CRESP

Critical Ecosystem Pressures on Freshwater Environments (CRESP)

4-year research strategy

Nixie Boddy, August 2024

Department of Conservation
Te Papa Atawhai

New Zealand Government

Overview

The Department of Conservation (DOC) has a core responsibility to protect and enhance New Zealand's indigenous freshwater ecosystems and species. This includes advocating for the conservation of freshwater values by influencing national and regional policy and natural resource plans and consents, including through collaborative catchment management.

A key objective of freshwater advocacy, and freshwater conservation in general, is to reduce pressures on indigenous biodiversity. The Critical Ecosystem Pressures on Freshwater Environments (CRESP) research programme addresses four pressures on New Zealand's freshwater ecosystems: water levels and flows, critical habitat loss, sediment and nutrients, and fish passage.

We currently have incomplete knowledge of how these pressures are affecting New Zealand's freshwater ecosystems and their associated biodiversity and cultural values, limiting our ability to effectively advocate for and manage freshwater systems. DOC has committed to addressing this problem and increasing its advocacy for freshwater ecosystems and species.

Strategy purpose

This research strategy has been developed to provide strategic direction and inform annual investment priorities for research under DOC's CRESP programme for the next 4 years (2024–2027).

It aims to:

- support DOC's advocacy and management of freshwater ecosystems and species
- uphold DOC's section 4 obligations under the Conservation Act 1987 by undertaking freshwater research in partnership with our Treaty partners
- link to other relevant strategies to build a holistic approach and ensure research addresses high-priority threats to support implementation of the DOC Biodiversity Planning Approach (see p. 4 and Figure 1)
- identify critical science needs and apply a prioritisation framework to strategically invest in research
- promote opportunities for collaboration
- outline conservation outcomes that will be influenced by this programme.

Research programme scope

The CRESP research programme addresses the following four key abiotic pressures and their effects on freshwater ecosystems across New Zealand, including rivers, lakes and wetlands.

- **Water levels/flows** – This includes any hydrological alteration to freshwater ecosystems, such as changes in seasonal variation in the patterns of flow and water levels in rivers, lakes and wetlands. The primary pressures associated with water levels/flows include water abstraction, diversion, augmentation and drainage.
- **Habitat loss** – This includes the total loss of habitat, habitat deterioration and habitat modification in rivers, lakes and wetlands through activities such as piping and draining streams, removing aquatic plants, and channelisation.
- **Sediment and nutrients** – This includes the effects of deposited and suspended sediment on freshwater ecosystems and species, and the direct and indirect effects of nutrient enrichment, focussing specifically on nitrogen and phosphorus.
- **Fish passage** – This includes the effects of instream structures that alter freshwater habitats or block fish movements upstream and/or downstream. It encompasses the removal and modification of barriers, as well as the installation of barriers to protect native species.

It is recognised that the abiotic and biotic pressures that affect freshwater ecosystems often interact and/or have cumulative effects, and that scientific knowledge on how these pressures interact is limited. Whilst not a primary focus of this programme, multiple stressors and associated pressures, such as climate change and introduced species, will also be considered.

Research programme objectives

The CRESP research programme has three key objectives.

- To deliver research that produces new evidence and data on the ecological responses of freshwater systems to changes in critical ecosystem pressures (water levels/flows, habitat loss, sediment/nutrients and fish passage).
- To contribute knowledge to improving freshwater advocacy and management in New Zealand.
- To work in partnership with Treaty partners and regional, national and international organisations.

Supporting conservation outcomes

The CRESP research programme is being led by DOC's Biodiversity System and Aquatic Unit. It aims to provide knowledge that will strengthen DOC's advocacy and management of indigenous freshwater ecosystems and species (Figure 1).

Addressing the four critical pressures outlined above is fundamental for achieving DOC's freshwater goals and outcomes, including through Te Mana o te Taiao – the Aotearoa New Zealand Biodiversity Strategy.

CRESP also supports the freshwater actions in DOC's climate change adaptation action plan. This includes assessing the vulnerability and potential adaptation of ecosystems and species to climate change, understanding where/how to manage other pressures to increase resilience of ecosystems and species identified as at risk from climate change, and to assess the continued effectiveness of management tools and techniques considering climate change.

Key performance indicators

The overall outcome for the CRESP research programme is to deliver 'better knowledge of four critical freshwater ecosystem pressures'.

Specific outcomes and performance will be evaluated based on:

- KPI 1 – Science quality (robustness, accessibility and national relevance of research)
- KPI 2 – Science impact (research effectively incorporated into freshwater advocacy and conservation management).

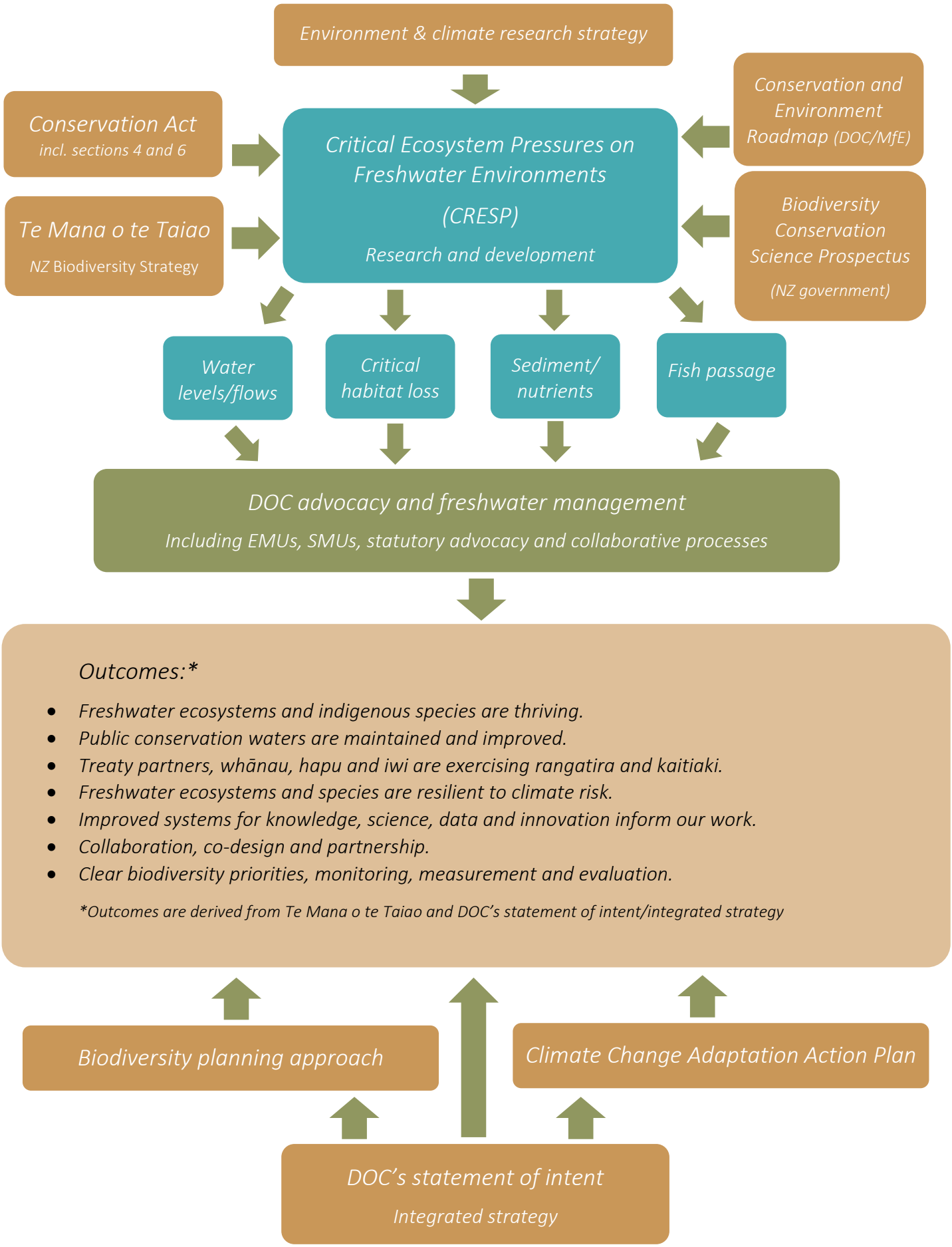

Figure 1. Conceptual framework for how the Critical Ecosystem Pressures on Freshwater Environments (CRESP) research programme contributes to DOC's strategic objectives for freshwater environments. MfE, Ministry for the Environment; EMU, ecosystem management unit; SMU, species management unit.

Summary of current knowledge

Water levels/flows

Research, monitoring and assessment of changes in river flows in New Zealand has been a primary focus of councils and research organisations. However, this work has largely focussed on how water levels and flow dynamics change in response to pressures such as water abstraction, leaving us with a more limited knowledge of how changes in water levels and flows affect indigenous ecosystems and species, particularly for lakes, wetlands and indigenous species in rivers.

DOC advocacy and management of water levels and flows currently relies on incomplete guidance and the extrapolation of site-specific data. Therefore, an improved understanding of the relationship between hydrological regimes and ecological values is required across New Zealand to underpin effective freshwater management.

Habitat loss

The current extent and rate of change of intact freshwater habitats in New Zealand are, in general, poorly understood. While the locations and extents of freshwater macro-habitats (lakes, rivers, streams, wetlands) are relatively well mapped at national and regional scales, little information is available on the integrity and rate of change of critical habitats for indigenous biodiversity (e.g. suitable in-stream and in-lake habitats).

Sediment and nutrients

Compared to research on other pressures, water quality monitoring and research on sediment and nutrients (particularly nitrogen and phosphorus) are relatively advanced in New Zealand, particularly for rivers and lakes. Modelling of land use and water quality pressures is available for much of New Zealand, and there is evidence for bottom-line thresholds for suspended and deposited sediment in most regions.

DOC advocacy and management of sediment and nutrients, however, currently relies on the limits defined in the broad national guidance (e.g. National Objectives Framework) and the extrapolation of site- or species-specific data. There also remains limited knowledge on the impact of these pollutants on freshwater biodiversity. Future management would be enhanced by an improved knowledge of mitigation methods for suspended and deposited sediment, the incorporation of acute versus chronic effects in limit setting, and the effects of interactions between sediment/nutrients and other pressures on freshwater ecosystem health and function.

Fish passage

There is an urgent need to increase our ability to review and improve the design of instream structures and to maximise fish passage around and through those structures, including improving the National Fish Passage Guidelines. This requires a better understanding of which designs provide appropriate fish passage and how and where

remediation tools are most effective at facilitating fish passage, in addition to improving our knowledge of the ecology, behaviour and swimming capabilities of native fishes.

Critical science needs

Knowledge gaps for each pressure have been assessed based on current understanding of their ecological impacts, their significance to the conservation of freshwater ecosystems and species, and DOC's ability to advocate for or manage them effectively.

We applied a prioritisation framework to rank the knowledge gaps and thus determine the primary research areas for each pressure. Prioritisation was based on four key criteria.

- The spatial scale of the research impact on freshwater systems (local, regional or national).
- The magnitude of the research impact on DOC advocacy and management of freshwater systems (low, medium or high).
- The collaboration opportunity (yes or no).
- The time pressure – timing of collaboration or urgency of the knowledge requirement (not urgent or urgent).

Input obtained from across DOC, Treaty partners, universities, councils, Crown Research Institutes (CRIs) and other government and research agencies was collated to identify which knowledge gaps were perceived as being most critical. Treaty partners and the DOC RMA team were asked to independently prioritise potential projects for funding, and this feedback used in addition to the prioritisation framework outlined above to rank potential projects for funding.

Water levels and flows

Ecosystem	Critical knowledge gap	Rank
River	Flow curves for limit setting, including flow requirements for multiple species and different life stages	2
	Effects of repeated bed-moving floods on freshwater food webs and recovery rates/resilience, and potential management actions	5
	Impacts of river flows and mouth opening duration and timing on fish migration and food webs in river mouths	7
Lake/Wetland	Understanding effects of lake and wetland level management on the biodiversity and cultural values associated with lakes and wetlands	4
Integrated	Interactive impacts of extreme events and non-native species on native fish	1
	Understanding key flow regime attributes that cue spawning, emergence or migration events of aquatic organisms	3
	Understanding the effects of long duration low flows/water levels on biodiversity	6
	Flow harvesting impacts on freshwater habitats	8

Critical habitat loss

Ecosystem	Critical knowledge gap	Rank
River	Ecological value of small-order headwater streams and their vulnerability to habitat disturbance	2
	Determine the minimum width required to retain habitat diversity and resilience in modified rivers	4
	Identify and define spawning habitat and threats to it in such a way it can be protected, e.g. spawning reserves	8
Wetland	Wetland management for ecological purposes, e.g. vegetation composition required for spawning/rearing native species, contribution of small wetlands to catchment hydrology and ecology, fencing vs. not fencing re weed growth	6
Integrated	Habitat and flow requirements of native fishes for spawning, including tools for identification of spawning habitat	1
	Quantifying the loss of extent of freshwater ecosystems	3
	Restoring/maintaining hydrology and habitat quality in degraded streams/wetlands/lakes that are still valuable habitat	5
	Ecological value of ephemeral freshwater ecosystems and their vulnerability to habitat disturbance and climate change	7

Sediment and nutrients

Ecosystem	Critical knowledge gap	Rank
Integrated	Physiological tolerances of native species to changing nutrient and sediment levels to define thresholds of ecosystem health	1
	Investigate resilience of ecosystems and ecosystem processes to changes in sediment, nutrients, dissolved oxygen and temperature, particularly in response to climate change	2
	Temporal effects of multiple fine sediment inputs on freshwater communities and food webs	3
	Examine riparian vegetation species' resilience to disturbance and contribution to biodiversity and cultural values	4
	Impact of topography of riparian zones on sediment and nutrient inputs	5
	Evaluate the relationship between sediment and invasive weeds, including impacts on geomorphology, flows and biodiversity	6
	Identifying targeted locations within landscapes where sediment management can effectively protect and restore ecosystems	7
	Natural vs induced sediment delivery and its relationship to ecological tipping points – determine biotic thresholds or where high value habitats are at risk	8

Fish passage

Ecosystem	Critical knowledge gap	Rank
River	Effectiveness of different methods to facilitate fish passage for different species and size classes	1
	Fish passage solutions for adult migrant eels including pump stations and dams	2
	Characteristics and performance of flood/tide gates including monitoring and maintenance requirements	4
	Fish responses to hydraulic characteristics through and at the entrances to fish passes	5
	Water intake and fish screen design for small, medium and large takes to avoid impacts on upstream and downstream migration	7
Integrated	Selective barrier design and deployment to stop the spread of invasive species and protect native populations	3
	Monitoring and maintenance requirements of fish passage solutions	6
	Technical fish way design for high head structures	8

Priority research areas

The following research areas have been identified as priorities for DOC investment over the next 4 years. External collaboration on these research areas is welcomed and encouraged.

Many of these priority research areas will have multiple research questions or lines of enquiry associated with them.

Water levels/flows

Project title	Description	Outcome
Extreme events and non-native species	Understand how native fish are impacted by interactive effects of extreme flow events and non-native species	Non-native species distributions and abundance is managed to increase native species resilience to extreme events
Flow curves for limit setting	Develop flow curves for limit setting, including flow requirements for multiple species and different life stages	Flow habitat curves are developed and nationally applied to protect native species
Flow cues	Understanding key flow regime attributes that cue spawning, emergence or migration events of aquatic organisms	Protect elements of flow regimes crucial to cue key life history stages of aquatic life

Critical habitat loss

Project title	Description	Outcome
Tools to identify spawning habitat	Develop tools for identification of native species spawning habitat, to support work on flow requirements/mechanisms of native fishes for spawning	Key spawning habitats are identified and protected
Ecological value of headwater streams	Evaluate the ecological importance of small-order headwater streams and their vulnerability to habitat disturbance	Knowledge is gained to improve advocacy and legal protection for the conservation of headwater streams
Quantifying loss of freshwater ecosystems	Quantify the national loss of stream length and wetland area via drainage and straightening. Includes effects, e.g. geomorphic consequences, habitat loss.	Knowledge improves advocacy and legal protection for the conservation of freshwater habitats at risk of loss

Sediment/nutrients

Project title	Description	Outcome
Physiological tolerances of native species	Define the physiological tolerances of native species to changing levels of nutrients and sediment (deposited and suspended), for use as evidence for thresholds of ecosystem health	Physiological tolerances of native species are used to set regional and national limits on water quality
Ecosystem resilience	Investigate resilience of ecosystems and ecosystem processes to changes in sediment, nutrients, dissolved oxygen and temperature, particularly in response to climate change	Knowledge of ecosystem and ecosystem process resilience is used to improve advocacy and management of threatened ecosystems
Impact of repeated sediment pulses	Temporal effects of multiple fine sediment inputs on freshwater communities and food webs	Knowledge of sediment impacts informs national limits and is applied nationally to protect freshwater ecosystems

Fish passage

Project title	Description	Outcome
Effectiveness of fish passage remediation	Test the effectiveness of different methods of facilitating fish passage for different species and size classes	Best practice methods are applied to enhance native fish passage
Fish passage solutions for migrant eels	Determine the attributes and installation requirements fish passage solutions for adult migrant eels, including for pump stations and dams	Best practice methods are applied to enhance native fish passage
Selective barrier design for native species	Determine the attributes and installation requirements for the design and deployment of selective fish barriers to stop the spread of invasive species and protect native populations	Best practice methods are applied to protect and enhance native fish populations using barriers

Collaboration opportunities

Gaining an improved understanding of the vulnerability of New Zealand's freshwater ecosystems and species to changing water levels/flows, deteriorating water quality, habitat loss and fish barriers presents a complex science challenge that can only be effectively addressed through research collaboration.

Through the CRESP research programme, DOC is keen to work in partnership with Treaty partners and regional, national and international organisations to collectively build evidence that supports ecologically sustainable approaches to managing the effects of land and water use on freshwater biodiversity. Collaborative research will particularly be sought with iwi and hapū, councils, CRIs, universities, and other research and government agencies. This includes partnerships with Ministry of Business, Innovation and Employment (MBIE)-funded freshwater research programmes and other national and regional science initiatives. Opportunities for supporting post-graduate and post-doctoral study will also be targeted.

Communication

Freshwater conservation outcomes will only be achieved if the knowledge, data and tools that are produced in the CRESP research programme are effectively communicated both within DOC and externally. Consequently, the dissemination of research outputs and management outcomes is recognised as being fundamental to the success of this programme.

The short-term (1–2 year) communications strategy for this programme has three aspects.

- Liaise with Treaty partners, CRIs, councils, universities and other relevant organisations to obtain input on critical information gaps limiting conservation action.
- Network with the above organisations and groups to facilitate collaboration opportunities that are relevant to the projects selected as priorities.
- Communicate the results and outcomes in the form of reports, newsletters, a website, interviews, blogs and other short media initiatives to a wide variety of audiences, including (but not limited to) the organisations listed above.