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Freshwater Biodiversity – Issues and Management Needs
Summary paper for Biodiversity Collaborative Group from the Department of Conservation

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Scope of the paper:

We understand the Collaborative group would like to better understand the range of impacts on indigenous freshwater biodiversity, and what action is needed to address negative impacts. It is seeking an appropriately qualified and experienced ecologist to provide advice to the group on:

The nature of the issue

- States and trends for native aquatic biodiversity.
- What the key impacts on native aquatic biodiversity are.
- Whether, and if so the extent to which, introduced flora and fauna are one of the key impacts,
- The process/s through which these impacts give rise to effects (e.g. habitat disturbance/loss, predation, competition for food).
- The species and habitats that are most impacted and where.

Management

- Current management interventions and their effectiveness:
    - What actions are working and why, and what are their enablers and drivers?
    - What actions are not working and why, and what are the barriers?
- What's good about the current framework for planning and management and what should we encourage/amplify?
- What's broken in the existing framework and what should we discourage?
- What's missing in the existing framework and what should we create?

Status and trends of indigenous aquatic biodiversity

Knowledge and ranking of elements of biodiversity and natural heritage

The following systems are in place:

- A geopreservation inventory that classifies and ranks geological features, natural landforms and soils.
- Taxonomic systems for species, and a threat ranking system for species.
- A wetland classification system (Johnson & Gerbeaux 2004).
- The New Zealand Freshwater Fish Database (NZFFD), E.g. Crow et al 2016
- River classification systems, River Environment Classification (REC) and Freshwater Environments of NZ (FWENZ, part of FENZ below).

- Freshwater Ecosystems of NZ (FENZ), a database that includes both actual and modelled data, which can be used to identify where freshwater ecosystems are located, their condition, and locations of priority river, wetlands and lakes.
- A (dated) inventory of geothermal surface features.
- An inventory of coastal hydrosystems (i.e. estuaries and waterbodies at the bottom end of rivers).
- A system within DOC to identify the highest priority ecological units for active management.

Ecosystems

New Zealand has a wide range of freshwater ecosystems. When comparisons are made between the original extent of an ecosystem type and current extent (in a reasonably natural state), the results range from virtually 100% remaining (e.g. some types of high alpine bogs) to less than 1% (e.g. fertile riverine forest in northern NZ). Most lowland ecosystem types are reduced to such an extent that they are considered to be extinct or threatened.

A key problem in NZ is slipping baselines. For example most people consider muddy lowland rivers and estuaries to be normal, when in fact all would have had clear water and sandy/rocky substrates.

Changes to ecosystems range from complete loss of not only the ecosystem but the physical environment that created it (e.g. when a wetland is drained), through loss of the major components of the ecosystem (e.g. felling of kahikatea forests and their replacement with introduced pasture and weeds), degradation (e.g. Tongariro wetlands invaded by heather), to relatively minor changes (e.g. a stream with slightly altered hydrology as a result of changes in surrounding land uses).

Trends vary with ecosystem type and location. In general, ecosystems within protected areas at the top of catchments are stable or have only slow deterioration (e.g. as a result of climate change and introduced species). In areas where landuses are intensifying (e.g. areas newly converted to dairy or grapes, areas being urbanised), deterioration is often rapid, and complete loss of ecological integrity is a high risk. A number of freshwater sites are being restored by communities (Clean-up and Protection Projects MfE Website, Freshwater Improvement Fund) or DOC (Arawai Kākāriki, Project River Recovery, Living Water), and their condition is generally stabilising or improving.

Species

Any species that is dependent on a threatened ecosystem type (i.e. not found in other ecosystem types) is likely to be threatened with extinction. Further degradation of ecosystems will result in increased risks to the species that use those ecosystems. Most lowland aquatic species are facing increasing loss of habitat extent and quality.

Some species are also particularly sensitive to individual threats, such as the threat to whio (blue duck) from introduced predators. In those cases, they may be threatened with extinction even if their habitats are not.

The threat classification system addresses those species for which data is available. http://www.doc.govt.nz/about-us/science-publications/conservation-publications/nz-threat-classification-system/

State and trend of freshwater biodiversity was reported in “Ecosystems, habitats, and species” sections of New Zealand's Environmental Reporting Series: Our fresh water 2017 but lack of ongoing representative biodiversity monitoring limited the explanation of perceived trends and impacts. This was also observed in the Office of the Prime Minister’s Chief Science Advisor’s New Zealand’s fresh waters: Values, state, trends and human impacts.

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Threats

Key drivers of change

Key drivers of change in ecosystems include:

1. Changes in the catchment vegetation and landuses that have effects on hydrology and diffuse discharges, including nutrients and sediments.
2. Direct physical changes to the waterbody, including piping, channelization, reclamation, damming, drainage, sediment that changes the bed substrate.
3. Water abstraction.
4. Direct discharges (point source discharges and contaminated stormwater discharges).
5. Changes in connectivity between parts of a system, including new connections (e.g. hydro diversion channels) and loss of connections (e.g. separation of wetlands from the river by stopbanks).
6. Direct changes to the ecosystem itself, including logging, burning, grazing.
7. Invasion by weeds and pests.
8. Harvest (e.g. of fish).
9. Changes in fish passage due to structures within the waterbody.

Species may also be affected by

10. Changes in species on which they depend (e.g. prey species, dispersal agents for their juveniles).
11. Diseases.
12. Loss of spawning sites.

Many of these threats are difficult to reverse, due both to the technical difficulties of achieving restoration (e.g. eradicating aquatic species; achieving flushing of sediment), and the fact that restoration often requires major changes in landuses and economic investments (e.g. changes in landuse within floodplains if stopbanks are removed or shifted; changes in agricultural landuses).

Introduced species

Introduced species are a major issue for some species and ecosystems. They are a key threat for some vertebrates and for many wetlands. Most freshwater ecosystem values are, however, more affected by direct human impacts (e.g. drainage, pollution).

Key introduced species issues are:

1. Introduced predatory fish, eg trout (McIntosh et al. 2010) and perch (Ludgate & Gloss 2004). These can affect indigenous species through direct predation, forcing changes in behaviour to avoid predation, and competition for food with indigenous predators. For example whitebait adults are predated by trout, have to spend more time in parts of streams where they are less vulnerable to trout (e.g. close to the bottom and banks and among woody debris), have to limit the times and places in which they feed, and are competing with trout for high quality food.
2. Introduced fish that alter habitat (e.g. koi carp that bottom feed and stir up sediment).
3. Terrestrial predators (e.g. rats, stoats) that affect birds and may also feed on species such as freshwater mussels.
4. Introduced weeds, particularly in wetlands, but also on lake and riverbeds.
5. Didymo and potentially other unicellular organisms that contribute to periphyton (slime) and plankton blooms (lake snow).

6. Introduced and farmed species as vectors and reservoirs of diseases that infect native fauna and flora.

The relative impact on types of freshwater biodiversity (red = high and Green = negligible) for various pressures identified by the Technical Advisory Group (TAG) for Our Freshwater 2017 is presented in Table 1 as a guide to comparative severity of impacts. The TAG members also undertook a scoring exercise for freshwater state topics (e.g. pressures). Sediment, nitrogen, wetland loss, phosphorous, reduced water flows and habitat loss were identified as the worst pressures.

Table 1. The relative severity of impacts on a range of types of freshwater biodiversity.

Pressure	Biodiversity Asset										
	Rivers	Lakes	Wetlands	Groundwater	Estuaries	Native fish	Native aquatic birds	Native Benthic Macro-Invertbrates	Native Zooplankton	Native Phtyoplankton	Native In-fauna
High Sediment (deposited and suspended)											
High Nitrogen											
Loss of Wetland extent											
High Phosphorus											
Reduced Surface water flows and levels											
Reduced Physical habitat											
Reduced Water clarity											
High Periphyton and phytoplankton											
Lost Connectivity											
Low Dissolved oxygen											
High E.coli (as an indication of faecal pathogens)											
High Temperature											
High Benthic cyanobacteria											
Invasive Plants (macrophytes)											
Invasive Fish											
Reduced Groundwater flows and levels											
Increased Heavy metals											
Emerging contaminants (hydrocarbons, PCPs, hormones, etc)											
High Pesticide residues											
Increased Groundwater salinity											

It should be emphasised that pressures do not occur in isolation and many pressures coincide in lowland waterways, generating larger impacts than would be expected from individual pressure levels. Sensitive species and lifestages may suffer larger impacts than suggested from water quality limits. Comprehensive consideration of ecosystem health value and objectives implemented via the Freshwater Management NPS could protect a wider range of instream biodiversity.

Measurement of freshwater biodiversity especially in lowland waterways is hampered by the lack of quantification of what good biodiversity looks like, and that affects the setting of appropriate goals. The Environmental Reporting Act 2015 and associated Environmental Reporting Regulations 2016 also require much better representative monitoring of freshwater biodiversity to show national state and trends. Concerns about the state and trend of NZ Freshwaters is exacerbated by the lack of a representative set of protected areas for sustaining or increasing the resilience of the full range of NZ freshwaters, although this was a goal of the NZ Biodiversity Strategy.

Management

Current interventions

These can be broadly grouped as:

- Preventing threats from operating
- Restoration
- Replacement

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Key tools to prevent new threats within a freshwater system are:

- Biosecurity systems, under the Biosecurity and Conservation Acts. For example, there are statutory controls on the movement of aquatic life between waterbodies to prevent new pests entering a waterbody.
- Legal protection of the waterbody, through inclusion in the protected area network or through covenant/kawenata.
- Rules set in RMA plans to prevent certain types of impacts (e.g. controls on water abstraction, damming, discharge, reclamation, structures, landuse changes).
- Fencing, fire control, management of fertiliser use, and similar actions to prevent threats such as grazing, burning and nutrient regime alterations.

Those tools can also stop an existing threat from continuing to operate. In some cases, waterbodies may naturally recover once a threat has stopped operating. For example, a river may gradually flush nutrients and sediment once discharges have stopped.

Active restoration is often needed to reverse the effects of past change. That includes:

- Pest and weed eradication or control.
- Removal of structures and restoration of physical form of the waterbody.
- Restoring water levels in wetlands through mechanisms such as weirs.
- Revegetation of catchments and margins.
- Active flushing, for example through release of water from dams.
- Reintroduction of lost species.
- Ex-situ breeding of threatened species and other manipulation of threatened species populations.

In some cases, replacement is an appropriate management response, but it is probably of limited value. For example, it is relatively easy to create waterfowl habitat (duck ponds), but very difficult to create functioning wetlands with high indigenous character because of the weed invasion problem and the fact that most species (e.g. invertebrates) will be missing and will not be able to naturally colonise a new wetland.

Reliance on creation of new freshwater ecosystems is not a recommended approach for “offsetting” of new threats. For example, the concept of “no net loss of wetlands” is not currently a viable approach in NZ if it would involve the creation of new wetlands while continuing to drain indigenous wetlands.

Biosecurity

The biosecurity system has an adequate range of tools.

Effectiveness issues relate to

1. Poor use of the tools. In particular, no pathway plans have been put in place under the Biosecurity Act.
2. Technical difficulties in using the tools. Eradication and control of aquatic pests is often more difficult than with terrestrial pests.
3. A lack of public awareness of aquatic pests and weeds, so there is less public involvement in control and more accidental spread.
4. Deliberate breaches of controls, particularly the deliberate spread of pest fish.

Legal protection of land

Again, the legal tools are available and adequate for the purpose. Key problems in implementation are the cost of land purchase, the cost of survey (e.g. for transfer of Crown lands or for

covenants/kawenata), and the difficulty of achieving effective protection of water and the biodiversity it supports (NZCA 2011).

Historically legal protection of waterbodies has not been treated as a priority, e.g. compared to protection of forests. The protected area network does not protect a representative network of freshwater systems, and most publicly owned riverbeds are not legally protected (they sit under the Land Act).

Legal protection of the land can control certain types of threats, such as grazing, gravel extraction, structures, channelization, etc. It cannot, however, protect the waterbody from effects of landuses, water abstraction and discharges within the catchment unless the entire catchment is protected. That is why streams within large protected areas such as national parks are generally in good condition, while those within small protected areas in the lowlands are generally in poor condition.

Water conservation orders

A key role of WCOs is to provide public recognition of the value of the waterbody, and to ensure that water use does not degrade those values.

These are, however, effective only in preventing activities relating to the water itself (i.e. activities under sections 14 and 15). They do not manage catchment effects on the values of the waterbody, or section 13 matters.

There has been work to look at issues relating to the use of the mechanism, including the costs and delays in implementation.

Heritage Orders

Heritage orders under the RMA are a tool that has been little used for natural heritage, and almost never used for waterbodies. The mechanism places rules into district plans, and could be effectively used to protect site specific values of a waterbody (e.g. historic, scientific or geological features) without needing to change the legal status of the land or uses of the land that do not affect those values.

RMA Plans

Regional plans are a key tool to address water use, discharges and activities within waterbodies (i.e. matters covered by sections 13, 14 and 15 of the RMA). They have not generally (with some notable exceptions) been effectively used in the past to manage landuses within the catchment (i.e. section 9 and 11 activities) that have effects on waterbodies.

Those activities have been controlled under district plans, but generally district planning has not effectively tackled the cumulative effects of landuse changes within catchments, despite some issues being well understood (e.g. that if more than 7-10% of a catchment reaches a stream directly via a stormwater system most stream biodiversity values will be lost).

The National Policy Statement on Freshwater Management clearly places the responsibility for managing freshwater ecosystems on regional councils in their planning work, and provides a clear framework within which regional plans should be developed.

While this is a highly positive reform:

1. there is likely to be a long lag time before new regional plans become operative, with degradation and long term landuse changes continuing to occur in the meantime; and

2. legacy landuses and water rights are likely to be difficult to reverse given the economic impact of doing so; and
3. it addresses water quality and to a lesser extent quantity issues, but not physical changes to waterbodies such as channelization and gravel extraction.

Fish passage controls

The Freshwater Fisheries Regulations 1983 contain controls on the creation of fish passage. Those regulations are currently being reviewed, and it is likely that rewriting to create a clearer and more easily implemented set of controls will be recommended. They are, however, able to control most fish passage issues, and the key problem has been a lack of active enforcement. A national Fish Passage Advisory Group has been formed to lead improved implementation and develop and disseminate best practice advice on mitigating existing barriers and designing new structures to avoid effects.

Active restoration of ecosystems

There is increasing investment in this, from the community, DOC and businesses. However there has been relatively little success at catchment scale restoration (except for small waterbodies with small catchments and few threats operating).

In relation to wetlands, DOC has been running the Arawai Kakariki programme which aimed to provide improved knowledge and tools to restore wetlands. That has delivered some useful outcomes, but also highlighted the difficulties of wetland restoration within large catchments.

There has also been focused work by DOC and its partners on predator control, braided riverbed restoration, and control of some weed species (e.g. heather).

Clean-up programmes funded by MFE/MPI, and some research programmes (e.g. Carex in Canterbury), are identifying approaches to issues such as nutrients in rivers and lakes.

Most threats and restoration issues have not, however, had focused research or research by management effort, and there are few tools available to help in designing restoration programmes. That means that communities are often reluctant to tackle freshwater issues as part of terrestrial restoration projects, and struggle to identify priorities and approaches for catchment scale programmes within production or urban landscapes.

In addition, the focus may in some cases be on the wrong issues. For example, daylighting of urban streams makes them more visible and generates amenity values, but may not improve biodiversity values unless wider catchment issues (i.e. stormwater management) are also addressed.

Species recovery

Recovery work is underway for some species. Populations are stabilising or improving in some cases. However other populations are continuing to deteriorate.

Species recovery work is made difficult by:

1. Lack of recognition by the public of the species and their value (with the exception of birds), and therefore low investment and low public support for some types of recovery actions (e.g. use of toxins, control of public use of rivers, local eradication of trout).
2. Lack of knowledge about species biology and threats.
3. Lack of tools for recovery.

DOC has launched a Threatened Species Strategy that should provide greater clarity about the most critical actions across the wide range of threatened species.

Fisheries management
Aquatic life is managed under the Fisheries Act and Conservation Act. Harvest (fishing) is managed through both Acts. Movement of aquatic life is managed under the Conservation Act. There are real or perceived problems in management of eeling and whitebaiting, which are being addressed by MPI and DOC.

What is missing and what could be included in an RMA NPS

What is missing
The key problems that are relevant to RMA work are:

1. Failures in management of cumulative impacts, including across catchments and over time (e.g. where there is a lag between the impact and its effect becoming visible).
2. A focus on water quantity and quality, but not on waterbody physical form or ecosystem features.
3. Difficulties in achieving reversal of past loss, except where natural restoration will occur if the threat is stopped.
4. Poor understanding of freshwater systems, including slipping baseline problems, lack of visibility of impacts, lack of recognition of threats, and lack of knowledge about what is needed to allow recovery.

What could be done under the RMA
The NPSFM already provides a major step forward in management of water quantity and quality.

The key things that are needed as the next step in refinement of the NPSFM are:

- Inclusion of wetlands in the NOF. The technical work has mostly been done for that.
- Inclusion of fish habitat in the NOF. The technical work for that has commenced, and there is considerable scientific knowledge to draw from.
- Guidance on “significant values of wetlands”.
- Guidance on “outstanding waterbodies”.

Another key need is to pull together the available scientific information on important and threatened biodiversity elements (e.g. braided riverbed birds, inanga spawning, rare and threatened ecosystem types) and provide rapid guidance to regional planning processes on where specific values are located and what are the key parameters of the waterbody that need to be managed to maintain those values.

The NPSFM only covers water quantity and quality. There is a need for national direction on matters such as channelization, alteration of banks, catchment vegetation, gravel extraction, etc.

Related tools work
There is a need to ensure that the key data and models are maintained, managed and available. One suggestion that has been made is to put these under Statistics NZ, given their central role in state of the environment reporting as well as planning work.

There is a need to provide clear guidance or direction on how tools should be used. For example, there has been concern about the misuse of SEV and Overseer tools.

There is a need to develop new tools to support community groups as they seek to identify the most cost-effective regional planning rules, and the most cost-effective restoration activities.

That would include providing clear national guidance on "rules of thumb" that collaborative processes could use where they do not have site specific information, on issues such as the effect of impervious surfaces (7-10% as a bottom line), effect of loss of woody vegetation (i.e. the algorithms used in FENZ), etc.

There is a need to improve the development, compilation and dissemination of best practice in restoration and waterbody management. The Fish Passage Advisory Group and Arawai Kakariki provide possible models for that work.

Legal protection work
The Crown needs to improve the way it manages waterbodies that are within its control. That includes issues such as legal protection levels, stock exclusion, public access, and support for community restoration.

Funding for community restoration work
The current funding is generally only suitable for large restoration projects. Smaller projects that would be important in managing specific values (e.g. the habitat of a rare plant in a small wetland) and in improving public understanding of urban waterbodies are not supported by central government funding. A fund for that sort of work would be a useful addition.

Pathway plans
There is a need to progress Biosecurity Act pathway plans to address key freshwater risks, such as movement of aquatic weeds by recreational vessels.

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