SFF Project:405972 Adoption of Good Practice Fish Screening Project

Policy and Practice

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INTRODUCTION

Surface water is diverted and abstracted routinely across New Zealand to be utilised for such things as hydroelectricity, irrigation, industry, stock-water, and domestic purposes. Some of these are many thousands of litres per second and from large rivers and lakes, and some are only a few litres per second and from small rivers. However, all these diversions and abstractions have the potential to entrain and kill fish and hence endanger sensitive freshwater fish populations. The following paper provides background into the legislation that protects freshwater fish from the impact of diverting and abstracting water from rivers and lakes in New Zealand, with specific reference to fish screening practices and the lessons learnt in Canterbury.

This paper covers:

1. Legislative context - who manages fish screening?
2. Regional policy and plan development
3. Tangata Whenua as a partner
4. Implementation - lessons from Canterbury
    - resource consents
    - standard condition set
    - compliance
5. Issues and risks

1. LEGISLATIVE CONTEXT - who manages fish screening?

All freshwater fish in New Zealand are governed by the Conservation Act 1987 (CA87), which includes the Freshwater Fisheries Regulations 1983 (FFR83),[1] the Fisheries Act 1983 and specific responsibilities including protecting freshwater habitats,[2] and advocating for aquatic life and freshwater fisheries generally.[3] (The Conservation Act does not encompass functions relating to freshwater quota fisheries, these are managed under the Fisheries Act, 1996). These functions are managed by a number of organisations including the Department of Conservation (DOC), Ministry for Primary Industries, and Fish and Game New Zealand. The Ministry for the Environment and Regional Councils also have freshwater management responsibilities under the Resource Management Act 1991 (RMA91). Regarding fish screening more specifically, Regional councils and DOC are the primary governing entities with specific responsibilities. Regional councils gain these responsibilities through the RMA91 and DOC through the FFR83.

Resource Management Act 1991

The purpose of the RMA91 is to promote the sustainable management of natural and physical resources, while safeguarding the life-supporting capacity of air, water, soil and ecosystems, and avoiding, remedying and mitigating any adverse effects of activities on the environment. No person may undertake an activity that contravenes a national environmental standard or a regional rule unless the activity is allowed by a resource consent, or the activity is allowed for under other parts of the RMA91 (e.g. when water is required to be taken or used for individual's reasonable domestic needs, an individual's animal's drinking water, or for firefighting purposes).

Under section 13 and 14 of the RMA91, regional councils control effects relating to the use of water and waterways by placing restrictions on certain uses of beds of lakes and rivers (e.g. the use, construction and/or removal of structures in rivers and stream beds and/or avoiding, damaging or removing habitats of animals in, on or under the bed of a lake or river), and restrictions relating to water (e.g. the take, use, damming or diversion of water). Environmental effects relating to structures in river and stream beds are, therefore, controlled under the

[1] Subsidiary legislation administered under section 48(a) of the CA87.

[2] Section 6(ab) of the CA87

[3] Section 53(3)(d) of the CA87

RMA91, and these include consideration of the habitat of aquatic and terrestrial flora and fauna, and fish screening (by implication).

Regional Councils

Regional councils are responsible for implementing the requirements of the RMA91. This is primarily undertaken by developing regional policy statements, regional plans and the issuing of consents under the RMA91. The role of regional councils in relation to fish screening is primarily to ensure that any adverse effects on freshwater fish species caused by diverting or taking water is minimised. It is important to recognise that regional councils are also expected to assess the environmental impacts of fish screens and take the necessary actions to avoid remedy or mitigate any potential negative effects related to their implementation and ongoing operation.

Regional policy statements provide an overview of the resource management issues of a region, and objectives, policies and methods to achieve integrated management of the natural and physical resources of that region.

Regional plans set rules governing the use of resources within the region. Some activities, including most activities in the bed of a lake or river and the taking, using, damming or diverting of water, require express authorisation by a regional plan or resource consent. Other activities, such as the use of land, only require resource consent if they breach a national environmental standard or a rule in a regional or district plan. Rules implemented in regional plans can include the consideration of fish screening, and protection of areas of significant habitats for indigenous fauna. Regional plans usually require the installation of fish screens for most water takes and diversions. These plans can include specific guidelines and regulations to follow depending on the size and scale of the take or diversion activity.

National Direction

Regional plans and policy statements must give effect to any national policy statements, and be consistent with national regulations (such as national environmental standards).The Essential Freshwater package, which includes the National Policy for Freshwater Management 2020 (NPS-FM) and the National Environmental Standards for Freshwater (NES-F), is a package of such documents which outlines general guidance, and specific regulations, relevant to the management of freshwater New Zealand wide. Only once in this package is fish screening mentioned directly, however, the conceptual framework of Te Mana o Te Wai, which is an overarching requirement for the management of New Zealand’s

freshwater, requires that the health and well-being of water bodies and freshwater ecosystems are prioritised above and beyond anything else, including economic well-being (which is included under the third and last priority of Te Mana o Te Wai). In order to ensure that Te Mana o Te Wai is given effect to, when building instream structures that may have an effect on freshwater fish species, the well-being of the ecosystem (and therefore the fish) must be prioritised above economic well-being. Including a suitable fish screen could be a way to ensure this.

The NPS-FM establishes ecosystem health as a compulsory national value and sets out a requirement to maintain or improve ecosystem health (and other values) in relation to freshwater. Instream structures are a pressure on ecosystem health and can have significant adverse effects on fish and other aquatic species if not installed with the correct precautionary measures. Consequently, as the requirements of the NPS-FM are progressively implemented by national and regional government agencies, fish screens and other precautionary measures are likely to receive increasing focus.

Section 55(5)(f) of the NES-F requires that a fish screen with mesh spacing no greater than 3mm must be used on any intake related to an inland wetland if the activity is a diversion that uses a pump. This is the only direct requirement for a fish screen in the NES-F which primarily focuses on allowing for fish passage. Because the NES-F is guided by the NPS-FM, which also guides regional plans, the exclusion of significant fish screening direction alludes to the fact that fish screens are primarily managed at a regional scale. Because of this, it is essential to refer to local regional plan policies and rules to understand local legislative requirements and responsibilities in relation to fish screens.

Freshwater Fisheries Regulations 1983 and Department of Conservation

The FFR83 includes the following definitions:

*"**fish facility** means any structure or device, including any fish pass or fish screen inserted in or by any water course or lake, to stop, permit, or control the passage of fish through, around, or past any dam or other structure impeding the natural movement of fish upstream or downstream".*

"*fish screen* *means any device whether moving or stationary designed to impede or stop the passage of fish*".[4]

[4] Freshwater Fisheries Regulations 1983 Clause 2(1)

Part 6 of the FFR83 includes the specific responsibilities of DOC in relation to fish screening. These apply to all natural rivers, streams or other freshwater bodies but are limited to physical barriers, i.e. dams and diversion structures. Within these regulations, fish screening is referred to both directly and indirectly through the use of the phrase fish facility (which includes fish screens as per the definition provided above). DOC's responsibilities under the FFR83 include:

- DOC may require that any dam or diversion structure to be built has a fish facility included, and set conditions on their design and performance (regulations 43 & 44).[5]
- If a fish facility is required:
    - Every manager of a dam or diversion structure shall ensure the structure maintains adequate flow through or past, so it functions as specified at all times or periods specified within their control (regulation 45).
    - DOC may require that any fish facility undergo maintenance or repairs (regulation 46).
- It is an offence for anyone to injure or damage a fish facility (regulation 47).
- Approval is required for any person to make a structural change to a fish facility (regulation 48).
- Any DOC officer may inspect a fish facility (regulation 49).
- No person, other than a DOC officer acting in their official capacity, shall take, obstruct, contrivance or imped a fish on its passage through or past a fish facility (regulation 50).[6]

In order to interpret when these fish screening statutory requirements apply in relation to regulations 43 and 44 of the FFR83, it is important to understand the definitions of dam and diversion structure. Under the FFR83, these are defined as follows:

- **Dam**: any structure designed to confine, direct, or control water, whether permanent or temporary; and includes weirs.[7]
- **Diversion structure:** any structure designed to divert or abstract natural water from its natural channel or bed whether permanent or temporary.[8]

These definitions are intentionally broad, and as such, many instream structures (e.g. floodgates, tide gates, pumping stations and water intakes) will likely meet the definition of a

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[5] Subject to the RMA91 and any determination under that Act

[6] Except when provided for by the Director-General in writing to the manager of the fish facility.

[7] Freshwater Fisheries Regulations 1983 Clause 2(1)

[8] Freshwater Fisheries Regulations 1983 Clause 2(1)

dam or diversion structure. If so, these structures will be subject to the statutory requirements of Part 6 of the FFR83. An example of this would be a floodgate which can be opened or closed to admit or exclude water. Because this floodgate is 'controlling water', it would be considered a dam and would be subject to Part 6 of the FFR83.

The FFR83 regulations came into force on 1 January 1984, so generally apply to all structures built after 1 January 1984. These regulations apply to all dams or diversion structures in any natural river, stream or water, but exclude:

- Any net, trap, or structure erected and used solely for the purpose of taking or holding fish.
- Any dam constructed on dry or swampy land or ephemeral water courses for the express purpose of watering domestic stock or providing habitat for water birds.
- Any water diversion not being incorporated into or with a dam, that is solely and reasonably required for domestic needs or for the purposes of watering domestic stock and that empties, without dead ends, into any viable fish habitat.
- Any dam or diversion structure subject to a water right issued under the provisions of the Water and Soil Conservation Act 1967 (prior to 1 January 1983) or any structure authorised by a Regional Water Board not requiring a water right that in no way impedes the passage of fish. This Act was the primary legislation governing the use of water resources prior to the enactment of the RMA91.

Other Statutory Requirements

In addition to those administered under the RMA91 and the FFR83, it should be noted that there are other statutory requirements that need to be considered in any proposals for development and management of physical structures (including fish screens). These include:

- Design integrity for intended purpose and on-going management of structures and assets (e.g. Building Act 2004, Railways Act 2005, RMA91, Local Government Act 2002).
- Land status (such as landowner approval for any works on their property and on special status areas, e.g. Reserves Act 1977).
- Protection of species and habitat, for instance section 26ZJ of the CA87 which provides that it is an offence if any works (e.g. installing a structure into a waterway) disturb or damage spawning grounds of any freshwater fish; or regulation 70 of the FFR83, which makes it an offence to intentionally kill or destroy indigenous fish.
- Fish salvage, which can often be required in construction projects within waterways. If, during any fish salvage or translocation, someone wishes to transfer and release fish into any freshwater, they are likely to require approval under section 26ZM of the CA87 and/or regulation 59 of the FFR83.

- The requirement to manage for ecosystem health under the National Policy Statement for Freshwater Management (NPS-FM).
- The role of the Ministry of Fisheries in the Fisheries Act and management of quota species if a structure impedes or affects these species.

It is important to consider all of these factors when installing, maintaining or altering instream structures in New Zealand waterways.

In summary, New Zealand fish screening regulations and requirements aim to prevent fish from entering dams, diversion rivers, or other man-made waterway structures. Regional councils and DOC are the primary governing entities in relation to this topic and have specific responsibilities which they gain through the RMA91 and FFR83 respectively. Tangata Whenua at a national level via the Treaty Settlement Act and planning instruments have a significant role to play. It is likely that approval would be needed from both the relevant regional council and DOC as a minimum for the installation, maintenance, or alteration of instream structures in New Zealand waterways. When doing works in any waterway, it is best to contact the relevant authorities to check legislative responsibilities, as legislation and interpretation of legislation can change over time. If you are planning on installing any new instream structures, or altering existing structures, it is recommended that you contact your closest DOC permissions team, local runanga or representative agency, local Fish and Game and your Regional Council.

2. REGIONAL POLICY AND PLAN DEVELOPMENT

It is the responsibility of regional councils to carry out the obligations required by higher order documents outlined above - principally those dictated by the RMA91.

The primary way to do this is through the development of Regional Policy Statements and Regional Plans required by s59-70 of the RMA91. Regional Policy Statements take a wider overview of the resource management issues within a region and play a role of setting the scene with respect to what needs to be achieved, whereas Regional Plans drill down into more specifics matters through the development of Objectives, Policies and Methods (e.g. rules and advocacy) that are specific to a region or sub-region. A Regional Plan is designed to manage the issues identified in a Regional Policy Statement. Both Regional Policy Statements and Regional Plans are developed through a public process prescribed in Schedule 1 of the RMA91.

Regional Plans have a single purpose, and that is to assist a regional council to carry out any of its functions to achieve the purpose of the RMA91 - that is to promote the sustainable management of natural and physical resources as set out in Part 2.

With respect to fish, Regional Policy Statements, being higher order documents, typically contain issues, objectives, policies and methods which are designed to manage the *wider* environment within a region, so typically do not specify fish protection as a requirement per se. Rather they refer to managing the wider freshwater environment that fish inhabit - and within that they set issues, objectives, policies and methods that are relevant to things like aquatic ecosystems, beds of rivers and lakes, etc (i.e. fish habitat, rather than the fish themselves). The methods specified in a Regional Policy Statement typically involve preparing district and regional plans to ensure the regional issues, objectives, and policies are achieved. Multiple objectives, policies and methods can be developed to manage a single issue. However, the National Policy Statement for Freshwater Management (2020) and the National Environmental Standards for Freshwater have addressed fish passage as a significant issue that must be considered in regional policy statements and processes, largely because regional instruments to date have not adequately identified or acknowledged these matters, this will be an important aspect of planning and policy process going forward, particularly in Canterbury.

A brief example:

Issue - manage adverse effects of activities on freshwater ecosystems.

Objective - the sustainable management of freshwater.

Policy - enhancing freshwater environments and biodiversity.

Method - Regional and District plans will identify and protect sites and areas with threatened flora or fauna

While managing effects on fish can traverse a wide range of subject matters dealt with in a Regional Policy Statement, such as infrastructure management like hydro-electric dams or irrigation systems, it is the provisions directly relating to fish habitat, such as ecosystems and indigenous biodiversity, that form the core of how to manage potential adverse effects on fish.

However, to achieve any sort of desirable outcome within a region, it is critical that through the development of a Regional Policy Statement and Regional Plan, there is direct line of sight from the top to the bottom. In other words, to manage an issue within a region, such as the effects of activities on freshwater, there must be a direct link from issue identification to the methods used. For example, it should be obvious to anyone who reads the document,

particularly a resource user or council officer, what prescribed method of fish screening needs to be followed in any location to ensure there are no adverse effects on freshwater ecosystems.

While the above model appears intuitive and the legislative steps are set up to achieve the purpose of the RMA91 - that is sustainable management - unfortunately, despite many Regional Policy Statements and Regional Plans having laudable objectives and policies and methods, the results have not been delivered. This has largely been due to the failure of councils to require the necessary range of methods as well as a failure to implement the methods successfully. For fish, the result has been a plethora of poor fish screens.

Speeding up council planning processes - A new streamlined freshwater planning process was introduced in 2020 as part of several amendments to the Resource Management Act 1991 (RMA).

It must be followed by regional councils and unitary authorities when preparing, changing, or varying regional policy statements and regional plans (freshwater instruments) that give effect to any national policy statement for freshwater management, or otherwise relate to freshwater. This includes giving effect to Te Mana O Te Wai, as required under the National Policy Statement for Freshwater Management 2020.

Regional councils and unitary authorities are required to have amended freshwater policy statements and plans notified by the end of 2024, and operational by 2026.

3. TANGATA WHENUA PARTNERSHIP

The role of Tangata Whenua as partners needs to be reflected from the top to bottom in the development of better freshwater fish management. Engagement needs to occur early to ensure adequate protection of fish by resource users are put in place throughout the policy and plan development process - from objective setting, policy making, right through to setting the rule framework and consents and compliance.

Those that hold mana whenua for a particular area need to have input into all facets of the process. Where a proposal to abstract water has the potential to affect a freshwater toanga and mahinga kai species, consent applicants need to be advised to engage with their local rūnanga representatives *before* applying for any resource consent to ensure their views are taken into consideration when designing a fish screen. Reliance on regional councils to drive mana whenua input into an individual proposal while a resource consent is being processed is not acceptable. In accordance with schedule 4 of the RMA91, it needs to be done prior to a

consent application being submitted including giving effect to Iwi Management Plans and Iwi Fisheries Strategies.

4. IMPLEMENTATION - Lessons from Canterbury

In the context of this fish screen paper, implementation means processing resource consents in accordance with the regional planning framework, and the undertaking of compliance activity that is meaningful and resulting in correct fish screening practices being put in place to protect fish. This, in-turn, should deliver on any objective in a regional plan to protect and enhance freshwater ecosystems and deliver on Part 2 of the RMA91, provided there is an appropriate regional planning framework in place, which in terms of fish passage there has not been.

The design, construction and maintenance of a fish screen are critical steps if effective fish screening is to be delivered. Designing, building, and managing infrastructure to ensure fish are prevented from being removed from their natural environment is technically challenging. The dynamic nature of New Zealand's rivers and streams, combined with the varying habitat that both native and sports fish coexist in, make designing, constructing, and maintaining effective fish screens complicated. To emphasise the challenge, it is worth describing the issues associated with taking water from a river through a system that protects fish.

An example - for abstractions from larger generally braided rivers, of which there are many in the drier areas of New Zealand such as Canterbury, Otago and Hawkes Bay, a fish screen placed in the active channel will need to be protected by natural or heavily engineered protection structures, or able to be designed to be removed from the water before flood and fresh events, to prevent it being damaged by mobile bed material. Protected and removable screening structures have not been widely considered in New Zealand to date, despite being used elsewhere in the world.

Diversions have more commonly been constructed and maintained with heavy machinery within the braided riverbed to ensure water is consistently directed out of the river to the point of take. To date, abstraction and screening facilities have therefore generally been constructed in more stable locations usually on a berm adjacent to the braid-plain. The significant diversion therefore needs to be re-connected back to the active channel in the riverbed downstream to ensure fish can freely move up and down the river and are not stranded or trapped within or along the diversion. A fish screen capable of removing only water (not fish and debris) without significant blocking or clogging with debris then needs to be designed, built, and maintained

on the bypass channel. The screen must be of a size that can abstract water needed for water supply, as well as ensure all sizes of fish cannot pass through it, are not impinged against it, are not damaged by contact with it, and move past it without excessive stress or exercise. Diversions may need to provide a working head at the intake site and be far enough away from the active riverbed to avoid flood risks and can therefore be highly invasive on a waterbody, and to ensure connected fish passage involves diverting a great deal more water than is needed for the actual water abstraction. The length, maintenance, and connectivity of bypass channels are just one of the many fish screening challenges that needs to be overcome.

A critical consideration is therefore the cost and complexity of diversion abstraction/screening facilities compared to screening facilities close to or within rivers.

Canterbury

Approximately three quarters of all irrigation water abstracted in New Zealand is abstracted in Canterbury. Irrigation is a key part of agricultural development in the region and the bulk of the water is delivered by surface water abstraction through large irrigation schemes. There are approximately 920 water takes that require fish screens in Canterbury, of which over 680 are for water takes greater than 10L/s. However, 85% of all water taken by volume, is from 50 large surface water abstractions. These take water at a rate of 10-40m^3/s and are located on six large, braided rivers being the Waitaki, Rangitata, Rakaia, Waimakariri, Hurunui and Waiau uwha.

Fish screens have been required for water takes by various legislation but have been more common since the first regional plan was proposed in 2004. In 2005, the Canterbury Regional Council established the Fish Screen Working Party. This was a collaborative exercise with Irrigation New Zealand, Fish and Game New Zealand, and the Department of Conservation to prepare a set of good practice guidelines[9] to provide advice to assist in improving outcomes for fish and provide guidance on how to design, build and maintain an effective fish screen for a variety of sized water takes.

The Canterbury Good Practice Guidelines 2007 have helped considerably to lift the standard of fish screen design in Canterbury. They are the first set of standards for fish screen design in New Zealand and have been widely used, both within Canterbury and in other regions. However, outside of Canterbury policies and rules required to ensure good fish screening

[9] Fish Screening: good practice guidelines for Canterbury, NIWA Client Report: CHC2007-092, October 2007, NIWA Project: INZ006501

practices are implemented across New Zealand remains ad hoc and largely inconsistent, with some council's not requiring small water takes to be screened for fish at all.[10]

In an effort to prescribe critical design elements for fish screens, key design criteria from the Good Practice Guidelines were incorporated in the Canterbury regional planning framework, first as Schedule WQN12 in the Natural Resources Regional Plan (NRRP) Chapter 4 (proposed 2004-operative 2012), and then as Schedule 2 in the Canterbury Land and Water Regional Plan (CLWRP) in 2015 (Appendix 1) and similar schedules in other plans (i.e. HWRRP).

Schedule 2 of the CLWRP translates the Good Practice Guidelines into specific criteria that needed to be met for any water permit application that requires a fish screen. Schedule 2 presented approaches for small, medium and large scale abstractions/screens. This acknowledged the increasingly complex issues with designing screening facilities on larger abstractions.

In practice, implementing Schedule 2 has been difficult, especially for larger water takes of more than 500L/s. This is primarily because it is a significant engineering exercise to construct a mechanical screen that meets the Schedule 2 design criteria for larger water takes. Irrigation schemes often opted to consider 'novel' designs, such as BAFF technology, submerged rock infiltration galleries or rock bunds. 'Novel' screen technologies were provided for in Schedule 2 of the CLWRP, if they can demonstrate the same degree of effectiveness as a mechanical screen that meets the specific design criteria in the schedule. However, such demonstration has proven to be very difficult, and in most cases has not been shown to be effective.

The types of screens that can more easily meet the guidelines are physically engineered concrete and/or steel mechanical facilities where the seven criteria specified in Schedule 2, such as mesh size, approach velocity, and sweep velocity, can be calculated, designed, and built into the structure. This means the intake infrastructure, including the fish screen design and bypass, can be submitted with any water permit application, or after the water permit is granted but prior to water being abstracted, and can be assessed largely from a design criteria. Such "design" rather than "effectiveness testing" approaches have also been adopted for fish screening controls throughout most of the world.

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[10] Status Report Summarising Fish Screening Issues across New Zealand prepared for Irrigation NZ and MPI February 2020; P.G. Jellyman; NIWA Client Report 2020027CH; https://www.irrigationnz.co.nz/Attachment?Action=Download&Attachment_id=680

No ‘novel’ non-mechanical screen, of which there are several in Canterbury, has been able to demonstrate they achieve the same degree of effectiveness as a mechanical screen designed in accordance with the seven specific Schedule 2 criteria. One key reason for this is that field tests involving live sportsfish have proven to be expensive to undertake and with poor resolution. Conversely, in other incidences field tests have more easily proven some ‘novel screens’ are demonstrably ineffective, showing fish or fish sized particles readily pass through the facility. Laboratory tests show effectiveness for excluding native fish is even more difficult to achieve and is more difficult to demonstrate in the field, than sportsfish.

Further, physical measurements of the required criteria, as well as theoretical calculations where physical measurements cannot be undertaken, have proven to be difficult or inconclusive in demonstrating effectiveness. Maintenance is another key issue, with rock bund and gallery screens blocking up and having to be de-silted and, in many cases, de-constructed and rebuilt several times per year, often without ceasing the water take. Finally, and perhaps most tellingly, is that sports and native fish are invariably found in the irrigation races and canals behind many of the large ‘novel’ rock bund type screens, showing significant numbers have passed through the screens.

This has resulted in the Canterbury Regional Council now publicly notifying and not supporting applications for any new ‘novel’ rock bund or gallery screen designs on the basis they have adverse effects on fish, particularly native fish that cannot be managed.

Resource Consents

Typically, fish screens are a requirement expressed in condition(s) on a water permit (resource consent) to mitigate any adverse effects of the take of water on fish. Water permits are granted pursuant to s14 of the RMA91 which deals with restrictions relating to water. Section 14 is considered a *restrictive* provision, meaning a person is prohibited from taking, using, damming, or diverting any water unless expressly allowed by a national environmental standard, a rule in a regional plan or a proposed regional plan for the same region (if there is one), or a resource consent, other than for an individual’s reasonable domestic needs; or the reasonable needs of a person’s animals for drinking water.

This effectively means that under the RMA91, unless it is expressly permitted in a plan, a resource consent is required for *all* water takes other than for small amounts for domestic use or farmed stock drinking water needs.

When applying for a resource consent to abstract water all potential adverse effects are required to be addressed. The affects assessment is largely dependent on the environment where the activity takes place. For example, if a water take proposal was in a highly valued waterway with significant ecological sensitivities and rare fish, it is expected that any consent application will undertake a detailed ecological assessment and include methods to avoid, remedy or mitigate any identified effects (such as a comprehensive fish screen proposal). However, if the proposal was in a degraded waterway with no fish present, or of a relatively small scale, then less detail and mitigation may be required.

Historically, the potential effects on fish from water abstraction has received scant attention. While considered in resource consent processes, it was typically only large water takes that were required to install fish screens and through the advocacy work of Fish and Game New Zealand, these were often focused more on the risks posed to sports fish (trout and salmon), rather than native fish. Further, the fish screens were often poorly designed and contained design features focused on keeping fish and debris out of the irrigation canals and races themselves, but not necessarily on returning fish unharmed to the waterways through careful bypass and fish passage management. Many consent conditions were very basic in nature, and while fish may have been physically prevented from going down canals and races, they were often killed by being impinged on screens due to very high through screen velocities when screens were placed at right angles to the flow direction with little or no bypass, or stranded in bypass channels that failed to connect back to the main river.

Standard consent conditions

To assist consent applicants and experts in their efforts to design effective fish screens the Canterbury Regional Council, with input from the Canterbury Fish Screen Working Party, has developed a set of draft ‘standard consent conditions’ (Appendix 2). These conditions can be placed on water permits to ensure more effective mitigation is achieved with respect to any potential adverse effects on fish.

The draft standard conditions cover both smaller water takes (typically less than 100L/s) where the screen is placed over a pipe that pumps water directly from a river, as well as larger ones, where water is diverted down a side channel along the berm of a river and an open water take established on the diversion.

The draft standard conditions have been carefully worded to ensure the design of the fish screen meets the seven key effectiveness criteria specified in the Good Practice Guideline’s and Schedule 2 of the CLWRP. The conditions cover the design, installation and maintenance

of a fish screen and allow for flexibility for consent holders to install a variety of mechanical screen types depending on the physical characteristics of the location and the consented abstraction rates.

The draft standard conditions included could be considered for use in other similar irrigation/water takes and may be adopted for a resource consent application or by a consenting authority in most New Zealand regions. They have been developed to put the Good Practice Guideline's into practice, however there are a number of variations on physical and regulatory conditions depending on the abstraction, its location and other factors. The draft standard conditions are not 'formally endorsed' by the Fish Screen Working Group but are offered as an example of a set of conditions that may inform consent applicants and regulators in other regions.

Compliance with existing fish screens

Due to the concerns raised above, in 2018, a compliance investigation was undertaken into 32 fish screens. The results showed a significant level of non-compliance and poor design and maintenance resulting in 90% being deemed ineffective.[11] Following this, in 2019, a dedicated fish screen compliance programme was put in place and a five year plan was developed to improve fish screening practices in Canterbury.[12] This involves prioritizing the largest screens to ensure 95% of all the surface water allocated has been checked over the period, and ensuring each ineffective screen has a dedicated action plan to bring it up to standard (Figure 1).

[11] https://www.ecan.govt.nz/document/download?uri=3481187

[12] https://www.ecan.govt.nz/get-involved/news-and-events/2017/fish-screens-whats-the-story/

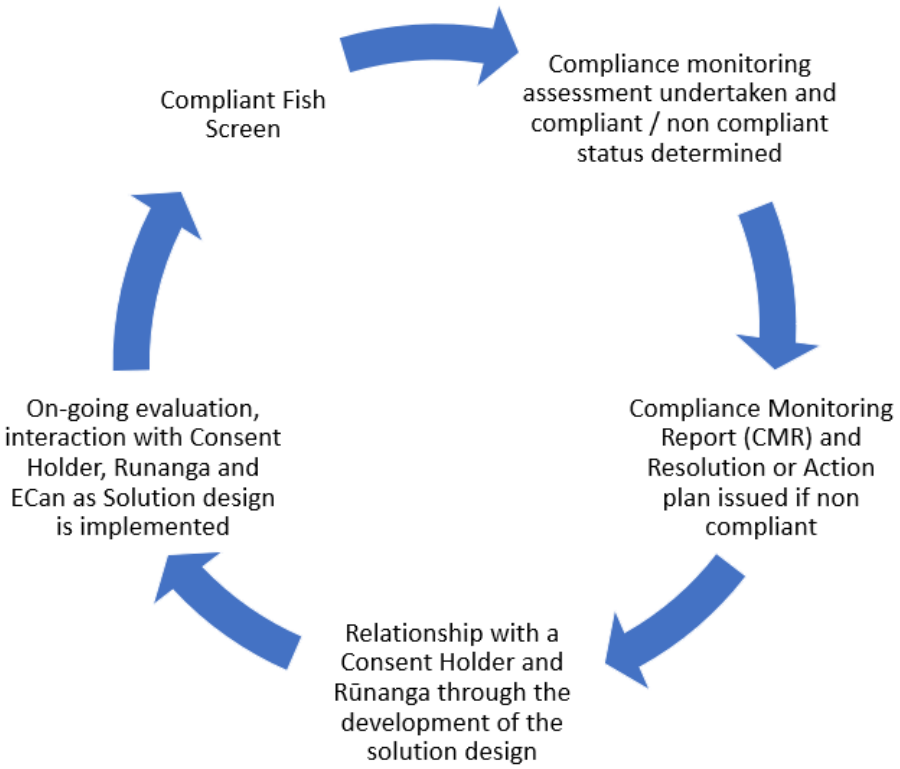

Figure 1: Fish screen compliance process.

Generally, the challenges when it comes to ensuring compliance with fish screen standards in Canterbury can be summarised into four areas:

- **Age** - dealing with old water (pre-2004) permits that were granted for 35 years that may not even have fish screen conditions.
- **Cost** - designing and upgrading fish screen infrastructure to a level where they are compliant and effective is an expensive proposition.
- **Scale** - there are 922 surface water takes that require fish screening alone in Canterbury, meaning the sheer scale of resourcing improvements is daunting for everyone involved, both the compliance checking as well as the design and construction carried out by experts in the private sector.
- **Legal complexity** - enforcing compliance to get the improvements required can be difficult given the variation in conditions that have been put on resource consents over

many years, and the level of resistance that can be encountered by some consent holders.

Prior to the development and implementation of any compliance programme the above challenges need to be considered carefully and steps put in place to deal with them.

5. ISSUES AND CHALLENGES

The key resource management challenges concerning protecting freshwater fish from being harmed through water abstraction involve:

1. Developing a strong national and regional policy and planning framework
2. Ensuring effective fish screens are required when water permits are granted
3. Compliance is achieved and fish screens are designed, constructed and maintained that protect fish

To overcome these challenges the following are necessary:

- Knowledge of freshwater fish - their habitat and behavior
- Policy, plan, and rule development based on sound knowledge
- Tangata whenua input
- Good practice guidance on fish screen design principles
- Robust resource consent processes
- Robust and defendable compliance processes
- Inclusion of both engineering and ecological expertise in designs

CONCLUSION

Better fish screening practices in New Zealand are necessary to halt the present decline in freshwater fish. The implementation of such practices will largely depend on the development of better national and regional policy direction, stronger compliance, and

better guidance from both the public and private sectors. It is hoped this paper provides a summary of current fish screening practice and the lessons learnt from Canterbury. However, ultimately the challenge in building effective fish screens is best summarized as *"it's where engineering meets biology"*[13] and it is in overcoming this challenge, that fish will be protected from the effects of surface water abstraction.

[13] Dr Adrian Meredith- pers comm

Appendix 1- CLWRP Schedule 2 Fish Screen Standards and Guidelines

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 m3 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 (m2) 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 m3 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 m3 per day and the diversion is less than 10 m3/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 m3/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.*

Appendix 2- Standard Consent Conditions

NB - there are two sets of standard conditions. Condition set 1 is for smaller (end of pipe) pump takes (typically less than 100L/s) within the active channel, and Condition set 2 for larger takes. Larger water takes are likely to be via open water channels from water often diverted down a diversion channel away from, and then back into, the main channel. The two condition sets are similar, except for Condition 1(e)(ii) for the smaller takes dealing with where the screen needs to sit in the water column, and Condition 2c for the larger ones, which deals with trying to ensure the physical construction works to install the screen are done correctly.

Condition set 1 – pump takes (typically <100L/s)

Note

Condition:

1	Fish screens: a. A fish exclusion device to ensure that fish are prevented from passing into the intake and remain uninjured and unconstrained in the natural waterway shall be installed before first exercise of this resource consent. b. Water shall only be taken when a fish screen with a maximum mesh slot or width and height size of [*1.5 mm slot width or 2 mm side of square mesh for intakes within three kilometres from the coast; and 2 mm slot width or 3 mm side of square mesh for anywhere else*] is operated and maintained across the intake to ensure that fish and fish fry can remain in the natural waterway and are prevented from passing through the intake screen. c. The material used in clause (b) of this condition shall be smooth in nature and all parts of the screen shall be maintained to prevent damage or injury to fish. d. To avoid the entrapment of fish at the point of abstraction, and to minimise the risk of fish being damaged by contact with the screen face, the fish screen shall: i. be positioned as close to the river as possible, and ii. ensure minimal exposure of fish to the screen structure; and/or iii. provide an effective bypass to ensure that there is unimpeded fish passage to and from the waterway. e. The fish screen shall be designed and installed to ensure that: i. The screen surface is orientated parallel to the direction of water flow; and

	ii. The screen is positioned in the water column a minimum of 300 mm above the bed of the waterway and a minimum of one half screen width from the surface of the water in 7DMALF (7 day mean annual low flow) flow conditions; and iii. The through screen velocity perpendicular to the face of the screen shall not exceed 0.06 metres per second if no self-cleaning mechanism exists, or 0.12 metres per second if a self-cleaning mechanism is operational; and iv. The sweep velocity parallel to and calculated or measured off the face of the screen shall exceed the through screen velocity at all times and at all locations across the screen.
2	Design, construction and maintenance specifications: a. The fish screen shall be designed or supplied by a suitably qualified person who shall ensure that the design criteria specified in condition (1)(a)-(e)(i -iv) of this consent is achieved. b. No less than 15 working days prior to the installation of the fish screen the consent holder shall provide to Environment Canterbury Attention Regional Leader- Monitoring and Compliance, a report: i. Containing the final design plans; and ii. Illustrating how the fish screen will meet the required design criteria outlined in condition (1); and iii. Containing an effective operation, monitoring and maintenance plan for the fish screen. c. Upon construction completion, the consent holder shall provide a certificate from a suitably qualified person to Environment Canterbury Attention Regional Leader- Monitoring and Compliance to certify that the fish screen has been installed in accordance with condition (1). d. The fish screen shall be maintained in good working order in accordance with condition (1). Records shall be kept of all inspections, monitoring and maintenance, and those records shall be provided to Environment Canterbury attention Regional Leader- Monitoring and Compliance, upon request.
3	Repair or replacement procedures: a. The consent holder shall regularly check the fish screen to ensure that it is fully operational and can meet the requirements outlined in condition (1).

	b. If the fish screen becomes damaged or requires repair such that it can no longer meet the requirements outlined in condition (1), the consent holder shall: i. Stop operating the intake structure so that water does not flow through the fish exclusion barrier and intake structure. The intake structure may not resume operation until conditions (3)(b)(ii) -(3)(b)(iii) are met. ii. Repair the fish screen so that it operates in accordance with the requirements specified in condition (1). iii. Ensure that the repaired fish screen is inspected by a suitably qualified person to assess performance against condition (1). The suitable qualified person shall prepare a report documenting compliance which shall be submitted to Environment Canterbury attention Regional Leader-Monitoring and Compliance within five working days of the report being supplied to the consent holder. **Definition** For the above fish screening conditions a 'suitably qualified person' shall mean: *an experienced fisheries ecologist with experience in salmonid and New Zealand native fisheries and in the design, construction and testing of fish exclusion and fish passage devices.*

Condition set 2– medium to large takes (100L/s – 10,000L/s)

Condition:

1	Fish screen scope and design: a. A fish exclusion device to ensure that fish are prevented from passing into the intake/other structure and can remain uninjured in the natural waterway shall be installed before first exercise of this resource consent. b. Water shall only be taken when a fish screen with a maximum mesh width and height size of maximum mesh slot or width and height size of [*1.5 mm slot width or 2 mm side of square mesh for intakes within three kilometres from the coast; and 2mm slot width or 3 mm side of square mesh for anywhere else*] is operated and maintained across the intake to ensure that fish and fish fry are prevented from passing through the intake screen. c. The material used in clause (b) of this condition shall be smooth in nature and all parts of the screen shall be maintained to prevent damage or injury to fish. d. To avoid the entrapment of fish at the point of abstraction, and to minimise the risk of fish being damaged by contact with the screen face, the fish screen shall: i. be positioned as close to the river as possible; and ii. ensure minimal exposure of fish to the screen structure; and iii. provide an effective bypass to ensure that there is unimpeded fish passage to and from the waterway. e. The fish screen shall be designed and installed to ensure that: i. The screen surface is oriented at an angle to the flow (generally greater than 45^0) to ensure fish pass past the screen and to a bypass entrance (where necessary); and ii. The through screen velocity perpendicular to the face of the screen shall not exceed 0.06 metres per second if no self-cleaning mechanism exists, or 0.12 metres per second if a self-cleaning mechanism is operational; and iii. The sweep velocity parallel to and calculated or measured not more than 75mm off the face of the screen shall exceed the through screen velocity at all times and at all locations across the screen.

2	Design, construction and maintenance specifications: a. The fish screen shall be designed or supplied by a suitably qualified person who shall ensure that the design criteria specified in condition (1)(a)-(e)(i-iii) of this consent is achieved. b. No less than 15 working days prior to the installation of the fish screen the consent holder shall provide to Environment Canterbury Attention Regional Leader- Monitoring and Compliance, a report: i. Containing the final design plans; and ii. Illustrating how the fish screen will meet the required design criteria outlined in condition (1); and iii. Containing an effective operation, monitoring and maintenance plan for the fish screen. c. A field inspection shall take place while the screen is being installed by a suitably qualified person to ensure it is being installed correctly and meets all the design criteria specified in condition (1). d. Upon construction completion, the consent holder shall provide a certificate from a suitably qualified person to Environment Canterbury Attention Regional Leader- Monitoring and Compliance to certify that the fish screen has been installed in accordance with condition (1). e. The fish screen shall be maintained in good working order in accordance with condition (1). Records shall be kept of all inspections, monitoring and maintenance, and those records shall be provided to Environment Canterbury attention Regional Leader- Monitoring and Compliance, upon request.

3	Repair or replacement procedures: a. The consent holder shall regularly check the fish screen to ensure that it is fully operational and can meet the requirements outlined in condition (1). b. If the fish screen becomes damaged or requires repair such that it can no longer meet the requirements outlined in condition (1), the consent holder shall: i. Stop operating the intake structure so that water does not flow through the fish exclusion barrier and intake structure. The intake structure may not resume operation until conditions (3)(b)(ii) -(3)(b)(iii) are met; and ii. Repair the fish screen so that it operates in accordance with the requirements specified in condition (1); and iii. Ensure that the repaired fish screen is inspected by a suitably qualified person to assess performance against condition (1). The suitable qualified person shall prepare a report documenting compliance which shall be submitted to Environment Canterbury attention Regional Leader- Monitoring and Compliance within five working days of the report being supplied to the consent holder. **Definition** For the above fish screening conditions a 'suitably qualified person' shall mean: *an experienced fisheries ecologist with experience in salmonid and New Zealand native fisheries and in the design, construction and testing of fish exclusion and fish passage devices.*