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Dear Bridget

Please see below the proposed methodology for fish screening trial work for the MPI project.

Yours sincerely

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Proposed methods for MPI fish screening trials

1.1 Fish collection and maintenance

Fish will be collected from rivers within c. 100 km of Christchurch. 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.

1.2 Outdoor stream simulator

An outdoor artificial stream will be used to examine hypotheses relating to screen size, velocity and bypass use (see **Error! Reference source not found.**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 (2 or 3-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. Two nets will be placed to collect fish if they penetrate the screen or bypass it. Cameras (GoPro™ Hero4 Silver and Turnigy HD WiFi ActionCam 1080p) in waterproof housings will be setup in the water to provide a view of fish interacting with the screen; one viewing along the screen from the side and one viewing it straight on. Prior to the experiments it will be calibrated so that when the header tank outlet's adjustable gate valve is opened 25 mm the velocity would average 0.12 m s^{-1}, or 0.24 m s^{-1} when opened 35 mm; 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). It is not easy to maintain a consistent second vector sweep velocity in this apparatus, so to ensure a decent proportion of the flow is directed down the bypass a notch will be cut into the 'dam board' (which will maintain the water level within the channel). The notch will also provide a pathway for fish into the bypass. The water is sourced from the Christchurch City 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 ml^{-1}.

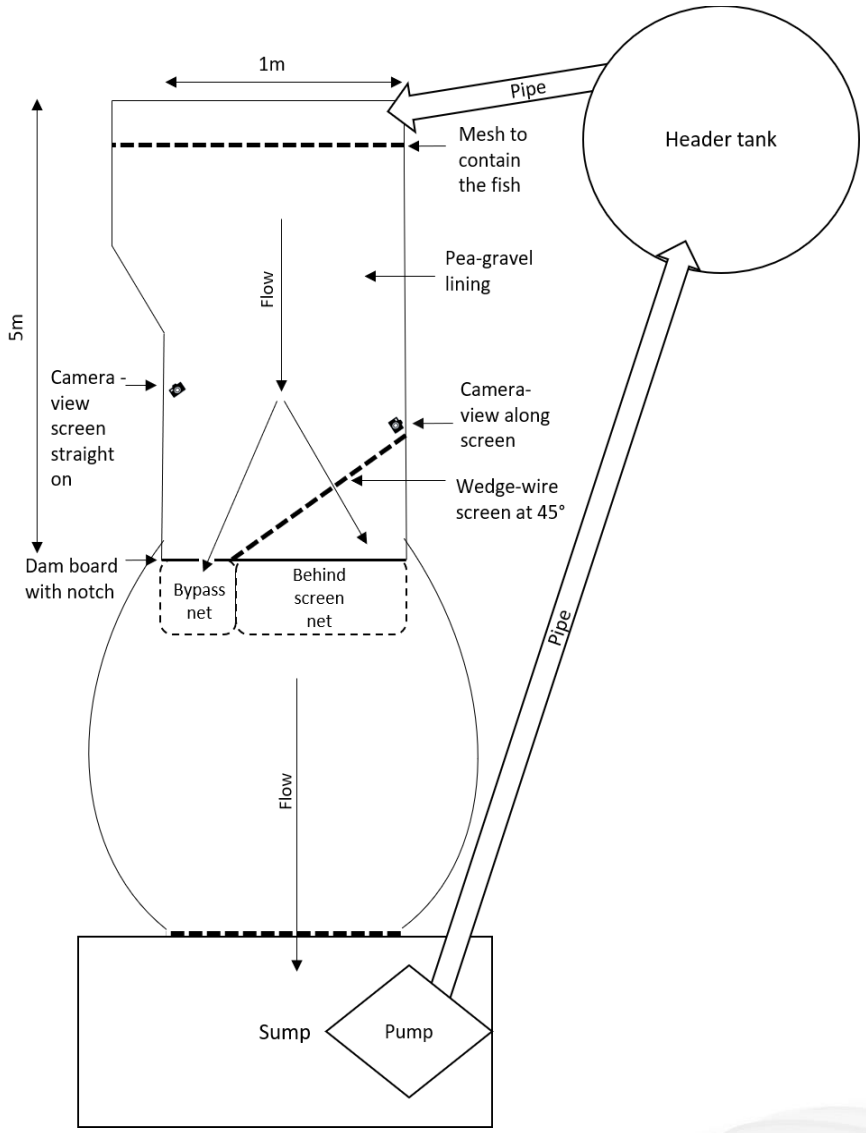

Figure 1. Schematic of the outdoor stream simulator channel.

1.3 Experimental procedure

Before each experimental run, three velocity measurements will be taken and averaged to check it was within 0.02 m s^{-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 cameras will be turned on and five fish released 2 m downstream of the top exclusion mesh in the centre of the channel. All experiments will be run in an upstream to downstream direction. Each experimental run will last 15 minutes, and during this time the nets will regularly be checked for fish. Time of capture will be taken for fish that are collected from the nets during the trial. After collection from nets or the stream, 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 treatment in Table 1.

Table 1. Experimental treatments in the stream simulator.

Treatment	Velocity ($m\ s^{-1}$)	Mesh (mm)	Species
1	0.12	2	
2	0.24	2	Common bully
3	0.12	3	
4	0.24	3	
5	0.12	3	
6	0.24	3	Bluegill bully
7	0.12	2	
8	0.24	2	
9	0.12	2	
10	0.24	2	Shortfin eel
11	0.12	3	
12	0.24	3	
13	0.12	3	
14	0.24	3	Canterbury galaxias
15	0.12	2	
16	0.24	2	

Once these experiments are completed then approximately 8 months later further trials will be conducted testing fish in a downstream to upstream direction (i.e., simulating migratory fish arriving into fresh water from the sea). The same experimental apparatus will be used although it will require some minor changes, for example, the placement of an additional wedge to increase the likelihood of fish interacting with a screen as they move upstream. For these trials, we will attempt to use smaller fish than the upstream to downstream trials and also test smaller mesh size (e.g. 1.5 mm wedge-wire screen); given some regional councils have this screening criterion for water abstractions closer to the coast. The species that will be tested in this work will be determined by technical advisory group involved with this project (e.g., DOC, Fish & Game, NIWA, Environment Canterbury) but will again have a strong focus on native fish requirements.