Te Uru Kahika

Regional and Unitary Councils Aotearoa

UC University of Canterbury

waterlink

National guidance for Threatened freshwater species in regional planning under the NPS-FM

Envirolink 2506-NLCC131

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Document revision and status

Revision	Date	Status	Reviewed by	Approved by
v1	18/7/2025	Final	Co-authors	

Cover photograph:
Targeted fixed-reach survey in the Māwhera Grey River catchment on the South Island's West Coast. Improving the understanding of Threatened species' distributions, habitats and dynamics is urgently needed to inform strategies for improving their resilience and encourage recovery from long term declines.
Photo: Shane Orchard

Foreword

The catalyst for this Envirolink project came from a series of Manatū Mō Te Taiao Ministry for the Environment (MfE) funded regional council focus workshops to discuss how councils identify Threatened species and habitat and then how councils might set NPS-FM limits and targets for them. The Surface Water Integrated Management Group (SWIM) led on this Envirolink project to understand knowledge gaps, and explore regional planning, monitoring and actions that could be used for developing and implementing NPS-FM action plans for Threatened freshwater species.

SWIM operates at two broad levels, at a national level, providing input, advice, and response to policy, national science and research, and at the Regional sector level, where we are collaborating, sharing ideas and advancing our respective disciplines. To this end, this report aims to provide national guidance for implementing NPS-FM action plans that will be applicable for Threatened species dependent on freshwater.

The Threatened fish, shortjaw kokopu (*Galaxias postvectis*), is used as an example to introduce concepts of threats and pressures, critical habitat, spatial planning, selection of attributes and monitoring options. Examples of freshwater actions are also provided for managing pressures that will contribute to meeting specific environmental outcomes and improvements in freshwater management within Freshwater Management Units.

This report is our thinking to date and a foundation to encourage more discussion and investment from councils, MfE and DOC to outline best practice for quality planning, options for core attributes, to standardise monitoring methods that enable a nationally consistent and coordinated approach and ultimately deliver effective NPS-FM action plans. The information and recommendations provided in this report are based on feedback from an online survey and workshop of SWIM members and contributions from the co-authors, which may not represent all views.

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Executive Summary

This report provides national guidance to assist regional councils in implementing action plans for Threatened freshwater species under the National Policy Statement for Freshwater Management (NPS-FM). Prompted by knowledge gaps identified through Ministry for the Environment workshops, the project was led by the SWIM (Surface Water Integrated Management) group with Envirolink funding. The document outlines a collaborative and scientifically robust framework that regional authorities can use to incorporate Threatened species values into regional plans, enhancing both biodiversity protection and freshwater ecosystem health. Throughout the document shortjaw kōkopu (*Galaxias postvectis*) is used as an example to illustrate the steps and key considerations for implementing a NPS-FM action plan for a Threatened fish species.

Objectives

- To support councils in identifying and managing freshwater-dependent Threatened species.
- To outline methods for identifying critical habitats and selecting appropriate ecological attributes.
- To present monitoring and action planning guidance aligned with the National Objectives Framework.
- To address key knowledge gaps and capacity constraints that hinder effective implementation.

Key Components of the Guidance

1. **Threatened Species Identification**: Criteria and case studies are provided to help councils define and identify freshwater-dependent species relevant to their regions.
2. **Habitat Mapping**: Strategies for combining data from field surveys, eDNA analysis, and species distribution models (SDMs) are discussed, alongside recommended spatial units like the REC2 river network.
3. **Critical Habitat Definition**: Emphasis is placed on understanding life-cycle requirements and integrating local, expert, and mātauranga Māori knowledge to delineate high-priority areas.
4. **Attribute Selection**: Practical examples are given for defining attributes for assessing Threatened species and setting management targets related to their presence, abundance, habitat quality, and pressures such as pollution or barriers to fish passage.
5. **Monitoring & Action Plans**: The guidance offers workflows for monitoring species and threats across Freshwater Management Units (FMUs), with a focus on cost-effective, scalable solutions.
6. **Information Gaps**: The report highlights the need for improved data quality, consistent monitoring protocols, and investment in expert-led workshops and modelling.

Conclusion

This guidance represents a step toward nationally consistent, science-based freshwater planning for Threatened species. It provides a living document to support ongoing adaptation and collaboration between councils, DOC, and communities.

Electrofish survey of Waitetuna River, Wellington: Darien Kissick/GW

Koaro (*Galaxias brevipinnis*) being viewed and measured. The reach is dominated by koaro, with abundant redfin bully (*Gobiomorphus huttoni*) and banded kōkopu (*Galaxias fasciatus*) and less abundant shortjaw kōkopu (*Galaxias postvectis*).

Exemplar plan on a page

Relevant long-term visions from RPS	[Long term visions for freshwater should be set as objectives in regional policy statements and can be cross checked for relevance to Threatened species value]		
Environmental Outcome	The freshwater habitats of Threatened species are protected, and Threatened species have persisted and recovered in the FMU.		
Strategic processes	Plan, prioritise, and map a pathway forward.	Monitor and report on attributes	Review and responsive actions
How will we measure success?	Spatial maps and models	Track the state of attributes in FMUs Compare current with target state Annual presence in each FMU Species distribution identified based on the habitat extent required for all life stages (juvenile, adult, spawning)	Fish passage maintained and improved Habitat enhancement Threats reduced with predator control Management and recovery (e,g., IUCN green status) Cultural Health Assessments Community engagement

What will focus on to get there?	Develop the action plan for Threatened species values	Threatened species and critical habitat attributes	Ecosystem health attributes	Manage threats, provide security, and build resilience
What will we do?	Identify freshwater dependent and Threatened species in the region to include in the Action Plan Collate data sources Identify critical habitat Select attributes to report on the critical habitat and life stages of the Threatened species. Examples of attributes are provided in Appendix 1.	Survey records NZFFD, regional council monitoring, DOC monitoring eDNA presence of fish species Assess the quality of habitat for adult and juveniles, RHA/ Pfunkuch Stability score, fish passage assessment Dependent on regional threats/pressures and existing habitat condition	Confirm recruitment of juveniles Fish-IBI and other metrics for measuring the fish community and progress with Action plan	Habitat loss and degradation (altered hydrology, pollution, food supply, spawning habitat, riparian cover, others Fish passage maintained Introduced pest species/predation Instream works Level of protection provided by tenure Climate change
Our five year goals	Occurs in a representative set of ecosystems within its range	Sufficient information is collected to report on the attributes and progress toward the environmental outcomes.	The population is viable (i.e., fish passage, spawning and recruitment is maintaining the population) and the taxon is not undergoing decline in the region	To have SMART goals in place that will address the key issues and identify the required resourcing, achievable time frames and actions underway.

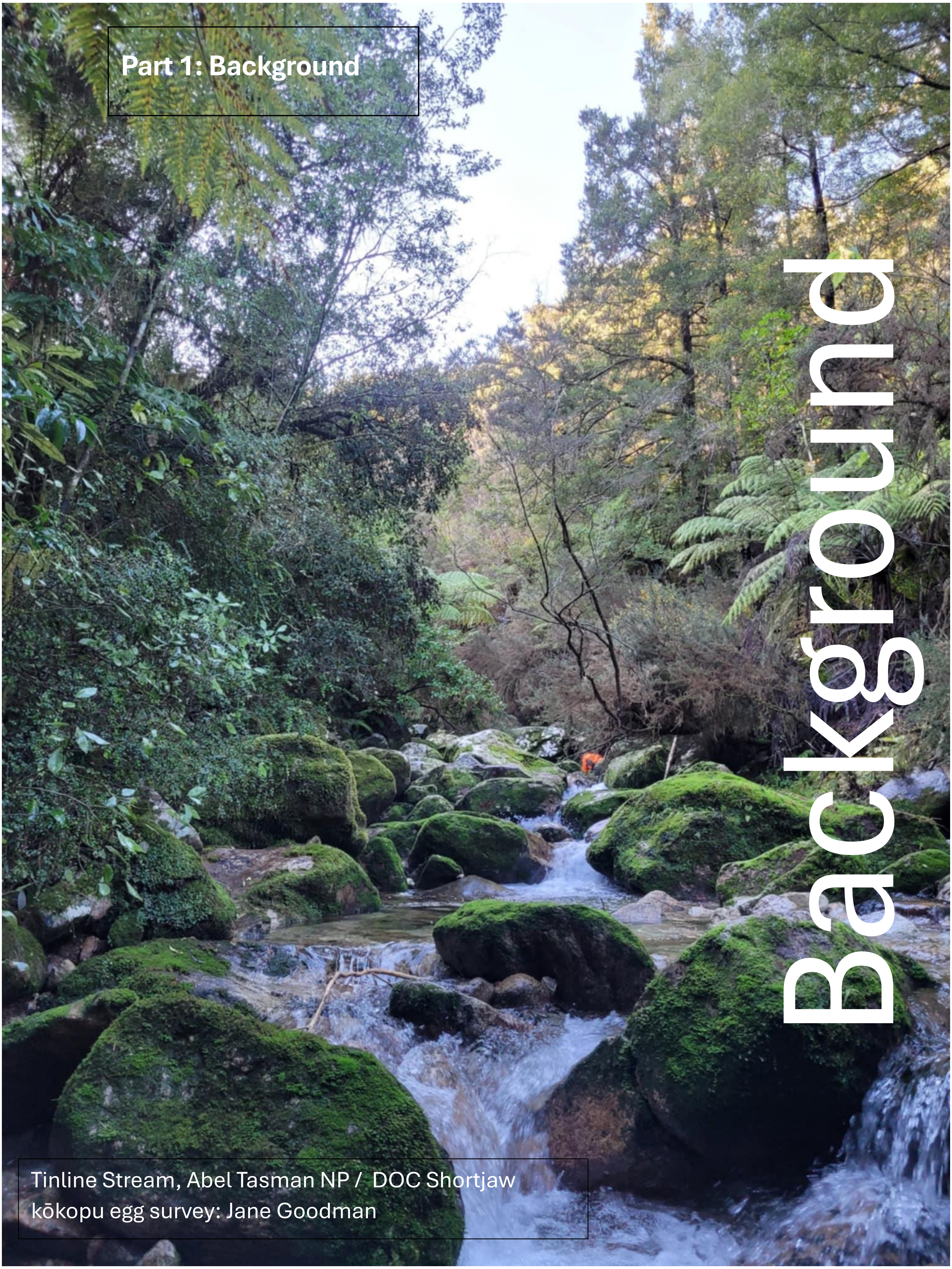
Abbreviations

DOC	Department of Conservation
eDNA	Environmental DNA
ESA	US Endangered Species Act 1973
Fish-IBI	Fish Index of Biotic Integrity (Joy & Death, 2004)
FMU	Freshwater Management Unit
GIS	Geographic Information System
GW	Greater Wellington Regional Council
IBI	Index of Biotic Integrity
LiDAR	Light Detection and Ranging
MBIE	Ministry of Business Innovation and Employment
MfE	Ministry for the Environment
NOF	National Objectives Framework
NPS-FM	National Policy Statement for Freshwater Management 2020 (and amendments)
NZFFD	New Zealand Freshwater Fish Database
NZTCS	New Zealand Threat Classification System
qPCR	quantitative Polymerase Chain Reaction
REC	River Environment Classification (Snelder & Biggs, 2002)
REC2	River Environment Classification v2.5 (NIWA, 2019)
RMA	Resource Management Act 1991
RHA	Rapid Habitat Assessment (Clapcott 2015)
SDM	Species Distribution Model
SJK	Shortjaw kōkopu (*Galaxias postvectis*)
SWIM	Surface Water Integrated Management regional sector Special Interest Group
TAS	Target Attribute State

Contents

Shortjaw kōkopu pool habitat, Waitohu stream, Kapiti: Bram Mulling, GW

Part 1: Background



Tinline Stream, Abel Tasman NP / DOC Shortjaw kōkopu egg survey: Jane Goodman

1.1 Introduction

1.1.1 Current guidance on implementing the NPS-FM for Threatened species

The Ministry for the Environment produced a Threatened species factsheet, published in December 2020, as part of the Essential Freshwater package. This guidance provides the Threatened species definition from the National Policy Statement for Freshwater Management (NPS-FM) and briefly describes regional council requirements amongst other general guidance. These requirements relate directly to steps from the National Objective Framework for Threatened species. This factsheet does not elaborate further on how to implement the National Objective Framework for Threatened species and remains silent on processes to identify Threatened species and potential attributes for consideration for the Threatened species value.

Objectives

Councils are seeking guidance on how to deliver on their requirements to help protect Threatened freshwater species' habitats under the NPS-FM, alongside the responsibilities of the Department of Conservation (DOC) and other stakeholders.

Existing guidance to support this work is limited to the Ministry for the Environment's two-page fact sheet that highlights the relevant sections of the NPS-FM. To address this gap, the SWIM Fish Group initiated a project to prepare guidance on this topic using a collaborative approach that was funded by a MBIE Envirolink grant. It was expected that national guidance on the preparation of council-led plans could promote the integration of efforts among groups working on the conservation of Threatened species and related projects such as the recovery of culturally important species.

The objectives of the project include:

- Identifying the methods and information sources that could be used to address Threatened species values in regional planning under the NPS-FM.
- Developing a collaborative national approach to outline key steps for implementation of NPS-FM action plans within regional planning. This collaborative approach includes liaising and sharing knowledge with the Department of Conservation.
- Identifying key information gaps or capacity constraints for practical implementation of the NPS-FM that could be addressed to further support councils in their freshwater management role.

Scope of this guidance

This guidance document was developed through a survey of council staff perspectives and workshop process (see details on 1.1.2). It provides a synthesis of the information that was received and focuses on identifying the approaches and methods that were generally agreed to be scientifically robust and practically feasible in council planning contexts given the nature of existing information sources and capacity constraints.

Part 1 provides a brief overview and background information on the context for this guidance, including an introduction to the relevant policy drivers within the NPS-FM and a description of recent amendments that have introduced changes to several aspects.

Part 2 provides guidance for addressing Threatened species values in the context of regional planning under the NPS-FM. These sections are presented in an order that matches the sequence of steps that require consideration under the National Objective Framework.

Where possible, the material is set out in a step-by-step fashion to assist council staff with interpreting and implementing the policy requirements. These sections include a description of practical methods for four aspects of the NPS-FM, including:

- Identifying Threatened species habitat (section 2.2)
- Identifying critical habitat (section 2.3)
- Identifying assessment attributes and examples of monitoring options (section 2.4)
- Planning responses and actions (section 2.5)

We also provide a summary of the key information gaps that were identified in the project (section 2.6). Many of these present significant challenges and opportunities to further support councils in their freshwater management functions.

Lastly, it is intended that this guidance is a living document. Additional information on methods and approaches to address Threatened species values in regional planning may become available in future versions of the document.

1.1.2 Regional council survey and workshop process

The Threatened species guidance project was developed in two main stages. In the first stage, an online survey was used to identify and collate regional council perspectives on key aspects of the Threatened species requirements of the NPS-FM.

The objectives of the survey were to identify information on current approaches, information gaps, opportunities, and key considerations for addressing Threatened species under the NPS-FM. An associated objective was to identify the key topics to be addressed in a facilitated workshop in the next stage of the project. The survey questions addressed monitoring and reporting practices, current or desirable policy, rules or activity limits, and perspectives on information gaps, challenges and other constraints that are relevant to council responsibilities. A summary of results from the council perspectives survey are available in a separate report (Orchard & Fisher, 2025).

In the second stage of the project a working group was convened to design and facilitate the workshop process to further explore and refine ideas that were identified in the survey. The full-day online workshop followed an open invitation format that was promoted for a 2-month period leading up to the workshop date. Workshop promotions included email messages that were distributed through council and DOC networks including the SWIM Fish Group, Biodiversity Working Group, and Coastal Special Interest Group.

The target audience for the workshop was not restricted to those who had participated in the online survey and included both technical and planning or policy staff. The workshop was held on 8 May 2025, attended by 34 participants, representing all the regional councils. Following the workshop, an initial draft of this guidance document was prepared by the working group and reviewed by a SWIM co-convenor.

This guidance is a living document that represents the culmination of the combined survey and workshop process.

Throughout the document we illustrate some of the practical steps using an example Threatened species, shortjaw kōkopu (*Galaxias postvectis*), which we briefly introduce in the Section 2.2.

1.2 Policy context

1.2.1 National Policy Statement on Freshwater Management (NPS-FM)

The NPS-FM provides direction from central government including objectives and policies for freshwater management under the Resource Management Act 1991 (RMA). The current NPS-FM came into effect on 3 September 2020 and has received several amendments since then, with the most recent dated October 2024. Hereafter we refer to this most recent and currently operative version of the NPS-FM (Ministry for the Environment, 2024).

Under clause 1.5, the NPS-FM applies to all freshwater and receiving environments to the extent they are affected by freshwater. This requires attention to the hydrological connectivity of different water bodies that may include surface water, groundwater and coastal features as well transition areas such as estuaries and ephemeral wetlands. Through this holistic approach the NPS-FM promotes the integrated management of water resources from the mountains to the sea.

This guidance has been produced during a time of legislative reform; however, requirements remain for freshwater to be managed consistent with the RMA and NPS-FM, in the anticipation that fundamental elements are likely to feature in any future policy context. A. These include the ongoing and enduring need to assess the current state and appropriate targets for freshwater values, and the need to develop planning approaches to achieve those targets. In this guidance, linkages to these enduring needs are identified while also addressing the specific requirements of the NPS-FM in its current format.

1.2.2 Applying the National Objectives Framework

The National Objectives Framework (National Objective Framework) performs several key functions in the approach to freshwater management and it is directly mentioned in Policy 5, which describes the desired outcomes of freshwater management under the NPS-FM. The National Objective Framework plays a central role by directing a sequence of steps for identifying FMUs, identifying values, setting environmental outcomes for values, identify attributes and baseline states, setting target attribute states, setting limits as rules and preparing action plans to achieve environmental outcomes, as summarised in clause 3.7(2). See insert Box 1.1 for definitions of the National Objective Framework process 3.7 and Policy 5 desired outcomes.

Values

The National Objective Framework process requires that regional councils identify and monitor the status of freshwater environments by identifying the values of FMUs, and attributes that support those values. The NPS-FM additionally provides four compulsory values, a suite of other values that must be considered, and allows scope for the identification of other values. The NPS-FM identifies Threatened species as one of four compulsory values, to which the National Objective Framework process must be followed.

Attributes

Attributes are measurable characteristics (numeric, narrative, or both) that can be used to assess the extent to which a particular value is provided for. The NPS-FM identifies a suite of attributes for Ecosystem Health and Human Contact compulsory values, though no attributes have been identified specifically for the Threatened species value. In some cases, the listed attributes may be useful and relevant for informing the state of the Threatened species value (e.g., the Fish IBI may be informative for Threatened freshwater fishes).

As set out in the National Objective Framework process, the identification and subsequent assessment of these attributes is used to assess the extent to which this value is provided for. This is defined and facilitated by the setting of a Target Attribute State (TAS) for each selected attribute in each FMU or part FMU. The process of monitoring and comparing current and target states serves as a guiding principle for the achievement of environmental outcomes, and determines the type(s) of responses, including regulatory and non-regulatory. These may include the revision of limits or other environmental controls and development of action plans (see NPS-FM clause 3.12)[1].

1.2.3 Freshwater Management Units (FMUs)

The National Objective Framework requires the identification of freshwater management units (FMUs). Many councils have completed a process to identify FMUs, with local and regional context in mind, so little consistency may exist for the size and complexity of FMUs within and between councils. Within the National Objective Framework process, regional councils are required to identify the location of habitats of Threatened species within each FMU. MfE also promotes the inclusion of these identified habitat locations of Threatened species into regional plans (MfE Factsheet), which is recommended here as it usefully provides for the development of a rule framework for managing activities and their effects within known habitats. Note this step of the National Objective Framework is a useful addition, above and beyond requirements for compulsory values.

[1] See the MfE website for links to the factsheets. https://environment.govt.nz/acts-and-regulations/freshwater-implementation-guidance/

Box 1-1

Definition of the National Objectives Framework process (NPS-FM 3.7) and Policy 5 desired outcomes

Policy 5

Freshwater is managed (including through a National Objectives Framework) to ensure that the health and well-being of degraded water bodies and freshwater ecosystems is improved, and the health and well-being of all other water bodies and freshwater ecosystems is maintained and (if communities choose) improved.

3.7 National Objective Framework process

(2) By way of summary, the National Objective Framework process requires regional councils to undertake the following steps:

- *a) identify Freshwater Management Units (FMUs) in the region*
- *b) identify values for each FMU*
- *c) set environmental outcomes for each value and include them as objectives in regional plans*
- *d) identify attributes for each value and identify baseline states for those attributes*
- *e) set target attribute states, environmental flows and levels, and other criteria to support the achievement of environmental outcomes.*
- *f) set limits as rules and prepare action plans (as appropriate) to achieve environmental outcomes.*

Part 2: NPS-FM Guidance

NPS-FM Guidance

Shortjaw kōkopu: Shyam Morar, GW

2.1 Introduction to Threatened species values

For the purposes of the NPS-FM, “Threatened species” are defined as any indigenous species of flora or fauna that:

(a) relies on water bodies for at least part of its life cycle; and

(b) meets the criteria for nationally critical, nationally endangered, or nationally vulnerable species in the *New Zealand Threat Classification System Manual*

Through the National Objective Framework, regional councils are required to identify the locations of habitats of Threatened species and are guided to include these in regional plans.

As with the other compulsory values, regional councils are required to:

- Identify an environmental outcome for Threatened species in each FMU and include these outcomes as an objective in the regional plan.
- Identify attributes that are relevant to achieving the outcome.
- Identify target states for those attributes and assess FMUs or part FMUs against those targets
- Develop and implement planning methods to achieve the environmental outcome and target attribute states.
- Monitor FMUs and part FMUs to evaluate the effectiveness of the planning methods for achieving the environmental outcomes and to enable an adaptive management approach going forward.

There are also several other aspects of the NPS-FM that may indirectly help to manage Threatened species values, such as implementation of the ecosystem health value and its component parts. However, there are also requirements that are specific to the assessment and needs of the Threatened species of the region.

The remainder of this guidance concentrates on providing information that is specific to these needs.

The overall process involves a series of assessment and goal-setting steps that guide the management of freshwater values in each FMU of the region (Figure 1).

Regional and unitary council functions

In relation to Threatened species values, the council perspectives and other information collected in this project conveyed a perception that the management of habitat is a key function and responsibility of regional councils. Despite this focus on habitat, the ultimate outcome is that this habitat must provide for the presence, abundance, survival, and recovery of Threatened species, and attributes and action plans must align with this. Threatened species and their habitats are intrinsically linked, and their management cannot be logically separated. This is also relevant to the functions of councils under s30 of the RMA, including to maintain indigenous biological diversity, and to control the use of land for the purpose of maintaining and enhancing ecosystems in water bodies. There is a focus on identifying the locations of habitats, as well as the critical habitats and conditions necessary to support the presence, abundance, survival and recovery of the Threatened species. This includes attention to specialised habitats or conditions that are needed for only part of the life cycle of the Threatened species. Therefore, it is important to understand the drivers of decline of Threatened species at these same scales, and also their response to interventive management which aims to achieve recovery.

Role of attributes

An understanding of habitat and the concept of critical habitat are central to the process of identifying attributes for the assessment of Threatened species values (see section 2.3 and 2.4). This is especially important in view of the lack of compulsory attributes other than Fish-IBI, and a clear requirement that a range of attributes will be needed to address a range of species.

Councils must therefore identify their own attributes that are fit-for-purpose for the Threatened species values of each FMU.

Determining the list of species dependent on freshwater bodies is a key step to identify the species that fall within the scope of the NPS-FM. We address this topic in section 2.2.2 before providing guidance on the identification of Threatened species habitat, critical habitat and attributes for implementing the NPS-FM.

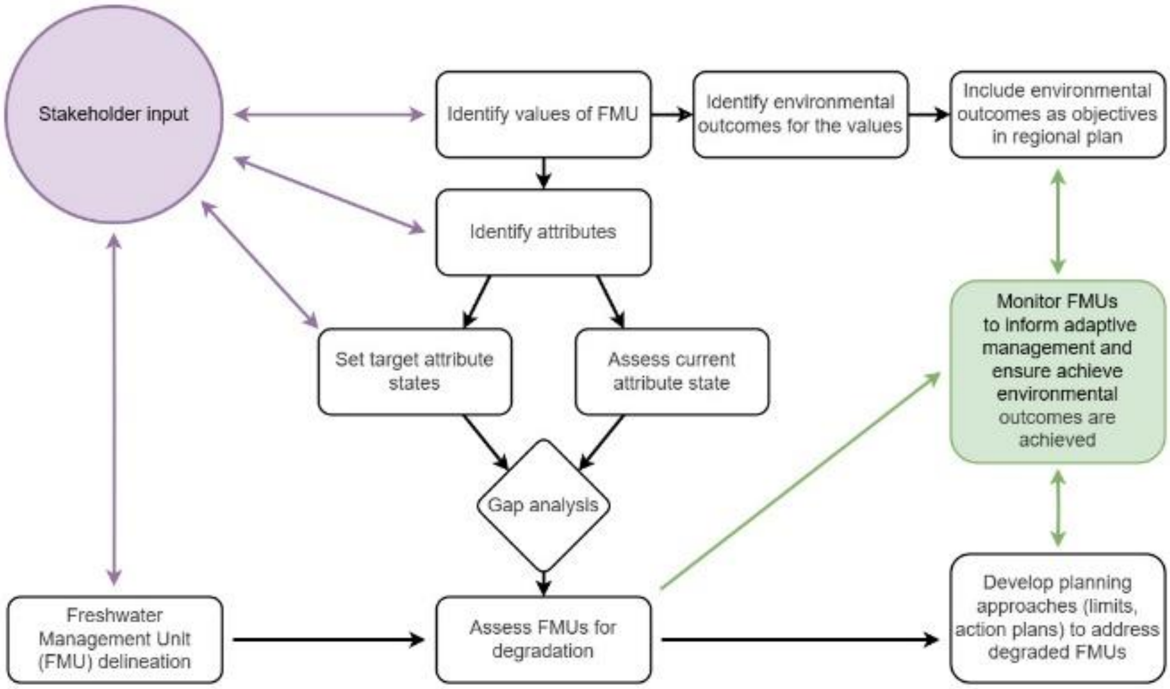


Figure 1. Key steps for assessing freshwater values and identifying management needs using assessment attributes and target attribute states (TAS) under the NPS-FM.

2.2 Threatened species

2.2.1 Example species shortjaw kōkopu (*Galaxias postvectis*)

Shortjaw kōkopu are the rarest of New Zealand's five diadromous galaxias. They have a nationwide distribution typical of diadromous species. Although most of the known populations are found on the west coast in both islands (McDowall et al., 1996). Shortjaw kōkopu are typically found in small to medium-sized rivers with bouldery substrates and abundant riparian cover (Bowie & Henderson, 2002; Goodman, 2002; McDowall, 1990). They also have a preference for podocarp / hardwood catchments, and are seldom found in beech forest (McDowall et al., 1996).

The transparent juveniles of shortjaw kōkopu are captured as whitebait; however they are the least abundant of the five migratory galaxiids based on catch composition data (McDowall, 1965).

Shortjaw kōkopu are listed as 'Threatened – Nationally Vulnerable' In the most recent conservation status assessment under the New Zealand Threat Classification System (Dunn et al., 2018). Causes of decline are thought to include habitat loss and degradation, barriers to fish passage and large scale disturbances caused by weather events (Department of Conservation, 2005; Goodman, 2018).

As is typical of many freshwater fish species, there are significant gaps in the knowledge of the ecology and biogeography of shortjaw kōkopu. Key knowledge gaps include spawning behaviour, larval fish habitat and behaviour, and the temporal variation and regional structure of populations (Goodman, 2018). For these reasons, addressing information gaps and implementing long term monitoring is an important aspect of current needs for conservation and management.

Although surveys often find juvenile shortjaw kōkopu in the same location as adults, there is evidence for patchy recruitment in comparison to other migratory fish species (Bowie & Henderson, 2002; McDowall, 2010). To date, there is only sparse information on spawning behaviour, it is known to occur on the riparian margins of streams during increased flows in the vicinity of previously established adult habitat (Charteris et al., 2003; Donovan, 2024).

Figure 2. Spotlighting is one of the recommended survey methods for shortjaw kōkopu: Shane Orchard

2.2.2 Identifying freshwater-dependent species

Threatened species that fall within the scope of the NPS-FM include any indigenous species of flora and fauna that rely on water bodies for at least part of their life cycle. Implementing this aspect requires decisions on the taxa that are deemed to be reliant on water bodies, which we hereafter refer to as 'freshwater-dependent' species. This is a nuanced topic and there has been considerable debate on the extent to which the NPS-FM intends to capture species that are present in both freshwater and terrestrial environments. The answer to this question lies in the often-overlooked reference to water bodies, defined through the RMA to mean fresh water or geothermal water in a river, lake, stream, pond, wetland, or aquifer, or any part thereof, that is not located within the coastal marine area. This means that the dependency of these species is not freshwater, but reliance on water bodies for any part of their life cycle.

Practical aspects of identifying freshwater-dependent species in the Otago Region were investigated by Thorsen (2022) who developed a framework of six qualifying criteria to define freshwater dependence.

These are:

- Most individuals permanently inhabiting freshwater habitats; or
- Most individuals use freshwater habitats for a part of their lifecycle; or
- Some individuals recorded temporarily or occasionally using freshwater habitats; or
- The species is listed as a 'freshwater' species during NZ Threat Classification Assessments (Table 1), in Clarkson et al. (2021) (plants only), Storey et al. (2018) (birds only), or has been designated elsewhere as freshwater-dependent in a similar exercise to this; or
- The species is known to inhabit freshwater habitats in addition to other non-freshwater habitats; or
- Some individuals are mapped as occurring in freshwater but their link to freshwater is not known.

These criteria were applied to species occurrence records for the region that were extracted from publicly available electronic biodiversity databases. This resulted in a total of 140[2] candidate species being identified as freshwater-dependent in the Otago region (Thorsen, 2022). The list of candidate species was then refined to 78 species utilising the three most defensible lines of evidence for freshwater-dependence, however, is subject to change with input from experts.

Crisp (2023) performed a similar exercise for the Wellington Region that was based on an expert knowledge approach. Freshwater-dependence was determined by considering the critical elements of the life cycle of candidate species. The assessment resulted in a total of 30 species being identified as freshwater-dependent in the region (Crisp, 2023). For example, the wrybill (*Anarhynchus frontalis*) breeds on braided river systems and feeds on the coast, so part of the species lifecycle is dependent on freshwater habitat.

For the time being, inclusion of Threatened – Nationally Increasing or At Risk threat status species are optional and above the minimum requirements for NPS-FM Threatened species values.

However, a consistency with the NZTCS could be readily achieved by referencing the 'Threatened' category as a whole and specifying the use of the most recent assessment under the NZTCS (Figure 3).

[2] Revised from 135 to 140 species based on expert opinion in consultation with ORC

Summary

Aside from decisions on the taxa to be included within the scope of the NPS-FM, the remaining steps can be summarised as:

1) **Required:** Compile a list of regional Threatened freshwater-dependent species

2) **Optional:** Consider other regionally significant freshwater dependent species that may be desirable to identify as FMU values for assessment and inclusion in NPS-FM action plans.

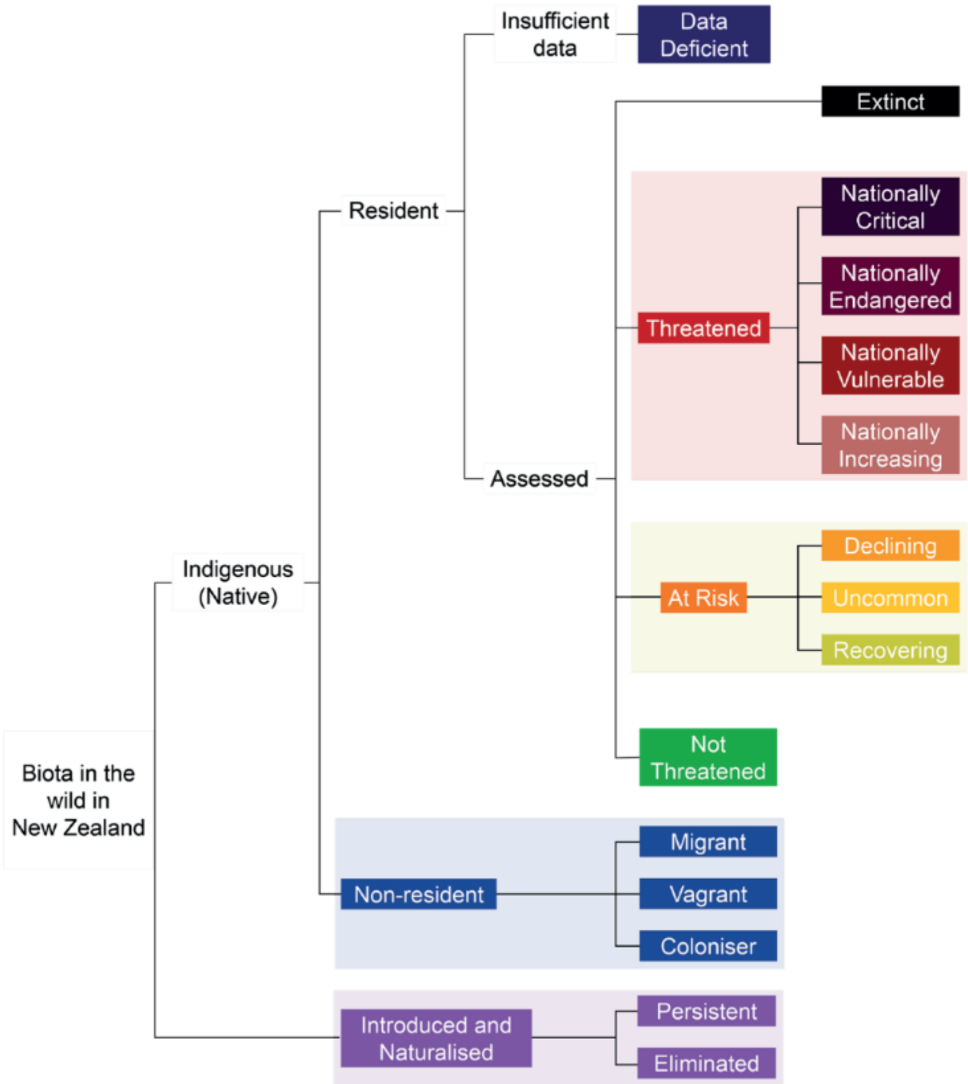


Figure 3. Revised structure of the New Zealand Threat Classification System (Rolfe et al., 2022).

Table 1. Summary of freshwater species counts by taxonomic group for species within the Threatened, At Risk, and Data Deficient categories. Counts indicate the number of species assigned to the freshwater environment within the NZTCS, noting that species are assigned to a single environment despite using more than one environment. Green rows indicate threat statuses which meet the NPS-FM definition for "Threatened species" and therefore meet NPS-FM requirements. Orange rows indicate threat categories and statuses indicative of extinction risk for assessed taxa and may be considered optional for NPS-FM requirements. Information from this table forms part of one criterion used by Otago Regional Council (Thorsen 2022).

	Freshwater invertebrates 2018[1]	**Vascular plants 2023**[2]	**Freshwater fishes 2017**[3]	**Birds 2021**[4]	**Coleoptera 2010**[5]	**Mosses 2014**[6]	**Amphibians 2024**[7]	**Spiders 2020**[8]	**Macroalgae 2019**[9]	**Earthworms 2014**[10]	**Hornworts and liverworts 2020**[11]	**Lichens 2018**[12]	**Grand Total**
Threatened													
Nationally Critical	48	10	4	3									**65**
Nationally Endangered	14	4	6		1								**25**
Nationally Vulnerable	16	11	12	4		1	1						**45**
Nationally increasing				3									**3**
At Risk													
Declining	10	18	11	4			1						**44**
Naturally Uncommon	86	32	6	3	3	2		2					**134**
Relict		2		2									**4**
Data Deficient													
Data Deficient	178	1		1		1			21	2	1	11	**216**
Grand Total	**352**	**78**	**39**	**20**	**4**	**4**	**2**	**2**	**21**	**2**	**1**	**11**	**536**

[1]Grainger et al. 2018, [2]de Lange et al. 2024, [3]Dunn et al. 2018, [4]Robertson et al. 2021, [5]Leschen et al. 2012, [6]Rolfe et al. 2016, [7]Burns et al. 2025, [8]Sirvid et al. 2021, [9]Nelson et al. 2019, [10]Buckley et al. 2015, [11]de Lange et al. 2020, [12]de Lange et al. 2018.

2.2.3 Data sources for species and habitat mapping

Identifying the location and spatial extent of a Threatened species' habitat provides fundamental information for understanding the drivers and pressures on populations, prospects for the recovery of declining populations, and the selection of monitoring sites. Tracking changes in the extent of suitable habitat may also be highly relevant as an indicator of the species' status within a given catchment or FMU. Identifying the location of habitat of Threatened species is an additional requirement for regional councils as part of following the National Objective Framework process and has been advised to be included in regional plans. When included in regional plans, locations of the habitats of Threatened species can be used to trigger more stringent assessment of effects and set conditions and limits on activities causing pressures where activities may affect Threatened species and their habitats. An initial assessment for data sources for this process, including limitations, was provided by Whately (2020).

In general, the most useful sources of information for habitat mapping are species presence records, which should consider information gaps due to limited surveys, based on the expected species range and model predictions from species distribution models (SDMs). Distribution models can also be used to assess the connectivity of discrete fish populations. Planning monitoring and actions at larger geographic scales, e.g. an ecological district, may be required to reflect the species life history connected by their migratory (marine) phase, rather than defined by regional or unitary council boundaries that may intersect river networks and catchments.

Records for Threatened freshwater fish and their habitat can include a range of methods, however, the quality of information needs to be checked with some means of validating the information, e.g. photographic or eDNA confirmation of the fish species. Preference should be given for species records of known quality, derived from systematic surveys (i.e. using a defined methodology that also measures catch effort and habitat condition). Typical methods to confirm the presence of fish species include:

- SOE monitoring data collected by regional councils
- Fish surveys (including electrofishing)
- Netting and trapping surveys (including larval netting)
- eDNA surveys
- Chemical signatures (e.g. pheromone sampling)
- In addition to the detection of species presence, habitat mapping may utilise information from: Site visits to assess habitat types and condition
- Predictions from SDMs
- Documents supporting resource consent applications, where Threatened species or their habitats are identified.

Existing records should also be checked and used to inform surveys and monitoring site selection e.g., historical records from the NZ Freshwater Fish Database (NZFFD) and DOC Threatened Fish surveys. Contributions of records from citizen science projects and biodiversity apps such as iNaturalist are also used for biodiversity assessments and can provide a useful resource for species and habitat assessment as well as community engagement.

Data gaps and limitations

Data deficiency issues are likely to affect at least two important aspects of Threatened species management under the NPS-FM. The first is where the species is poorly known and there may be relatively few presence records. In many cases these reflect a lack of survey effort in contrast to a known situation of species absence. Similarly, there is likely to be a lack of understanding of the drivers of species distribution and habitat preferences as is needed to inform predictive models.

A pragmatic solution for council processes involves making use of the best available data and considering additional data collection efforts where there is evidence that the species may be present or expected from modelling in unsurveyed parts of the region. The sources of such evidence can include the traditional knowledge of tangata whenua and the anecdotal knowledge of community members who may be familiar with areas that have not been formally surveyed.

It is also worth considering the status of old records of species presence at locations that may have changed considerably since the survey date. These considerations add to the challenges of data gaps and uncertainties when identifying the data sources that will be used to identify the current location of habitat as is needed under the NPS-FM. It is recommended that records older than 10-years are treated with caution and the locations concerned with suitable habitat are ideally re-surveyed to obtain current information. Where this is not possible a desktop evaluation should be conducted using aerial imagery to check for notable habitat changes.

Conservation status assessments

Another data limitation to note relates to the reliance on a conservation status assessment for each freshwater species. The reference to the NZTCS in definition of a Threatened species in clause 1.4 effectively means that only those species that have been subject to a NZTCS assessment can fall within the scope of the NPS-FM. Although this is a notable limitation, regional councils have the option to include regionally Threatened or rare species, or species of significance to tangata whenua and the community. It is also likely that additional taxonomic groups will receive assessments in the future, which will require a plan review. Progressing this also presents an opportunity to support comprehensive freshwater management by informing regional council planning.

2.2.4 Combining data from different sources

To obtain a robust picture of Threatened species habitat it is desirable that all of the available data sources are considered. In general, data requirements should consider the following:

(i) Descriptions of habitat requirements that will support models to predict where species may occur and inform options for habitat recovery.

(ii) Detection power of available methods (e.g., considering likelihood of missed detection leading to false negatives).

(iii) Monitoring methods to track population trends and more intensive methods to estimate population size.

(iv) Identification of factors that may prevent species from accessing and optimising their use of potential habitat (e.g. weirs that block fish passage to spawning grounds)

Making the best use of the available information requires methods to combine data that is derived from different sources including sampling or modelling techniques that may be conducted at different spatial scales. Recommended approaches are discussed in the following sections.

Field observations

Field observations will be required to validate desk top assessments for habitat and provide the opportunity to collect key information, including presence of the species and evidence of spawning, observations of size classes to confirm recruitment and to quantify the habitat condition, threats and pressures. Although field observations from visual sightings or capture techniques provide confirmed evidence of the species presence, all of these sampling methods are associated with a degree of uncertainty that is associated with imperfect detection. This represent a Type II error, or false negative, in which individuals of the species may have escaped detection and yet were present in the sampling. This presents a specific consideration for combining information from different sampling and survey techniques using standardised methods and constant effort, because the detection rate will characteristically differ between methods. In most cases these error rates will be largely unknown unless it has been the subject of independent trials.

In general, it is not possible to directly resolve these considerations when selecting data to use to be used for the identification of Threatened species habitat, but it is worth keeping in mind for the selection of methods that may be chosen to improve the knowledge of species distribution through the establishment of baseline surveys in new areas or resurveying of old records.

A recommended pragmatic approach is to simply combine all the species presence records that are associated with reliable location data, whilst keeping in mind the above recommendations for old survey records and the consideration of environmental changes.

eDNA and pheromone sampling

These sampling techniques are based on the detection of signals of the species' presence (i.e., DNA fragment or chemical signature) that have been transported to the sampling site from a distant and unknown location. Where species presence is recorded using these methods an assumption must be made to associate the detection with a spatial footprint or area of habitat.

A pragmatic approach to this question involves the use of a standard measure of the water body (e.g., river network) that is associated with the presence record. The selection of an appropriate unit will typically vary in different uses cases.

For example, if an existing data set of shortjaw kōkopu records is available from spotlighting and electrofishing in fixed reach surveys, it will be tempting to interpret additional eDNA at the same scale, and perhaps associating eDNA presence records with the longest reach length that is typically surveyed. In the shortjaw kōkopu example this would likely be a 400 m reach as has been used for spotlighting in targeted fixed reach surveys (Jack, 2020/DOC; Orchard, 2021). The eDNA record would therefore be associated with a 400 m reach upstream of the sampling point.

Ideally such assumptions will be backed up by field evidence to demonstrate that the eDNA source could have originated from at least that far upstream, but this too is likely to be a highly variable parameter due to hydrological variation (e.g., varying flow rates) and other factors.

It is important to note that the situation is a little different for lentic water bodies in which there is little or no flow. In this case, determining the dimensions of the spatial unit to associated with a presence record is more nuanced and should ideally be the subject of field trials.

For example, Bird et al. (2024) found that an eDNA signal in a wetland environment remained very localised to its origin (e.g., within a 10 m radius). This suggests that only a small footprint should be associated with a presence record, and conversely, that absence records should not be taken to indicate absence in a large area such as the entire hydro system being sampled. Our understanding of these spatial dynamics and their implications for aquatic eDNA sampling is still in its early stages of development and yet vitally important for the interpretation of sampling results (Melchior & Baker, 2023; Orchard, 2023b).

Another pragmatic alternative (see below) involves the use of the REC2 river network as a standard spatial unit. Following this approach, presence records from any data source are simply mapped to the REC2 unit in which they were observed. Although this approach also carries the same inherent assumptions as to the true location of the species concerned, it has the additional benefit of facilitating the aggregation of field observation with SDM outputs that use REC2 as their spatial domain (or other SDMs that can be mapped to it).

Species distribution models (SDMs)

SDMs include spatial simulations and statistical approaches that are used to predict where a species can or does occur that are derived from correlations between known locations and descriptive environmental variables (Elith & Leathwick, 2009; IPBES, 2016). They provide a way to obtain complete spatial coverage for a metric of interest, such as species presence or abundance across the environmental domain of interest such as a river network.

There are two main types of SDMs (Dormann et al., 2011). Correlative SDMs such as climate envelope models apply statistical routines to fit an ensemble of potential predictor variables to known occurrence data. In this approach the predictor variables may be relatively general and often reflect the availability of data sources that cover the spatial extent and intended resolution of the model (Franklin, 2010).

In contrast, mechanistic or process-based SDMs use more targeted information on the known drivers of species distribution to build up a model that depicts favourable conditions and locations (Cuddington et al., 2013).

Examples for freshwater fish include a correlative SDM based on the REC1 network that used 23 environmental predictor variables (Leathwick et al., 2008; Snelder & Biggs, 2002). Another SDM was developed subsequently on the REC2 network using 86 predictor variables (Crow et al., 2014; NIWA, 2019).

Assessing the accuracy of model predictions is ideally done using independent validation based on data that was not used for training, building, or calibration of the model (Araújo et al., 2005; Elith & Leathwick, 2009). In many cases an estimation of the uncertainty of correlative models is instead evaluated using cross-validation procedures which are a form of internal validation. Importantly, this process can only make comparisons between data from the same spatial and temporal domains as the model training data. Therefore, its ability to simulate new domains (e.g., other parts of a river network) remains untested (Cuddington et al., 2013; Dormann et al., 2011).

Combining information from different SDMs

Another consideration that is related to the uncertainties of model predictions can arise when there is more the one SDM available for the species. This is the case for freshwater fish species where there are two readily available nationwide models in addition to others covering smaller areas (Figure 4). The probability of occurrence that is predicted by each model will differ, even though they may share similarly high calibration metrics (i.e., good model fits).

The recommended approach for combining information from multiple models is to apply the probability of occurrence threshold that has been derived for each model. This threshold relates the modelled probabilities to predicted presence/absence and can be used to identify the REC segments where presence is expected. The models can then be directly compared.

The degree of consistency between models can also be used to classify the REC2 segments as shown in the shortjaw kōkopu example in Box 2-1. A decision must then be made on the degree of consistency (or conversely, uncertainty) that will be accepted as evidence of true presence. A recommended approach is to accept predictions that concur between the SDMs and regard the discrepancies as unconfirmed habitat that may warrant further investigation.

Over time further model refinements are also likely and would ideally be accompanied by validation (ground-truthing) studies. It is also noted that there are other methods for combining model predictions (e.g., joint probability analysis) but these techniques may not be appropriate for models where the probability scaling is fundamentally different.

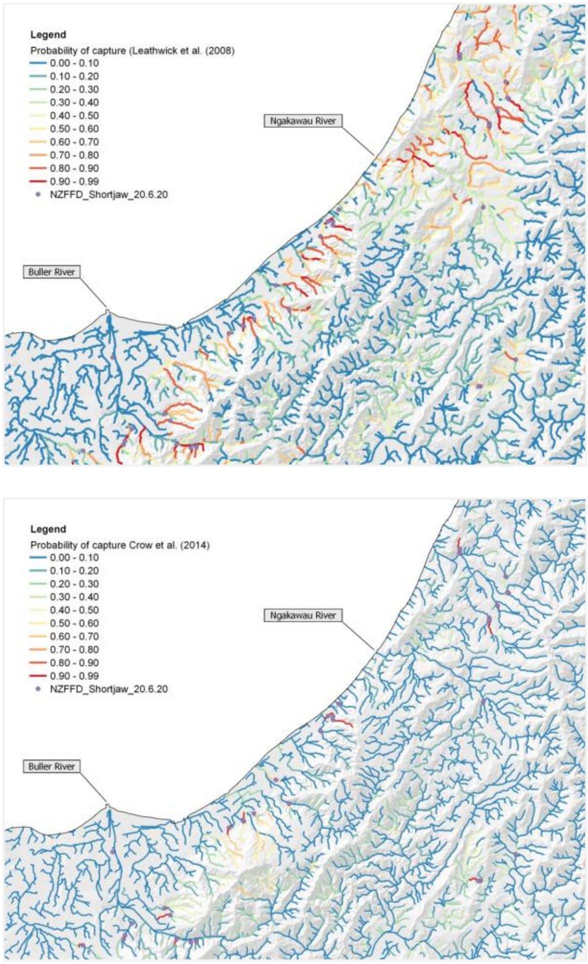


Figure 4. SDMs for shortjaw kōkopu in the Buller region showing the probabilities of capture predicted by each model. A) Leathwick et al. (2008). B) Crow et al. (2014).

Using REC2 as a standard spatial unit for habitat mapping

There are several practical advantages associated with the adoption of existing biogeographical units such as REC2 as a standard spatial unit for the purposes of identifying Threatened species habitat. These include their convenience for aggregating data from different sources including model predictions and the availability of other environmental data that has been prepared at the scale of these units. This provides useful information for the design and interpretation of monitoring programmes as well as practical information for habitat management.

Despite these advantages, the NPS-FM also requires attention to the concept of *critical habitat* which may demand an additional focus on finer scale assessment units within a river network or other water body type. Therefore, a combination of standard spatial units such as river network segments and water body feature types will ultimately be required.

Recommended approaches include:

- Using standardised, broader scale, spatial units when identifying the overall habitat of Threatened species based on combinations of the available data sources (Figure 5 & Box 2-1).
- Developing finer scale methods to identify critical habitat. These will be specific for each species and their characteristic life history traits as discussed in section 2.3.
- Improving REC2 digital river networks and models for regions with LIDAR, which can also be used to assess the extent of change in habitat, including river morphology and vegetation cover at any given scale.

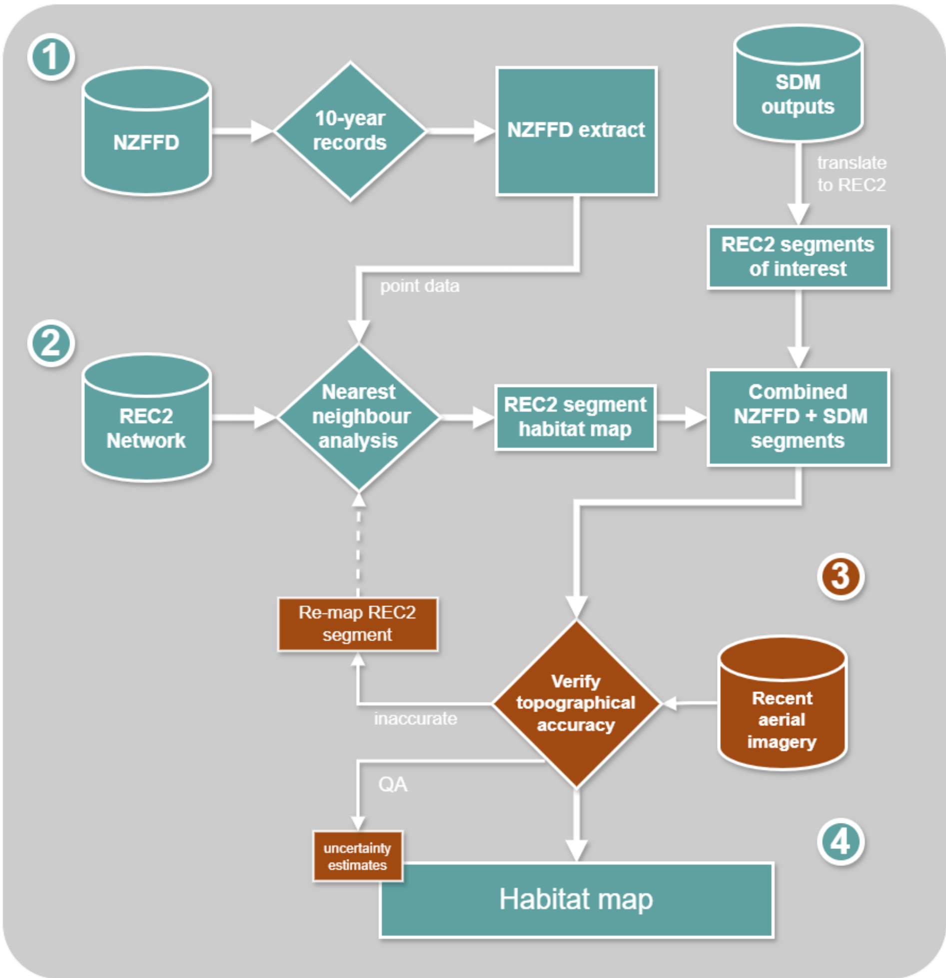


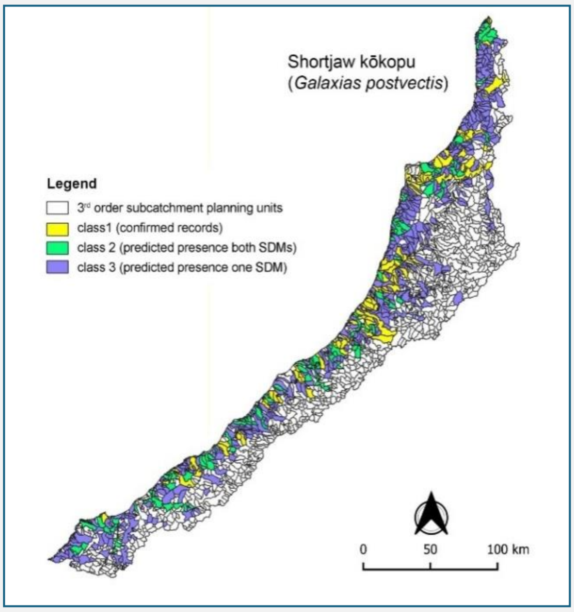
Figure 5. Workflow for mapping habitat of Threatened freshwater fish species using combined data from the New Zealand Freshwater Fish Database (NZFFD) and species distribution models (SDMs) mapped to the REC2 river network. Step 3 analyses (brown boxes) are validation and uncertainty estimates in the workflow.

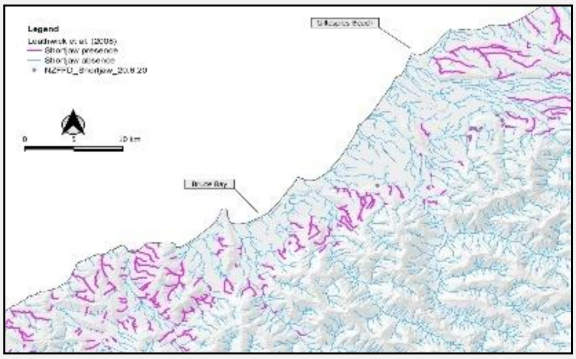
Box 2-1

Combining NZFFD records and SDM predicted occurrence data from different SDMs for shortjaw kōkopu

Step 1
Map NZFFD records and SDM presence/ absence predictions onto the REC2 catchment framework

Step 2
Identify REC2 river segments of interest using all data sources combined (e.g., class 1+2 units in the shortjaw kōkopu example)





Step 3
Intersect REC2 segments with FMU boundaries

shortjaw kōkopu habitat maps (in this case, adult fish habitat)

Legend: Worked example of combining NZFFD records and predictions from two SDMs (Crow et al., 2014; Leathwick et al., 2008) for shortjaw kōkopu in the West Coast region. For the purposes of the NPS-FM the recommended classes of interest for the identification of Threatened species habitat are class 1 (confirmed records based on field surveys) and class 2 (predicted presence in both SDMs). Additional decisions on acceptable levels of uncertainty need to be made on the inclusion of old surveys records (e.g., >10 years) and the potential for further refinement of the available SDMs. Figures adapted from Orchard (2020).

2.3 Identifying critical habitat

Critical habitat

Defining and delineating the critical habitats of Threatened freshwater species is a core requirement of the NPS-FM. It is also a logical and practical approach for managing Threatened species habitat, which recognises that some parts of the overall habitat may be highly important or essential at different life stages. In this sense, a focus on critical habitat can promote a more effective and efficient approach to setting environmental limits and targeting actions for the conservation of Threatened species and habitats and ensure that actions and investments are where they are most needed. This also helps to avoid unnecessary trade-offs with other values that may include productive and intensive land uses that are proposed or are underway in the same locations. Attention to these effectiveness and efficiency considerations are directly required by the RMA (particularly under section 32).

In the context of Threatened species conservation, we define critical habitats as the habitat features necessary to support the presence, abundance, survival, and recovery of a Threatened species as described in the NPS-FM Appendix 1A – Compulsory Values.

Critical habitats are the physical or biological features essential to the conservation of a species. These include areas where the species breeds, feeds, migrates, disperses or hibernates at different times in its life cycle. These may require special management considerations or protection to enable the species to complete its life cycle. More specifically, critical habitat is linked with the concept of high-quality habitat, which equates to an area's ability to provide resources for population persistence.

The concept of critical habitat is not directly defined in the NPS-FM or RMA. However, it is utilised in other jurisdictions including in the US under the Endangered Species Act 1973 (ESA) (US Government, 1973).

Our suggested definition also aligns with Grinnell’s life-zone concept that recognises the needs of different life stages (Grinnell, 1917) and is a dimension of the ecological concept of niche space (Sexton et al., 2017). It also generalises the interpretation of Dunk et al. (2019) who specially included attention to species’ demography when addressing the ESA requirements for US species listed as ‘endangered’. This policy context has many similarities with the statutory setting of the NPS-FM. In that case, the critical habitat concept also requires attention to areas that are required for the recovery of an endangered species to a predefined policy goal that relates to the risk of extinction (Dunk et al., 2019). In contrast, the NPS-FM conveys a flexible approach for the setting and achievement of recovery goals.

Relationship with species range

Critical habitat can also be viewed as a layer of additional biogeographical detail in comparison to the related concept of species range which may be defined as the geographical area where a species can be found during its lifetime (Gaston, 2003).. The delineation of range limits involves many aspects of the evolution and ecology of species distributions including attention to the concepts of fundamental and realise niches (Miller et al., 2020; Sexton et al., 2009). The spatial and temporal dimensions of these aspects are highly dynamic and often strongly influenced by climatic changes (Huang et al., 2021; Shay et al., 2021).

Within the context of the NPS-FM requirements, the range concept is therefore aligned with the overall habitat of a species as discussed in section 2.2.

Local and expert knowledge approach

As illustrated by the above discussion and definitions, the methods for defining and delineating the critical habitat of Threatened freshwater species will be highly dependent on the characteristics of the life cycle and the areas that are used and needed at each life stage of a given species. These aspects vary considerably across species and, in many cases, may be poorly understood or have little documented information. For these reasons, it is advantageous to consider and include a wide range of knowledge sources when identifying and characterising the critical habitat of a given species as is required under the NPS-FM. This is especially important where an understanding of the current locations and the overall distribution of critical habitat is required.

We recommend that these needs are best addressed at a national scale using an expert and local knowledge derived process to provide guidance on the definition and delineation of critical habitat for each Threatened freshwater species. Advantages of this approach include the ability to include mātauranga Māori and local or traditional sources alongside insights gained from formal studies of life history traits and habitat requirements.

A qualitative local and expert derived approach that can interpret and build upon any quantitative habitat data offers a practical means of assisting councils to identify critical habitats for Threatened freshwater species in the context of regional planning. We suggest that these needs could be addressed by facilitating a series of local and expert derived workshop for each Threatened freshwater species (or logical groups) within a national workshop series.

This is an efficient approach to support all councils nationally for each species that is addressed with the initial scope of the workshop series being guided by the current list of Threatened freshwater species. This approach can also be applied in the future to address revisions that result in additional species being classified as Threatened under the NZTSC.

A generic workflow for a local and expert knowledge process is set out in Figure 6.

DOC Threatened species management plans also utilise Population Viability Analysis, which models direct drivers and pressures on population persistence. This analysis, where possible, provides a method to prioritise actions to target and mitigate activities that impact on the species life history requirements. It is enabled and supported by an understanding of critical habitat, along with knowledge of the current or future threats and pressures that may be relevant.

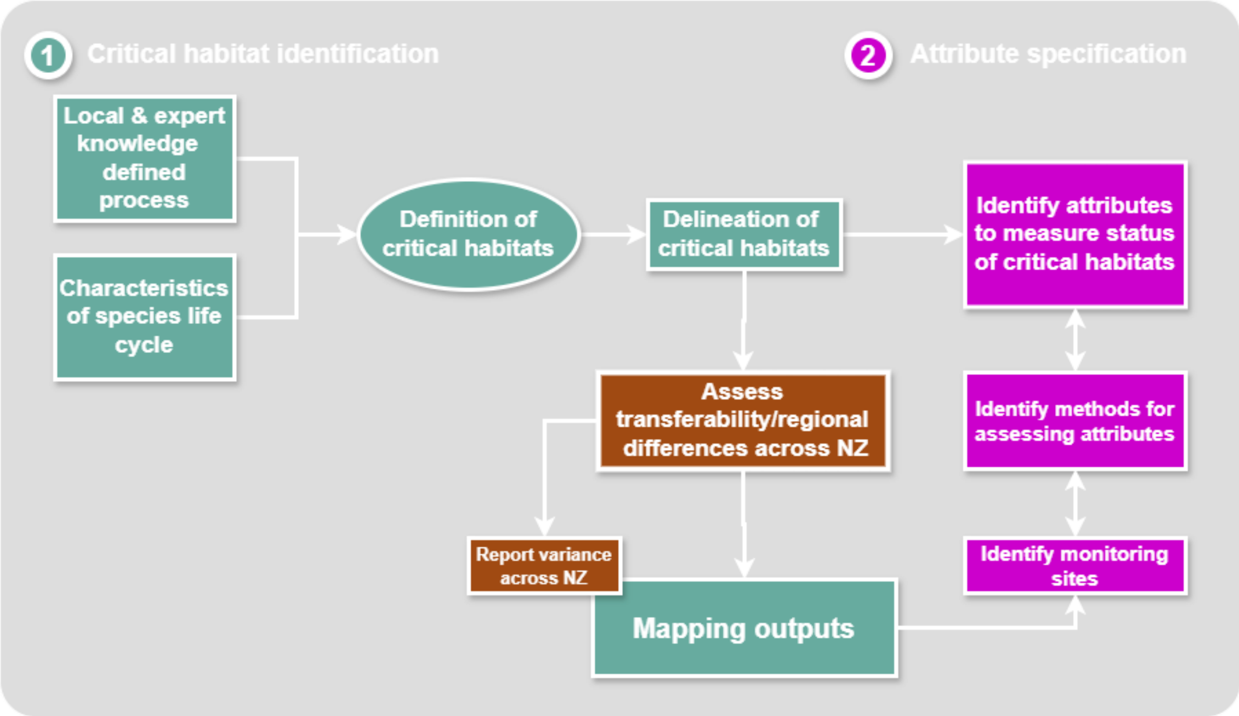


Figure 6. Generalised workflow for applying an expert derived process to define and delineate critical habitats for Threatened freshwater species.

Shortjaw kōkopu: Shyam Morar, GW

Box 2-2

Factors contributing to critical habitat for shortjaw kōkopu

The consideration of critical habitat for migratory species such as shortjaw kōkopu emphasises the important role of discrete geographical areas that are used at different times in the life cycle. The diadromous life cycle of most shortjaw kōkopu populations includes both freshwater and marine life stages (Figure 7). As with other migratory freshwater fish, the spawning grounds, larval habitat and migratory pathways are examples of critical habitats that may differ from the spatial extent of adult fish habitat.

Identification of spawning grounds

For shortjaw kōkopu, very few spawning sites are known, but those that have been found are in the vicinity of adult habitat. This suggests that it would be reasonable to use adult fish presence as an indicator of potential spawning habitat. However, as with other galaxiids including giant kōkopu (*G. argenteus*), the spawning events are triggered by high flow events and the spawning grounds are often found on the river banks adjacent to the low flow channel (Charteris et al., 2003; Donovan, 2024; Franklin et al., 2015; Orchard & Wilkinson, 2024). In view of this evidence, the critical habitat for spawning can be related to the extent of the riverbank and floodplain areas adjacent to waterway channels. For spawning to occur, suitable ground cover to deposit eggs, bank stability and shade are some of the factors that are considered for quantifying habitat quality. These areas provide the spawning grounds and yet may appear to be largely terrestrial environments. This is known to be the case for īnanga (*G. maculatus*), where the spawning sites may be located a considerable distance from the riverbed and may co-occur with land-based activities such as mowing, spraying, trampling and vehicle movements (Orchard, 2019; Orchard & Schiel, 2021).

Identification of migration pathways

For shortjaw kōkopu and other diadromous fish, the waterways downstream of adult fish habitat are dispersal and migration pathways to and from the larval habitat in lower river and coastal environments. However, identifying these migration pathways based on current adult fish occurrence will tend to miss legacy issues (e.g., from existing fish barriers) that may be responsible for the lack of adult fish presence in otherwise suitable upstream habitat. For these reasons, a systematic approach to identifying and characterising fish passage issues is recommended.

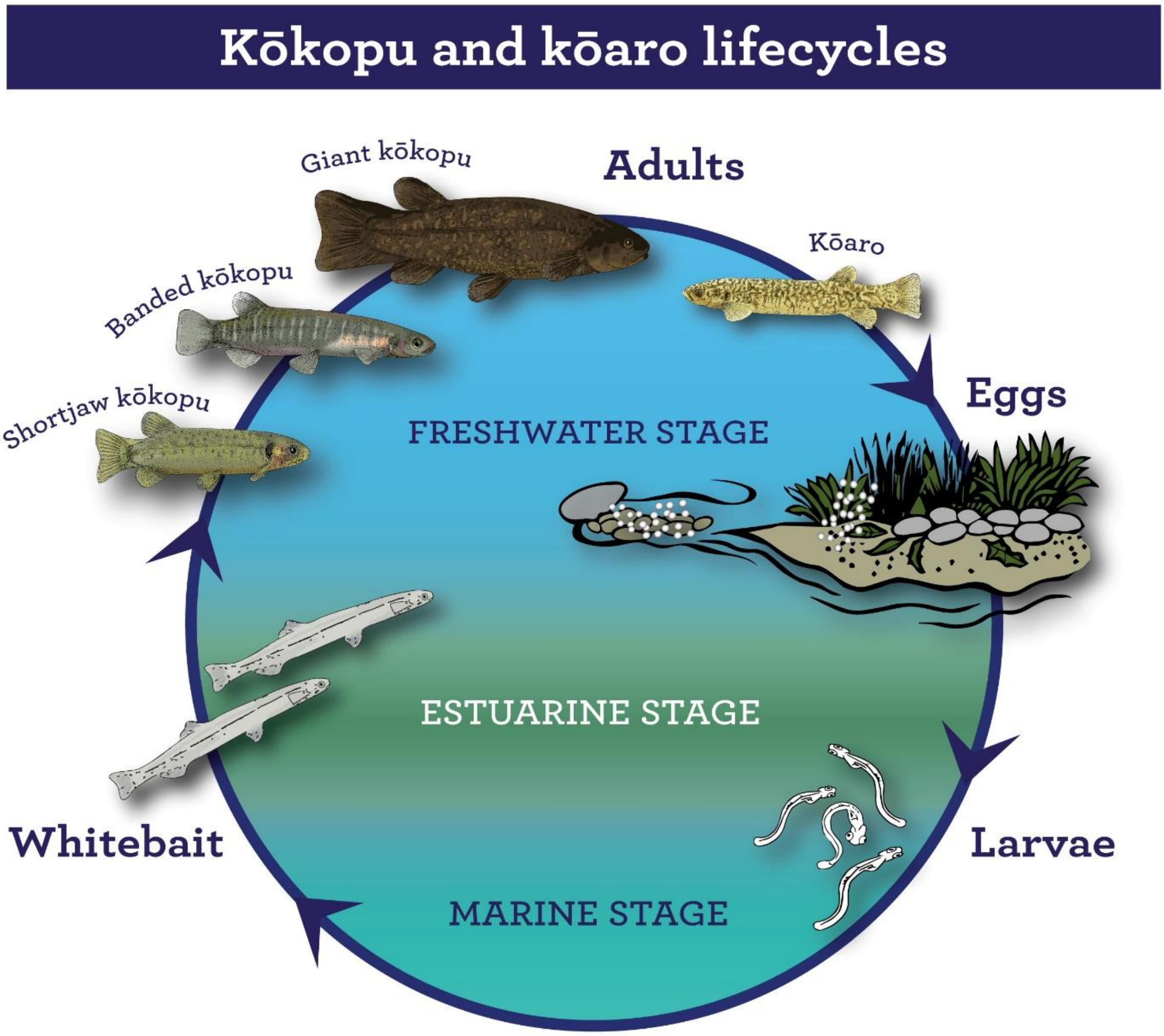


Figure 7. Generalised life cycle diagram for large bodied galaxiids such as shortjaw kōkopu in Aotearoa New Zealand. Source: DOC/ diagram credit Sonia Frimmel

2.4 Identifying attributes

The identification of attributes is a fundamental requirement of the National Objective Framework process that is crucial for Threatened species values. Currently, no attributes have been included in the NPS-FM for the Threatened species value, even if some Ecosystem Health attributes seem relevant for Threatened species (e.g., Fish IBI). Due to the focus on identifying critical habitat and the condition of critical habitat for each species, other attributes have an important role to play. In this section we provide guidance for identifying attributes to address these requirements building on the identification of overall habitat and critical habitat as discussed in the sections above. When selecting attributes, it is important that each attribute:

1. Meets the definition of an attribute in the NPS-FM; and
2. Is measurable, numerically (preferred) or in a narrative sense; and
3. Is informative of state, relative to an objective; and
4. Can be followed through each step of the National Objective Framework process specific to an attribute; and
5. Is relevant for measuring the achievement of an environmental outcome.

2.4.1 Species presence and abundance attributes

There was general agreement in the workshop process that direct measures of population health, such as continued presence or relative abundance, were recommended would ideally be monitored as attributes for Threatened species values. However, this requires information on the distribution of target species within and across FMUs. Achieving this requires that suitable data are already available or that new survey programmes can be established to fill information gaps. Whilst spawning areas are yet to be confirmed for most SJK populations, adult populations appear to have high site fidelity, associated with available critical habitat, which can be used to prioritise the selection of sites and inform additional surveys in areas where fish populations may exist.

It is important to note that predicted presence or abundance metrics from SDMs are generally not useful for this purpose because these models are not regularly updated even if procedures were developed to make them more directly comparable. Instead, SDM model outputs are more useful for determining the initial extent of suitable habitat and for guiding the selection of monitoring sites to determine population change over time.

Subsampling approach

The difficulty in obtaining measures of occupancy (the area or proportion of available habitat that is occupied) or abundance across many sites and species is difficult for regional councils to achieve given resourcing and capacity constraints. For these reasons we describe a workflow for using a subsampling approach to identify one or more monitoring sites at which occupancy metrics will be measured. We also describe some options for obtaining relative abundance data within these units where this is desirable and feasible for the target species.

Selection of monitoring sites

Setting a minimum number of sites for field measurements is a practical consideration for implementing the assessment and monitoring of attributes under the National Objective Framework process. There may also be a need to strike a balance between the available resources for baseline assessments and ongoing monitoring (e.g., five yearly) and the number of Threatened species that are present.

We suggest that a minimum of one monitoring site is needed for each Threatened species within each FMU. In most cases, however, a single monitoring site, e.g. at a spawning site, is unlikely to adequately represent changes in the Threatened species population of interest and the establishment of additional monitoring sites will be warranted. This is ideally tackled by adopting a representative sampling design that might also include stratification across any distinct differences in environmental conditions or context within the FMU (e.g. exposure to threats or stressors as discussed in section 2.5).

An additional cross-cutting consideration that interacts with all the above is the need to assess the critical habitats of each Threatened species. In many cases this will require that at least one monitoring site for each critical habitat type is established within the FMU.

Existing monitoring sites

In many cases existing monitoring sites could be adapted to fulfil these needs and the data available from those sites can provide useful baseline information. However, where existing monitoring sites and data are used, the associated field survey protocols should be reviewed to assess their applicability for the NPS-FM. For the assessment of Threatened species values the survey protocols must provide an appropriate level of detection power for each of the species that is being monitored. As with the establishment of new sites this will require decisions on the selection of survey methods and the specific protocols that will be deployed at the site. In many case the existing monitoring programmes will not be sufficient to assess Threatened species attributes at a FMU or regional level.

Selection of monitoring methods

Methodologies that can detect several species with known and reasonably low missed detection rates in standard operating conditions are likely to be advantageous as this can help to improve the efficiency of survey investments.

Examples include eDNA metabarcoding of water samples or other materials provided that the sampling approach is sufficient to detect the target species (Ficetola et al., 2015). This will include decisions on the volume of water or amount of material (e.g., sediment), number of subsamples and specific equipment or techniques to use in the procedure.

As this is an active area of research it is recommended that the most recent protocols are used to identify appropriate sampling approaches for different water bodies and target species. For example, assessments of the detection power of varying replicates using the syringe method (David et al., 2021) in lotic (flowing) waterways has shown that six replicates are necessary to reliably detect shortjaw kōkopu when abundant (Orchard, 2023a) and to consistently detect a high proportion of the species that are likely to be present across a range of taxa (Smith et al., 2024).

Current guidance on standard field procedures for aquatic eDNA sampling is best developed for lotic waterways (see Melchior & Baker 2023) and being actively developed for other water body types and situations. At the same time, more sensitive eDNA analysis techniques using qPCR methods are being developed for priority target species, particular focus on biosecurity risks for which early detection is desirable (e.g., Cary et al. 2014).

Presence attributes

The inclusion of an attribute based on presence is, arguably, one of the most simple and relevant measurements for assessing the status of a Threatened species in a FMU. When identifying such attributes it is important to note that they must be further qualified with details of the data collection protocols and spatial unit associated with the metric that will be measured. Following the subsampling approach described above, such attributes will be measured at one or more monitoring sites that will represent locations at which the species was previously recorded (e.g., in the baseline assessment). Long term monitoring of Threatened species at selected sites can also enable the detection of relative abundance trends and information on recruitment from size-class data. Further if data are shared between regional council and with DOC, then the relative abundance data is more powerful and can be used to look at patterns within regions, and nationally. A rapid assessment approach over several visits, using spot fishing to target appropriate habitat may be more appropriate for presence or absence, to cover a larger distance and provide some certainty given the diadromous life cycle.

As an example, an appropriate presence attribute for shortjaw kōkopu could be 'presence within a 400 m fixed reach monitoring site as detected by spotlighting, electrofishing or a six-replicate eDNA sample taken at the downstream end of the reach'. The 400 m fixed reach monitoring site is also consistent with the DOC shortjaw kōkopu monitoring plan, which also includes habitat assessments (Appendix 2).

Abundance attributes

Abundance attributes are generally more difficult to measure than presence/ absence and may require specific techniques. In many cases the information that is feasible to collect will represent an estimate of the relative abundance (e.g., captures in a series of traps) rather than the true abundance of individuals within a given area.

The amount of survey investment that is required to obtain a relative abundance estimate that is reliable and comparable is a critical decision for councils. It is essentially a decision on whether the additional detail on species population health, that is conveyed by an abundance measure, is warranted for each species, in addition to the presence/absence attribute. This decision should be undertaken with stakeholder input and consideration of the species value at relevant scales (e.g., including its culturally significance and current threat status).

More cryptic species or those that are hard to capture pose additional challenges for obtaining reliable estimates without sophisticated techniques.

Where eDNA sampling has been used as an approach for presence/monitoring, the prevalence of eDNA sequence counts for each species can be calculated as a proportion of the total and many studies have investigated the potential interpretation and utility of these data (Fonseca, 2018; Goldberg et al., 2016; Lamb et al., 2019). For the purposes of monitoring change over time, this does not provide a reliable abundance attribute due to the inability to distinguish between the presence of numerous individuals in the sampling unit or a single large individual or other strong eDNA source in the vicinity of the sampling point. Despite this, eDNA prevalence measures can contribute to the characterisation of broader landscape scale patterns where there is data available from many monitoring sites (Melchior & Baker, 2023).

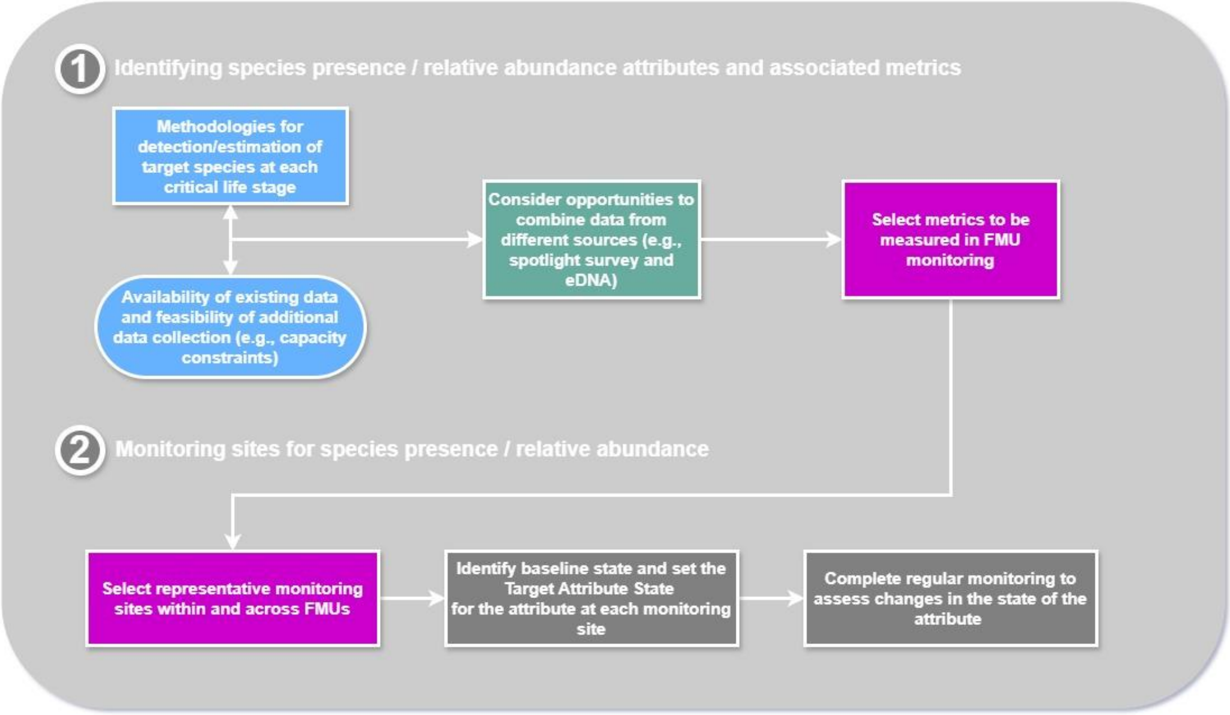


Figure 8. Workflow for identifying species presence or relative abundance attributes and associated metrics. Examples of monitoring options and methods used by DOC for shortjaw kōkopu are provided in Appendix 2.

2.4.2 Pressure attributes

Attributes for Threatened species values will ideally include some measures of the distribution or intensity of pressures (also referred to as threats) that are relevant to the maintenance or recovery of Threatened species populations. DOC have reviewed the threats and pressures for shortjaw kōkopu and other Threatened migratory fish species, described in the DOC Migratory Fish operational Plan Ngā Ika e Heke 2020-2025 (see Box 2-3).

It may also be possible to measure attributes such as percentage riparian cover and other measures of habitat condition across the entirety of each FMU (e.g., through remote sensing techniques). This has the potential to provide a much-improved spatial basis for monitoring over time in comparison to presence and abundance attributes for Threatened species that can only be practically monitored using the subsampling approach described above.

A focus on measures of pressures also provides opportunities to track and address widespread threats that may affect several freshwater taxa, e.g., predation of eggs from introduced rodents. This offers an efficient approach for supporting management objectives across multiple values. Storey et al. (2018) used a literature review to identify pressures that have been shown to affect multiple freshwater species. These include land-use changes, presence of exotic species and the presence of dams and other fish passage barriers (Storey et al., 2018).

Depending on the location and freshwater species concerned, one or more of the topics is likely to be relevant to the identification of multi-species pressure attributes.

Scale of measurement

Some attributes will intrinsically need to be monitored at a site scale, e.g., where specific habitat is provided for spawning, and presence/absence or relative abundance of the target species for long term monitoring. Some of the relevant pressures may be already flagged for attention within the standard approaches for measuring environmental parameters (e.g., biotic and abiotic variables) at the monitoring site. Many of these may be included within standard field survey protocols (e.g., Clarkson et al., 2003; Joy et al., 2013). Examples of environmental variables that may be relevant to the assessment of pressures for a given freshwater species include riparian and instream cover, periphyton, water quality parameters and deposited fine sediment.

Although the monitoring sites that are selected for Threatened species values may not necessarily be the same as those used for other NPS-FM compulsory values, some of the attributes that are measured for other values at the site may represent threats to freshwater species (e.g., as set out in Appendix 2A of the NPS-FM). However, it is also important to identify other pressures that strongly influence the survival of each Threatened species at the site and ensure that these are included for measurement where possible. This adds a site and species-specific dimension to the selection of the appropriate attributes.

As an example, the presence or relative abundance of a predatory species such as brown trout (*Salmo trutta*) at the monitoring site is likely to be a relevant attribute for the monitoring of Threatened freshwater fish (McIntosh et al., 2010). In that case, the same fish survey approaches used for a target species such as shortjaw kōkopu could be extended to include brown trout, and changes in the presence/absence or relative abundance of brown trout would be identified as an assessment attribute that is associated with a relevant Target Attribute State.

Attributes will also need to be monitored at the catchment or regional scale to adequately assess the scale of the habitat or critical habitat requirements of the Threatened species within the FMU, e.g. the connectivity between habitats, fish passage and the distribution or density of predators for management at a landscape scale. This approach is potentially powerful approach but relies on the feasibility of undertaking regular measurements at that scale. Examples of habitat condition metrics that could be measured at this larger scale using remote sensing methods include vegetation cover, substrate composition and suspended sediment in water bodies that are visible from above. Figure 9 shows a general workflow for this approach.

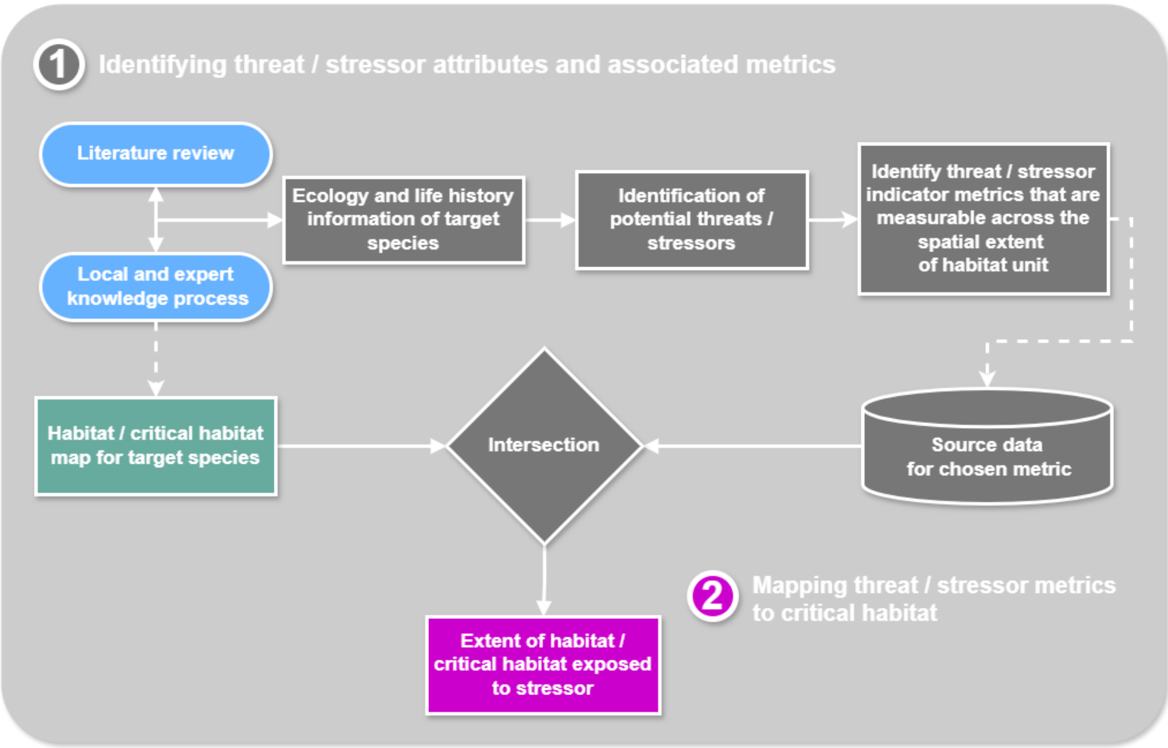


Figure 9. Workflow for identifying threat / stressor attributes that are measurable across the full spatial extent of Threatened species habitat or critical habitat within a FMU.

Box 2-3

Threats and pressures for shortjaw kōkopu and other Threatened migratory fish species

(summarised from the DOC Migratory Fish operational Plan Ngā Ika e Heke 2020-2025)

1. Habitat loss and degradation (e.g. sedimentation, flood protection works, macrophyte incursion, stock trampling and loss of riparian cover)
2. Water quality and quantity (e.g. degraded from increased suspended sediment and reduced wetted habitat)
3. Instream barriers to species movements (e.g. culverts, weirs and dams)
4. Instream river activities (e.g. fish mortality and damage to habitat from drain maintenance)
5. Whitebait fishing (commercial, recreational and customary)
6. Pests (animal and plants and introduced species)
7. Managing disease
8. Genetic isolation
9. Climate change

This Plan also provides a summary of legislative (including regulatory) and policy tools (examples), site focused actions (examples), recommended guidance, best practice and points of contact for each of the pressures.

Selecting attributes that are relevant for each species

In general, a species conceptual model is an informative way of identifying perceived threats and their linkages with potential management actions. The preparation of such models could also provide a point of focus for engaging with stakeholders. Figure 10 shows an example that was developed by O'Donnell, (2016) to support the management of Australasian bittern (*Botaurus poiciloptilus*), which first identifies the environmental outcomes that are important to the survival of bittern populations. It then links these to known or potential threats and potentially beneficial management actions, which may occur in different critical habitats over a large geographical range to include nesting, migration and maintenance of juvenile and post breeding birds in the non-breeding season.

For some species, threats and pressures have been previously described and documented. For example, DOC work in the Ngā Ika e Heke migratory fish workstream provides information on pressures for four Threatened freshwater fish. A consideration of whether any of these threats might occur within a given FMU could therefore be used as the basis for identifying relevant assessment attributes for these species.

Field monitoring protocols

The general approach for designing a field monitoring protocol to be applied at a Threatened species monitoring site includes reviewing any existing standard protocols for that species or environment to identify options for measuring the attributes that have been selected for monitoring under the NPS-FM. For example, suitable protocols for monitoring Threatened freshwater fish are likely to include a combination of elements from the guidelines for fish monitoring in wadable streams (Joy et al, 2013) and any species-specific protocols that are available for the target species. For example DOC provide an informative set of guidelines for surveying lamprey / kanakana / piharau populations (Baker et al, 2024).

The inclusion of relevant habitat parameters for measurement is an additional consideration that will partly depend on the number of monitoring sites and available resources. The top priorities will include variables that are directly required to measure NPS-FM attributes and others that can help to gauge changes in exposure to pressures, especially those that cannot be feasibly measured at larger scales, e.g., through remote sensing approaches.

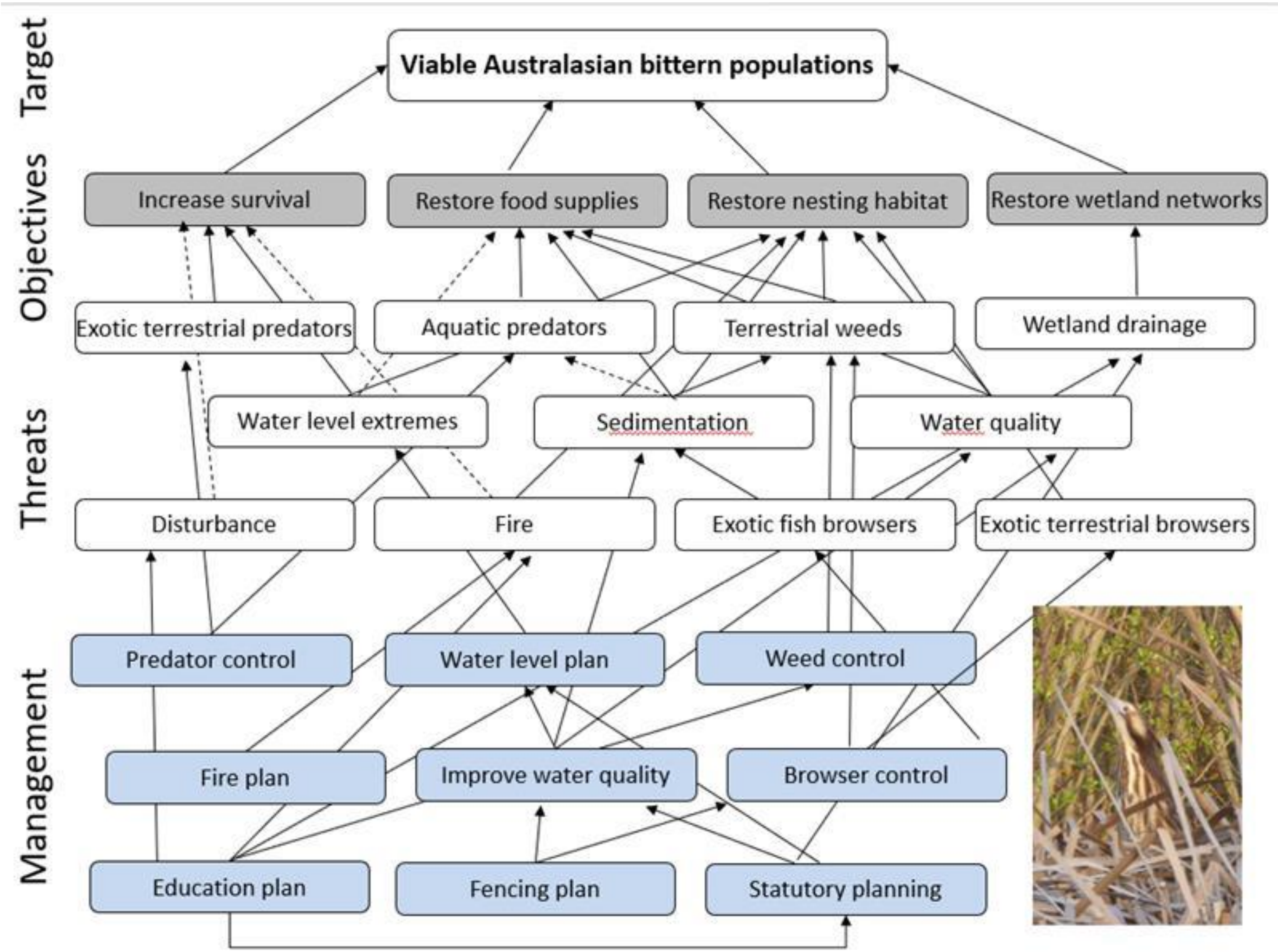


Figure 10. Exemplar conceptual model for the Australasian bittern (*Botaurus poiciloptilus*) threats and pressures, which identifies the environmental outcomes, objectives and management actions that are important to the survival of bittern populations (O'Donnell, 2016). Habitat used by bittern for nesting, foraging for rearing young and in maintenance of life-history traits in NZ over-wintering areas are all considered critical habitat for this species.

2.4.3 Fish IBI

Fish IBI is one of the attributes that must be managed to meet the 'aquatic life' component of ecosystem health. Ecosystem health is a compulsory value of the NPS-FM.

A Fish Index of Biotic Integrity (IBI) was developed for Aotearoa New Zealand in 2004 to account for the unique attributes of New Zealand freshwater fish, such as low species diversity and a high proportion of migratory species (Joy and Death, 2004). A Fish IBI, based on Joy and Death (2004), was incorporated as an attribute in the NPS-FM (MfE 2023c).

Fish IBI is one of the attributes that must be managed to meet the 'aquatic life' component of ecosystem health. Ecosystem health is a compulsory value of the NPS-FM. Guidance on Fish-IBI and a web app calculator has been developed by MfE in consultation with regional councils, as a project led by the SWIM Fish group to support fish monitoring and reporting, understand the development of the NPS-FM attribute, the limitations, and best practice. The guidance and web app calculator are available on the MfE website (MfE 2023c).

The NPS-FM requires regional councils to:

• monitor fish communities to calculate IBI scores.

• at a minimum, develop action plans to achieve target states determined in consultation with communities. The Fish IBI is a multi-metric indicator that considers natural gradients in species richness (altitude and distance from sea).

How the A–D band thresholds were generated in the NPS-FM

The thresholds were derived from the quartiles of the full dataset of IBIs available from the NZFFD, collating surveys conducted between 2010 and 2017. This means that grades are presented as equal quantiles, such that sites falling in the A-band represent the top 25 per cent nationally, and D-band in the lowest 25 per cent. With reference to these grades, the NPS-FM does not mandate a bottom line. Grades provide an approximation of state and are by no means definitive. Instead, councils have full discretion to set their own target states so long as the current state is maintained (or improved). Any new observations are compared to the thresholds that were derived from the original dataset.

Monitoring sites

Each FMU should have one or more monitoring sites for Fish IBI. Councils are required to monitor and report on the achievement of long-term outcomes and target attribute states at these sites. As discussed above, the sites must be representative of all or part of the FMU.

The metrics for the Fish IBI are measures of ecological integrity, based on species richness, habitat guilds (dependency on riffle, benthic pool, pelagic pool, tolerance to impacts such as migration barriers and water quality variables such as temperature, sediment, and ammonia and the proportion of native to non-native fish species. This attribute does not specifically report on Threatened fish, though underpins the ecological importance of fish communities and need to undertake fish monitoring as indicators of ecosystem health.

The value of regionally specific Fish IBIs

It is important to consider any results from regionally derived models alongside the national IBI model. While calculating a regional IBI score is not a requirement of the NPS-FM, regional fish IBI scores may be used to inform non-regulatory actions to identify areas of fish declines (or improvements) and develop immediate and ongoing management plans. A regionally developed IBI model, or other types of ecological models, may form part of the best available information that councils rely on to assess a site's performance against the NPS-FM IBI bands.

A major benefit of a national Fish IBI is that it provides a nationally consistent indicator that can be used for the purposes of inter-regional comparisons and national environmental reporting. Regional IBIs, or other types of ecological models, on the other hand, may have merit where a region has natural characteristics that influence fish communities and differ from the national norm. For example, climatic drivers, catchment and river typologies or differences in coastal processes that affect recruitment. These broader environmental differences may alter the general relationship between fish communities and elevation, or distance inland and so affect how a local monitoring site compares with the national IBI bands. A combination of national and regional findings is therefore beneficial for the interpretation of results and the development of appropriate action plans, when responding to poor grading or a decline in Fish IBI scores.

2.4.4 Baseline attribute state

This baseline attribute state is defined directly within the NPS-FM as the best state out of the following:

- the state of the attribute on the date it is first identified by a regional council, or
- the state of the attribute on 7 September 2017, or
- whenever the regional council set a freshwater objective for that attribute under the previous NPS-FM.

This definition suggests that several assessments should be completed (i.e., to reflect each of the above points in time) to identify the best state that is adopted as the baseline state for the attribute. This information is then taken forward to inform the setting of an appropriate Target Attribute State in collaboration with stakeholders.

Identifying specific baseline states and attributes bands for Threatened species and their critical habitats requires more discussion to co-ordinate a national approach and is included as a core topic in the section Further Support Opportunities.

2.4.5 Monitoring attributes against target attribute states

Following the architecture of the National Objective Framework, each attribute that is selected to assess Threatened species values must be associated with a Target Attribute State for the each FMU or part FMU to which it relates. The NPS-FM directly requires councils to engage with communities and tangata whenua when implementing the National Objective Framework and the selection of an appropriate Target Attribute State is one of the key focal points for this engagement and input. The National Objective Framework process also specifies that each Target Attribute State must be set at or above the attribute's 'baseline state'.

2.5 Planning responses and actions

2.5.1 Tracking the status of attributes in FMUs

As set out in the National Objective Framework process, there is a need to evaluate and report on the results of attribute assessments that are completed in each FMU or part FMU. For Threatened species values, the management objectives are defined by the relevant Target Attribute State that isset in collaboration with stakeholders in contrast to other values that must be assessed against national bottom lines. This will involve the assessment of one or more attributes for one or more Threatened species against their relevant Target Attribute State within each FMU or part FMU. Noting that the actual measurements may be derived from individual monitoring sites.

The combined results of these multi-attribute assessments can be visualised across one or more FMUs or monitoring sites using a dashboard approach (Figure 11). This provides a convenient way to present the status of FMUs to stakeholders and the wider community.

In addition to reporting the results of attribute assessments against the relevant Target Attribute State, it is desirable to track changes in the status of each attribute over time. The use of graphs or report cards to display trends in the status of attributes over time are also recommended to support the development of action plans and the communication of outcomes to stakeholders.

2.5.2 Developing action plans

Action plans are a planning response that is initiated to achieve desired outcomes and targets in situations where the limits and rules set out in the operative plan are insufficient to achieve the improvement that is needed. As indicated in existing guidance, their primary role is to communicate the council's planned actions to address attributes that require attention in specific FMUs or part FMUs in the region (Ministry for the Environment, 2023a). As such, they are not designed solely to be a regulatory tool and can sit outside of the regional plan that they contribute to. The actions within an action plan can include regulatory and non-regulatory approaches as required to achieve an environmental objective. For many reasons, action plans should be regularly reviewed and updated as needed (e.g., in response to new information, or as part of adaptive management).

Clause 3,12 of the NPS-FM identifies potential trigger points for preparing actions plans, and Clause 3.15 of the NPS-FM sets out some specific requirements for preparing action plans.

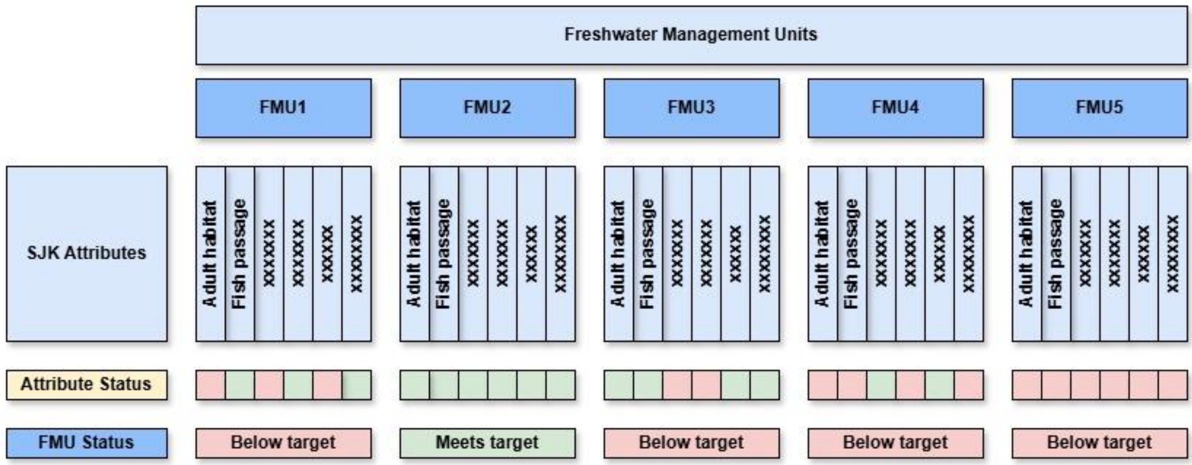


Figure 11. Example dashboard approach for reporting on the status of multiple assessment attributes across FMUs

In general, an action plan will help to document undesirable outcomes, contributing drivers of degradation and approaches to address them, along with the proposed monitoring and evaluation metrics that are being used to track progress and inform adaptive management. In this way, action plans can contribute to the popularisation of voluntary activities that might assist with Threatened species management, particularly on private land. They can also contribute to education and awareness raising in the community and help with the coordination of efforts between stakeholders.

Although Threatened species are one of the compulsory values to be considered under the NPS-FM it is important to remember that degraded FMUs will be identified through the consideration of all relevant values. Assessments of Threatened species may be relevant to other values such as mahinga kai or ecosystem health. In addition, the development of action plans or limit setting to address degraded Threatened species values will need to maintain all other values contributing to the health and wellbeing of freshwater bodies and ecosystems.

Components of action plans might include:

- Details on the current status of the management unit, including information on the Threatened species, critical habitat and pressures that need to be addressed to recover the species and critical habitat.
- A description of the attributes that have been selected to monitor progress to the desired outcomes, along with details of the monitoring programme, Target Attribute States and contributing assessments.
- Baseline states used to derive Target Attribute States and the use of limits on activities may be identified through a range of complementary processes, including expert panel, plan change, inclusion in Farm Plans and non-regulatory actions supported by tangata whenua and the community.
- Selected actions that cover several attributes and are supported by iwi and engaged communities, and a description of their relationship with the operative regulatory setting.
- Information on knowledge gaps and other potential barriers to the

implementation of effective responses.
- Resources or other materials that could support the selected/planned actions, e.g., educational materials or how-to guides for voluntary actions.
- Long-term and strategic planning may be required to integrate the action plan with the council budget programme and existing activities, e.g., Utilities/Capital programmes for river flood protection works, Parks reserve maintenance plantings, sustainable land and catchment programmes and land acquisition to protect habitat from future development.

Plans need to be flexible to incorporate a range of non-regulatory actions that are identified through iwi and community participation and may be in varying stages of development. The collection and interpretation of monitoring data may also contribute to actions that are identified, e.g., with citizen science and participatory monitoring methods. Actions to address various attributes may also need to be changed over the life of the action plan to reflect and respond to new information, e.g., from outcome monitoring and new research.

Box 2-4 provides an example of a Regional Council action plan developed for the Tāmaki Makaurau Auckland Council shortjaw kokopu recovery programme prepared by Matt Bloxham. The action plan includes key questions and management options that form part of a regional NPS-FM Action Plan.

Some specific actions within an action plan will require engagement with tangata whenua and agencies such as DOC to identify a "nominated lead" for specific Target Attribute States where other stakeholders hold the knowledge or expertise.

The actions that have been selected to manage threats and pressures and recover or maintain Threatened species values may also require different ways of reporting on the success of outcomes to support a more holistic approach to management issues. Examples include describing the broader connections and societal dependence on indigenous biodiversity and ecosystem health, recognition of mātauranga Māori, and benefits of sustainable land and water use for community wellbeing.

Box 2-4

Regional council action plan example

TĀMAKI MAKAURAU SHORTJAW KŌKOPU RECOVERY PROGRAMME

Prepared by Matt Bloxham
Auckland Council

1. Is shortjaw kōkopu distribution adequately known?

The distribution of shortjaw kōkopu is moderately well known in the region and most populations centre around our two largest regional parks, Waitakere Ranges and Hunua Regional Parks. Both regional parks contain streams with the large high energy pools bounded by large substrate, a habitat type that shortjaw kōkopu prefer, but which is underrepresented in other parts of Auckland.

Waitakere Ranges: Shortjaw kōkopu are present in Piha Stream/Glen Esk Stream, Karamatura and in Mangatawhiri reservoir (Hunua) and in tributaries feeding the reservoir and mainstem below the reservoir. Shortjaw kōkopu have also been observed intermittingly in Marawhara and Wekatahi Streams, although they disappeared from Marawhara Stream following Cyclone Gabrielle. Shortjaw kōkopu could be reintroduced into Marawhara Stream and Wekatahi Stream (if no longer present) but not until instream and riparian habitat reforms. The riparian corridor and instream habitat in Marawhara Stream were substantially denatured by Cyclone Gabrielle.

Aotea (Great Barrier Island): There have also been reliable historic shortjaw kōkopu observations from Rosalie Bay (Aotea). Two sampling rounds using separate eDNA methods and analysis (Cawthron and Wilderlab), have cast doubts on whether shortjaw kōkopu are still present on Aotea. However, in the second sampling round, giant kōkopu (Cawthron) were detected here (when none had been observed from this stream previously). eDNA's efficacy in distinguishing between shortjaw kōkopu and giant kōkopu with the assays available has been problematic previously. This and the fact that rudd (Wilderlab) and red finned perch (Cawthron) eDNA have been detected in the stream, have increased the importance of sampling this stream by spotlight (i.e., to corroborate the eDNA results). An initial scoping survey has confirmed the suitability of this stream for shortjaw kōkopu (and potentially giant kōkopu as well) and a spotlight survey is being undertaken in Rosalie Bay Stream on the 23rd Feb 2025.

Waiheke Island's flourishing giant kōkopu fishery suggests that the Hauraki Gulf islands may hold the key to the salvation of large bodied kōkopu species, especially given the Aotea's relatively intact headwater to coast forest sequence.

North Auckland: Shortjaw kōkopu eDNA signatures have been detected in Glen Esk Stream (Matakana) which have yet to be corroborated by survey.

Hunua: A small shortjaw kōkopu population is also known from and the tributaries feeding in Mangatawhiri reservoir (Hunua) and in the mainstem and side streams below the reservoir. Since the 2010 Hunua regional boundary adjustment (when Auckland Council came into being), the reservoir population now falls outside Auckland and is instead situated within the Waikato region. The two councils have an informal agreement to work together to investigate options for sustaining the Hunua population. Key to this is understanding the impact of rainbow trout in this system given the potential for niche overlap in the reservoir inflows' large pools. These were formerly stocked by Fish and Game, but now thought to have naturalised.

We would like to establish:

- whether trout are trending down now that they are no longer stocked.
- whether trout are currently having an impact on shortjaw kōkopu and is this impact going to get worse or will it likely decrease?

Otolith work done by NIWA confirmed Mangatawhiri reservoir shortjaw kōkopu as a lacustrine population. Shortjaw kōkopu are also found in low numbers in the streams *below* the reservoir in Mangatawhiri River (situated within Auckland Council boundaries). The presence of barriers further downstream in Mangatawhiri River suggests that recruitment into these streams is more likely to be from the reservoir rather than from sea-run adult fish. In future work we will investigate whether the mainstem's inflows hold value as shortjaw kōkopu habitat and whether there is any potential to improve their potential for shortjaw kōkopu by excluding rainbow trout.

Further survey priorities

Shortjaw kōkopu are possibly present in Rosalie Bay, Kakamatua, Anawhata, Karekare, Wekatahi, and Glen Eden (Matakana) Streams.

2. Is decline understood?

The causes of past decline and ongoing pressures in shortjaw kōkopu populations is moderately well understood in the region. Unlike giant kōkopu populations that have declined and disappeared from numerous mainland Auckland streams, shortjaw kōkopu has undergone no obvious range contraction.

This is probably more a reflection of the following factors:

- shortjaw kōkopu are not widespread in Tamaki Makarau and unlikely to have ever been, because they are habitat specialists and, as with other regions, the amount of optimal shortjaw kōkopu habitat is relatively limited.
- little archetypal shortjaw kōkopu habitat exists outside of Hunua and Waitakere Ranges, Auckland's two largest regional parks.

However, with an estimated wild population of <250 mature individuals, shortjaw kōkopu are thought to be in decline in Tāmaki Makaurau. More tellingly, seldom are more than 30 fish ever encountered in surveys, even in their regional strongholds in the Waitākere Ranges.

Several streams are awaiting survey, or survey results to confirm presence including in Mangatawhiri in the Hunua. Here, overlapping niches (large stable pools) suggest trout may be a major predator of juvenile shortjaw kōkopu in the Mangatawhiri reservoir and in the mainstem above and below the reservoir (Mangatawhiri River).
Although their prime deep pool habitat bounded by large substrate confers some level of protection from (streamside) ambush, there is a concern that terrestrial predators including cats, and stoats may predate adult fish (as per adult giant kōkopu).

There is now documented evidence from Northland that ship rats predate shortjaw kōkopu nests (eggs are laid over open ground on forest litter, moss and in crevices) and, that a single rat can eliminate an entire nest over several nights. The implications therefore are that no shortjaw kōkopu population is invulnerable, even those occurring within regional park habitat, where small rodent populations abound. Intensive predator management is an absolute requirement but remains a challenge in linear stream habitat.

Red-eared slider turtles present as an emerging threat for large bodied kōkopu (of both eggs and adult life stages), particularly given the pest's catholic diet and the varied habitat they occupy and are capable of exploiting. However, as yet, red-eared sliders are not believed to overlap Auckland's known shortjaw kōkopu populations.

3. Have pressures been adequately identified?

Pressures on shortjaw kōkopu adult populations are relatively well understood in the region. Larger magnitude/frequency storm and flood events (of the type expected more with climate change) can have a major impact on local populations and transformative impacts on their habitat (both instream and riparian). For example, Cyclone Gabrielle denatured one Waitākere shortjaw kōkopu stream, impacting a small population.

Urban development in the Waitākere occupies reaches downstream of known adult shortjaw kōkopu habitat. Therefore, potential impacts (wastewater contamination and impassable instream structures) are more likely to register on juvenile stages, i.e., migrants travelling up from the ocean. However, Karakare Stream, the site of a former population, has several fish passage barriers (associated with private crossings) downstream that have obviously prevented oceanic migrants from reaching adult habitat.

In the Hunuas, Mangatawhiri dam and potentially other structures downstream, restrict the passage of oceanic migrants. Although as yet unconfirmed, the possibility remains that shortjaw kōkopu populations found *below* the dam may have recruited from Mangatawhiri's lacustrine population upstream. If true, this would increase the importance of protecting the reservoir population from trout impacts (as without this, downstream populations would eventually suffer). Although work done by Ecoquest has confirmed the presence of shortjaw kōkopu in some of Mangatawhiri River's side streams *below* the dam, more needs to be done to fully understand shortjaw kōkopu population dynamics and distribution both upstream and downstream of the dam.

This work scheduled for summer 2024-2025 when ESU will join with Ecoquest and Environment Waikato colleagues and use eDNA and spotlighting to survey for shortjaw kōkopu.

The potential for shortjaw kōkopu egg predation by rats, mice, and hedgehogs is acknowledged and in the case of rats, is increasingly well understood.

4. Management options

Captive breeding programme

Captive bred shortjaw kōkopu (parent stock obtained from neighbouring Waitakere catchments) have been released into streams feeding the Waitākere's upper and lower Huia Reservoirs. This has been done to create geographically disparate populations (which are separated from the more westerly population strongholds), as a nest egg and to buffer Waitākere shortjaw kōkopu from future storm events. Following the June 2024 release, the first Target Attribute State is to monitor the survival shortjaw kōkopu at the release sites. Further releases may be required (to form a self-sustaining Huia population).

Habitat improvement

Shortjaw kōkopu occupy 'reference state' regional park sites, so none of the usual interventions (fencing, planting riparian vegetation, and introducing large wood to create cover and refuges in homogenous stream environments) are necessary (i.e., due to good habitat conditions at present)[3]. Sustained and effective pest animal control along with 'spreading the risk' by creating additional populations are the most pressing needs for regional park shortjaw kōkopu populations presently. As with the other large bodied galaxiids, shortjaw kōkopu spawn throughout their adult range. So, unless spawning areas have been identified and we are able to focus our control effort on discrete spawning sites, we face the challenge of maintaining predators at a low biomass throughout the adult range. This isn't practicable when the predator's home range is also relatively small (e.g. mice 10m). Spending time identifying and protecting spawning sites must therefore become a priority, because only then can we remove this life history bottleneck. It may also be feasible undertaking captive breeding programs by harvesting eggs and milt in situ. Pilot studies have shown how challenging it is striking upon adults in breeding condition (i.e., with females with fully developed eggs and males with active milt). However, this remains preferable to removing adults from otherwise small populations to breed from. Trout barriers, which exploit the climbing advantage shortjaw kōkopu have over trout, may be one way to protect the Mangatāwhiri population in the Hunua (to be investigated).

Legally protected habitat

Legally protected habitat is present in the Mangatawhiri River network and Reservoir (Hunua), Piha, Glen Esk, Karamatura, Marawhara and Wekatahi (Waitākere).

[3] Although it may be necessary to remove fish passage barriers associated with crossings in some catchments.

2.5.3 Spatial prioritisation of FMUs

During this project some thought was given to the role of spatial prioritisation techniques that could be applied to FMUs or areas within FMUs, such as Threatened species habitat. Spatial prioritisation was thought to be more useful at the regional scale where it could serve the function of identifying the most important FMUs that require action, or the urgency of such actions.

The connection between critical habitat concepts and the potential scales of spatial prioritisation was also noted. This includes the potential to identify priority sites or habitat at a national or bioregional (ecological district) scale, which would transcend the jurisdictional boundaries of regional councils. The results from such exercises could subsequently inform council and stakeholder decisions on priority sites for the allocation of funding and other resources to restore degraded FMUs in their regions. Such exercises could also inform the setting of Target Attribute State for Threatened species attributes in FMUs. For example, this could help to place the regional values in a national context as a consideration for decision-making.

Information from spatial models can also be used to undertake broad scale regional spatial assessments of habitat and species priorities using ecosystem and river classifications that include a ranking process based on criteria such as representativeness, condition and connectivity. These criteria can include ecological connectivity both across the landscape for terrestrial ecosystems and lakes, and longitudinally along river and stream networks (for example, Leathwick 2016; Brandt & Godfrey 2023). These approaches to prioritisation are more suited to inform targets for a Biodiversity Strategy, including terrestrial habitats and biodiversity not considered in the NPS-FM, and could potentially be used to inform regional spatial plans, integrating FMUs. Aquatic Sites of Significance, identified spatially to incorporate biodiversity hotspots and the migratory range and critical habitat of Threatened fish (Beveridge & McArthur 2017) is another approach to prioritise fish habitat within FMUs, which can be used in a spatial planning context to trigger assessment of effects or conditions to protect the connectivity of the species and habitat.

2.6 Information gaps and support needs

Several key information gaps and opportunities to further support regional councils in their freshwater management functions were identified during the development of this guidance. These are described briefly in the following sections.

2.6.1 Further support opportunities

Workshop series to identify and explore attributes that measure Threatened species

An essential step to measure the achievement of environmental outcomes for Threatened species is to identify attributes that measure the state of Threatened species presence, abundance, survival, and recovery. Attributes are also essential to measure and improve the success of actions in action plans, directing management to the greatest need.

We recommend that attributes are explored at a national scale using expert knowledge, and where possible, be applicable consistently for many species. The development of individual attributes for each species is an exhaustive task, which can be streamlined by the identification of attributes that cater for all Threatened species, or many in a particular functional group. The IUCN Red List, has been locally adapted into the New Zealand Threat Classification System The International Union for the Conservation of Nature (IUCN) Red List has been locally adapted into the New Zealand Threat Classification System and both systems are developed to apply equally to terrestrial, freshwater, and marine biota throughout the tree of life. This efficiently allows broad applicability across the various taxonomic and functional groups which meet the threatened species definition. To complement the red list, IUCN have recently developed metrics for the recovery of threatened species, namely the green status of species (Akçakaya et al. 2018), which measures a key focus of the threatened species compulsory value. It is useful to have an outcome monitoring metric to quantify the recovery of species to see if an action plan is working and environmental objectives are likely to be realised – in this sense the green status is a useful potential attribute to explore. Recently, the green status has been applied to eight threatened freshwater fish in Australia (Lutz, M. unpublished thesis), displaying its applicability to NPS-FM requirements. Calculating the green status also provides other metrics (e.g., conservation legacy, conservation dependence, conservation gain, and recovery potential) from scenarios with and without intervention which helps to prioritise management. Furthermore, this system for species recovery is complemented at ecosystem scale by the IUCN advancing a Green Status of Ecosystems (Walsh et al. 2024). Essential Biodiversity Variables (Pereira et al. 2013) should also be explored for potential relevance to the selection of attributes for threatened species values. They provide standardised measures of biodiversity change.

Workshop series to define, delineate and identify attributes for critical habitats

The identification of critical habitats and how they are defined and interpreted in policy is a core requirement for addressing Threatened species values under the NPS-FM. This is also considered to be a practical focus that will improve planning efficiency and outcomes by directing assessment and management actions to the areas in which they are most needed.

We recommend that these needs are addressed at a national scale using an expert and local knowledge derived process to provide guidance to councils on the definition and delineation of critical habitat for each Threatened freshwater species. This approach could also provide guidance on relevant attributes and practical metrics for the assessment of each critical habitat. We suggest that these needs could be addressed by facilitating a series of local and expert derived workshop for each Threatened freshwater species (or logical groups) within a national workshop series.

Compendium of effective planning approaches

Councils see value in being able to locate and refer to examples of planning approaches that have been designed (and ideally have also been evaluated) to support the recovery of degraded freshwater values such as those that would be identified through the implementation steps of the NPS-FM. To support the specific requirements of the NPS-FM, such examples and resources should be clearly related to the specific attributes that are likely to be selected by regional councils and stakeholders to assess Threatened freshwater species values. In this way, examples of planning response and actions can be clearly related to an expected improvement in one or more selected attributes as would be the focus of monitoring. Ideally, information will also become available from the results of such monitoring to gauge to success of the actions. Over time the compilation of example actions and associated outcomes has the potential to show whether various planning responses have proven successful in improving degraded freshwater values as measured using attribute-based approach that is central to National Objective Framework and NPS-FM.

2.6.2 Research priorities

Suggested priorities for further research that could support regional councils in their freshwater management responsibilities include:

- **Coordinated regional council policy responses to critical habitat attributes**: Regional councils do not have the capacity to monitor all the populations of all the Threatened freshwater species that occur in our regions. An alternative approach could be to establish coordinated policy responses to critical habitat attributes for Threatened freshwater species as hypotheses to be tested across the species range. This would facilitate random, stratified sampling that responds to the species distribution and would likely require less monitoring collectively than if regional councils are required to do it individually within their regions.

- **Quantifying threats and pressures to select the most effective mitigation actions**: Improving the understanding of the factors that drive the distribution, occupancy patterns, abundance, and recruitment of Threatened fish species.

- **Plan effectiveness:** Consistent approaches for councils to evaluate the effectiveness of planning responses for action plans under the NPS-FM, including the relative contributions of regulatory and non-regulatory methods.

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Appendix 1. Examples of attributes to select for Action Plans

Table A1 Examples of potential attributes for to describe the status of the Threatened fish species in a reach, FMU, catchment and/or region

Attribute category	Attribute focus/component	Level/scale[4]	Potential monitoring method(s)[5]	Pros and cons[6]	Comments
Species	Presence	Population●	– eDNA (species specific)● – eDNA (metabarcoding)● – Pheromone sampling● – Spotlighting (400m reach, rapid survey/spotfishing)● – Electrofishing (quantitative or spotfishing) ● – Fyke/gee-minnow ●	– Most basic attribute in relation to species monitoring – Low ability to assess/react to population trends will limit opportunity for timely intervention – Established and standardised survey methodology for fish surveys	– Pheromones and eDNA: methods are still in development and currently do not guarantee detection present within the survey (more research required) – eDNA species specific: can be used as screening method to potential unknown populations – eDNA metabarcoding: Provides information on general freshwater ecosystem health and water quality through community indexes (eF-IBI, eMCI, TICI) – Spotlighting: DOC 400m method may require validating to ensure the survey area/effort is adequate to detect small fish
	Abundance	Population●	– Spotlighting (400m)● – Electrofishing (quantitative) ● – Fyke/gee-minnow ●	– Direct measurement of population condition – Provides ability to assess/react to population – Resource heavy surveys – Requires fish identification skills – Established and standardised survey methodology for fish surveys	– Large national database available with historic and/or reference data, New Zealand Freshwater Fish Database (NZFFD) – Spotlighting: The DOC 400m method is used for shortjaw kōkopu and may require validating to ensure the survey area/effort is adequate to detect small fish. This method could also potentially be used for large migratory galaxiids. Larger reach surveys can be undertaken using rapid surveys targeting the habitat species are most often found in.

[4] Assessment location indication: ●) In FMUs where they are expected based on NZFFD records and probability of occurrence models, ●) within wider catchment and/or FMU Target Attribute Site

[5] Method difficulty indication: ●) Low skill/expertise levels required, ●) Moderate level of training and/or experience and ●) specialise methodology and/or high-level analysis skills/experience and/or permits required

[6] Advantages and disadvantages related to the attribute focus/component. Pros and cons of the associated potential methods have not been fully discussed but mentioned if deemed useful

Attribute category	Attribute focus/component	Level/scale[4]	Potential monitoring method(s)[5]	Pros and cons[6]	Comments
	Population demographic	Population●	– Spotlighting (400m) ● – Electrofishing● – Fyke/gee-minnow●	– Direct measurement of population condition – Provides ability to assess/react to population – Resource heavy surveys – Requires fish identification skills – Established and standardised survey methodology for fish surveys	– Recruitment (abundance/proportion of juveniles/adolescents) – Spotlighting: DOC 400m method may require validating to ensure the survey area/effort is adequate to detect small fish
	Spawning	Sub-population●	– Visual searches●	– Provides information on species life cycle functioning – Resource heavy surveys – Timing of surveys limited to spawning period	– Limited knowledge about SJK spawning habitat/habits and absence of guidelines make surveys currently difficult – No standardised methodology available (more research required)
	Recruitment	Sub-population●	– Trapping/netting (white baiting) ● – Spotlighting ● – Electrofishing● – Fine mesh Fyke/gee-minnow ●	– Provides information on species life cycle functioning – Requires juvenile fish identification skills – Timing of surveys dependent on migration period/peak/run	– Surveys are conducted within migration route which can be missed during survey leading to potential false negatives – No standardised methodology available (more research required) – Targeting different specific habitat, e.g. for post whitebait juveniles – Fine mesh Fyke/gee-minnow traps useful for mudfish
	Fish community/diversity	Community●	– eDNA (metabarcoding) ● – Spotlighting (150m) ● – Trapping/netting (150m) ● – Electrofishing (150m) ●	– Existing attribute associated banding thresholds – In most cases this will be an indirect measure of target species (monitoring site would likely not be based within know SJK habitat). – Low ability to assess/react to population trends will limit opportunity for timely intervention – Established and standardised survey methodology for fish surveys[7]	– Based Fish-Index of Biological Integrity (F-IBI) – eDNA metabarcoding: methods are still in development and currently do not guarantee detection present within the survey (more research required) – eDNA metabarcoding: Provides information on general freshwater ecosystem health and water quality through community indexes (eF-IBI, eMCI, TICI) – Trapping/netting and electrofishing require permits to be conducted

[7] Joy, M.K., David, B.O., & Lake, M.D. (2013). New Zealand Freshwater Fish Sampling Protocols: Wadeable Rivers and Streams.

Attribute category	Attribute focus/component	Level/scale[4]	Potential monitoring method(s)[5]	Pros and cons[6]	Comments
Threats/pressures	Physical habitat quality	Catchment, FMU, Reach	– Habitat assessment(s) – Fine sediment cover/substrate assessments – Species Distribution Modelling – Native vegetation cover	– Generally focused on adult population only – Assessments may have limited detection of short-term changes – Established survey methodology for most assessments – No confirmation on occupancy of suitable habitat – Usable for identification of potential intervention/management actions	– Native vegetation cover: based on landcover mapping – Native vegetation cover: periodic national analysis conducted, Land Cover Data Base (LCDB) – Native vegetation cover/ Species Distribution Modelling: Can be conducted on regional or national scale – Habitat assessments: e.g. Rapid Habitat Assessment (RHA)[8], pfunkuch stability[9], Stream Ecological Valuation (SEV)[10] – Substrate assessments: national standardised sediment assessment methods[11] available
	Habitat extent	Catchment, FMU	– Species Distribution Modelling – Native vegetation cover	– Generally focused on adult population – Assessments may have limited detection of short-term changes – No confirmation on occupancy of suitable habitat – Provides information on habitat availability/loss/fragmentation – Usable for identification of potential intervention/management actions	– Native vegetation cover: based on landcover mapping – Native vegetation cover: periodic national analysis conducted (LCDB) – Native vegetation cover/ Species Distribution Modelling: Can be conducted on regional or national scale
	Connectivity/Fish Passage	Catchment, FMU	– Fish passage assessment(s)	– Provides information on life cycle obstacles and recruitment potential of juveniles – Usable for identification of potential intervention/management actions	– National database associated with the fish passage assessment tool (FPAT) can be used as starting point of an assessment
	Water quality	Catchment, FMU, reach	– Nutrient monitoring – Heavy metal monitoring – Macroinvertebrate monitoring	– Measurement of stressors on the ecosystem as a whole – Standardised survey methodology available – In most cases this will be monitored outside the species of interest habitat and	– Standardized methods described within the National Environmental Monitoring Standards (NEMS)

[8] Clapcott, J.E. (2015). Rapid Habitat Assessment Protocols for Wadeable Streams. Cawthron Institute Report No. 2752
[9] Collier, K. (1992). Assessing River Stability: Use of the Pfankuch Method. Science & Research Internal Report No. 131. Department of Conservation, Wellington, New Zealand
[10] Rowe, D., Quinn, J., Parkyn, S., Collier, K., & Hatton, C. (2006). Stream Ecological Valuation (SEV): A method for scoring the ecological performance of Auckland streams and quantifying mitigation. Auckland Regional Council Technical Publication No. 302
[11] Clapcott, J.E., Young, R.G., Harding, J.S., Matthaei, C.D., Quinn, J.M. and Death, R.G. (2011) Sediment Assessment Methods: Protocols and guidelines for assessing the effects of deposited fine sediment on in-stream values. Cawthron Institute, Nelson, New Zealand

Attribute category	Attribute focus/component	Level/scale[4]	Potential monitoring method(s)[5]	Pros and cons[6]	Comments
			– Periphyton cover assessments	conducted at the FMU Target Attribute State monitoring site – Existing attribute and associated banding thresholds available for most measurements – Usable for identification of potential intervention/management actions	
	Predation pressure	Catchment, FMU, reach	– Predator abundance surveys – Predator trapping (catch rate)	– Provides information on life cycle obstacles and recruitment potential of juveniles – Usable for identification of potential intervention/management actions – Requires research-based approach – Likely resource heavy	– Can target different predator associated with distinct life stages, e.g. predation of juveniles during migration (introduced fish species), predation of eggs at spawning habitat (rats, mice, etc.) – Some information may be available through pest control data collection
	Harvesting pressure	Catchment, FMU	– White baiting intensity surveys	– Provides information on life cycle obstacles and recruitment potential of juveniles – Requires research-based approach – Likely resource heavy	– Difficult to quantify and limited opportunity translate into management actions
	Resource competition	Reach	– Introduced species abundance assessments – Food web studies	– Provides a good understanding of the local ecosystem functioning and drivers – Requires research-based approach – Likely resource heavy	– Limited opportunity translates into management actions

Select the attributes

Some of the attributes selected should reflect life history traits critical to the survival and recovery of Threatened species within a Freshwater Management Unit (FMU). These traits may include aspects such as abundance, recruitment, spawning success, habitat quality, and connectivity.

Where possible, it is beneficial to establish attributes that are applicable across multiple species. This broad applicability helps streamline monitoring efforts and supports consistent implementation of the National Policy Statement for Freshwater Management (NPS-FM) across the motu (country).

Table A2 provides an example to describe the status of the shortjaw kokopu population in an FMU and incorporates the key attributes of abundance, spawning and recruitment. This tiered approach allows for clear status classification and tracking of changes over time, which is essential for adaptive management.

Table A2 Example SJK attribute and associated state bands based on a selection of components listed within Table A1

State	Definition
A	>20 shortjaw kokopu in 400 m of river length; 20% < 100 mm to indicate recruitment; successful spawning observed
B	5- 20 shortjaw kokopu in 400 m of river length; at least some recruitment observed
C	Shortjaw kokopu present to 5 individuals in 400 m of river length
D	Shortjaw kokopu not detected at site where previously known

Monitoring and Adaptive Management

While attributes are used to report on progress, the monitoring programme may also include supporting indicators that provide indirect evidence of ecosystem health e.g. monitoring ecosystem metabolism, where periphyton, dissolved oxygen and temperature are known stressors. These indicators help identify stressors that may not be directly linked to species presence but are critical for understanding broader ecosystem function.

Attributes may need to be revised over time as new information becomes available or as management actions evolve. For example, outcome monitoring may be introduced to assess the success of a constructed wetland, riparian planting or/and or fish passage improvements.

To meet the objectives of the NPS-FM and ensure effective, long-term monitoring of Threatened species and their habitats, it is important to design a strategic monitoring schedule that balances scientific rigour, cost-efficiency, and adaptive management. The following principles can guide this process:

1. Prioritise High-Value Sites

Focus initial monitoring on sites with:

- Known populations of Threatened species (e.g. shortjaw kōkopu)
- High ecological value or restoration investment
- Identified pressures (e.g. barriers, poor water quality)

This ensures early data collection where it matters most for species recovery and policy compliance.

2. Rotate Sites to Maximise Coverage

To reduce costs while maintaining spatial representativeness:

- Rotate monitoring sites on a 2–5 year cycle
- Ensure each FMU or catchment is sampled at regular intervals
- Use a mix of core sites (monitored annually) and rotational sites (monitored less frequently)

This approach spreads effort and cost while still detecting trends and changes over time.

3. Align with NPS-FM Timeframes

Monitoring should be scheduled to:

- Inform Freshwater Management Unit (FMU) assessments
- Support Action Plan development and review cycles

- Provide data for Environmental Outcomes and Target Attribute States

Ensure that monitoring frequency is sufficient to detect meaningful ecological change within the NPS-FM planning and reporting cycles.

4. Integrate Multiple Methods

Where possible, use a combination of:

- Low-cost, broad-scale methods (e.g. eDNA, landcover mapping)
- High-resolution, targeted methods (e.g. spotlighting, spawning surveys)

This allows for efficient screening and detailed follow-up where needed.

5. Build in Flexibility

Monitoring plans should be adaptive:

- Allow for method updates as new technologies emerge
- Adjust site selection based on species movement, habitat change, or management interventions
- Include trigger points for increased monitoring if thresholds are breached (e.g. population decline)

6. Leverage Partnerships and Citizen Science

- Collaborate with iwi/hapū, community groups, and DOC
- Incorporate community-based monitoring for simple attributes (e.g. presence/absence, habitat condition)
- This builds local capacity and reduces long-term costs

Appendix 2. Monitoring approach - DOC example for shortjaw kōkopu

DOC's migratory fish programmes provide options for monitoring shortjaw kōkopu and their critical habitat (Goodman 2022).

Monitoring Approach

• The locations were stratified by bioregions; groupings of WONI Biogeographic units that represent diadromous fish "populations" and sea currents

• Timing of monitoring: ideally monitoring should be undertaken from February to April. However, if this is not possible from December through to May is acceptable.

• Monitoring cycle: - Up to 9 sites in total will be monitored in each bioregion; up to 3 of these sites will be monitored in any one year; each site will be monitored on a 3 yearly rotation/every 3 years; monitoring is intended to be ongoing indefinitely to provide long-term data on the status and trend of shortjaw kōkopu populations.

The following toolbox methodologies are used to complete shortjaw kōkopu population surveys and collect habitat data:

Freshwater fish: spotlighting – *fixed reach* (https://www.doc.govt.nz/globalassets/documents/science-and-technical/inventorymonitoring/im-toolbox-freshwater-fish/im-toolbox-freshwater-fish-spotlighting-fixedreach.pdf)

Freshwater fish: spotlighting – *spotfishing* (https://www.doc.govt.nz/globalassets/documents/science-and-technical/inventorymonitoring/im-toolbox-freshwater-fish/im-toolbox-freshwater-fish-spotlightingspotfishing.pdf)

Pfunkuch Stability index: https://www.doc.govt.nz/globalassets/documents/science-andtechnical/srir131.pdf

National rapid habitat assessment protocol (Clapcott 2015): http://envirolink.govt.nz/assets/Envirolink/1519-NLRC174-National-Rapid-HabitatAssessment-Protocol-for-Streams-and-Rivers.pdf

Epi-collect – Epicollect5 App – DOC rangers have developed: NZFFD, Rapid Habitat Assessment, Pfankuch Stability Assessment & eDNA field, data forms. Coastal Otago also have a Memento Database non-migratory galaxiid monitoring field form.

Fish Passage Assessment Tool (Fish Passage Assessment Tool | NIWA)

See also the **DOC Freshwater fish inventory and monitoring Introduction** for an overview of planning fish surveys, methods and reporting https://www.doc.govt.nz/our-work/biodiversity-inventory-and-monitoring/freshwater-fish/. This module describes methods to inventory and monitor freshwater fish species and fish communities.

Appendix 3: Glossary

This section describes the context in which these terms are used in this guidance. Font in italics is taken from national policy as listed.

abundance	in relation to a population, means the number of individuals in a population, in an area, at a point in time
action plan	means a document prepared in accordance with clause 3.15 of the NPS-FM
area of occupancy	in this guidance is taken to mean the area occupied by a species, taking into account the fact the species may not occupy all areas throughout its potential range because habitat is inaccessible or unsuitable
attribute	*means a measurable characteristic (numeric, narrative, or both) that can be used to assess the extent to which a particular value is provided for* as described in the NPS-FM
baseline state	*in relation to an attribute, means the best state out of the following:* *(a) the state of the attribute on the date it is first identified by a regional council under clause 3.10(1)(b) or (c)* *(b) the state of the attribute on the date on which a regional council set a freshwater objective for the attribute under the National Policy Statement for Freshwater Management 2014 (as amended in 2017)* *(c) the state of the attribute on 7 September 2017* as described in the NPS-FM
biological diversity (biodiversity)	*means the variability among living organisms, and the ecological complexes of which they are a part, including diversity within species, between species, and of ecosystems* as defined in the Resource Management Act 1991
community	in this guidance is taken to mean a group of species that live and interact in an area or environment
compulsory value	*means the four values described in Appendix 1A, being: ecosystem health, human contact, mahinga kai, and Threatened species* as described in the NPS-FM
conditions	in an ecological sense, is taken to mean the set of environmental features required to support the persistence of a population in this guidance
connectivity	*refers to the structural or functional links or connections between habitats and ecosystems that provide for the movement of species and processes among and between the habitats or ecosystems* as described in the National Policy Statement for Indigenous Biodiversity 2023
critical habitat	refers to the habitat features necessary to support the presence, abundance, survival, and recovery of a

	Threatened species as described in the NPS-FM Appendix 1A – Compulsory Values
degraded	*in relation to an FMU or part of an FMU, means that as a result of something other than a naturally occurring process:* *(a) a site or sites in the FMU or part of the FMU to which a target attribute state applies:* *(i) is below a national bottom line; or* *(ii) is not achieving or is not likely to achieve a target attribute state; or* *(b) the FMU or part of the FMU is not achieving or is not likely to achieve an environmental flow and level set for it; or* *(c) the FMU or part of the FMU is less able (when compared to 7 September 2017) to provide for any value described in Appendix 1A of the NPS-FM or any other value identified for it under the NATIONAL OBJECTIVE FRAMEWORK* as described in the NPS-FM
ecological integrity	*means the extent to which an ecosystem is able to support and maintain its:* *(a) composition (being its natural diversity of indigenous species, habitats, and communities); and* *(b) structure (being its biotic and abiotic physical features); and* *(c) functions (being its ecological and physical processes)* as described in the National Policy Statement for Indigenous Biodiversity 2023
ecosystem	*means the complexes of organisms and their associated physical environment within an area (and comprise: a biotic complex, an abiotic environment or complex, the interactions between the biotic and abiotic complexes, and a physical space in which these operate)* as described in the National Policy Statement for Indigenous Biodiversity 2023
ecosystem function	means the abiotic (physical) and biotic (ecological and biological) flows that are properties of an ecosystem as described in the National Policy Statement for Indigenous Biodiversity 2023
environmental outcome	means, in relation to a value that applies to an FMU or part of an FMU, a desired outcome that a regional council identifies and then includes as an objective in its regional plan
essential	in relation to an attribute, means the environmental factors without which a population cannot persist in an area
expected range	means range expected due to range shifts including from conservation translocation and dispersal in response to climate change
fragmentation	in relation to indigenous biodiversity, refers to the fragmentation of habitat that results in a loss of connectivity and an altered spatial configuration of habitat for a given amount of habitat loss
habitat	*means the area or environment where an organism or ecological community lives or occurs naturally for some or all of its life*

	cycle, or as part of its seasonal feeding or breeding pattern; but does not include built structures or an area or environment where an organism is present only fleetingly as described in the National Policy Statement for Indigenous Biodiversity 2023, however in this guidance we have interpreted habitat to be limited to the area or environment in which the species for which limits and targets are being set occurs
Indigenous biodiversity	*means the living organisms that occur naturally in New Zealand, and the ecological complexes of which they are part, including all forms of indigenous flora, fauna, and fungi, and their habitats ecosystem* as described in the National Policy Statement for Indigenous Biodiversity 2023
Māori freshwater values	*means the compulsory value of mahinga kai and any other value (whether or not identified in Appendix 1A or 1B) identified for a particular FMU or part of an FMU through collaboration between tangata whenua and the relevant regional council* as described in the NPS-FM
natural range	*in relation to a species, refers to the geographical area within which that species can be expected to be found naturally (without human intervention)* as described in the National Policy Statement for Indigenous Biodiversity 2023
occupancy	in this guidance is taken to mean the actual area within a species' geographic range that is physically occupied by the species, excluding vagrancy
persistence	in this guidance is taken to mean a 95% probability of a species surviving for the next 50 years or three generations (whichever is longer) if all human-induced threats that are likely to occur over the longer term (e.g., within 300 years) are adequately mitigated
population	in this guidance is taken to mean the individuals of a species that live and interact in an area or environment
population viability	In this guidance is taken to mean the ability of a population to avoid extinction. A population is only considered viable where it has an intrinsic ability to increase due to its large size or because recruitment exceeds mortality, and where it is resilient to low and moderate level stochastic events over a 50-year time frame given suitable management. The minimum acceptable level of population viability is the point at which the species has been secured from extinction (i.e., is no longer in decline), key threats are understood and managed, and the population is able to recover given additional management
recovery	In this guidance is taken to mean a reduction in the risk of extinction of a species (including as recognised through improvements in national and regional conservation status assessments), and progress towards being fully recovered, which is achieved when a species is: (a) present in all parts of its range, even those that are no longer occupied but were occupied prior to major human impacts/disruptions; and

	(b) viable (i.e., not Threatened with extinction) in all parts of its range; and (c) performing its ecological functions in all parts of its range
resilience	*in relation to an ecosystem, means the ability of the ecosystem to recover from and absorb disturbances, and its capacity to reorganise into similar ecosystems* as defined in the National Policy Statement for Indigenous Biodiversity 2023
restoration	*means the active intervention and management of modified or degraded habitats, ecosystems, landforms, and landscapes in order to maintain or reinstate indigenous natural character, ecological and physical processes, and cultural and visual qualities, and may include enhancement activities* as defined in the National Policy Statement for Indigenous Biodiversity 2023
species	*means a group of living organisms consisting of similar individuals capable of freely exchanging genes or interbreeding, including subspecies, varieties and organisms that are indeterminate* as defined in the National Policy Statement for Indigenous Biodiversity 2023
survival	In this guidance is taken to mean the ability of an individual, population, or community to persist over time
Threatened species	in this guidance *means any indigenous species of flora or fauna that:* *(a) relies on water bodies for at least part of its life cycle; and* *(b) meets the criteria for nationally critical, nationally endangered, or nationally vulnerable species in the New Zealand Threat Classification System Manual* as defined in the NPS-FM
water body	*means fresh water or geothermal water in a river, lake, stream, pond, wetland, or aquifer, or any part thereof, that is not located within the coastal marine area* as defined in the Resource Management act 1991