Levels Plain irrigation fish screen trial 6-9 December 2010

DOCDM-682985, see also draft full experimental scope - DOCDM-667388
Compiled by Nicholas Dunn

Objectives:

- Test the efficiency of the DIDSON to record species, count, movement and size of fish moving around and/or through the water intake (using salmon (100mm) and rainbow trout (25mm) as indicators.
- Test combination of DIDSON and trapping
- Determine what core data and methods will be collected at water intakes in the proper trials to determine whether key water intake criteria (Jamieson et al. 2007) identified to protect freshwater fish are met
- Test the efficiency/use of the bypass

Background

The investigation was undertaken at the Levels Plain irrigation intake fish screen (Topo50 BZ19 Timaru E1453239 N5097713), accessed from Butlers Rd, near Pleasant Point. The irrigation scheme is currently managed by Opuha Water. The screen was constructed in 1987 by the then Ministry of Works (Figure 1, 2, and 3). The total length of the fish screen is 16 m, and consists of 18, 0.7 m wide panels of 3 mm mesh. The most downstream end panel has a mesh size of 5 mm. This panel was recently damaged and is now slightly deformed. The original design for the entire screen was for 4. 8 mm mesh but this was changed to 3 mm mesh, as the larger mesh was found to be weak and deformable. This suggests that mesh size of screens is determined by engineering constraints rather than consenting requirements.

In 2005 and 2006, Kevin McFall (formerly ECAN) took measurements of sweep and intake velocities of the screen. He calculated that at the design maximum flow of 1.5 cumecs the screen will have a theoretical "through screen" velocity of 0.145 $m{\cdot}s^{-1}$, and with the gauged flow at the time of his studies (1.368 cumec take), an intake velocity of 0.133 m·s^{-1}. Using a SonTek doppler FlowTracker, he measured approach velocities of 0.3 – 0.4 m·s^{-1}, while sweep velocities varied between 0.2 – 0.55 m·s^{-1}. These results indicate that while sweep velocities are acceptable, measured and theoretical approach velocities are both higher than optimal. During the present study, Mark Webb (Central South Island Fish and Game) measured a mean approach velocity of 0.436 m·s^{-1} at 0.6 x *depth*, 20 cm in front of the screen using a Gurley current meter. Measured velocities ranged from 0.312 – 0.536 m·s^{-1} at the most down stream end of the screen and approximately 3.5 m from the upstream end, respectively. Gaugings taken by Mark Webb during the study period calculated flow as 1314 and 1237 l·s^{-1} at 13:40 on 8 December, and 09:15 on 9 December 2010, respectively. Flow in the Opihi River, taken at 14:55 on 8 December, was calculated as 7989 l·s^{-1} at the Saleyards Bridge.

Figure 1. The Levels Plain irrigation screen on 7 December 2010. The DIDSON is positioned halfway along the length of the screen, supported by warratahs. The upstream control gate is position upstream of the bridge. Photo by Sjaan Bowie.

Figure 2. The dewatered forebay and screen, looking upstream toward the bridge and the control gate (left), and the downstream side of the screen while water was shut off. (right). Both photos were taken on 7 December 2010. Left photo by Sjaan Bowie, righr photo by Nicholas Dunn.

Methods

The current investigations took place during 6 – 9 December 2010. The study consisted of two trials in which rainbow trout (*Oncorhynchus mykiss*) and Chinook salmon (*Oncorhynchus tshawytscha*) were released into the fore bay area between the control gate and screen (Area 1 in Figure 3), followed by electrofishing this area the next morning. This sought to test the efficiency of the DIDSON, to record species present, count numbers, and record movement and size of fish moving around and/or through the screen. The DIDSON camera was set up at Position 1 (Figure 3) on 6 December 2010 by Aaron Quaterman (Cawthron Institute), and allowed to record background readings overnight, to determine fish species already present in the fore bay above the screen.

Pre Trial electrofishing – 7 December 2010

Prior to Trial 1, electrofishing was conducted in Area 1 and 2 to determine what species of fish were naturally present both upstream and downstream of the screen, before experimental fish were introduced. Area 1 was 38 m long, with a mean width (± 1 SEM) of 3.52 ± 0.31 m, resulting in an area of approximately 134 m^2, and a depth of 25 cm when the water was shut off. Area 2 was smaller with a mean width of 4 m, and a length of 20 m, or an area of approximately 80 m^2. Initially, the cleaning brush was turned off, the fish bypass closed, a box seine net placed below Area 2, and the DIDSON camera removed. The water race was then dewatered by closing the control gate. This gate remained closed for 48 minutes. As water receded and was shut off, areas were fished separately, using a mainset electrofishing machine, with the cathode placed at the downstream end of each area. Fishing was conducted in an upstream direction by Dave West (DOC). Sjaan Bowie (DOC) acted as the bankside mainset operator. Adrian Meredith (ECan), Aaron Quaterman, and two members of the irrigation scheme used handheld scoop nets to capture fish. Fish were transferred from the stream bank via bucket to a measuring area by Nicholas Dunn (DOC), where they were processed further by Dave Kelly (DOC). Following identification to species, and measurement of Total length, or Fork Length for brown trout (*Salmo trutta*), for each area separately, fish were released back intothe head race downstream of the control gate. Following electrofishing in Area 2, the downstream seine net was checked for captured fish. The control gate was then re-opened and normal flow in the race resumed. The DIDSON camera was then re-installed at Position 2.

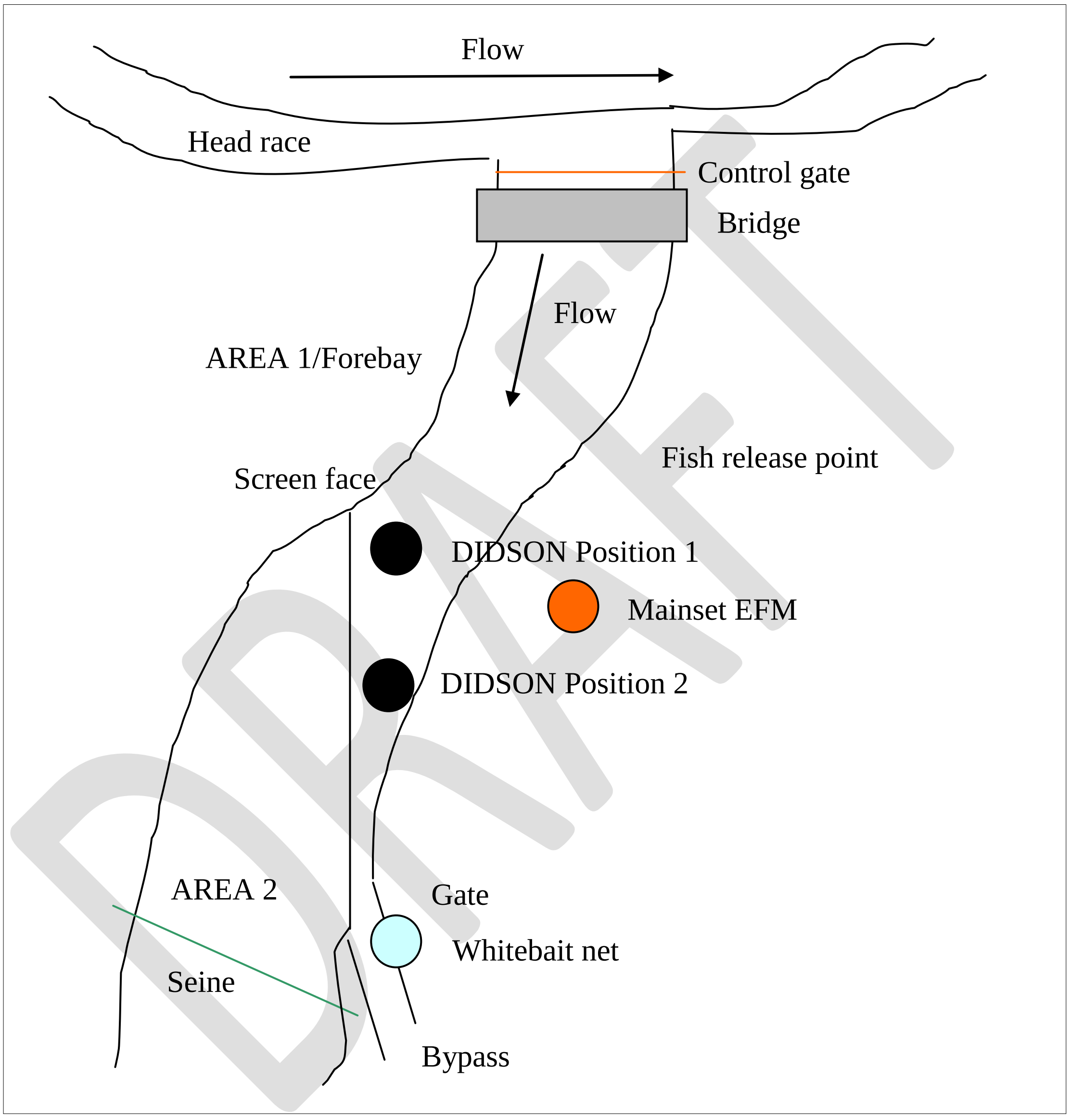

Figure 3. Schematic overview of the fish screen and water race, with approximate location of experimental equipment.

Trial 1 – 7 – 8 December 2010

This trial was designed as a staged release of rainbow trout and Chinook salmon to ensure the DIDSON was capable of detecting different species and different life stages. Before release of the trial fish, the screen cleaning brush was parked at the upstream end of the screen. At circa 1 hour intervals the brush was operated to clear the screen of debris throughout the trial period. The fish bypass was also closed prior to trial fish release, using a metal plate gate, and kept closed over the whole period of the trial, to assist assessment of use of the bypass by fish. At 14:55, 500 hatchery reared rainbow trout (mean fork length ± 1 SEM: 29.8 ± 0.74 mm FL), were released into Area 1 at or about NZTM E1453243 N5097718. One hour later 1000 hatchery reared Chinook salmon (mean fork length ± 1 SEM: 111.8 ± 1.81 mm FL) were also released.

On the morning of 8 December 2010, the seine net at the downstream end of Area 2 was checked at 10:00, and captured fish removed, identified to species, and measured. The water was shut off at the control gate at 11:03 for a period of 43 minutes. Electrofishing was then conducted in an upstream direction by Mark Webb over a period of 40 minutes. The earth strap cathode was set up from the bridge. During six minutes of this period, electrofishing was suspended as the cathode broke and required repair. Aaron Quaterman used a handheld scoop net and Nicholas Dunn a pole seine net, to capture fish. Spot fishing was also conducted for 5 minutes, once the water flow had resumed, to capture fish not previously caught. Whitebait- and scoop- nets used to catch fish around bypass intake. Following electrofishing, fish were identified to species and total numbers caught were recorded.

Trial 2 – 8 – 9 December 2010

Trial 2 was designed to test if the DIDSON was capable of detecting different species and different life stages with the fish bypass open. At the conclusion of Trial 1 the bypass was opened and left open. Initial attempts to place a whitebait net in front of the bypass to capture fish going into this structure proved unsuccessful, thus was discontinued. Rainbow trout and Chinook salmon were kept in live bins over night downstream of the screen in Area 2. These trial 2 fish were released into Area 1 beginning with 903 rainbow trout at 13:34. Over the period 14:02 – 14:10, 300 Chinook salmon were released in three batches of 100 individuals. The DIDSON was then allowed to record fish behaviour overnight. On the morning of 9 December 2010, electrofishing was conducted in a manner similar to that described in Trial 1 beginning at 10:30. Electrofishing was conducted by Mark Webb, assisted by Aaron Quaterman, and Hamish Stevens (Fish & Game).

Results

Pre Trial electrofishing – 7 December 2010

Fish species captured during the pre Trial 1 electrofishing in areas 1 and 2 are summarised in Table 1.

Trial 1 – 7 – 8 December 2010

One hour after the rainbow trout were released, the seine net was lifted and checked. No rainbow trout were captured downstream of the screen. Neither were rainbow trout caught in a whitebait net placed downstream of the large mesh screen during the same period. However, when the seine net was checked at 10:00 on 8 December 2010, seven rainbow trout had been captured. This is despite the net becoming detached from one of its supporting warratahs between 00:00 – 07:00. These rainbow trout which had passed through the screen had a mean (± 1 SEM) length of 28.4 ± 1.04 mm FL.

Prior to water shut off and electrofishing, behaviour of fish was observed from the bank. Schools of rainbow trout were observed close to the grassy margin of the true left bank of the fore bay in Area 1. However, the larger Chinook salmon did interact with the screen and brush. Chinook salmon were typically in small schools. No Chinook salmon were observed to become entrained on the screen when the water was on. Also they were able to swim underneath the brush as it did not reach to the stream bed. Further, a solid metal skirt formed the bottom of the screen, meaning fish were not entrained on the screen when swimming close to the stream bed.

Table 1. Fish species present in Area 1 and 2 captured during the pre Trial 1 electrofishing and their measured lengths. Lengths are Total length (mm) for all species except brown trout which is given as Fork Length.

Common name	Species name	Number captured	Length (mm)
Area 1			
Longfin eel	*Anguilla australis*	10	190, 280, 280, 320, 370, 430, 450, 610, 650, 700
Torrent fish	*Cheimarrichthys fosteri*	6	106, 107, 110, 111, 123, 132
Upland bully	*Gobiomorphus breviceps*	12	49, 50, 58, 60, 62, 62, 63, 69, 72, 90
Common bully	*Gobiomorphus cotidianus*	1	132
Brown trout	*Salmo trutta*	6	53, 53, 59, 84, 150, 580
Area 2			
Upland bully	*Gobiomorphus breviceps*	5	41, 50, 50, 52, 60

No rainbow trout were captured during electrofishing. However, using electrofishing and scoop nets to catch fish around the bypass intake, a total of 794 Chinook salmon (79.4 % recapture success) were captured, meaning 206 individuals remained in Area 1 at the end of Trial 1. Further, 1 torrentfish and 1 common bully were also caught during electrofishing. Once the flow was resumed, 8 Chinook salmon (included in the 794) were found to have become trapped against the screen as the water quickly rose. Chinook salmon that were stuck on the screen were washed off as the cleaning brush approached, then pushed away from both brush and screen.

Trial 2 – 8 – 9 December 2010

During electrofishing of Area 1, no rainbow trout were captured, but 153 Chinook salmon were recaptured. Three hundred Chinook salmon were released in Trial 2, and an additional 206 were not captured in Trial 1. At the conclusion of Trial 2 it was estimated that 20 Chinook salmon remained that were not caught. As the bypass was open, it is unclear the number of Chinook salmon in Area 1 at the start of Trial 2, meaning a percentage capture success cannot be calculated.

Conclusions and lessons

The following can be summarised based on the work reported here, which does not include DIDSON results:

- A variety of fish species have become entrained in the canal system between the intake on the Opihi River and the screen.
- Entrained species are represented by a range in length of individuals. Larger shortfin eel and brown trout individuals can be considered predatory.
- Small rainbow trout can pass through the screen, the mesh size of which is 3 – 5 mm.
- Electrofishing both upstream and downstream of screens is required to determine baseline/background fish populations. This is also required to identify screen facility parameters, the efficiency of the bypass, and fish behaviour with the screen. Whether this is assessed using trapping and/or the DIDSON should be based on the DIDSON findings from the present study.
- Rigid traps down stream of screens and on any bypass are required in any future work. Rigid nets are required as in these trials both the seine net and whitebait nets failed. Cawthron are aware of floating, rigid nets in the North Island that could be utilised for future studies.
- Downstream nets are critical, as it needs to be specifically determined if fish are passing through the screen.
- The effects (mortalities) generated by cleaning systems have to be quantified in future studies.

- In Trial 1 and 2 there were only 3 people electrofishing, probably 4 would be better, but this is dependant on the layout of future screens tested.
- A longer period with the water being turned off is needed; this requires better coordination with the irrigation scheme water managers. A longer period would allow thorough, multiple electrofishing passes.
- It is important that future work uses a suite of species and/or life stages, as a number of species were recorded downstream of the screen. It is unclear if these species were present in the race network prior to installation of the screen or passed through the screen post installation.

Reference

Jamieson, D.; Bonnett, M.; Jellyman, D.J.; Unwin, M.J. 2007: Fish screening: good practice guidelines for Canterbury. NIWA Client Report CHC2007-092. National Institute of Water and Atmospheric Research, Christchurch, New Zealand. 70 p