NIWA
Taihoro Nukurangi

DRAFT

Status report summarising fish screening issues across New Zealand

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Cover image: The retractable fish screens at Browns Rock Intake on the Waimakariri River. [Photo credit: Phil Jellyman, NIWA]

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During the last decade there has been increasing interest in issues relating to water quality and quantity and this has also resulted in increased recognition around environmental issues relating to water infrastructure. This recognition has seen a resurgence in interest at a national scale to improve the outcomes for fish that interact with water infrastructure (e.g., intakes and fish screens associated with irrigation schemes). Nationally, there are a number of issues related to fish screening and to address some of these issues the Ministry for Primary Industries (MPI) has recently funded a project titled “Adoption of Good Practice Fish Screening”.

The first milestone for this project was to understand what fish screening conditions are currently required by councils around New Zealand and whether there are any major differences between regions. To investigate this topic, regional plans were examined coupled with an email questionnaire sent to all councils. MPI funded work over a decade ago to develop some best practice for fish screening so part of the current project was to assess whether this previous information was being used by councils.

All council plans were examined to extract information on fish screening, but a response to the questionnaire was only received from some councils. The report reviews the plan of 16 councils and details all fish screening requirements in their plans.

The key points from this review are summarised as follows:

- Council regulations pertaining to fish screening are highly variable across New Zealand ranging from nearly absent to highly prescriptive;
- Four councils require no fish screening of smaller surface water takes;
- The effectiveness of fish screens is largely untested around New Zealand;
- The lack of adoption of the Jamieson et al. (2007) guidelines into the majority of the council plans warrants further investigation. There may be a number of impediments across councils to more prescriptive conditions being included in plans. Coming up with viable national-scale solutions needs to better understand these issues (which would also be helped by input from more councils);
- It is considered likely that some councils/staff are not aware of the importance of fish screening and that better communication pathways relating to future findings from the current project will be needed if the project is to be effective;
- As identified by one questionnaire respondent, if the current guidelines are not safeguarding fish appropriately then the project needs to think about how other options could be applied as a consent condition(s) to reduce any effects on fish because of the length of time it takes to change regional plan rules.

1 Introduction

During the last decade there has been increasing interest in the state and health of fresh waters across New Zealand. Issues relating to water quality and quantity have been a focus of central government policy (e.g., National Policy Statement for Freshwater Management 2017) and this has also resulted in increased recognition around environmental issues relating to water infrastructure. During this same timeframe, there has been increased concern about declining freshwater fisheries, in particular, the increasing number of threatened native fish species (Dunn et al. 2018). As a consequence of these concerns, there has been a resurgence in interest at a national scale to improve the outcomes for fish that interact with water infrastructure (e.g., irrigation schemes). Specifically, there are concerns regarding the risk of entrainment for juvenile freshwater fishes (i.e., likelihood of being drawn into an abstraction scheme) during their downstream or upstream dispersal phase. Addressing this issue is viewed as a key management objective for both native and sports fishery managers across New Zealand.

1.1 Report background and scope

It has been recognised for many years by the regulatory agencies responsible for protecting fish populations and/or approving surface water infrastructure (e.g., regional councils, Department of Conservation, Fish and Game New Zealand [FGNZ]) that there are a wide range of issues concerning water intakes and fish screens[1]. As described in greater detail in Jamieson et al. (2007), a group of interested parties was first assembled by Environment Canterbury (ECan) in 2005 to start examining the varied issues related to fish screening at intakes. This led to a successful Sustainable Farming Fund project, through Irrigation New Zealand (INZ), to provide good practice guidelines that represented an agreed position between interested parties (e.g., ECan, INZ, FGNZ).

The Jamieson et al. (2007) report provided an overview of current fish exclusion technologies at the time, reviewed a range of principles associated with fish screening practices and identified seven key principles as part of a 'whole of intake design' approach. These principles were designed to assist regulatory agencies when assessing whether fish will be effectively diverted away from intakes without injury. Since this report was completed there has been a strong focus on examining whether a range of existing fish screen designs are operating effectively (see Bonnett et al. 2014 for a review of six different fish screens at irrigation intakes), but there has been limited research conducted to address New Zealand-specific knowledge gaps identified by Jamieson et al. (2007).

Addressing a number of these knowledge gaps forms part of a new Sustainable Farming Fund[2] project, funded by the Ministry for Primary Industries (MPI), titled "Adoption of Good Practice Fish Screening". However, as outlined in the application, scientific knowledge gaps are only part of the suite of issues related to improving fish screening effectiveness as we need to understand what requirements the regional councils have on imposing new and existing water abstractors around New Zealand. To investigate this topic, regional plans were examined/used to identify fish screening requirements. On behalf of the Fish Screening Working Group[3], an email composed by the author was sent to all regional councils that contained a series of questions (see Appendix A) related to how they regulate fish screens and what knowledge gaps they perceive. This questionnaire was sent by Dr

[1] Hereafter, the term fish screens is generally used as a term intended to capture all infrastructure related to the screening of surface water (e.g., bypass, headworks, screen, etc.).
[2] After the INZ application was submitted this fund was renamed "Sustainable Food and Fibre Futures (SFF Futures)".
[3] The Fish Screening Working Group is comprised of a diverse range of interested parties addressing issues related to fish screening, it members include: ECan, INZ, FGNZ, Department of Conservation, Ngāi Tahu, Otago Regional Council, MPI, MfE, Irrigators, Salmon anglers, NIWA, engineers and irrigation consultants.

Adrian Meredith (Environment Canterbury) to all the councils on the 15th October 2019 and a quick turnaround requested (as there had been a delay in the email being sent). I firstly summarise the fish screen assessment guidelines from Jamieson et al. (2007) in Section 2, before summarising council plans and questionnaire results for councils that responded in Section 3. Section 4 identifies the conclusions and the report concludes with a brief summary (Section 5).

2 Current best practice guidance for fish screening

The following guidelines are taken from Jamieson et al. (2007) in which a fish screen would only be considered effective[4] when all seven criteria below are met:

- **Site location**: The site is located to minimize exposure of fish to fish screen structure, and minimizes the length of stream channel affected while providing the best possible conditions for the other criteria;
- **Screen apertures**: Screening material (mesh, profile bars or other) on the screen needs to have openings small enough to exclude fish, and a surface smooth enough to prevent any damage to fish. Jamieson et al. (2007) recommended a bar gap of 2 mm or mesh/plate aperture size of 3 mm;
- **Approach velocity**: Water velocity ("speed") through the screen ("approach velocity") is slow enough to allow fish to escape entrainment (being sucked through or washed over the screen) or impingement (being squashed or rubbed against the screen). Jamieson et al. (2007) recommended an approach velocities of no more than 0.12 m/sec;
- **Sweep velocity**: Water velocity across (or past) the screen ("sweep velocity") is sufficient to sweep the fish past the intake promptly. Jamieson et al. (2007) recommended a sweep velocity greater than the approach velocity;
- **Bypass provision**: A suitable fish bypass is provided so that fish are taken away from the intake and back into the source channel;
- **Bypass connectivity**: There needs to be "connectivity" between the fish bypass and somewhere safe, usually an actively flowing (i.e., not still) main stem of the waterway;
- **Operation and maintenance**: The intake needs be kept operating to a consistent, appropriate standard with appropriate operation and maintenance. This should be checked or monitored.

[4] Fish screen effectiveness is considered to be maximised at a site by Jamieson et al. (2007) when all the seven criteria have been satisfied.

3 Council regulations and responses to email questionnaire

All council plans were examined and used to extract information on fish screening, but not all councils provided a response to the questionnaire. Some email responses directly addressed the questions provided whereas others provided an analysis of fish screening issues for their region. Email responses, where received, are paraphrased in the sections below and in instances where questions from the questionnaire were answered directly these are provided in Appendix A.

The evaluation of regional plans in the present report is not intended to be a criticism of particular councils but simply an analysis of their fish screening guidelines. It may also be unrealistic to expect that council plans provide extensive guidance on fish screening if they have relatively few surface water takes within their council boundaries. It is further acknowledged that plans only determine some of the regulations/conditions that might be imposed on a consent which is, in part, why an email questionnaire was also circulated to council staff. The councils are ordered from north to south below and a summary table containing the fish screening requirements for all councils is provided in Section 4.

3.1 Northland Regional Council

3.1.1 Operative rules for fish screening

Under the currently operative Regional Soil and Water Plan for Northland, small surface water takes are a permitted activity provided the daily take volume is less than 10 m^3 from December to May or 30 m^3 in other months and a number of other conditions are met. One of those conditions requires a fish screen to be present and that the velocity across the intake screen does not exceed 0.3 m/s and that the screen does not have holes or slots with a diameter or width greater than 5 mm.

This plan also has an Appendix 15 titled “Principles of fish pass design” in which the following text is provided relating to intake screens:

“Slotted screens of 5 millimetres maximum mesh size are preferable. Smaller mesh sizes may be desirable in some circumstances. Examples are wedge wire screens and Johnson-T-screens. Screens should be sized to achieve screen surface intake velocities of no greater than 0.3 metres per second and preferably 0.15 metres per second. The latter is desirable to allow for up to 50% clogging of screen area with debris at times.

Velocities across the screen surface at least twice the through screen velocity will enhance self-cleaning properties and minimise the potential for impingement of biota. This effectively means targeting high flow areas for siting of intakes, preferably away from the bank and one metre out into flowing water above the stream bed. This also is preferable because fish movement tends to be close to the bed or the bank of a river where velocities are lower and where there is more natural cover and refuge.”

There is currently also a ‘Proposed Regional Plan for Northland ¬– Appeals Version (July 2019)’ which has suggested changes to the regional plan to better safeguard fish. The Proposed Regional Plan for Northland now states: “For a surface water take, the water intake structure is designed, constructed, operated and maintained so that: a) the maximum water velocity into the entry point of the intake structure is not greater than 0.12 metres per second, and b) if the take is from a coastal river, outstanding river or lake, the intake structure has a fish screen with the intake screen mesh spacing not greater than 1.5 millimetres, or c) if the take is from a small river or large river, the intake structure has a fish screen with mesh spacing not greater than three millimetres”.

3.1.2 Email response from Northland Regional Council

No response was received.

3.2 Auckland Council

3.2.1 Operative rules for fish screening

Under the Auckland Council Regional Plan: Air, Land and Water (ALW Plan) the taking and use of no more than 20 m^3/day of water from a lake or 5 m^3/day of water from a stream, river or spring is a permitted activity subject to the conditions below. These conditions relate to any water intake structure that is designed and constructed:

- The maximum water velocity into the entry point of the intake structure is no greater than 0.3 metres per second;
- The intake screen mesh spacings are no greater in one dimension than 1.5 millimetres;
- The intake screen is located no less than 0.5 metres instream from the water's edge, or in streams less than 1 m width, as far as practicable from the water's edge.

3.2.2 Email response from Auckland Council

No response was received.

3.3 Waikato Regional Council (Environment Waikato)

3.3.1 Operative rules for fish screening

The Waikato Regional Plan is fully operative and requires all water intakes to be screened. All water intake structures shall be screened with a mesh aperture size not exceeding 3 mm in diameter at locations less than 100 metres above mean sea level, or 5 mm in diameter at locations greater than 100 metres above mean sea level. In addition, the maximum intake velocity for any water intake structures shall not exceed 0.3 m/s. Smaller mesh aperture is required for significant trout fisheries and trout habitat because no mesh sizes can exceed 3 mm. For significant indigenous fisheries and fish habitat, intake structures less than 100 metres above mean sea level must be screened with a mesh aperture size ≤1.5 mm or ≤3 mm at higher elevation sites.

3.3.2 Email response from Waikato Regional Council

The email response confirmed that for most water takes, the mesh aperture is not to exceed 1.5 × 1.5 mm below 100 m.a.s.l and the approach velocity rule of less than 0.3 m/s is applied at the peak rate of take. The 3 mm aperture size is typically applied above this elevation.

The respondent noted that they have previously allowed longer elongated 1.5 mm slots (dimensions not specified), as opposed to square, which allows a higher take rate without affecting the approach velocity. However, the respondent did not know if this influences the safe passage of fish past the intakes in both directions – but they have presumed that it does provide safe passage with the potential exception of larval fish. The respondent highlighted critical knowledge gaps around downstream drifting larvae as a key area of concern.

3.4 Bay of Plenty Regional Council (Environment Bay of Plenty)

3.4.1 Operative rules for fish screening

The Bay of Plenty Regional Natural Resources Plan (RNRP) is a renamed version of the Regional Water and Land which became operative in December 2008. Minor takes (e.g., up to 15 m^3/day per property) are a permitted activity but unlike several other councils, Environment Bay of Plenty do require fish screens on these takes. The takes must meet certain conditions (i.e., not from a wetland, <30°C, rate of take < 2.5 L/s) and contain an intake screen with a mesh aperture size not exceeding 3 mm by 30 mm in the tidal areas of rivers and streams or 5 mm by 30 mm or 5 mm diameter holes in any other area that is not in the tidal area of a river or stream. The intake velocity through the screen must not exceed 0.3 m/s. However, Plan Change 9 (currently being considered by the Environment Court) is proposing to remove a requirement for screening these takes. Surface water takes that are greater than 15 m^3/day per property are either a controlled or discretionary and thus it is presumed that conditions relating to fish screening are specified in any consent issued.

For the installation/alteration/reconstruction of a new surface water intake there are 24 conditions that need to be met to be considered a permitted activity. Many relate to the disturbance of the works and their timing but the following conditions are highly relevant to achieving fish screening outcomes: (a) The structure shall not include an infiltration gallery in the bed of a surface water body. (b) The structure shall not restrict the cross-sectional area by more than five square metres, or 5% of the width of the river, stream, or lake; whichever is the lesser. (c) The intake structure shall be screened with a mesh aperture size: (i) Not exceeding 3 mm by 30 mm in the tidal areas of rivers and streams. (ii) Not exceeding 5 mm by 30 mm or 5 mm diameter holes in any other area that is not in the tidal area of a river or stream. (s) The structure shall at all times be maintained in a sound condition for the purpose for which it was constructed, and be kept clear of accumulated debris. (v) Structures in, on or over the beds of lakes shall be designed and constructed to account for natural lake water level fluctuations.

3.4.2 Email response from Bay of Plenty Regional Council

No response was received.

3.5 Gisborne District Council

3.5.1 Operative rules for fish screening

The Gisborne District Plan has now been replaced by the Tairāwhiti Resource Management Plan (TWRP, operative July 2018). The taking and use of surface water, spring water or groundwater at rates of less than 5 litres/second to a maximum of 10 m^3/day per property is a permitted activity provided fish are prevented from entering the water intake. The TWRP states that an intake structure established for a surface water take would be permitted provided it met the following conditions:

a) The structure shall not restrict the cross-sectional area by more than five square metres, or 5% of the width of the river, stream, or lake; whichever is the lesser;

b) The intake structure shall be screened with a mesh aperture size:

I. Not exceeding 3 mm by 30 mm in the tidal areas of rivers and streams;

II. Not exceeding 5 mm by 30 mm or 5 mm diameter holes in any other area that is not in the tidal area of a river or stream;

c) The intake velocity shall not exceed 0.3 m/s;

g) The structure shall at all times be maintained in a sound condition for the purpose for which it was constructed, and be kept clear of accumulated debris;

i) Structures in, on or over the beds of lakes shall be designed and constructed to account for natural lake water level fluctuations.

3.5.2 Email response from Gisborne District Council

An email response was received from Gisborne District Council outlining that they do specify conditions around fish screening in Gisborne. They noted that the general conditions below are included in their surface water take consents.

Conditions: "The intake shall incorporate a fish screen with a mesh size no greater than 5 mm by 30 mm, or holes not exceeding 5 mm diameter. The water velocity through the screen shall not exceed 0.3 metres per second. The consent holder must ensure regular maintenance is undertaken."

3.6 Hawke's Bay Regional Council

3.6.1 Operative rules for fish screening

Hawke's Bay Regional Council have an Regional Resource Management Plan (RRMP) that became operative in 2006. The RMMP has no requirements pertaining to fish screening but in Chapter 6 (Regional rules) of the Plan it is stated that for the replacement of an existing surface water consent that HBRC may apply its discretion regarding "the effects of any intake structure on fish passage and the need for fish exclusion devices or screens". The Regional Policy Statement Change 5 Land Use and Freshwater Management (operative August 2019) makes no reference to fish screening.

The RMMP specifies abstraction of up to 20 m^3/day/property is a permitted activity and reading of the plan suggests that a surface water take could be unscreened and compliant provided it did not exceed the 20 m^3/day/site abstraction volume, was taking less than 10% of the instantaneous flow at the point of take and had an intake velocity less than 0.3 m/s.

3.6.2 Email response from Hawke's Bay Regional Council

Hawke's Bay Regional Council responded to the questionnaire (see Appendix A for responses) noted that when processing fish screening consents they have referred to the NIWA fish screening good practice guidelines. They did note there has been some debate over the design standards to be applied and the practicality and cost implications of some of the outcomes, particularly given the size of the screens that seem to be required in some cases. They do not have fish screening requirements in their plan and do not require fish screening effectiveness testing, however, they did note that out of the Water Conservation Order for the Ngaruroro River that it is likely that fish screening design criteria will be required on intakes within this catchment (see Figure 1).

Feature	Outstanding Characteristics or Features
Screen location	At the point of water diversion from the river (or as close as practicable)
Screen size (aperture)	Aperture size not exceeding • 2mm in diameter for profile bar screens • 3mm in diameter for woven mesh screens • 3.2mm in diameter for perforated plate screens (round opening)
Approach velocity	No greater than 0.12 metres per second
Sweep velocity (parallel to the face of the screen)	Equal to or greater than the approach velocity at all times
Return of fish to an active flowing channel of the water from which they were diverted	Effective bypass structure
Screen maintenance and operation	To ensure that the screen remains effective at all times

Figure 1: The minimum requirements for fish screens and intakes. This is from Schedule 3 of the Ngaruroro Water Conservation Order.

3.7 Taranaki Regional Council

3.7.1 Operative rules for fish screening

The Regional Freshwater Plan for Taranaki (operative October 2001) stipulates that existing structures in a river are permitted provided they do not restrict the passage of fish or result in significant adverse effects on aquatic life. Similar wording appears in a various 'Rules' in the Plan but there is no specific mention of fish screening in the plan. In Taranaki, a property can take and use of up to 50 m^3/day of surface water as a permitted activity provided no more than 25% of the instantaneous flow is taken and the rate of abstraction does not exceed 1.5 L/s (or 5 L/s for not more than 30 mins/day). There was no specific requirement to screen these intakes for fish.

3.7.2 Email response from Taranaki Regional Council

No response was received.

3.8 Manawatu-Wanganui Regional Council (Horizons)

3.8.1 Operative rules for fish screening

Horizons One Plan became operative in December 2014. Minor takes (e.g., up to 15 m^3/day per property) are a permitted activity but unlike several other councils, Horizons do require fish screens on these takes. The takes must meet certain conditions (i.e., not from rare or threatened habitat, rate of take <2 L/s) and contain an intake screen with a mesh aperture size not exceeding 3 mm in

diameter and an intake velocity less than 0.3 m/s. Screening requirements are unspecified for the larger surface water takes and given they are not permitted activities are presumably outlined in individual consent conditions.

3.8.2 Email response from Manawatu-Wanganui Regional Council

No response was received.

3.9 Greater Wellington Regional Council

3.9.1 Operative rules for fish screening

The taking of less than 20 m^3 per day of fresh water is a permitted activity under Greater Wellington Regional Council's operative Regional Freshwater Plan, subject to several conditions. One of the conditions is that "Fish, including small fish, are prevented from entering the reticulation system" although there are no specific criteria that need to be met. Under their Proposed Natural Resources Plan a surface water take would require the installation of a fish screen with a minimum mesh size of 3 mm.

3.9.2 Email response from Greater Wellington Regional Council

No response was received.

3.10 Tasman Regional Council

3.10.1 Operative rules for fish screening

The freshwater part of the Tasman Resource Management Plan became operative in March 2014. This Plan classifies the taking of between 5 to 20 m^3 of fresh water per day (catchment dependent) as a permitted activity but one of the conditions is that fish and eels are prevented from entering the reticulation system. For fish screen compliance the screen mesh size must not be greater than 5 mm, constructed so that the intake velocity at the screen's outer surface is less than 0.3 metres per second and needs to be maintained in good working order at all times.

3.10.2 Email response from Tasman Regional Council

Tasman Regional Council responded to the questionnaire (see Appendix A for responses) and noted they do not get many consents relating to fish screening and would appreciate further guidance. They do not require fish screens to be tested and stated that few would be monitored by the compliance team. Whilst Tasman were the only region to raise that compliance checks are likely to be limited, this is highly likely to be an issue for councils around New Zealand based on various ad hoc conversations I have had with council staff over many years.

3.11 Nelson City Council

3.11.1 Operative rules for fish screening

The Nelson Resource Management Plan (operative September 2004) requires that water intake structures are designed and constructed in a way that prevents fish entering the structures. To

achieve this the maximum water velocity into the structure must be less than 0.5 L/s[5], the mesh spacing can be no larger than 1.5 mm in one dimension, and the intake screen must be located at least 0.5 m into the water column.

3.11.2 Email response from Nelson City Council

No response was received.

3.12 Marlborough District Council

3.12.1 Operative rules for fish screening

Marlborough District Council (MDC) have an operative Resource Management Plan (RMP). This plan does not specify any fish screening requirements for freshwater abstractions (although it is noted that the majority of water abstraction in Marlborough is from groundwater). The RMP specifies abstraction for domestic needs of up to 10 m^3/day/site as a permitted activity and reading of the plan suggests that a surface water take could be unscreened and compliant provided it did not exceed the 10 m^3/day/site abstraction volume and was taking less than 5% of the streamflow at the time of abstraction.

3.12.2 Email response from Marlborough Council

The email response from MDC confirmed that "We do not have anything specific here in Marlborough and refer people to the NIWA document [Jamieson et al. 2007] on the DOC website". A follow-up phone conversation confirmed that these guidelines are applied for Discretionary and Non-Complying Activities in the district.

3.13 West Coast Regional Council

3.13.1 Operative rules for fish screening

The West Coast Regional Council (WCRC) Land and Water Plan became operative in May 2014. The Plan stipulates several conditions for a surface water take to be a permitted activity. One of the conditions is that the intake is protected by a fish screen which ensures as far as is practicable, that eels, fish and fry are prevented from passing through the intake and from being trapped against the fish screen. There are no specific design criteria mentioned in the Plan.

3.13.2 Email response from West Coast Regional Council

West Coast Regional Council responded to the questionnaire (see Appendix A for responses) and noted that consenting staff "get little if any information on fish screens" from applicants so check with science staff when determining if a fish screen is suitable. They do not require a fish screen to be tested and noted that "We have very little knowledge or expertise in regard to fish screening in our Council or region".

[5] It is noted that this is a very odd condition as it mentions a velocity but then provides a volume.

It was also noted by a council staff member that their previous plan had more prescriptive fish screening criteria, as outlined below, but these did not make it into the currently operative plan.

FISH SCREEN GUIDELINES FOR WATER INTAKES

Where a person is taking water from a surface water body in reliance on Rules 12.1.1, 12.1.2 or 12.1.3 a fish screen shall be installed which ensures, as far as practicable, that fish are prevented from entering the intake. The screen shall be functional at all times. The following fish screen design specifications are considered to be best practice standards.

(a) To exclude native fish fry, the following mesh sizes are recommended:
  (i) 2mm for intakes within 2kms of the coast, a coastal lake or estuary;
  (ii) 3mm when between 2kms and 8kms from the coast, a coastal lake, estuary or in a recognised trout spawning stream; or
  (ii) 5mm for anywhere else.

(b) To exclude salmon, the following mesh sizes are recommended:
  (i) 3.2mm ordinary mesh size; or
  (ii) 2.4mm slot mesh size; or
  (iii) 4.2mm perforated plate.

Note: the 2mm mesh size is based on native fish requirements. Mesh sizes can differ because of different aperture shapes – for instance ordinary mesh has a square aperture which is more restrictive to fish than the rectangular slot mesh aperture. Similarly, the round holes of perforated plate are more restrictive than ordinary mesh, so can be slightly larger. For example, a 3mm opening size in woven mesh screens is equivalent to a 2mm opening in profile bar screens and 3.2mm opening for perforated plate screens.

(c) the fish screen should be positioned to ensure that there is unimpeded fish passage to and along the waterway to avoid the entrapment of fish at the point of abstraction.

(d) sweep velocities should be higher than approach velocities and the angle between the intake grill face and the water current should be less than 45 degrees. Orientating the inlet structure as parallel to the water flow as practicable will also assist in minimising the approach velocity.

(e) for all open channel intakes where there is no direct pumping (e.g. diversions with rotary and static screens), the design and maintenance of the fish screen should ensure that the velocity of flow at and through the screen will prevent fish and fish fry being trapped on the screen.

3.14 Canterbury Regional Council (Environment Canterbury)

3.14.1 Operative rules for fish screening

The Canterbury Land and Water Regional Plan became operative in September 2015. The take and use of water from a river, lake or an artificial watercourse is a permitted activity (allowable volumes vary with flow for river takes) provided fish are prevented from entering the water intake as set out

in Schedule 2. Environment Canterbury's fish screen standards and guidelines are the most prescriptive of any council, as outlined below:

Schedule 2 Fish Screen Standards and Guidelines

1. Where the diversion or take does not exceed a maximum rate of 10 L/s and a maximum volume of 100 m^3 per day, a fish screen shall be installed to prevent fish from entering the intake. The fish screen shall be designed to the following standard and kept functional at all times that water is being taken:

(a) Water shall only be taken when a fish screen with a mesh size or slot width not exceeding 2 mm for intakes within 2 km of the coast, a coastal lake or estuary, or 3 mm for anywhere else, is operated and maintained across the full width of the intake to ensure that fish and fish fry are prevented from bypassing the screen into the intake; and (b) The screen area shall be designed to ensure the calculated average through screen velocity does not exceed 0.12 m/s (screens should generally be designed to exceed this area to account for some routine level of clogging of the screen with detritus). The required area (m^2) of fish screen should exceed = Flow (L/s)/120.

Example: The minimum required fish screen area for a cylindrical screen can therefore be calculated from

Area = $2\pi r(r + h) \times z$

Where: $\pi = 3.14159$

r = radius of cylinder (m)

h = length or height of cylinder (m)

z = proportional open mesh area of screen material (i.e. 0.5 for mesh that is 50% open area)

Note: The above formula holds where the screen is fully immersed in water as is usually the case with pump takes. Where this is not the case, the area will need to be adjusted accordingly. Where 50% of the screen may be exposed, then the area calculation will need to be adjusted to half (or multiplied by 0.5), or the actual screen area would need to be doubled (multiplied by 2) in order to achieve the same area immersed. This example makes no allowance for the area taken up by the end of the intake pipe. Where high levels of detritus and other clogging materials are present, screen areas should be increased to account for reduced effective screen area.

2. Where the diversion or take does not exceed a maximum rate of 10 L/s and a maximum volume of 100 m^3 per day but does not meet the standards in 1 above; or where the diversion or take exceeds a maximum rate of 10 L/s and a maximum volume of 100 m^3 per day and the diversion is less than 10 m^3/s or the take is less than 500 L/s pumped, a fish screen shall be installed to prevent fish from entering the intake. The fish screen shall be designed with the following features:

(a) The site is located as close to the river source as possible to minimise exposure of fish to the fish screen structure, and minimises the length of stream affected while providing the best possible conditions for (b) - (f) below;

(b) Water velocity through the screen ("approach velocity") is slow enough (generally <0.12 m/s) to allow fish to escape entrainment (being sucked through or washed over the screen) or impingement (being squashed or rubbed against the screen);

(c) Water velocity across (or past) the screen ("sweep velocity") is greater than the approach velocity (b) and is sufficient to sweep the fish past the intake;

(d) An effective bypass system is provided that is easily accessible to entrained fish, and fish are taken away from the intake and back into the source channel, or into water which provides the fish with unimpeded passage back into the source channel;

(e) Screening material (mesh, profile bars or other) on the screen needs to have a smooth surface and openings that prevent any damage to fish coming into contact with the screening material; and

(f) The intake structure and fish screen are operated to a consistent, appropriate standard with appropriate operation and maintenance procedures, and this operation and maintenance should be regularly checked or monitored. A record should be kept of all the maintenance and monitoring carried out

3. Where the diversion is more than 10 m^3/s or the take is more than 500 L/s pumped, in addition to the features listed in 2 (a) to (f) above, it will be necessary for the intake to be purpose designed and to consider on a case by case basis whether any additional features will be necessary to ensure fish are prevented from entering the intake.

Notes:

1. Submerged galleries (abstracting water vertically) and galleries in river banks (abstracting water horizontally), or behavioural barriers and devices such as those that use light and sound diversions may not meet all of the engineering features set out in 2 above, but shall be considered to comply with them where it is demonstrated that they are able to exclude fish to the same degree of effectiveness

2. In conjunction with a number of stakeholder groups, the CRC has developed good practice guidelines for fish screening in Canterbury. A copy of this guideline can be obtained from the CRC to help in ensuring fish screens are designed, installed and operated to include the features identified in 2 above.

Good Practice Guidelines - https://www.doc.govt.nz/globalassets/documents/conservation/native-animals/fish/fish-passage/fish-screen-guidelines.pdf

3.14.2 Email response from Canterbury Regional Council

No response was received from Environment Canterbury but as they are part of the Fish Screening Working Group some of their responses are known. As outlined above, Environment Canterbury has the most prescriptive fish screening conditions specified in a currently operative plan. Unlike other respondents, Environment Canterbury regularly requires effectiveness testing of fish screens, particularly for novel screen designs. They have been involved in the testing of a number of different fish screen types and this is summarised in the report of Bonnett et al. (2014)[6].

[6] This report is freely available from: https://www.irrigationnz.co.nz/KnowledgeResources/Attachment?Action=Download&Attachment_id=64

3.15 Otago Regional Council

3.15.1 Operative rules for fish screening

Otago Regional Council (ORC) has a Regional Plan, Water for Otago, that allows for the taking and use of up to 25 m^3 of surface water for domestic needs or the needs of animals for drinking water as a permitted activity. These permitted surface water takes do not have a requirement to be screened.

3.15.2 Email response from Otago Regional Council

Otago Regional Council responded to the questionnaire and noted that consenting staff rely heavily on the expertise of their science staff when determining whether proposed fish screens are appropriate. For new consent applications they now include a standard fish screening condition (see Appendix A) that incorporates mesh size, approach velocity, sweep velocity and an operation and maintenance plan. These new conditions require the screen to be maintained so that they work as per the design although they not previously required effectiveness testing of a new screen.

3.16 Southland Regional Council (Environment Southland)

3.16.1 Operative rules for fish screening

Environment Southland have a Regional Water Plan that permits the abstraction and use of up to 10 m^3/day of surface water but one of the conditions is that fish are prevented from entering the reticulation system. This is the operative plan but it provides no detail regarding fish screen specifications. The proposed Southland Water and Land Plan contains an Appendix R – Fish Screen Standards and Guidelines[7], as the proposed plan is expected to become operative in 2020 it is noted below:

(a) Where the diversion or take does not exceed a maximum rate of 10 litres per second and a maximum volume of 100 cubic metres per day, a fish screen shall be installed to prevent fish from entering the intake. The fish screen shall be designed to the following standard and kept functional at all times while water is being taken:

> (i) Water shall only be taken when a fish screen with a mesh size or slope width not exceeding 2 millimetres for intakes within 2 kilometres of the coast, a coastal lake or estuary, or 3 millimetres for anywhere else is operated and maintained across the full width of the intake to ensure that fish and fish fry are prevented from bypassing the screen into the intake; and
>
> (ii) The screen area shall be designed to ensure the calculated average through screen velocity does not exceed 0.12 metres per second (screens should generally be designed to exceed this to account for some routine level of clogging of the screen with detritus). The required area (square metres) of fish screen should exceed = Flow (litres per second)/120.
>
> Example: The minimum required fish screen area for a cylindrical screen can therefore be calculated from: Area = $2\pi r (r + h) \times z$ Where: π =3.141592659 r = radius of cylinder (metres) h = length or height of cylinder (metres) z = proportional open mesh area of screen material (i.e. 0.5 for mesh that is 50% open area)
>
> **Note:** The above formula holds where the screen is fully immersed in water as is usually the case with pump takes. Where this is not the case, the area will need to be adjusted

[7] Appendix R is identical to Environment Canterbury's Schedule 2 Fish Screen Standards and Guidelines.

accordingly. Where 50% of the screen may be exposed, then the area calculation will need to be adjusted to half (or multiplied by 0.5), or the actual screen area would need to be doubled (multiplied by 2) in order to achieve the same area immersed. This example makes no allowance for the area taken up by the end of the intake pipe. Where high levels of detritus and other clogging materials are present, screen areas should be increased to account for reduced effective screen area.

(b) Where the diversion or take does not exceed a maximum rate of 10 litres per second and a maximum volume of 100 cubic metres per day but does not meet the standards in (a) above; or where the diversion or take exceeds a maximum rate of 10 litres per second and a maximum volume of 100 cubic metres per day and the diversion is less than 10 cubic metres per second or the take is less than 500 litres per second pumped, a fish screen shall be installed to prevent fish from entering the intake. The fish screen shall be designed with the following features:

(i) The site is located as close to the river source as possible to minimise exposure of fish to the fish screen structure, and minimises the length of stream affected while providing the best possible conditions for (ii) - vi) below;

(ii) Water velocity through the screen ("approach velocity") is slow enough (generally Proposed Southland Water and Land Plan (Decisions Version, 4 April 2018) Page 192 washed over the screen) or impingement (being squashed or rubbed against the screen);

(iii) Water velocity across (or past) the screen ("sweep velocity") is greater than the approach velocity (b) and is sufficient to sweep the fish past the intake;

(iv) An effective bypass system is provided that is easily accessible to entrained fish, and fish are taken away from the intake and back into the source channel, or into water which provides the fish with unimpeded passage back into the source channel;

(v) Screening material (mesh, profile bars or other) on the screen needs to have a smooth surface and openings that prevent any damage to fish coming into contact with the screening material; and

(vi) The intake structure and fish screen are operated to a consistent, appropriate standard with appropriate operation and maintenance procedures, and this operation and maintenance should be regularly checked or monitored. A record should be kept of all the maintenance and monitoring carried out.

(c) Where the diversion is more than 10 cubic metres per second or the take is more than 500 litres per second pumped, in addition to the features listed in (b)(i) to (vi) above, it will be necessary for the intake to be purpose designed and to consider on a case by case basis whether any additional features will be necessary to ensure fish are prevented from entering the intake.

Note: Submerged galleries (abstracting water vertically) and galleries in the river banks (abstraction water horizontally), or behavioural barriers and devices such as those that use light and sound diversions that may not meet all of the engineering features set out in (2) above, but shall be considered to comply with them where it is demonstrated that they are able to exclude fish to the same degree of effectiveness.

3.16.2 Email response from Southland Regional Council

No response was received.

4 Conclusions

The many issues associated with fish screening, as noted in the introduction, are not evenly represented across councils because surface water takes vary in frequency and complexity across New Zealand. The review of relevant plans from councils around New Zealand has highlighted that, for fish screening, a number of issues and inconsistencies are present. For example, all councils must allow the taking of fresh water for reasonable domestic needs[8], but four councils did not require a fish screen as a condition related to this permitted activity (Table 1). Because these surface water takes are a permitted activity there is no way to know how many of these unscreened surface water takes exist but given these four councils have issued many surface water consents in their regions (see Appendix B) it would be logical to assume that there are also many unscreened permitted takes.

The Jamieson et al. (2007) best practice guidelines have been published and are freely available (see link in Section 3.14.1). Despite being freely available for over a decade, most of the seven criteria considered necessary to maximise fish screen effectiveness are not mentioned in most council plans; see Table 1 for a summary. The most consistent criteria noted in plans was an aperture size requirement although the review also identified that the aperture sizes that are allowed to constitute a fish screen varied more than three-fold around New Zealand. Whilst larger surface water takes should be required to include a fish screen as part of their take, and thus additional fish screening conditions could be included as part of a consenting process, this approach to fish screening has several risks. For example, it could be relatively ineffective if the consent staff have limited experience assessing fish screening applications[9] and this is reinforced by the one of the questionnaire responses "*As far as conditions go we just require fish screening and do not generally require a specific design or type"*. Thus, having prescribed fish screening criteria in a plan should prevent issues relating to inconsistent fish screening as well as providing potential applicants with greater transparency at the start of any consenting process. The cost of a correctly designed and installed fish screen can be highly variable, but it is important that applicants are aware that it will be a requirement — the questionnaire response from Hawke's Bay Regional Council (HBRC) about resistance to fish screens from applicants cites cost as an issue and this is perhaps more understandable when the plan notes that HBRC may apply its discretion to "the need for fish exclusion devices or screens". In contrast, the very prescriptive fish screening schedule used by Environment Canterbury provides clarity for applicants that they must be including (and therefore budgeting) an appropriate fish screen as part of their consent application.

From the questionnaire responses received, no councils had required any testing to prove whether the fish screen that had been installed was effective (or not) – although it is known to the author that Environment Canterbury require this to be done in certain instances. A lack of monitoring has previously been highlighted in relation to fish passage solutions (e.g., no follow-up monitoring after a presumed 'solution' has been installed) and an argument could easily be made that this same requirement should be applied to fish screening. For example, there are numerous instances in Canterbury where a fish screen installer has not correctly followed the approved fish screen design and/or the novel fish screen design is unproven – both situations would warrant effectiveness testing.

[8] This is a requirement outlined in section 14 of the Resource Management Act (1991).

[9] Only one respondent identified fish screening knowledge gaps in their response which could suggest that staff may not be particularly familiar with fish screening issues – this would not be surprising given it has not received significant attention for many years.

Table 1: Summary of the fish screening requirements in the statutory plans of councils from around New Zealand. For councils where proposed plans require fish screening these are shown in the table.

Council	Screen on minor takes	Site location	Screen aperture		Approach velocity	Sweep velocity	Bypass provision	Bypass connectivity	Operation & maintenance	Individual consents reference guidelines	Notes
			Tidal river[1]	Other rivers							
Northland Regional Council	Yes	-	≤1.5 mm[2]	≤3 mm[2]	<0.12 m/s[2]	-	-	-	-	?	
Auckland Council	Yes	-	≤1.5 mm	≤1.5 mm	<0.3 m/s	-	-	-	-	?	
Waikato Regional Council	Yes	-	≤1.5 mm[3]	≤3 mm[3]	<0.3 m/s	-	-	-	-	?	
Bay of Plenty Regional Council	Yes[4]	-	≤3 mm	≤5 mm	<0.3 m/s[5]	-	-	-	-	?	
Gisborne District Council	Yes	-	≤3 mm	≤5 mm	<0.3 m/s	-	-	Yes	Yes	?	
Hawke's Bay Regional Council	No	-	-	-	<0.3 m/s	-	-	-	-	Yes	
Taranaki Regional Council	No	-	-	-	-	-	-	-	-	?	
Manawatu-Wanganui Regional Council	Yes	-	≤3 mm	≤3 mm	<0.3 m/s	-	-	-	-	?	6
Greater Wellington Regional Council	Yes	-	≤3 mm[7]	≤3 mm[7]	-	-	-	-	-	?	
Tasman Regional Council	Yes	-	<5 mm	<5 mm	<0.3 m/s	-	-	-	Yes	?	
Nelson City Council	Yes	-	<1.5 mm	<1.5 mm	0.5 L/s (?)	-	-	-	-	?	
Marlborough District Council	No	-	-	-	-	-	-	-	-	Yes	
West Coast Regional Council	Yes	-	-	-	-	-	-	-	-	?	8
Canterbury Regional Council	Yes	Yes	≤2 mm	≤3 mm	<0.12 m/s	Yes	Yes	Yes	Yes	Yes	
Otago Regional Council	No	-	-	-	-	-	-	-	-	Yes	9
Southland Regional Council	Yes	Yes	≤2 mm	≤3 mm	<0.12 m/s	Yes	Yes	Yes	Yes	Yes	10

[1]Also coastal rivers in some plans (e.g., <2 km from sea), [2]operative plan aperture ≤5 mm, sweep velocity <0.3 m/s, [3]for significant indigenous fisheries and fish habitat, otherwise 3 mm (<100 m.a.s.l) and 5 mm (<100 m.a.s.l), [4]under a current Plan Change this would be removed, [5]specified as 'velocity through the screen', [6]for larger takes council control the screening requirements, [7]operative plan has no mesh size specified – values are from the proposed plan, [8]previous Plan use to have more prescriptive fish screening criteria, [9]a standard consent condition is applied that is aligned with Jamieson et al. (2007) guidelines, [10]under the operative plan only the presence of a fish screen is required.

5 Summary

As a starting point for the Adoption of Good Practice Fish Screening project, this review has identified several key points:

- Council regulations pertaining to fish screening are highly variable across New Zealand ranging from nearly absent to highly prescriptive;
- Four councils require no fish screening of smaller surface water takes;
- The effectiveness of fish screens is largely untested around New Zealand;
- The lack of adoption of the Jamieson et al. (2007) guidelines into the majority of the council plans warrants further investigation. There may be a number of impediments across councils to more prescriptive conditions being included in plans. Coming up with viable national-scale solutions needs to better understand these issues (which would also be helped by input from more councils);
- It is considered likely that some councils/staff are not aware of the importance of fish screening and that better communication pathways relating to future findings from the current project will be needed if the project is to be effective;
- As identified by one questionnaire respondent, if the current guidelines are not safeguarding fish appropriately then the project needs to think about how other options could be applied as a consent condition(s) to reduce any effects on fish because of the length of time it takes to change regional plan rules.

6 Acknowledgements

Thank you to the regional council staff who responded to the email questionnaire – they have been kept anonymous as no staff replied explicitly stating whether or not they were happy to be named. Jade Arnold is thanked for her assistance with reviewing some of the council plans.

7 References

Bonnett, M.L., Bowie, S., Meredith, A., Reese, P., Webb M. (2014) Findings from field investigations of six fish screens at irrigation intakes. *Prepared for Irrigation New Zealand*. NIWA Client Report CHC2014-045. 37 p.

Dunn, N.R., Allibone, R.M., Closs, G.P., Crow, S.K., David, B.O., Goodman, J.M., Griffiths, M., Jack, D.C., Ling, N., Waters, J.M., Rolfe, J.R. (2018) Conservation status of New Zealand freshwater fishes, 2017. *New Zealand Threat Classification Series 24*. Department of Conservation, Wellington. 11 p.

Jamieson, D., Bonnett, M.L., Jellyman, D.J., Unwin, M. (2007) Fish screening: good practice guidelines for Canterbury. Prepared for Fish Screen Working Party. *NIWA Client Report CHC2007-092*. 70 p.

New Zealand Government (2017) *National Policy Statement for Freshwater Management* (2014) (Updated August 2017 to incorporate amendments from the National Policy Statement for Freshwater Amendment Order 2017).

Appendix A Email sent to regional council staff

On behalf of the Fish Screening Working Group, thank you for taking the time to read and respond to this email below.

Who/what is the Fish Screening Working Group? It is a group comprising a range of stakeholders (MPI, MfE, NIWA, some RCs, DOC, F&G, iwi, industry, recreational anglers, Irrigation NZ) that has been meeting approximately monthly for the last year and a half trying to make headway on a range of fish screening issues of national relevance.

We were recently successful in gaining some MPI sustainable farming funding for the work and we had proposed that the first stage of this project would be to widely consult with other councils around the country to summarise existing information on good water intake design that prevents entrainment and impingement of freshwater fish and get their input on what they consider to be the major issues and gaps they are currently facing in this area of water intakes design and maintenance— the outcomes of which will help to inform the technical/science side of the 2-yr programme.

This programme hopes to build on the work previous done to establish Canterbury good practice (see links under Fish screen design for water intakes here https://www.doc.govt.nz/nature/habitats/freshwater/fish-passage-management/resources/) and move towards establishing national guidance. Note, when looking at questions below relating to fish screening we are using that as a general 'catch all' term to describe a suite of issues relating to water intake infrastructure (i.e., intake position, fish bypass, mesh size, maintenance schedules, etc), not just the screen that may be prevent fish from entering an intake or pipe. Just to be clear, this work is not addressing issues with flood pumps or pumping stations but is focussed on fish screening.

As a region dealing with a water abstraction consents we were hoping to get your input on the following:

1) When receiving a consent application relating to fish screening (potentially as part of a larger water-related application), do you feel you have access to sufficient information or guidance documents to assist you in determining whether or not the proposed fish screen is appropriate/fit-for-purpose? If not, what are the major resources/pieces of information you feel are lacking? If yes, what are the key guidance you use?
2) Does the council have specific fish screening criteria identified in its regional plan and if so, what are these criteria? Do you have standardised consent conditions?
3) Are recent consents aligned to the criteria in the plan or are you often faced with needing to examine bespoke solutions on a case-by-case basis?
4) Does your region require fish screens to be tested for effectiveness after being installed, and if so, what measures or information are typically supplied to the council as part of effectiveness testing (in as much as you might be allowed to share such information)?
5) What do you consider to be the key knowledge gaps around fish screening for your region (and more generally if you have additional thoughts that are relevant outside of your region)?
6) Has your region done any fish screen testing or work in the last decade that could contribute (or at least be useful to know about) as we consider whether current guidance documents need updating. Do you have any good examples of water intakes designs that you would suggest are working well?

Council responses to email questionnaire

Hawke's Bay Regional Council

1) When receiving a consent application relating to fish screening (potentially as part of a larger water-related application), do you feel you have access to sufficient information or guidance documents to assist you in determining whether or not the proposed fish screen is appropriate/fit-for-purpose? If not, what are the major resources/pieces of information you feel are lacking? If yes, what are the key guidance you use? *We have referred to the NIWA fish screening good practice guidelines. There has been some debate over the design standards to be applied and the practicality and cost implications of some of the outcomes, particularly given the size of the screens that seem to be required in some cases.*
2) Does the council have specific fish screening criteria identified in its regional plan and if so, what are these criteria? Do you have standardised consent conditions? *No, we don't have any set requirements in our plan at the moment The Water Conservation Order for the Ngaruroro River looks set to contain some design criteria (see Figure 1). This would become the minimum requirement for all intakes within the Ngaruroro River Catchment.*

3) Are recent consents aligned to the criteria in the plan or are you often faced with needing to examine bespoke solutions on a case-by-case basis? *Where these have been required, and as we have no plan guidance, it has been a matter of considering the design proposed, including with advice from our engineers.*

4) Does your region require fish screens to be tested for effectiveness after being installed, and if so, what measures or information are typically supplied to the council as part of effectiveness testing (in as much as you might be allowed to share such information)? *No we haven't to date.*

5) What do you consider to be the key knowledge gaps around fish screening for your region (and more generally if you have additional thoughts that are relevant outside of your region)? *Fish screening hasn't been a major area of focus for us to date. A lot of our takes are from shallow wells or gravel galleries in the stream bed/margin. We've had some resistance to requiring fish screens and have had questions over the fish species and life stages to be designed for, their effectiveness given the costs and practical implications e.g. need for removal and cleaning, how they impact on weed and maintenance activities, and how they can be transported from site to site for irrigators with multiple irrigation sites and point of take.*

6) Has your region done any fish screen testing or work in the last decade that could contribute (or at least be useful to know about) as we consider whether current guidance documents need updating. Do you have any good examples of water intakes designs that you would suggest are working well? *Not that I am aware of.*

Tasman Regional Council

1) When receiving a consent application relating to fish screening (potentially as part of a larger water-related application), do you feel you have access to sufficient information or guidance documents to assist you in determining whether or not the proposed fish screen is appropriate/fit-for-purpose? If not, what are the major resources/pieces of information you feel are lacking? If yes, what are the key guidance you use? *No. This is not an area that we manage very well and we would appreciate more guidance. Part of the problem is that*

we get very few of these consents and I don't always see them. Few would be monitored by compliance.

2) Does the council have specific fish screening criteria identified in its regional plan and if so, what are these criteria? Do you have standardised consent conditions? *The only criteria in the Tasman Resource Management Plan is: "Fish and eels are prevented from entering the reticulation system." The footnote to this about the "means of achieving this is "Installing a screen or screens on the river intake that has a screen mesh size not greater than 5 millimetres and is constructed so that the intake velocity at the screen's outer surface is less than 0.3 metres per second and is maintained in good working order at all times. Other measures to prevent fish entering reticulation systems may also be adopted".*

3) Are recent consents aligned to the criteria in the plan or are you often faced with needing to examine bespoke solutions on a case-by-case basis? *The latter.*

4) Does your region require fish screens to be tested for effectiveness after being installed, and if so, what measures or information are typically supplied to the council as part of effectiveness testing (in as much as you might be allowed to share such information)? *No*

5) What do you consider to be the key knowledge gaps around fish screening for your region (and more generally if you have additional thoughts that are relevant outside of your region)? *It would take a while just to get data on the status of fish screens in the region e.g. how many, what types, what flow rate.*

6) Has your region done any fish screen testing or work in the last decade that could contribute (or at least be useful to know about) as we consider whether current guidance documents need updating. Do you have any good examples of water intakes designs that you would suggest are working well? *No*

West Coast Regional Council

1) When receiving a consent application relating to fish screening (potentially as part of a larger water-related application), do you feel you have access to sufficient information or guidance documents to assist you in determining whether or not the proposed fish screen is appropriate/fit-for-purpose? If not, what are the major resources/pieces of information you feel are lacking? If yes, what are the key guidance you use? *We usually get little if any information on fish screens and would be required to check with our resource science staff to have any idea if information was suitable. A fact sheet would be useful.*

2) Does the council have specific fish screening criteria identified in its regional plan and if so, what are these criteria? Do you have standardised consent conditions? *As far as I know there is nothing specific in our plan. As far as conditions go, we just require fish screening and do not generally require a specific design or type.*

3) Are recent consents aligned to the criteria in the plan or are you often faced with needing to examine bespoke solutions on a case-by-case basis? *N/A*

4) Does your region require fish screens to be tested for effectiveness after being installed, and if so, what measures or information are typically supplied to the council as part of effectiveness testing (in as much as you might be allowed to share such information)? *We do not require testing of fish screens.*

5) What do you consider to be the key knowledge gaps around fish screening for your region (and more generally if you have additional thoughts that are relevant outside of your region)? *We have very little knowledge or expertise in regard to fish screening in our Council or region.*

6) Has your region done any fish screen testing or work in the last decade that could contribute (or at least be useful to know about) as we consider whether current guidance documents need updating. Do you have any good examples of water intakes designs that you would suggest are working well? *No*

Otago Regional Council

1) When receiving a consent application relating to fish screening (potentially as part of a larger water-related application), do you feel you have access to sufficient information or guidance documents to assist you in determining whether or not the proposed fish screen is appropriate/fit-for-purpose? If not, what are the major resources/pieces of information you feel are lacking? If yes, what are the key guidance you use? *We rely on the RSU [Resource Science Unit] team to give guidance on determining whether proposed fish screens are appropriate.*

2) Does the council have specific fish screening criteria identified in its regional plan and if so, what are these criteria? Do you have standardised consent conditions? *Nothing specific in the plan but we have new standard condition, see the wording below:*

A fish screen must be designed and installed that meets the following requirements:

(a) Water must only be taken when a fish screen with a mesh size or maximum slot width of 3 mm is operated and maintained across the full width of the intake to ensure that fish and fish fry are prevented from passing through the intake screen; and

(b) As far as possible, the screen area must be designed to ensure the calculated average through-screen velocity does not exceed 0.12 m/s if a self-cleaning mechanism is in place, or 0.06 m/s if no self-cleaning mechanism is in place.

(c) The sweep velocity parallel to the face of the screen must exceed the design approach velocity.

Prior to installation of any fish screen, a report containing final design plans and illustrating how the screen will meet the required design criteria and an operation and maintenance plan should be provided to the Consent Authority.

3) Are recent consents aligned to the criteria in the plan or are you often faced with needing to examine bespoke solutions on a case-by-case basis? *All fish screens are assessed on a case by case basis but we have the standard condition.*

4) Does your region require fish screens to be tested for effectiveness after being installed, and if so, what measures or information are typically supplied to the council as part of effectiveness testing (in as much as you might be allowed to share such information)? *This is a new process where we require maintenance and inspection records. See the condition wording below:*

The fish screen required by condition 9 must be maintained in good working order, to ensure that the screen is performing as designed. Records must be kept of all inspections and maintenance and these should be made available to the Consent Authority, on request.

5) What do you consider to be the key knowledge gaps around fish screening for your region (and more generally if you have additional thoughts that are relevant outside of your region)? *The key concern is in relation to entrainment of all life stages of Otago non-migratory galaxiids, but particularly larvae. The majority of Otago non-migratory galaxiids are now restricted to small order streams, these streams are generally located at higher altitudes, making access to them difficult, limiting routine maintenance. They tend to be hydrologically steep and receive bed moving flows making the need for regular maintenance. The takes associated with these waterways are generally small (10-20l/s) and there existing water take structures tend to be of a 'No 8 wire" type design. Shifting into new fish screens and the associated cost with some screen designs, has given rise to significant concern with many abstractors as the cost can outweigh the financial benefit of the water. I appreciate that this is an abstractor decision but in some cases we need this water to be taken as the removal of this water is the only mechanism limiting the invasion of salmonids.*

   Is there low-cost practicable designs that a farmer can install , that are proven to be effective?

6) Has your region done any fish screen testing or work in the last decade that could contribute (or at least be useful to know about) as we consider whether current guidance documents need updating. Do you have any good examples of water intakes designs that you would suggest are working well? *Sadly no.*

Appendix B Surface water consent numbers by region and primary use

Region	Drinking	Flood control	Hydro	Industrial	Irrigation	Not specified	Stock	Total
ARC	16			16	131		7	170
EBOP	22		7	36	285		2	352
ECan	68		13	38	948		60	1,127
ES	42	1	5	34	14		27	123
EW	103	7	17	104	180		18	429
GDC	3				56			59
GWRC	21		3	8	165		7	204
HBRC	18		2	22	212		1	255
HRC	49		24	33	176	1	96	379
MDC	60		2	17	511			590
NCC	4			2	4		1	11
NRC	54		8	18	146		4	230
ORC	118	3	33	107	1,049		6	1,316
TDC	33		6	15	254		3	311
TRC	21		6	48	67		7	149
WCRC	46		25	224	25			320
Total	**678**	**11**	**151**	**722**	**4,223**	**1**	**239**	**6,025**

Data source: Ministry for the Environment, Appendix C - Part 1: Water allocation - Consent database summaries and comparisons.

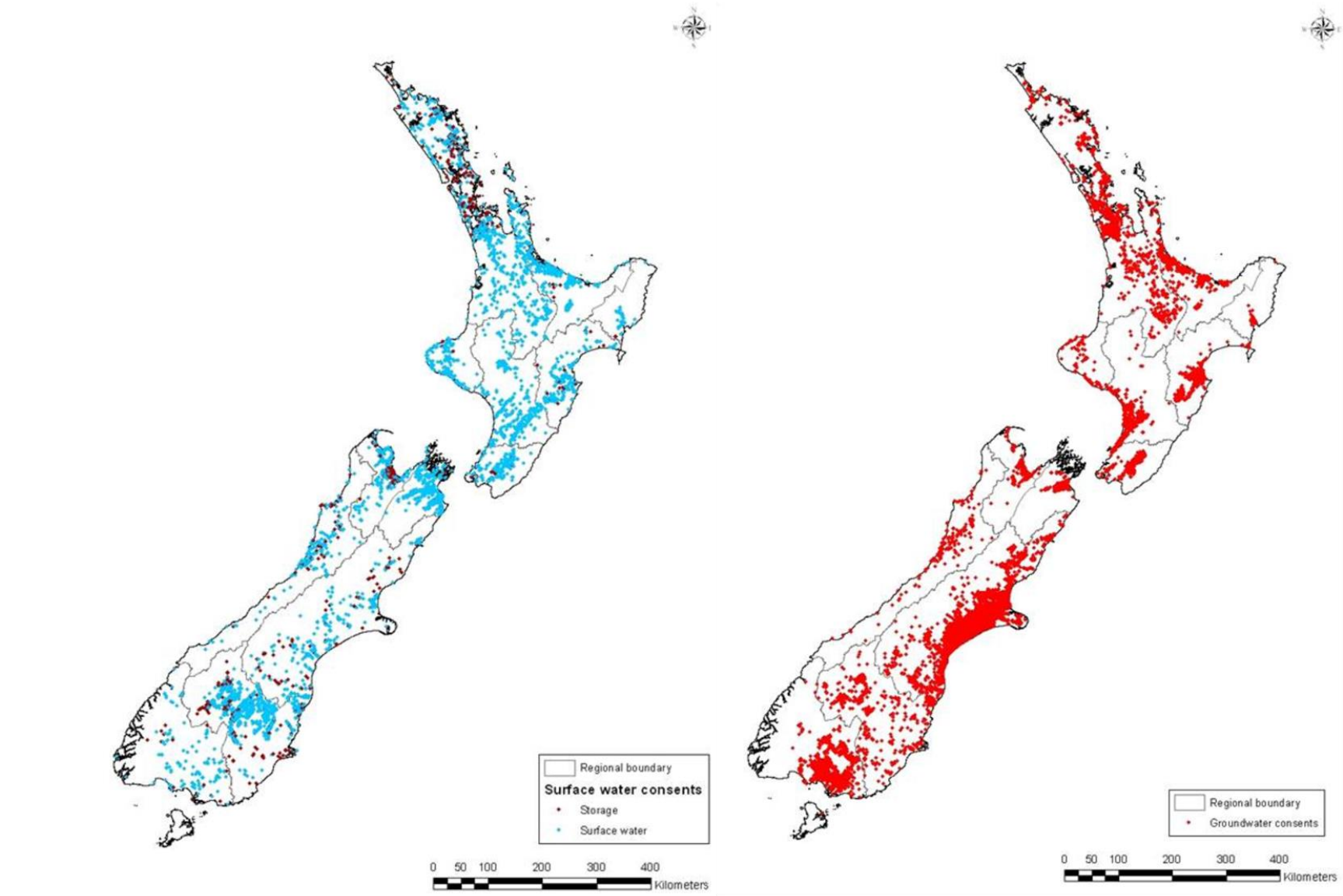

Figure A1: Distribution of surface (left) and groundwater (right) consents around New Zealand.