Biodiversity: Supporting Information

Draft Summary for Discussion

NOT Federated Farmers Policy

E McGruddy, FFNZ, December 2017

INTRODUCTION

The Project Plan for the Biodiversity Collaborative Group sets out milestones including:

- **Milestone Two**: review documentation analysing states, trends and pressures, make recommendations for future research
- **Milestone Three**: policy paper outlining the group's position on findings of state, trends and pressures; and implications for NPS/complementary measures
- **Milestone Four**: evaluate options – analysis of efficiency and effectiveness of regulatory/complementary methods for managing biodiversity.

This paper collates material from a range of recent publications to support FFNZ understanding and contribution to group discussions in relation to these project milestones. An earlier draft focussed on state and trends: this paper now presents expanded consideration of context and drivers, strategy and priorities, and preliminary consideration of implications for NPS/complementary measures.

EVIDENCE

The project plan identifies the importance of evidence-based policy, while also identifying a risk that data may be inaccessible for the group, impacting on the robustness of the evidence base.

Acknowledging the risk, a significant premium must be placed on front-end data collection. Indeed, a key value of this process is the opportunity to assemble and analyse the data that is currently available across multiple agencies, and from there, prioritise key areas for further work.

This paper attempts a reasonably comprehensive compilation: any advice of more recent or comprehensive sources will be welcomed. It indicates areas where further information or analysis may be useful, and includes "placeholders" (pending receipt of work currently in train).

SCOPE

In general, the larger and more visible elements of NZs indigenous biodiversity are better researched than the smaller, more cryptic components: this paper focusses on plants, birds and fish.

Assessment of state is in part an artefact of classification systems - "lumping" or "splitting": this paper generally presents aggregate data first, then more fine-grained information where available.

Assessment of trends is in part an artefact of the time period selected: this paper focusses on contemporary trends, in particular the period from around 1990.

Estimates of state and trend are inevitably "fuzzy": numbers are generally rounded here, in part recognising the uncertainties, and also to assist in readability (not losing the wood for the trees).

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EXECUTIVE SUMMARY

The Biodiversity Collaborative Group (BCG) is tasked with developing evidence based recommendations for an NPS and Complementary Measures:

- The Terms of Reference mirror those of the Ministerial Advisory Committee (MAC) for biodiversity on private land in 2000
- At that time, the MAC emphasised the need for more sophisticated partnerships for active management; and questioned the value of a top-down NPS unless it was well-integrated with central and regional government funding resources and operational capabilities
- A key question for the BCG is the extent to which new evidence supports the MAC approach or compels a new approach, more or less geared to regulatory or partnership settings.

A substantial body of evidence was assembled in the Environment Aotearoa 2015 report (EA2015), updating on state and trends for biodiversity. Against the common conception that "biodiversity is declining", EA2015 data shows a more nuanced context in contemporary New Zealand. For the major vegetation communities:

- The major indigenous landcover categories – native forest, scrub/shrub communities, tussock grassland – are broadly stable with any changes at the margins (less than 1%)
- For wetlands and sand-dunes, work is currently in train to clarify the extent of recent change
- For "naturally uncommon ecosystems", work is currently in train to map distributions, but there is no baseline for assessing contemporary trends.

In respect of species: NZ has a high proportion of endemic species (courtesy of our longer geological history) and a high proportion of threatened species (the legacy of human settlement), most of which depend on active management to survive (or thrive) in the presence of introduced species. From a total of 800 "threatened" species, EA2015 reported "genuine changes" for a smaller subset:

- 12 species genuinely improved, 8 of which were birds (due to active management, ie, predator control and/or island translocations)
- 60 species genuinely worsened, of which 30 were plants (work in train to clarify reasons), 11 were birds (eg, kiwi, black-billed gull), and 8 were fish (mainly non-migratory galaxiids)
- For the balance – over 700 threatened species – no discernible recent trends were reported (a result which may in part be testament to management efforts to "hold the line").

Briefly expanding on the three major species groups – plants, birds and fish - recent work mapping distributions suggests (to borrow language from the PCE) that "some are in serious trouble, some are in some trouble, and some are doing OK":

- Populations of the widespread forest trees are "doing OK"; the plants which are in trouble are not currently well mapped or described but are generally in the non-forest communities, with a high level of overlap with the "naturally uncommon ecosystems" (mapping in train)
- Populations of native or recently self-introduced birds or birds of open habitats are "doing OK", eg, tui; other endemic birds are in "some trouble", eg, kereru; the groups which are in "serious trouble" are mainly the deep endemic (ancient) species, eg, kiwi, wrybill

- Populations of most native fish (the diadromous species which migrate to and from the sea) are “doing OK”; the non-migratory galaxiids centred on the ancient Otago peneplain and recently identified as distinct species are in “serious trouble”.

Acknowledging that some species are in serious trouble, a critical next step is to understand the key factors impacting those species. In 2000, the NZ Biodiversity Strategy noted that widespread clearance of native vegetation has stopped; and that the greatest single threat to terrestrial and freshwater ecosystems is from invasive introduced species:

- This finding seems to be incontrovertible in respect of bird species; and well-supported in respect of critical and declining fish species (either acute threats or ongoing suppression)
- For forest communities, the scale of damage from introduced browsers (deer, goats, possums) is less of an issue in current times (not least the result of past management)
- For non-forest communities – including the “successional” systems which have greatly expanded in extent since human settlement (scrub/shrub/tussock/gumlands/heathlands) and the “naturally uncommon ecosystems” (together with their associated threatened plants) – understanding key drivers cannot easily be untangled from the contemporary reality that most exist as highly modified “matrix” communities; that many are unstable successional states with uncertain trajectories (or requiring active management to “arrest” successions); and that the most vulnerable native plants, eg, small turf plants, may only survive or thrive with active management of the more vigorous introduced species.

Of the four groups above, it is arguably the last which is the most vexed and contentious area, and the one which is least well supported by evidence elucidating current distribution/trends/drivers:

- Improved base information is a necessary precursor to sensible consideration by the BCG
- Work is currently in train for naturally uncommon ecosystems, sand-dunes and wetlands: pending that work coming to the table, information to hand to date suggests that active management of introduced plants/weeds may be required to maintain and/or restore threatened plants/uncommon ecosystems
- Further information has been requested for scrub/shrub/tussock communities to support analysis of context and drivers: pending that analysis, information to hand to date suggests a key issue is agreeing the biodiversity values of these communities (in total comprising 4.4 million hectares) vis-à-vis other areas of public policy.

Forest and non-forest communities can be distinguished by both slope and tenure – the forest (and threatened birds) are mostly in the uplands, mostly on conservation estate, whereas non-forest communities (and threatened plants) are mostly in the lowlands, mostly in private tenure:

- NZ biodiversity investment is here estimated (ballpark) at $400 million pa (average $15/ha)
- Around half is invested principally in the uplands (Vote Conservation) – a portion under active management, most under little or no management
- Around half is invested principally in the lowlands - perhaps half central/local government funding and half landowners, perhaps with similar levels of management coverage.

Accepting the scale of the challenge to secure threatened species from extinction, let alone control pest species more widely, let alone restoration ambitions, funding is a recurring theme:

- For the conservation estate, DOC is investing in commercial/philanthropic partnerships to top up Vote Conservation
- For the private estate, some partnership funding is available for prioritised sites but demand is always greater than funds available (and there is little support for active management)
- Where government funding is made available to assist private landowners, some estimates put the landowner contribution at greater than 10:1.

Accepting that funding will always be limited, prioritisation is another recurring theme. In the past, prioritisation principally informed selection of a representative network of "protected" sites. Today, prioritisation tools principally inform prioritisation of areas for active management - albeit New Zealand has been making haste slowly:

- For the conservation estate, DOC have been working towards prioritising Ecological Management Units, integrating species and ecosystem management in prioritised areas
- For the private estate, DOC/MfE developed a Statement of National Priorities in 2007 to help align partnership investments, ie, to focus conservation efforts where the need is greatest
- Predictably, the Statement highlighted non-forest systems (wetlands, sand-dunes, naturally uncommon ecosystems) but these categories are very broad, and little further work has been undertaken in the succeeding ten years to finetune these very broad "priorities".

Most recently, the strategic landscape has shifted – the new imperative is partnerships for coordinated landscape scale management across all land tenures, with a particular focus on multi-species pest control to deliver on the new Predator-Free NZ vision:

- These new developments supercede (tbc) the NZ Biodiversity Strategy 2000-2020 and the Statement of National Priorities 2007 - arguably the draft DOC Threatened Species Strategy, the Predator-Free NZ vision, current landscape initiatives and the Regional Council Thinkpiece could now be integrated within a refreshed strategy for the period to 2050
- A key element would be identification of the portfolio of actively managed areas (across both public and private land) which are priorities for national investment (supported by the increasingly sophisticated array of prioritisation tools/overlays)
- The national portfolio can be expected to include large offshore islands, peninsulas, and large "mainland islands" with intensive management in the "core" and strategic management in the "halo" (supported by increasingly sophisticated understanding of predator movements, and increasing efficiency of trap network technologies)
- The national portfolio could be supplemented by places prioritised for regional partnerships.

Accepting that the new strategic directions are evident – albeit the threads have not as yet converged – the implications include:

- The extent to which structural or statutory changes are needed to give effect to the imperative for "joined-up action" as advocated in the Regional Council Thinkpiece (not commented on in this paper)
- The extent to which a refreshed Biodiversity Strategy to 2050 would sensibly precede preparation of an NPS and complementary measures – both of which could be expected to help give effect to such a strategy
- The potential timing for development of a refreshed NZ Biodiversity Strategy.

Accepting for the moment that this may be an open question – and proceeding for the moment on the basis that the strategic direction is clear, even in the absence of a refreshed strategy – the implications for an NPS and complementary measures include that:

- Both should be strongly informed by the emerging national strategy and prioritised places (in part responding to the PCE criticism that this was a weakness in the NPS for Freshwater)
- Both should be strongly linked to central and regional government financial and operational resources and commitments (in part responding to the MAC recommendation to this effect)
- Both should strongly emphasise the partnership principle (responding in part to the unanimous emphasis on this point by the NZ Biodiversity Strategy, MAC, the Tahi Group, the draft DOC Strategy, the Regional Council Thinkpiece, and the Predator-Free NZ vision).

From the inception of the BCG process, it was apparent that participants shared significant common ground, and that a focus for the BCG process would be to document and enlarge that common ground, while identifying and narrowing the inevitable differences. Key areas of common or uncontested ground may include:

- A central commitment to treasuring the indigenous biota who share these islands
- Agreement that some are doing OK, some are in some trouble, and some are in serious trouble – and that that last group must be prioritised for investment
- That biodiversity strategies should operate across tenures – with DOC lead partner on the conservation estate, landowners lead partner on the private estate, and Regional Councils lead partner on coordinating integrated public/private operational projects
- That Predator-Free NZ is a "stretch goal", demanding active engagement from all partners
- That progress will be made on a rolling front, prioritising large landscapes (with mosaics of ecosystems and threatened species) across both public and private land
- That priority places (or special or significant places) should be spatially mapped.

Within this strategic context, areas for creating or enlarging common ground may include:

- National priorities for an extended network of legally protected sites on private land, eg, short tussock grassland, with funding increased (or re-aligned) to secure the network
- National priorities for active management of ecosystems on private land, eg, finetuning/mapping the naturally uncommon ecosystems, with partnership funding increased to maintain and/or restore the priority sites (eg, through management covenants)
- National priorities for active revegetation/re-introduction/restoration on private land, eg, using a range of classification system overlays to identify "hotspot" opportunities for restoration – perhaps in concert with the prioritised large landscapes as above.

Areas of creative tension which may require active support from the active observers might include:

- Achieving strategic coherence across related areas of government policy, eg, biodiversity vis-à-vis carbon vis-à-vis exotic forestry and agriculture vis-à-vis regional development
- Specifically: the biodiversity values of non-forest secondary, successional communities on private land (scrub, shrubland, tussock grassland) vis-à-vis those other values, including but not exclusively on maori land

- Achieving strategic coherence across land and water, eg, extending the predator-free vision to prioritised indigenous fish locations – perhaps in concert with the large landscape projects

Areas of difference – some of which could be resolved with further information - may relate to:

- The extent to which vegetation clearance is an historic or current issue – and, related to that, the extent to which regulation is already in place to address it
- The extent to which vegetation modification is occurring in modified "matrix" systems (scrub, shrubland, tussock grassland) – and the relative weighting of biodiversity vis-a-vis production and other values
- The extent to which factors other than introduced pests and predators are materially impacting indigenous species, eg, "intensification" – and the evidence to support it
- The extent to which biodiversity reporting conflates historic and contemporary trends – and the extent to which any targets should be benchmarked to the contemporary period, or to a potential (pre-human or non-human) state
- The extent to which classification systems may be best deployed as decision-support tools, utilising a range of systems to help illuminate priorities vis-à-vis selecting one
- The extent to which biodiversity strategies and policies should continue to rely on "principles" and "criteria" – or can now be taken forward to land priorities and places
- The extent to which "significance" under the RMA is conceptually and practically different to "priorities" developed outside the RMA – and if so, the implications of disjunct priorities
- The extent to which concepts of "maintenance" or "no net loss" can be easily applied to contemporary biodiversity – and the extent to which a "reductionist" approach to measurement is useful
- The extent to which information gaps should be prioritised for further research, before or after landing policy recommendations – and the extent to which the "precautionary principle" should be employed as a stop-gap.

For clarity: the conclusions above are presented as tentative findings, subject to further discussion within and beyond FFNZ, and subject to further information as indicated in the next section. Corrections, challenges and criticisms are welcomed.

SUMMARY of "PLACEHOLDERS"

The body of this report includes "placeholders" pending further information: some are in train, others are proposed by FFNZ to support BCG discussions - all placeholders summarised below.

Indigenous vegetation

- Extend the analyses for maori land to land in other private tenure; and assess the relationship between intensification opportunities/implications for indigenous vegetation
- Analysis of context and drivers behind indigenous cover changes in key regions:
    - Indigenous forest: West Coast/Southland, including vis-à-vis MPI Permits
    - Scrub: gains in Gisborne, losses in West Coast/Southland
    - Shrubland: losses in Marlborough/Taranaki, gains in Banks Peninsula
    - Tussock: Otago - including consideration vis-a-vis the Tenure Review process
- Cross-check LCDB/Carbon Inventory estimates to assist understanding of context and drivers
- Assess carbon sequestration implications of more indigenous cover, less exotic forestry
- Assess succession pathway possibilities/probabilities under passive "reversion"
- Assess options for the selection of baselines and targets, contemporary or historic
- Deployment of a range of classification systems to assist in identifying priority ecosystems
- Assessment of the current extent of regulation

Non-Forest Communities

- **Sand-dunes**: provide regional breakdown (2008 or more recent) and analysis of context and drivers for recent change in key regions, eg, Northland
- **Wetlands**: update estimates of current wetland extent and trends; provide regional breakdown by wetland type
- **Tussock:** cross-check LCDB data with the more recent estimates of reductions
- **Novel ecosystems**: assess the extent to which estimates of change in indigenous cover occurred in modified (mixed) environments - sand-dunes, wetlands, tussock grassland
- **Naturally uncommon ecosystems**: update on mapping completed (x23) and timeframe for the balance (x49); update on any recent quantitative data improving threat assessments
- **Threatened plants**:
    - Clarify reasons for "genuinely worse" status
    - Provide a higher level of ordering/mapping of threatened plants
    - Update on extent to which mapping of uncommon ecosystems is being undertaken in conjunction with mapping of threatened plant distributions; and extent of distribution on private land

Indigenous Fish

- Clarify status/timing of work assessing state, trends and pressures on native fish
- Clarify extent to which indigenous fish are prioritised within DOC EMUs, and/or within the upcoming portfolio of national priority places

Legal Protection/Active Management

- Update stocktake on land tenure (public, private, maori) and legal protection, dis-aggregated by region and ecosystem type
- Update on priority ecosystems (locations) for legal protection and/or active management.
- Update on protection mechanisms for private land (Reserves Act, Nature Heritage Fund, QEII, Nga Whenua Rahui, Forest Accord), including current criteria and budgets

Strategy/Priorities

- Update broad estimates of biodiversity investments by DOC, Councils and landowners
- Update on current agency priorities for formal legal protection, eg, non-forest communities, wetlands, uncommon ecosystems
- Clarification of the extent to which DOC, Regional Councils and Predator-Free NZ are collaborating to develop a portfolio of national priority places for active management
- Clarification that the NZ Biodiversity Strategy and DOC/MfE Statement of National Priorities have been superceded by more recent strategic initiatives

INDIGENOUS VEGETATION

Pre-Human Context

The NZ pre-human flora is most often depicted as dominated by forest communities. More recently, Landcare Research have reported on "*spectacular improvement in our understanding of the history of NZ forests"*[1] including oscillations between forest and non-forest dominance during glacial advances and retreats:

- "*The Pleistocene era marked a definitive break with the warm temperate world of the Neogene. The initiation of glacial-interglacial alternations…created a historically unusual situation in which, for most of the time, most species had severely restricted ranges"*
- *"The glacial maxima were characterised by widespread near-treeless grassland-shrubland vegetation in the southeastern areas…forest patches in the western and central districts, and a transition to more or less complete forest at around 38 degrees latitude"*
- *"Interglacial maxima are characterised by near complete forest and tall shrub cover…with the exception of small areas of the inter-montane valley system of Central Otago"*
- *"In discussing the biogeography of NZ forests, the c. one million years since the mid-Pleistocene should be used as the unit of analysis, rather than privileging the present instant as the "norm" … we will call this one million year interval the 'extended ecological present".*

The authors suggest this "*extended ecological present*" helps explain key features in the NZ flora, eg, most tree species in NZ have ranges that are much less than their climatic tolerance would suggest:

- "*We suggest this can largely be attributed to the effect of repeated glacial-interglacial cycles, combined with limited dispersal ability exhibited by most trees"*
- *"Propagule pressure decreases precipitously within a few canopy widths of a seed source tree in NZ and few seeds go long distances"*
- *"Even tree species that persist can end up with disjunct or truncated populations despite the presence of suitable habitat beyond their range limits"*
- *"Kauri is an example of this: planted kauri currently grow well and produce seed in Christchurch – its limited dispersal, and time to maturity, are possibly as important in geographic restriction as its climate tolerance"*
- *"Seed dispersal characteristics were therefore a critical factor in maintaining range size – species that range from Northland to Southland are much more likely to be bird-dispersed*".

This biogeographic context also helps explain why NZ forests have few "stress-resistant" trees, relevant in consideration of opportunities for restoration:

- *"NZ lacks trees with high levels of frost resistance, and the sub-alpine beech trees which are among the most frost-resistant, have poor drought tolerance"*
- *"Reshaping of the archipelago into a longer, narrower configuration with a more mountainous topography, created a highly oceanic, low-ignition climate which effectively eliminated all but rare fires"*
- *"NZ has only a few fire-adapted species (ti kouka, matagouri, kanuka, manuka, bracken). Most NZ trees have thin bark by global standards and so have low resistance to ground fires"*

[1] McGlone et al, NZ Journal of Botany, 2016: The formation of the oceanic temperate forests of NZ

Human Settlement

Clearance by Fire

The last point above regarding fire is relevant to the next wave of change with the arrival of humans, which coincided with a period of widespread forest cover. Landcare Research distinguish two phases of forest clearance by fire[2]:

- "*Fires set by maori caused deforestation of most of the eastern parts of the North Island and South Island within a hundred years of settlement"*
- *"Destruction of original forests in the dry east of both main islands has been so complete that by the mid-1800s there were few remnants left. The reduction of seed sources and loss of dispersers…meant that forest recovery was limited"*
- *"In contrast, Europeans felled and burned large areas of forests in the wetter regions. Successions after fire in wetter regions were more rapid, and often proceed through bracken or manuka/kanuka to more species rich forests".*

The importance of fire as an agent of ecological transformation in NZ was comprehensively assessed by Perry et al in a recent review[3]:

- *"We can now be certain that a relatively small number of people, perhaps fewer than 100, settled NZ around 750 years ago, and that rapid and widespread forest loss followed immediately thereafter. Fire was the primary agent of this transformation"*
- *"The paleo-ecological record describes the widespread loss of tall forest and its replacement with seral vegetation, especially bracken, and a massive wave of extinctions in the vertebrate fauna, which is best documented in the avifauna"*
- *"During the initial burning period, it seems likely that more than 40% of existing forest cover was burned, with nearly all lowland and montane dry forest disappearing…as a result, some montane and lowland dry podocarp-hardwood forest types have been all but extirpated"*
- *"The answer to the longstanding question of the motivation for the dramatic clearance may be that there was none. Instead, widespread loss may have been inevitable once fire was introduced to such fire-sensitive and non-adapted ecosystems".*

The review charts the second wave of forest loss during early European settlement:

- *"Beaglehole (2012) estimates 90% of this forest loss occurred during the early European period, (eg) 3.3 million hectares burned in the period 1830-1873"*
- *"Fires during the early European period were sometimes huge…events were often associated with drought conditions, and with railways, sawmilling and other forestry activities*".

Current levels of burning are assessed as much lower, with > 90% occurring in scrub or grasslands:

- "*There are currently relatively few fires in forests … On the conservation estate, around 2,400 hectares each year are burned (average over period 1987-1998)"*
- *"Fires in Otago accounted for more than 40% of the national burned area over the period 1991/2 to 2006/7".*

[2] Allen et al, 2013, NZs indigenous forests and shrublands, *in* Ecosystem Services in NZ
[3] Perry et al, 2014, Ecology and long-term history of fire in NZ *in* NZ Journal of Ecology (2014) 38 (2): 157-176

Perry et al categorise indigenous species which are adapted to or sensitive to fire:

- "*Those indigenous species that are fire adapted tend to be of Australian origin and are fast growing: manuka, kanuka, bracken, matagouri, ti kouka"*[4]
- *"The vast majority of NZs seral (successional) species are fire-susceptible and relatively slow growing: pittosporum, wineberry, mahoe, rewarewa, kamahi, tauhini, chionochloa (tussock)"*
- *"Finally, there are a group of long-lived, large forest trees that are highly susceptible to fire, including totara, rimu, matai, kahikatea, kauri, tawa".*

Post-fire successions are described as typically starting with manuka/kanuka scrub and bracken, later invaded by wind-dispersed, followed by bird-dispersed species. However:

- "*In many modern settings, these successional pathways are slowed or diverted by exotic herbivores (eg, deer) and seed predators (eg, rats, mice)"*
- *"Secondary successions have also resulted in "novel" ecosystems in which native and exotic species sit alongside each other…invasion by pyrophyllic exotic species potentially amplifies the fire-begets-fire cycle"*
- *Until recently, some exotic pyrophyllic species such as gorse have been seen as (almost) desirable as they may act as nurse crops…recent studies however suggest that there are important differences in succession through manuka as opposed to gorse, with species richness lower under gorse and little evidence for longterm convergence of successional pathways"*
- *"There is no reason that other exotic species would not stall or divert succession in a similar way, eg, a number of studies have described the invasion of burn sites by exotic grasses and the subsequent failure – even after fertilisation and over-sowing of native species – of woody shrubs and beech to establish".*

Perry et al assess the "winners and losers". The main losers were dryland forests:

- "*The losers are species associated with the dry and open forests that once occurred across much of lowland eastern NZ – matai, totara, lacebark, ribbonwood, hinau, kowhai … nevertheless, most of these dryland species are still relatively common as scattered stands although large patches of dryland forest are now rare".*
- *"In the semi-arid inland basins of the eastern South Island, low forest communities (kanuka, phyllocladus) were among the first burned"*

For native species, the winners are scrub and grassland systems (plus exotic s - gorse, broom, pines):

- "*Expansion of ecosystem types such as grasslands, gumlands/heathlands, and pākihi mires"*
- "*Obvious winners are bracken, manuka and kanuka. All three species are highly flammable and so their increased abundance renders modern landscapes more susceptible to large fire events. These and other fire-adapted species such as matagouri are now widespread in places where pollen and macro-fossil evidence suggests they were absent (or rare) before the onset of anthropic fire".*

[4] Interestingly, NZ had a number of fire adapted species during the Miocene period – eucalyptus, acacia, casuarina – but all were lost during the Pleio-pleistocene period (Perry et al, page 160)

The significance of these fundamental shifts in fire regimes and vegetation communities is the implications for moving forward (including the meaning of concepts such as "maintenance" or "no net loss"). Perry et al pose the conundrums:

- "*The anthropic origin of much of NZs lowland and montane grassland poses difficult management and conservation questions"*
- *"In the absence of repeated fire, grassland will eventually return to a forested state…prescribed burning provides one potential tool for holding the system in an early successional state, although it brings with it the risk of weed invasion and other deleterious effects"*
- *"Ragamuffin ecosystems comprising early successional native species (manuka, kanuka) alongside pyrophyllic exotic species (gorse, pines) are now common and are probably much more flammable than non-invaded communities (with) significant implications for forest regeneration and efforts to restore areas which were once forested"*
- *"Whether ragamuffin communities are quasi-stable or whether they will inevitably move towards either high-flammability exotic-dominated communities or lower-flammability native forest is unclear".*

Indigenous Forestry

Indigenous forestry was an important industry in the early period of European settlement[5]:

- "*Indigenous timber output peaked in 1907 with smaller peaks after the two world wars as returned soldiers sought to create farms on marginal forest land provided by the government*
- *During the 1950s, forests on private land began to be felled with greater intensity following a wool boom triggered by the Korean war. This contributed to the last surge of the indigenous timber industry. By 1960 it was on the wane, overtaken by exotic timber. In three decades, from 1960 to 1990, indigenous timber declined from 50% of total production to less than 5%*
- *"Clear-felling has declined from several thousand hectares annually to just several hundred. The clear-felling which continues is confined to a few specially approved areas covered by the West Coast Accord and the South Island Landless Maoris Act"*
- *"Most of the remaining indigenous forest is now protected or is not on usable farmland. The main pressures now come from the degenerative effects of forest fragmentation and the impacts of alien plants and animals, particularly possums, goats and deer".*

In 1989, an MfE stocktake of indigenous forests confirmed the very restricted scale[6]:

- *"The cessation of land development encouragement loans and changes to the tax regime have greatly decreased the amount of forest clearing for farmland and plantation forests*"
- "*In the last two years, the area of state forest zoned for timber production has decreased to the point where there is now only 150,000 ha available (total public forests 5 million ha). This decrease means the industry is turning increasingly to private forests as a source of supply"*
- *"There are approximately 125,000ha of forest potentially commercially available in the private estate (total private forests 1.3 million ha). The area of private land actually available*

[5] MfE, 2007, Environment NZ, Figure 8.4
[6] MfE, 1989, A national policy for indigenous forests – a discussion paper

for logging is restricted because approximately half the total area has been effectively precluded through the Soil Conservation and Rivers Control Act; of the remaining area, about 75% is commercially inaccessible due to low timber volumes or past logging; and, where substantial volumes of currently merchantable forest on private land exist in a small number of counties, planning controls made under district schemes restrict cutting rights".

More recently, Orr presented MPI data for the period 1921 to 2015, which showed continued reductions in the volume and proportion of indigenous vis-à-vis exotic timber– in the most recent period 1990-2015, indigenous timber production declined by over 80%[7]:

Production of sawn timber	**Indigenous**	**Exotic**
1921	701	25
1971	442	1407
1990	87	2034
2015	11	3999

Exotic Forestry

As above, the decline in importance of the indigenous forestry industry is paralleled by the rise in importance of exotic forestry. Various histories of the NZ Forest Service chart the context, eg[8]:

- "*A timber-famine scare in all English speaking countries was one of the products of the Great War, and it was perhaps inevitable that under the existing conditions of those times, extensive tree planting with quick growing exotics should follow"*
- *"In 1958-59 when the Forest Service drew up revised forecasts of the supply and demand for wood in NZ, it concluded that the country's forest resources might be insufficient by the end of the century even for local needs; that forest planning must provide increasingly for export markets to improve the balance of payments; and that only a vigorous afforestation effort would ensure requirements could be met".*

The exotic forestry plantings were mostly in areas of "scrub", deemed unsuitable or uneconomic for agriculture. In 1969, Poole reported[9] that forestry is "*usually expected to use land that is difficult to develop, often carrying useless second-growth or infested with gorse or other weeds*", eg:

- "*Kaingaroa, the extensive tussock or scrub-covered pumice areas of Rotorua-Taupo…until a remedy for bush sickness was discovered in 1937, afforestation was looked on as the heaven-sent opportunity for this land with its mile upon mile of golden tussock"*

[7] Orr, 2017, Keeping NZ Green – our forests and their future, page 63 (units not provided)
[8] Kirkland and Berg, 1997, A century of state-honed enterprise
[9] Poole, 1969, Forestry in New Zealand

- *"Golden Downs, on the Moutere gravels, Nelson…the coastal end was being developed in the 1920s for fruit trees, but the rest was mostly scrub and gorse-covered land, the scrub apparently having been induced by the burning of beech forest in Maori times"*
- *"Riverhead, north of Auckland, on difficult and desolate gum-lands covered by stunted native scrub and introduced weeds…Maramarua, waste scrubland, south of Auckland…Karioi, tussock grassland on the lower slopes of Mt Ruapehu…Eyrewell and Balmoral, on shallow, shingle soils in North Canterbury…West Coast, on the cutover terrace forest".*

By the early 1950s, foresters were suggesting that forestry should not be relegated to sub-marginal land, but, because of difficulties in gaining access to agricultural land[10]:

- "*Afforestation continued to focus on cut-over indigenous forest land, and developing protection-production lands – degrading hill country and coastal sand-dunes"*
- *"The extensive sand dune areas of the North Islands west coast had always caused problems with their ceaseless drift*[11]*. Early experimental work by the Public Works Department to protect farmland, roads and railways in various locations, were taken over by the Forest Service, and became the basis for extensive plantations"*
- *"Coastal sand-dunes at Ninety Mile Beach were planted in marram grass as part of the sand stabilisation process, and pines. The vast extent of the dune areas to be covered meant more efficient methods needed to be developed, in this case, a six-man planter was used to plant 20 or more hectares in a single day"*
- *"Eventually stabilised sand dunes made up 8% of the State's plantation area*".

In contemporary times, exotic plantings have been promoted in erosion-prone hill country; but more recently again, the appropriateness of plantation forestry in steep hill country has been questioned, potentially posing a conundrum for where exotic forests can be located (a theme picked up later in this paper in relation to biodiversity and carbon stocks).

Agriculture

As briefly noted above, central government (including Forest Service, L&S, Maori Affairs, IRD) actively participated in programmes to bring land out of indigenous cover and into production (clearing bush, draining wetlands, stabilising sand dunes, marginal land clearance, soldiers settlement farms): initially through the period of early European settlement, later through the depression/war years, and continuing through the post-war period up until the 1980s.

This context is material to understanding the scale of landcover change through that 150 year period, including the extent to which "public-private" partnerships were instrumental in shaping the NZ we see today - and may be required again to reset the trajectory going forward.

[10] Kirkland and Berg, 1997, A century of state-honed enterprise

[11] Anecdotally, rabbits were a key agent in destabilising sand-dunes, preferentially eating native sand-binding plants

The economic reforms of the 1980s marked a sharp shift in central government priorities; and landcover change today is a fraction relative to earlier times - the amount of land in agriculture has in fact been decreasing in recent years.

Today, concerns about the relationship between farming and biodiversity tend to relate more to "intensification", than to landcover change. In a recent report recommending standardised indicators for biodiversity monitoring, Landcare Research (LCR) proposed a new indicator M8 (change in area under "intensive" land use) to be considered alongside M9 (habitat and vegetation loss) "*because of the considerable overlap between intensification and loss of habitat"* [12].

At a workshop convened to discuss the proposed new indicators, participants questioned this assumption: '*Do you assume that because there is more intensification there is a loss in biodiversity? That isn't what data always show";* and the report acknowledges that: "*There is little systematic information on how intensification of agriculture influences biodiversity nationwide*".

The report also acknowledged that definitions of "intensification" are problematic. In this context, it is relevant to note recent work by MPI which analysed productivity trends, and specifically addressed the question: "Is New Zealand's pastoral farming "intensifying?"[13].

The research found that overall, the pastoral farming landscape is becoming more dynamic and sophisticated; and that current measures of intensification seem too simplistic to capture the essence of how pastoral farm management practices have changed, with some inputs increasing and others decreasing. For example, between 2002 and 2009:

- The amount of land being used for agriculture and forestry dropped by nearly I million ha
- Within this (reduced) area, there has been continued interplay between different land uses.

In terms of other indicators:

- Productivity: it took fewer animals and less labour to produce one kg of milk, beef or lamb
- Fertiliser application per ha and per unit of production fell significantly between 2002-2009
- Stocking rates: beef cattle per ha decreased by 8%; sheep per ha decreased by about 11%; in dairy farming, animals per ha increased by 2% over 2002–2009.

For dairy (with overall 8% reduction in the area of land to produce one kg of milk solids), MPI suggest the reduction has been achieved through a combination of improved animal and forage genetics, better pasture management and animal health, and through irrigation and supplementary feed.

Within this more nuanced context, MPI have also considered whether there are opportunities for further intensification, including on maori land. In 2013, MPI commissioned work to assess the size of the opportunity[14]. In brief, that work dis-aggregated maori freehold land by LUC class and region, and estimated scope for improved productivity.

[12] LCR, 2016, Standardised terrestrial biodiversity indicators for use by regional councils, Indicator M8/M9
[13] MPI, 2012, Pastoral input trends in NZ
[14] PWC *for* MPI, 2013, Growing the productive base of maori freehold land

The following tables summarise the results. First, land tenure by LUC class, noting that this table would usefully include data for land in other private title:

LUC Class	**NZ Total Ha[15] (% of NZ)**	**Maori freehold land [16] (% of MFL)**	**Private freehold land (% of PFL)**
I & II – highly versatile	1,400,000 (5%)	50,000 ha (3%)	
III & IV – limited for arable	5,200,000 (20%)	240,000 ha (16%)	
V & VI – grazing, forestry	7,700,000 (29%)	515,000 ha (34%)	
VII – forestry only	5,700,000 (21%)	470,000 ha (31%)	
VIII – too steep, not suitable	5,800,000 (22%)	230,000 ha (15%)	
Total	**26,000,000**	**1, 500,000**	

Second, the PWC report presented land tenure by region, noting that the totals seem to be different but nevertheless highlighting that over half of maori freehold land is in 3 regions (90% in six regions) – arguably the main regions for potential intensification might be Waikato and Bay of Plenty:

Region	**Maori freehold land (% of MFL)**	**Total Region Hectares (MFL as %)**
Waikato	280,000 ha (22%)	2,500,000 ha (11%)
Bay of Plenty	220,000 ha (17%)	1,200,000 ha (18%)
Gisborne	190,000 ha (15%)	800,000 ha (23%)
Man-Wanganui	180,000 ha (14%)	2,200,000 ha (8%)
Hawkes Bay	170,000 ha (14%)	1,400,000 ha (12%)
Northland	120,000 ha (9%)	1,200,000 ha (9%)
Taranaki	30,000 ha (2%)	700,000 ha (4%)
Wellington	12,000 ha (1%)	800,000 ha (2%)
Auckland	7,000 ha (1%)	500,000 ha (1%)
Southland	30,000 ha (3%)	3,200,000 ha (1%)
Marlborough	7,000 ha (<1%)	1,000,000 ha (1%)
West Coast	5,000 ha (<1%)	2,300,000 ha (0.2%)
Otago	5,000 ha (<1%)	3,200,000 ha (0.1%)
Canterbury	4,000 ha (<1%)	4,500,000 ha (0.1%)
Total	**1,200,000 ha**	**27,000,000 ha (5%)**

In the next table, PWC classified maori land as well developed or under-developed, suggesting that 80% may be "under-performing" relative to industry benchmarks or "under-utilised" apparently by reference to LUC classes (the assumptions are not clear) – presumably most of the under-performing/under-utilised land might be LUC Class VI-VIII, and arguably the potential for intensification might be mainly with LUC VI land:

[15] AgResearch et al, 2009, Landuse Capability Survey Handbook, Table 27, excludes Stewart Island

[16] Area of maori freehold land updated from the PWC report, using data in BCG Attachment 6, November 2017

Development Tiers	Maori freehold land (% of MFL)	Private freehold land (% of PFL)
1 – well developed	300,000 ha (20%)	
2 – under-performing	600,000 ha (40%)	
3 – under-utilised	600,000 ha (40%)	

The authors acknowledged that the assumptions used to derive these estimates are fairly crude and recommended ground-truthing:

- "*To make an assessment of maori land potential more realistic, more information is needed on the size, quality and geographic location of the land parcels*"
- *"An undertaking of this size and scale will require coordination across different areas of government…perhaps in this sense, the absolute size of the opportunity is less important than having a common framework and therefore language to engage and build through*".

In 2011, Te Puni Kokiri also considered opportunities for the utilisation of maori land, reporting that owners have a wide range of aspirations, including retaining and improving existing longterm farming businesses[17]. That report highlighted ownership and governance structures – arguably the potential for intensification might be mainly on land held by 140 large entities:

- "*Over 2 million ownership interests exist in around 26,000 maori freehold land titles, with 60% of titles less than 5 hectares"*
- *"76% of ahu whenua trusts manage lands under 50ha"*
- *"A relatively small number of management entities (concentrated in a small number of districts) control significant amounts of land – 140 large incorporations or ahu whenua trusts account for about 50% of all maori land".*

In 2013, AgResearch challenged the suggestion that almost 80% of maori land is under-performing[18]:

- *"Maori agriculture in NZ is vibrant, diverse and has several unique characteristics that indicate the emergence of resilient farming system structures"*
- *"The contribution of the maori pastoral sector is estimated…these statistics are difficult to verify… to be around 8-10% of national milk solids production, and 10-15% of national sheep & beef stock units".*

The author identified two developing trends - arguably these trends apply more widely across the farming sector:

- "*The aggregation of smaller land titles into larger farming units, and the formation of multiple farm units into farming collectives"*
- *"The advantages of scale efficiencies, enterprise diversification and greater capacity to capture value chain opportunities are evident".*

[17] TPK, 2011, Owner aspirations regarding the utilisation of maori land
[18] Tanira Kingi, 2013, Cultural bastions, farm optimisation and tribal agriculture in Aotearoa *in* Proceedings of the 22nd International Grassland Congress

Most recently, information has been supplied to the Biodiversity Collaborative Group[19], indicating the proportion of maori land by landcover class: again this information would usefully be expanded to include breakdowns for other private land. The BCG paper uses different landcover categories and timeframes (LCDB2 instead of LCDB4) to those used in EA2015 - acknowledging these differences, the following table is indicative only:

Indicative Landcover	**NZ Total Ha (EA2015) (% of NZ)**	**Maori land (BCG) (% of MFL)**	**Private freehold land (% of PFL)**
Indigenous forest	6,400,000 (24%)	600,000 (39%)	
Scrub	1,500,000 (6%)	210,000 (14%)	
Shrubland	600,000 (2%)	?	
Tussock grassland	2,300,000 (9%)	?	
Pastoral grassland	10,700,000 (40%)	400,000 (27%)	
Exotic forest	2,000,000 (7%)	200,000 (14%)	
Cropping/Horticulture	500,000 (2%)	12,000 (<1%)	
Other	2,600,000 (10%)	65,000 (4%)	
Total	**27,000,000**	**1,500,000**	

At face value, the table above indicates a significant proportion of maori land in indigenous forest – interesting in the context that most of the indigenous forest is in the South Island, whereas most of the maori land is in the North Island. It would be useful to follow up with a regional breakdown (eg, does this include Te Urewera?) to help illuminate any patterns and implications arising. In particular, a closer analysis should indicate the extent to which intensification opportunities may conflict with land currently in old-growth native forest, or (perhaps more often) in secondary scrub/shrubland.

In summary, the reports above seem to indicate:

- Maori land is around 10% of land in farming
- Maori enterprises account for perhaps 10% of farm production
- It is not currently clear the extent to which proportions of maori land in different LUC classes or landcover classes differ to land held in other private title
- It is not currently clear the extent to which "intensification" opportunities on Maori land or land in other private tenure might imply clearance of indigenous vegetation
- Pending more complete data being available, information to date perhaps suggests intensification opportunities on maori land might relate in particular to LUC Class VI land in the upper North Island, perhaps comprising mostly scrub/shrubland.

Placeholder pending extending the analyses for land in other private tenure; and further assessment of the relationship between intensification opportunities and implications for indigenous vegetation.

[19] BCG meeting materials November 2017, Attachment 6

Contemporary State & Trends – Forest Communities

NZs forest trees comprise 200+ species, of which 98% are endemic (unique to NZ). Acknowledging the earlier history of fire and clearance, today both main islands still have large tracts of forest[20]:

- The largest extents of old-growth forests are in the South Island, eg, the near continuous forest from Kahurangi to Fiordland
- In the North Island, most forests are fragmented; little old-growth forest remains, and secondary forests are widespread[21].

In 2015, MfE published Environment Aotearoa (EA2015), assessing the current health of NZ forest trees. Based on nearly 900 survey plots on both public and private land - each plot was surveyed between 2002-2007 and resurveyed between 2009-2014 - EA2015 reported general stability:

- "*At a national scale, the rates of recruitment and mortality of most of NZs common forest trees are in balance, suggesting that their populations are stable*."

This finding is supported by further analysis undertaken by Landcare Research:

- "*Even with the invasion of exotic species and the dramatic historical deforestation, there are no native trees or shrubs known to have suffered extinction*"[22]
- "*As introduced herbivorous mammals spread through NZ during the early-mid 20th century, there was often rapid growth in their numbers and they depleted forests of the species they prefer to eat, so forests now bear that initial impact…yet an objective, systematic assessment of NZ forests showed not only that there is very little if any evidence that populations of common tree species are failing to regenerate, but also little change in the populations of these trees"* [23].

EA2015 then used LCDB satellite data (Land Cover Database) to estimate current proportions of land in indigenous or exotic systems. In brief, indigenous vis-à-vis exotic vegetation is now broadly 50/50; and indigenous forest vis-à-vis indigenous non-forest is also broadly 50/50:

Indigenous Vegetation @ 2012	**Hectares**	**% of NZ land area** (27m hectares)
Indigenous forest	6.4 million	24%
Scrub	1.5 million	6%
Broadleaf hardwoods[24] (regenerating shrubland)	0.6 million	2%
Tussock grassland	2.3 million	9%
Alpine/other	1.0 million	4%
Total Indigenous Vegetation	**12 million**	**44%**

[20] Dymond et al, 2017, Estimating change in areas of indigenous vegetation cover in NZ
[21] Bellingham et al, 2014, DOC biodiversity indicators – 2014 assessment
[22] Allen et al, 2013, NZs indigenous forests and shrublands, *in* Ecosystem Services in NZ
[23] Bellingham et al, 2014, Department of Conservation biodiversity indicators – 2014 assessment
[24] Broadleaf hardwood species include successional species - wineberry, tutu, mahoe, tree ferns

The expansion in non-forest communities is supported by further work from LandcareResearch[25]:

- "*Over the last 50 years, the area dominated by native woody species has increased in some areas as land that was formerly used for agriculture, or was otherwise de-forested, is now following a successional process through shrublands"*
- "*Where shrublands reverting to forest occur in production land settings, the shrublands are usually a blend of indigenous and exotic species – creating "novel-ecosystems".*

It is relevant to note here that the "scrub" class above includes both indigenous and exotic scrub; and as noted earlier, succession to native forest cannot necessarily be assumed in these systems.

Regional analysis shows strong patterns, reflecting the prehuman/human context outlined earlier, in particular the conversion of dryland forest to scrub/shrub/tussock communities (EA2015 data):

Indigenous Vegetation	**Total (ha)**	**Key regions (ha)**	**Key regions (%)**
Indigenous forest	6.4m	West Coast 1.4m Southland 1.2m	40%
Scrub/shrubland	2.1m	Canterbury 0.3m Man-Wang 0.2m Hawkes Bay < 0.2m Waikato < 0.2m	40%
Tussock	2.3m	Otago 0.8m Canterbury 0.7m Southland 0.4m	80%

EA2015 also used LCDB data to estimate change in indigenous cover in the period 1996-2012. The following table indicates the net reduction in indigenous cover was around 100,000ha from a total around 11 million ha, ie, less than 1%, again with strong regional patterns:

Indigenous Vegetation	**Hectares reduced (%)**	**Key regions Ha reduced**	**Key regions % of net loss**	**Key regions Ha gained**
Indigenous Forest	10,000ha (0.2%)	West Coast 4,000ha Southland 1,500ha	55%	
Scrub	49,000ha (3%)	Southland 10,000ha West Coast 7,000ha	35%	Gisborne 4,000ha
Shrubland	7,000ha (1%)	Marlborough 2,000ha Taranaki 2,000ha	60%	
Tussock	30,000ha (1%)	Otago 20,000ha Southland 8,000ha Canterbury 1,500ha	98%	
Total	**96,000ha (0.8%)**			

[25] Allen et al, 2013, NZs indigenous forests and shrublands, *in* Ecosystem Services in NZ

LCDB relies on satellite imagery and there has been some contention about the conclusions, eg:

- 29% of samples mapped as shrubland by LCDB were observed - using 1200 groundtruth samples - to be indigenous forest[26]
- LCDB2 estimated total extent of matagouri shrublands to be <30,000ha, yet LUCAS estimates the extent to be >200,000ha[27].

LandcareResearch acknowledge the uncertainties:

- *"LCDB1 and LCDB2 data represent the first nationally comprehensive vegetation monitoring undertaken in NZ. However, they provide only a coarse assessment of changes in indigenous habitats and ecosystems, due to the broad qualitative nature of LCDB cover classes, the reliance on manual distinction of spectral signatures, and resolution issues associated with the 1ha mapping unit used"*[28]
- "*We caution against interpreting changes in indigenous cover between LCDB versions as a direct indication of changes that have occurred on the ground…rather (it) should be regarded as a high-level, broad-scale overview.*"[29]

In 2016, LandcareResearch undertook an exercise to estimate the uncertainties[30]:

- "*Even though the overall mapping accuracy is known, it is not known how well the LCDB can report the area of individual classes, nor how well it can report the change in area of a class"*
- *"We have quantified this uncertainty by comprehensive truth sampling of >30,000 samples"*
- *"As a percentage, the uncertainty in change is much higher than the uncertainty of area. Our reported uncertainties (of change) may be acceptable for tall tussock grassland (7%) and indigenous forest (15%), but not for the other classes – manuka/kanuka (22%), broadleaf shrubs (40%). This uncertainty should be taken into account…and may have a significant impact on reporting change for some ecosystems".*

A recent Landcare Research report put it bluntly[31]: "*There are major research issues to be resolved to determine the circumstances where comparing different versions of the LCDB is fit for purpose as a tool to estimate biodiversity loss".*

To follow on with a further blunt comment: EA2015 omitted to include these caveats in reporting LCDB estimates of landcover change and biodiversity loss.

Acknowledging the uncertainties – which in future should be explicitly tabled alongside any estimates - nevertheless the LCDB data confirms landcover change today is a fraction relative to earlier times. The data again shows marked regional patterns: some regions account for most of the estimated reductions, a number of regions are relatively stable, and Gisborne has one notable increase ("scrub" increased by 4,000 hectares).

[26] Dymond et al, 2016, Estimating change in areas of indigenous vegetation cover in NZ from the NZ LCDB
[27] Allen et al, 2013, NZs indigenous forests and shrublands, *in* Ecosystem Services in NZ
[28] Walker et al, 2006, Recent loss of indigenous cover in NZ
[29] Cieraad et al, 2015, An updated assessment of indigenous cover remaining and legal protection
[30] Dymond et al, 2016, Estimating change in areas of indigenous vegetation cover in NZ from the NZ LCDB
[31] LCR, 2016, Standardised terrestrial biodiversity indicators for use by regional councils, Indicator M8, 7.2.1

Patterns in the data have been evident through each LCDB review cycle (1996-2002-2008-2012), but to date, only brief analysis has been applied, eg, in 2006[32]:

- "*Nearly 40% of all forest loss that occurred in NZ from 1997-2002 occurred in Northland…although the Northland deforestation rates are still the highest in the country, it is notable that they have been greatly reduced over the past 20 years"*
- *"Deforestation rates in Southland are also relatively high, reflecting the impact of logging activities on land owned by indigenous groups. Southland is home to almost half of the forest granted to named maori people under the South Island Landless Natives Act 1906, and these remain today as the only privately owned forests in NZ that are not required to have Sustainable Forest Management Plans under the 1993 Forests Act".*

In 2008, district level analysis was applied to LCDB data, with recommendations for further work[33]: *"We recommend the investigation and comparison of the social, economic and regulatory drivers of indigenous vegetation loss in councils where most loss, (eg, Far North, Central Otago and Marlborough districts) and least loss, has occurred".*

FFNZ is not aware that this recommendation has been followed through to date but this analysis should now be a high priority, integrating and groundtruthing data from a range of sources to understand the regional patterns. For example, the 2017 Southland Economic Project[34] provides useful background to the "loss" of indigenous forest in Southland:

- *"Forestry in Southland is divided into two main industries: plantation forestry (80,000 hectares) and indigenous forestry, harvested from sustainably managed native forests"*
- *"There is an estimated 54,000 hectares of indigenous forest on private land, including SILNA land, largely beech (of which) there is 12,000 hectares of indigenous forestry"*
- *"The majority of this is not harvested. Instead, a Sustainable Forest Management Plan allows for harvest of native timber, while retaining the forest's natural values"*
- *"The largest consent holder of sustainable forest management permits for harvesting is Lindsay & Dixon Ltd, based in Tuatapere. The company dates back to 1931 and is NZs largest processor and marketer of indigenous timbers (producing) high-value sawn timber for flooring, furniture, panelling and veneers".*

It may or may not be useful to extend the analysis to other regions with smaller estimates of reductions. For example, in Auckland a recent report referenced a personal communication suggesting differences between LCDB satellite data and data on vegetation change sourced from regional aerial imagery[35]: notably, the difference in both cases was in the decimal points - one to the second decimal point (0.2%), the other to the third decimal point (0.03%) – perhaps begging the question whether this level of difference warrants closer investigation as to the extent it is ecologically meaningful.

Alongside analysis of the context and drivers behind reductions in key regions or districts, it would be instructive to assess the drivers behind the increase in scrub in Gisborne.

[32] Ewers et al, 2006, Past and future trajectories of forest loss in NZ
[33] Walker et al, 2008, NZs remaining indigenous cover: recent changes
[34] Environment Southland et al, 2017, The Southland Economic Project – agriculture and forestry
[35] LCR, 2016, Standardised terrestrial biodiversity indicators for use by regional councils, para 7.2.1

The temporal scale of analysis may be as important as the spatial scale. For example, in Banks Peninsula:

- *"By the early 1920s, less than 1% of Banks Peninsula's original indigenous forest remained, but by 2008, indigenous cover has increased to nearly 10%"*[36]
- A more recent estimate (2016) is that, through regeneration, indigenous cover is now between 15 and 18 percent[37].

Placeholder pending analysis of context and drivers behind changes in key regions:

- *Indigenous forest: West Coast/Southland, including analysis vis-à-vis MPI Logging Permits*
- *Scrub: gains in Gisborne, losses in West Coast/Southland*
- *Shrubland: losses in Marlborough/Taranaki, gains in Banks Peninsula*
- *Tussock: Otago - including consideration vis-a-vis the Tenure Review process*

Landcover Change

A key question arising from the statistics showing reduction of indigenous cover (-0.8%) is what the new landcover is: this should be addressed in the regional analysis recommended above.

At the national level, EA2015 reported that exotic grassland declined by 175,000 hectares (-1.6%). By contrast, urban land increased by 20,000 hectares (+10%); and in particular, exotic forest increased by over 200,000 hectares (+11%).

This last is relevant to understanding the balance between indigenous and exotic cover, including the extent to which exotic forests (increase 200,000ha) were planted (or self-seeded) into areas of scrub/shrub/tussock grassland (reduction 86,000ha).

This is also relevant to understanding the balance between biodiversity stocks and carbon stocks: EA2015 (Figure 36) shows steady state carbon sequestration for indigenous forests, but a steady increase from exotic forests, and interestingly (notwithstanding LCDB estimates of reductions in scrub/shrub area), a small but steady increase in carbon from regenerating indigenous forest.

Indigenous forest categories are slightly different for the purpose of reporting Kyoto carbon stocks (tall scrub/shrubland is included with forests), but the broad area estimates are in the ballpark with LCDB estimates. In the period 2008-2012, national deforestation was estimated at 36,000ha[38]:

- "*The majority seems to have occurred on land in exotic forest, with a small percentage occurring in natural forest*"
- *"The highest occurrence of non-anthropogenic change was detected on the West Coast (800ha) …this can be attributed to wind damage and occurrence of large slips in the surrounding mountain range*".

[36] Allen et al, 2013, NZs indigenous forests and shrublands, *in* Ecosystem Services in NZ
[37] Independent Hearing Panel, Christchurch Replacement District Plan, Decision 50, October 2016
[38] MfE, 2013, "Land use, land use change and forestry sector – greenhouse gas emission projections

Further details of the "small percentage" of deforestation in natural forests was not available at the time of publication (2013), but would now usefully be made available to support analysis of the context and drivers behind estimates of reductions in indigenous forest. For example, the analysis of anthropogenic vis-à-vis non-anthropogenic causes would usefully be applied to the EA2015 data, eg, if the 800ha of slips on the West Coast were in native forest, this could represent 20% of the reduction in West Coast forest estimated by EA2015.

As with LCDB, international guidance directs that uncertainty estimates are an essential component of carbon inventories – not to dispute the validity of the estimates, but to help prioritise efforts to improve the accuracy of inventories. In the NZ case, uncertainties arise from cloud cover, or difficulties in discriminating young forest, but "*progressively the reliance on desk-top analysis of satellite imagery to confirm destocking has been reduced in favour of an aerial-based process*"[39].

In 2016, the Parliamentary Commissioner for the Environment published a report on farming and carbon[40], concluding that: "*This investigation has made me a greater advocate of planting trees, although we cannot rely on trees alone. Establishing forests does not rely on technological breakthroughs. Photosynthesis is simplicity itself compared to the arcane mysteries of the rumen and the complexities of what happens after the urine hits the soil*".

The PCE compared the carbon accumulation rates of native trees (300 tons carbon/ha after 50 years) vis-à-vis pines (600 tons carbon/ha after 20 years), while noting that the natives would keep going, but the pines would have to be replanted. The PCE suggested perhaps a million hectares of marginal agricultural land has the potential to revert to scrub or gorse, and eventually to native forest.

This last figure relies on work undertaken by Landcare Research in 2008[41] suggesting that up to 1.5 million hectares of "marginal grasslands" - with native seed sources in striking distance - could potentially be available for "indigenous reversion":

- 85% would be private land; around 4% maori land and 11% DOC/public/covenant land
- Most of the change would be on sheep & beef farms, in particular East Cape and Tararua.

This report was presented with the caveat that the results should be treated with caution for various reasons; but notably, both the PCE and the Landcare Research report seemed to assume a reasonably steady trajectory to native bush (albeit it might take a while). This assumption may need testing in light of other work referred to earlier, questioning which way successional pathways might go in NZs modern state (and from there, any implications arising, be it for carbon or biodiversity).

Neither report considered wider socio-economic implications for rural New Zealand.

Placeholder pending:

- *Cross-check LCDB/Carbon Inventory estimates to assist understanding of context and drivers*
- *Assess carbon sequestration implications of more indigenous cover, less exotic forestry*
- *Assess succession pathway possibilities/probabilities under passive "reversion".*

[39] Indufor, prepared for MfE, 2013, Deforestation mapping 2012 – final report
[40] PCE, 2016, Climate change and agriculture
[41] Shepherd et al, 2008, Nature and scale of eligible post-1989 non-planted forests

Contemporary Pressures

The discussion of landcover change relates principally to pattern, ie, how many bits are left. This next section considers process, ie, key factors impacting on forest health in the bits that are left.

As noted earlier, EA2015 reported that populations of widespread forest trees are generally stable. Having said that, most lowland forest is fragmented, particularly in the north and rain-shadow east.

A key question arising is how best to support the health of remnant forest stands in the context of contemporary pressures - either by controlling/excluding introduced species, or by replanting/re-introducing indigenous species.

To date, the results tend to highlight the complexities in restoration agendas. For example, Smale et al[42] assessed the longterm impacts of grazing on hill country forest remnants at Whatawhata (Waikato). The findings included that:

- Topography and aspect exert a major influence on the survival of forest remnants – many are found in gullies and south facing slopes, ie, damper sites
- An indirect effect of grazing is reduced humidity, alongside direct effects of reducing palatable shrubs and ground layer species
- Major shifts in the composition of grazed forest remnants are evident – "decreasers" include tawa, rewarewa; "increasers" include mahoe, kahikatea; "newcomers" include kanuka (plus shining privet)
- The authors concluded fencing is the single most important measure to improve the longerterm viability of these forest fragments.

In this next example, Burns et al[43] reported on the effectiveness of both stock exclusion and possum control in 40 old-growth forest remnants in Waikato, in particular the ability for canopy species to recover from grazing pressure:

- The effect of fencing was mainly seen in the under-storey, with a high density pulse of seedlings and saplings that thinned after ten years (and suppression of weedy species)
- The effect of possum control was an increase in species which are palatable to possums (eg, muehlenbeckia); but interestingly, the effect of no possum control was higher indigenous species richness (including other native climbers - clematis, kohia/native passionfruit), possibly because of higher light transmission through possum-damaged canopies
- The authors proposed that both tools – fencing and possum control – increase the ecological integrity of forest fragments by reducing adventive species and re-initiating regeneration of some native species
- However, neither treatment resulted in re-establishment of canopy trees (tawa, podocarps) – the authors suggested that forest fragments have already diverged substantially from their predecessor forests and regeneration processes are favouring different species
- Additional measures such as active re-planting may be necessary, not only to ensure replacement of current canopy species but also to restore lost species.

[42] Smale et al, 2008, Longterm impacts of grazing on indigenous forest remnants on North Island hill country
[43] Burns et al, 2010, Effects of forest fragment management on vegetation condition and maintenance of canopy composition in a NZ pastoral landscape

Work by Innes et al[44] took a slightly different tack: again the effectiveness of stock exclusion fencing was tested, but this time looking at what effect this had on rat numbers. The authors report that the results confirm a dilemna for conservation in forest fragments:

- Fencing will in time significantly increase the density of seedlings of understorey and sub-canopy trees, increasing litter biomass and invertebrate abundance but also increases the number of ship rats, which destroy seeds, invertebrates and nesting birds
- The rat density observed in fenced forest fragments was the highest yet measured on the NZ mainland (6.5 rats per hectare)
- The authors concluded that maximising biodiversity values therefore requires both fencing and rat control – while recognising that removing rats is easy but re-invasion is inevitable, necessitating repeated control, and/or increasing the scale of rat control to include adjacent source areas, and/or making the fencing rat-proof.

In another twist, Ruffell et al[45] sought to understand the relative impact of forest loss versus invasive mammals to help inform how conservation resources can be spent most effectively. This work measured the effects of different levels of forest cover, and different levels of pest control (eradication, high-intensity, low-intensity) on the abundance of native birds. The key finding was that both factors can affect the abundance and richness of bird species, but the effects are strongly context-dependent and species-dependent. In essence:

- The benefits of pest control may be limited unless intensive methods are used
- Pest control makes a difference for some bird species, eg, kereru, tui; makes little difference for other reasonably abundant bird species, eg, fantail; and (predictably) no difference for birds already lost from the local landscape, eg, kokako
- This means that even intensive pest control may only benefit a small subset of species, unless coupled with the re-introduction of locally-extinct species
- For forest cover, the abundance and richness of birds was apparently relatively steady across different levels of cover, but declined rapidly where forest cover dropped below 5-10%
- The authors suggest managing forest cover may be relatively unimportant in landscapes with greater than 5-10% forest cover.

The first implication of this work is that restoration programmes would sensibly be prioritised first to areas with existing forest cover >10%. Alternatively, targets could be set to re-establish forest cover up to the >5-10% benchmark, eg, potentially extending out of the gullies and south faces onto higher or drier ground. Acknowledging that multiple landowners and community groups around the country have restoration projects like this underway, the logistics and costs can be very challenging, not least in the context of trying to re-establish frost-sensitive, drought-sensitive tree species in exposed, high-light environments.

Future work (or other more recent work FFNZ is not aware of) could yield further insights to support effective and cost-effective management and restoration of forest remnants.

[44] Innes et al, 2010, Effect of grazing on ship rat density in forest fragments of lowland Waikato
[45] Ruffell and Didham, 2017, Conserving biodiversity in NZs lowland landscapes: does forest cover or pest control have greater effect on native birds

At this time, on the strength of the work above, it appears that the multiplicity of contemporary pressures demands a multi-faceted and prioritised response:

- Effective restoration of forest remnants as multi-layered, fully functioning indigenous habitats may require fencing and possum control and rat control and replanting of locally extinct plant species and reintroduction of locally extinct bird species (with both possum and rat control undertaken at a wider scale than the site, at a higher intensity, probably involving other predator guilds, and sustained through time)
- Cost-effective restoration to this level probably requires disciplined prioritisation and active coordination - stepping up from individual sites to coordinated landscape-scale management in prioritised locations to deliver best bang for conservation buck (eg, starting in areas with >10% forest cover and with extant populations of less common birds).

Forest Classification Systems

While EA2015 and the Kyoto Inventory report indigenous cover in broad categories, more fine-scale descriptors of indigenous forest communities are available.

It is important to note that vegetation classes (be they broad or fine-scale) have not been mapped, eg, DOCs Ecosystem Optimisation Project sought to enable the prioritisation of ecosystem management units, but a "*limitation has been the lack of comprehensive maps of NZs terrestrial ecosystem pattern…despite the value of doing so being identified more than 30 years ago*".[46]

Instead, various classification systems have tended to rely on theoretical or modelled constructs for disaggregating indigenous communities into component parts. The simplest division is into beech or podocarp forest; others distinguish beech, podocarp/broadleaf, kauri/broadleaf, coastal/broadleaf or variations on similar themes. The following table reports current area based on one system[47]:

Forest & Shrubland Alliances	**Hectares**
Forest	
Beech (6 sub-categories)	1 million
Beech-broadleaf (3 sub-categories)	1.3 million
Beech-broadleaf-podocarp (4 sub-categories)	1 million
Podocarp-broadleaf	1.8 million
Shrubland	
Kanuka forest/shrubland (3 sub-categories)	0.4 million
Matagouri shrubland	0.2 million
Manuka, turpentine, gorse, grey scrub	0.1 million
Total	**5.8 million**

[46] DOC, 2016, Mapping the services and benefits of indigenous biodiversity in NZ
[47] Allen et al, 2013, NZs indigenous forests and shrublands, *in* Ecosystem Services in NZ, Table 2

At face value, the total is less than LCDB (8.5 million ha), but of note is the dominance of beech communities. The authors go on to note that beech species (valued by niche markets) dominate the allowable harvest of indigenous timber (88%), a point graphically depicted in Figure 3 of their report and relevant to understanding EA2015 data on reductions in the indigenous forest class.

Classification systems are central to how biodiversity state and trends are reported, and central to identifying and ranking priorities for conservation. In a recent publication, DOC reviewed NZ classification systems, finding in essence that there are no hard lines in mother nature[48]:

- *"In NZ, ecosystem taxonomy is in its infancy… (but)…classifying ecosystems is a priority in NZ and globally as the science and application of spatial conservation prioritisation and ecosystem threat ranking gathers pace"*
- *"The classification of an ecosystem is essentially a conceptual exercise… ecosystem boundaries are open and dynamic …ecosystem units are an arbitrary construct at any particular scale"*
- *"The continuous variation in ecosystem composition, structure and processes, and our limited understanding of that complexity makes it extremely difficult to describe their distinguishing properties and map their distributional limits – which may explain the scarcity of comprehensive classifications that are suitable for providing lists for threat evaluation".*

The report canvassed the plethora of classification attempts to date, finding all had limitations:

- *"Several plant community and ecosystem classifications have been produced in the past…PNAP, Forest Class maps, Vegetative Cover map, LCDB, Leathwick/NVS, Hall & McGlone/LINKNZ, Meurk/bioclimatic, Wiser/alliances, LENZ…all parts of NZs biological environment have been covered by one or other of the above classifications"*
- *"However, these have been applied at variable spatial scales and have incorporated selective vegetation attributes, and none of these classifications meet all of the criteria described earlier – ie, providing national-scale mappable coverage of a full range of terrestrial ecosystems, with alignment to an abiotic framework of environmental drivers and associated processes, and scale-versatility"*
- *"The PNAP was the strongest scheme in terms of integrating at least physical variables and biotic composition…linking landforms, soil and vegetation within an ecological district geographic setting".*
- *"LENZ provides the most comprehensive treatment of abiotic environment…however, there is a conspicuous absence of a classification that attempts to biotically "truth" numerical classifications of physical environments".*

Following through re LENZ: as noted above, LENZ (Land Environments of NZ) is not a vegetation classification system per se but rather an "abiotic" system which divides NZ into zones based on climate, soil and landform. In 2006, Landcare Research combined LENZ with two other spatial datasets to develop a new environmental reporting tool[49].

[48] DOC, 2014, A classification of NZs terrestrial ecosystems
[49] Walker et al, 2006, Recent loss of indigenous cover in NZ

In this system, each abiotic zone is used to estimate pre-human indigenous vegetation, assuming that each zone supported a unique assemblage, and using estimates for each zone as a "*surrogate for the potential full range*" of terrestrial biodiversity found in the past.[50]

Two further steps then involve overlaying LCDB indigenous vegetation data, ie, current cover; and estimating how much is legally protected. The legal protection measure is a "*surrogate for the relative vulnerability of indigenous biota to pressures such as land clearance*"[51]:while noting it is not complete[52]: "*The dataset included some areas that were legally protected by organisations other than DOC, councils and QEII, eg, Hinewai Reserve… we did not include these privately owned areas".*

A more important caveat is that this LENZ methodology focusses on pattern rather than process[53]: "*A far greater challenge lies in developing measurements of, and systems for, reporting changes in the key processes that sustain indigenous species, their assemblages and ecosystem function. This is particularly important in NZ due to the high vulnerability of the biota to invasive species*."

Acknowledging this caveat, the following table presents indicative results broadly grouped by high country, hill country and lowlands; with a further caveat that the data source is now dated[54]:

LENZ (Level 1)	**Indig. Vegetation Hectares @ 2006**	**% of Former Extent Indig. & Protected**
Southern Alps	2,000,000	95%
Western SI foothills, Stewart Is	1,300,000	81%
Central mountains	3,000,000	77%
Western SI recent soils	120,000	45%
Northern hill country	900,000	22%
Southeastern hills/mountains	1,800,000	21%
Central sandy recent soils	50,000	21%
Central dry foothills	600,000	21%
Central hills, volcanic plateau	2,000,000	20%
Central upland recent soils	60,000	16%
Southern lowlands	100,000	7%
Northern recent soils	60,000	5%
Northern lowlands	340,000	5%
Central poorly-drained soils	6,000	2%
Central dry lowlands	70,000	1%
Central well-drained recent	20,000	1%
Western/southern NI lowlands	30,000	1%
Eastern SI plains	160,000	<1%

[50] DOC, 2008, NZs remaining indigenous cover
[51] Cieraad et al, 2015, An updated assessment of indigenous cover remaining and legal protection
[52] Cieraad et al, 2015, An updated assessment of indigenous cover remaining and legal protection
[53] Walker et al, 2006, Recent loss of indigenous cover in NZ
[54] 2006 estimates sourced from Environment NZ, 2007, Table 12-5

The results are reasonably predictable – more vegetation and legal protection in the uplands, less in the lowlands. A limitation of the table above is that it conflates indigenous cover and legal protection into one value; and seems to report the latter by reference to assumed former extent.

The next table dis-aggregates current indigenous vegetation, before assessing the level of legal protection relative to current extent. Two caveats:

- Again the data is dated: current extent is LCDB1 data, ie, based on satellite imagery taken 20 years ago; and legal protection is based on data available over ten years ago[55]
- The LENZ areas used in the earlier table are repeated below, but there are obvious errors (eg, ultramafic soils) so all values should be treated as indicative only.

Acknowledging these caveats, nevertheless the broad pattern is similar to the earlier table, with less indigenous vegetation and legal protection in the lowlands. Zones with less than 10% indigenous cover, or less than 10% legal protection are highlighted in red:

LENZ (Level 1)	**LENZ Area Hectares**	**Indigenous Veg. Current Ha (%)**	**Indigenous Veg. % legally protected**
Southern Alps	2,000,000	2,000,000 (100%)	94%
Ultramafic soils (Nelson, W/land)	30,000	33,000 (110%)	95%
Western SI foothills, Stewart Is	1,400,000	1,300,000 (92%)	89%
Central mountains	3,300,000	3,100,000 (95%)	71%
Permanent snow & ice	370,000	320,000 (86%)	61%
Central dry foothills	1,300,000	1,000,000 (76%)	21%
Central upland recent soils	160,000	120,000 (72%)	22%
Southeastern hills/mountains	3,300,000	2,100,000 (63%)	27%
Central sandy recent soils	130,000	50,000 (63%)	63%
Northern hill country	2,100,000	940,000 (44%)	46%
Central hills, volcanic plateau	5,200,000	2,000,000 (37%)	50%
Northern lowlands	1,800,000	350,000 (19%)	24%
Northern recent soils	340,000	65,000 (19%)	33%
Central dry lowlands	700,000	120,000 (18%)	5%
Eastern SI plains	2,000,000	340,000 (17%)	3%
Southern lowlands	800,000	120,000 (15%)	49%
Central well-drained recent	300,000	35,000 (12%)	9%
Western/southern NI lowlands	650,000	30,000 (5%)	17%
Central poorly-drained soils	120,000	5,000 (4%)	31%

Two zones have less than 10% of their area in indigenous vegetation. Arguably, these zones might be priorities for active revegetation (albeit with caveats as noted earlier re practical challenges). The following table shows one of these zones expanded to LENZ Level Two, indicating that these are mainly low-lying swampy areas, which have been drained and modified, but which still contain remnant or secondary indigenous vegetation. The last column indicates the additional area which may need to be replanted to swamp to achieve a target of 10% indigenous cover:

[55] MfE, 2004, A snapshot of council effort to address indigenous biodiversity on private land, Appdx 1, Table iii

Central poorly-drained soils (LENZ Level 2) Coastal plains/river valleys Gisborne to Canterbury	**LENZ Hectares**	**Indig. Veg. Hectares (%)**	**% of indig. protected**	**Extra ha for 10% cover**
I1 *no descriptor*	1,600	740 (45%)	16%	
I2 drained inland swamps, similar to C1	48,000	1,700 (3%)	25%	3,000
I3 drained swamps - Ch/ch, Rangiora, Wairau	27,500	1,800 (7%)	46%	900
I4 Kaikoura coast, remnant ngaio, ti kouka	400	40 (9%)	0%	4
I5 Swamp – sedge/harakeke	40,000	800 (2%)	15%	3,000
I6 Napier saltmarsh/lagoon, uplifted 1931	4,000	230 (6%)	59%	200
Total	120,000	5,000 (4%)	31%	**7,000**

In short, 7,000 hectares may need to be converted to swamp vegetation to achieve a 10% target. With this data - preferably supported by closer regional/ spatial mapping - a cost-benefit analysis could then be undertaken, eg:

Conversion to Swamp	**Costs**	**Benefits**
Convert xxha urban land (Gisborne, Napier, Blenheim, Rangiora, Christchurch)	Cost of land Opportunity costs Upfront revegetation cost Ongoing maintenance	Increased native vegetation Habitat for native wetland species Other water quality benefits Other aesthetic/recreation benefits
Convert xxha rural land (horticulture, grapes, arable, dairy, drystock finishing)	Cost of land Production/jobs lost Upfront revegetation cost Ongoing maintenance	Increased native vegetation Habitat for native wetland species Other water quality benefits Other aesthetic/recreation benefits

The earlier table above also indicated three LENZ zones have less than 10% legal protection. Arguably, these might be potential priorities for increased formal protection. The following table shows the LENZ Level Two breakdown for one class (albeit the descriptors in the source document are less than descriptive):

Central dry lowlands (LENZ Level 4) Dry hill country, low elevation Central North Island	**LENZ Hectares**	**Indig. Veg. Hectares (%)**	**% of indig. protected**	**Extra ha for 10% protn**
B1 Podocarp forest & tawa/titoki/nikau	180,000	14,000 (8%)	5%	16,000
B2 as for B1	70,000	4,400 (6%)	25%	
B3 no descriptor	190,000	58,000 (31%)	3%	4,000
B4 carex swamp/kahikatea, inland beech	2,500	350 (13%)	13%	
B5 Podocarps, to bracken/tutu/tussock, to manuka/kanuka/tauhini/matagouri	50,000	850 (2%)	6%	35
B6 as for B5	30,000	700 (2%)	0.5%	70
B7 as for B5	50,000	2,500 (5%)	1.5%	200
B8 as for B5	85,000	38,000 (44%)	5%	1,800
B9 as for B5	20,000	1,500 (8%)	6%	50
Total	700,000	120,000 (18%)	5%	**22,000**

In short, 22,000 hectares (mainly dryland podocarp/tawa forest) might be a priority for legal protection. With this data, a cost-benefit analysis could then be undertaken to assess the merits of either public purchase (eg, through the Reserves Act, Nature Heritage Fund) or covenanting (eg, through QEII). A related question would be the extent to which these areas require active management as well as, or in preference to, legal reservation.

For clarity: the tables above are indicative only. *Placeholder pending more up-to-date and reliable data being available, perhaps utilising a range of classification systems to help illuminate patterns and priorities*. In the interim, these tables are intended principally to illustrate the value of more fine-grained information to support cost-benefit analysis of a range of options before landing recommendations for priorities, targets or methods.

Returning to classification systems more generally: the authors of the DOC paper referred to above (Singers & Rogers) discussed the limitations of LENZ and other classification systems and proposed a new variant, in two broad parts:

- "Zonal" ecosystems, where vegetation communities are influenced by the underlying zone, mainly temperature and moisture (similar to LENZ)
- "Azonal" ecosystems, where extreme factors (eg, heat, frost, salinity, chemistry, volcanics) over-ride the general zone characteristics (similar to "naturally uncommon" ecosystems).

Singers and Rogers acknowledge the challenges in trying to reconstruct the past from the present[56]:

- *"In the last 750 years, the clearance of forest has been so comprehensive across parts of semi-arid and sub-humid zones of NZ, that it has been necessary to draw upon historical accounts, modelling, and descriptions of seral remnants to supplement insights from the sparse distribution of relict stands when classifying their forest ecosystems"*
- "*In some areas, seral vegetation resulting from fire or land clearance masks the previous community boundaries…and can inhibit recognition of the limits of active vs stable dunes, the margins of wetlands, frost-flats and saline patches, and long-stabilised river braids"*
- *"The most challenging environment to classify was rain-shadow NZ, where modification and loss of vegetation greatly compromises understanding of ecosystem patterns and processes*
- *"It must be accepted that in today's pyrophylic dryland environments that contain a pernicious and persistent exotic flora, the testing of model predictions of fire-lost states may be a distant proposition".*

In plain language: we could spend a lot of time attempting to model/classify what we think NZ used to look like without being able to confirm or disconfirm the results.

The authors grapple with "lumping" or "splitting" (fine-scale or broad-scale); and grapple with the difficulty of drawing hard lines, favouring terms such as "*transitional, discrete and mosaic to highlight imprecision in scale and boundaries".*

[56] DOC, 2014, A classification of NZs terrestrial ecosystems

A more recent publication from Landcare Research[57] similarly notes the plethora of classification approaches taken by various councils and acknowledges the same challenges as the DOC report, including that: *"The choice of classification will have a very strong influence on results".*

The differences may in part relate to scale:

- *"One notable difference between LENZ (previously used) and PVNZ[58] (currently used) is the number of classes, with LENZ Level IV having 500 classes and PVNZ only 24"*
- *"It is not entirely clear that finer division is biologically meaningful"*
- *"It is of course possible to use more than one classification and provide comparisons of the results*".

This last suggestion merits further consideration. The critical point is what is the purpose of classification: as noted earlier, Singers and Rogers suggest it is principally to do with prioritisation. Accepting this point, priorities may be set for two reasons:

- to guide a representative network of legally protected sites – arguably the historic driver
- to inform priorities for active management – arguably the current driver.

In this context, arguing the merits of various classification systems – or attempting to select one "winner" - may be less important than accepting and using a range of classification systems as decision support tools, ie, tabling and comparing the results to assist in that prioritisation.

Another important consideration is how indigenous cover (against whatever classification system or scale) is "counted", recognising again that the NZ environment today is extensively modified[59]:

- *"Many of NZs non-forested landscapes have complex mixtures of native and non-native plant species, and there is poor understanding of the species that dominate successions"*
- "*In the current analyses, LCDB classes are considered either exotic or indigenous (but) in many of the classes considered indigenous, the vegetation is highly modified from the "natural" or "potential" vegetation…a more sophisticated approach is to consider landcover as a continuum of "indigenous-ness"*
- *"For example, in inland Otago, current analyses show c. 50% of vegetation is indigenous (because) current analyses consider highly modified tussock grasslands to be indigenous and "natural", even when the "potential" vegetation is woodland".*

These points are sufficiently important to merit closer consideration. To date, environmental reporting has tended to rely on assumptions of discrete boundaries between indigenous and introduced cover; and similarly, classification systems have attempted to draw "hard lines". More recently, some ecologists suggest that[60]:

- "*The reality of the modern world is that native biodiversity is increasingly being sustained within novel ecosystems comprised of mixes of native and naturalised biodiversity"*

[57] LCR, 2016, Standardised terrestrial biodiversity indicators for use by regional councils
[58] PVNZ means "potential" vegetation of NZ
[59] LCR, 2016, Standardised terrestrial biodiversity indicators for use by regional councils
[60] Craig et al, 2013, Enhancing our heritage: conservation for 21st century New Zealanders

- *"Processes and goals for conservation benefit from flexibility and reflecting the realities of current and likely future conditions, rather than largely by comparison with yesterday"*
- *"This approach does not mean NZ should abandon kiwi for stoats, but people should recognise that indigenous biota must now be sustained within a range of ecosystems including those that are now fundamentally different from those that occurred in the past*".

Closely related to consideration of classification systems (and the importance of mapping, not just modelling) is selection of baselines (for trend analysis) and/or selection of targets (for restoration to a past or future state): "*An important decision is whether to report on state only, or to also report on change…baseline measures provide the starting points (at some time or state) against which change can be assessed…most NZ schemes currently focus on measuring status and change relative to baselines derived from initial surveys*" [61].

FFNZ concur that most environmental reporting reports status and change from the time of initial survey, most often around 1990. Alternatively, baselines may be predicated on hypothetical or modelled states, for example:

- "Pre-human" extent: "*if humans had never arrived*"
- "Potential" extent: "*in the absence of any anthropogenic influences or large-scale natural disturbances*".

In a recent publication, Landcare Research appear to favour the second (ie, a potential, theoretical state) as the baseline for national biodiversity reporting[62]. Others however argue that[63]: "*In many New World cases like the US or NZ, the restoration model is often the time of first European contact. It seeks a freeze-frame moment, the moment when in theory, evolution reached a point of perfection in balance and harmony*…a*s nature is dynamic, to freeze evolution is an unachievable goal".*

Acknowledging the diversity of opinions, the key point arising is that these alternate views highlight that there are clearly:

- a range of options for selecting classification systems – if a primary purpose is to support prioritisation for active management, then it may be that classification systems are best used as decision support tools, utilising a range of systems to help illuminate priorities
- a range of options for selecting baselines, eg, pre-human, pre-European or perhaps most sensibly 1990 or thereabouts (consistent with other environmental reporting); and
- a range of options for selecting targets, eg, back to the past or forward to the future, with or without acknowledgement of introduced species and novel ecosystems.

Placeholder pending:

- *Assessment of options for the selection of baselines and targets, contemporary or historic, mapped or modelled*
- *Deployment of a range of classification systems to assist in identifying priority ecosystems for legal protection and/or active management*

[61] LCR, 2016, Standardised terrestrial biodiversity indicators for use by regional councils
[62] LCR, 2016, Standardised terrestrial biodiversity indicators for use by regional councils
[63] Valentina Dinica referencing a book by Benfield, *in* Protected Areas – how will they contribute to third millenenium challenges, Policy Quarterly, Vol 12, Issue 1, February 2016

Contemporary State & Trends – Non-Forest Communities

As noted above, indigenous landcover has oscillated through recent geological time between forest and non-forest communities. Today the balance is roughly 50/50, with a significant increase in non-forest communities since human settlement. Much of the change from forest to non-forest communities was fire-induced, and disproportionately impacted lowland/dryland forest, especially along the rain-shadow east coast of both islands.

Forest communities are still dominant in the steeper upland areas and wetter west coast (mostly in public tenure); whereas non-forest communities are now dominant in the lowlands and drylands (mostly in private tenure). Non-forest communities include tussock grasslands, sand dunes, wetlands, and a range of ecosystem types restricted to particular niches, eg, geothermal areas, cliffs or other extreme environments. Many (most?) of NZs threatened plants are associated with these non-forest systems, in particular the "uncommon" ecosystems.

Classification systems for non-forest communities are even more confusing than for forest types, including for the reason that some are included in the new typology of "uncommon ecosystems".

Similarly, the selection of "baselines" or consideration of "maintenance", or targets for "restoration" are more vexed for non-forest systems. For example, strict application of pre-human baselines – or adoption of these as targets - might presume a significant retraction in extent, at least for some; and almost inevitably implies an expectation of active management.

Most of these non-forest systems are modified, in part a legacy of central government or catchment board programmes through to around the 1970s to bring land into production and to protect communities from flooding, including through draining wetlands, stabilising sand-dunes and widespread planting of willows. In this context, the concept of "novel ecosystems" (comprising mixes of native and introduced species) is especially relevant for non-forest communities. The implications include a heightened risk of fire as described earlier; and the extent to which introduced plants may be identified as a key factor impacting condition and "ecological integrity". Some species, eg, gorse, wilding pines, may be implicated on both counts.

The ubiquitous NZ weeds are mostly found in the open, disturbed, high-light situations associated with non-forest communities. In a recent report[64], DOC identified 180 "weed" species, of which two-thirds originated as ornamental plants, predictably with "hotspots" mapped around NZ cities.

Eight species are widespread (across >25% of NZ): gorse, broom, blackberry, ragwort, California thistle, crack willow, pampas and wandering jew. DOC reported that "*weed eradication is often attempted in NZ, can be successful against aquatic weeds, but it is rarely completed when targetting terrestrial weeds".*

In 2012, a companion DOC report[65] attempted to assess the effectiveness of weed control for biodiversity (eg, spraying willow at Kopuatai Peat Dome), but the results were ambivalent:

[64] DOC, 2016, The creation of a NZ weed atlas
[65] DOC, 2012, Does environmental weed control achieve conservation gain

- *"Several recent meta-analyses have confirmed that invasive plants can have negative impacts on native plant populations. However, in general, these studies demonstrated correlation, but not causality"*
- *"We were unable to identify universal factors that determine whether weed control programmes achieve conservation gain"*
- *"The lion's share of weed management money tends to be used for killing the weed, with little left for expensive post-control monitoring of biodiversity".*

More recently, the NZ Biodiversity Action Plan (2016-2020) emphasises that "*hundreds of invasive weeds are smothering NZs native forests, wetlands and coastal areas, harming natural species, and transforming natural landscapes":*

- *"Wilding conifers are considered "enemy number one" in the war on weeds, alongside a "dirty dozen" of 12 other widespread weeds. Wilding conifers currently cover more than 1.8 million hectares of land, and are spreading at an estimated rate of 5% each year".*

Currently, national data on contemporary state and trends for non-forest ecosystems is very limited, but is a necessary precursor to analysis of context and drivers (including the role of weeds or other factors), preliminary to developing well-evidenced recommendations for national policy. The following pages briefly describe current state and trends to the extent data is available, while indicating areas where further information would be useful (summarised below).

Placeholder pending:

- ***Sand-dunes**: provide regional breakdown (2008 or more recent) and analysis of context and drivers for recent change in key regions, eg, Northland*
- ***Wetlands**: update estimates of current wetland extent and trends; provide regional breakdown by wetland type (work in train)*
- ***Tussock:** cross-check LCDB data with the more recent LCR study to update estimates of reductions*
- ***Novel ecosystems**: analysis of the extent to which estimates of change in indigenous cover occurred in modified (mixed) environments - sand-dunes, wetlands, tussock grassland*
- ***Naturally uncommon ecosystems**: update on mapping completed (x23) and timeframe for the balance (x49); update on any recent quantitative data improving the accuracy of the preliminary threat assessments*
- ***Threatened plants**:*
    - *clarify reasons for "genuinely worse" status*
    - *clarify extent to which threatened plants are restricted to offshore islands or uncommon ecosystems*
    - *clarify extent to which threatened plants have been categorised by degree of endemism and overlap with "biodiversity hotspots"*
    - *update on extent to which mapping of uncommon ecosystems is being undertaken in conjunction with mapping of threatened plant distributions*
    - *clarify extent to which threatened plants occur on private land*
    - *update on priority ecosystems (locations) for legal protection and/or active management.*

Tussock Grasslands

Tussock grasslands are the most extensive non-forest category (an artefact of post-human fires), currently estimated at around 2.3 million hectares, ie, just under 20% of indigenous land cover (or just under 10% of NZs land cover).

As noted earlier, EA2015 used LCDB to estimate a 1% reduction in area from 1996-2012; or, to be more precise (+/- 7%), from 2,368,391 hectares to 2,338,342 hectares. Also as noted earlier, there are uncertainties in interpreting landcover changes from satellite images: these difficulties are especially marked in trying to interpret changes in tussock grasslands, especially in conversions to exotic grass cover, or change within mixed native/exotic grasslands.

Acknowledging these uncertainties, Landcare Research undertook a more indepth assessment in a South Island study area, using "*multiple sources of evidence including information from satellite images, photographs, land-use databases, local knowledge and field inspection*" to map conversions[66]. This study found that 70,000ha were "converted" between 1990-2008, principally to pasture (48,000ha) and afforestation (18,000ha), and smaller areas to crops, mining and urban.

Both the study area and time period are different to EA2015 so the numbers are not directly comparable, except that they indicate a higher rate of conversion than the LCDB data. Most of the change was found in three districts – Waitaki, McKenzie, Central Otago – and most individual conversions were <140 hectares.

Both methodologies imply a "hard edge" between indigenous and exotic grassland, but, as noted earlier, hard edges are rare in nature, and distinctions between indigenous and exotic communities may be blurred on the ground. Landcare Research have estimated that the percentage of non-native plants in indigenous forests is low (on average 3% within survey plots); but the percentage is higher (average 14%) in non-forest ecosystems[67]. FFNZ is not currently aware of any estimates for tussock grassland systems, but a key question in relation to estimates of conversion from indigenous to exotic is the extent to which the "conversions" occurred in existing grazed grassland areas.

Related to this last point, Landcare Research recently tested the extent to which sampling methodologies may skew results in mixed grassland communities[68]:

- "*The different abundance and spatial distributions of indigenous and exotic species significantly influenced their likelihood of detection by different sampling methods"*
- *"Our results caution against two methodological approaches that have been commonplace in studies of NZs mixed indigenous-exotic grasslands…first, the measurement of vegetation within very small areas (eg, sub-plots), and second, the use of plot average statistics"*
- *"Sampling smaller areas, sub-sampling plots, and using fewer plots, significantly biased down estimates of indigenous species richness & dominance… because rare, spatially-clustered species – which in our study happened to be mainly indigenous – were more difficult to detect than those that were abundant, ubiquitous and/or spatially well-dispersed – which were mainly exotic*".

[66] Weeks et al, 2013, Patterns of past and recent conversion of indigenous grassland in the South Island
[67] Bellingham et al, 2014, DOC biodiversity indicators – 2014 assessment
[68] Walker et al, 2016, Sampling method and sampling size affect diversity and indigenous dominance estimates

Active Sand Dunes

Data on contemporary state and trends indicates reductions in area, albeit as noted earlier there are difficulties in distinguishing "hard lines" between "active" and "stable" dunes:

- State: EA2015 reported the area of active sand dunes at 2008 as 25,000ha
- Trends: EA2015 reports a reduction in area from the 1990s (40,000ha) to 2008 (25,000ha).

The earlier figure derives from an inventory undertaken by DOC in 2000, which found inter alia[69]:

- "*Dunelands were present in all regions, though they were most extensive along the west coast…east coast active dunelands are, in general, smaller (and) less dynamic*"
- "*The area of active duneland has undergone a striking decline since WWII…the main cause of the decline in area has been the stabilisation, then afforestation, of active dunelands*".

As noted earlier, the NZ Forest Service actively engaged in the stabilisation and afforestation of sand dunes (in part responding to rabbit incursions, preferentially eating native sand-binding plants).

The DOC report (Table 2) presents regional breakdowns, highlighting Northland with nearly 40% of 1990s area. The 1990s column includes a number of "*n/a*" entries but the total apparently includes 1980s estimates (included here in brackets). The regional breakdown for 2008[70] would usefully supplement this table, to support understanding patterns in recent trends:

Region	**1990s (ha)**	**2008 (ha)**
Northland	15,000	
Auckland	(5000)	
Waikato	2,000	
Manawatu	2,400	
West Coast	(2,400)	
Southland	3,400	
Bay of Plenty	900	
East Coast	700	
Hawkes Bay	1,500	
Taranaki	400	
Wellington	(900)	
Marlborough	(250)	
Nelson	n/a	
Tasman	700	
Canterbury	1,800	
Otago	1,000	
Total	**39,000**	**25,000**

[69] Hilton et al, 2000, Inventory of NZs active dunelands

[70] EA2015 does not supply source data, except to note 2008 is based on "existing data & remote imagery".

Wetlands

As for sand dunes, there is limited contemporary data on national state and trends:

- State: EA 2015 estimated wetland area at 2008 was 250,000ha (1% of NZ area)
- Trends: no contemporary national trend data is currently available.

Instead, various attempts have been made to estimate historic extent. In 1997, the national State of the Environment report estimated 700,000 hectares. More recently, Landcare Research attempted to estimate former extent, relying on soil maps available at the time of the work, and arriving at an estimate of 2.5 million hectares. Maps illustrating the estimated pre-human extent highlight several regions with extensive wetland areas: key regions shown as having the greatest historic extent are Waikato, Manawatu, West Coast and Southland, perhaps followed by Wairarapa and Northland[71].

FFNZ is not currently aware of the extent to which estimates of pre-human wetland extent have been correlated with estimates of pre-human forest extent (eg, at face value the Wairarapa wetland estimates perhaps duplicate Wairarapa forest estimates); and, to date, no analysis of the sources or level of uncertainty in the pre-human wetland estimates have been undertaken. As for LCDB and the national carbon inventory, uncertainty analysis should be a pre-requisite for national reporting.

Accepting that there used to be more and now there is less, a recent paper[72] suggests wetland loss was most significant during early European settlement, then another phase post the world wars:

- *"Most of the more recent loss of wetlands and drainage for farmland occurred between 1920 and 1980. In the 1970s, government subsidies for forestry and agricultural land clearance resulted in significant wetland loss: between 1954 and 1976 the NZ Wildlife Service documented 264,000ha of wetland loss"*
- *"Central government landuse activities from 1945 to 1985 were a major contributor to biodiversity decline during this period. The Lands & Survey Department's farm development activities cleared thousands of hectares of shrublands and wetlands in regions such as Northland, Marlborough and Tasman. Beginning in 1984, the government subsidies were gradually removed*".

Central government programmes were not just intended to support bringing land into production, but were also designed to protect communities and infrastructure from flooding, including through the development of major drainage schemes, eg, Waikato, Manawatu. As recently as the 1960s, central government was a major partner in the lower Wairarapa drainage/diversion/flood control scheme; with the conversion of swampland to farmland ancillary to the main project, and intended to help pay for it.

The contemporary extent has been estimated using satellite imagery (noting all the same caveats as for other vegetation types); and dis-aggregated by category, by region and by size. Several major categories of wetlands have been identified, summarised in the table below (EA2015 data):

[71] MfE, Environment New Zealand 2007, Figure 12.3

[72] Myers et al, 2013, Wetland management in NZ – are current approaches and policies sustaining wetland ecosystems

Wetland Type	Hectares @ 2008
Swamp	90,000
Pakihi-gumland	57,000
Bog	40,000
Fen	37,000
Marsh	24,000
Seepage	2,000
Inland saline	300
Total	**250,000**

As noted earlier, some of these wetland types (eg, pākihi-gumland) may have increased in extent subsequent to human settlement, whereas others diminished. The category estimates were subject to uncertainty analysis, finding high error rates[73]:

- *"Data limitations led to much uncertainty in our wetland classification"*
- *"Field verification in Otago indicated high error rates, with only 60% overall agreement. This may reflect reliance on soil data with mapping resolution between 1:50,000 and 1: 250,000"*
- *"A classification test in a region with better soil maps is a desirable next step".*

FFNZ is not currently aware if further work has been undertaken in regions with better soil maps.

The regional breakdown of current extent summarised in this next table (EA2015 data) shows strong patterns, again dominated by West Coast and Southland. A useful next step would be to include the wetland categories by region, to assist understanding/ground-truthing of patterns and priorities:

Region	Hectares	Wetland Type (Hectares) Swamp Pakihi Bog Fen Marsh Seepage Saline
West Coast	84,000	
Southland	47,000	
Waikato	28,000	
Otago	27,000	
Canterbury	20,000	
Northland	14,000	
Man-Wanganui	7,000	
Tasman	5,000	
Bay of Plenty	3,000	
Taranaki	3,000	
Wellington	3,000	
Auckland	3,000	
Hawkes Bay	2,000	
Marlborough	2,000	
Gisborne	1,000	
Nelson	6	
Total	**250,000**	

[73] Ausseil et al, 2011, Wetlands systematic conservation planning

NZ has a high level of legal protection for wetlands, including lowland wetlands: 70% of all wetlands >100ha, and 30% of all wetlands <100ha are held in DOC or other conservation tenure.

In 2015, DOC reviewed the status of wetland reserves[74], finding that all wetland types increased the extent of legal protection since 1990. In total, 30,000 hectares were added between 1990-2013, nearly all being wetlands with relatively high ecological integrity (<300ha were in poor condition).

The largest increases were pākihi-gumland (11,000ha added) and swamp (7,500ha added). The report noted bogs have a good level of legal protection, whereas fens and marshes have a lower level of reservation. In total, over 60% of wetlands have legal protection:

- 60% are on land administered by DOC (150,000ha)
- 3% are in other conservation areas, eg QEII covenants (5,000ha).

The DOC report referenced the Reserves Act 1977, wherein one of its general purposes is: *"the preservation of representative samples of all classes of natural ecosystems and landscape which in the aggregate originally gave NZ its own recognisable character".* Related to this, DOC commissioned work in 2008, proposing a candidate list of nationally important wetlands[75].

The highest ranked sites were often the largest wetlands. Smaller wetlands were ranked highly if they contained rare hydro-classes and/or had high ecological integrity, eg, Maymorn Ridge (5ha) contains 40% of fen habitat in the Wellington region, coupled with high ecological integrity. The 2008 report (Table 14) lists the first site selected in each of 29 "bio-regions" – notably the top ten sites account for 90% of the area, mostly in the South Island:

First Ranked Wetlands By Bio-region	**Hectares**	
Waikato	Kopuatai wetland	10,500ha
Stewart Island	Ruggedy Flats	10,000ha
Grey/Buller	Lake Hochstetter	5,000ha
Westland	Haast wetland	4,000ha
Clutha	Von Valley	2,500ha
Taieri	Upper Taieri wetland	2,500ha
Waitaki	Braemar Rd Tussock	1,500ha
Canterbury	Lake Stream-Cameron Fan	1,500ha
Northland	Kaipara Head	2,000ha
Northland	Waihuahua swamp	1,500ha
Other bio-regions	Wetland sites x19	5,000ha
Total	**First-ranked sites x 29**	**46,000ha**

[74] Robertson, 2015, Wetland reserves in NZ – the status of protected areas between 1990 and 2013
[75] Ausseil et al, 2008, Wetland ecosystems of national importance for biodiversity

The report considered conservation effectiveness, eg, if the objective is to achieve 70% conservation effectiveness (CE) in each region, then: "*In Southland, 70% CE is achieved from the first 9 wetlands that make up about 45% of the wetland area, and it captures all wetland classes except seepages".*

Environment Southland have recently reported on work attempting to assess contemporary wetland trends[76]: relative to an estimated 47,000 hectare total extent, 100 hectares was cleared in the survey area in the period 2007-2015 (0.2% of the total), and 1,000 hectares reduced in size (2% of the total).

FFNZ is not currently aware of any follow-on work to assess change in conservation effectiveness.

Uncommon Ecosystems

EA2015 did not present state and trend data for naturally uncommon ecosystems for the simple reason it is not available: "*Data on current distributions of NZs naturally uncommon ecosystems and their current rates of change in area are scarce"*[77].

This is not least because the concept and classification of "naturally uncommon ecosystems" was developed relatively recently. As noted above, there is no one agreed national level classification system, but in 2007, Landcare Research compiled a list of 72 "rare" ecosystems based on literature and discussions with ecologists[78].

The list includes broad categories discussed above (wetlands, dunes) and a range of more specialised ecosystems, often located in extreme environments or geological outcrops. The classification leans towards "splitting" rather than "lumping"; and the cut-off selected (original extent <0.5% of NZs land area or 135,000ha) captures 72 ecosystem types[79].

The intent is partly that: "*Instead of focussing on individual species, this targets the preservation of ecosystem habitat…hopefully leading to the protection and longterm integrity of populations of the full suite of species within each ecosystem. However, for these ecosystem-based conservation efforts to be prioritised, the most threatened ecosystem types must be identified*" [80].

Landcare Research then devised a threat classification system (based on the IUCN red list criteria), and assigned each of the 72 ecosystems to one of "critical/endangered/vulnerable" or "not threatened", again based on literature review and "expert opinion" about distribution and trends. Landcare Research acknowledge this is a preliminary assessment:

- "*We recommend using current risk status for setting conservation priorities – in conjunction with other factors such as… probability of success, availability of funds, while further quantitative data are collected to test and improve the accuracy of the threat assessment*"[81].

[76] Environment Southland, 2016, Wetland inventory project – interim report for 2016
[77] Holdaway et al, 2012, Status assessment of NZs naturally uncommon ecosystems
[78] Williams et al, 2007, NZs historically rare terrestrial ecosystems set in a physical & physiognomic framework
[79] LCR have produced excellent fact sheets for each ecosystem, readily accessible on the LCR website
[80] Wiser et al, 2013, NZs naturally uncommon ecosystems *in* Ecosystem Services in NZ
[81] Holdaway et al, 2012, Status assessment of NZs naturally uncommon ecosystems

Currently, the list includes systems that might accord with common understandings of "rare", eg[82]:

- volcanic dunes which exist only at one location - Rangipo desert (thought to be threatened by army training activity and invasion by exotic plants)
- seabird guano deposits (compromised by the loss of seabird colonies due to predation)
- shell barrier beaches, of which there are only about 12 in the world, and the largest in NZ (Miranda) is the only one actively aggrading
- coastal turfs which occur along the coast in eight regions but the total extent may be <40 ha.

Coastal turfs are a good illustration of the complexities in restoration agendas. Recent work by DOC/LCR[83]suggests that turf represents an "unstable, successional state", ie, successional to coastal shrubland and forest (where seed sources are available). The turf state is maintained only in the presence of grazers - previously moa, geese and swans - which are now extinct. Notwithstanding that the birds are extinct, these turfs still support many uncommon/threatened plants, many of prostrate form, that are vulnerable to smothering by taller native and non-native species. Herein lies the dilemna:

- let nature take its (new) course, ie, eventual succession to coastal forest; or
- arrest the succession by using farm stock in lieu of birds to maintain the turf plants.

Both options probably require active management: the first to re-establish seed sources/tree species, the second to maintain the balance between under and over-grazing. Alternatively: if reliance was simply placed on legal protection, the outcome may likely be neither a coastal forest nor a coastal turf, but a "novel ecosystem" comprising some new balance of indigenous and introduced plants (and if it's fenced, possibly more introduced than indigenous). This is the same dilemna touched on earlier in relation to "reversion" from scrub/shrubland systems.

The list of uncommon ecosystems also includes ecosystem types which are widely distributed throughout NZ and do not accord so readily with common conceptions of "rare and uncommon", eg, ephemeral wetlands, seepages/flushes, active sand dunes, stable sand dunes, lake margins, lagoons and estuaries. Importantly also, these ecosystem types (as with coastal turfs) will today often comprise modified "novel" assemblages of both indigenous and introduced species.

Mapping of these and the other "uncommon" ecosystems is underway, and can be expected to assist in refining priorities. Landcare Research recommend that: "*Within naturally uncommon ecosystems, the greatest conservation gains are likely to be obtained by concentrating conservation efforts on those most critically threatened, if management action can reduce the threats*".[84]

Many of these ecosystems have a high level of legal protection, eg, old tephra plains 80%, marine mammal haulouts 40%. Landcare Research propose that the four ecosystems that have so far been identified as having less than 20% of their area in formal protection – shell barrier beaches, volcanic dunes, young tephra plains plus coastal turfs – are "*the top priority for protection efforts*"[85].

[82] Holdaway et al, 2012, Status assessment of NZs naturally uncommon ecosystems – Table S1
[83] Rogers and Monks, 2016, Restoring lost ecological function – ecological surrogates facilitate maintenance
[84] Holdaway et al, 2012, Status assessment of NZs naturally uncommon ecosystems
[85] Bellingham et al, 2016, DOC biodiversity indicators – 2016 fact sheets

The table below lists all the "uncommon ecosystems" with those four priorities highlighted in red. As noted above, these threat rankings were a preliminary assessment made five years ago, intended to assist in prioritising protection efforts. An exercise is currently underway to map distributions, and can be expected to adjust some rankings, finetune priorities for legal protection and/or active management, and clarify the extent to which uncommon ecosystems are on public or private land.

Uncommon Ecosystems	**Critical** x18	**Endangered** x17	**Vulnerable** x10	**Not Threatened** x23
Bird/Mammal Induced	Seabird guano Seabird burrows Mammal haulouts			
Subterranean	Cave entrances	Sinkholes		Karst caves Subt. river gravels
Geothermal	Fumeroles G/t streamsides G/t heated ground G/t altered ground			Recent lava flows G/t acid rain
Coastal	Shell barrier beach Coastal turf	Active sand dune Stable sand dune Shingle beach Stony beach ridge Deflation hollow Calcareous cliffs Ultramafic cliffs	Mafic cliffs	Siliceous cliffs Sil-intermediate cliffs Rock stack
Wetlands	Damp sand plains Ephemeral w/lands	Dune slacks Domed bog Seepages & flushes Lagoons	Blanket mire Lake margins Estuary	Cushion bogs Pakihi String mire Tarn
Inland & Alpine	Old tephra plains Inland sand dunes Inland saline Outwash gravels Leached terraces Gumlands	Volcanic dunes Frost hollows Volc. boulderfields Sandst. pavements Braided river beds	Young tephra plains Mafic cliffs/tors Calcareous screes Calc. boulderfields Calc. cliffs/tors Moraine	Siliceous screes Silicic boulderfields Silicic cliffs/tors Sil-int boulderfields Sil-int cliffs Ultramafic b/fields Ultramafic screes Ultramafic cliffs & hills Granite sand plains Granite gravel fields Limestone pavements Debris flow/lahar Cloud forest Snowbanks

Threatened Plants

As noted earlier, no forest species are known to have become extinct in NZ; and populations of widespread forest trees are generally stable. Instead, threatened plant lists are dominated by non-forest plants; and, perhaps predictably, there is a high level of overlap with uncommon ecosystems: "*Naturally uncommon ecosystems contain 145 (85%) of mainland threatened plant species…66 (46%) of which are confined to naturally uncommon ecosystems*"[86].

EA2015 does not present quantitative state and trend data for threatened plant species (perhaps understandably, appreciating the logistics involved in estimating population numbers and trends for small, often cryptic, plants on the ground).

For state, EA2015 instead relies on classifications of threat status, which are based on more qualitative (field research supplemented by expert opinion) assessment of numbers and trends: of 2,500 "vascular plant" taxa identified to date, >10% (nearly 300) are assessed as "threatened". The following table shows the threat rankings, based on EA2015 data and supporting information[87]:

Threatened Plants	**2008**	**2012**
Critical	141	155
Endangered	55	62
Vulnerable	47	72
Total threatened	**243**	**289**

For trends, EA2015 relies on changes in threat status, highlighting genuine changes in distribution. Across all indigenous species, EA2015 reported that plants dominated the "genuinely worse" list:

- 12 species genuinely improved – including birds, bats and others, but no plants
- By contrast, nearly 60 species genuinely worsened, of which half were vascular plants.

DOC have reported on the reasons for the changes to conservation status - including "genuine" improvements or declines - for most species, but not for plants[88]:

- Bats, birds, fish and others are presented with brief comments, explaining the changes
- No explanations are provided for the changes to plants (the comments column is empty), but this information would usefully be made available.

In 2009, a consortium of scientists reported that some plants may be on the brink of extinction[89]: *"Unless further action is taken soon (within the next decade for some plants), we stand to lose from the wild a wealth of botanical diversity, including such iconic species as kakabeak, and other equally significant but less well-known plants such as buttercup (Ceratocephala pungens), coastal peppercress (Lepidium kirkii) and Pimelia actea*".

[86] Wiser et al, 2013, NZs naturally uncommon ecosystems *in* Ecosystem Services in NZ
[87] De Lange et al, 2013, Conservation status of NZ indigenous vascular plants, 2012: Table 1
[88] DOC, 2013, Summary of changes to the conservation status of taxa in the 2008-2011 listing cycle
[89] De Lange et al, 2010, Threatened and uncommon plants of NZ (2008 revision)

This is a clarion call, which has been responded to in part with publication of DOCs draft Threatened Species Strategy[90]. The draft strategy identifies 150 priority species, of which a quarter are plants: most of the plants are "critical" (albeit not all critical plants made the list).

Accepting that plants feature heavily in threatened species lists, they are often presented simply as long lists. FFNZ suggest a level of ordering (and mapping) would assist in illuminating patterns and priorities, eg, the names on these lists indicate that many may be restricted distribution:

- Offshore islands: Chatham Island forget-me-not, Three Kings kaikomako
- Named locations: Castle Hill buttercup, Banks Peninsula scurvy grass.

It would also be useful to know the extent to which the priority threatened plants correlate with the priority "uncommon ecosystems", eg, the four named earlier as priorities for protection; and the extent to which they overlap with "hotspots of endemism" [91], eg:

- Deep endemics: north of the North Island & northern offshore islands (30% in DOC estate)
- Species level endemics: offshore islands, Stewart Island and selected areas in the South Island, eg, Central Otago, south Canterbury, coastal Marlborough (40% in DOC estate).

In addition, it would be helpful to understand the extent to which threatened plants are located on private land: one author suggests 20% are found only on private land, while a further 60% occur on both public and private land, albeit with many having their largest populations on private land[92]. The exercise currently underway mapping uncommon ecosystems can be expected to assist in mapping patterns in the distribution of threatened plants (and from there, priorities for management).

The draft DOC threatened species strategy is intended to support prioritising investments across both public and private land. Importantly, the strategy marks a shift towards priority ecosystems rather than species per se:

- *"This strategy promotes the use of spatial planning tools to identify Ecological Management Units (EMUs) – sites that contain mosaics of related ecosystems and threatened species (and) a shift towards managing ecosystems using the prioritisation approach"*
- *"Not all conservation projects are of equal value. Some ecosystems contain numerous threatened species, and a single project could achieve benefits for a greater number of species"*
- *"Instead of managing multiple species across several different sites, the system can identify where those species could be more efficiently managed at the same site within a high value ecosystem".*

Placeholder pending:

- *A higher level of ordering/mapping of threatened plants*
- *Further details of the proposed DOC priority ecosystems (encompassing threatened plants) including their extent on public and/or private land.*

[90] DOC, 2017, NZs threatened species strategy – draft for consultation
[91] LCR website, Hotspots of Endemism, downloaded 2/6/2017
[92] Norton and Miller, 2000, Some issues and options for the conservation of native biodiversity in rural NZ

Land Tenure & Legal Protection

In the international context – out of all the OECD countries – NZ has the highest proportion of its land area protected for conservation purposes[93].

EA2015 notes that, in 2012, nearly half (44%) of 500 LENZ land environments were "well-protected" (>30% relative to former extent[94]), representing nearly 60% of NZs land area.

A recent update on actions taken to achieve the 2020 Aichi Biodiversity Targets similarly reported[95]:

- "*Agriculture occupies about half the land area of NZ, mainly on the relatively fertile lowlands. Indeed, there is less native vegetation remaining in lowland areas"*
- *"Approximately a third of NZs land area is legally protected for conservation purposes. Between 2004-2012, protected land (public and private) increased by 4% to over 8.5m ha".*

In 2016, a stocktake categorised by regional council[96] showed strong regional patterns. Most of the legally protected areas are in the South Island, in particular West Coast and Southland (40% of the protected area), followed by Canterbury:

Region	Legal protection (ha)	% of region area
South Island		
West Coast	2,000,000	85%
Southland	1,900,000	58%
Canterbury	1,200,000	27%
Otago	650,000	20%
Marlborough	490,000	47%
Nelson	20,000	39%
North Island		
Man-Wanganui	450,000	20%
Waikato	440,000	18%
Bay of Plenty	440,000	36%
Hawkes Bay	320,000	22%
Wellington	210,000	26%
Northland	190,000	15%
Taranaki	150,000	21%
Gisborne	110,000	13%
Auckland	80,000	16%

[93] MfE, April 2010, INFO 492, Environmental Report Card – Legally protected conservation land in NZ
[94] The 30% trigger relies on assumptions from area-extinction curve theories
[95] Convention on Biological Diversity - NZ Country Profile: www.cbd.int/countries, downloaded August 2017
[96] LCR, 2016, Standardised terrestrial biodiversity indicators for use by regional councils, Indicator M18, Table 3

Acknowledging that New Zealand as a whole has a high rate of legal protection, it can also be acknowledged that this is principally in upland New Zealand. In lowland New Zealand:

- Wetlands have a high level of legal protection: as noted earlier, 60% are in DOC estate
- Many of the "naturally uncommon" ecosystems have a high level of legal protection
- A number of intact lowland forest systems are in public tenure or covenants.

Other lowland ecosystems (eg, secondary/regenerating scrub/shrub communities, lower elevation short tussock/grassland communities, some wetlands (fens, marsh), maybe sand dune communities, and some of the uncommon ecosystems discussed earlier) may have a lower level of formal protection, but FFNZ is not currently aware of any comprehensive stocktake, nor the extent to which these are currently priorities for public tenure or covenant protection.

In 2007, Environment NZ reported on the 1000% increase in QEII covenants from 1977 (170) to 2007 (2,600); and reported on covenants by ecosystem type[97]. The following table would usefully be updated, eg, in an updated national stocktake dis-aggregated by ecosystem type:

QEII covenants	**Area (ha) @ 2007**	**Area (ha) @ 2017**
Lowland forest	35,000	
Non-lowland forest	30,000	
Forest/shrubland		
Tussock/grassland	12,000	
Wetland, stream, river, lake	8,500	
Geological, eg, cliff, outcrop	2,500	
Archaeological/historical	1,500	
Saltmarsh, estuary, dune	500	
Montane saline plain	200	
Total	**90,000**	**180,000**

In 2017, QEII report that progress continues apace – on average two covenants have been registered every week for 40 years[98]:

- The covenant area has doubled to 180,000 hectares; covenants have doubled to 4,400
- One percent of all private land in NZ is protected by QEII covenants
- Over the last 40 years, landowners have committed over $1 billion to protect their sites
- For every $1 of government investment, covenanters invest $14
- Up to 200 covenants are applied for each year; available funds can support around 100 pa
- The funding gap to meet demand and some limited management support is estimated around $3-4 million per annum
- In the perfect world, QEII would be funded to a level to support active management of covenant sites, similar to the Nga Whenua Rahui scheme for maori land.

[97] MfE, 2007, Environment NZ, Table 12.7

[98] Mike Jebson, October 2017, A background on the QEII National Trust *for* Biodiversity Collaborative Group

The funding gap – between landowner demand and QEII capacity - is not a new theme. In 2000, the Ministerial Advisory Committee (MAC) on Biodiversity and Private Land published a comprehensive report with recommendations to support a "vision for quality biodiversity management".

The MAC report included (Table A1) information dis-aggregated to district level on land tenure (including maori land), area in indigenous vegetation, and percentage in private ownership - this information would usefully be updated.

Similarly, an MfE report in 2004[99] estimated council expenditure on biodiversity, including an attempt to estimate landowner contributions - this information would also usefully be updated to complement the QEII estimates of landowner investments. Pending updated estimates being available, the following (very rough and incomplete) estimates are perhaps illustrative:

- NZ biodiversity investment: estimate $400m (average $15/ha/pa, $85/per head/pa)
- Biodiversity investment on public land: $200m pa (Vote Conservation)
- Biodiversity investment on private land: $200m pa (50/50 government/ landowner?).

The last estimate is a ballpark only pending more careful analysis. It is based on ballparks for AHB possum programmes including landowner contributions (biodiversity benefits), council pest and weed programmes, council biodiversity partnership programmes (potentially for every $1 council spends, landowners spend $10[100]), central government biodiversity partnership programmes (in the case of QEII covenants, for every $1 government spends, landowners spend $14).

Placeholder pending:

- *Updated stocktake on land tenure (public, private, maori) and legal protection, dis-aggregated by region and ecosystem type*
- *Update on protection mechanisms for private land (Reserves Act, Nature Heritage Fund, QEII, Nga Whenua Rahui, Forest Accord), including current criteria and budgets*
- *Update on current agency priorities (eg, DOC, LCR) for formal legal protection, eg, non-forest communities, wetlands, uncommon ecosystems*
- *Updated broad estimates of biodiversity investments by DOC, Councils and landowners.*

As noted above, the MAC produced a comprehensive report, supported by a comprehensive process. The challenge – or opportunity – at the heart of it was sustaining biodiversity on private land. The same challenge – opportunity – is central to the collaborative process currently underway.

The Terms of Reference for the MAC in fact were almost identical to the ToR for the current process, ie, advice on how the RMA should be implemented through a national policy statement, and the set of instruments that could be implemented alongside or in place of RMA measures such as an NPS.

In the event, the MAC recommended that the Government not proceed with an NPS at that time, but consider facilitating the establishment of a National Biodiversity Forum, and continue or increase funding support for action on the ground. The MAC recommendations included that Government:

[99] MfE, 2004, A snapshot of council effort to address indigenous biodiversity on private land
[100] MfE, 2004, A snapshot of council effort to address indigenous biodiversity on private land, pg 16, TRC estimate

- Continue to support an independent QEII Trust, and resource it to a level that enables it to respond credibly to public demand
- Continue to support the Nature Heritage Fund to provide the highest level of security for high-priority sites
- Continue to support the Nga Whenua Rahui Fund at levels which recognise the significant areas of indigenous vegetation in Maori ownership
- Investigate how it can reduce the cost of covenanting by reviewing the need for formal survey; and consider initiating a purchase-covenant-resale scheme modelled on the Australian revolving fund
- Support the greater use of management agreements, and encourage their use by making any additional public funding conditional upon the existence of such agreements
- Establish a new fund aimed at encouraging and supporting regional councils to coordinate and fund contributions to ongoing management of natural areas
- Facilitate the establishment of a rural (including peri-urban) extension service aimed at the sustainable use and protection of natural resources, with biodiversity as a core purpose.

Arguably, all these recommendations have been implemented to some level; and failure to keep up with demand should not be read as a criticism of Government per se (the ongoing and growing demand might rather be seen as a good problem). Instead, the key point is probably that all these MAC recommendations are still relevant today.

In this context, there is value in recapping the rationale for these recommendations, as set out in the MAC report. The following extracts suffice to illustrate - and further illustrate that the MAC grappled with exactly the same creative tensions that the BCG is grappling with. The MAC report outlined some of the tensions apparent at that time:

- *"The RMA facilitates and enables the public to intrude across the "private threshold". Every intruder is confident that the morality and virtue of the cause justify the heresy of the violation. Those intruded upon rarely share that view"*
- *"The Crown carries a particular burden as the nation's largest rural landowner. The financial resources to effectively manage Crown estates have never matched the ambitious rhetoric that has accompanied successive additions to a diverse and demanding portfolio of properties, all of which present daunting management challenges"*
- *"This is a particular irritant to the Crown's rural neighbours: to have a less than perfect neighbour, exercising legislative authority to direct them on how they should conduct their domestic chores on their own land"*
- *"The full might of Crown authority can be brought to bear to protect what is euphemistically referred to as "significant" – the definition of which, by its very nature and the factors involved in making that judgement, leans more to the subjective than the objective".*

As today, the MAC recognised both the scale of the task and the need for active management:

- "*If we as a society choose to nurture our indigenous biodiversity, we must be prepared to actively manage all our land by standing between our threatened species and their vigorous competition and predators. Such a commitment will be permanent and at ongoing cost, be it on reserve, residential or productive land"*

- *"If it is necessary for landholders to 'buy in' to the need to protect biodiversity and participate in that protection – as we think it is – a far more sophisticated and comprehensive approach is required"*
- *"We reach that conclusion because we recognise the scale of the problem is vast. We have little doubt that the cost is likely to outstrip the generosity of the public purse. Thus, solving the problem, in anything other than a token way, will require contributions from others, not least the resident custodians of what it is we seek to protect"*
- *"Whatever measures are used they must not undermine the goodwill that does exist. Indeed, we argue that measures should be aimed very much at gaining and/or sustaining the goodwill of landholders".*

The MAC discussed what the goal might be:

- *"A number of submitters promoted the concept of "no net loss". The Committee remains uncertain about how its proponents envisage it being applied…we wonder about the ecological integrity of such an approach"*
- *"Relative to the goal…there are only three ways to lower the 'gap of frustration": increase public contribution, increase landholder contribution, or lower the goal. The practical reality of the "gap" is that its size varies around the country…the Committee prefers a pragmatic goal (which) focusses our attention on what is practical and reasonable – and what needs to be put in place to make the impractical practical, and the unreasonable reasonable".*

Closely following on from the goal, the MAC debated how best to achieve it:

- *"Having decided what it is we are trying to achieve, the key issue remains: do we seek to achieve that object by helping landholders, or by telling them what they must or must not do?"*
- *"We have made no secret of the fact that we think regulation has limited value in arresting the decline. We say that for two reasons. First, regulation is ideal when you need to stop adverse behaviour. But when you aim is to engender positive action, regulation is generally ineffective and at times counter-productive"*
- *"In the absence of unlimited public funding, some method of rationing is necessary. Targeting the funding towards the "best" sites is rational to that extent. However, we do find something inequitable in some landholders being assisted, while others are left subject to regulation (and cost) simply because their sites are not "important" enough to qualify for assistance. In other words, there is something odd in the proposition that a site might be important enough to regulate but not important enough for public assistance"*
- *"In summary, it is probably not accurate to characterise the debate as being about "carrots' versus 'sticks". In our view, while regulation might be optional (depending on risk analysis), incentives and assistance are not".*

The MAC discussed the pros and cons of an NPS at some length:

- *"We caution against a fixation with top-down measures"*

- *The legislation we have basically makes sense (but) we remain weak with regard to motivating and assisting action from the ground up, eg, the Landcare Trust and QEII Trust are poorly resourced and their services are over-subscribed"*
- *"We should focus first and foremost on what it is that stakeholders (public and private) need in order to be better biodiversity managers. Only then should we consider whether an NPS is a tool that could usefully assist in delivering what is needed…we need to ask, what is it that local government is not doing that perhaps it should be doing"*
- *"Some believe an NPS is needed to ensure that councils uniformly address effects on biodiversity. This view assumes an NPS will lead to greater levels, and greater uniformity of regulation, and that regulation will lead to better outcomes. It is not a view the Committee shares. For a start, the current level of regulation is under-appreciated"*
- *"We need to guard against that old trap of treating the symptom and not the cause. The symptom might be that councils are failing to act for biodiversity in sufficient numbers or with sufficient vigour. But in our view, the cause is not just that no-one has told them what to do".*

Placeholder pending assessment of the current extent of regulation.

The MAC could potentially see merit in an NPS, if it was part of a wider programme:

- *"We place an NPS in the useful but not critical category, while noting that an NPS would only be useful if it was part of a much more extensive programme"*
- *"It would be hugely counter-productive for the Government to show leadership through strong directives, but remain unwilling to participate meaningfully in the practical achievement of the desired outcomes"*
- *"If an NPS were written so as to encourage local government, in partnership with central government, to actively engage in biodiversity matters using the full range of its financial and operational functions and powers, then the committee would support an NPS…such an NPS would need to be well-integrated with central government assistance schemes"*
- *"If government were to proceed with the sort of NPS we suggest, there would be little sense in restricting its scope either to land use effects, or private land. If effort is to be put in, it would be remiss not to deal with biodiversity comprehensively, and include all lands".*

The key recommendations from the MAC had partnership as a central theme:

- *"In many ways, a National Policy Statement is the ultimate top-down approach, with both benefits and obvious limitations. The question is not whether we promote a top-down or bottom-up approach. We need both. The question is how we bridge the gap"*
- *"In simple terms, we can only bridge that gap by forming partnerships between public agencies and community and individuals. By partnerships, we mean working arrangements where each party contributes something towards a common goal"*
- *"A key principle of partnership is that each party should do what it can to help the other so as to achieve common objectives"*
- *"In our view, central government would be better to focus on capacity building, by developing effective partnerships and investing in programmes that assist and support local government to be effective biodiversity managers".*

The MAC recommendations for a national biodiversity forum foreshadow a similar suggestion made in the Regional Council thinkpiece; and the recommendations for regional and local coordination have much in common with developments currently underway, eg, Wild for Taranaki, Cape to City:

- *"Landholders and other stakeholders could readily see the benefit of (voluntary) multi-party agreements that committed participants to specific action on the ground"*
- *"The Committee distinguishes between two possible needs: the first is for a biodiversity forum at the regional level; the second is to provide a framework for bottom-up property-based initiatives"*
- *"By this, we mean, voluntary agreements between multiple landholders (or with regulatory/funding agencies). In the case of pest control (the same may also be true in the case of riparian management and aquatic ecosystems) coordinated multi-landholder buy-in and commitment are required, often at a catchment scale"*

The spirit in which the MAC made its recommendations is partly expressed in the following extracts:

- *"Increasing numbers of landowners are deriving economic benefit, while at the same time, sustaining natural values. One goal does not have to be at the expense of the other"*
- *"It is something of a tragedy that in the enthusiasm to implement the RMA and move towards codified responsibilities we have forgotten to acknowledge and respect the many good deeds done"*
- *"We believe we could achieve much greater buy-in if we turned the approach around from accusatory to appreciative; from implying a lack of trust to offering acknowledgement and assistance…deficient, under-funded schemes can still do wonders if those involved have the right attitude and style".*

In summary: the MAC was charged with the same brief as the BCG and, at that time, landed recommendations which questioned the value-add of a top-down NPS, instead emphasising the need for active management and the importance of a more sophisticated and comprehensive partnership approach.

Acknowledging that the MAC carefully set out its rationale at that time, that thinking can now usefully inform the BCG process, while testing the extent to which the MAC rationale and recommendations are still relevant today, in particular against any new evidence of state, trends and drivers which may compel an approach more or less geared to regulatory settings or to more sophisticated partnerships for active management.

INDIGENOUS BIRDS

Pre-human Context

The loss of the bird fauna in NZ mirrors the pattern described earlier for their forest habitats. In 1989, Holdaway described two waves of extinctions following human settlement[101]:

- *"Evidence for massive habitat degradation during Polynesian times is overwhelming (and) the most vulnerable species had been exterminated by 1769…the first pulse of extinctions coincided with the introduction of three mammalian predators - kiore, dogs and humans"*
- *"When Europeans arrived, the NZ avifauna was only a battered remnant, surviving in a much altered environment… but there was another pulse of extinctions under the onslaught of cats, two more species of rats, and mammalian herbivores and omnivores".*

As with the flora, Holdaway suggests there were losses (including larger, meatier birds and ground dwelling or flightless birds) as well as gains, including for Australian migrants:

- "*New niches resulting from changes in vegetation during the Polynesian period allowed new species to colonise from Australia"*
- *"Several species (morepork, harrier) are rare or absent in pre-human deposits"*
- *"Others (pied stilt, black backed gull) have increased in abundance since Europeans arrived".*

Like Perry et al, Holdaway was concerned with implications, noting the most frequent application of island bio-geographic theory in NZ has been in reserve design, but: "*Species-area relationships based on drastically altered and incomplete lists provide a poor basis for management decisions… the ecology of a threatened species is perhaps a better measure of the suitability of a projected reserve".*

In plain language: species-area relationships assume that below x area left, species may be on a slippery slope to extinction, thereby driving calls for x% habitat restoration, depending on the selected trigger. An alternative approach recommends getting a grip on the key issues impacting that species (which may or may not be x amount of habitat) and addressing them accordingly.

Contemporary State & Trends

As for threatened plants, national state and trend reporting relies on DOC assessments of threat status, and changes in status determined as part of regular reviews. Today, NZ has just over 400 living bird taxa, of which just under 20% (77) are assessed as "threatened"[102]:

Category	**2008**	**2012**
Critical	24	25
Endangered	15	18
Vulnerable	38	34
Total threatened	**77**	**77**

[101] Holdaway, 1989, NZs Pre-human avifauna and its vulnerability, NZ Journal of Ecology 12
[102] DOC, 2013, Conservation status of NZ birds, 2012

Between 2008-2012, eight species genuinely improved, all through active management - either predator control, island translocations or both. All bar one are forest birds (none are listed as "critical")[103]:

Genuine Improvements	DOC Comment
NI Kokako	Managed populations increasing or stable
Whio/blue duck	Management of predators being undertaken successfully at several sites
Pateke/brown teal	Successful translocations, good response to improved pest control
NI kaka	Male sex bias in mainland populations, but secure populations on islands
Mohua/Yellowhead	Substantial island populations and protection by Operation Ark
SI saddleback	Ongoing successful island translocations
Stewart Island robin	Established and abundant on Ulva and Putauhina Islands
Chatham Petrel	Recovering as a result of management. Five fledged from Pitt Is. in 2008.

Between 2008-2012, eleven species genuinely worsened ("critical" species highlighted in red)[104]:

Genuine Declines	DOC Comment
Great Spotted Kiwi	Worst measured decline rate from call counts
Sth Fiordland Tokoeka	Popn 5,000 adults; decline rate guessed lower than Great Spotted kiwi
Grey Duck	Most are hybrids
Black-billed gull	c. 90,000 adults. Serious concern about rate of decline
Banded dotterel	Coastal breeding range contracted. Winter counts down to c. 6000
Red-billed gull	Kaikoura breeding popn halved. Mokohinau population crashed.
Pied Shag	Possibly <2000 pairs. Populations may have now stabilised
E. Rockhopper Penguin	Colonies fragmenting on Campbell Is. Similar declines on Antipodes
Greyhead Mollymawk	87% decline since 1940s. No data since mid-1990s
Gib. Wand. Albatross	8,000 breeding pairs. Decline of c. 25% last 4 years
Pitt Island Shag	Mortality in crayfish pots

The draft DOC Threatened Species Strategy lists 150 priority species, of which a quarter are birds. The next table lists the DOC priority bird species in three broad groupings – kiwi, other forest birds, and waders/coastal birds; but excludes 11 offshore island/marine species (eg, black robin, Campbell Island teal, South Georgian diving petrel - all bar one of this "offshore" group are "critical").

The table indicates that DOC priorities for active species management tend to be in the South Island. Species recorded as genuinely improving are highlighted in blue; those recorded as genuinely worsening are highlighted in red; the balance are species (*all subject to active management – tbc*) where current management is arguably holding the line - or was as at 2012.

[103] DOC, 2013, Summary of changes to the conservation status of taxa in the 2008-2011 listing cycle
[104] DOC, 2013, Summary of changes to the conservation status of taxa in the 2008-2011 listing cycle

At face value, the table indicates that – within these DOC priority species - Great Spotted kiwi and Black-billed gull may be priorities for increased management to turn around current trends:

Critical X8	**Endangered** X5	**Vulnerable** X10	**At Risk** X5
Kiwi			
Haast brown kiwi	Stewart Is brown kiwi	Great spotted kiwi	Little Spotted kiwi
Okarito brown kiwi		Fiord. brown kiwi	
		NI brown kiwi	
Forest Birds			
Kakapo	Kea	Whio	NI kokako
Takahe	Rock wren	Mohua	SI saddleback
		NI Kaka	NI saddleback
		SI kaka	
		Hihi	
Waders/Coastal Birds			
Black-billed gull	Bittern	Wrybill	Bartail godwit
Black stilt	Blackfronted tern	Hoiho	
NZ shore plover			
Southern dotterel			

Contemporary Pressures

The draft DOC Threatened Species Strategy describes predators as the key threat:

- "*If there is a single thing we can do for our threatened species it is to eliminate the main mammalian predators"*
- *To get the best gains for threatened species, we need to integrate large-scale ecosystem predator control programmes with the location of threatened species…thereby securing maximum benefits for both threatened species and the habitats that support them*".

This strategy strongly accords with recent recommendations from the Parliamentary Commissioner for the Environment (PCE) for prioritising large-scale areas for sustained predator control[105]:

- "*There are 158 species of native birds in NZ. Of these, 93 are especially precious because they are found in no other country"*
- *"Only 20% - one in every five - is in good shape. And one in every three is not far off from following the moa and many others into extinction. The situation is desperate"*
- *"Our native birds need three things…undoubtedly, safety from predators is the most urgent"*
- *"The first recommendation is for the development of a plan for Predator Free 2050…all the disparate efforts currently underway will not just magically come together"*

[105] PCE, 2017, Taonga of an island nation – saving NZs birds

- *"The first element of such a plan needs to be the preparation of a portfolio of areas for sustained predator control...these areas need to be large*".

The PCE presents a vision looking forward to the future, rather than backwards to the past:

- "*Taking NZ back to a pre-human state is not possible or desirable – we are here now"*
- *"The Government has set a goal for kiwi to shift from an annual decline of 2% to an annual increase of 2%. But many other precious birds are in similar or greater trouble".*
- *"For a long time, interest and concern has been focussed on forest birds. That NZ is "seabird capital of the world" is only now being appreciated – about 10% of all the seabird species in the world breed in no other country"*
- *"Unsurprisingly, the endemic birds are generally in more difficulty than the other native birds. Only 13% of the endemic birds are doing OK and 45% are in serious trouble. It is not all bad news. Three endemic birds that have increased their ranges over the last few decades are tui, piwakawaka/fantail and riroriro/grey warbler"*
- "*A great success of NZ conservation has been the eradication of predators on offshore islands (but) let us aim for more than bird "museums" on offshore islands that few can ever visit"*
- *"This report begins with a vision – the restoration of abundant, resilient and diverse birdlife back on the mainland".*

The PCE applauds the Predator Free 2050 vision and takes it forward:

- *"It is ambitious and inspiring (but) it is not a plan of action. And that is what is needed now"*
- *"The starting point should be geographic – developing a portfolio of areas in different areas of the country where it makes sense to focus efforts on clearing predators"*
- *"The areas chosen should be in different regions of NZ, include different ecosystems, and not be restricted to the conservation estate. The areas need to be large…large, safe areas can support more abundant wildlife (and) re-invasion by predators occurs more slowly…there is merit in targetting peninsulas".*

The PCE report is supported by two comprehensive reports prepared by Landcare Research. The first report describes recent range declines, especially in the endemic and deep endemic birds [106]:

- "*Endemic taxa tend to occupy small geographic ranges which decreased between measurement periods"*
- *"Range declines were greatest in two groups of endemic birds: forest and alpine birds, especially the "deep endemics"; and wading birds, terns or gulls that breed mainly in the inland eastern South Island"*
- *"It is the forest and inland basins most remote from large human communities that still provide sufficient habitat for there to be a prospect of maintaining large, viable populations. Achieving this outcome would require large-scale management of multiple predators in forests and inland basins".*

In contrast, other bird species have increased their ranges:

[106] Walker et al, 2017, NZs native land birds – status and change on the mainland

- *"Non-endemic native species and self-introduced species typically occupy larger areas, and most increased their ranges"*
- *"Most of the wading birds, terns and gulls that breed on the coast, and most birds of coastal and freshwater wetlands and other open habitats, increased their ranges*".

The second supporting report emphasises that the opportunity to retain large viable populations of endemic birds on the mainland is retreating[107]:

- *"Between 1969-1979 and 1999-2004, there was widespread and systematic loss of endemic forest birds from NZs forests. This trend is likely to have continued since 2004. Our results are consistent with predation by introduced mammals being the primary cause of recent decline"*
- *"A number of taxa appear intolerant of deforestation as well as predation, especially the "deep endemics". Our results caution against expectations that they would be able to sustain viable populations in deforested and partially forested landscapes (even) if mammal predators were absent"*
- *"Restoration of viable endemic forest bird populations through predator management is more likely to be successful in large, continuous tracts of forest".*

The PCE reports suggest that the last bastion for the deep endemic forest birds is South Island forests, in part because of the continuous extent, and in part because these colder forests do not contain the rat populations which have invaded the warmer North Island forests. The management imperative in the South Island is episodic predator control in the beech mast years (as in "Battle for our Birds"). By contrast, the challenge in the North Island is to achieve sustained predator control, preferably (at least initially) in the larger tracts of existing North Island forest.

The PCE reports are supported by a substantial body of research implicating introduced predators as the key threat to NZ birds. As noted earlier, the ground-dwelling birds were first in the firing line, closely followed by hole-nesting birds (who can't get away); and in both cases, it is most often the eggs, chicks and attending parent who are most vulnerable to predation. The result may be significant skews in sex ratios, eg, as noted earlier for kaka, where apparently visible and healthy populations may comprise mostly elderly males. The following brief extracts suffice to illustrate:

- Whio: "*Whio is now so precarious that the focus of conservation management must shift from determining the relative importance of the agents of decline to securing whio from extinction…since large-scale native forest clearance has been curtailed in the last 20 years, the most important agent for decline has been predation…reducing the density of stoats is the only action we can currently take that is likely to lead to a significant improvement*"[108]
- Kiwi: "*Mammalian predators are the key cause of kiwi declines, and all unmanaged populations in NZ are declining, albeit at different and sometimes little known rates…increasing the scale of cost-effective pest control is a clear requirement for kiwi recovery, as it is for restoration of most other NZ biodiversity*"[109]

[107] Walker et al, 2017, Status and change in native forest birds on NZs mainland
[108] DOC, 2010, Whio/blue duck recovery plan 2009-2019
[109] LCR, 2015, Saving a national icon – preliminary estimation of the additional cost of achieving kiwi population stability or 2% growth

- Forest birds: *"Much experimental and circumstantial evidence suggests or demonstrates that predation by introduced mammals remains the primary cause of declines and limitation in remaining large native forest tracts"*[110]
- Alpine fauna: "*At least ten introduced predator species have been confirmed as frequent predators of native alpine species, particularly birds and lizards. We consider the primary threats to be mice and stoats, but this review highlights uncertainty about the current importance of rats, cats, pigs, possums and hedgehogs as predators in this ecosystem. In the case of takahe and rock wren, stoats are the primary predators, likely to be impacting significantly on population viability"*[111]
- Wetland birds: "*All introduced mammalian predators are abundant and/or widespread in NZ wetlands…while their precise impacts on the longterm viability of threatened bird populations have not been evaluated, (evidence suggests) that six threatened wetland specialists are at high risk of predation – brown teal, banded rail, fernbird, marsh crake, spotless crake and Australasian bittern"*[112]
- Coastal/riverine birds: "*The same predators as prey on wetland birds have a considerable impact on water bird populations in river and coastal habitats. For example, a single predator can destroy entire colonies of black fronted terns*"[113].

While predators are implicated as the key threat across most of NZ, braided river habitats present particular complexities. As noted earlier, braided river beds have been identified as an "uncommon ecosystem". Across NZ, the extent is around 250,000 hectares: 60% is in Canterbury, of which 13% is in the Upper Waitaki (McKenzie) Basin, which has some of the largest braided river systems in NZ.

Most of the river beds in the Upper Waitaki are Crown Land administered by LINZ, but managed by other agencies (eg, ECan for flood control, DOC for native plants and animals). The braided river habitat in Upper Waitaki has been modified, in part by introduced plants which invade nesting sites and provide cover for predators (crack willow and poplar were widely used in bank stabilisation, and weed species include gorse, broom, lupin); and in part by hydro schemes (eight hydro power stations have been built in the McKenzie Basin, supplying up to 30% of NZs electricity) [114].

A recent stocktake of management priorities[115] emphasised the importance of predator control:

- "*Strong evidence indicates that predation by introduced mammals and native avian predators is one of the most important threats to the viability of the bird populations that live on braided rivers"*
- *'Many trapping and poisoning operations have been undertaken over the past 30 years, but only three of these have yielded clear benefits for the birds. Most have had equivocal results, because they were not implemented at a landscape scale at sufficient intensity, and failed to target the full range of potential predators"*

[110] Innes et al, 2009, Predation and other factors currently limiting NZ forest birds
[111] O'Donnell et al, 2017, Impacts of introduced mammalian predators on NZs alpine fauna
[112] O'Donnell et al, 2015, Impacts of introduced mammalian predators on indigenous birds of freshwater wetlands in NZ
[113] Ibid
[114] Caruso, 2006, Effectiveness of braided, gravel-bed river restoration in the Upper Waitaki Basin
[115] DOC, 2016, Management and research priorities for conserving biodiversity on NZs braided rivers

- *"A very high priority is to develop cost-effective and efficient strategies to maintain and restore threatened species by reducing the impacts of predators on river birds, lizards and invertebrates, as well as salmonid predation on native fish*".

Weeds were also highlighted as a focus for management:

- "*Introduced weeds can be highly invasive, with long-lasting, possibly irreversible impacts on river braid geomorphology, ecosystem processes and competitive displacement of many indigenous plants and animals…weed invasions are a serious threat to river birds"*
- *"Weed encroachment reaches up to 75% in some rivers and as such reflects the extent of habitat loss. Weeds often establish on higher, more stable areas of islands and force breeding birds to nest closer to water – raising the risk of nests flooding"*
- *'Not all weeds are terrestrial. Didymo has become widespread through braided rivers"*
- *"Many riverbed weeds produce large quantities of seed, which can last decades in seed soil banks. A lapse in control for just one year can negate many previous years of investment".*

Experience shows that both predators and weeds may need to be targetted:

- "*In 2007, Meridian and ECan transformed a weed infested island to a "clean' site"*
- *"River birds were essentially absent prior to weed control, whereas after clearance, the island was used as nesting/roosting habitat by a range of river birds"*
- *However, breeding success in the first year appeared to be low, almost certainly because eggs and/or chicks were preyed upon"*
- *"This reinforces the need for predator control, as well as weed control, if threatened river bird populations are to persist or recover*".

The review identified uncertainties around other factors or recommended more research, including:

- Trout/salmon: "*Develop salmonid control methods to benefit threatened native galaxiids"*
- Fishing/recreation: "*Human use of riverbeds, eg, fishing, 4WD vehicles, has increased dramatically and research is needed to assess the impact of these factors"*
- River flows: "*The specific flow requirements of individual riverbed plants and animals are not well understood (and) our understanding is not sufficient to accurately assess the effects of altered flow regimes or to prescribe optimal flow regimes. We can hypothesise, but data need to be collected to confirm these hypotheses*"
- Catchment landuse: "*Landuse in the catchments of braided rivers potentially impacts on habitats of threatened species, especially as intensification increases. However, there has been no research conducted in NZ to determine what the precise impacts of such changes would be on the viability of threatened species populations".*

Acknowledging the complexities in the MacKenzie Basin, restoration projects in other areas are also grappling with complex systems, in particular complex predator-prey relationships. For example, the Cape to City project has captured the imagination of landowners, but recent research[116] notes that landowners understand the complexities: "*While landowners were supportive of a coordinated control programme, particularly because of their strong emotional connection to native biodiversity,*

[116] Niemic et al, 2016, Landowners perspectives on coordinated, landscape-level invasive species control

landowners considered how the programme may interact with their nuanced understandings of the local social and ecological context".

In plain language, this means landowners have seen the unintended consequences of past programmes (eg, less stoats, potentially more rabbits; less possums, potentially more blackberry): "*Landowners thus expressed a clear desire to see a plan for addressing these potential unintended consequences …ideally participatory processes involving landowners could examine potential unintended consequences and develop collaboratively a strategy for mitigating them".*

Returning to the draft DOC Threatened Species Strategy: in broad terms, it confirms that the strategy will be centred on prioritised locations across both public and private land: *"A shift towards managing ecosystems using the prioritisation approach (and) spatial planning tools to identify EMUs – sites that contain mosaics of related ecosystems and threatened species".*

The draft strategy presents principles for prioritisation of sites, accompanied by lists of threatened species but the priority locations are not identified or mapped as yet. Some submissions have questioned the species priorities, and recommended more detail on the spatial priorities, eg[117]:

- "*It may be that endemism needs multiple rankings, so there is most weight on taxa that are endemic at the level of the order, then family, then genus, species, sub-species, and the lowest weight given to taxa that are non-endemic at all levels, eg, Australasian bittern, which although nationally critical, also occurs in Australia".*
- "*Focussing beyond conservation land is a sound strategic theme. However, this needs to be supported by narrative and statistics that show where the problem lies and where to focus. How many and what types of threatened species occur on private land or leased public land? How many are now threatened because of past and ongoing habitat loss, and/or by other pressures, and where?"*
- *"This is the sort of contextual information required to direct conservation effort beyond public conservation land…for example, a well-intentioned large predator control project will yield few benefits for threatened species if there is little habitat remaining, and few species present that can benefit".*

In relation to the first point (what to prioritise), it is relevant to note here the new genetic analysis tools developed to identify biodiversity hotspots, especially hotspots of deep endemism:

- hotspots for deep endemic plants are the northern NI and northern offshore islands
- hotspots for deep endemic forest birds are today the cold beech forests in the deep south

In relation to the second point, the question of where to prioritise is a recurring theme in conservation literature; but arguably the threads have not yet converged at the national level:

- Predator Free NZ sets interim goals for eradication of predators (20,000ha) and suppression (1mha) by 2025, supported by Government investment of $7 million pa
- Applications were recently invited for projects to commence in 2018, leveraging off that Government investment (around 40 received, for significantly more than funds available)

[117] NZ Ecological Society, 2017, submission on DOC draft Threatened Species Strategy

- It is not currently clear the extent to which projects selected will coincide with the (emerging) DOC priority places and/or the (existing) regional priority places (eg, Cape to City) and/or the new government objective of planting one billion trees (presumably with concomitant requirements for predator control in the new habitat).

Accepting that the threads have not quite converged as yet – *placeholder pending more detail on the proposed national portfolio of priority places* – it can also be acknowledged that the new strategic imperatives are building forward from reasonably solid foundations. In this context, a recent publication[118] usefully charts the recent history of pest management in New Zealand.

On the offshore islands, around one-third are predator-free, and the report notes that the total area freed of introduced mammals doubled since 2003 to nearly 50,000 hectares.

On the mainland, the report notes that control of browsers (goats, deer) has generally declined in importance, but highlights the possum control undertaken under the TB-free programme:

- *"Control of possums to eliminate bovine TB from wildlife remains the single largest mammalian pest management programme in NZ. It began in the 1970s, paused in the 1980s, and then increased to an annual expenditure in 2014 of more than $50 million, covering over 8 million hectares"*
- *"Over the last decade about 75% of TB-possum control has been undertaken on farmland or in accessible areas adjacent to farmland (plus) about 2 million hectares of conservation estate (mostly using aerial 1080)"*
- *"The TB-possum control programme has been highly effective…an emerging issue for conservation is that if the TB-free goal is achieved, control efforts against possums (and collaterally against rats and stoats) will eventually cease".*

An earlier stocktake of possum control programmes attempted to estimate how many possums are in New Zealand, and how many there would be with no control[119]. In brief, that report estimated:

- Highest densities of possums in indigenous vegetation: 5-9 possums/ha in indigenous forest (less in beech forest, more in podocarp/broadleaf), 3 possums/ha in indigenous scrub/shrub, 2 possums/ha in exotic forest, 0.2 possums/ha in exotic grassland and tussock grassland
- No-control population: 50 million possums
- Post-control population: 30 million possums, ie, nearly 40% reduction
- The biggest reduction was in indigenous forest (non-beech), from 28m to 16m possums.

The authors emphasised the estimates were speculative; and more importantly emphasised that the point is not the numbers per se:

- *"What is important is not the number of possums, or the change in possum numbers as a result of control, but the change in the resources on which they impact"*

[118] Parkes et al, 2016, Past, present and two potential futures for managing NZs mammalian pests *in* NZ Journal of Ecology (2017) 41 (1): 151-161

[119] Warbuton et al, 2009, How many possums are now in NZ following control and how many would there be without it?

- *"Possum control is carried out for specific reasons (either to manage bovine TB or to protect conservation values) and it is critical that the focus remains on achieving a desired outcome, (ie, reduction in TB or increase in conservation value) rather than numbers killed"*
- *"Such general metrics have no relevance to management unless eradication is the goal".*

Arguably the same point applies, even under eradication scenarios.

Over these past decades, possum control has been largely focussed on the TB-free objective. For example, in 2008/9 possum control was undertaken over half of NZ (13m ha), of which 75% (nearly 10m ha) was AHB control, with the remaining 25% being undertaken by DOC (2m hectares) and regional councils (1.4m hectares)[120]. Warburton et al explain that, in respect of conservation values:

- *"Possums are not always the key threat at a particular site or for a particular native species or ecosystem"*
- *"In addition, control of possums alone may not always have net benefits for biodiversity because, for example, of the increase in rodent numbers, and hence predation, that can occur when possum numbers are reduced"*
- *"While DOC formerly used a possum control plan to prioritise its possum control, the focus is shifting from mainly single-species control to control of key pest threats at high-value conservation sites".*

In these coming decades, the challenge is how to consolidate the gains made under the TB-Free programme, while gearing up to deliver on the new Predator-Free vision, ie, expanding to a wider suite of predators at prioritised (large) high-value sites. Briefly resetting the context:

- In the early 2000s, DOC took the predator-control technologies developed on offshore islands and applied them to a network of "mainland islands" (eg, Trounson)
- Today, the DOC mainland islands (6000 ha) have been supplemented with nearly 40 community led eco-sanctuaries (10,000 ha)
- Most of these sanctuaries (fenced or unfenced) are relatively small: the largest are Maungatautari (3700ha) and Cape Kidnappers (2200ha)
- It is a quantum leap to control a wider suite of predators across the millions of hectares covered by the AHB programme, let alone the whole of New Zealand (27 million hectares).

In 2016, Parkes et al reported the emergence of large-scale control of possums and predators across private and DOC estate by partnerships of DOC, regional councils, NGOs and private landowners. The recent Cape to City Conference updated on examples of landscape-scale predator control programmes currently underway (in particular Cape to City 25,000 hectares, but also Taranaki Mounga, Project Janzoon, Wellington City); and highlighted the substantial investments being made by the Next Foundation (a private, philanthropic trust) to fund the initial knockdown operations.

Related to the last point: in 2014 DOC short-listed eight sites for consideration by the Next Foundation, outlining the rationale as follows[121]:

[120] Warbuton et al, 2009, How many possums are now in NZ following control
[121] DOC, 2014, Game change proposal for conservation in NZ

- "*Approaches that aim to conserve a full range of ecosystems, supplemented by work targeted at particular species, is the most cost-effective strategy for biodiversity"*
- *"Because of the pervasive effects of a range of pressures (browsers, predators, weeds etc) many elements of NZs biodiversity are dependent on active management for their persistence (and) in general, it appears that systematic management of all major pressures is much more effective than removal of just one or two pest species"*
- *"Having identified the need to comprehensively manage threats to both ecosystems and threatened species we are left with the question of how best to choose where to apply such management*".

Against a set of criteria, DOC selected 30 sites which were then shortlisted to the final eight, each supported by a dossier describing biodiversity values, key pressures and opportunities for community partnerships. The sites were, from north to south:

- North Island: Waipoua Forest, Great Barrier Island, Pureora, Mount Taranaki
- South Island: Kahurangi, Molesworth/Seaward Kaikoura, Arthurs Pass, Paringa-Haast.

In the event, Taranaki Mounga was selected as the front-runner case study by the Next Foundation.

Returning to the report by Parkes et al, the authors note that priorities are currently a "mish-mash":

- *"The current system for managing introduced mammals is the sum of a large number of individual projects that have been independently added (or abandoned) according to local, regional and national priorities assigned by a largely un-coordinated mix of funders, agencies and stakeholders with different goals and objectives"*
- *"The strength of the current deployment is it takes account of regional, local and special interest priorities. Conversely, a consequential weakness is that regional and local decisions may not take explicit account of national priorities"*
- *"There is no doubt this strategy can be improved… by continuing the recent shift from the 1990s focus on single pest plans towards management at prioritised conservation sites"*
- *"A key question is how future additions (and deletions) to the areas and/or the pest species managed might be used to enhance the national conservation interest… pest management also needs to be integrated with other conservation actions (such as active restoration) across a portfolio of actively managed sites".*

Parkes et al acknowledged the new spatial prioritisation tools:

- "*There is a growing literature on prioritising and optimising the spatial layout of biodiversity assets, usually with a focus on reserve design… However, in NZ the reserves are essentially in place and the main management issue is to maintain or improve their quality by controlling threats such as introduced mammals"*
- *"Most of the forested and alpine areas of NZ are connected along the axial ranges. The problem is not a lack of native habitat connectivity but lack of safe passage"*
- *"Outside the main axial ranges conservation units are in more or less isolated patches (eg, the native forests in Northland, Mount Egmont, Banks Peninsula) and connecting units will require pest management in urban or rural habitats or active restoration of linking habitats".*

The authors question the predator-free vision, instead favouring the core-halo model:

- "*The risk with the vision is that despite local and international enthusiasm, it may distract focus and resources from advancing the practical improvements we know we can achieve under the current or enhanced mainland island/network models, ie, lead to slogans rather than the thoughtful solutions we can already achieve – and lead us down the failed "last rabbit" and "last deer" policies of the past"*
- *"We suggest that the core/halo model of pest management, within a network of assets to be protected, will best protect NZs biodiversity for the foreseeable future"*
- *"The issue of community support does not apply only to control methods, but also to the goals, especially as these increase in scale and vision"*
- *"To gain complete support will require the lead agencies to work with communities in partnership, rather than through the currently used consultation process in which decisions are made essentially without wider inputs and then delivered more or less as fait accompli".*

While these authors question the predator-free vision, others are more optimistic[122]:

- "*Clearing predators from all of NZ may seem to be a fantasy, but 50 years ago, so did clearing predators from tiny one hectare Maria Island. With the right tools and social investment, history has shown what transformations can be achieved"*
- *"Removing multiple introduced species from a large inhabited archipelago is at least as much an economic and social challenge as a biological one"*
- *"Addressing the challenge will require the integration of pest control research activities with wider biological, social and economic considerations. Ecologists will need to step well outside their traditional boundaries and work with social scientists, economists and policy-makers…at the core of the process is a bottom-up driven approach to community engagement in conservation"*
- *"Eradication of invasive predators from the two largest offshore islands (Great Barrier 28,000ha and Stewart Island 175,000ha would demonstrate proof of concept for scaling to the NZ mainland…simultaneously, mammal-free peninsulas have been advocated as a stepping stone to achieving local eradications"*
- *"Following this, more larger eco-sanctuary reserves (larger than 100,000ha) are proposed, providing connectivity of halos across landscapes".*

Picking up this last point re connectivity: connectivity is traditionally thought of in terms of vegetation corridors, but – as noted in the Cape to City project – habitat connectivity may be a non-issue for most forest birds (they can fly). Instead, connectivity may be as much or more about predator control[123]:

- *"For many indigenous species, connectivity between habitat patches may be hindered not only by structural barriers but also by the presence of invasive species"*
- *"Invasive species management is usually not considered explicitly in the design of reserve networks and linkages, despite the fact that it is a prerequisite for persistence of many taxa*

[122] Russell et al, 2015, Predator-Free NZ – conservation country *in* Bioscience, May 2015/Vol 65 No. 5
[123] Glen et al, 2013, Connectivity and invasive species management *in* Biol Invasions (2013) 15:2127-2138

and ecological processes… Researchers and managers should remember that linkages need not always be structural, and that structural linkages may not always be sufficient"

- *"By incorporating invasive species management into the design of reserve networks, conservation management must move towards an integrated landscape approach, in which reserve selection, connectivity and off-reserve management are optimised at landscape scale*
- *"This approach refocuses invasive species management away from individual sites towards planning at the scale of landscapes and meta-populations, and obliges conservation managers to understand the mechanisms behind "core' and "halo" effects"*
- *"Such approaches can extend the effective area of a reserve at significantly lower cost than purchasing and managing new reserves…temporal as well as spatial targetting should be tested, eg, linkages created by continuous management could be compared with a pulsed approach in which invasive species management is conducted only when dispersal is likely".*

Briefly re the last point: smart targetting was a key theme at the recent Cape to City Conference, underpinned by research currently underway developing a better understanding of predator movements across the landscape. The key point is that – while the unit of management is the whole landscape – spatial/temporal targetting can significantly improve the effectiveness and cost-effectiveness of trap networks. Two brief examples from Cape to City:

- Control for cats/ferrets/stoats is undertaken across the landscape; control for rats is targetted to the time and place and the values being protected
- Across a trap network, some traps catch nothing, and conversely some traps catch most of the target species (the trick is knowing which!).

Pulling threads together from the preceding section on key issues and ways forward for the birds:

- Not all bird species are in trouble – some are surviving or thriving in the presence of humans and introduced species, eg, tui; others will not make it without human help, eg, kakapo
- The most vulnerable mainland species are the deep endemics – mostly forest birds, eg, kaka, but also inland nesting wader/coastal species, eg, wrybill
- Key habitat for these species is in the South Island – west coast beech forest and Mckenzie Basin braided river habitat
- The key threat is predators, especially in beech-mast years; compounded by weeds in the braided rivers
- The key management action is predator control (plus weed control in the braided rivers)
- Where these vulnerable populations are not managed, the decline is inexorable, eg, kiwi
- Where populations are managed, they can recover – either through predator control and/or island translocations, eg, kokako, up from 400 pairs in 1999 to 1600 pairs
- Island translocations can secure some species from extinction (but not all, eg, whio), and habitat is inevitably limited on the smaller offshore islands
- The new frontier is making a stand on the mainland, building forward from the TB-free possum programme and the current network of mainland islands/community sanctuaries.

The expectation is that "making a stand" requires multi-species pest control in large areas, in particular large areas with existing habitat and extant threatened species – potentially episodic control in the South Island, but sustained control in the North Island:

- The order of progress is likely to be some progression through large islands (eg, Great Barrier, Stewart Island), peninsulas (eg, Banks Peninsula, Coromandel, Northland), and prioritised large mainland areas (eg, Taranaki Mounga, Cape to City)
- Multiple agencies are currently invested in the prioritisation of areas, but it is not currently clear whether these will converge into an agreed national portfolio of priority places
- Within the priority places, the "core-halo" model of management is likely to apply, ie, intensive management in the core supported by strategic management within the halo.

Some see the end-game as Predator-Free NZ, others question the "last deer" philosophy – either way, it is ultimately the impact for the birds that is most at issue:

- The challenge is partly technical, but equally economic and social - it will be the last predator (or the last 20%) which tests all three dimensions
- In the meantime, work is proceeding apace towards the Predator-Free 2025 goals – a stocktake in 2025 could be expected to check and reset the trajectory to 2050 as necessary.

Place holder pending update on the extent to which work is underway – under Predator Free NZ and/or the DOC Strategy and/or Next Foundation and/or regional initiatives - to identify an agreed portfolio of national priority places for sustained predator control.

INDIGENOUS FISH

Pre-human context

The longer geological history of NZ is as important in explaining key features in the NZ fish fauna, as it is for NZ flora. In 2009, NIWA explored distribution patterns in NZ freshwater fish, both fossil and living, finding that present day patterns reflect a deep ecological dichotomy between diadromous (migrating to and from the sea) and non-diadromous fish (who live and breed inland)[124]:

- *"About half the fauna is diadromous, and the habit of these species, moving to and from the sea, provides them with great resilience in the face of major landscape perturbations, resulting from orogeny and land submergence, glaciation and volcanism.*
- *"Diadromous species, with few exceptions, have distributions that span the full latitudinal range, so that the southern fauna is much the same, taxonomically, as the northern one*
- *"There must have been historic impacts when…glacial ice sheets obliterated the river fauna…similarly, volcanism would certainly have removed fauna from rivers in areas of major ash deposition, eg, Mt Taranaki only about 300 years ago and Mt Tarawera in 1886*
- *"But the ability of diadromous species to reinvade from coastal seas (means) there has clearly been rapid restoration of fish communities once congenial habitats ave been restored, just as happens today when there are local fish kills that result from industrial discharges of toxic materials, or from ash falls and lahars".*

In contrast, non-diadromous species are more strictly confined to freshwater habitats:

- *"As a result, species are much less resilient, they exhibit complex patterns of sympatry[125], and their ranges are much more localised"*
- *"There is a major shift in taxonomic composition across latitudes, so that the northern fauna is entirely different from the southern one"*
- *"As well, molecular studies are revealing that patterns of distribution may be even more fragmented and localised than the present taxonomy indicates"*
- *"Perhaps as a consequence, it is in this group that the negative impacts of introduced trout have been most obvious".*

The NIWA report identifies geographic patterns in the distribution of non-diadromous species, spotlighting the Otago area:

- *"It seems the most active local speciation/radiation processes of the non-diadromous fauna took place across the old Otago peneplain, which is widely regarded as the most ancient well-defined land surface in NZ…if any of NZ was permanently emergent, it was probably the southern half of the South Island"*
- *"Moreover, diversification may have involved an area rather wider than just the old Otago peneplain, perhaps extending north into the present Waitaki River. Certainly, there is some local endemism in the freshwater fish fauna of the McKenzie Basin".*

[124] Robert McDowell, 2009, Historical and ecological context, pattern and process, in the derivation of NZs freshwater fish fauna

[125] Wikipedia: An initially interbreeding population that splits into two or more distinct species

Contemporary State & Trends

As for plants and birds, national reporting of state and trends relies first on DOC threatened species classifications. A DOC paper published in 2010 sets out the process in some detail [126]:

- "*Key population metrics in assessment of threat status were the number of mature individuals estimated to be in the population, and/or the area of occupancy for the species*
- *"For each species, key threats were identified and the likelihood that these would continue…an estimation of the predicted rate of decline was also required"*
- *"The majority of the threatened species occur in the Canterbury and Otago regions where a suite of non-migratory galaxiids exist".*

Of around 50 resident native fish, around 40% (21 species) are identified as threatened[127]:

Category	**2009**	**2013**
Critical	4	5
Endangered	3	6
Vulnerable	7	10
Total threatened	**14**	**21**

No fish species were recorded with genuine improvements, but 8 were recorded as genuinely worse in the period 2005-2011 - the non-migratory galaxiids, plus Canterbury mudfish ("critical" species in red) [128]:

Genuinely worse	**DOC comment**
Canterbury mudfish	Serious range contraction, likely loss of all peripheral populations
Teviot flathead galaxias	Precautionary, may not be distinct entity, only one decent population
Eldons galaxias	18 populations, 6 recently lost, only 2 secure
Dusky galaxias	Lost populations since last listing, only 4 strong populations left
Roundhead galaxias	17 sub-popns, vulnerable to trout invasion, drought/floods fluctuations
Bignose galaxias	17 sub-popns, Waitaki consents hearing outcome may affect status
Upland longjaw galaxias	Hurunui/Buller popns gone. Now only in Rakaia and Rangitata Rivers
Clutha flathead galaxias	58 popns, barrier failures and trout liberations, koaro predation

The DOC draft Threatened Species Strategy identifies fourteen fish species, including:

- Canterbury mudfish and eight galaxias; plus
- Longfin eel, giant kokopu, shortjaw kokopu, lamprey, torrentfish

[126] Allibone et al, 2010, Conservation status of NZ freshwater fish, 2009
[127] Goodman et al, 2014, Conservation status of NZ freshwater fish, 2013
[128] DOC, 2013, Summary of changes to the conservation status of taxa in the 2008-2011 listing cycle

Of the latter fish species, the longfin eel is perhaps best known and best researched. Following through from a PCE report questioning the status of longfin eel, MPI commissioned an independent review in 2015[129] which found limitations in current analytical approaches:

- "*Graynoth et al developed a novel approach, in which current and pristine eel biomass are estimated from a model, (concluding) that current spawner escapement is probably <20% of the pristine state"*
- *"The longfin model is tuned on data from 212 sites, located in 5 regions (and) extrapolates that to the whole country…there is little doubt that this is a restricted basis for the analysis"*
- *"The analysis applies a mix of a limited set of observations, empirically derived relationships, simulated relationships, and GIS extrapolation…noting the many uncertainties in the relationships and parameter values in the current analysis…the panel considers that further development is required before the adequacy and relevance of the results for management of the stock can be evaluated".*

FFNZ suggest that, to the extent similar approaches are employed in other areas of biodiversity, ie, limited data/modelled extrapolations, similar caveats should apply to their use in policy.

The independent panel acknowledged the difficulties of estimating state and trends:

- "*Estimating the status of any fish population is fraught with difficulty. In most cases this is simply due to lack of data from when the population was in a pristine state. This is certainly the case for NZ eel populations which have comparatively little data prior to the 1990s"*
- *"Given these difficulties, it would be inappropriate for us to draw strong conclusions on the status of NZ eel populations"*
- *"We note that, in general, electric fishing surveys provide indices that are similar to the trends in relative biomass seen from CPUE[130] indices: a period of decline from the early 1990s to the late 2000s, followed by relatively stable abundance"*
- *"For shortfin eels, both the North Island and South Island CPUE indices show similar trends: a decline in the 1990s, followed by a quite sudden and substantial increase in CPUE starting in the mid-2000s".*

The Independent Panel made cogent wrap up points which may be relevant more widely than eels:

- "*Our most striking observation is that most data sets seem to have been collected and analysed in relative isolation. Depending on the data used and the approach taken, different conclusions have been reached. What appears to be lacking is an integration of the different information sources, a comprehensive assessment addressing all potential impacts/threats to the eel, informing the managers on the status of the stock as well as its resilience to human impacts"*
- *"We have noted that several data sources have been identified, that have not yet been used to the fullest extent possible, while at the same time the shortage of adequate information is a recurring theme in discussions".*

[129] Haro et al, 2015, 2013 Independent Review of the information available for monitoring trends and assessing the status of NZs freshwater eels

[130] Catch per unit effort

Looking beyond eels, EA2015 reported an estimated 11% decline in IBI (Index of Biotic Integrity) in the period 1970-2007. The IBI is based on records entered in the NZ Freshwater Fish Database (presence/absence), and curiously includes trout. The estimates rely on work published in 2009, dis-aggregating IBI scores by landcover and decades[131]:

IBI scores	Indigenous	Scrub	Tussock	Exotic	Pasture	Urban
!970s average	30	41	35	35	34	33
2000-2007 average	36	37	17	32	27	27

MfE preface the estimate of a decline in IBI with caveats about accuracy. It is relevant here to note that the assumed trends are somewhat confounded by very different sample sizes: just over 1,000 records for the 1970s, relative to just under 10,000 records for the 2000s[132].

More recently, MfE commissioned further analysis of the NZ Freshwater Fish Database[133], recognising that: "*without accounting for confounding factors in the NZFFD, there is too much noise in the dataset to accurately describe trends in the abundance of eels and other fish species".* In particular, this work attempted to estimate "probability of capture", rather than just using raw presence/absence information. The findings included that in the 1977-2015 period: "*There were seven increasing trends and twelve decreasing trends. All species with increasing trends were native, and all species with decreasing trends were exotic".*

The report includes (Appendix D) trend graphs for individual species, eg, Canterbury galaxias, longfin eel, brown trout, but the authors emphasise:

- "*The present study provides information on the direction and magnitude of trends in the relative abundance of freshwater fish species, but it does not consider implications"*
- *"Assessing ecological or management implications of the trends would require the socio-ecological values supported by the fishes to be clearly defined, and an understanding of the pressures structuring the populations".*

Contemporary Pressures

EA2015 is light on analysis of pressures structuring indigenous fish populations.

It includes a section on freshwater pests which may impact through predation and competition; relying on NIWA factsheets which identify 9 fish species, 11 invertebrate species and 41 plant species as pests of greatest concern. These factsheets follow on from earlier summaries presented in Environment NZ 2007, eg, that pest aquatic plants have invaded over 60% of lakes in NZ. However, the NIWA factsheets are not especially relevant for assessing or prioritising current pressures impacting on indigenous fish (they were not designed for that purpose). Instead, the Biodiversity Collaborative Group is currently commissioning specific analysis: *placeholder pending completion of work assessing state, trends and pressures on native fish.*

[131] Mike Joy, 2009, Temporal and Landcover trends in freshwater fish communities in NZs rivers –Figure 4-10
[132] Mike Joy, pg 13-14 *in* WWF, 2012, Beyond Rio
[133] Crow et al, 2016, Temporal Trends in the relative abundance of NZ freshwater fishes

In the interim, this section summarises a selection of recent work for just some river/lake species, including research assessing the role of introduced species.

The NZ Biodiversity Strategy sets the context, including that many freshwater ecosystems are subject to a high degree of invasion by introduced pest species, significantly affecting indigenous habitats and ecological processes[134]:

- "*Most freshwater ecosystems have been significantly modified by introduced species"*
- *"Many animal and plant pests are highly invasive in freshwater environments, but are not detected until the extent of their spread makes them difficult to control. Effective technologies for control or eradication are not always available"*
- *"The illegal transfer and release of aquatic species create significant risks to indigenous freshwater biodiversity"*
- *"Trout have had significant adverse impacts on indigenous freshwater species and ecosystems, and their continuing effects are not fully understood…in some places, they may need to be reduced or removed*".

As noted above, the non-migratory galaxiids currently dominate the threatened species list. Importantly the DOC Recovery Plan for non-migratory galaxiids (2003-2013) notes that it is only within the last decade that many of these species have been described - most were formerly considered to be "Canterbury galaxia", a species that was not considered threatened.

The Recovery Plan highlights that the stream-dwelling galaxiids in the South Island who dominate the threatened species list have all undergone range reduction and population fragmentation following salmonid introductions, eg:

- "*Eldon's galaxia: range has been reduced by the spread of brown trout"*
- *"Roundhead galaxia: fragmentation of populations has occurred as a result of water abstraction and brown trout"*
- *"Dusky galaxias: the presence or absence of this species is generally controlled by predatory and competing fish species such as brown trout, brook char and koaro"*
- *"Flathead galaxias: populations have fragmented as the flatheads have been displaced by brown trout".*

In 2003, Townsend reviewed a decade-long series of studies on the effects of brown trout in NZ streams to throw light on the way an exotic fish can influence every aspect of the ecology of the ecosystem it invades[135].

His approach focussed on streams with and without non-migratory galaxiids to help infer the impact of the trout invasion. In summary:

- "*At the individual level, grazing invertebrates showed changes in behaviour as a result of the introduction of brown trout'*
- *"At the population level, trout have replaced non-migratory galaxiids in some streams but not others, and have affected the distribution of koura and other large invertebrates"*

[134] The New Zealand Biodiversity Strategy, page 49, page 51
[135] Townsend, 2003, Individual, population, community and ecosystem consequences of a fish invader in NZ

- *"At the community level, trout have suppressed grazing pressure from invertebrates, and are thus responsible for enhancing algal blooms"*
- *"At the ecosystem level, essentially all annual production of invertebrates is consumed by trout (but not by galaxiids), and algal productivity is six times higher in a trout stream*".

A 2009 report found that the decline of some non-migratory galaxiids is related to episodic invasion by predatory salmonids, and larger native fish: "*For many streams, the probability of invasion is related to the loss of a downstream barrier (usually a waterfall which moved during high flows), or the introduction of predatory fish upstream of the barrier*"[136].

In 2013, research in the Waimakariri catchment confirmed the role of trout as predators[137]:

- "*Trout created demographic sinks for G. vulgaris across most invaded reaches, while refuge populations in streams above barriers to trout acting as demographic sources"*
- *"Predation pressure is likely to be highest in areas where infrequent flooding allows high densities of large trout to occur, and where there are few refugia for galaxiids"*
- *"G. vulgaris fry recruitment was high in trout-free refuge streams (65% of all trout-free reaches retained fry) but recruitment of fry was limited to 9% in trout-invaded reaches…91% of trout-invaded reaches contained no fry at the end of summer"*
- *"G. paucispondylus recruitment does not appear to be as severely affected…but further investigation is required"*
- *"Management plans for galaxiids should assess the costs and benefits of active rehabilitation projects, eg, creating trout barriers…a conservation covenant could be set up with the landowner, whereby the landowner agrees to maintain trout barriers and riparian habitat".*

The impact of trout and other introduced fish is not confined to non-migratory galaxiids: in 2013 a review of invasive species in lakes reported that[138]:

- *"As a result of the introduction of salmonids to NZ lakes, several commonly occurring fish, such as koaro and inanga, have been drastically reduced in their abundances in lakes…these species now remain only as diminished, remnant populations confined to refugia"*
- *"Sediment and nutrient retention and processing have been altered by the introduction of alien fish, often illegally for angling opportunities. The negative association between water clarity in North Island lakes and the presence of rudd, tench, perch, catfish, goldfish and/or koi carp, indicated that water clarity was reduced by as much as one-third to one-half in lakes containing these fish compared with those without"*
- *"The apparent local extirpation of native dwarf inanga in a Northland lake followed introductions of mosquito fish"*
- *"The recent spread of alien bladderwort throughout Northland and Auckland appears to be at the expense of the native bladderwort, which has been designated "nationally critical"*
- *"Significant correlations have been found between dominance by the macrophyte Egeria densa, the presence of rudd, tench, catfish, koi carp, and sudden regime shifts in shallow lakes to a turbid state".*

[136] Allibone et al, 2010, Conservation status of NZ freshwater fish, 2009
[137] Woodford and McIntosh, 2013, Effects of introduced trout predation on non-diadromous galaxiid fish
[138] Schallenberg et al, 2013 *in* Ecosystem Services in NZ

While the predatory role of trout (and large native fish) has been known for some time, another report implicates a more unexpected source of predation – introduced mammals - noting that anecdotes throughout NZ show that mammalian predators regularly take freshwater fish, eg[139]*:*

- *"Mice have been video-recorded consuming all eggs of inanga from spawning sites; and mice along with rats, hedgehogs and stoats are likely to feed on nests of other galaxids, such as short-jawed, banded and giant kokopu"*
- *Cats have been seen taking eels and kokopu in Northland; stoats have been recorded dragging live and freshly dead eels and a live lamprey along tracks, presumably after catching them; stoats have also been seen taking freshwater crayfish"*
- *Fish were a regular dietary item of stoats at Okarito and Te Urewera, present in up to 5% of gut samples in some seasons".*

Turning now to Canterbury mudfish, another national priority: the NZ Mudfish Recovery Plan (2003-2013) identified loss of wetlands as the main historical factor; suggested the biggest agents of decline currently are "*drainage schemes, irrigation and land development*"; and emphasised that developing good relationships with landowners is imperative.

key actions in the Recovery Plan included securing key sites from pest fish invasions; managing water levels; and surveying for new populations. Notably, the last action was successful. In 2007, Harding et al reported that the status of Canterbury mudfish was precarious owing to the limited number of sizeable populations not accessible to predatory fish; but went on to announce the discovery of a major new population in the Waianiwaniwa Valley[140]. The significance and interesting features of this new population were:

- The mudfish were occupying riverine habitat, rather than wetlands
- Flows in the mainstem Waianiwaniwa River were greatly reduced in summer 2007 and large portions of the Hororata and Selwyn rivers further downstream had been consistently dry for long periods over previous years. Dry reaches downstream would make access for eels and other migratory species particularly difficult
- The seeming absence of trout and eels meant the river may be largely free of major predatory fish.

Turning now to longfin eels: accepting that they may be predators of other native species, they are also iconic species in their own right. In 2010, NIWA undertook work to assess the status of longfin eels in the tributaries feeding Te Waihora (Lake Ellesmere, Canterbury)[141].

The tributaries in the lower Selwyn River catchment –eg, Irwell, Halswell, Harts Creek – are notable on two counts: they are one of the very few lowland areas where commercial eel fishing is prohibited, and they also have some of the highest nitrate levels in NZ.

Key findings in the NIWA report indicate that the first may be more material for the eel population:

[139] O'Donnell et al, 2016, Impacts of introduced mammalian predators on NZs alpine fauna
[140] Harding et al, 2007, Persistence of a significant population of a rare Canterbury mudfish
[141] Jellyman & Graynoth, 2010, The importance of tributary streams of Te Waihora in maintaining longfin eels

- Compared with the commercially fished area, the reserve area contained a significant number of longfins, while the fished area had none (and the size of shortfin eels was much larger in the reserve area)
- Highest biomass was in Birdlings Brook, and relatively high in the Selwyn at Coes Ford (strongly influenced by the presence of overhanging willows/roots which provided cover)
- Comparing the size of longfins with other fished rivers in the South Island, the mean lengths from Te Waihora tributaries exceed those of all other rivers assessed
- Growth rates have improved in Te Waihora since studies commenced in the 1970s, despite the loss of the macrophyte beds in the 1968 Wahine Storm and some decline in water clarity – compared with annual growth rates for other South Island rivers, growth is above average for shortfins and well above average for longfins
- In summary: the authors estimated the Te Waihora tributaries may support as many as 10,000 large female longfin eels, of which around 500 could migrate each year (around 2% of the estimated total annual NZ breeding migration).

The extracts above indicate that - as for other indigenous species - direct predation is a key issue impacting on indigenous fish populations (be it commercial fishing, trout, other game fish/pest fish, and even mice/rats/cats/stoats); and that active management may be required to secure or restore thriving populations.

One aspect is fish barriers. On the one hand, there is an imperative to open up migratory pathways for the diadromous native species. On the other hand, barriers might ideally be designed to allow native passage, but exclude trout. For example, in 2011 McDowall wrote that Hamurama Stream, a major tributary of Lake Rotorua, was rich in koaro before the introduction of trout[142]:

- *"For centuries, maori communities living around NZ lakes had depended heavily on their fisheries production which had abounded in the lakes prior to trout being introduced"*
- *"Before long, huge bags of large trout were being caught by anglers…but there was a cost"*
- *"The massive decline of native fish populations in these lakes is (described elsewhere) but it is relevant to recall Gilbert Mair's description of maori overnight harvesting a ton weight of whitebait (koaro) from the Hamurama Stream in the 1860s".*

Fast forward 150 years, and a fish pass has been installed in the Hamurama Stream – a prototype fish pass designed to exclude trout, but allow free passage for koaro. FFNZ is not currently aware of the success or otherwise of this trial.

A slightly more drastic approach has recently been trialled in the Karori Reservoir, in the heart of the Zealandia Wildlife Sanctuary in Wellington City. This time, the objective was eradication of trout (using rotenone, a fish poison). Fish & Game reported the story in their magazine in 2012[143]:

- "*Zealandia is well-known for its conservation successes, with booming populations of little spotted kiwi, kaka and tuatara thriving within the mammalian predator-proof fence"*

[142] McDowall, 2011, Ikawai – freshwater fishes in maori culture and economy, page 313, page 646
[143] Pham and Gloss, 2012, Silently spreading death

- "*In a collaborative project led by DOC, brown trout were eradicated from small streams within the sanctuary to provide habitat for banded kokopu, which were present in low numbers within the catchment"*
- *"Banded kokopu were captured prior to the poisoning, the streams and top Karori Reservoir were treated, and the banded kokopu released back to their home streams"*
- *"In the ten months since the treatment, surveys indicate the trial was successful, with no trout being detected in the tested areas, and banded kokopu and koura thriving".*

In the Waikato region, a similarly bold, experimental approach is being taken with koi carp, considered to be one of the most invasive freshwater fish in the world. Koi carp were introduced to NZ as an ornamental fish, but are now a significant problem in Waikato shallow lakes - uprooting water plants, lowering water quality, and eating insects normally consumed by native fish. In 2012, Waikato Regional Council built a koi carp trap and digester to remove koi carp from Lake Waikare[144]:

- "*Over 4 years, our demonstration site has removed over 35t of invasive fish from the lake"*
- *"The harvested fish are converted into a granular, nutrient-rich fertiliser/fishmeal"*
- *'Recycled' invasive fish meal fertiliser pellets are being trialled in dune restoration planting…planting trials suggest many dune ecosystems need this additional fertiliser for improved plant survival and growth because historical marine-derived nutrients provided by large colonies of nesting sea birds has been significantly reduced"*
- *"We have also compressed invasive fish meal into baits for use in rat and stoat traps and chew cards. It's a simple concept – using one invasive animal to control another. Preliminary trials indicate the baits and chew cards are attractive to rats and also hedgehogs"*
- *"The long term aim is a self-funded, cost neutral invasive fish removal programme with outputs supporting other environmental initiatives. The same model could be applied by other agencies where invasive fish are problematic".*

A final point: the NZ Biodiversity Action Plan includes a target that "*By 2017, NZ will have identified significant freshwater systems for restoration*". FFNZ is not currently aware of the extent to which this has been done, or whether these will be part of – or separate to – the DOC EMUs. *Placeholder pending update on the prioritisation of indigenous fish within DOC EMUs, and/or within the upcoming portfolio of national priority places.*

In summary:

- Indigenous fish have historically been significantly impacted by introduced species
- Today, evidence indicates that most indigenous fish species are relatively stable, but some species in Canterbury/Otago (non-migratory galaxiids, mudfish) are declining
- The key threat to these populations is predation by introduced (and native) species; a key management action is maintaining barriers to trout passage
- For other indigenous fish, indications from (limited) control/eradication trials to date are that introduced species continue to suppress indigenous fish populations
- FFNZ is not currently aware of any systematic national approach to prioritise control of introduced species; nor any Predator-Free initiatives for fish (as for birds) at this time.

[144] WRC website, CarpN Neutral Project, downloaded 23/10/2017

STRATEGY & PRIORITIES

The NZ Biodiversity Strategy was published in 2000, setting out high-level goals to be achieved by 2020. The key issue identified was the impact of introduced species in both land and water:

- "*While ongoing habitat loss and modification continue to be a threat, an even more serious and pressing threat in terrestrial and freshwater ecosystems is from invasive introduced species. Collectively invasive pests pose the greatest single threat to our remaining natural ecosystems and habitats and threatened native species"*
- *"Widespread clearance of native vegetation, often under subsidy, drainage of wetlands, extensive reclamation of estuaries, and unrestricted fishing have stopped".*

The Strategy identifies issues relating to priorities for protection of habitats on private land:

- *"RMA provisions to promote protection of significant indigenous vegetation and habitats have not been effectively implemented…due to difficulties in defining "significant", lack of clarity over values to be protected, uncertainty over the right mix of rules and non-regulatory methods, ineffective consultation with landowners, resourcing problems in local authorities, and unresolved issues relating to private property rights, community benefit & cost-sharing"*
- "*There is a need for consistent identification of significant remnant natural habitats through enhanced survey and assessment programmes, to determine relative biodiversity value and therefore national and local protection priorities".*

Arguably, 17 years later, limited progress has been made on this last recommendation.

The Strategy was published in the same year as the MAC report on biodiversity on private land and similarly recommended a partnership approach to working with landowners:

- "*The Strategy proposes that agencies work together with land managers to ensure that the critical elements of our indigenous biodiversity are sustained…most of the remnant natural areas on private land are there by the conscious choice of landowners and their forebears"*
- *"Many landowners want to contribute, but want to be sure that their efforts are part of a coherent larger programme; they are also looking for partnerships based on mutual respect of their rights and responsibilities, along with those of management agencies and other interest groups"*
- *"Regulation alone is not a preferred option to protect remnant natural areas on private land. Many landowners actively manage remnant habitats now and want to be acknowledged for, and assisted in, what they are doing. Landowners generally don't react positively to being told what to do, therefore regulation is likely to be counter-productive and risks losing many private conservators across the country. Securing the active and willing participation of landowners is therefore pivotal to sustaining indigenous biodiversity on private land"*
- *"The use of incentives to facilitate voluntary protection has not been fully explored or tapped…existing funding cannot meet current demands on the Nature Heritage Fund, Nga Whenua Rahui and QEII Trust, nor provide assistance for ongoing pest management".*

In 2005, an independent review charted progress made against the Biodiversity Strategy[145]:

- *Weeds: "Two years ago the 'Weedbuster" programme was launched. We believe this was one of the most important developments in the past five years as it capitalises on the synergies between DOC, regional and district councils and community voluntary efforts. Many of the Biodiversity Condition Fund projects were for weed control on private land where weeds spread with urbanisation and peri-urban development"*
- *Pests: "Improved control techniques and Package funding made possible the impressive successes in eradicating rodents from priority islands (and) ten other islands have remained rodent free. The result has been significant gains for indigenous species and ecosystems, including many threatened species"*
- *Progress: "We need to comment on the gains in the context of the overall size of the task. There has been success in pest control and eradication for high-value areas such as offshore islands, sanctuaries and mainland islands but these represent less than 3% (200,000ha) of the lands administered by DOC. A further 32% received less intensive management, and about 55% of the lands administered by DOC received only limited or no management".*

Arguably, the proportions might be similar (or better?) for private land. The independent reviewers commented on the difficulties in assessing progress:

- *"It is difficult to score progress towards achieving the desired outcomes without quantifiable targets and given the patchy monitoring and reporting systems. What information we do have indicates that controlling animal pests to achieve specific outcomes for threatened species and habitats remains perhaps the most difficult problem facing the management of conservation and private lands*".

The independent review reiterated the importance of public-private partnerships and priorities:

- "*Community involvement in conservation and sustainable use of biodiversity is probably at an all-time high in NZ (and) the number of partnerships has also grown rapidly"*
- *Integrating private and public approaches is needed. Good priority setting should ensure that the most important places and critically endangered ecosystems are protected and restored*".

Looking forward, the reviewers emphasised the need for more sophisticated partnerships:

- "*In looking forward five years, we see the next phase of implementing the strategy as having to sustain and increase efforts by key central government departments, plus a much greater effort on conserving biodiversity on private lands"*
- *"This will involve more than simply increasing the allocation to funds such as QEII, Nga Whenua Rahui and the Nature Heritage Fund, although those initiatives are an important part of the mix"*
- *"It will involve forming more complex partnership arrangements and putting more emphasis on the economic and social aspects to "win hearts and minds"*

[145] Wren Green and Bruce Clarkson, 2005, Turning the tide? A review of the first five years of the NZ Biodiversity Strategy – the synthesis report

- *"It will mean clarifying and integrating important matters of scale: national scale objectives for resource management, economic and social development; regional scale planning and management; local scale community concerns over particular places; and property scale imperatives to earn a living"*
- *"A related issue is the need to address different capacities for biodiversity management at different scales (including) implementation and funding – this messy aspect of helping people needs to be faced".*

In 2007, DOC and MfE developed a Statement of National Priorities in response to these recommendations for improved priorities and partnerships on private land[146]:

- "*We are fortunate in NZ because many of our landowners are already showing a growing interest in, and commitment to, conservation. To build on this, the government has been exploring ways of supporting and encouraging private landowners in their endeavours"*
- *"We have already established funds to provide financial assistance…nevertheless there remains a need to provide a better framework for decision making about biodiversity on private land. To this end, we have developed a statement of national priorities to focus conservation efforts on private land where the need is greatest"*
- *"The four national priorities are land areas with 20% of their original native vegetation cover; wetlands and sand-dunes; ecosystems that have always been limited in extent, such as geothermal areas; and habitats of NZs most threatened species…as we learn more, this information is likely to be refined and improved"*
- *"Our expectation is that the priorities in this statement will be used to support and inform council's biodiversity responsibilities under the RMA. We believe this can be best achieved within a cooperative rather than a legislative framework".*

Arguably, some councils have interpreted these priorities as legislative imperatives (reflected also in the NZ Coastal Policy Statement). More importantly, the 2007 priorities are very broad, and, as noted earlier, these "priorities" have not been well-supported by follow-on work in the last ten years to more closely map their distribution, condition and trends. Accepting that progress has been slow, the more pertinent point now is perhaps that the 2007 statement may have been superceded by more recent strategic initiatives, eg, the new DOC strategy.

The new DOC strategy follows on from a recent review of DOC by the Controller and Auditer-General (CAG)[147]. A key finding was the need for an (updated) national biodiversity strategy:

- *"In the regions, my staff found examples of DOC working well in collaboration with others, and examples of where improvements are needed…my staff did not find an integrated, strategic framework that the examples of regional partnerships fitted into. Such a framework is needed*"
- "*Although the NZ Biodiversity Strategy has not been set aside or replaced, our audit research confirmed that the strategy is considered historical and, currently, is not considered relevant to managing biodiversity in NZ".*

[146] MfE/DOC, 2007, Protecting our places – information about the statement of national priorities
[147] Controller and Auditer-General, no date, DOC – prioritising and partnering to manage biodiversity

Placeholder pending confirmation that the NZ Biodiversity Strategy and DOC/MfE Statement of National Priorities have been superceded by more recent strategic initiatives.

The CAG went on to highlight the new DOC prioritisation tools:

- "*The job of managing biodiversity on conservation land is far greater than the resources available. In 2012/13, DOC will spend about $200 million out of the total Vote Conservation appropriation of $450 million, (managing) only about one-eighth of NZs conservation land, and about 200 of the 2,800 threatened species"*
- *"DOCs tactic of prioritising its work and looking to other partners for resources is logical, given the size of the responsibility and the funding constraints…the new prioritisation tools are viewed by some as one of the most important changes to conservation management since DOC was created"*
- *"DOC has started focussing its work on what it calls "prioritised management units", each containing a cluster of ecosystems. DOC plans to manage 400 such units in the next 4 years".*

Prioritisation is still to the forefront in the draft DOC Threatened Species Strategy:

- *"Conservation, like any other investment, needs to be about smart targetting and maximising the benefit from scarce resources".*

Landcare Research also promote the value of prioritisation and cost-benefit analysis:

- "*Conservation in NZ is becoming increasingly strategic, systematic and reliant on accurate information on which to plan and prioritise goals and actions"*[148]
- *"There is growing awareness internationally that considering costs is not just helpful but vital for allocating conservation resources in order to halt as much biodiversity decline as possible"*[149].

The recent Regional Council thinkpiece[150] is the latest report recommending a systematic prioritised approach to managing biodiversity. The report notes there are "*fair winds*" to assist our endeavours (social, political, technological), and emphasises the need for "*joined-up action*" on the things that will make the greatest difference.

The report recaps the context, including highlighting gaps in information:

- "*Although conventional wisdom is that NZ is suffering ongoing and serious decline in biodiversity, there is actually a paucity of credible, comprehensive, "state and condition" data at the national or regional scales to support that assertion, or to allow the monitoring of change over time"*
- *"Prioritisation can consequently be misplaced by a misunderstanding of habitats and ecosystems in greatest decline"*
- *"In 2011, Regional Councils commissioned Landcare Research to develop a monitoring framework for terrestrial biodiversity, based on 18 indicators"*

[148] Ausseil et al, 2011, Provision of natural habitat for biodiversity – quantifying recent trends in NZ
[149] Walker et al, 2012, A unified approach to conservation prioritisation, reporting and information gathering
[150] Enfocus, 2017, Biodiversity and the role of regional councils

- *"The approach in freshwater mirrors – but is even less developed – than the terrestrial environment. Regional Councils do not generally monitor the composition/abundance or health of freshwater species, other than macroinvertebrates"*
- *"A final information issue relates to the tendency for information to be closely held amongst many different agencies. There are few effective means of searching and sharing the data that exists across central government, local government, iwi and community groups"*
- *"While not explored in detail, the idea of a data commons for biodiversity information deserves further consideration, ie, a platform for open access to a comprehensive set of biodiversity information".*

FFNZ agree that the conventional wisdom that "*biodiversity is declining"* is not well-supported by evidence; and that "*the likely reality is that the situation for some species and/or in some areas has improved since 2000, while others will have declined*". The earlier sections of this report provide concrete data to support that more nuanced assessment.

FFNZ also agree that biodiversity information is currently fragmented across many agencies, including academia; and that there is significant merit in an open platform for biodiversity information. Importantly, the BCG is making best efforts to assemble a rich evidence base to inform policy recommendations and that material could form the foundation for an open data platform. On this point, all reports cited in this paper can be made available for loading on request.

Pending the fuller assembly and analysis of the evidence that is currently available across agencies, FFNZ suggest the following statement from the thinkpiece may be premature: *"NZ collectively has suffered intervention failure and business as usual will not be good enough if we are to maintain indigenous biodiversity*".

As above, this statement needs to be considered within the more nuanced context described in this paper - some elements increasing, others relatively stable, some declining – together with a sharper appreciation of the context and drivers. For example: few would argue that un-managed populations of kiwi are declining – but that is not reason in itself to describe this situation as "intervention failure".

Arguably the key point is rather that "business-as-usual" will deliver "business-as-usual", ie, many or most species/ecosystems relatively stable - or at least "holding the line" in the case of those threatened species prioritised for active management - but not necessarily thriving.

To the extent NZ aspires to do more and better – which is certainly the case with the Predator-Free NZ vision – then the choice is succintly put in the Regional Council thinkpiece, ie, get more coordinated, get more efficient, get more money:

- *"Prioritisation is critical… the alternative to prioritisation is ad hoc-ism"*
- *"However, even with very rigorous prioritisation, the task remains a very large one. This situation calls for two shifts: greater coordination and collaboration at strategic and operational levels between all parties engaged in biodiversity projects to get best value for the investment; and increasing the level of investment in biodiversity by NZ as a whole".*

The recommendations in the Regional Council thinkpiece are strikingly similar to the earlier MAC recommendations, ie, the emphasis is on priorities and partnerships for active management:

- "*The most urgent need is more active management… (we need to) reposition the discussion about biodiversity to centre it on the need for active management, particularly aggressive pest control"*
- *"The focus and communication messaging around biodiversity needs to shift from a compliance focus to a focus on winning hearts and minds and a constituency of support for active management"*
- *"Working alongside people gets more effective results than forcing them with regulations, which at best can only ever achieve passive protection of biodiversity"*
- *"It will be important for the BCG to understand that an NPS can only address a subset of the threats faced by biodiversity and hence can only ever be one part of the solution".*

For the larger part of the solution, the thinkpiece emphasises (emphasis added): "*the need for agreement on where we should focus our efforts at national, regional and local scales";* and goes on to recommend structural and statutory changes to help deliver those joined-up agreements (strategic and operational, national and regional).

Notably – like the draft DOC strategy – it stops short of making concrete recommendations for where to prioritise. Arguably, this is an ongoing theme, ie, that strategies for biodiversity tend to be long on principles and criteria, but short on maps and named, priority places.

The importance of strengthening the links between people and place is central to another strategic offering, this time from a consortium of scientists. In 2013, the Tahi Group published a joint paper outlining a vision for 21st century conservation[151]:

- "*We make a plea to move on from the constant reiteration of conservation problems to a focus on developing and implementing solutions with the engagement of all NZers"*
- *"This vision requires all people who call NZ home to start by accepting native biota as part of their collective heritage, rather than simply presenting an environmental challenge. Acceptance also demands that environmental problems are no longer considered and treated independently from social and economic opportunities and constraints"*
- *"Restoring and enhancing NZs heritage depends on establishing new and inspired management of a complex of integrated environmental, economic and social forces".*

The Tahi Group recommend a paradigm shift:

- *"NZs conservation paradigm needs a radical realignment to take into account all land tenures and uses and engage all NZers"*
- *"Much of the NZ conservation rhetoric is judgemental, prescriptive and alienating rather than inclusive and respectful of other people's values and ways of operating"*
- *"A fundamental paradigm shift is required to celebrate people and economy as welcome keystones in conservationist's world view. The view that people and their economies are inconvenient obstacles must be radically changed. Maintaining people and their economies will keep NZ brimming with natural, social, human and economic capital".*

[151] Craig et al, 2013, Enhancing our heritage – conservation for 21st century New Zealanders

The authors challenge assumptions about direct and indirect threats:

- "*Another inflexible approach seen frequently in RMA decisions in NZ is severe restrictions on clearance of native vegetation. Such direct human-induced change is seen as irreplaceable loss that must be stopped at any cost, whereas the indirect losses across all of NZ through predation, competition and habitat modification by introduced mammals is largely ignored and thus tacitly sanctioned over much of the conservation estate and private land*".

As in the earlier MAC report, the Tahi Group emphasise the people factor:

- *"Many of the challenges and opportunities for conservation operate mainly at the local level. If there is to be a link between people, place and nature, it is important that people are committed and engaged throughout the nation, yet empowered to act locally and now by exercising their own agency and vision"*
- *"Ecological restoration and resilience are as much about restoring people's connections to each other as well as to land and place, as it is about restoring plants and animals".*

The Tahi Group steer clear of prescriptions:

- *"Success is more likely if first there is recognition of the complexity and uncertainty of natural systems… too often people forget that they are all so many times more ignorant than they are knowledgeable about how complex socio-ecological systems work or will respond to interventions, even the best intentioned changes"*
- *"(NZers) should not allow themselves to be constrained by trying to agree in advance on a single destination, a single vision, a single description of heritage, let alone how to get there"*
- *"A more diverse, innovative and deliberately experimental range of conservation approaches is needed if NZs indigenous biota are to be sustained in more than just a few fenced sanctuaries and on offshore islands".*

A final word from the Tahi Group before wrapping up this section:

- *"Collaborative efforts for at least partly shared goals between all the players and layers become the main opportunity for transformation".*

In summary:

- The strategic framework for NZ biodiversity was set in 2000 with the publication of the NZ Biodiversity Strategy, and the MAC report on biodiversity on private land
- Nearly 20 years later, the framework is under review but the central themes are still evident in the draft DOC Threatened Species Strategy, and the Regional Council thinkpiece
- The key threat is still introduced species, and the key response is active management
- People and partnerships are still to the forefront (engaging and enabling)
- Prioritising places is still to the forefront, supported by an array of principles, criteria, tools & classification systems - but threads have not yet converged on an agreed national portfolio
- Arguably, the new DOC Strategy, the Predator-Free NZ vision, current initiatives & the Council thinkpiece could be integrated within a refreshed strategy for the period to 2050

- A key element should be identification of the portfolio of actively managed areas (across both public and private land) which are priorities for national investment (potentially supported by a second tier of regional priority places, funded through regional partnerships)
- Achieving this result will require multi-agency coordination (which may or may not require structural or statutory changes).

Placeholder pending clarification of the extent to which DOC, Regional Councils and Predator-Free NZ are already collaborating to develop a portfolio of national priority places for active management.

IMPLICATIONS FOR NPS & COMPLEMENTARY MEASURES

This section presents preliminary consideration of implications for an NPS and complementary measures, pending wider discussion within and beyond FFNZ.

The earlier sections in this paper outline substantive findings - subject to further information as noted – on state and trends, context and drivers, strategy and priorities; and are not repeated here. Instead this section briefly summarises guidance on good evidence-based process from the Ministry for the Environment (MfE) and the Parliamentary Commissioner for the Environment (PCE) as it relates to the substantive findings.

BCG recommendations are expected to be accompanied by a robust s32 assessment, and MfE guidance for section 32 reporting emphasises the need for a strong evidential base:

- *"A well-defined problem forms a strong foundation for an evaluation: the degree of clarity about the problem will influence the type and range of policy solutions considered and the quality of analysis of the options"*
- *"Evidence-based analysis should be able to demonstrate relationships between issues, objectives and policy responses. This avoids policy being developed on the basis of gut instinct, habit, imitation or prejudice"*
- *"All costs and benefits of a proposal should be identified and assessed so decision-makers have a sound understanding of the impact a proposal will have on the community, the economy, and the environment*".

This advice is in accord with the project plan for the BCG; and this paper gives particular attention to understanding the size and shape of "the problem" before advancing to solutions. Based on the data to hand, FFNZ suggest the assumption that "biodiversity is declining" may have been appropriate in earlier times; but is not supported by contemporary data. Instead the data to hand suggests a more nuanced assessment of trends is more accurate today; in turn suggesting a more nuanced and targetted portfolio of solutions.

Various reports from the PCE have emphasised the importance of good process to underpin good policy. For example, in 2015 the PCE examined the NPS for freshwater[152], recommending inter alia a more strategic approach to prioritising action:

- "*A weakness of the NPS is it does not direct Councils to take a strategic approach to the water quality challenges in their regions"*
- *"It is critically important that councils prioritise their water quality efforts and expenditure so that immediate problems and pressure points are tackled early. Not every waterbody in the country is in need of management. And where water quality is under pressure, not every attribute is important. Comprehensiveness should not trump effectiveness"*
- *"Taking a strategic approach to prioritising action would entail focussed efforts on certain waterbodies, including those that are especially vulnerable, or under particular pressure*".

In 2016, the PCE again emphasised priorities, perspective and place[153]:

[152] PCE, 2015, Managing water quality – examining the 2014 NPS
[153] PCE, 2016, The State of NZs Environment – commentary on Environment Aotearoa 2015

- "*Much environmental concern is reactive, and to some extent subject to fashion. We need both evidence and reasoning to be judge which environmental issues we should worry about the most, which we should worry about the least – and which we should worry about somewhat. We need perspective on the state of our environment"*
- *"Location matters: it is important to make it clear where an environmental issue is significant and where it is not".*

This paper has outlined the new strategic imperatives emerging from DOC and others, towards prioritised landscape scale management units. This counsel from the PCE suggests these strategic directions/prioritised places would appropriately be reflected in an NPS for Biodiversity. Consequential questions relate to the extent to which prioritised places mean the same as "significant" places; and, either way, the extent to which national priorities/significant sites continue to be expressed as "principles" or "criteria" or can now be named and mapped.

The PCE emphasises the importance of the underpinning evidence base in her 2016 report:

- *"A state of the environment report must be built on a bedrock of scientific understanding that is based on a weight of evidence and communicated clearly"*
- *"Cause-and-effect relationships sit at the heart of science and require careful analysis… (an) important aspect of tracing cause-effect relationships is using time-series that span the appropriate period, allowing before and after comparisons"*
- *"Indicating the degree of uncertainty with major results is important. Modelled results should always be groundtruthed where possible. The limitations of models should be explained".*

In this paper, attention has been given to understanding the weight of evidence behind assertions, in particular the weight of evidence regarding key threats to indigenous biodiversity. On the strength of the information to hand to date, FFNZ suggest introduced pests and predators are squarely implicated as the key threat, directly impacting the extent to which threatened species and ecosystems can survive – or thrive – in New Zealand today. The implication is that the NPS and supporting measures should prioritise active management to address this key threat.

In this paper, attention has also been given to understanding contemporary trends, noting that EA2015 presented a somewhat confusing mix of historic and contemporary, modelled and measured, qualitative and quantitative data. As recommended by the PCE, careful attention should be given to ensuring the NPS and complementary measures are built on a bedrock of scientific understanding and evidence, and clearly communicated as the context for BCG recommendations.

The PCE concluded the 2016 report by identifying four areas from across all environmental domains that stood out for particular attention, including one which is relevant here: "*Our native birds and animals are under sustained attack from predators. The Government's "Battle for our Birds" has been successful in preventing the damage from "masts" in some areas. But we must lift our sights from battles that "hold the line" to figuring out how to win the war".*

FFNZ suggest it will be people and partnerships that will win the war – and that the partnership principle should be given central expression in recommendations for an NPS and complementary measures.