Kakapo recovery: the basis of decision-making

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Abstract Conservation and management of kakapo (*Strigops habroptilus*) has spanned more than a century and has cost many millions of dollars. Government policy goals have supported these efforts throughout this long period but decisions made have not always reflected an optimal approach to achieving them. Decisions made have influenced not only whether kakapo will recover, but also the time span to recovery and its cost, which have impacted on the ability to meet broader biodiversity goals. The establishment, in 1987, of a single conservation agency, administering both the land and the species contained thereon, significantly changed the way biodiversity management was delivered in New Zealand and created enormous potential for integrated conservation outcomes. Despite this, decision-making for managers of threatened species conservation programmes has become more complex as an increasing number of endangered species compete for limited resources. Using kakapo as an example, historic and recent recovery decisions are evaluated and the need for a decision-making framework to improve threatened species recovery and overall biodiversity maintenance is discussed.

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INTRODUCTION

The New Zealand Department of Conservation and its predecessor, the Wildlife Service, have been successful at saving species from the brink of extinction (Wilson 2004). A number of notable conservation achievements have been made through transfers to, or between, predator-free islands e.g., South Island saddleback (*Philesturnus c. carunculatus*; Merton 1975), Chatham Island black robin (*Petroica traversi*; Butler & Merton 1992), and by close-order interventions where species are directly manipulated e.g.,Chatham Island black robin (Reed & Merton 1991), takahe (*Notornis hochstetteri*; Lee & Jamieson 2000). However, in the documentation of these conservation programmes are few records of how, or why, certain actions were taken and what the key considerations were. Most simply report on method and outcome. This lack of record within the literature of discussion leading to the making of key decisions is not symptomatic of the lack of a decision-making process since, clearly, some bold and highly effective action was taken which required a decision to do so.

Discussions with those that have held key roles in many of the successful New Zealand species conservation initiatives indicates they are reluctant to credit themselves directly with a decision, stating "it was a team effort" or "just a good thing to do at the time". Many of these important decisions to act were made in the field by those directly involved in the work without reference to either administrators or to guiding policies but have still achieved significant conservation gains. However, this undocumented approach has prevented institutional learning on how and why these key decisions were made, and the absence of that record now hinders timely action for many at-risk species. Without institutional learning based upon recorded examples, development of decision frameworks for threatened species management in New Zealand has not gone beyond standard operating procedures based on risk of failure. These standard operating procedures, while excellent support for implementing decisions, do not replace the need for appropriate decision-making between actions, or between species.

A tool that has been used to support decision-making for threatened species management in New Zealand is the "Threat Classification System Lists" (Hitchmough 2002) which allocates each of 6000 plant and animal species from the marine freshwater and terrestrial environments to one of eight hierarchical categories of threat. However, this is not a decision-making framework. That it is not a key driver in allocation of resources and management activity is evidenced by many species with low threat classifications receiving management while some more acutely-threatened species do not. For every "nationally critical" species (the highest threat category) receiving management, two of lower threat categories are also managed by the Department of Conservation. However, only 15% of "nationally critical" species were, in 2005, receiving any form of management (DoC 2005a). How, and why, this has happened is unclear as no transparent decision-making framework was used and there is no publicly-available record identifying the factors considered. A decision-making process that is

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based on clearly-understood criteria, to assess and re-assess priority biodiversity conservation actions, is essential if further species declines or extinctions are to be prevented.

Development of a decision-making framework to assign priority between species may be assisted by retrospective analysis of decisions taken in various threatened species programmes. Although the need for optimal outcomes to maintain biodiversity is widely acknowledged, the need for a systematic approach to decision- making has not been so universally accepted by those managing individual threatened species recovery programmes. Scepticism that such a system will make substantive positive change is a primary cause, particularly if the system is hard to understand. While retrospective analysis often lacks the constraints imposed on decision-makers at the time, such as limited information, urgency, and tension between opposing views, it has the advantage of providing greater relevance to managers of current species recovery programmes. This is important as it will improve confidence in any new framework and, consequently, the priority of any management action that the framework generates.

In this discussion, the Department of Conservation's recovery programme for kakapo (*Strigops habroptilus*) is used as a case example to test the decisions made for species recovery. Key elements of these decisions are declared as well as their relevance to policies and goals of Government in order to provide support to the development of an appropriate decision-making framework for biodiversity management.

THE KAKAPO

Efforts to secure kakapo from extinction have spanned over a century. The initial effort to save kakapo from the threats of habitat destruction and predation by introduced mammals was undertaken by Richard Henry, the first conservator of wildlife employed in New Zealand (Hill & Hill 1987). Henry transferred kakapo to Resolution Island in Fiordland between 1894 and 1900 because he believed that recently-introduced mammals would cause the extinction of kakapo and other birds on the mainland. Richard Henry's decision was taken in the absence of any quantitative data and while his efforts failed when stoats (*Mustela erminea*) colonised Resolution Island, kakapo have disappeared from the mainland of New Zealand in the intervening years, confirming Henry's sobering prediction.

In the mid-1980s, the last two male kakapo on mainland New Zealand were left to die there by a decision that is hard to justify today. Was the decision to stop moving the birds to a predator safe location and combining them with Stewart Island birds a well-reasoned decision at that time? In hindsight this was clearly a costly mistake that now places the long-term security of kakapo recovery in jeopardy through inbreeding depression (Elliott *et al.* 2006; Robertson 2006). At best, this decision has increased the total cost of recovery for kakapo by increasing the time span to build a resilient population. At worst, it may be the single most important factor in causing their extinction long term.

Below I analyse the way in which these historic decisions were made, then visit some decisions applied within the kakapo recovery programme in more recent times.

Richard Henry's kakapo transfer to Resolution Island

As early as 1870 kakapo were considered doomed to extinction by introduced animals. A noteworthy article appearing in the English magazine *The Field* in that year stated "….the cat, the rat, the pig, and the dog, has doomed [the kakapo] to certain extinction" (quoted in Butler 1989). Pleas for the protection of fast-vanishing bird species by creating island reserves free of predators (Reischek 1885; Martin 1885) were supported by Henry with letters to the Government in 1888. Within a few years three islands were purchased for this purpose by the government; Little Barrier, Kapiti, and Resolution. Henry began 12 years as caretaker of Resolution Island in 1894 transferring hundreds of kakapo and kiwi to his sanctuary home (Butler 1989). There can be little debate that these efforts and the support of the Government of the time show an abiding commitment to preventing the extinction of kakapo and other native species.

The options available to these conservationists to prevent the loss of kakapo were no different to those available today, except for the limitations of their technologies. Essentially these were to remove the threat from the bird or the bird from the threat. Just as has been done today, they removed the bird from the threat.

While the outcome of Henry's action was unsuccessful the decision made was sound. Had Richard Henry been successful, and the translocation to Resolution Island defended kakapo from stoats, an estimated $25 million spent on kakapo recovery over the last 45 years would have been significantly reduced. Kakapo would now inhabit a 22,000 ha site and its conservation status would not be so tenuous.

We can test further whether Henry's decision was optimal by changing his key assumption that stoats would invade mainland forest habitats and cause the extinction of kakapo. If his assumption had been wrong hundreds of kakapo would have been removed from the adjoining mainland and placed in a habitat that had not contained kakapo. Kakapo would not be endangered and instead of presently planning to eradicate stoats from Resolution Island the problem would be one of where next to transfer kakapo from the island. The negative ecological consequences of 100 years of browsing by a low-density population of a herbivorous parrot, in essentially the same ecosystem as that formerly occupied by kakapo on the adjoining mainland, are unlikely to have been significant.

Retaining male kakapo in Fiordland National Park

The last Fiordland kakapo were left to die from predation or old age at a time when there were fewer than 100 known kakapo (Butler 1989). The decision, in 1984, by the then administrators of Fiordland National Park, to refuse a request from the Wildlife Service to move the last two birds to predator-free Maud Island and thereby contribute to a planned breeding programme with newly-discovered females from Stewart Island, is particularly interesting.

This somewhat odd circumstance arose because of the then divisions of responsibilities between Government departments on matters of land and wildlife administration; the Department of Lands and Survey managed crown-owned lands, assisted by local advisory boards at each national park, whereas the Wildlife Service (Department of Internal Affairs) was responsible for fauna and flora conservation and management. The latter agency was required to manage wildlife in the absence of any ability to manage wildlife habitat, a dislocation put right by the 1987 amalgamation of these two agencies, and parts of the former New Zealand Forest Service, to form the present Department of Conservation.

Other than the serious inter-departmental rivalries of the time, two possible factors that have an ecological basis may have contributed to this decision. Firstly, the survival of kakapo removed from Fiordland had not been high, with six birds dying in captivity in the 1960s. A further three birds died after transfer to Maud Island during drought conditions, with a fourth bird being killed there by a dog. By 1984 only one transferred bird remained alive, having survived nine years on predator-free islands. Secondly, the transfer, in 1982, of seven female and 15 male kakapo from Stewart Island to Little Barrier Island in the Hauraki Gulf had been successful. However, a drought in the summer of 1983, resultant weight losses by the birds, and the death of a male, may have influenced the Fiordland Park Board against the merits of transfer. That booming was heard, and track-and-bowl systems (Powlesland *et al.* 2006) found on Little Barrier in April of 1984, did nothing to alter the Park Board's decision.

The Park Board may have believed that female kakapo were still present in Fiordland despite none having been located during the previous 20 years of effort. The catastrophic decline of kakapo in Fiordland, whether due to adult mortality or recruitment failure, indicated that even if females were present successful kakapo breeding was unlikely. Without proof of females surviving in Fiordland, or having a technique to find them, protecting any breeding attempts was impossible.

By 1984 several female kakapo had been located on Stewart Island and some had been transferred to Little Barrier Island. If the remaining Fiordland kakapo were to have any possibility of breeding successfully the only option then, as now, was to aggregate them with the Stewart Island birds at a predator-free site.

These two decisions, made by Henry and the Fiordland National Park Board over half a century apart, are valuable in showing how and why good and bad decisions fail. The legacy of these decisions has also profoundly influenced kakapo management today. While Henry's actions have had no negative effects for kakapo, the Park Board's refusal has meant the loss of Fiordland founders to the current population that would have increased diversity and reduced the effects of inbreeding depression (Westemeier 1998). The described lack of genetic diversity of kakapo (Robertson 2006) has direct implications to the recovery of the species extending the total time, and cost, of recovery. The decision to stop removal of Fiordland birds also demonstrates the consequences of decisions that are not based on an agreed goal to maximize biodiversity outcomes.

Modern kakapo management decision-making

For the past 12 years, the management and recovery of kakapo has been undertaken by a dedicated unit within the Department of Conservation, the National Kakapo Team (NKT). Mindful of the long-term, and often unappreciated, consequences of management decisions (which the above two examples highlight) the NKT has adopted the following principles within its decision-making framework:

1. Set clear outcomes to guide decision-making
2. Maximise future options
3. Confront risk and uncertainty
4. Retain flexibility and adapt to new information

In the following section the value of these four principles will be highlighted in a range of modern kakapo recovery decisions.

The decision-making climate for endangered species management in New Zealand should have become significantly better over the past two decades. The restructuring of the conservation activities of many government departments into one under the Conservation Act 1987, and the development of the New Zealand Biodiversity Strategy (MFE 2000) are two key government actions in support of biodiversity conservation. However, an increasing number of New Zealand's native and endemic species require conservation management for their survival (Hitchmough 2002). The ever-increasing number of threatened species, and their dependence on conservation management, is a global trend putting significant strain on conservation resources around the world. This has increased the complexity of the decisions needing to be made as not only does each decision affect the species it is being applied to but also the potential use of resources that could be used to avert extinction of another taxon.

It is under these conditions that decisions within the current kakapo recovery programme have been made. Time to recovery, and by default total recovery costs, and reducing management costs as quickly as possible, pervade kakapo management decision-making.

Setting clear outcomes to guide decision-making

Government policy, as expressed by Goal 3 of the New Zealand Biodiversity Strategy, clearly states a will to "*maintain and restore viable populations of all indigenous species and subspecies across their natural range and maintain their genetic diversity*". This goal has served kakapo recovery well. Actions within the kakapo recovery programme have been optimized to ensure the bird's future security while minimising total recovery cost, thereby releasing resources for other biodiversity maintenance programmes as soon as practicable. This is best demonstrated by an intended change to management of kakapo; when a target of 53 females is achieved (Elliott 2006), the present high-cost interventions of nest management, hand raising, and double clutching will be reduced to providing supplementary food to support females during breeding years only. This will provide an order of magnitude saving, from approximately NZ$1m to NZ$100k per annum. Under this altered management regime kakapo would increase less rapidly but with a significantly reduced cost of recovery and the benefit of redistribution of funding to other species recovery programmes. The benefits of this strategy for retaining maximum biodiversity could be significant and outweigh the increased risk to kakapo from inbreeding depression or stochastic event.

Priority setting between recovery actions for kakapo is also vital in meeting policy goals. A key performance measure in the current (1996 - 2006) kakapo recovery plan (Cresswell 1996) has been exceeded by two-and-half-fold, with 20 female kakapo having been produced. However, the success of the recovery actions in the plan came from an unstated but over-arching objective "*to make more kakapo*". This unwritten objective became a maxim of the NKT when implementing the plan and setting priorities, and it applied equally well across all recovery plan goals and objectives. For example, when a proposal to investigate what weather conditions induced rimu (*Dacrydium cupressinum*) to fruit, it was rejected because to make more kakapo weather patterns would have to be controlled. However, the proposal was reworked to ask the question "how can rimu trees be made to fruit?" because making rimu trees fruit more frequently would make more kakapo. By applying this simple "filter", research was stringently directed at recovery.

When birds were to be directly manipulated, application of this filter was even more important because the consequences to kakapo of poor management intervention were more severe than of poor research, especially if the natural productivity of kakapo was affected. An example was the removal of the male kakapo Richard Henry (the only Fiordland-sourced bird alive) and the female Flossie from Little Barrier to Maud Island to maximise breeding. Richard Henry had never attended a dominant lek site at the summit of Little Barrier Island and thereby had not contributed to breeding. Flossie, too, was a bird without any breeding history over 14 years and her location on Little Barrier Island made it impossible to provide her with supplementary food, or other interventions for successful breeding. Maud Island's less defined summit and fewer males resulted in Richard Henry occupying the dominant lek site there and 18 months after Flossie's arrival, and management with supplementary food, he sired her three fertile eggs, ensuring the inclusion of Fiordland genes within the new generation of kakapo.

Maximise future options

A second filter applied to decision-making was maximising the reproductive potential of every bird. No intervention was committed to that could not be undone, thereby maximising future options.

An action demonstrating this approach was the release into the wild of Hoki, a young female that had been hand-raised and held in captivity for six years. As the youngest female kakapo, and nearing sexual maturity, her value to the breeding population of kakapo was immense. Debate focused on establishing a captive population with Hoki as the founding female. However, there were no hand-raised males nearing sexual maturity and historic efforts to acclimatise wild birds to captivity had not been successful. Consequently if potential productivity was to be maximised, Hoki needed to be released to mate with wild males. Acclimatisation to the wild was accomplished and subsequently Hoki has mated and been a surrogate parent to a chick.

Since this time, all hand-raised birds have been returned to the wild. However, through regular human contact, reinforced with hand-feeding, these birds willingly approach field staff during nocturnal visits. The association of free-living birds with humans will ease any future transition of these birds back to captivity if required.

Confronting risk and uncertainty

Many decisions made as part of the kakapo recovery programme have challenged accepted thinking associated with endangered species, particularly in regard to assessing and managing risk. For example, the decision to place all adult females on a single island (Codfish Island / Whenua Hou) to maximise breeding, is one that still sits uncomfortably with many conservation managers and academics. The benefits associated with this approach were judged to be significantly higher than the risks, and those risks, in turn, to be lower than tolerating further population decline through poor breeding performance, in-breeding depression, and increased aging of the population. Arguments against this approach centred on the increased vulnerability of the population to a single catastrophic event, such as a disease epidemic. However, disease has not been demonstrated to have caused extinction or widespread population decline of indigenous avifauna in New Zealand, despite several rare species being confined to single small islands (e.g. Chatham Island black robin). Furthermore, at Codfish Island (Whenua Hou), the most stringent quarantine procedures in New Zealand wildlife management already applied, thereby making an unforseen disease outbreak less likely. The short duration of this management intervention (approximately 12 months) also significantly reduced the level of risk. Due to this calculated action a 39% increase in the kakapo population was achieved in one breeding season (Elliott *et al.* 2006). With 37 sub-adult kakapo produced since 1997, 20 of which are female, the significant increase to the population now necessitates that birds are located on more than one island.

Retain flexibility and adapt to new information

The ability to respond to new information, or the re-evaluation of existing information, has been an important factor in increasing productivity of kakapo over the last 10 years. While there is a natural reluctance to make change once significant commitments are made, there is always a need to regularly assess the validity of every action against the twin measures of cost and recovery effectiveness. On two occasions the NKT has removed kakapo from islands that did not maximise breeding potential despite recent and significant development of infrastructure. For example, only two years after construction of a field base on Little Barrier Island (as recommended in an independent review of the recovery programme), the NKT concluded that the island's rugged terrain and the presence of kiore (*Rattus exulans*) severely compromised its ability to support females while nesting and to protect their chicks. The increased number of chicks that could be produced and cared for on Codfish Island (Whenua Hou), due to its benign topography and absence of rats, greatly outweighed the cost and effectiveness of management on Little Barrier Island. All kakapo were removed from Little Barrier Island.

A similar situation arose on Maud Island when an assessment of the number of accumulated female-years on the island clearly demonstrated that breeding there was an exceptional, rather than a regular, event when compared to other sites. Continued management on Maud Island, based on the recent investment in the island's infrastructure, was evaluated as false economy as it would significantly increase the overall cost of recovery for the species.

DISCUSSION

The modern kakapo recovery programme has been successful in reversing the decline of kakapo. Kakapo numbers have almost doubled in the past decade due to highly intensive management interventions that have boosted the success of natural breeding attempts (Elliott *et al.* 2006). However, without this scale of intervention it is equivocal whether kakapo will survive unaided due to their perilously low reproductive success, compounded by the high degree of genetic similarity within the population (Robertson 2006). The loss of genetic diversity as a consequence of the last Fiordland males not being aggregated on predator safe islands together with Stewart Island birds, now haunts the modern kakapo programme. This outcome, produced by poor decision-making, clearly demonstrates the need for agreed goals being the fundamental cornerstone of any decision-making process. This example also clearly demonstrates that these goals should be set for the long-term maintenance of populations and not solely at the maintenance of individuals.

Risk and uncertainty

Appropriate evaluation of risk and uncertainty is a key attribute of the modern kakapo recovery programme. Continuation of transfers of birds found on Stewart Island to predator safe islands, despite initial high rates of mortality, was the most important decision averting extinction of the species (Clout & Merton 1998). The original concept, employed by Richard Henry over 100 years ago, of isolating the bird from the agents of decline, is still an important recovery action for kakapo and many other endangered New Zealand species. The ability to understand the risks and uncertainties of such actions, and to manage appropriately, is vital if conservation gains are to be maximised.

The aggregation of all adult female kakapo on Codfish Island (Whenua Hou) in advance of predicted exceptional mast fruiting of rimu there in 2001-02 is also a good example of weighing risk against benefit. The only way to maximise diversity of kakapo without the addition of new founders (which is now extremely unlikely) is through rapid expansion of the population (F. Allendorf pers. comm.). With breeding of kakapo occurring, on average, every three - four years (Powlesland *et al.* 1992, 2006), and productivity exceptionally low (Elliott 2006; Elliott *et al.* 2006), the value of having as many females contribute to a breeding event becomes obvious. Transferring nine females from an island lacking rimu to join the 12 already on Codfish Island (Whenua Hou) nearly doubled expected productivity. This benefit was not without risk or uncertainty to those individuals. However, during 25 years of monitoring kakapo intensively, mortality has been exceptionally low, no disease events have arisen, and numerous relocations of birds have been undertaken thereby providing a basis for assessing risk. In the end, the risk of losing further genetic diversity through restricting productivity, and the consequent increased risk of extinction this creates, outweighed the increased probability of mortality through aggregation of all adult females at one site.

Moving adult females between islands to achieve the highest possible productivity in any given year is now an ongoing strategy. However, the attendant risks have reduced significantly with the rapid production of 20 sub-adult females over the last decade. Many of these females are now held on different islands because no single island available for kakapo can contain the entire population. This accelerated population increase, while assisting genetic diversity, has significantly increased the resilience of the population by injecting a missing age cohort. This positive outcome is an estimated 10 years in advance of a supposed more risk-averse strategy of maintaining two isolated adult female populations. This outcome emphasises the need for incorporating appropriate risk and uncertainty variables within a decision-making framework if optimal species recovery outcomes are to be achieved.

Maximising future options

Maximising future options is also a component of risk mitigation and is particularly relevant in dealing with uncertainty. For example, the ability to breed kakapo in captivity has yet to be evaluated, but adult birds placed into captivity have not adapted well. There is a reluctance to remove sub-adults from the wild and their opportunity to encounter natural foods and respond to natural breeding triggers. However, hand-raised birds are seen as the most suitable candidates for any future captive breeding experiments. Hand-raised birds arise from the necessity to bring occasional mal-nourished or ailing chicks into care. Upon fledging they are released to the wild but they retain familiarity with humans through regular, managed encounters. This ensures they encounter natural foods, behaviourally interact with other wild kakapo, are exposed to natural breeding triggers and behaviours and ensures their future natural breeding potential. Through this elegant process the option of acclimating birds to a captive situation on or after sexual maturity remains open while ensuring that all birds are competent reproductively in a wild setting.

This principle of effective multiple outcomes is relevant in decision-making affecting critically endangered species, particularly when numbers are below a threshold allowing more than one strategy to be attempted at any given time. When facing decisions involving a high degree of uncertainty, exercising this principle may provide opportunities to retain all desirable options with little or no compromise. The inclusion of an approach that copes with risk and uncertainty should be incorporated within any decision-making framework.

The challenge of new information

Regular testing and evaluation of management actions provides opportunity to exercise flexibility and adapt strategies to include new information. While this principle is broadly understood, it is seldom achieved in a timely way in New Zealand species conservation. Several Department of Conservation species recovery programmes have had to undergo independent internal reviews to effect change after concern about their ability to deliver recovery had been expressed. For example, the kakapo programme had effectively stalled when few offspring were produced despite adults being moved to predator safe islands. It took three years of lobbying before a review of kakapo management was accepted as necessary, and a further two years to implement effectively. Likewise other recovery programmes e.g., brown teal (*Anas chlorotis*), kiwi (*Apteryx* spp.), blue duck (*Hymenolaimus malacorhynchos*), kaki (black stilt; *Himantopus novaezelandiae*), takahe (*Notornis hochstetteri*), and grand & Otago skink (*Oligosoma grande & O. otagense*), were reviewed in response to various levels of dysfunction, especially of resource allocation and recovery strategy. The expense of these reviews, while significant, is overshadowed by the loss of resources and time through applying sub-optimal recovery strategies which, in turn create a higher risk of extinction, a lengthening of time to recovery, greater cost to effect recovery, and consequential delayed action for other at-risk species through resource limitation. Unsurprisingly, these reviews did not recommend radical new ideas but enforced a qualitative evaluation of existing information and suggested interpretations that had been either overlooked or rejected prematurely. Why these more perceptive evaluations had not been undertaken was, in all cases, difficult to explain, but finding management techniques and procedures to encourage a change in analytical and management behaviour clearly has the potential for maximising biodiversity gains.

An example of the lack of timely change in relation to new information is the NKT's response when kakapo were removed from islands judged unsuitable for their future management. Considerable effort and cost had been expended in establishing suitable infrastructure on Little Barrier and Maud Islands. Despite these facilities costing only about 20% of the annual kakapo recovery budget, and the potential benefits to kakapo through greater productivity elsewhere being obvious, National Kakapo Team members were initially reluctant to abandon these facilities for reasons best described as "natural conservatism" - that inbuilt loathing of wastage by responsible people. The NKT also had concerns over how this seemingly radical change would be perceived by the Department of Conservation's senior administration and staff, both of the programme itself and of the individuals involved. Reputation and credibility are important drivers for many people and the collective NKT proved no different in this regard. Despite these concerns subsequently proving to be unfounded, this example demonstrates that the way risk may be perceived may be distorted by factors that have no relationship to the declared outcome for a project and, in some cases, may cause the corruption of achieving those outcomes in a timely way.

A reluctance to change a strategy may also be driven by an unwillingness to acknowledge a problem or a failure to understand the broader consequences to biodiversity of a sub-optimal approach. It can also arise from an unwillingness to acknowledge a problem, even if it is recognised as being "too hard". It is also clear that quantitative models underpinning decision-making can appear complicated and difficult for people unfamiliar with the mathematics employed, further reinforcing the difficulty of finding a solution. A user-friendly interface for managers and administrators to better understand the values assigned in models, and the way they function together, has been suggested as a way of encouraging greater uptake of decision analysis tools in conservation (Guikema & Milke 1999).

A directing strategy

The effectiveness of decisions made by the NKT, and its associated advisory group, during the past decade has been based on an unwavering dedication to maximising productivity. A goal of maximising productivity should be a corner stone of every threatened species programme, yet, within the Department of Conservation, there is no consistent strategy which overtly supports this approach. In its absence, and also of other clearly-understood strategic goals for biodiversity management, managers of threatened species programmes can become confused by subtle shifts in Departmental thought relative to Government policy (e.g., *New Zealand Biodiversity Strategy* (MFE 2000) and *Department of Conservation Statement of Intent 2005* (DoC 2005b)). Independent reviews of conservation agencies and organisations internationally show little link between strategic goals and objectives of those organisations with their annual activities and expenditures (Guikema & Milke 1999; Doerksen *et al.* 1998). One reason put forward for this is a lack of specified objectives on which decisions can be made (Metrick &Weitzman 1998). The development of a decision-making framework based on a clearly-defined and well-understood set of objectives, is possibly the single most important change that could assist those attempting biodiversity conservation in New Zealand.

CONCLUSION

Kakapo declined rapidly with the arrival of exotic pests in New Zealand, but, over the past 10 years, have begun to recover. Strong Government policy and direction has been pivotal to this recovery. With the creation, in 1987, of a single conservation agency responsible for land and biodiversity management, and with clear government goals articulated in the New Zealand Biodiversity Strategy (MFE 2000), the ability to optimise kakapo recovery has never been better. These goal statements have also gone some way to assisting the increasingly complex decision-making necessary to allocate resources to maintain indigenous biodiversity more broadly. However, as more species are listed as threatened, and as costs of managing endangered species increase, conservation managers are having difficulty assigning resources to the species most at risk, and in a way that expedites recovery. A quantitative decision-making framework would aid this process, providing consistent ways to assess information and to deal better with risk and uncertainty. The use and relevance of such a framework would be significantly enhanced by clearly-articulated Department of Conservation management objectives that unambiguously link back through the Department's strategy to the goals of Government. The use of conservation examples, like the kakapo recovery programme, to develop and test the decision-making framework, would provide biodiversity managers with the confidence to use it.. While extinction of kakapo is now less likely than 10 years ago, the future of the 600+ New Zealand species listed as acutely and chronically threatened (Hitchmough 2002) and that presently do not receive any management is by no means secure. Finding more effective ways to undertake the complex task of allocating conservation resources optimally is the greatest single challenge confronting those attempting to minimise the loss of New Zealand's unique biodiversity, and turn the tide.

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