ecological effects of the Christchurch February earthquake on our city rivers

summary & management recommendations

Environment Canterbury Regional Council
Kaunihera Taiao ki Waitaha

CHRISTCHURCH CITY COUNCIL · YOUR PEOPLE · YOUR CITY

Why Did We Do These Studies?

The 22 February 2011 earthquake affected Christchurch's waterways following liquefaction sand/silt, bank slumping, uplift of streambeds, and input of raw wastewater. These may have adversely affected aquatic ecosystems in the Avon/Ōtākaro and Heathcote/Ōpāwaho rivers. Environment Canterbury and the Christchurch City Council thus arranged for a number of ecological studies to help answer the following key questions:

- What ecological effects are ongoing wastewater discharges into the rivers having?
- Given the nature and scale of these effects, are there any mitigation measures that could be used to reduce impacts?
- Are there any mitigation measures required to reduce impacts of liquefaction on reaches of the upper rivers that might previously have had high ecological value or on the estuary?
- If dredging is to be undertaken in the lower rivers for flood control work, are there any particular ecological hotspot areas that should be avoided?

These questions formed the basis of five studies undertaken by NIWA, EOS Ecology, and AEL, with input from the CCC and Environment Canterbury. They were:

1. Modelling to predict oxygen depletion and ammonia toxicity in the Avon/Ōtākaro and Heathcote/Ōpāwaho rivers.
2. Determine whether sewage and sand/ silt inputs had impacted on aquatic invertebrate communities.
3. Determine whether sewage and sand/silt inputs had impacted on fish communities.
4. Quantify adverse effects to inanga spawning habitats.
5. Identify any important areas in the two rivers that represent ecologically important regions for either aquatic plants, invertebrates or fish.

These studies were reported in a number of reports (Rutherford and Hudson 2011; James and McMurtrie 2011a, b; McMurtrie 2011; Taylor and Blair 2011) and as GIS maps showing specific ecological hotspots. Key findings follow, with management recommendations highlighted.


Liquefaction sand / EOS Ecology


Bank slumping and cracking / EOS Ecology


Suspended silt / EOS Ecology

PEOPLE INVOLVED:

NIWA Taihoro Nukurangi — Alastair Suren, Neale Hudson, Kit Rutherford

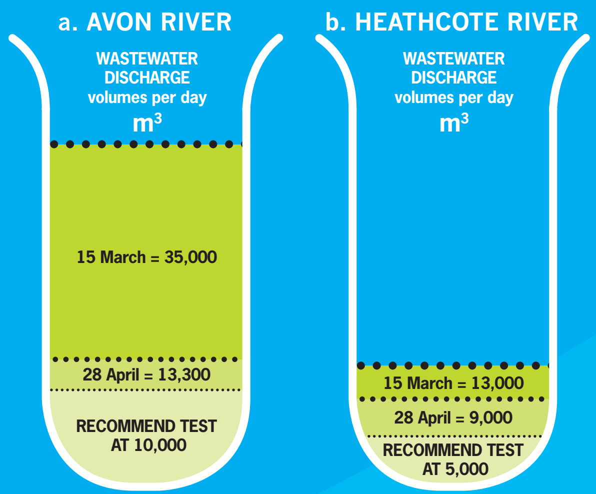
EOS Aquatic Research & Science Communication Consultants — Shelley McMurtrie, Alex James

Aquatic Ecology — Mark Taylor

Christchurch City Council · Your People · Your City — Zoe Dewson, Mike Bourke

Environment Canterbury Regional Council Kaunihera Taiao ki Waitaha — Michele Stevenson

1
Modelling Oxygen Depletion & Ammonia Toxicity



SUMMARY OF NIWA REPORT
Effects of Wastewater Overflows on Oxygen and Ammonia in the Avon and Heathcote Rivers, June 2011

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a. AVON RIVER/ŌTĀKARO

Immediately following the February earthquake, large volumes of wastewater were discharged into the river. For example, on 15 March an estimated total of 35,000 m³ per day of wastewater was discharged, but by 28 April discharges had reduced to about 13,300 m³ per day. In late April/early May both modelled and observed ammonia concentrations were below ANZECC guidelines for either chronic or acute toxicity at the lower wastewater discharges.

In late April/early May both modelled and observed depleted oxygen (DO) concentrations showed reduced concentrations between Swanns Rd and the Avondale Bridge. In the tidal reaches downstream of the Avondale Bridge there was an increase in DO. The model suggested that only some sensitive fish species may have been adversely affected between Banks Ave and Bridge St. With higher discharge volumes as occurred in late February, March and early April modelled DO concentrations were very low (close to zero) in this reach, and fish kills were possible.

Provided that wastewater inflows remain below about 10,000 m³ per day, then significant adverse effects on fish or invertebrate communities below the discharges are unlikely, and no management intervention is needed.


Raw sewage input / EOS Ecology

b. HEATHCOTE RIVER/ŌPĀWAHO

Following the February earthquake, wastewater discharges of about 13,000 m³ per day could have caused severe de-oxygenation between the Opawa Rd Railway Bridge and Ferrymead, potentially causing significant fish kills. By 28 April, discharges had reduced to about 4000 m³ per day. Predicted and observed DO concentrations still suggested appreciable DO depletion, particularly between the Opawa Rd Railway Bridge to Ferrymead. In this stretch of the river DO concentrations were lower than ANZECC chronic guideline values for fish, and occasionally lower than the acute guideline values. Sensitive fish species may thus be adversely affected in this reach. Ammonia concentrations in April were below ANZECC guideline values for both chronic and acute toxicity.

Provided that wastewater inflows remain below about 5,000 m³ per day (as measured), then significant adverse effects in the Heathcote/Ōpāwaho are considered unlikely, and no management intervention is needed.

RECOMMENDATIONS:

For both rivers, it is recommended that if wastewater discharges approach the above recommended limit of 10,000 m³ per day (Avon) or 5000 m³ per day (Heathcote), then DO should be measured to confirm whether low DO is a problem, and identify what reach needs attention. Assessments should be made either early morning or over a full day-night cycle using strategically deployed data sondes. Once this confirmation has been made, aeration of either the wastewater or the receiving water should be undertaken. During this time, it is recommended that data sondes be deployed below the discharge points, and at the lower boundary of the reach to see whether reaeration is successful. NIWA staff can provide more specific advice if needed.

2 Effects on Aquatic Invertebrates

INVERTEBRATES FOUND POST EARTHQUAKE (a. Upper Wadeable River Study)

Commonly Found | **More Sensitive**

SNAIL: *Potamopyrgus*
SNAIL: *Physa*
CADDISFLY: *Hudsonema*
CRUSTACEAN: Ostracoda
WORM
CADDISFLY: *Hyrdobiosis*
CHIRONOMID: midge
CRUSTACEAN: *Paracalliope*
CADDISFLY: *Pycnocentrodes*

SUMMARY OF EOS ECOLOGY REPORT
Christchurch February Earthquake Effect on Aquatic Invertebrates, June 2011
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SUMMARY OF EOS ECOLOGY REPORT
Christchurch February Earthquake Effect on Invertebrates of the Lower Rivers, June 2011
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a. UPPER WADEABLE RIVER STUDY

Surveyed sites on the Avon River were grouped into three categories:

1) "Control" or no earthquake effect.

2) "Sand/silt" inputs.

3) "Sand/silt and wastewater" inputs.

Historic data on the invertebrate communities at these sites allowed for a "before and after" comparison. The depth of fine sediment on the river bed increased most at the "sand/silt and wastewater" sites, and least at control sites. Such deposited sediment may have smothered cobbles in the streambed, possibly affecting invertebrates. The invertebrate community was dominated by taxa such as snails, crustaceans, midges, worms and caddisflies. Of the three categories, none displayed any consistent major change to invertebrate communities. However, small site-specific changes were observed, such as increases in relative abundance of snails in some control sites, and decreases in worms at a site affected by sand/silt inputs. The greatest earthquake related change was a large reduction in the relative abundance of caddisflies at the Kilmore Street site. Many other un-surveyed Christchurch streams have been subject to extensive liquefaction.

Removing cages from the upstream Avon River site / EOS Ecology

RECOMMENDATIONS:

1. **Caddisflies are rare in Christchurch waterways so the population at Kilmore Street should be checked regularly to see if it naturally recovers. If it doesn't recover then reintroducing them to this area should be considered.**
2. **Tributary waterways of the Avon, Heathcote and Styx catchments should be surveyed to determine the extent of liquefaction. If significant liquefaction damage has occurred, especially in reaches identified in Section 5, sand and silt should be removed to prevent it moving downstream. Mechanical removal by digger should be carefully managed to minimise damage to the bed and banks of waterways. Rather than simply dislodge silt from upstream areas where it will drift downstream and settle, it is best to try and physically remove silt from affected reaches.**

b. LOWER NON-WADEABLE RIVERS STUDY

This study examined effects of wastewater discharges on survival of three common invertebrates: the amphipod *Paracalliope*, the snail *Potamopyrgus*, and the freshwater shrimp *Paratya*. In both rivers animals were placed in cages above and below wastewater discharges. In the Avon River survival of *Paracalliope* and *Potamopyrgus* was lower below than above the discharges. In the Heathcote River the survival of all three species was similar at both sites. It was concluded that the moderate volumes of wastewater discharging into the Avon River at the time were increasing mortality of sensitive taxa such as *Paracalliope*. The much higher wastewater inputs immediately after 22 February, and again after 13 June were likely to have caused more mortality for sensitive invertebrates, and possibly fish.

RECOMMENDATIONS:

Apart from further monitoring work to assess potential recovery of invertebrate populations, no other management actions were identified.

3
Effects on Fish in the Upper Wadeable Avon River


Measuring fish / EOS Ecology

SUMMARY OF EOS ECOLOGY REPORT
Christchurch February Earthquake Effect on Freshwater Fish of the Upper Avon River, June 2011

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Surveyed sites on the Avon River were grouped into three categories:

1) “Control” or no earthquake effect.

2) “Sand/silt” inputs.

3) “Sand/silt and wastewater” inputs.

All sites had previously been surveyed for fish, allowing a before and after comparison. The most common fish species were shortfin eel, common bully, and longfin eel. There was no evidence of mass reductions in fish abundance or a reduction in species as a result of the earthquake, despite wastewater inputs and sand/silt deposition. Subtle changes in fish distribution patterns throughout the Avon were noted, reflecting an increase in shortfin eel abundance and a decrease in common bully abundance. The most notable change was a reduction in the relative abundance of bluegill bullies at the Kilmore Street site, where caddisflies also declined.

RECOMMENDATIONS:

No immediate earthquake-related management actions were identified for fish in the Avon River in the central city. However, to reduce the downstream transport of sediment and protect the bluegill bully population, liquefaction at the recently naturalised No. 2 Drain should be removed, and the habitat restored with the advice of an ecologist.

FISH FOUND IN THE AVON RIVER


COMMON BULLY


UPLAND BULLY


BLUEGILL BULLY


GIANT BULLY


SHORTFIN EEL

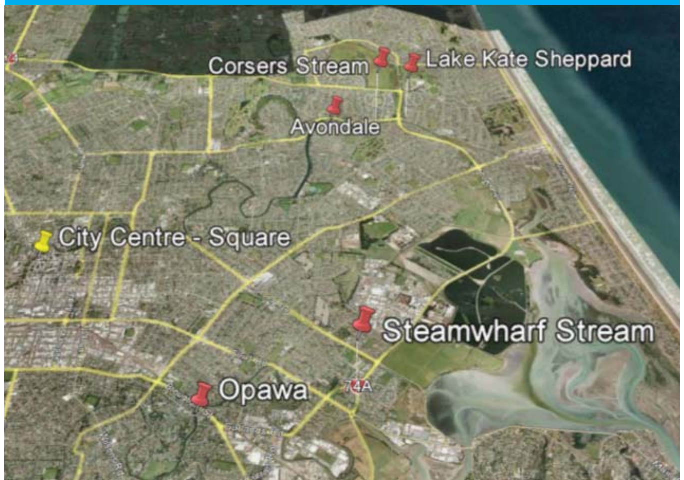

LONGFIN EEL


BROWN TROUT


YELLOW EYED MULLET


Electrofishing at the Hereford St site / EOS Ecology

4 Effects on Inanga (Whitebait) Spawning Habitats



SUMMARY OF AQUATIC ECOLOGY REPORT
Status of the City's Inaka Spawning Grounds Following Recent Seismic Activity, June 2011

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Seven known inanga (inaka/whitebait) spawning habitats on the Avon and Heathcote rivers were surveyed in April and May 2011 to determine if spawning was occurring, and to characterise the extent of earthquake related damage. Damage to sites was highly variable, ranging from minor to severe. Inanga eggs were observed at only the Avondale site, but this may not reflect earthquake effects alone. Some of the spawning sites were heavily overgrown by weedy species, reducing their spawning attractiveness. AEL identified specific management actions in order of ecological importance as follows:

RECOMMENDATIONS:

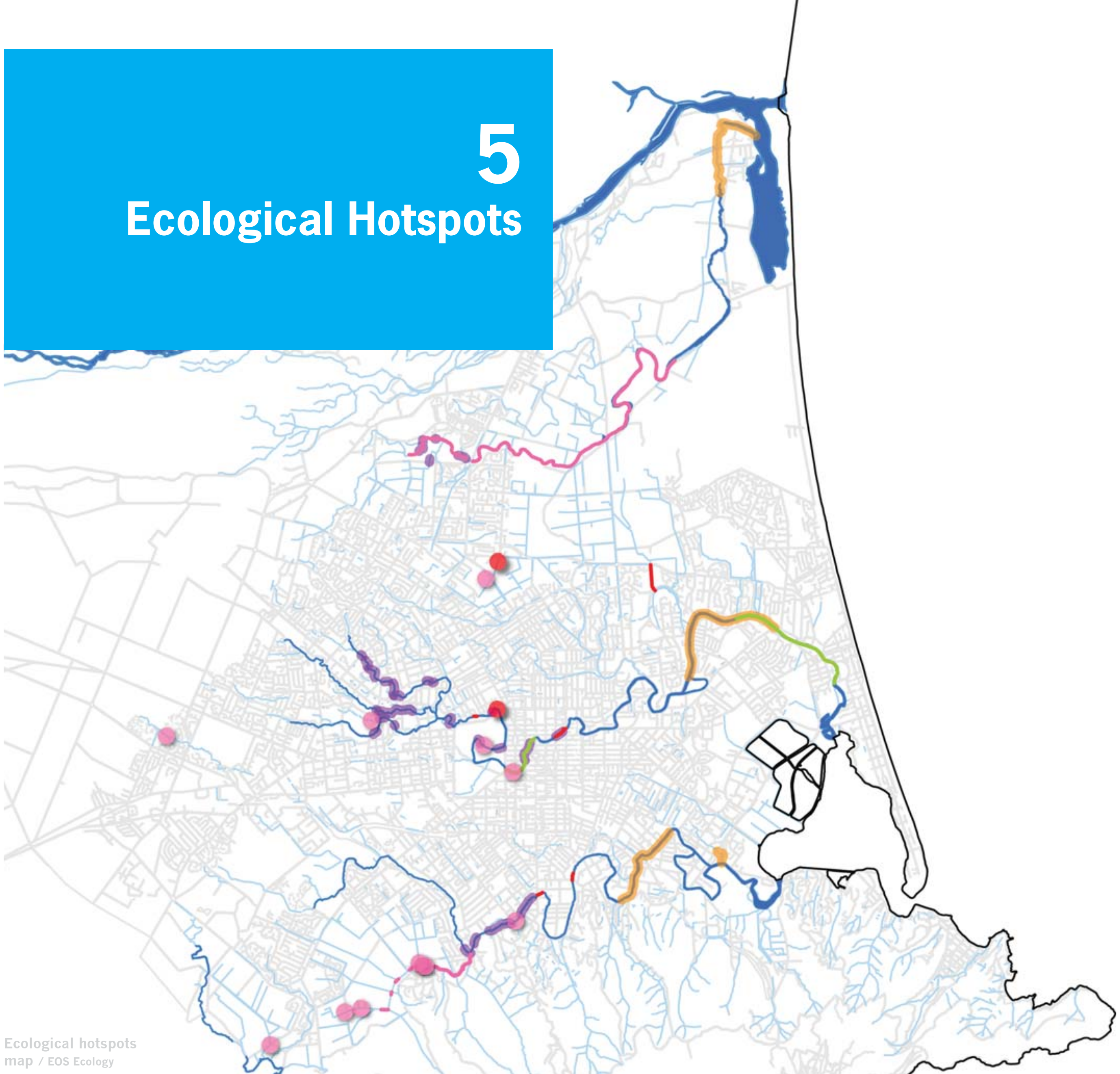
1. **Erect a silt trapping fence at the Avondale site to ensure silt does not enter spawning vegetation from remedial road works.**
2. **Weed control measures for yellow flag iris need to be maintained at Avondale.**
3. **Regrade and resow localised areas of lateral spread at Avondale to stabilise them.**
4. **Regrade and resow the Opawa spawning site to remove weedy plant species not conducive to spawning. Root mats in these plants were coated with silt, further reducing their spawning attractiveness.**
5. **Re-contour and replant the Lake Kate Sheppard site. Accumulated soft sediment on the lake's bottom should also be removed.**
6. **Narrow and deepen the lower channel Steamwharf Stream as banks have slumped badly.**
7. **Removal of liquefaction silt from the newly created areas in Corsers Stream.**
8. **Inter-tidal vegetation at Woolston Park was coated with fine silt, but this was expected to naturally self cleanse. Hand-weeding unwanted vegetation is all that is necessary.**
9. **Removal of unwanted vegetation is all that is necessary at the Amelia Rogers Reserve.**

AEL also recommended that rivers not be over-dredged to avoid potential upstream movement of the saltwater wedge, which is linked to inanga spawning.


Inanga eggs (actual size = 1 mm) / Aquatic Ecology


Opawa spawining site, Heathcote River / Aquatic Ecology

5 Ecological Hotspots



Ecological hotspots map / EOS Ecology

- Trout spawning reaches
- Inanga spawning reaches
- Fish high value ecological reaches & sites
- Invertebrate high value ecological reaches & sites
- Macrophyte high value ecological reaches
- Major rivers
- Waterways
- Coastline
- Roads

Discussions with staff from CCC, EOS Ecology, AEL, NIWA and Environment Canterbury identified five major ecological values that need to be considered should any major instream or bankside remedial works be taken. These are:

1. **Trout** spawning and habitat reaches.
2. **Inanga**/whitebait spawning areas.
3. Areas of significant native **fish** populations.
4. Areas supporting significant **invertebrate** populations.
5. Areas supporting significant **macrophyte** communities.

The spatial extent of these areas has been mapped on GIS layers. Any remedial works undertaken in these areas should therefore be cognisant of these values, and of the potential for remedial action to affect these values. For instance, it may be beneficial to avoid removing bankside vegetation in lower reaches during inanga spawning (February–April), or avoiding instream work in upper reaches during trout spawning (May–August).

RECOMMENDATIONS:

Consultation with any of the above ecological specialists should be sought prior to work commencing. The GIS layers for each of the five ecological values are available from CCC and should be consulted for more detail on the location of ecological hotspots.

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