

Boat electrofishing salvage of fish in the Lower Mangamahoe Dam reservoir



ERI Report Number 158

by

Brendan J. Hicks, Warrick Powrie, Greg Larkin¹ and Angela Smith¹

Client report prepared for the
New Plymouth District Council

26 February 2022

Email: b.hicks@waikato.ac.nz

Environmental Research Institute
Division of Health, Engineering, Science & Computing
University of Waikato, Private Bag 3105
Hamilton 3240, New Zealand

¹BTW Company Ltd, 179 Courtenay Street, New Plymouth 4310, New Zealand

Cite report as:

Hicks B.J., W.S. Powrie, G. Larkin and A. Smith. 2022. Boat electrofishing salvage of fish in the Lower Mangamahoe Dam reservoir. *Environmental Research Institute Report No. 158*. Client report prepared for New Plymouth District Council. Environmental Research Institute, Division of Health, Engineering, Computing & Science, The University of Waikato, Hamilton. 9 pp. ISSN 2463-6029 (Print), ISSN 2350-3432 (Online)

Cover picture: Lower Mangamahoe Dam viewed from upstream. Photo: Brendan Hicks.

Reviewed by:



Ross Beaven

Project Manager

Infrastructure

New Plymouth District Council

Approved for release by



Charles Lee

Co-director

Environmental Research Institute

University of Waikato

Executive summary

The aim of the survey was to salvage fish from the Lower Mangamahoe Dam reservoir before dewatering and dam removal.

We used the University of Waikato's 4.5 m-long, aluminium-hulled electrofishing boat to catch a total of 140 fish weighing an estimated 37.0 kg along 8 fishing tracks sites on 24 February 2022. These tracks comprised 2,807 lineal m and 11,228 m² in area. Shortfin eels (*Anguilla australis*) and common bullies (*Gobiomorphus cotidianus*) were the only fish species present.

Mean density of eels caught was 2.9 fish 100 m⁻² and mean biomass was 7.84 g m⁻². The eels and bullies were transferred to sites downstream in the Waiwhakaiho River by iwi members of the two hapū - Ngāti Te Whiti and Ngāti Tawhirikura.

Water clarity, expressed as black disc distance (BDD, 1.05 m), was good for a shallow lake, and water temperature and water conductivity were close to optimum for electrofishing. Poor water clarity can reduce the efficiency of electrofishing, so we left time after fishing each track for the sediment suspended by the propellor wash to sink before refishing a track.

Table of contents

Executive summary.....	1
Table of contents.....	2
List of tables.....	2
List of figures.....	2
1. Introduction.....	3
2. Methods.....	3
3. Study site.....	7
4. Results and discussion	7
Fish density and biomass by site	7
6. Acknowledgements.....	9
7. References.....	9

List of tables

Table 1. Temperature and dissolved oxygen profile in the Lower Mangamahoe Dam reservoir at the dam face at 1200 h on 24 February 2022.	3
Table 2. Tracks in the Lower Mangamahoe Dam reservoir that were boat electrofished on 24 February 2022.	5
Table 3. Midpoints used for calculating weights from total lengths with the regression parameters of Jellyman et al. (2013).	7
Table 4. Total number of fish in the Lower Mangamahoe Dam reservoir caught by boat electrofishing on 24 Feb 2022.....	8

List of figures

Figure 1. Warrick Powrie retrieving the University of Waikato’s electrofishing boat, Hiko hi Ika. Photo: Brendan Hicks.	4
Figure 2. Brendan Hicks and Leia Murcott fishing in the Lower Mangamahoe Dam reservoir on 24 February 2022. Photo: Angela Smith.....	4
Figure 3. Laydown area and fish release points for the Lower Mangamahoe Dam fish salvage operation. Source: Site specific safety plan: Mangamahoe Low Head Dam, Fish Salvage Operation.....	5
Figure 4. Tracks fished by boat electrofishing on 24 February 2022 starting from the dam face and proceeding upstream. Site numbers correspond to locations in Table 2. Image source: Google Earth.....	6

1. Introduction

The New Plymouth District Council (NPDC) contracted the University of Waikato to conduct fish salvage of the Lower Mangamahoe Dam reservoir (39° 6' 41.32"S, 174° 7' 51.63"E) prior to dewatering and decommissioning.

Table 1. Temperature and dissolved oxygen profile in the Lower Mangamahoe Dam reservoir at the dam face at 1200 h on 24 February 2022.

Depth (m)	Temperature (°C)	Dissolved oxygen (DO)		100% saturation DO for
		Saturation (%)	(mg L ⁻¹)	temperature
				(mg L ⁻¹)
0.2	18.5	119.7	11.22	9.36
0.5	18.5	116.2	10.89	9.36
1.0	18.6	116.4	10.85	9.34
1.5	18.6	115.3	10.78	9.34
2.0	18.4	115.4	10.83	9.38
2.5	18.1	109.0	10.02	9.44
3.0	17.9	98.7	9.32	9.48

2. Methods

We used a 4.5 m-long, aluminium-hulled electrofishing boat with a 5-kilowatt pulsator (GPP, model 5.0, Smith-Root Inc, Vancouver, Washington, USA) powered by a 6-kilowatt custom-wound generator. Two anode poles, each with an array of six stainless steel wire droppers, created the fishing field at the bow, with the boat hull acting as the cathode. The boat was launched and retrieved with a HIAB arm attached to a truck (Figure 1) stationed on the laydown area (Figure 3).

Prior to fishing, electrical conductivity was measured with a Yellow Springs Instruments ProSolo 600 optical dissolved oxygen and conductivity meter. Horizontal underwater visibility was measured using a black disc (Davies-Colley 1988). All sites were fished with the pulsator set to low range (50-500 volts direct current) and a frequency of 60 pulses per second. The percent of range of the pulsator was set to 80%, which gave an applied current of 3.7 amps root mean square. From past experience, an effective fishing field was noted to achieve a depth of about 2-3 m, and 2 m either side of the centreline of the boat. A total of 8 tracks in the reservoir were fished on 24 February 2022 (Table 2, Figure 4). We assumed from previous fishing (e.g., Hicks et al. 2018) that the boat fished a transect about 4-m wide, consistent with previous behavioural reactions of fish at the water surface, and so the linear distance fished, measured with hand-held Garmin GPSMAP 60Cx global positioning system, was multiplied by 4 m to calculate the area fished (Table 2).

During fishing, the two fishers stood on the bow of the boat with the skipper at the navigational console (Figure 2) and fish were released soon after capture at the fish release points (Figure 3) by members of the two hapū (= kinship groups) Ngāti Te Whiti and Ngāti Tawhirikura, the local iwi.



Figure 1. Warrick Powrie retrieving the University of Waikato's electrofishing boat, Hiko hi Ika. Photo: Brendan Hicks.



Figure 2. Brendan Hicks and Leia Murcott fishing in the Lower Mangamahoe Dam reservoir on 24 February 2022. Photo: Angela Smith.



Figure 3. Laydown area and fish release points for the Lower Mangamahoe Dam fish salvage operation. Source: Site specific safety plan: Mangamahoe Low Head Dam, Fish Salvage Operation.

Electrofishing commenced immediately upstream of the concrete dam and proceeded upstream. The sites were spread throughout the reservoir and incorporated different habitats representative of the entire channel. We applied a fishing effort of 19-38 minutes at each site, which included littoral areas, macrophyte beds and mid-channel habitats.

Table 2. Tracks in the Lower Mangamahoe Dam reservoir that were boat electrofished on 24 February 2022.

Date	Track number	Number of points	Track length (m)	Track area (m ²)	Minimum depth (m)	Maximum depth (m)	Time start (h)	Time stop (h)	Duration (mins)
24-Feb-22	1	282	422	1688	2.0	2.4	9:41	10:00	0:19
24-Feb-22	2	200	236	944	0.2	0.8	10:27	10:45	0:18
24-Feb-22	3	279	358	1432	0.2	1.4	11:00	11:22	0:22
24-Feb-22	4	279	332	1328	1.0	2.2	11:35	11:57	0:22
24-Feb-22	5	97	236	944	0.4	2.0	13:29	14:00	0:31
24-Feb-22	6	260	425	1700	0.4	1.4	14:20	14:42	0:22
24-Feb-22	7	305	502	2008	0.3	1.8	15:00	15:22	0:22
24-Feb-22	8	240	296	1184	0.2	0.8	16:02	16:40	0:38
Total		1942	2807	11228					3:14
Mean		243	351	1404					0:24



Figure 4. Tracks fished by boat electrofishing on 24 February 2022 starting from the dam face and proceeding upstream. Site numbers correspond to locations in Table 2. Image source: Google Earth.

Fish had to be processed rapidly because of hot weather and the need to release them unharmed. To speed up processing, fish were assigned to length categories rather than the normal method of length measurement under anaesthesia. To estimate biomass, the midpoint of each category was taken as an estimate of all fish in that category. For common bullies, which were large for the species, midpoint lengths were 75 and 120 mm. For shortfin eels, the midpoint lengths were 75, 150, 250, 350, 500, 700, 900, and 1,200 mm. Weights were calculated for these lengths from species-specific regression parameters (Jellyman et al. 2013).

Table 3. Midpoints used for calculating weights from total lengths with the regression parameters of Jellyman et al. (2013).

Species	Length (mm)	Calculated weight (g)
Common bully	75	5
Common bully	120	22
Shortfin eel	75	0.5
Shortfin eel	150	5
Shortfin eel	250	26
Shortfin eel	350	78
Shortfin eel	500	247
Shortfin eel	700	731
Shortfin eel	700	731
Shortfin eel	900	1643
Shortfin eel	1200	4153

3. Study site

The Lower Mangamahoe Dam reservoir is situated on the Mangamahoe Stream below the main Mangamahoe Dam reservoir and was constructed in 1919 to generate electricity. It has never fulfilled its intended purpose and is now scheduled for removal. The fishable length was 426 m and the average width was 11 m, which implies a water surface area of about 4,700 m².

Water temperature at the starting point of fishing was 17.8°C at 0930 h NZDST on 24 February 2022 and the fishing depth ranged between 0.2 to 2.4 m (Table 2). Specific conductivity, i.e., standardised to 25°C, was 122.9 $\mu\text{S cm}^{-1}$, and ambient conductivity, which controls power transfer of the electrical field to the fish, was 105.9 $\mu\text{S cm}^{-1}$, necessitating a relatively high percentage output (80%) from the pulsator. The riparian zones of the reservoir were mainly indigenous trees. The submerged macrophytes observed throughout the channel were the introduced pondweed (*Elodea canadensis*), the native charophyte *Nitella* spp., the introduced creeping water primrose (*Ludwigia peploides*), and the native milfoil (*Myriophyllum triphyllum*). The black disc distance (BDD), which measures horizontal underwater visibility (Davies-Colley 1988), was 1.05 m.

4. Results and discussion

Fish density and biomass by site

We caught a total of 140 fish weighing an estimated 37.0 kg along 8 fishing tracks sites on 24 February 2022. These tracks comprised 2,807 lineal m and 11,228 m² in area, so the entire area of 5,000 m² was fished twice. Shortfin eels (*Anguilla australis*) and common bullies (*Gobiomorphus cotidianus*) were the only fish species present.

Shortfin eels were the most numerous fish species, and mean density of eels caught was 2.9 fish 100 m⁻² and mean eel biomass 7.84 g m⁻².

Water clarity, expressed as black disc distance (BDD, 1.05 m), was good for a shallow lake, and water temperature and water conductivity were close to optimum for electrofishing. Poor water clarity can reduce the efficiency of electrofishing, so we left time after fishing each track for the sediment suspended by the propellor wash to sink before refishing a track.

Table 4. Total number of fish in the Lower Mangamahoe Dam reservoir caught by boat electrofishing on 24 Feb 2022.

Track	Shortfin eel			Common bully		
	Number	Mean weight (g)	Total weight (g)	Number	Mean weight (g)	Total weight (g)
1	4	113	451	1	22	22
2	18	135	2,439	1	5	5
3	16	451	7,220	0		
4	10	88	882	0		
5	14	268	3,756	1	22	22
6	18	322	5,792	1	22	22
7	15	139	2,082	1	22	22
8	38	374	14,219	2	14	27
Total	133		36,842	7		120

6. Acknowledgements

This research was funded by New Plymouth District Council. We thank Ross Beaven for his superb organisation, site preparation and review. We thank Leia Murcott for exceptional fishing skills on the bow of the electrofishing boat and Soraya Ruakere-Forbes for assistance with catch handling on the boat. We also thank Teone Smith and the two hapu Ngāti Te Whiti and Ngāti Tawhirikura for their assistance in release of the captured fish.

7. References

- Davies-Colley, R. J. 1988. Measuring water clarity with a black disk. *Limnology and Oceanography* 33: 616-623. [DOI 10.4319/lo.1988.33.4.0616](https://doi.org/10.4319/lo.1988.33.4.0616)
- Hicks, B.J., Bell, D.G. and Powrie, W. 2018 Boat electrofishing survey of fish abundance in the Ohau Channel, Rotorua, in 2017. ERI Report No. 116. Client report prepared for Bay of Plenty Regional Council. Environmental Research Institute, Faculty of Science and Engineering, University of Waikato, Hamilton, New Zealand. [Download PDF](#)
- Jellyman PG, DJ Booker, SK Crow, ML Bonnett & DJ Jellyman. 2013. Does one size fit all? An evaluation of length–weight relationships for New Zealand's freshwater fish species, *New Zealand Journal of Marine and Freshwater Research* 47: 450-468. [DOI 10.1080/00288330.2013.781510](https://doi.org/10.1080/00288330.2013.781510)