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Dear Julie

Please see below the proposed methodology for the fish screening lab trial work for Year 2 of the MPI project.

Yours sincerely

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# Proposed methods for MPI fish screening trials – Year 2

## Trial objectives

This trial will be studying the behavioural changes displayed by indigenous and introduced fish (shortfin eel, *Anguilla australis;* common bully, *Gobiomorphus cotidianus*; bluegill bully, *Gobiomorphus hubbsi;* īnanga, *Galaxias maculatus;* and Chinook salmon, *Oncorhynchus tshawytscha*) when encountering wedge-wire fish-exclusion screens of different 'slot' sizes in an outdoor artificial stream. For the first time trials will be conducted in a downstream to upstream direction simulating how diadromous species would be interacting with fish screens.

The trials have several objectives:

- Quantify the difference in effectiveness for 2-mm wedge-wire compared to 1.5-mm wedge-wire at excluding different juvenile fish species from a simulated intake;
- When compared with Year 1 results, identify whether screen penetrations, contacts and impingements are altered by the direction (upstream *vs.* downstream) that a fish approaches a screen;
- Determine how fish length effects the ability of individual fish for different species to penetrate wedge-wire screens.

## Fish collection and maintenance

Fish will be collected from rivers within c. 100 km of Christchurch (Table 1). A Kainga EFM 300 backpack electrofishing machine will be used to momentarily stun fish so that they can be captured in a push net by an assistant downstream. The smallest fishes available, at the time of sampling, will be preferentially selected for use in the trials. The fish will be transported back to NIWA Christchurch in an aerated, insulated container and then kept in a temperature-controlled room at 17°C with dissolved oxygen continuously supplied from a compressed air manifold system. Extra river water will be collected with each set of fish and swapped every evening to maintain optimal conditions for the fish. As some fish will need to be held for several days in the laboratory, they will be fed on frozen bloodworms or fish food depending on the usual diet of the species. Fish will be fed each evening and given a minimum of 24 hours to recover from electrofishing/acclimatise before use in trials.

**Table 1:** Proposed fish collection sites with the target size range for testing different fish species.

| Species name | Common name | Proposed collection site | Target size range (mm) |
|---|---|---|---|
| *Anguilla australis* | Shortfin eel | Ashley (or Grey) | 55–70 mm |
| *Gobiomorphus cotidianus* | Common bully | Ashley (or Cust) | 35–60 mm |
| *Gobiomorphus hubbsi* | Bluegill bully | Ashley (or Waimakariri) | 35–60 mm |
| *Galaxias maculatus* | Īnanga | Ashley (or Heathcote) | 40–55 mm |
| *Oncorhynchus tshawytscha* | Chinook salmon | Montrose Hatchery | 40–70 mm |

## Outdoor stream simulator

An outdoor artificial stream will be used to examine hypotheses relating to screen size, velocity and bypass use (see Figure 1). The outdoor setup will consist of a header tank which releases water into a fiberglass channel mounted above ground level and lined with 6 mm pea gravel. The water will flow along the channel, then either through the fish screen or down the bypass and then into a sump, it is then pumped back to the header tank by a submersible electric pump. The pump is fitted with a float switch, so it will switch off when the water level in the sump drops to prevent the pump (and the experimental system) running dry. The water will be supplied to the channel at a constant flow rate due to the adjustable gate valve on the header tank's outlet. Exclusion screens are in place at either end of the channel, so fish cannot escape (although nets will be in place in the downstream end to capture fish before contact with that exclusion screen). In preliminary trials, the channel was lined with small cobbles (c. 60 mm) to try and create a river environment with larger substrate size, but the small fish were instantly lost within the interstitial spaces between the substrate. Therefore, a polythene lining was placed over this cobble-layer and a thin lining of 6 mm pea gravel placed on top to maintain as natural a simulation as possible whilst still having a viable experiment.

Vertical bar wedge-wire screens (100 cm x 30 cm) of varying mesh sizes (1.5 or 2-mm spacing between bars) will be inserted into the channel at 45° to the flow direction (maximum screen angle specified in New Zealand fish screening standards; Jamieson et al. 2007), with a bypass of 15% of the screened width; this is where the fish will end up if they pass by the screen. A channel (180 mm width x 900 mm length) will be constructed parallel to the screen to generate a sweep velocity vector and to ensure species interact with it as they swim upstream. This modification will more accurately simulate a vertical flat screen design at an irrigation intake. A notch will be made in the dam board (used to retain water in the main channel) to enable fish passage upstream and to ensure equal flow through the screen and downstream channel. A GoPro™ Hero4 Silver camera in a waterproof housing will be setup in the water to provide a view of fish interacting with the screen. Prior to the experiments it will be calibrated so that when the header tank outlet's adjustable gate valve is opened 25 mm the approach velocity will be maintained within ± 0.02 $ms^{-1}$ of 0.12 $ms^{-1}$ (Jamieson et al. 2007). Approach velocity measurements will be measured approximately 8 cm in front of the centre, as per North American fish screening guidelines (National Marine Fisheries Service 1997). To minimise the effect of hydraulic head on the rate the water entering the stream simulator, the water level in the header tank will always be kept between two marks. Velocity measurements will be taken with a SonTek FlowTracker (SonTek/YSI Inc., San Diego, USA). The water is sourced from the Christchurch City Council supply, which is artesian and untreated (at this location). The water in the simulator was continuously circulated through the header tank, and oxygen concentrations were close to 100% saturation at typically >9 mg $L^{-1}$.

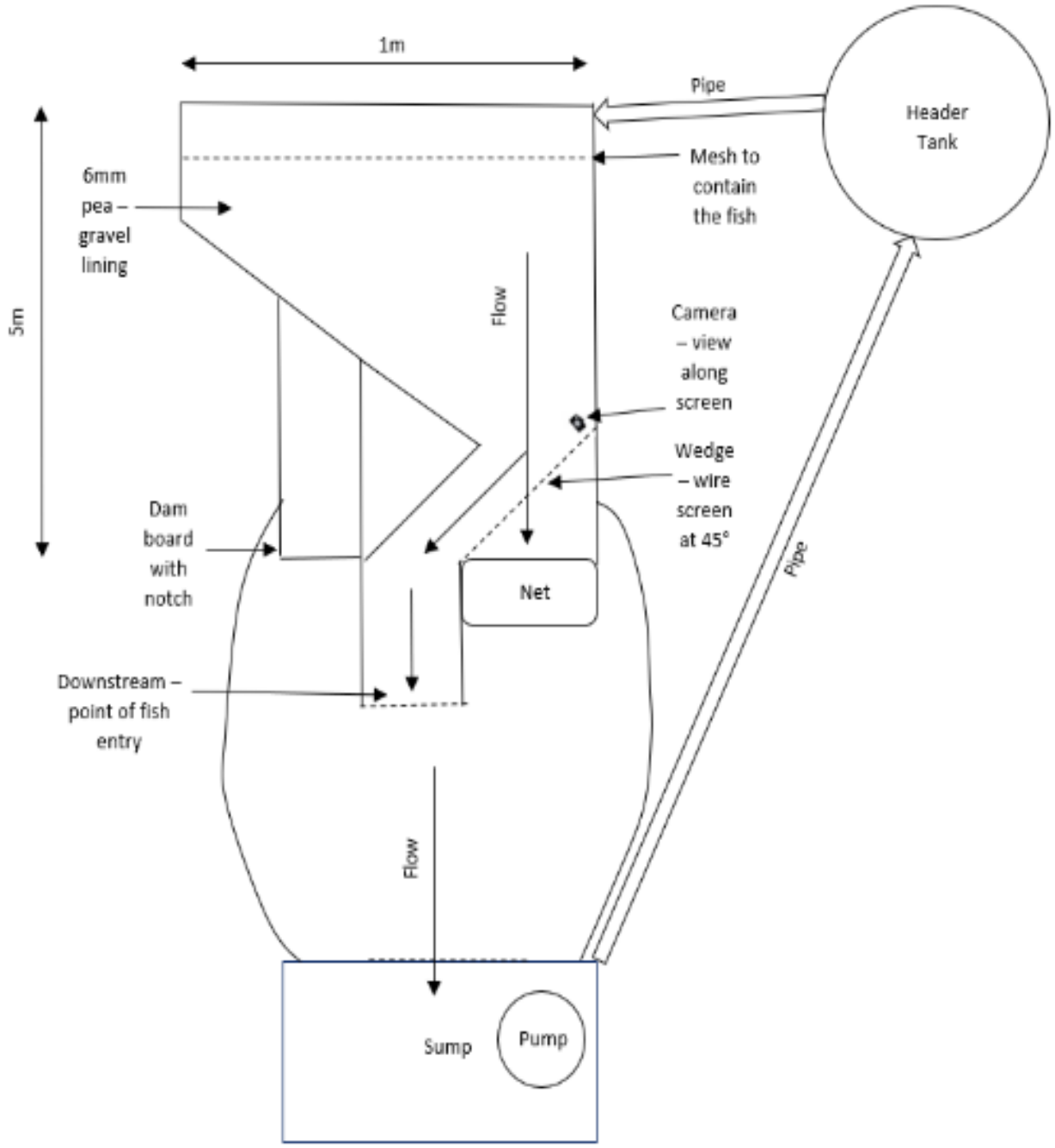


**Figure 1:** Schematic of the outdoor stream simulator channel.

## Experimental procedure

The species that will be tested in Year 2 have been determined by freshwater fish experts on the project's Fish Screening Technical Advisory Group involved with this project (e.g., Department of Conservation, Fish and Game, NIWA, Environment Canterbury) and it will again have a strong focus on native fish requirements.

Before each experimental run, three velocity measurements will be taken and averaged to check they are within 0.02 $ms^{-1}$ of the intended treatment velocity. The water temperature cannot be controlled because the stream simulator is outdoors but does not vary markedly throughout the day based on previous experimental work with the simulator. Water temperature will be monitored and kept within 2.5°C of the 17°C fish storage room to minimise temperature shock changes that could impact fish behaviour. If the water temperature rises above 19.5°C, then the water will be drained and replaced with new artesian water.

Once the simulator is setup appropriately, the camera will be turned on and five fish released 2 m downstream of the wedge-wire screen. This year, all experiments will be run in an downstream to upstream direction (i.e., simulating migratory fish arriving into fresh water from the sea). Each experimental run will last 30 minutes to give fish time to acclimatise to their surroundings and ensure a normal behavioural response when approaching the screen. Every five minutes, the net will be checked for entrained fish and the position of individuals in the simulator recorded (if visible). This process will be repeated until the end of the trial and time of capture will be recorded for fish that are collected from the nets during the trial. After collection from nets or the stream simulator, the fish's length (in mm), location and any visible injuries (if present) will be noted. Later the videos will be analysed for screen impingements and contacts. Impingements will be defined as any fish being visibly stuck to the screen for 10 seconds or more. Screen contacts will be defined as any contact the fish made with the screen, whether sitting by the screen, swimming along it, or actively trying to force their way through the screen. If a fish moves off the screen and then comes back it will be counted as two separate contacts. There will be five replicates for each species tested with the 2-mm wedge-wire screen (Table 2). If any species penetrate this screen, they will be then tested against the 1.5-mm wedge-wire screen with five replicates.

**Table 2: Experimental treatments in the stream simulator.** The 1.5 mm treatments will only be carried out if individuals of that species pass through the 2 mm screen.

| Treatment no. | Velocity ($ms^{-1}$) | Mesh size (mm) | Species |
|---|---|---|---|
| 1 | 0.12 | 2 | Common bully |
| 2 | 0.12 | 1.5 | |
| 3 | 0.12 | 2 | Bluegill bully |
| 4 | 0.12 | 1.5 | |
| 5 | 0.12 | 2 | Shortfin eel |
| 6 | 0.12 | 1.5 | |
| 7 | 0.12 | 2 | Īnanga |
| 8 | 0.12 | 1.5 | |
| 9 | 0.12 | 2 | Chinook salmon |
| 10 | 0.12 | 1.5 | |

## References

Jamieson, D., Bonnett, M., Jellyman, D. and Unwin, M. (2007) 'Fish screening: good practice guidelines for Canterbury', NIWA Client Report: CHC2007–092.

National Marine Fisheries Service (1997). Fish Screening Criteria for Anadromous Salmonids. Southwest Region. 10 p.