammals. Among the notable ideas debated were the suggestions that some growth forms disproportionately common in the New Zealand flora, particularly divarication, were adaptations to resist and tolerate moa browsing (Atkinson & Greenwood 1989), that the largest-fruited New Zealand native trees were now virtually reliant on one bird species, the kereru *Hemiphaga novaeseelandiae*, for seed dispersal (Clout & Hay 1989), and that deer might be ecologically partly analogous to moa in their impact on native vegetation (Caughley 1989). These latter two topics featured again in Feathers to Fur (Kelly et al. 2010, and Forsyth et al. 2010, respectively).

The changes in New Zealand ecological research since the 1980s are evident in the common words and phrases used in the full text of all *New Zealand Journal of Ecology* articles from the 1980s and 2000s (Fig. 1). Notable examples of groups of words and phrases that more than doubled in usage between the 1980s and 2000s, as a proportion of all words in that decade, are databases (“database(s)”, “data base(s)”) (increased 6.5×), fragmentation (“fragmentation”, “edge effect(s)”, “habitat loss”, “habitat modification”, “deforestation”)



Figure 1: Word maps of the most common words and two-word phrases used in the full text of all articles of *New Zealand Journal of Ecology* from the 1980s and 2000s (excluding common, short English words), generated using www.wordle.net. The size of each word or phrase indicates its relative frequency.

(5.4×), “conservation” (3.6×), statistics (“statistics”, “anova”, “regression”, “glm”, “bayesian”, “data analysis”) (2.6×), mammalian predation (“predator”, “predation”, “rat(s)”, “stoat(s)”, “weasel(s)”, “ferret(s)”, “mustelid(s)”) (2.5×), and climate change (“climate change”, “global warming”, “climate warming”, “greenhouse effect”) (2.2×). Notable declines are divarication (“divaricate”, “divaricating”, “divarication”) (0.5×) and moa (0.5×). Use of words and phrases associated with browsing, invasion, evolution, and behaviour changed little between the decades. Words and phrases associated with mammalian predation, browsing, and invasion were far more frequent than those associated with fragmentation and habitat loss (1980s: 28–142×, 2000s: 10–23×), and vastly more frequent than those associated with climate change (1980s: 89–444×, 2000s: 78–175×). This reflects New Zealand ecologists’ ongoing emphasis on invasions and their impacts (cf Didham et al. 2007).

Feathers To Fur

The “Feathers to Fur” conference reviewed progress since 1986. A one-day symposium of invited speakers was held on 20 November 2007 at the University of Canterbury, followed by two days of contributed papers. In a notable shift from the vertebrate-focused 1986 conference, the first speaker was an insect ecologist, George Gibbs, who assessed whether New Zealand’s insect fauna showed unusual features as a result of evolving in the absence of terrestrial mammals (except for New Zealand’s once three, now two, bat species) (Gibbs 2010). The conference also broadened taxonomically by the inclusion of ecological changes in New Zealand fungi (Johnston 2010) and freshwater fish (McDowall 2010; McIntosh et al. 2010) and the impacts of invasive invertebrates (Brockerhoff et al. 2010).

Two topics not discussed in the 1989 issue are raised here. Huge advances in the last 20 years in the use of eradication and island refuges for conservation purposes are reviewed by Bellingham et al. (2010), and McGlone et al. (2010) discuss the unusual abundance and odd nature of the New Zealand tree flora.

Four of the “Feathers to Fur” talks are not included in this issue but add important perspectives on New Zealand’s ecological transformation. Janet Wilmshurst presented work dating seeds gnawed by kiore (Pacific rats, *Rattus exulans*), which, alongside other evidence, date the first arrival of Polynesians in New Zealand at around 1280 A.D. (Wilmshurst et al. 2008). This work overturns some previous claims of longer Māori occupation of New Zealand, and means that the massive ecological transformation of New Zealand’s biota has taken only 730 years. Many of the older trees in New Zealand’s forests pre-date human colonisation by centuries (Ogden & Stewart 1995)!

Richard Holdaway reviewed the many advances in our understanding of moa ecology since 1986, and since the last published review (Worthy & Holdaway 2002). New technologies are leading to rapid advances in the knowledge that can be gleaned from the bones of the fallen (e.g., Turvey et al. 2005; Turvey & Holdaway 2005). As Richard put it in his conference paper, ancient DNA has opened up “a brave new ancient world” (see Haile et al. 2007). Radioisotope work is also revealing unprecedented details on what, and where, individual moa were feeding.

Richard Duncan reviewed our recent understanding of how earthquakes have shaped the composition of the forests of the South Island, causing regeneration gaps in forest age-

structure that puzzled earlier ecologists (Wells et al. 1999, 2001). Dendrochronology and geological evidence show that the South Island is well overdue for a magnitude 8+ earthquake. As Richard concluded, the trees tell us that we have lived in relatively quiet times.

Leo Condron provided an important soils perspective on understanding forest change, reviewing recent soil chronosequence work on how forest ecosystems progress from nitrogen limitation to phosphorous limitation as soils age (Richardson et al. 2005; Allison et al. 2007; Turner et al. 2007).

Several themes ran through “Feathers to Fur”. We now understand in much more detail how exquisitely strange was New Zealand ecology before people (or, at least, how much it was unlike the temperate Northern Hemisphere). We also have a better understanding of how extensive, and rapid, the transformation has been from this unusual outlier of global evolution to the relatively depauperate and invaded New Zealand of today. There is also now an abundance of new evidence, and growing consensus, in the old debates of 1986–1989 about whether deer are ecologically equivalent to moa (“no”) and whether moa played a role in the evolution of unusual woody plant growth forms (“yes”; see Forsyth et al. (2010) and Lee et al. (2010)).

Some bibliographic indicators are revealing about trends in science 1989–2010. The papers in this issue have far more authors (3.76 per paper with only 4 of the 13 sole-authored, compared to 1.25 per paper with 12 out of 16 sole-authored in 1989) showing the increasing tendency to work in teams. As a result of the team approach and accumulating information, many of the papers in this issue are substantially longer than the equivalent treatment in 1989. Gender equality shows substantial progress off a low base: none of the 20 authors in 1989 were women, compared to 13 of 49 (27%) in this issue. While all the lead authors in this issue are men, that is only because Janet Wilmshurst’s symposium talk was published elsewhere (see above).

Despite the many recent scientific advances detailed in this issue, it is also clear that many extant New Zealand native species and ecosystems remain under threat (Kelly & Sullivan 2010). The transformation of New Zealand continues. For example, most extant native forest bird species are in national decline (Innes et al. 2010), with flow-on effects on weakened pollination mutualisms (Kelly et al. 2010). New Zealanders have yet to face up to the impacts salmonid sports fish are having on native galaxiids (McIntosh et al. 2010) and our knowledge of the impacts of invasive invertebrates, fungi, and plants are still in their infancy (Brockerhoff et al. 2010; Johnston 2010). There are many challenges for New Zealand ecologists for the next 20 years, and there is no time to lose.

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