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LEAD ARTICLE

Te Ao Hurihuri

Te Ao Hurihuri means (among other things) *the world moves on*. It was in that sense that Eru Manuera, DOC's Tumuaki Kaupapa Atawhai, suggested that I use it as the title for our seminar series on scientific investigations working with tangata whenua. The series attracted much interest, and individuals who could not attend asked if written material could be made available. Initially I had not intended this, but as the number of requests grew I thought that there was a real need for some written follow-up, and that *ConScience* was a good vehicle. Hence we will have, over the next few issues, material from the seminars. The final seminar by Christine Jacobson was a review of the material on mataraunga maori and western science which emerged in the previous seminars, and considered it in relation to section 4 of the Conservation Act 1987.

When the seminars were being organised, we discussed at length whether this section 4 material should come first or last. For the seminars it was decided to make it the concluding thought on the series. This time it will be first, and act as a preface to the presentation of actual projects which illustrate varying degrees of interaction between tangata whenua and scientists. We will begin the project material in the next issue. *Kaye Green—Editor*

'I'm a scientist. What has section 4 got to do with me?'

Giving effect to the principles of the Treaty of Waitangi in the work of the Department of Conservation

Although the Department of Conservation was established by the Conservation Act 1987, which included section 4, it has taken some time for staff to grasp what this section 4 of the Act means. Indeed, there is still uncertainty in some areas.

'Section 4' requires the Conservation Act, and all the Acts listed in its First Schedule, be interpreted and administered so they give effect to the principles of the Treaty of Waitangi. Should there be any conflict between the Treaty principles and the purposes of conservation legislation, the conservation legislation provisions must be implemented.

In 2001 the department published Nga Akiakitanga Nuka Kaupapa Maori, draft policy papers, including Waahi

Department of Conservation
Te Papa Atawhai

Opinions expressed are those of the contributors, and do not necessarily represent the policy of the Department of Conservation

Tapu and Customary Use policy guidelines and a Partnerships 'toolbox', Te Kete Taonga Whakakotahi. During the development of the Nga Akiakitanga policy papers, it was decided to revisit Section 4, and ask what this requirement means to us in our everyday work. The vision is that partnerships between the department and tangata whenua achieve enhanced conservation of the natural and historic heritage of New Zealand/Aotearoa.

A set of guiding principles was used to develop goals for the department (Table 1), and to identify how the department could achieve those goals. The guiding principles were adopted from those identified by the Waitangi Tribunal, the government, the Courts, and Conservation Management Strategies. For each of these goals, we have developed a set of implementation statements. While all these statements are closely inter-related, and should not be considered in isolation, there are some goals and implementation statements of which scientists should be particularly aware.

Partnerships: The department will build and support relationships and partnerships with tangata whenua which are based on mutual good faith, co-operation and respect.

Governance: The department will make decisions and take actions in accordance with the legislation and the circumstances which apply in any particular case, including government's conservation goals and section 4 of the Conservation Act.

Tino Rangatiratanga: The department will, in relation to areas and natural resources which it manages, work with tangata whenua to deter-

TABLE 1. GUIDING PRINCIPLES USED TO DEVELOP GOALS FOR THE DEPARTMENT.

GUIDING PRINCIPLES[1]	GOALS FOR DOC
Partnerships	The department builds and supports relationships and partnerships which are appropriate to local circumstances and are based on mutual good faith, co-operation and respect.
Governance	The department implements conservation legislation and works effectively and efficiently to achieve conservation outcomes for the benefit of all citizens.
Citizenship	The department treats all citizens fairly and equitably.
Tino Rangatiratanga	The department recognises the exercise by tangata whenua of traditional authority over their lands, waters, sites, waahi tapu and other taonga, in accordance with the concepts of mana whenua and mana moana.
Kaitiakitanga	The department recognises the exercise by tangata whenua of their customary duty as kaitiaki over their natural and historic taonga according to tikanga over taonga-tukuiho and taonga-koiora according to tikanga.
Active Protection	The department actively protects the interests of tangata whenua in the land, species and other taonga managed by the department or affected by the department's work, and does this in co-operation with tangata whenua.
Informed Decisions	The department makes informed decisions which have regard to the interests and needs of tangata whenua and taonga tukuiho regarding taonga-tukuiho and taonga-koiora.
Redress	The department avoids actions which would prevent the redress of Treaty claims, and seeks to avoid creating further grievances.

1 These guiding principles are derived from those identified by the Waitangi Tribunal, the Government, the Courts, and Conservation Management Strategies.

mine and implement a reasonable and practicable degree of tangata whenua involvement at sites or with issues of interest to them, covering a range of options from a right to be consulted to the exercise of tangata whenua control.

Kaitiakitanga: The department will, in relation to areas and natural resources which it manages, support the kaitiaki role of tangata whenua and be clear about applicable accountabilities by:

- Recognising and respecting Maori conservation practices and associated cultural values
- Recognising and providing for the customary use of indigenous species by Maori, consistent with kaitiakitanga, wise conservation and conservation legislation
- Affording to tangata whenua an effective degree of participation and control in the protection and management of waahi tapu

Active Protection: The department will work with tangata whenua to:

- Understand their interests and needs in relation to areas and resources which the department manages or which are affected by its work
- Ensure that reasonable and practicable steps are taken to protect those interests
- Ensure that actions which might undermine those interests are avoided wherever practicable
- Recognise the role of matauranga Maori in conservation management

What does this mean for DOC scientists?

There is an emphasis in these particular implementation statements on developing relationships and recognising and respecting Maori cultural values and matauranga Maori.

Why is this so important? The department manages areas, resources, and sites that are of importance to Maori. Archaeological sites and materials for customary use are just two examples. If we have two cultures and lack of contact between communities we also have a lack of trust. Without trust we cannot have successful relationships, let alone partnerships—and the vision of enhanced conservation outcomes is less likely to be realised.

But there are barriers. Alaskan anthropologist Ellen Bielawski once remarked 'I work with elders who speak no English, and it's quite similar to working with scientists, because they don't speak any English either.'

There is knowledge and wisdom that can be shared, brought by both the traditional 'western scientist' and the holders of indigenous knowledge. Although the 'language' spoken may be different, the practical experiences of those that have sought to bring this knowledge together have clearly demonstrated the real value to conservation outcomes. Most of the speakers in this seminar series spoke of their journeys to understand the perspectives and concerns of each other, and the value to conservation this eventually brought.

The Matauranga Kura Taiao fund aims to give recognition to the importance of tangata whenua participation in managing biodiversity that is consistent with customary knowledge and practices. The criteria for projects include those where there is the greatest risk of loss of knowledge, that protect the tapu and mauri of taonga, that revive knowledge/practices and protect taonga, that enhance the transmission of knowledge within hapu/iwi, and that increase the ability of hapu/iwi to manage their taonga. While the fund is only available to Maori applicants, there may be opportunities for DOC to share our technical and scientific knowledge if requested.

After a very slow beginning we now have a powerful team of Kaupapa Atawhai Managers (KAMs) in conservancies who have played pivotal roles in helping establish and develop relationships with tangata whenua. Through Pukenga Atawhai, training has been provided to enable staff to build and maintain effective working relationships with tangata whenua.

The new challenge is for each one of us as we plan our work to consider the goals the department has set itself for giving effect to the principles of the Treaty of Waitangi, and how the implementation statements can be applied in the work we are doing.

For our decision-makers need to be able to make decisions based on the best possible knowledge. And can it be said that the knowledge of western science can stand alone, separate from the information and knowledge held by tangata whenua and the public?

Mere Roberts et al. (1995), after discussing the issues and problems surrounding the differences between the western conservation ethic and Maori perspectives of the environment, concluded that 'Understanding and acceptance by non-Maori New Zealanders of the Maori world view, allied with a commitment to honouring the Treaty of Waitangi, will hopefully lead to a more respectful and reciprocal relationships not only with our environment, but also with each other.'

No one said that giving effect to section 4 in our work was going to be easy. It will be an effort, and will take time. But you won't be the first. And you won't be doing it alone. The KAMs are out there in the community supporting staff. STIS is in the process of appointing its own KAM. And there are people, academics and scientists, both inside and outside the department who have already paved the way.

Christine Jacobson
Conservation policy
November 2002

Roberts, M.; Norman, W.; Minhinnick, N.; Wihongi, D.; Kirkwood, C. 1995. Kaitiakitanga: Maori perspectives on conservation. *Pacific Conservation Biology 2(1)*: 7–20.

Christine Jacobson came to DOC in 1987, along with the rest of her National Parks Centennial Team. Since those heady days she has helped to set up and co-ordinate the department's volunteer programme and the Conservation Corps, as well as maintained close relationships with our social scientists. Now in the Conservation Policy Division, Christine has worked on Nga Akiakitanga Nuka Kaupapa Maori, Strategic Maori Policy initiatives, and the Conservation with Communities Strategy. Along the way in her 'spare time' she has acquired 2 children, and a couple of community conservation projects focussing on the Pauatahanui Inlet, its protection, and a process to achieve integrated management of this important estuary and its catchment.

She's a great sheep dog on the family's small farm, and enjoys wandering through its 12 ha QEII covenant. And although she doesn't mind singing in public, she's shy about anyone except the family listening to her piano-playing!

Christine, with daughter Elsie, feed Josephine a special treat. The mulch in the background is made from willow thinnings.

STAFF NEWS

New to our staff is Theresa Newson, who tells us ...

Theresa Newson

I have been profoundly deaf since birth, but my parents did not find out until I was two. I grew up in Seatoun, Wellington and am a Kiwi, but I have a mixture of Irish, English, and French in my blood. I have been mainstreamed at St Anthony's School and St Catherine's College. The highlight of my youth life was to represent New Zealand at an International Youth Deaf Camp in Dublin, Ireland in 1997. It was fabulous to visit my ancestors' land and the landscape is so beautiful. I moved to Christchurch in early 1998 to study at Lincoln University, and completed my four-year degree, Bachelor of Landscape Architecture (Honours) last November. I have been filmed for a documentary about my student life as a *Deaf student and there were also a few articles published in newspapers about me, one recently in The Press. My friends and family see me as the 'Star'. After I finished my final challenging and difficult year at Lincoln, I moved back to my home town and worked as a Landscape Architect for Porirua City Council. After a few months on a break, I worked for the Queen Elizabeth II National Trust before I came here to the Department of Conservation.

I enjoy spending time with my Canadian partner, family, and friends. Other hobbies are reading, gardening, visiting art galleries and museums, going to cafes to drink coffee with friends, and going for long walks with my partner. Travelling is one of my passions—I travelled to Canada once in 2001, but would love to visit there in the near future to see my partner's family and friends again.

I just started my career-oriented job with Department of Conservation as a historical trainee at Science and Technical Centre. I am responsible for undertaking and co-ordinating research related to historical and cultural landscapes. I am currently compiling comments and discussion from the consultation process concerning Caring for Archaeological Sites Guidelines, prepared in collaboration with Kevin Jones. I also write administrative histories of reserves that can be circulated to new reserve trustees, i.e. nga iwi. I am enjoying my job and I am looking forward to gaining new skills and knowledge in heritage management.

* The use of an uppercase D indicates that the writer considers deafness a culture not a disability. Deaf culture includes a language, a world view and characteristic ways of interacting with the world and other people in it—*Editor*

Maui dolphins displaying the characteristic rounded dorsal fin. *Photo: Kirsty Russell*

A long-time staff member—Dr Alan Baker—has another triumph ...

Alan Baker, along with colleagues Adam Smith from Canterbury Conservancy, and Franz Pichler from Auckland University's School of Biological Sciences, has described a new subspecies of Hector's Dolphin. It is called *Cephalorhynchus hectori maui*, and commonly known as Maui's dolphin, after the mythological Polynesian hero Maui who fished up

STAFF NEWS

the North Island. A scientific paper describing the new subspecies has been published in the *Journal of the Royal Society of New Zealand* and can be found at www.rsnz.org/publish/jrsnz/2002/036.pdf

Alan began studying Hector's dolphins in Cloudy Bay in 1978, where he established their residential habit. He is also no stranger to describing new species, being an authority on a new beaked whale from California, the beautiful sea urchin *Diadema palmeri* from the Poor Knights Islands, and the enigmatic Sea Daisy from the deep ocean, among many others.

Alan has been working for DOC since 1993, when he left the old National Museum, where he was Director, to move into conservation science and the protection of our sea mammals.

Maui's dolphin lives on the west coast of the North Island between north Taranaki and Ninety Mile Beach. It is present in very small numbers, perhaps fewer than 100 individuals. The South Island subspecies is found almost all around the southern coasts and has an estimated population size of just over 7000. Both subspecies live close to the coast and are prone to entanglement in gill nets.

FUTURE RESEARCH DIRECTIONS

Future research directions for the Species and Ecosystems under Threat Portfolio, 2003 onwards—Part 2

(Continued from *ConScience News 45*, pp. 8-10)

In the last issue of ConScience *we printed part one of a paper on the development of the national science portfolio concerned with threatened species and ecosystems. In this issue we present the second part of the paper. I believe that conservation workers will find this part both interesting and reassuring, because it demonstrates that scientists working in this area have not lost sight of the problems affecting the work of conservation officers and rangers —Editor*

6. Specific directions within Priority Actions

A. Establish guidelines that will enable managers to identify appropriate conservation management units for threatened taxa in order to maximise biodiversity and survival of these taxa.

Proposed directions

Defining appropriate conservation management units for threatened taxa:

- Size and number of populations/subpopulations
- Basic definition of populations requiring management
- Taxonomic and genetic units
- Scale of population management in the environment (e.g. demic structure, metapopulations, etc.)

Definition of both ecological (site) and biological (taxa) units.

Specificity of definitions of 'biological units' to different taxonomic groups.

Recent actions

—Preparation of a Discussion Paper outlining the issues relating to defining populations we should manage (CHCCO-29754)*.

—Approval to run workshops aimed at defining guidelines for identifying taxonomically distinctive units that require management, defining the populations of these taxa, and deciding how many populations or subpopulations should be conserved to ensure continuing viability of the taxa (Investigation No.3351).

—Approval of Investigation No. 3575, aimed at defining appropriate conservation units for a suite of indeterminate threatened taxa each financial year.

* These are Document Manager identification numbers and they are available only on the DOC computer network—*Editor*

—Strong link with Natural Heritage Management Systems (NHMS) and Measuring Conservation Achievement (MCA), which especially focus on identification of ecological units (see Priority Action G).

Recommendations for the future

Research requested by DOC staff in recent years highlights a strong need to increase our understanding of what population units we need to manage and their relative priority in the Department's mission to conserve threatened species. We should use the outcomes of Investigation 3351 to develop the Conservation Management Units Programme further in 2003/04.

B. Test conservation biology principles in the New Zealand context.

Emphasis will be on determining the:

- Role of genetic diversity in maintaining long-term viability of threatened species.
- Importance of linkages in the landscape as a means of maintaining biological diversity.
- Utility of demographic models and population viability analysis (PVA) in conservation planning.

Proposed directions

Determine the importance of managing genetic diversity.

Provide effective tools for improving management of populations.

Test the utility/use of a range of conservation biology principles and analytical techniques for DOC managers (e.g. PVA).

Determine the composition of founders for translocations.

Test utility of Indicator Species, Umbrella Species, Keystone Species and Surrogate Species.

Development of ecosystem approaches to managing diversity and functioning of ecosystems.

Indicators of ecosystem trends.

Importance of linkages in the landscape.

Demographic characteristics of threatened species (e.g. long-term factors affecting recruitment, identifying and interpreting population fluctuations, demography of small populations, understanding relationships between juvenile dispersal and recruitment, core area size, edge effects of management, thresholds for management action).

Behavioural characteristics of threatened species (e.g. behaviours that make different taxa particularly vulnerable to decline or poor recovery, such as breeding systems, behaviour of specific cohorts, etc).

Recent actions

—Approval of Investigation no. 3576 investigating the role of inbreeding and genetic diversity in founder populations. This is a joint study with Otago University, which is also providing considerable resources.

—Work on *Hebe speciosa* looking at genetic structuring and the presence of clonal populations.

—Approval of Investigation no. 3581, aimed at providing a guide to Population Viability Analysis for conservation managers, a case study using a suite of threatened species from braided river communities

—Development of the Fragmentation Programme (Investigation 3482, 3579).

Recommendations for the future

We should aim to develop well-worked case studies for managers (with suitable explanation of the data needed, assumptions, scenarios chosen) demonstrating the utility of conservation biology techniques. These should be written in language that managers can understand and framed in a way to provide impetus for them to use conservation tools confidently in their own situations. Specific needs for the future:

- Expand work in fragmented landscapes to look at other classes of organisms and ecosystem types. Look at use of analogue species, especially for invertebrates.

- Depending on results of PVA pilot study, expand effort.
- Demonstrate the strength of new analytical techniques for mark-recapture analysis.
- Test utility of Indicator Species, Umbrella Species, Keystone Species and Surrogate Species.
- Develop a programme aimed at understanding effects of demography of threatened populations on long term viability. A lot of work has focused on direct threats, but little on understanding characteristics of species that may either limit or enhance recovery potential (i.e. the basic building blocks of understanding—productivity, survival, fitness). Little work has focused on understanding the importance of population fluctuations on long-term viability.

C. Establish, develop and test guidelines and criteria for defining the long-term security of populations and ecosystems under threat.

Proposed directions

Trajectories: Define how we know threatened taxa, communities and ecosystem types are secure relative to different time trajectories. This is likely to vary among different types of taxa and communities, so requires work on a range of taxa and systems (strongly linked to implementing DOC's Ecological Management Framework and to Recovery Planning SOP).

Thresholds: Establishing thresholds for commencing and ceasing management. (How are trajectory end-points set?) Identify critical rates of decline over specific time periods.

Defining ecosystem types: Understanding the ecological dynamics of places we need to manage. Measuring ecosystem health.

Demographics: Develop useful Population Viability Analysis frameworks. Link PVA risk assessment with long term knowledge of survival (and factors influencing it) in a range of threatened taxa. Develop guidelines based on good data for defining self-sustaining populations.

Long-term databases: Make the most of existing investment and further that investment by using long-term population databases. Long-term databases are particularly valuable when there has been a major perturbation (management activity and/or natural fluctuations and/or suite of activities) and where there have been significant gains in our understanding of threatening processes and our management techniques (e.g. kiwi, kokako, kaka, long-tailed bats, mohua, Otago skinks—but big gap for other taxonomic groups).

Recent actions

—Nothing so far, but closely linked to scoping work being done for NHMS.

Recommendations for the future

Increase effort.

Choose some long-term population case studies of populations of threatened species (e.g. each major taxonomic group) and long-term studies in selected ecosystem types (e.g. Eglinton Valley beech ecosystem) and use to illustrate how to identify critical factors influencing long-term population viability (e.g. long-term work on mohua, kokako and long-tailed bats illustrate the values of this approach—these studies identified critical factors that would not be detected in short-term studies, they continue to alert us to new threats, and indicate real advances in conservation management (e.g. pulsing pest controls, cost-benefit, return times for conservation management). They would provide benchmarks for assessing effects of global climatic perturbations.

Link with DOC's Inventory and Monitoring Project (see NHMS business cases).

Link to PVA work and research on factors influencing the demography of threatened taxa (recommendations will come out of Investigation 3581).

Commence work on defining trajectories for security of ecosystem types/ priority places. Link to work on seral communities.

Continue to lever more research on predictive models for ecosystems (e.g. masting events in forests).

D. Review and assess current techniques for monitoring threatened species, ecosystem health and trends.

Develop new techniques where there are no appropriate methods. Techniques for monitoring invertebrates are a priority.

Proposed directions

Development of specialist monitoring techniques for cryptic taxa, especially at low densities (e.g. reptiles, invertebrates).

Calibrate monitoring indices against actual population trends derived from intensive population monitoring.

Develop techniques for monitoring population and ecosystem health.

Recent actions

—New projects commenced on *Albugo* rust in threatened brassicas (Investigation 3635) and work with chytrid fungus in endemic frogs (Investigation 3578).

—Work on carabid monitoring techniques and use of sticky traps.

—Calibrating index counts of forest birds using Distance Sampling.

—Calibrating index counts for long-tailed bats and developing new analysis protocols.

—Evaluating digital cataloguing of invertebrate samples using Koiora-Bioassist.

Recommendations for the future

Increase work with threatened invertebrates (test rapid survey techniques and Koiora-Bioassist) and demonstrate/investigate the use of Indicator, Keystone and Surrogate Species.

Develop molecular based techniques for assessing population health (e.g. diagnostic tools for disease).

Conduct work calibrating more widely used monitoring techniques against actual population parameters (e.g. 5-minute bird counts are being used extensively, but are never analysed correctly, and never calibrated against actual population responses).

Produce 'road maps' for commonly applied, but poorly understood, techniques.

Develop long-term monitoring protocols (e.g. >50-year trajectories)

Develop appropriate techniques for monitoring ecosystem health (Support NHMS Inventory and Monitoring project).

Develop marking techniques that minimise animal welfare concerns.

Application of Foliage Browse Indices to small-leaved plants and nutrient impoverished ecosystems.

E. Develop and test approaches to the management of several threatened species at key sites to maximise return on investment.

Proposed directions

Develop frameworks for dealing with the sort of compromises that might be needed when managing multiple species in threatened communities.

Risk analyses for reconciling multiple management demands.

Understanding flow-on effects of management on other biodiversity, food webs, etc.

Recent actions

—Braided river wildlife community PVA (Investigation 3581).

—New work on flow-on benefits of kiwi sanctuaries.

—Strong link to Priority Action C.
—Work on offshore island community restoration.
—Site-based research by management (e.g. mainland island research).

Recommendations for the future

Need to increase efforts. Investigation 3581 (PVA) starts to get the message across to managers that they have to start thinking more about multi-species management. The message needs to be that different taxa have different optimum requirements and multiple threats and that we need to come some way to developing frameworks for dealing with the sort of compromises that might be needed when managing these communities. We also need to come some way in thinking about presenting risk analyses that reconcile multiple management demands.

F. Identify critical factors limiting the viability of threatened taxa, threatened communities, threatened ecosystems, and threatened ecological processes.

Test ways to mitigate such threats. Fragmentation in threatened lowland ecosystems is a priority.

Proposed directions

Develop understanding of threats (and their interactions) where we have had a poor investment in the past:

Stochastic threats: Climate change/ perturbations, environmental stress (disease/pathogens/ parasitism), food limitation and its influence on sex ratio, nutrient changes.

Human induced changes: Competition, degradation in habitat quality, disturbance regimes (plant and invertebrate communities), fragmentation and edge effects, recreation impacts, introduced invertebrates, hybridisation, fertility changes, browsing and predation by pests we have little data for, grazing, fire, landuse practices, flow-on effects.

Poorly studied ecosystems: Redress balances by working on threatened ecosystem types that have had little work done in them, assessing critical threat processes to biodiversity in non-forest environments (pest pressures, disturbance processes, interactions), examples include:

- Coastal systems (turfs, dunes, alluvial zones, wetlands)
- Karst systems
- Inland cliffs
- Ultramafic ecosystems

Adaptive management: Develop adaptive management techniques to address critical threats.

Species mutualisms: Threats to ecosystem processes and functioning (e.g. nutrient cycling, pollination, seed dispersal, etc.).

Recent actions

—Approval of Investigation 3580 (Dune slacks and ephemeral wetlands).
—Approval of Investigation 3577 (Disturbance regimes in seral shrub lands).
—Approval of Investigation 3579 (Pollination and seed dispersal in fragmented landscapes).

Recommendations for the future

Test true adaptive management techniques for threatened taxa and ecosystems on private land (integration of iwi and community aspirations and testing efficacy of participation in threatened species programmes). Recent reviews by MfE have highlighted the importance of conservation of threatened biodiversity on private lands. A considerable number of taxa and many ecosystem types only occur in such areas, so in the future we need to develop techniques to undertake such work if we are to implement the objectives of the Biodiversity Strategy. Such a study would have strong links with the People, History and Conservation Portfolio, and should monitor the set-up, implementation and cost-benefit of a threatened species programme on private land.

Increase effort in Fragmentation Programme (impacts on other groups of threatened organisms, other ecosystem types and urban areas; and integrate with investigations of impacts of fragmentation on freshwater wetland communities).

Increase research into poorly understood threatening processes (human induced change and stochastic events).

Sponsor a workshop on implications of climate change on threatened species and ecosystems. (Is it possible to reduce risks and in what situations? Can we detect and manage impacts?)

Initiate work aimed at understanding interactions among critical threatening factors influencing long-term viability of taxa, sites, and ecosystem types (e.g. predator versus browser control versus manipulating habitat quality, reducing environmental stress, etc.).

G. Establish objective methods for identifying outstanding and threatened ecosystem types.

Proposed directions

Identification of priority places for biodiversity conservation in New Zealand

Definition of outcome visions for sites.

Recognition of when outcome visions have been achieved.

Recent actions

—Natural Heritage Management Systems (NHMS) are being developed as a matter of priority. These aim to integrate:

- Guiding principles (Ecological Management Framework).
- Identifying information on the state of our natural heritage (TFBIS and BIOWEB databases and national Inventory and Monitoring Programme).
- Identifying priority environments for undertaking ecological management (Land Environments of New Zealand—LENZ).
- Measuring the difference we are making (Measuring Conservation Achievement—MCA).
- Reporting the outcomes (Measuring for Performance—MfP).

—Identifying priority sites for maintaining and restoring biological diversity in New Zealand (Investigation 3574) aims to provide critical research, which will assist in developing these tools

Recommendations for the future

Increase our efforts to improve NHMS tools by testing underlying assumptions. Research should focus on improving our ability to:

- Identify priority places to do our ecological management work (where are threatened ecosystem types and communities?).
- Measure responses to that management (calibrating models and perceived benefits).
- Report on the difference this work is making.

Increase relevance of existing projects to testing NHMS tools (e.g. MCA).

Develop techniques for defining viability of sites.

How are outcomes at sites best defined?

Viability of remnants of biodiversity in highly modified environments.

Colin O'Donnell
Portfolio Group Leader
August 2002

The conclusion to this article (Part 7 —Priority recommendations) and new projects arising from this research, will be published in the next ConScience News—*Editor.*

RESEARCH IN PROGRESS

Short-tailed bats in time and space: a phylogeographic investigation

'... results that present a major challenge to current approaches to biodiversity conservation in New Zealand.'

Phylogeography is a relatively new field of study concerned with genetic variation in time and space. A species demographic and evolutionary history leaves traces in the geographic distribution of its genetic variation. Phylogeography interprets these traces to unravel the species history. This approach has been made possible by recent advances in molecular techniques, in particular the routine sequencing of mitochondrial DNA. Avise (2000) provides a good overview of the topic. Over time phylogeographic methods are likely to become crucial to biodiversity assessment.

In a recent study I used phylogeographic methods to investigate genetic variation in the lesser short-tailed bat *Mystacina tuberculata*.

Previously abundant throughout New Zealand, short-tailed bats are now threatened, with less than 50 000 individuals in thirteen known populations. Most are in the central North Island where seven populations contain a total of about 40 000 bats. Outside of central North Island there are four small isolated populations on the mainland and two sizeable populations on offshore islands. Mainland populations outside of central North Island each contain only a few hundred bats and are vulnerable to extinction.

Because populations of short-tailed bats require numerous large cavities in the main trunk of mature trees for their colonial roosts, they only occur in extensive stands of old-growth forest. Prior to European settlement in the nineteenth century, short-tailed bats were widespread throughout the almost continuous tract of old-growth forest that covered central North Island. Extensive deforestation during the period 1890–1980 restricted bat populations to remnant patches of forest. Despite being capable of strong flight, short-tailed bats are rarely found far from forest and long-distance dispersal has not been documented. Thus, it seemed likely that in the contemporary fragmented landscape, deforested areas would hinder dispersal between populations. This study was designed to provide information on current and historic levels of dispersal among short-tailed bat populations in the central North Island. This information was required both for assessing the impact of recent forest fragmentation on the remaining populations, and for interpreting the results of management practices and population census data.

Because of their mobility, most bat species show low levels of genetic differentiation and little geographic structure over distances of thousands of kilometers. In many bat species high levels of dispersal give rise to continent sized populations. I therefore used sequences from an extremely rapid evolving section of mitochondrial DNA, the control region. Control region sequences are suitable for investigating relatively recent events spanning a period of tens of thousands of years. This seemed a reasonable choice as 20 000 years ago, during the last glacial maximum, most of New Zealand was inhospitable to bats. Surprisingly, phylogenetic analyses of control region sequences for 241 bats collected from throughout New Zealand showed that even within individual populations there were multiple lineages with divergences extending back nearly 1 million years. To confirm this result, I selected a subsample of 28 bats and sequenced a number of slow-evolving genes more suited to investigating such a time span. Phylogenetic analyses of these sequences identified six lineages that diverged from one another between 0.93 and 0.68 million years ago (Fig. 1). The lineages don't conform to the three subspecies defined by Hill & Daniel (1985). Each of the lineages has a restricted geographic range, but there are overlaps between lineage ranges, with most populations including representatives from two or more lineages (Fig. 2). The depth of divergence among these lineages is about half of that reported between congeneric bat species and similar or greater than reported between some New Zealand bird species. For instance North Island and South Island brown kiwi diverged 0.9 million years ago, while *Cyanoramphus* parakeet species diverged between 0.45 and 0.63 million years ago. The occurrence of such deeply divergent lineages together in an interbreeding population (i.e. sympatry) has not been reported for any other bat species.

Estimates for the time of divergence among the short-tailed bat lineages correspond to the onset of the severe climatic oscillations of the late Pleistocene and catastrophic volcanic eruptions from the Taupo Volcanic Zone. Both caused large fluctuations in the extent of forest habitat suitable for short-tailed bats, up until the time of human settlement. During warmer interglacials and interstadia, forest covered nearly 90% of New Zealand. In contrast, at glacial maxima continuous forest cover was limited to Northland and the north-west North Island, with only scattered fragments of forest in favourable microclimates persisting elsewhere. Pyroclastic flows from the Taupo Volcanic Zone repeatedly destroyed forest across large areas of central North Island, while associated ash deposits damaged forests over much wider areas. Such episodes of extensive habitat destruction by volcanism were followed by rapid regeneration within 200-300 years.

Divergence among the lineages probably arose following contractions of forest habitat in response to climatic fluctuation, in the South Island and southern North Island, and catastrophic volcanic eruptions, in the central North Island. Such range contractions would have fragmented the original population into sub-populations inhabiting isolated forest refugia, safe from climatic and volcanic deforestation. In these refugia the lineages could evolve independently. During periods of reforestation the lineages expanded into the new and empty forests (Fig. 3). Sympatric lineages occurred as a result of secondary contact when lineages, expanding from their respective refugia, met to form hybrid zones. The species social behaviour probably inhibited dispersal into established colonies and prevented mixing of lineages in the refugia.

Under this model, for most of the last million years, central regions of the North Island and most of the South Island functioned as ephemeral population sinks with repeated cycles of extinction and recolonisation from a small number of persistent source populations inhabiting isolated refugia. These refugia have now all been converted to agriculture leaving only previously ephemeral or sink populations.

It seems reasonable to expect that the profound and extensive environmental fluctuations New Zealand has undergone during the last million years might have had a similar effect on other forest biota. There are only two comparable studies of forest-dwelling taxa in New Zealand: one on the root parasite *Dactylanthus* (Holzapfel et al. 2002), and the other on North Island brown kiwi (M.L. Burbridge and others: Information from classic population analyses is augmented by genealogical methods in the study of North Island brown kiwi populations. Unpublished data). The North Island distributions of major lineages from both these species are similar to that observed in short-tailed bats (Fig. 4). Thus, there may be a common phylogeographic pattern reflecting the region's biogeographic history.

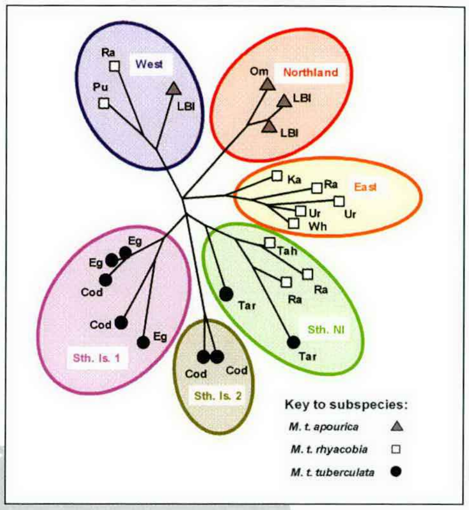


Figure 1. The intraspecific phylogeny of short-tailed bats determined from multiple mitochondrial gene sequences. Source populations for the individual sequences are indicated by abbreviations (see Fig. 2 for population names). Symbols indicate individuals' subspecific identity according to Hill & Daniel's (1985) taxonomy.

Conclusion

Results from this study indicate that levels of dispersal between populations in central North Island are extremely low, but that this is normal for the species and is unlikely to have serious deleterious demographic and genetic consequences for the long-term viability of populations. Historically low levels of dispersal have been interspersed with occasional episodes of large-scale dispersal in response to forest expansion, recurring at intervals of many thousand of years. The low levels of dispersal mean that census methods can be used to assess long-term population trends and monitor responses to management activity in individual populations.

More importantly, the results present a major challenge to current approaches to biodiversity conservation in New Zealand. Genetic diversity is the best available measure of biodiversity. In this study a comprehensive description of genetic diversity in short-tailed bats leads to rejection of the accepted subspecific taxonomy, but does not provide a useful replacement. The levels of divergence between the six lineages are significant; indeed they approach divergence levels found between species, but because of widespread sympatry they are of dubious management value.

Unexpectedly, geographic distance does not provide any indication of genetic diversity and hence biodiversity. Thus, any one of the populations in

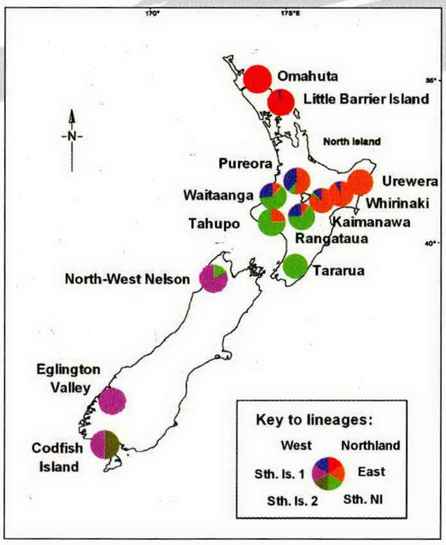
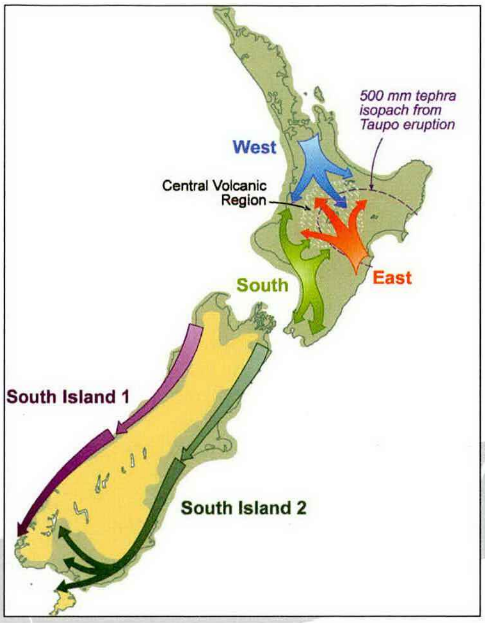


Figure 2. The geographic distribution of short-tailed bat lineages.

Figure 3. Hypothesised range expansion of short-tailed bat lineages, overlaying recurrent volcanism in North Island and post-glacial reforestation 9000 years ago.



the central North Island hybrid zone contains considerably more diversity than all the Northland and South Island populations combined. I suggest that, given New Zealand's dramatic biogeographic history, the pattern of intraspecific diversity described in short-tailed bats—deeply divergent lineages occurring in close geographic proximity—may be typical of other New Zealand species. If this is the case, we may need to readjust our focus from a preoccupation with conserving taxon-diversity and representative sites to conserving the overall pattern of biodiversity.

Parallels between the results of this study and studies on *Dactylanthus*, and North Island brown kiwi indicate that by comparing the results of phylogeographic studies for several species it may be possible to gain insights into a region's biogeographic history. This could lead to the identification of evolutionarily distinct communities and areas which contain the greatest biological, as opposed to species, diversity.

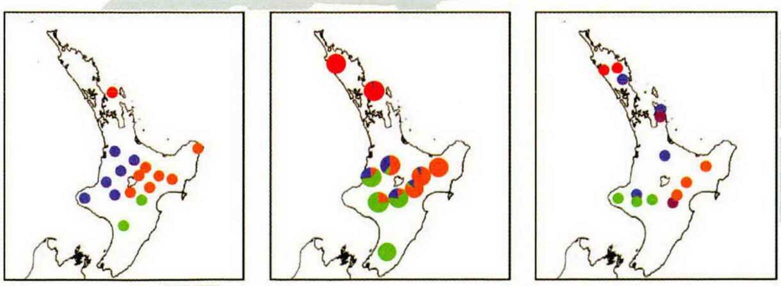


Figure 4. A recurrent biogeographic pattern in three North Island forest-dwelling taxa.

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Brian Lloyd

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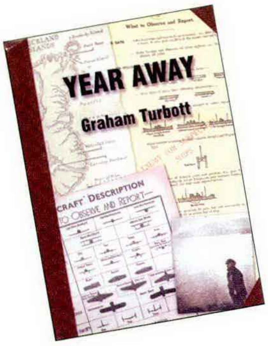

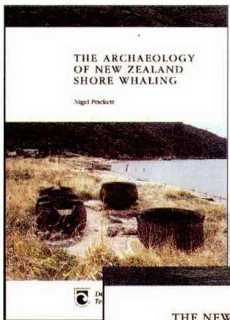

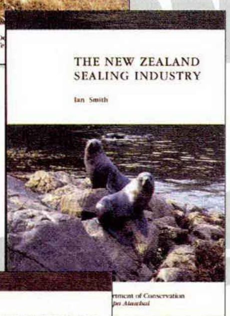

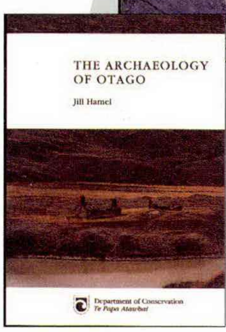

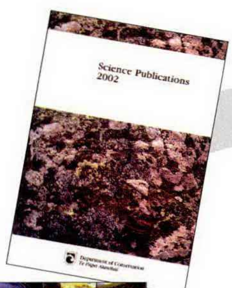

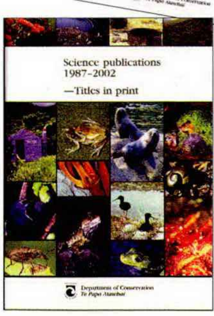

The year 2002 has been a great year for all of us in DOC Science Publishing, with some really interesting titles having been published.

Several important historic books have come out. *Year Away: Wartime Coastwatching on the Auckland Islands, 1944*, the tale of Graham Talbot's time on the Auckland Islands, was detailed in the previous issue of *ConScience*. Two works, *The archaeology of New Zealand shore whaling* and *The New Zealand sealing industry: history, archaeology, and heritage management*, have looked at two industries that, for relatively short periods in the past, were very important to New Zealand. The *Archaeological survey of the Arrow River and Macetown, Otago*, which contains some lovely hand-drawn maps of the area, presents details of the remains of another important industry in early New Zealand: gold mining.

We published 22 new titles in the *Science for Conservation* series, covering a wide range of topics. Invertebrates were examined in *Conservation status of the New Zealand red katipo spider* (Latrodectus katipo) and in a paper looking at the *Potential impact of the Argentine ant* (Linepithema humile) *in New Zealand and options for its control*. Possums received their share of the attention, as did other major pests like stoats. Weed work generated several new titles, including *Biological control options for invasive weeds of New Zealand protected areas*, and *A weed risk assessment system for new conservation weeds in New Zealand*.

One of the biggest to come out in this series during 2002 was *Measuring conservation achievement: concepts and their application over the Twizel area*. This landmark publication describes a process by which conservation managers can objectively quantify the achievements made by conservation work carried out in a particular area, and then use the information generated as a basis for future decision-making.

This year also saw the first full year of production of the new *DOC Science Internal Series*, with 66 new titles being published. Once again, the topics covered have been broad—plants and animals, pests and protected species—and there have been many papers from work that was funded by the Conservation Services Levy on the fishing industry.

There is not room here to cover all the details, but a full catalogue of titles published during this year—*Science Publications 2002*—will be available early in 2003. We are also putting together a catalogue (1987–2002) of all DOC publications which are still in print and available from us. If you would like a copy of either of these catalogues, or information about any of our titles, contact us at:

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