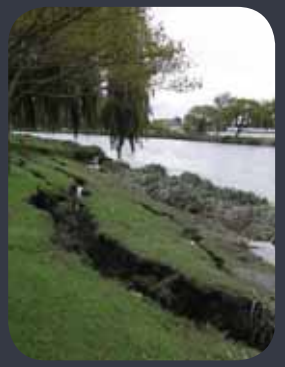
AQUATIC RESEARCH CONSULTANTS

Christchurch February Earthquake

EFFECT ON FRESHWATER FISH OF THE UPPER AVON RIVER

EOS Ecology Report No: 11011-CIV01-01 | May 2011
Prepared for: Environment Canterbury and Christchurch City Council
Prepared by: EOS Ecology; Alex James and Shelley McMurtrie



Environment Canterbury report no. U11/10
ISBN: 978-1-927195-87-1

Summary

The 22 February 2011 earthquake affected Christchurch's waterways through the inputs of liquefaction sand/silt, bank slumping, uplift of streambeds, and input of raw wastewater from broken sewage pipes. Such effects can have negative impacts on water quality, instream habitat condition, and the aquatic fauna.

EOS Ecology was asked to investigate if these sewage and sand/silt inputs had impacted on the Avon River's fish community. Sites were selected along an upstream-downstream gradient from no earthquake effects (Wairarapa Stream & Fendalton Rd), to possible sand/silt inputs (Carlton Mill & Hereford St), to known sand/silt plus sewage inputs (Kilmore St & Fitzgerald Ave). To determine if the earthquake had any negative impact on the fish of the Avon River through the central city, pre and post earthquake fish community data was compared.

There were no great differences in the number of species captured before and after the earthquake. The most common fish species were shortfin eel, common bully, and longfin eel.

Prior to the earthquake shortfin eel dominated sites upstream of Hagley Park while common bully dominated sites in the central city area. This upsteam-downstream pattern disappeared after the earthquake with fish communities becoming more similar; reflecting an increase in the relative abundance of shortfin eel and a decrease in common bully at the central city sites after the earthquake. The bluegill bully, a native fish considered to be declining nationwide, dropped in abundance at one site (Kilmore St) after the earthquake.

Catch per unit effort (CPUE) calculated by dividing the fish counts (the catch) with the time spent fishing (the effort) showed that the total CPUE was reduced after the earthquake at the three central city sites; sites that were possibly affected by sand/silt, sewage, or both. A reduced CPUE implies a reduction in fish abundance.

It is possible that the short-term sewage inputs, a subtle increase in siltation, or the disturbance of the earthquake itself had some impact on fish abundance in the central city, but it is difficult to apportion any fish community changes solely to such earthquake-related effects. Dramatic habitat changes that could explain the community changes was only seen at one site (Fitzgerald Ave).

Despite a reduction in the CPUE at the central city sites, fish are still found throughout the Avon River in the central city in good numbers. While there were some subtle changes to fish communities, there is no evidence of mass reductions in fish abundance or a reduction in species as a result of the earthquake. Since the sewage overflows in the central city have ceased (except for the overflow adjacent Fitzgerald Ave as of 21 May 2011) and there is no sign of substantial smothering of gravels by liquefaction sand, there are no immediate earthquake-related management actions that are required to protect the fish of the Avon River through the central city. However, the reduced abundance of bluegill bullies at the Kilmore St site should be monitored to see if they improve.

The Avon River the evening of the February 22nd earthquake

Effects of the February Earthquake on Christchurch Waterways

The devastation wrought by the 22nd February 2011 earthquake extended to Christchurch's waterways. Large amounts of sediment were released that smothered the aquatic plants and riverbed which is habitat for many aquatic animals (Fig. 1). In places the banks slumped and the riverbed was uplifted altering physical habitat characteristics of the river (e.g., depth, water velocities, and channel width). Numerous broken wastewater pipes discharged untreated sewage to the river (Fig. 1). Such organic material input can result in a spike in oxygen-demanding bacterial activity that can deplete dissolved oxygen levels and in extreme situations kill aquatic life.

FIGURE 1

FIGURE 1
Some of the physical effects of the earthquake on the Avon River that may have affected aquatic life.

Fish in the Avon River

At least 16 freshwater fish species have been recorded from the Avon River catchment with 11 species upstream of the Fitzgerald Ave bridge (Fig. 2). Two are introduced with the remaining nine species being native. The majority of the fish species recorded are diadromous meaning they migrate between fresh and salt water at some stage in their lifecycles. Yellow-eyed mullet is an estuarine species that commonly penetrates far upstream beyond the tidally influenced lower section of the river. Most fish species are rarely seen as they are nocturnal and cryptic and some species are not encountered often even in surveys (e.g., perch, lamprey). The most common fish observed off the City's bridges are brown trout, eels, and inanga. Large schools of yellow-eyed mullet can also be seen if you are in the right place at the right time.

Changes to water quality and habitat condition as a result of the earthquake may have negatively impacted Avon River fish populations. Additionally, the actual shockwave of the earthquake would have stressed fish and there is the potential that some may have suffered fatal internal damage, although there is no way we can confirm this.

FIGURE 2

FIGURE 2
At least 11 freshwater fish species have been recorded from the Avon River upstream of Fitzgerald Ave (derived from New Zealand Freshwater Fish Database and personal observations). Two are introduced with the remaining nine species being native. The threat classifications of Allibone et al. (2010) are given as are the diadromy status of each species (D=diadromous; species migrate between freshwater and the sea at some stage in their lifecycles).

Assessing Earthquake Effects on Avon River Fish

EOS Ecology and Aquatic Ecology have fish data from a number of locations in the Avon River catchment collected before the earthquake (i.e., McMurtrie & Taylor, 2003; McMurtrie *et al*., 2007; McMurtrie, 2009). Six sites were selected, and resampled on the 19–21 April 2011 to enable a pre and post earthquake comparison of fish communities (Fig. 3). Sites were selected along an upstream-downstream gradient from no earthquake effects (Wairarapa Stream & Fendalton Rd), to possible sand/silt inputs (Carlton Mill & Hereford St), to known sewage and sand/silt inputs (Kilmore St & Fitzgerald Ave). Ideally we would have included sites further downstream of Fitzgerald Ave, where there were more sewage and sand/silt inputs. However, the Avon River is too deep for electrofishing downstream of Fitzgerald Ave and as such there is very limited pre-earthquake quantitative fish community data from this section.

Fish were sampled using a Kainga EFM300 backpack electrofishing machine. Stunned fish were transferred to buckets, anaesthetised if necessary, measured, and released. To ensure the data was comparable with that collected previously, as far as was practical we employed the same sampling effort and methodology as was used in previous studies. Fish capture data has been expressed as 'catch per unit effort' (CPUE) to standardise the differing sampling efforts used in the original studies, and to compensate for lack of survey area information for pre-earthquake surveys undertaken by Aquatic Ecology. CPUE was calculated by dividing the number of fish captured (the catch) by the sampling effort which was the fishing time in minutes (unit effort).


Electrofishing at the Hereford Street site


Measuring fish at the Hereford Street site

SITE PHOTOS


Wairarapa Stream


Fendalton Road


Carlton Mill


Hereford Street

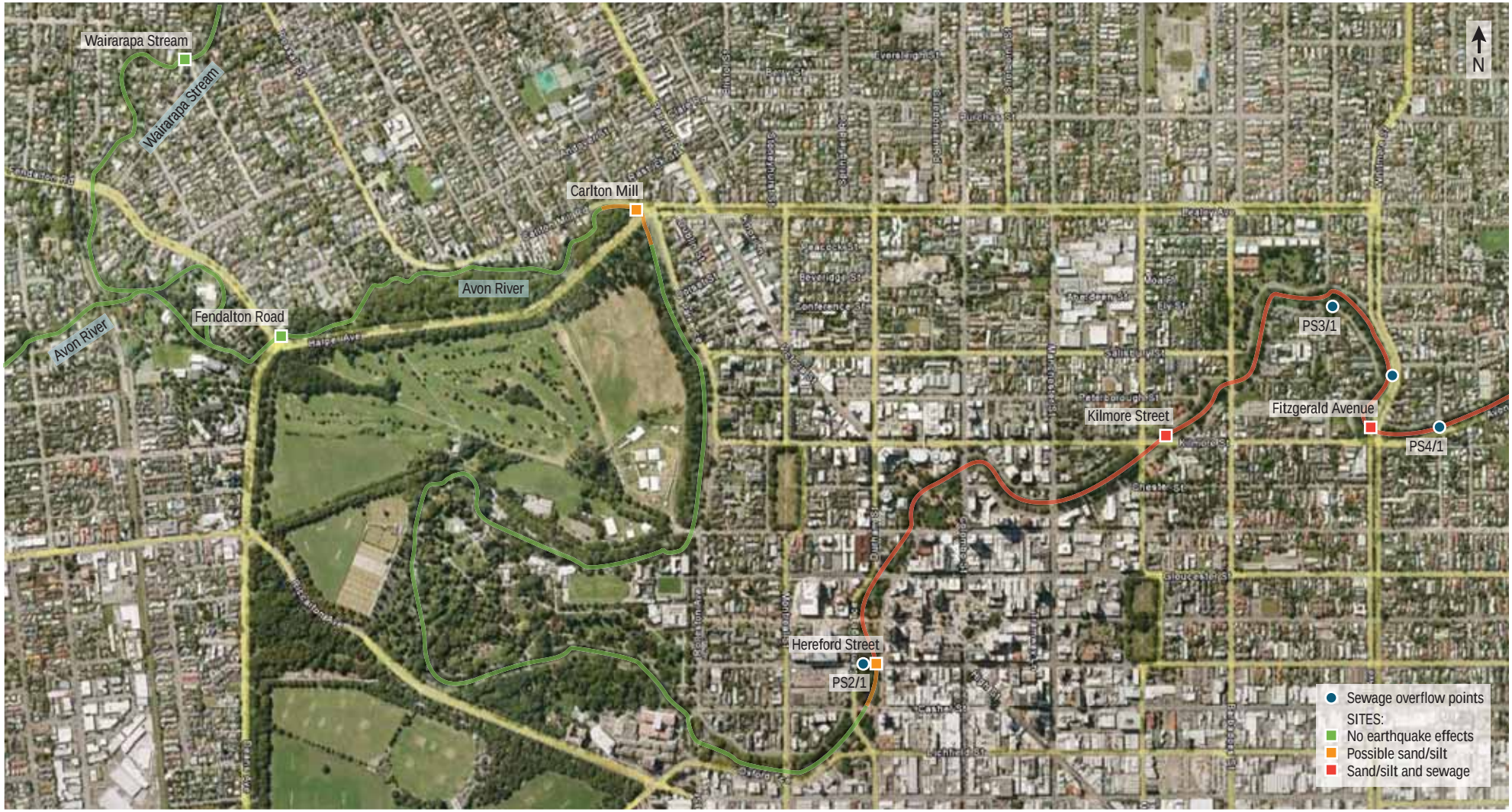

Kilmore Street


Fitzgerald Avenue

FIGURE 3

Sewage overflow locations (circles) and sites in the Avon River catchment sampled for fish on 19–21 April, 2011 (squares). Sewage overflows from the pumping stations PS2/1, PS3/1, and PS4/1 ceased in mid to late March. The overflow adjacent to Fitzgerald Ave still continues to discharge sewage (as of 21 May, 2011).

FIGURE 3


Wairarapa Stream
Wairarapa Stream
Carlton Mill
Avon River
Fendalton Road
Avon River
PS3/1
Fitzgerald Avenue
Kilmore Street
PS4/1
Hereford Street
PS2/1
N
Sewage overflow points
SITES:
No earthquake effects
Possible sand/silt
Sand/silt and sewage

Our Findings

Eight fish species were captured in the Avon River from the six sites before and after the 22 February 2011 earthquake. In order of most to least abundant these were; shortfin eel, common bully, longfin eel, bluegill bully, upland bully, brown trout, giant bully, and yellow-eyed mullet (Fig. 4). However, the fish community was numerically dominated by shortfin eel, common bully, and longfin eel (Fig. 5).

Before the earthquake there was a distinct difference in the relative abundance of fish species along the Avon River with sites upstream of Hagley Park being dominated by shortfin eel and those sites in the CBD dominated by common bully (Fig. 5). After the earthquake there was no such obvious upstream-downstream difference, with all sites having more similar communities. This reflected a general increase in shortfin eel abundance and decrease in common bully abundance at the four downstream (e.g., possibly earthquake affected) sites after the February earthquake.

Bluegill bullies were found at two CBD sites before the earthquake but were found at a third site after the earthquake (Fig. 5). While their abundance at the Hereford St site was similar over time, their abundance dropped at the Kilmore St site following the earthquake. Brown trout were only captured on one occasion before the earthquake (at the Carlton Mill site) but electrofishing often misses fast moving trout so they were likely present at other sites also.

FIGURE 4

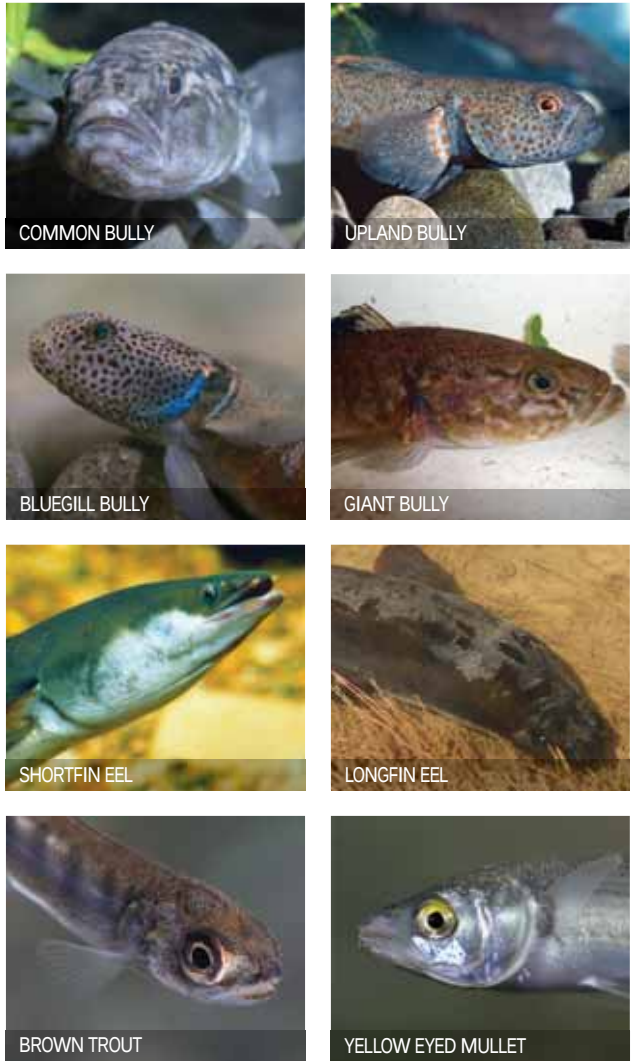


FIGURE 5

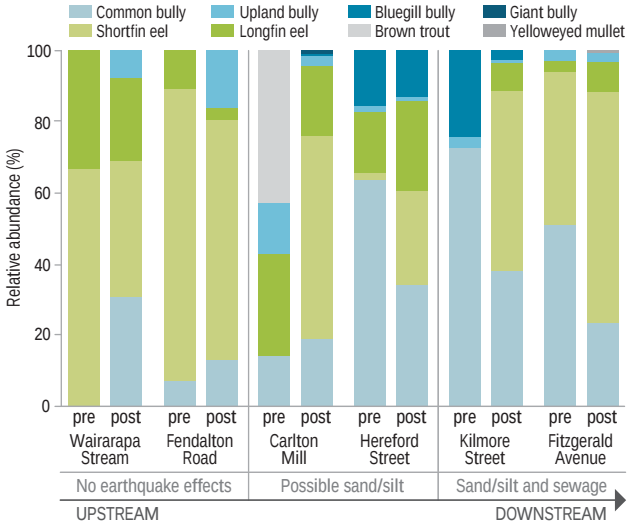


FIGURE 6

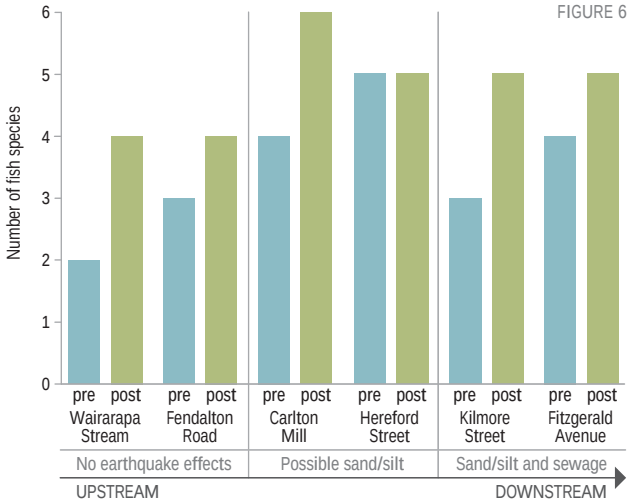


FIGURE 4
The eight fish species caught in the Avon River.

FIGURE 5
The relative abundance of the eight fish species captured in the Avon River at each site before and after the 22 February 2011 earthquake.

FIGURE 6
The number or fish species captured at each site along the Avon River before and after the 22 February 2011 earthquake.

The number of fish species captured ranged from two (Wairarapa Stm before the earthquake) to six (Carlton Mill after the earthquake) (Fig. 6). There were either the same numbers or more fish species caught at sites during the post-earthquake surveys (Fig. 6).

The total CPUE was lower at the three CBD sites (Hereford St, Kilmore St, and Fitzgerald Ave) after the earthquake (Fig. 7); sites possibly affected by sand/silt or sand/silt and sewage. It was similar before and after the earthquake at the two sites upstream of Hagley Park that were not affected by the earthquake (Wairarapa Stm and Fendalton Rd), and much higher at the Carlton Mill site (possible sand/silt effects) after the earthquake (Fig. 7). At the Hereford St and Kilmore St sites, many more fish were captured post-earthquake, however fewer were being caught per unit effort (time). At the Fitzgerald Ave site a similar number of fish were captured before and after the earthquake but they took more effort (time) to catch in the post-earthquake survey (Fig. 7).

Much of the CPUE pattern seen for the total catch was driven by the CPUE of common bully (the most common species captured at the three CBD sites before the earthquake) and shortfin eel (the most common species captured at the three CBD sites after the earthquake) (Fig. 7). The increased total CPUE post-earthquake at Carlton Mill was most likely because only spot-fishing was done in the pre-earthquake survey (Fig. 7). The CPUE for both eel species tended to be quite variable between sites and sampling occasions (Fig. 7).

FIGURE 7

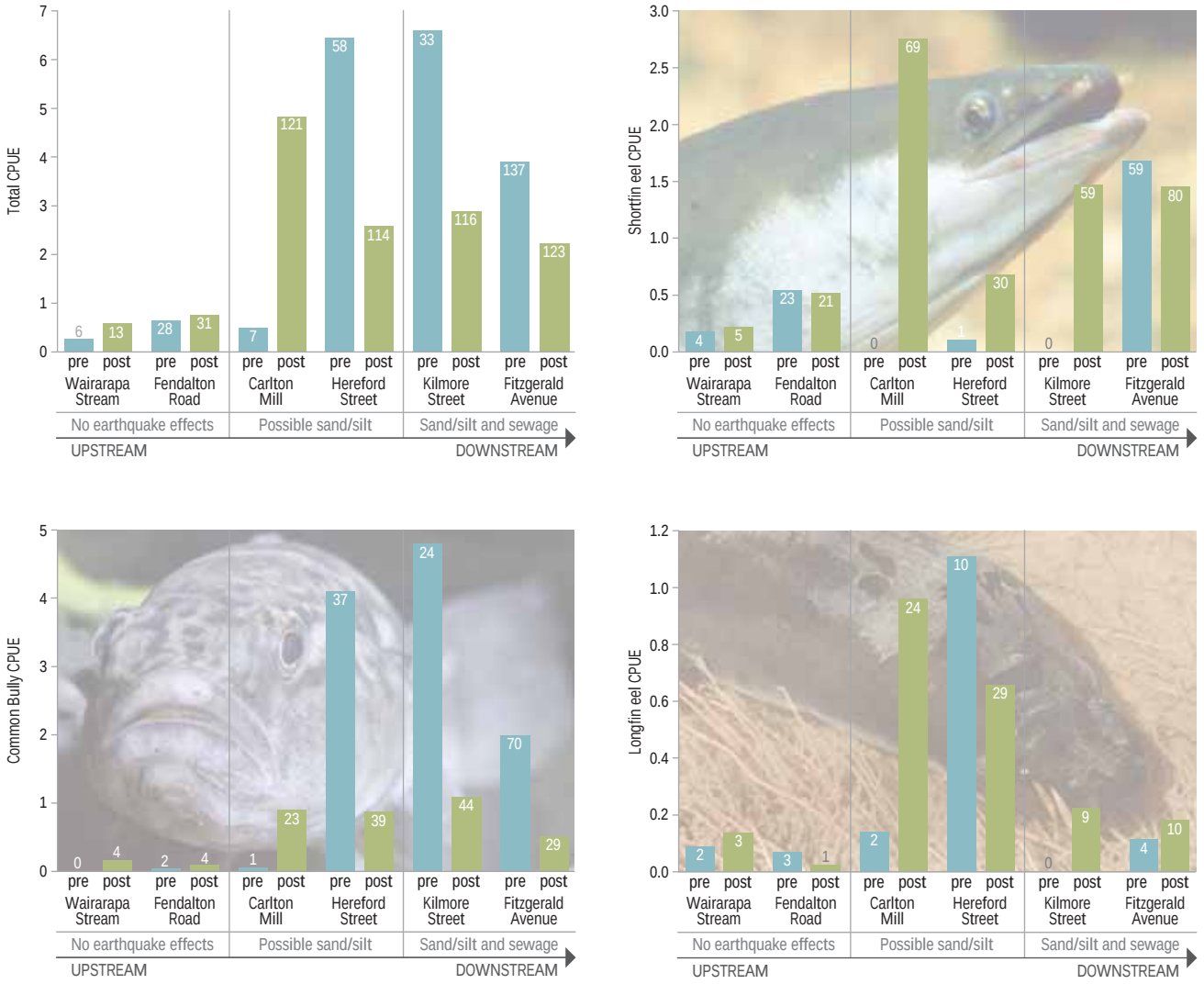


FIGURE 7

The catch per unit effort (CPUE) at sites along the Avon River before and after the 22 February 2011 earthquake for all the fish captured, and the three most common species. A higher CPUE means more fish were caught for the same amount of effort (time).

Conclusion and Management Actions

Some changes were evident in the fish community of the Avon River following the 22 February 2011 earthquake. Sites became more homogeneous in terms of species relative abundance and the total CPUE decreased markedly at the three downstream-most CBD sites (affected by sand/silt and sand/silt plus sewage) after the earthquake. These sites also showed an increase in the relative abundance of shortfin eels and decrease in common bullies.

Such post-earthquake changes may be the result of earthquake-related fish movement or simply natural seasonal population variation. The only site to have a noticeable change in habitat following the earthquake was Fitzgerald Ave, with a change from predominantly sand/silt pre-earthquake to more gravel and cobble; presumably as a result of bed uplift. Substrate composition did not dramatically change at Hereford St and Kilmore St following the earthquake but more subtle changes may have occurred, such as a slight in-filling of gravels. Perhaps the short-lived sewage input near Hereford St had some impact on fish abundance at these sites, but it is difficult to apportion the reduction in CPUE (and implied reduction in fish abundance) solely to the effects of the earthquake.

Despite a reduction in the CPUE at the CBD sites and some changes to relative abundance of the more common species, fish are still found throughout the Avon River in the earthquake-affected central city area in good numbers, including some species that are of conservation concern with a 'declining' threat classification (i.e., longfin eel, bluegill bully). There is no clear evidence of mass reductions in fish abundance or species as a result of the earthquake-related siltation or sewage inputs in the Avon River upstream of the Fitzgerald Ave bridge.

Since the sewage overflows in the central city have ceased (except the one adjacent Fitzgerald Ave) there are no immediate earthquake-related management actions that are required to protect the fish of the Avon River through the central city. It does not appear there has been a substantial smothering of gravel habitat through the central city from liquefaction silt but there maybe some subtle changes in substrate composition. It is likely that any localised reduction in overall fish abundance (as implied by the lower CPUE values) through the central city will self-normalise with time. However, the reduced abundance of bluegill bullies at the Kilmore St site should be monitored to see if they improve.

While there were subtle changes to fish communities, there is no clear evidence of mass reductions in fish abundance or species as a result of the earthquake-related siltation or sewage inputs in the Avon River upstream of the Fitzgerald Ave bridge.

Acknowledgements

Thank you to Mark Taylor (Aquatic Ecology Limited) for providing pre-earthquake data for the four most downstream sites.

References

Allibone, R., David, B., Hitchmough, R., Jellyman, D., N., L., Ravenscroft, P. & Waters, J. 2010. Conservation status of New Zealand freshwater fish, 2009. *New Zealand Journal of Marine and Freshwater Research* 44(4): 1-17.

McMurtrie, S. 2009. Major Sewer Upgrade: Impacts on the Aquatic Ecology of the Avon River Catchment. EOS Ecology, Christchurch. EOS Ecology Report No. 08033-RMG01-01. 25 p.

McMurtrie, S. & Taylor, M. 2003. Ecological assessment of the Avon River mainstem, from Fendalton Road to Fitzgerald Avenue. EOS Ecology, Christchurch. 61 p.

McMurtrie, S., Burdon, F.J. & Taylor, M.J. 2007. Assessment of environmental effects: Impacts of the Fitzgerald Avenue Bridge widening on the aquatic ecology of the Avon River. EOS Ecology, Christchurch. EOS Ecology Report No. 06001-CCC01-01. 16 p.

EOS ECOLOGY || AQUATIC RESEARCH CONSULTANTS

P: 03 389 0538 | E: 03 389 8576 | info@eosecology.co.nz | www.eosecology.co.nz || PO Box 4262, Christchurch 8140, New Zealand