Fish Passage Barriers in Christchurch City Waterways

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1. INTRODUCTION

Many of New Zealand's freshwater fish species are diadromous, which means they migrate between freshwater and the sea to complete their life cycle. Diadromy is particularly common amongst our native fish, with roughly half of New Zealand's 56 native fish taxa[1] being diadromous, compared to only one or two of the 21 introduced species. Structures in waterways, such as weirs, culverts, pump stations, and flap gates, may present a barrier to fish migration. Structures therefore disproportionately affect native fish compared to introduced species, due to the high proportion of diadromous native fish taxa in New Zealand.

The 1983 Fisheries Regulations legally require fish passage to be provided past structures built in waterways. However, many structures built prior to 1983 did not provide for fish passage. National fish passage guidelines provide design guidance for new structures and for remediation of existing barriers (Franklin et al. 2018). The related Fish Passage Assessment Tool (FPAT) is a mobile application (or "app") that uses standardised field methods to assess structures for fish passage. Data collected using the app is uploaded to a national database and structures are prioritised for remediation (Franklin 2018).

There are numerous structures in waterways within the Christchurch district, which includes Banks Peninsula and Christchurch city. In 2019, CCC commissioned a pilot study that assessed 32 structures in Banks Peninsula waterways using the newly-completed FPAT app (Instream 2019). The pilot study included collection of additional data on "constructability", which is an indicator of the relative ease or difficulty of remediating an identified barrier. Over summer 2019/2020, students funded by Environment Canterbury and CCC assessed approximately 150 structures on Banks Peninsula using the FPAT app and constructability data. Potential fish barriers in Christchurch city waterways have been identified during fieldwork undertaken as part of the Christchurch River Environment Assessment Survey (CREAS). However, the CREAS barriers have not yet been assessed using the FPAT app.

This report describes the results of fish passage assessments undertaken using the FPAT app and constructability data collected from Christchurch city waterways. The structure assessments focus on barriers previously identified during CREAS surveys in the Avon, Heathcote, and Styx River catchments.

2. METHODS

2.1. Field Data Collection

A total of 32 structures were assessed during this survey. CCC provided a list of 31 barriers identified during CREAS surveys over 2016 to 2018. Twelve of the CREAS barriers were not assessed during this study for various reasons, including: the barrier no longer exists; waterway realignment (existing or proposed) has or will remove the barrier; or because the potential barrier was debris build-up and not a structure. In addition to the 19 CREAS barriers, 13 structures were assessed that had not previously been identified. The additional structures comprised a mix of barriers known to Instream in similar locations to the CREAS barriers, as well as structures encountered while accessing another known barrier (Table 1, Figure 1).

[1] "Taxa" includes species that have been formally classified and those recognised as likely being a separate species but are awaiting formal classification. The total taxa count is based on Dunn et al. (2018).

*Table 1: All sites considered for fish barrier assessment. Grey italics indicates sites not assessed. * Indicates structure associated with stormwater treatment facility.*

Site code	Structure type	Reason why site was selected or removed
1	*Weir*	*No longer exists*
2	*Weir*	*No longer exists*
3	*Culvert*	*Water to be redirected to new stormwater facility soon*
4	*Culvert*	*Water to be redirected to new stormwater facility soon*
5	Culvert	CREAS site
6a	Culvert*	CREAS site
6b	Culvert*	New site associated with a CREAS site
6c	Fish pass*	New site associated with a CREAS site
7a	*Weir**	*New stormwater facility has since been built, no longer exists*
7b	Culvert*	New site associated with a CREAS site
7c	Culvert*	New site associated with a CREAS site
8	Culvert	CREAS site
9	Culvert	CREAS site
10	*Weir*	*No barrier present*
11	Weir	CREAS site
12	Weir	CREAS site
13	Weir	CREAS site
14	Weir	CREAS site
15	Weir	CREAS site
16	Weir	CREAS site
17	Weir	CREAS site
18	Weir	CREAS site
19	Weir	CREAS site
20	Weir	CREAS site
21	Weir	CREAS site
22	*Weir*	*Debris build-up, no longer exists*
23	Weir	CREAS site
24a	Weir	CREAS site
24b	Weir	New site associated with a CREAS site
24c	Weir	New site associated with a CREAS site
24d	Weir	New site associated with a CREAS site
25	*Weir*	*Debris build-up, no longer exists*
26	*Weir*	*Same site as above (double-up)*
27	*Weir*	*No longer exists*
28	Weir	CREAS site
29	Weir	CREAS site
30	*Culvert*	*Has been realigned, barrier no longer exists*
31a	Culvert	CREAS site
31b	Weir*	New site associated with a CREAS site
32	Culvert	New site selected by Instream
33	*Culvert*	*Structure has been removed*
34	Culvert	New site selected by Instream
35	Culvert	New site selected by Instream
36	Culvert	New site selected by Instream

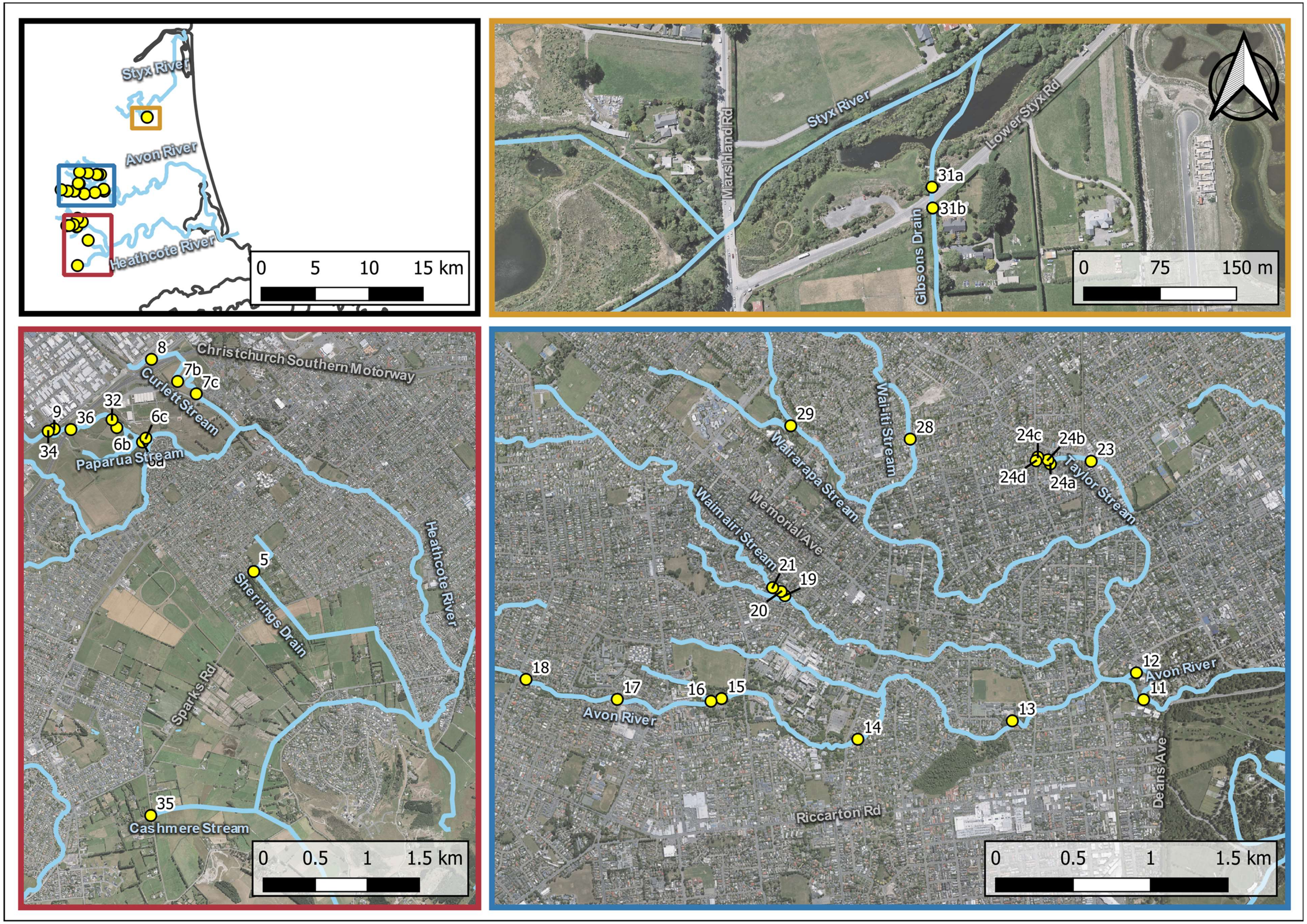

Figure 1: Location of structures assessed for fish passage. Mapping data were sourced from the LINZ Data Service and licensed for reuse under the CC BY 4.0 licence.

Structures were assessed between 11 July 2019 and 13 January 2020. Fish passage assessments were made using the FPAT app on a tablet or smart phone. Data collected during the FPAT assessment includes information on the type of structure (e.g., weir or culvert), physical attributes of the structure (e.g., culvert length or weir height), and photographs. After being uploaded, data appears on the FPAT website with the calculated structure risk level and priority score, usually within the next 24 hours. FPAT priority scores range from a low of 4 (lowest priority for remediation) to a high of 20 (highest priority).

The FPAT priority score is the sum of four separate scores based on the ecological benefits of removing or remedying a barrier. They include:

- Barrier risk score – greater if the structure presents a greater risk to fish passage.
- Downstream connectivity score – greater if there are few barriers downstream.
- Catchment position score – greater if the structure is closer to the coast.
- Accessible upstream habitat score – greater if there are few barriers upstream.

Important assumptions associated with the version of the FPAT app used include:

- Some small streams are not mapped within the app. This means the app cannot calculate a remediation priority score for structures on small, unmapped streams.
- The prioritisation score does not take into account whether remediation is practical.
- There is little account taken of potential habitat suitability or quality for fish (other than stream width). In other words, all habitat is equal.

Constructability data were also collected for each structure, following similar methods described by Instream (2019). Briefly, the following constructability data were included: site access for machinery, traffic management requirements, special access requirements (e.g., steep slopes or confined spaces), and native vegetation clearance (Table 2). Constructability categories were given a rank score and the category scores were summed to give an overall constructability score that ranged from 4 (poorest) to 11 (best). Constructability data were collected using the Fulcrum app on a tablet or smart phone.

Table 2: Constructability scoring criteria for structures.

Parameter	Options	Score
Site access for machinery	Good (off-road parking)	4
	Fair	3
	Poor (access from road only)	2
	Very poor (no road access)	1
Traffic management required?	No	2
	Yes	1
Special access required? (steep slope or confined space)	No	2
	Yes	1
Native vegetation clearance?	No	3
	Yes, minor (<10 m²)	2
	Yes, major (>10 m²)	1

2.2. Data Analysis

Field data were entered directly into the FPAT and Fulcrum apps. Following checks for errors and completeness, FPAT data were uploaded to the FPAT website. The FPAT risk level and priority scores calculated by the FPAT website were downloaded and plotted against constructability data, to help prioritise sites for remediation based on fish passage risk and the practicality of undertaking repair works to improve fish passage.

3. RESULTS AND DISCUSSION

3.1. Fieldwork Summary

A total of 32 structures were assessed, comprising a range of mostly weirs and culverts of varying shapes and sizes (Figure 2). Seven sites had no flow, including five sites (Sites 8, 16, 32, 34, and 36) that had water pooling either in or around the structure. Site 25 was a debris build-up that has been present since the CREAS survey several years earlier, so it was recorded in Fulcrum only as it is not an instream structure impeding fish passage, but rather a maintenance issue. See Appendix 1 for details of each structure assessed and Appendix 2 for representative photographs of all the structures.

Some sites were assessed more than once when issues with the FPAT app resulted in data loss. Version 1.2.15 of the app was released on 25 November 2019, which resolved most of the instability issues. It also made it easier to select a river segment and made it possible to submit a barrier assessment that did not have an associated river segment. The only issue with the app since the update has been less severe instability, usually while taking photographs in the app which only results in data loss for the active site.

Most structures assessed were in small streams and were readily assessed by one person. However, there were several structures that were on the mainstem of the Avon River or ran under major infrastructure such as a motorway. It proved useful to have more than one person at these sites, to help with structure measurements and for safety reasons.

3.2. Barrier Prioritisation

FPAT risk assessments were calculated for all 32 sites. Remediation priority scores were calculated for only 28 sites, as the remaining 4 sites were not associated with a stream segment in the app. This is an improvement on an earlier study of fish barriers on Banks Peninsula, where structure risk to fish passage could not be calculated for numerous sites without stream segments (Instream 2019). All but one of the 32 sites were assessed by the FPAT website as having a high or very high risk of impeding fish passage (97%; Figure 3). This differs markedly to the national fish barrier database on the FPAT website, where only 41% of structures assessed have a high or very high risk. The primary reason for this difference is that most structures assessed during this study were weirs and culverts, which usually pose greater risk to fish passage than bridges. The national database includes many bridge assessments and bridges are automatically considered a low risk by the FPAT.

Figure 2: Examples of the range of structures assessed.

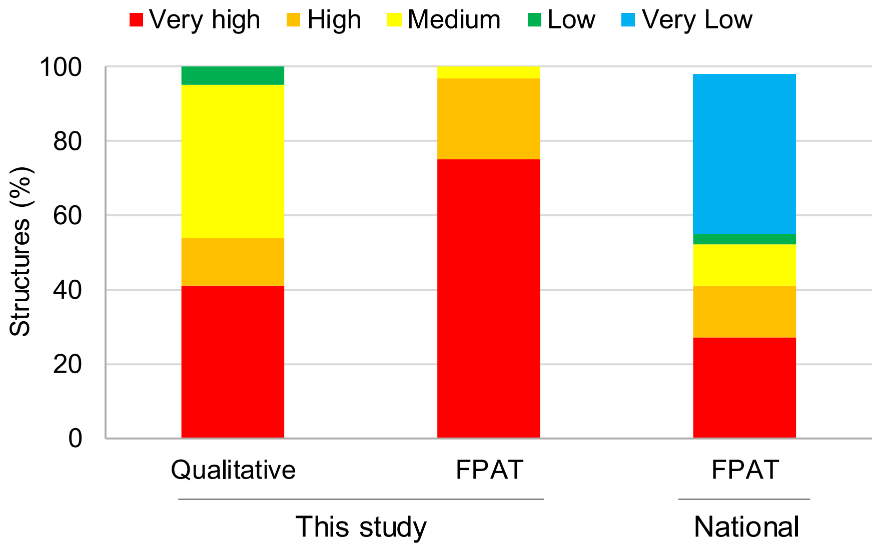

Figure 3: Risk to fish passage for structures, assessed qualitatively by the observer and assessed using the FPAT app. Data for this study are compared to national data from the FPAT website, downloaded on 31 March 2020.

The qualitative risk to fish passage (estimated in the field by the assessor) was often lower than the calculated FPAT risk assessment (Figure 3). This was mainly the case for structures in tributary waterways, where the structures were often small weirs made of material such as wood and stacked rocks. These structures were considered by the assessor to present less of a fish passage risk, as the structures had often degraded over time, creating better fish passage. For example, a low weir made of rocks at Site 20 was judged by the assessor to present only a medium risk to fish passage, when compared to a taller weir such as Site 12 (Figure 4). Similarly, a low wooden weir at Site 19 was constructed with logs that had slumped in places along its length, providing opportunities for fish to swim past, and so the structure was judged by the assessor to present a medium risk to fish passage (Figure 5).

Figure 4: A low-level weir made of rocks (left, Site 20) was qualitatively assessed as a medium risk to fish passage, but had an FPAT assessment of very high risk. A large weir on the Avon River (Site 12, right) was considered a high risk by both methods.

Figure 5: A low wooden weir (Site 19, left) presents less of a barrier to fish than a taller weir (Site 17, right), but both were assigned a very high risk to fish passage by the FPAT website. In the assessor's opinion, the low weir represented a medium risk, while they agreed that the taller weir presented a very high risk to fish passage.

Sites 7b and 34 were qualitatively assessed as low risk but calculated by the FPAT website to be high risk (Figure 6). Both sites were culverts with no flow through them, but based on the level of water ponding through the culverts, the assessor considered that the culverts would present a low risk to fish passage during normal flow conditions. It appears that the considerable length of the culverts (both were > 22 m long) substantially affected the FPAT score, as culvert length is a factor affecting the overall "passability" of a culvert in the FPAT risk calculation.

Figure 6: Site 7b (left) and Site 34 (right) were deemed low risk by the assessor but classified as high risk by the FPAT website. The outlet of Site 7b was temporarily sealed to retain water for watering new plants in the stormwater wetlands, but was assessed as if the seal was absent.

FPAT priority scores ranged from 5 to 15, with 20 being the highest priority score a structure can be given. Priority scores were overall lower than those calculated for structures on Banks Peninsula streams (Instream 2019). This was likely because in this study, multiple barriers were recorded along waterways, which reduces the priority score for an individual barrier. In addition, barriers were generally located further from the sea in this study, which also reduces their priority for remediation.

Constructability scores ranged from 4 to 11 with 11 being the highest possible score. We plotted FPAT priority scores against constructability scores to help identify sites that are the highest priority for remediation and relatively easy to repair (i.e., sites located to the top right of Figure 7). While the plot is useful for displaying the data, individual sites should still be scrutinised to check their prioritisation score makes sense from an ecological and engineering perspective. For example, the culvert at Site 5 on Sherrings Drain has the highest FPAT priority score (15), but the entire upstream catchment is piped, so there is little point improving fish passage through the culvert.

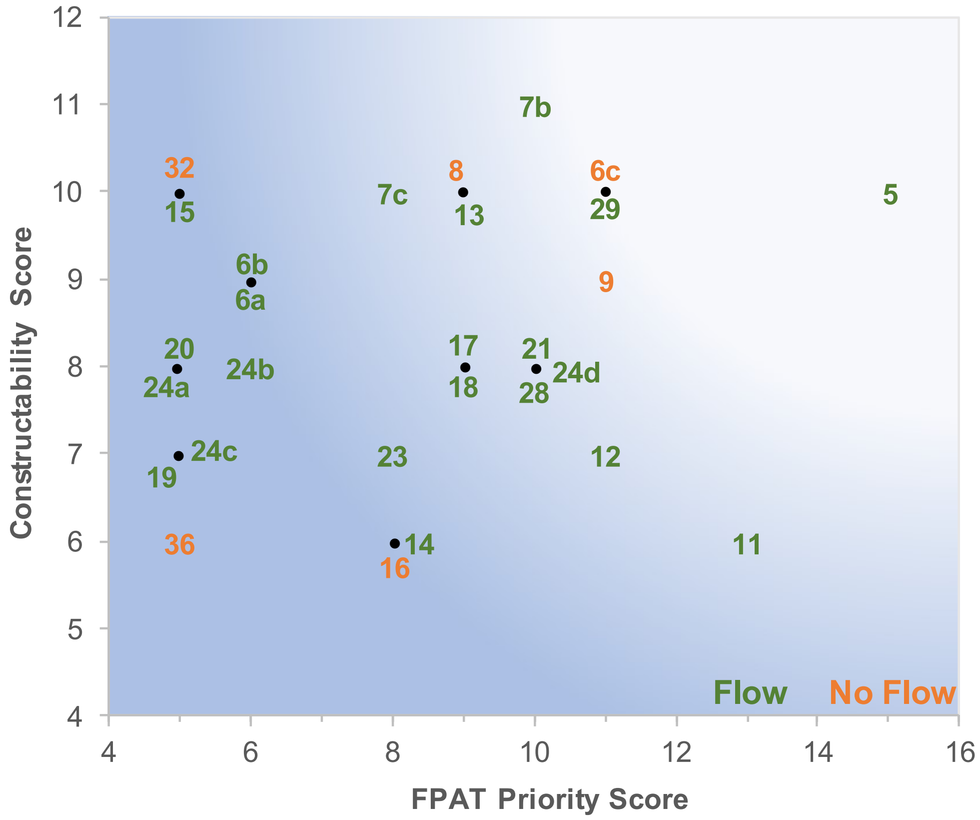

Figure 7: FPAT priority and constructability scores for the structures assessed. Coloured numbers on the plots are site numbers, with the site colour indicating whether flow was present (green) or absent (brown).

Of the structures surveyed, greatest priority should be given to remediating fish barriers in the Avon River catchment, starting with the large weirs on the Avon River near Mona Vale (Sites 12 and 13, Figure 8). That is because these structures have the largest upstream catchment of all those assessed, they are clearly significant barriers, and there is plenty of fish habitat upstream. The next highest priority should be given to the weir on the Avon River at Christchurch Boys High School (Site 13), followed by a weir on the Avon River downstream of Clyde Road (Site 14). Improving fish passage past these four weirs would provide by far the greatest opportunity for increasing native fish diversity and abundance upstream.

Figure 8: Four weirs on the Avon River that are the highest priority for improving fish passage of the structures assessed. The structures are located near Mona Vale (Sites 11 and 12), Christchurch Boys High School (Site 13), and downstream of Clyde Road (Site 14).

Fish barriers identified in the Curlett Stream and Paparoa Stream catchments are a lower priority than those in the Avon River catchment. That is because they have relatively small catchments upstream, they are primarily associated with stormwater facilities, and they have less aquatic habitat available upstream for fish. However, new stormwater structures have recently been built on both Curlett and Paparoa Stream, and any new structures are required to provide fish passage as part of the 1983 Fisheries Regulations. Given that both the Curlett and Paparoa Stream stormwater facilities were only recently completed during the site visits, it would be worthwhile CCC engineers visiting the site with ecologists to look at options for enhancing fish passage before the defects period expires for each new facility.

There are additional barriers present Christchurch city waterways that were not assessed as part of this project that are worthwhile investigating. These include numerous road culverts, pump stations, tide flap gates, and stormwater facilities. While bridges are used for road crossings of most of the larger waterways, culverts are more commonly used for smaller waterways and culverts typically present a greater barrier to fish passage than bridges. Recent studies in the Waikato region have shown very high mortality rates of migrating eels passing through pump stations (Vaipuhi Consulting 2017), but there have been no investigations into fish passage through pump stations in Christchurch. An investigation into fish-friendly tide gates in Christchurch found they were generally successful in passing fish (Instream 2018), but more work is needed to assess their effectiveness under a range of environmental settings. Numerous stormwater facilities have been built across the city over the last 20 years, but many were built without consideration of fish passage and virtually nothing is known of the fish communities these stormwater facilities support.

4. CONCLUSIONS AND RECOMMENDATIONS

A total of 32 structures were assessed for fish passage as part of this study, including sites in the Avon, Heathcote, and Styx River catchments. Of the 32 structures assessed, 19 had been previously identified during CREAS surveys and an additional 13 structures had not previously been identified. Nearly all the structures assessed were weirs and culverts. Several large weirs on the Avon River are considered the highest priority for remediation because they are clearly significant barriers and they have the largest upstream catchment of all the structures assessed. Improving fish passage past these structures therefore has the potential to substantially increase native fish diversity and abundance upstream.

Based on the results of this survey, we recommend the following:

- Prioritise improving fish passage past the major weirs on the Avon River, starting with the Mona Vale weirs and moving upstream.
- CCC engineers and ecologists visit new stormwater facilities on Curlett and Paparoa Streams to look at fish passage issues and options for enhancing fish passage.
- Assess fish passage associated with the following structures across the city:
    - Stormwater treatment facilities with significant baseflow.
    - Road culverts.
    - Pump stations.
    - Tide gates.
- As additional structures are assessed for fish passage, prioritise remediation for fish passage enhancement based on a combination of:
    - The FPAT app risk assessment.
    - Consideration of constructability and how practical remediation is.
    - Fish communities present in the catchment.
    - Priorities of iwi and local community groups.

5. REFERENCES

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APPENDIX 1: STRUCTURE ASSESSMENT DATA

Site code	Waterway	Easting (NZTM)	Northing (NZTM)	Flow	Structure type	Visual risk assessment	FPAT risk assessment	FPAT priority score	Constructability score
5	Sherrings Drain	1567078	5176347	Normal	Culvert	High	Very High	15	10
6a	Paparua Stream	1566010	5177594	Normal	Outlet for stormwater ponds	Very high	Very High	6	9
6b	Paparua Stream	1565763	5177733	Normal	Culvert	Very high	Very High	6	9
6c	Paparua Stream	1566042	5177631	No flow	Small pipe added for fish passage that discharges across grass	Very high	Very High	11	10
7b	Curlett Stream	1566347	5178176	Normal	Culvert	Low	High	10	11
7c	Curlett Stream	1566526	5178057	Normal	Culvert	High	Medium	8	10
8	Curlett Stream	1566096	5178388	No flow	Culvert	Medium	High	9	10
9	Paparua Stream	1565162	5177719	No flow	Culvert	Medium	Very High	11	9
11	Avon River	1568562	5180912	Normal	Weir	Very high	Very High	13	6
12	Avon River	1568515	5181087	Normal	Weir	Very high	Very High	11	7
13	Avon River	1567714	5180775	Normal	Weir	Very high	Very High	9	10
14	Avon River	1566717	5180656	Normal	Weir	Very high	Very High	8	6
15	Avon River	1565837	5180919	Normal	Weir	Very high	Very High	5	10
16	Avon River	1565769	5180902	No flow	Weir	Very high	Very High	8	6
17	Avon River	1565164	5180914	Normal	Weir	Very high	Very High	9	8
18	Avon River	1564575	5181043	Normal	Weir	Medium	High	9	8
19	Waimairi Stream	1566246	5181586	Normal	Weir	Medium	Very High	5	7
20	Waimairi Stream	1566222	5181613	Normal	Weir	Medium	Very High	5	8
21	Waimairi Stream	1566167	5181638	Normal	Weir	Very high	Very High	10	8
23	Taylor Stream	1568223	5182456	Normal	Culvert	High	Very High	8	7
24a	Taylor Stream	1567960	5182439	Normal	Weir	Medium	Very High	5	8
24b	Taylor Stream	1567944	5182465	Normal	Weir	Medium	Very High	6	8
24c	Taylor Stream	1567879	5182483	Normal	Weir	Medium	Very High	5	7
24d	Taylor Stream	1567867	5182459	Normal	Weir	Medium	Very High	10	8
28	Wai-iti Stream	1567055	5182599	Normal	Weir	Medium	Very High	10	8
29	Wairarapa Stream	1566284	5182685	Normal	Weir	Very high	Very High	11	10
31a	Gibsons Drain	1572556	5187807	Normal	Culvert	Medium	High	-	4
31b	Gibsons Drain	1572545	5187788	Normal	Weir	Very high	Very High	-	11
32	Paparua Stream	1565717	5177809	No flow	Culvert	Medium	High	5	10
34	Paparua Stream	1565104	5177698	No flow	Culvert	Low	High	-	9
35	Cashmere Stream	1566089	5173998	Normal	Culvert	High	Very High		10
36	Paparua Stream	1565322	5177714	No flow	Culvert	Medium	High	5	6

APPENDIX 2: STRUCTURE PHOTOGRAPHS

Figure 1: Site 5 (downstream end).

Figure 2: Site 6a (downstream end).

Figure 3: Site 6a (upstream end).

Figure 4: Site 6b (upstream end).

Figure 5: Site 6c (downstream end).

Figure 6: Site 7b (downstream end).

Figure 7: Site 7c (upstream).

Figure 8: Site 8 (downstream end).

Figure 9: Site 9 (downstream end).

Figure 10: Site 11 (downstream end).

Figure 11: Site 12 (downstream end).

Figure 12: Site 13 (downstream end).

Figure 13: Site 14 (downstream end).

Figure 14: Site 15 (downstream end).

Figure 15: Site 16 (upstream end).

Figure 16: Site 17 (downstream end).

Figure 17: Site 18 (downstream end).

Figure 18: Site 19 (downstream end).

Figure 19: Site 20 (downstream end).

Figure 20: Site 21 (downstream end).

Figure 21: Site 23 (downstream end).

Figure 22: Site 24a (downstream end).

Figure 23: Site 24b (downstream end).

Figure 24: Site 24c (downstream end).

Figure 25: Site 24d (downstream end).

Figure 26: Site 28 (downstream end).

Figure 27: Site 29 (downstream end).

Figure 28: Site 31a (downstream end).

Figure 29: Site 31b (downstream end).

Figure 30: Site 32 (downstream end).

Figure 31: Site 34 (downstream end).

Figure 32: Site 35 (downstream end).

Figure 33: Site 36 (downstream end).