Technical Memorandum
Draft Baseline State for the Fish Index of Biotic Integrity in Taranaki Rivers

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Purpose

The purpose of this memorandum is to provide an assessment of baseline state of fish using the Fish Index of Biotic Integrity (F-IBI) as a measure of ecosystem health, as required by the National Policy Statement for Freshwater Management 2020 (NPS-FM).

Overview of Fish Index of Biotic Integrity

New Zealand's freshwater environs are home to 50 known native fish species (Dunn et al., 2018) with 20 native species currently known to inhabit Taranaki's freshwaters for all, or part, of their life stages. Native fish play a crucial role in the functioning of a healthy ecosystem: transporting nutrients within, and between, freshwater and marine environs, and providing a source of food for a range of native birds. Many native species are highly valued as taonga by Māori.

Native freshwater fish species have declined over time, with 76 percent of species being classified as either threatened with or at risk of extinction in 2017 (MfE and Stats NZ, 2020). Potential stressors leading to a reduction in native fish numbers include predation/competition with introduced fish, gill damage and habitat reduction from excess sediment, decreases in dissolved oxygen resulting from elevated nutrient concentrations, and in stream structures preventing migration (MfE, 2019a).

As a result of the value placed on native freshwater fish and their observed decline, a nationwide standard measure for assessing freshwater fish community health was developed, the Fish Index of Biotic Integrity (F-IBI). Previous measures of fish abundance and trends were regionally or departmentally specific, with no nationwide standard. NIWA's New Zealand Freshwater Fish Database (NZFFD) is a nationwide fish database widely used by regional councils and the Department of Conservation (DoC) to hold fish monitoring data however, the database does not allow for comparison of fish populations within and between regions, or over time, with a standard metric.

Fish Index of Biotic Integrity and the National Objectives Framework

The NPS-FM sets out requirements for councils and communities to maintain or improve freshwater (where it is degraded). It includes a National Objectives Framework (NOF) that specifies nationally applicable standards for particular freshwater parameters (referred to as 'attributes'). The Fish Index of Biotic Integrity (F-IBI) is one of those attributes.

The F-IBI developed for NPS-FM use was based on metrics associated with individual fish species as well as information on the elevation, location, and distance from the sea, in relation to the recorded survey. Sampling is to occur at least annually between December and April (inclusive). Surveys need to meet the requirements found in Joy *et al* (2013), with survey results being entered into an online calculator to determine the numeric value and associated attribute band. Bands range from A (good) through to D (poor) and describe the integrity of fish communities and the degree of impact on fish habitat and migratory access. There is no national bottom line identified for F-IBI however, bands C and D are indicative of low to severe loss of fish community integrity, which would be expected to cause considerable impairment and high levels of stress to fish communities. Table 1 sets out the NOF attribute criteria for F-IBI.

Table 1: Fish Index of Biotic Integrity (F-IBI) attribute table (NPS-FM, 2020).

Value (and component)	Ecosystem health (Aquatic life)
Freshwater body type	Wadeable rivers
Attribute unit	Fish Index of Biotic Integrity (F-IBI)
Attribute band and description	**Numeric attribute state (productive class)**
A High integrity of fish community. Habitat and migratory access have minimal degradation.	≥34
B Moderate integrity of fish community. Habitat and/or migratory access are reduced and show some signs of stress.	<34 and ≥28
C Low integrity of fish community. Habitat and/or migratory access is considerably impairing and stressing the community.	<28 and ≥18
D Severe loss of fish community integrity. There is substantial loss of habitat and/or migratory access, causing a high level of stress on the community.	<18
Sampling is to occur at least annually between December and April (inclusive) following the protocols for at least one of the backpack electrofishing method, spotlighting method, or trapping method in Joy M, David B, and Lake M. 2013. New Zealand Freshwater Fish Sampling Protocols (Part 1): Wadeable rivers and streams. Massey University: Palmerston North, New Zealand. (see clause 1.8) The F-IBI score is to be calculated using the general method defined by Joy, MK, and Death RG. 2004. Application of the Index of Biotic Integrity Methodology to New Zealand Freshwater Fish Communities. Environmental Management, 34(3), 415-428. (see clause 1.8)	

Fish monitoring in the Taranaki region

Fish monitoring undertaken by Taranaki Regional Council (TRC) currently incorporates both State of Environment (SoE) fish monitoring and consent compliance fish monitoring. In total, TRC fish survey results have been recorded in the New Zealand Freshwater Fish Database (NZFFD) at 583 sites within Taranaki. The SoE fish monitoring programme for Taranaki focuses on targeted surveys for six (out of 20) native fish species

known to be present in the region. This monitoring programme covers 21 survey sites, with each site being surveyed every three years (seven sites monitored per year).

The SoE fish monitoring programme pre-dates the Joy *et al* (2013) fish monitoring methods required for F-IBI, resulting in the majority of these records not being suitable for F-IBI calculations. Consent compliance fish monitoring performed by the TRC varies in frequency depending on individual site consent conditions, with sites being monitored by the TRC at a frequency ranging from annual to triennial. As with SoE monitoring, compliance monitoring has not traditionally met the requirements of Joy *et al* (2013). When searching for suitable fish survey records, a 150 metre radius around each SoE fish site was also checked to determine if any survey results had been entered into the NZFFD at coordinates that did not exactly match the SoE fish site code coordinates.

Baseline state for Fish Index of Biotic Integrity

The NPS-FM requires all regional councils to identify baseline states for all attributes described in Appendix 2A and 2B of the NPS-FM 2020 within each Freshwater Management Unit (FMU). When compared against national bottom lines and the relevant objectives for an FMU, baselines provide the reference point from which councils must either maintain or improve an attribute, which in turn will contribute toward achieving freshwater objectives for each compulsory and non-compulsory value. Waterbodies must not be allowed to degrade, or remain below an identified baseline state unless that state is determined to be naturally occurring.

Under Clause 1.4 of the NPS-FM 2020, the baseline state, in relation to an attribute, is 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.

The Council has not previously set freshwater objectives under the NPS-FM 2014 (amended 2017) for F-IBI, so the state of the attribute under 1.4 (b) could not be calculated, and was excluded from identification of baseline states. Therefore, the best state out of Clause 1.4 (a) and (c) was used to identify the baseline states for F-IBI.

Under Clause 1.6 of the NPS-FM 2020, local authorities must use the best information available at the time (and if practicable, using complete and robust data) to give effect to the NPS-FM. In the absence of complete and robust data, the best information available should be used which may include modelling, partial data, and local knowledge, and preferably use sources that provide the greatest level of certainty (or take all practicable steps necessary to reduce uncertainty).

Under the NPS-FM 2020, F-IBI is associated with the 'Ecosystem Health' value, which is a compulsory value within the NOF (NPS-FM, Appendix 1A). Furthermore, F-IBI is included as an attribute that requires the development of action plans (NPS-FM, Appendix 2B). It is necessary for baseline states to be identified by TRC for the Taranaki region to ensure that target attribute states are set at a level that either achieve or exceed the best baseline state for that attribute and (at a minimum) achieve the national bottom line[1].

[1] See NPS-FM clauses 3.31, 3.32, and 3.33 for exceptions to this.

The remainder of this memo summarises the monitoring and work carried out by TRC to identify draft baseline states for F-IBI.

Criteria for identifying site-based baseline states for Fish Index of Biotic Integrity in rivers

Further instructions on how the F-IBI calculator should be used were communicated to the regional council Surface Water Integrated Management (SWIM) Fish Special Interest Group (Fisher, 2023). No length of monitoring record at a site is specified within the NPS-FM document for calculating F-IBI baseline state, but it has been determined that the median F-IBI value for sites with numerous years monitoring data should be used for informing baselines (Fisher, 2023).

Previous SoE Fish monitoring had moved to follow Joy *et al* (2013) protocols where possible since 2019, with some sites recording qualifying surveys as early as 1996 due to existing survey methods. Resource and time constraints of the current SoE fish programme however, have resulted in some surveys still not being performed to Joy *et al* (2013) protocols. In future, SoE fish surveys will be repeated at least annually and in accordance with Joy *et al* (2013) methods; a requirement of the NPS-FM to enable reporting of progress toward Target Attribute State (TAS) for the F-IBI attribute.

Table 2 sets out the attribute grades for each of the 583 individual fish records held by TRC, alongside the results for valid sites complying with NPS-FM requirements (Joy *et al* protocols), for each FMU.

Table 2: Valid State of the Environment fish monitoring sites (meeting the NPS-FM requirements) and all TRC fish surveys with median F-IBI categories by FMU, and monitoring network recommendations.

Freshwater Management Unit	NOF attribute band (F-IBI)								Total		Monitoring recommendations	
	A		B		C		D					
	Valid sites	All sites	Valid sites	All sites	Valid sites	All sites	Valid sites	All sites	Valid sites	All sites	Current representativeness	Additional sites recommended
Southern Hill Country	0	1	0	1	0	23	0	1	0	26	0%	3
Coastal Terraces	1	6	0	1	0	10	0	0	1	17	33%	2
Pātea	0	0	0	29	0	84	0	24	0	137	0%	3
Volcanic Ringplain	1	36	1	45	2	131	0	39	4	251	133%	0
Waitara	2	15	1	18	0	81	0	15	3	129	100%	0
Northern Hill Country	0	5	0	3	1	15	0	0	1	23	33%	2
Total	4	63	2	97	3	344	0	79	9	583	50%	9

Site-based baseline states for Fish Index of Biotic Integrity in rivers

Nine monitoring sites meet the F-IBI criteria for analysis (i.e. the surveys were carried out in accordance with the Joy *et al* (2013) protocols); the corresponding results are presented in Table 3 and Figure 1.

The results show that four sites are graded within band A, two sites are graded within band B and three sites are graded within band C. No sites with valid fish survey data were graded in band D; below the national bottom line (indicative of a severe loss of fish community integrity). There was no valid fish survey data from the Southern Hill Country or Pātea FMUs that could be included in this baseline assessment.

Table 3: Site-based baseline states identified for F-IBI using valid survey results

FMU	Site name	Site code	No. surveys	NOF grade
Coastal Terraces	Mangati Stream 40 m u/s of pump station	MGT000530	2	A
Volcanic Ring Plain	Kapoaiaia Stream 1.3 km u/s of Wiremu Road	KPA000230	1	C
Volcanic Ring Plain	Mangatete Stream at Carrington Road	MTT000125	2	A
Volcanic Ring Plain	Timaru Stream at Carrington Road	TMR000150	3	B
Volcanic Ring Plain	Otakeho Stream at Waimate West water intake weir	OTK000175	5	C
Waitara	Ngatoro Stream 20 m d/s of NPDC intake weir	NGT000106	4	B
Waitara	Maketawa Stream at Derby Road	MKW000200	1	A
Waitara	Matau Stream u/s of confluence with unnamed tributary	MTA000068	2	A
Northern Hill Country	Mangahewa Stream u/s of McKee Production Station	MHW000060	1	C

Earlier SoE fish surveys did not follow the Joy *et al* (2013) protocols, with a tendency for several sections of a stream to be surveyed by spotlight or electric fishing over a shorter distance rather than a continuous 150 metre reach as is now required. While additional data from TRC fish surveys may not meet the NPS-FM criteria, they can provide useful context around the current state of fish communities in areas lacking valid monitoring sites. F-IBI values for all TRC fish surveys recorded on the NZFFD have been calculated and are presented in Table 2 and Figure 2.

These results show that fish communities in 63 out of 583 surveys (10.8%) recorded across Taranaki were graded in band A, 97 surveys (16.6%) were graded in band B, 344 surveys (59.0%) were graded in band C, and 79 (13.6%) were graded in band D. When comparing the F-IBI values from valid sites to all TRC fish survey sites the overall trend is an over-representation of sites within band A and B for valid SoE sites compared to all TRC survey data, and an under-representation of sites in bands C and D. This is likely due to the valid surveys almost always requiring more survey effort (area and duration) in accordance with the Joy *et al.* (2013) protocols, compared to the non-valid surveys. This results in a higher likelihood of more species being detected during the valid surveys, resulting in higher F-IBI scores; at least partly explaining the higher number of sites in bands A and B, and lower number of sites in bands C and D seen when compared against the rest of the survey data. There is also a potential bias in the full TRC dataset towards recording lower F-IBI scores, as these surveys are often targeting known fish passage barriers or other activities which can be negatively affecting fish communities, as part of consent compliance monitoring programmes or environmental incident monitoring surveys.

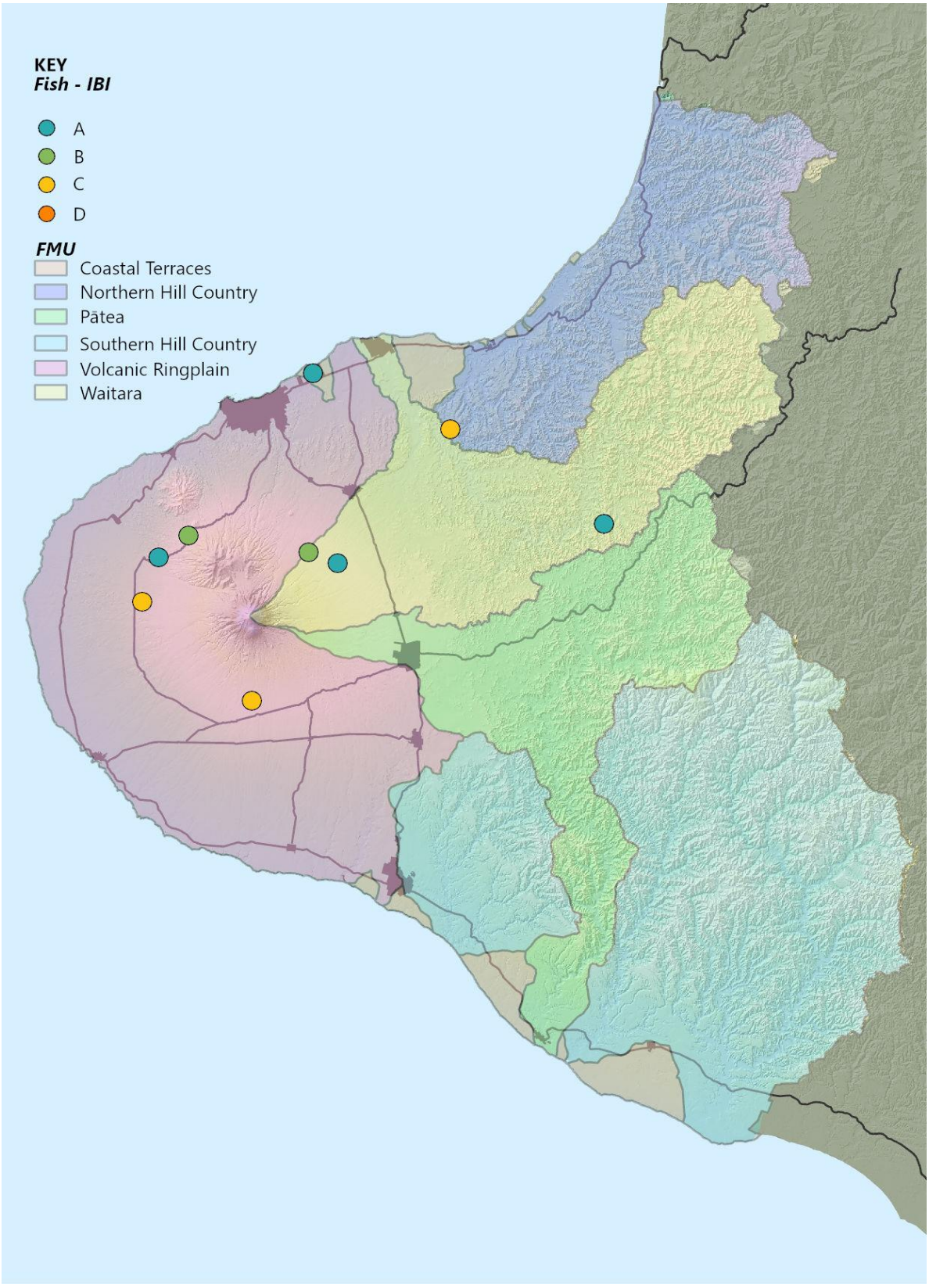

Figure 1: Valid State of the Environment fish monitoring sites and median F-IBI category.

This comparison demonstrates that the full TRC dataset can be used to provide an indication of the state of fish community integrity at a broader spatial scale throughout the region in the absence of valid baseline data, which is particularly useful for the Southern Hill Country and Pātea FMUs which lack any suitable survey data.

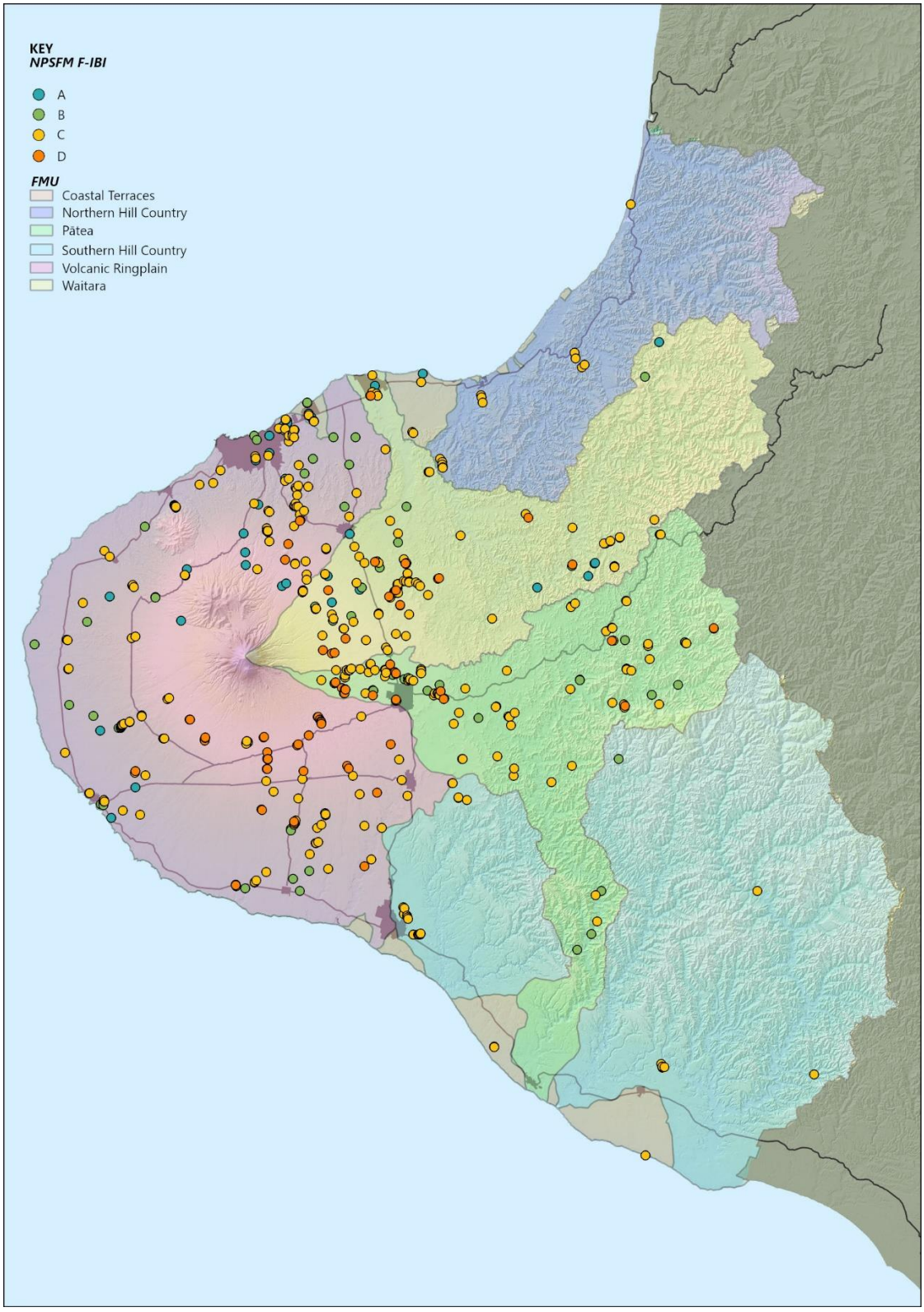

Figure 2: All TRC fish survey sites from NZFFD with median F-IBI values.

Baseline period and temporal state variability

Clause 1.4 of the NPS-FM addresses how to determine baseline states for attributes and Clause 1.6 further explains the type of data that can and should be used. As the F-IBI attribute is a median of values from previous qualifying surveys at a site, with no minimum or maximum number of surveys prescribed (Fisher, 2023), all qualifying fish surveys were used in determining baseline state. This was determined to be the most suitable approach, given that Clause 1.4 (a) would be a single value, and a median is always preferable to a single score for this attribute.

Clause 1.4 (b) does not apply as no previous objective has been set in relation to this attribute under any NPS-FM legislation. Clause 1.4 (c) would exclude any usable data for two of the nine sites used for baseline setting. By using all available valid survey data to determine baselines, the baseline state is equal to or higher than all of the other possible options listed for determining baseline state. This is consistent with the guidance stated in Clause 1.6 and uses the best available information, while resulting in baselines that are the best state from all possible options. The number of surveys at each site, the attribute state at first and last recorded survey, median F-IBI value for surveys up to 2017, and the median F-IBI value for all surveys are all displayed in Table 4.

Attribute state is shown to be relatively stable over time, with five of the nine sites used for baselines displaying no change in F-IBI attribute grade over their record length. Three of the nine sites improved over time, with only one site showing a reduction in F-IBI category over time. No change in attribute state over survey record length was greater than one attribute band.

Table 4: Temporal variability at sites used for F-IBI baselines

FMU	Site	Survey date	NOF attribute band	Number of surveys	NOF attribute band when first recorded	NOF attribute band when last recorded	Median NOF attribute band (all surveys to 2017)	Median NOF attribute band (all surveys)
Volcanic Ringplain	KPA000230	07/04/2016	C	1	C	C	C	C
	MTT000125	27/04/2018	B	2	B	A	n/a	A
		02/02/2021	A					
	TMR000150	29/01/1996	C	3	C	B	C	B
		26/04/2018	B					
		25/01/2021	B					
	OTK000175	18/03/1999	C	5	C	B	C	C
		02/05/2000	C					
		27/02/2009	C					
		21/03/2018	B					
		26/01/2021	B					
Coastal Terraces	MGT000530	25/05/2017	A	2	A	A	A	A
		01/02/2021	A					
Waitara	NGT000106	27/02/2008	B	4	B	C	B	B
		23/04/2012	B					
		25/05/2017	C					
		25/01/2021	C					

FMU	Site	Survey date	NOF attribute band	Number of surveys	NOF attribute band when first recorded	NOF attribute band when last recorded	Median NOF attribute band (all surveys to 2017)	Median NOF attribute band (all surveys)
	MKW000200	02/02/2021	A	1	A	A	n/a	A
	MTA000068	02/03/2012	A	2	A	A	A	A
		23/03/2017	A					
Northern Hill Country	MHW000060	14/06/1996	C	1	C	C	C	C

Freshwater Management Unit (FMU) coverage and representativeness

A recent review of the Council's SoE fish monitoring network for Taranaki has taken into account NPS-FM requirements, and recommends a minimum of three monitoring sites per FMU to inform a regional assessment of F-IBI.

An assessment of representativeness for each FMU (and the overall region) is also provided. Table 2 shows that two FMU's meet or exceed the recommended number of sites, while the remaining four FMU's are currently under represented. The Waitara FMU already has the recommended number of valid sites (three), while the Volcanic Ringplain FMU is slightly over represented with four sites. Monitoring network design and development is outside the scope of this document but will be pursued as part of the Council's overall freshwater implementation programme.

FMU-based baseline states

Site-based baseline states for F-IBI have been identified in Table 3 and Figure 1. These are the only sites meeting NPS-FM criteria for valid F-IBI calculations. Target attribute states will need to be set for these sites as part of the next step in this NPS-FM implementation process.

There are limitations as to how well the monitoring data can describe current state at the FMU scale, particularly given the limited number of valid survey sites available for this baseline assessment. The use of monitoring data alone has the potential to lead to biased conclusions given individual monitoring sites are non-random and are not entirely representative of the regional landscape and the pressures impacting on the health of the region's waterbodies. To help address these limitations, the use of modelled data can allow for an assessment of baseline states across both monitored and unmonitored waterways in the Taranaki region. Using modelled data, baseline states can be identified for each FMU, expressed as percentage waterway length in each FMU within each NOF attribute band. Furthermore, spatial models can be used to test the impacts of different management approaches, interventions and actions on freshwater outcomes in Taranaki.

Spatial models have been developed for Taranaki encompassing a range of water quality and biotic parameters. However, there are no reliable fish distribution models available, largely due to the high number of unknown fish passage barriers restricting the distribution of fish communities that would otherwise be predicted by habitat, elevation, distance from coast, and location. In lieu of a spatial model, the volume of monitoring coverage achieved through the TRC survey results (those not conforming to the Joy *et al.* (2013) protocols), is useful for providing an understanding of fish community integrity at broader spatial scales than is achieved by the designated monitoring sites with valid data (despite these results likely being biased towards lower scores, for reasons discussed earlier). It also allows for a comparison with the baseline state assessments carried out at the valid survey sites; providing insight regarding how well the site-based baseline state represents the wider FMU. The non-conforming sites and data set out in Table 2 and Figure 2 can also

be used to inform target attribute setting, but will not be appropriate for tracking changes over time as they will not be monitored to protocol.

Recommendations

Draft baseline states have been identified strictly using valid survey data for the F-IBI attribute at qualifying survey sites. Sites with invalid survey data have also had F-IBI values calculated, as a means of supporting this assessment by providing a broader indication of F-IBI state throughout each FMU.

Target attribute states will need to be set at a level that (at a minimum) achieves the best baseline state identified for each monitoring site, or exceeds the baseline state where this is necessary to achieve improvement. Consideration should be given as to whether target states should be set at broader spatial scales (e.g. at catchment or FMU scale) as well as at specific sites. Although invalid survey data have not been used for identifying site-based baseline states, this data should be considered for supporting the target setting process, particularly for FMUs that are lacking valid survey data currently.

The next step is to identify and assess the impact of possible actions and mitigations that are available to support the maintenance and improvement of freshwater in relation to F-IBI and more broadly, ecosystem health.

Finally, changes to the current SoE fish monitoring programme will be necessary to align with NPS-FM requirements. Current SoE fish survey sites that have been used for determining baseline state will need to be surveyed at least annually if they are to be used for monitoring progress towards F-IBI target state going forward. Additional F-IBI monitoring sites will need to be established in order to achieve monitoring coverage in all FMUs, and appropriate representativeness across the region. Additional F-IBI monitoring sites will also need to be monitored at least annually, and surveys for all sites will need to meet the sampling criteria set out in Joy *et al* (2013).

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