

Kākahi (freshwater mussels) in Christchurch Waterways

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1. INTRODUCTION

Kākahi (freshwater mussels; *Echyridella menziesii*) are an 'At Risk' species that are in national decline (Grainger et al. 2018). Kākahi are present in Christchurch's Cashmere Stream and the Styx River (Burdon & McMurtrie 2009; Instream 2018) and there have been numerous incidental observations of kākahi in other Christchurch waterways. This report summarises results of a survey for kākahi in Christchurch waterways, primarily targeting locations where kākahi have been reported in the recent past, but where no dedicated survey has been undertaken. The report purpose is to provide information on the extent, density and population structure of kākahi at locations across the city.

2. METHODS

A candidate list of potential sampling locations was compiled from anecdotal records held by Christchurch City Council (CCC) and records from a public survey undertaken by Duncan Gray at Environment Canterbury (Appendix 1). An additional survey location was included on Cashmere Stream downstream of Hoon Hay Valley Stream confluence; no kākahi records exist at this location, but waterway realignment is being considered in the area. The final list of sampling locations is provided in Appendix 2. The final survey list includes additional sites on the Avon River that were chosen to help delineate the extent of the kākahi population present. Two additional sites are also included in the lower Heathcote River, where kākahi were recently discovered as part of a dredging operation. Sampling occurred from 2 to 17 June 2020 for all sites, except for the two lower Heathcote River sites, which were sampled on 17 July 2020.

Sampling at the wadeable sites used a similar two-tier sampling approach to that recently used in Cashmere Stream (Instream 2020). The first tier of sampling involved an initial rapid survey for kākahi at a cluster of three sites per sampling location, with a central site at the point of the anecdotal record, one site upstream, one site downstream, and each site separated by approximately 150 to 200 m. This clustered sampling design was used to improve the likelihood of finding kākahi during the rapid survey. Additional individual sites were added in the Avon River, to better delineate the extent of the population found there.

The rapid survey was a 15-minute timed search, with two observers searching all potential habitats for kākahi, giving an equivalent of 30 minutes of combined search time. The second tier of sampling was quantitative and occurred at one site per sampling location, if any kākahi were found during the rapid survey. Quantitative sampling involved sampling for kākahi using 0.1 m² quadrats along five transects, with five quadrats per transect. Each kākahi found during the quantitative sampling was measured (length, width, depth) and a shell erosion score estimated, before returning the individual to the water. Considerably more rapid surveys were done than quantitative surveys, to provide a better understanding of kākahi presence across numerous sites, rather than density estimates at fewer sites. Non-wadeable sites in the Avon River and Horseshoe Lake were surveyed by snorkel, using a rapid assessment approach only.

Different methods were used at the two lower Heathcote River sites, because the focus was on salvaging and relocating kākahi prior to river dredging. At these two sites, the survey involved two people searching the entire width and length of the site, with all kākahi removed, measured, and relocated downstream afterwards. The search was done entirely

by hand (i.e., a tactile search), because the river was too turbid for a visual search. Both sites are in a tidal section of the river, so the search was done at low tide, with one searcher in waders and the other in a wetsuit.

Additional habitat data was collected for each rapid survey and quantitative sampling site, as per Instream (2020). This included rapid habitat assessments using the methods of Clapcott (2015). The rapid habitat assessment involves assigning 10 habitat parameters with a score from 1 to 10, with higher scores for better quality habitat. The habitat parameters include measures of fine sediment cover, habitat diversity and abundance, and riparian width and shade.

Kākahi density data were compared graphically with recent survey data from the mean of four sites in the Styx River (Instream 2018) and eight sites in Cashmere Stream (Instream 2020), as well as the mean of 11 New Zealand lakes (Walker et al. 2001) and the mean of three Waikato streams (Hanrahan 2019). Shell length data from the 33 individual kākahi collected from the two lower Heathcote River sites were converted to age using the length-age regression equation of Ogilvie (1993). Kākahi age class structure from the Heathcote sites was compared with recent data from Cashmere Stream described in Instream (2020).

3. RESULTS

3.1. Habitat Overview

Survey sites ranged from shallow and narrow timber lined drains, such as Horners Drain and Cavendish Drain, to the broad lower reaches of the Avon River at Kerrs Reach (see Figure 1 for representative site photographs). Water clarity was good and suitable for visual searches at most sites except for the two lower Heathcote River sites, which were very turbid and where searching was done entirely by hand. Clarity was also reduced at the Horseshoe Lake site. Macrophyte cover was high along much of Horners and Cavendish Drains, which reduced search efficiency. Fine sediment cover was typically high, with mean cover of over 50% across all sites surveyed, although stony bed sediments were more common in the upper Avon River sites. There was generally low diversity in hydraulic habitat, with most sites dominated by uniform run habitat.

Rapid habitat assessment scores were low overall and varied from a minimum of 33 at Cavendish Stream in Styx Mill Reserve to a maximum of 67 at the Avon River at Bealey Avenue. Factors contributing to low habitat scores overall include high levels of deposited fine sediment, poor riparian habitat and shade, little suitable habitat for sensitive invertebrate taxa, and low diversity of hydraulic habitat (Figure 2).

Avon River at Botanic Gardens



Horners Drain



Dudley Creek



Horseshoe Lake outlet culvert



Cashmere Stream near Hoon Hay Valley Drain



Heathcote River at Riverlaw Tce



Figure 1: Representative photographs of kākahi survey sites.

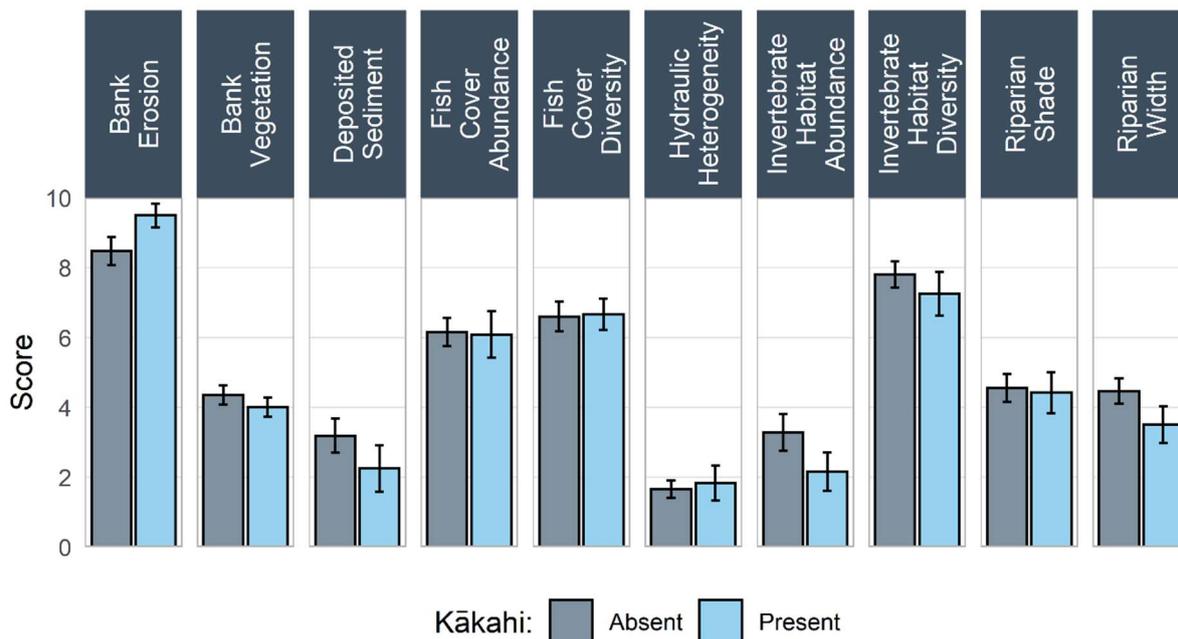


Figure 2: Results of the rapid habitat assessments categorised by sites where kākahi were either present or absent. Data are means (± 1 SE).

3.2. Kākahi Data

Kākahi were found at 17 of the 51 sites searched, with most of the records from the Avon River (Table 1, Figure 4). Empty shells were found at an additional five sites where no live kākahi were recorded. At the 17 sites where kākahi were found during the rapid survey, they were sparse at 12 sites, common at one site, and abundant at four sites. Kākahi were found at six of the ten locations with previous anecdotal records of live kākahi. No live kākahi were found at the five locations where only shells had previously been recorded.

Table 1: Sites where kākahi were found during rapid surveys and their abundance at those sites.

Site	Location	Relative abundance
Avon River Sites		
A1b, A1c, A1d	Mona Vale	Sparse
A2b, A2c	Christchurch Girls High School	Sparse
A3	Bealey Ave	Sparse
A5a, A5b	Botanic Gardens	Abundant
A5c	Botanic Gardens	Common
A5d	Botanic Gardens	Abundant
A5e	Botanic Gardens	Sparse
A6a	Montreal Street (Antigua Boatsheds)	Sparse
A10	Upstream of Gayhurst Rd (near Morris Street)	Sparse
A12	Horseshoe Lake confluence	Sparse
Other Sites		
Ho1	Horseshoe Lake at New Brighton Rd	Abundant
H2a, H2b	Heathcote River at Riverlaw Tce	Sparse

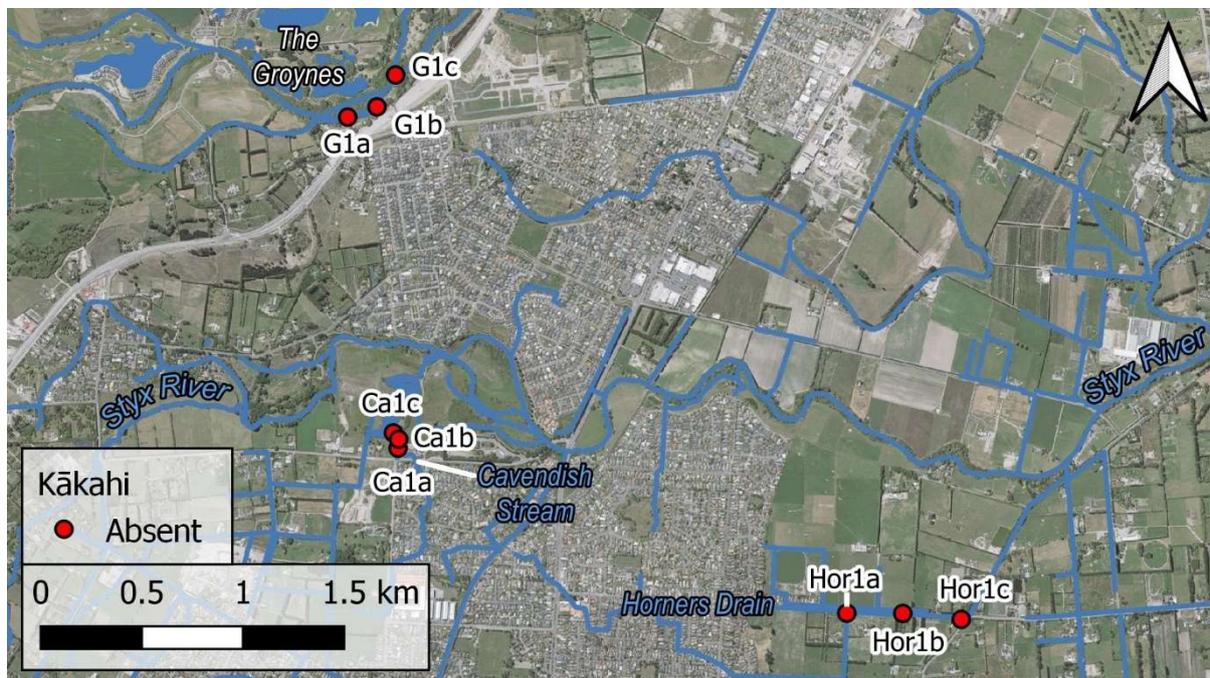


Figure 3: Kākahi survey sites at The Groynes (Otukaikino River) and in the Styx River catchment.

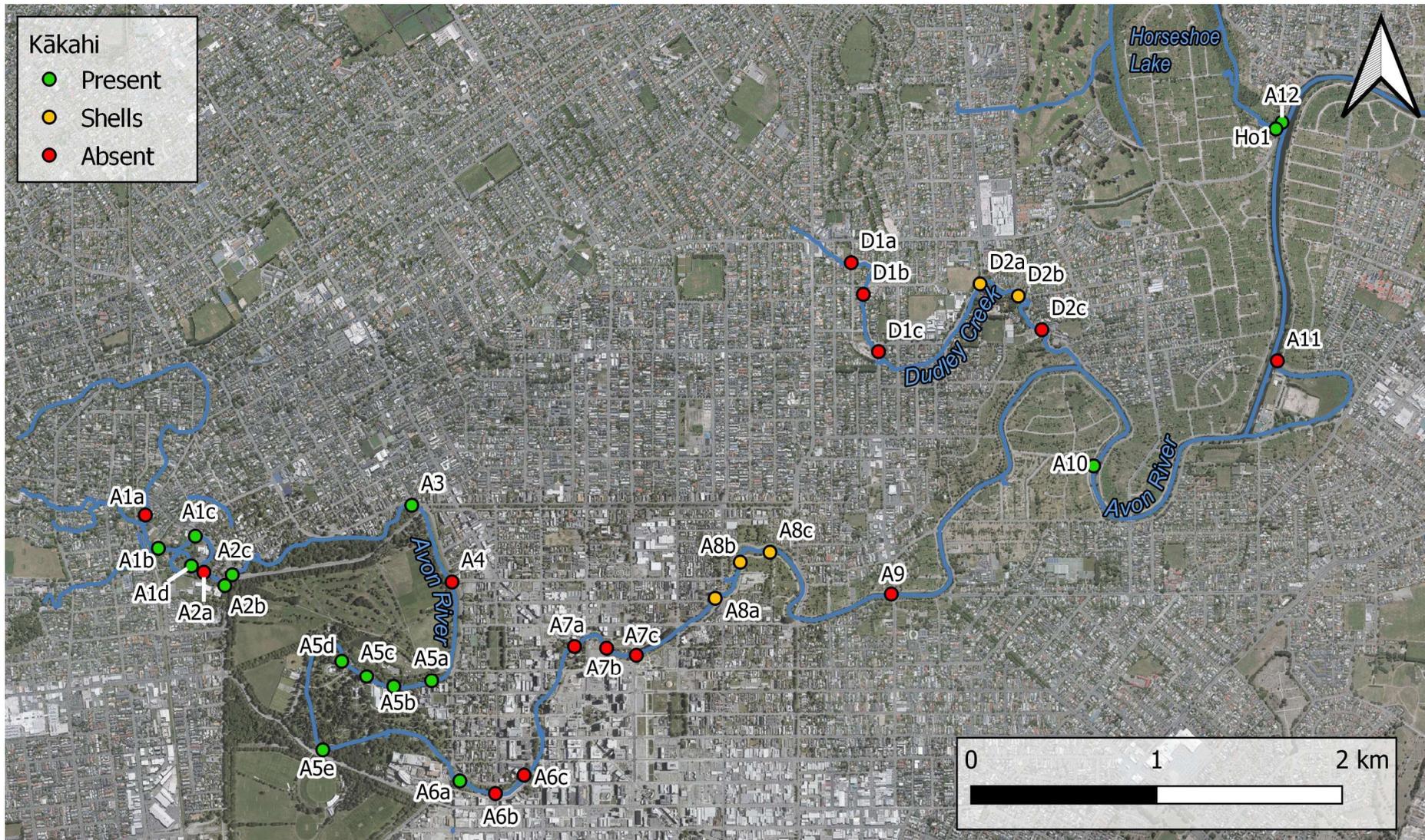


Figure 4: Kākahi survey sites in the Avon River catchment.

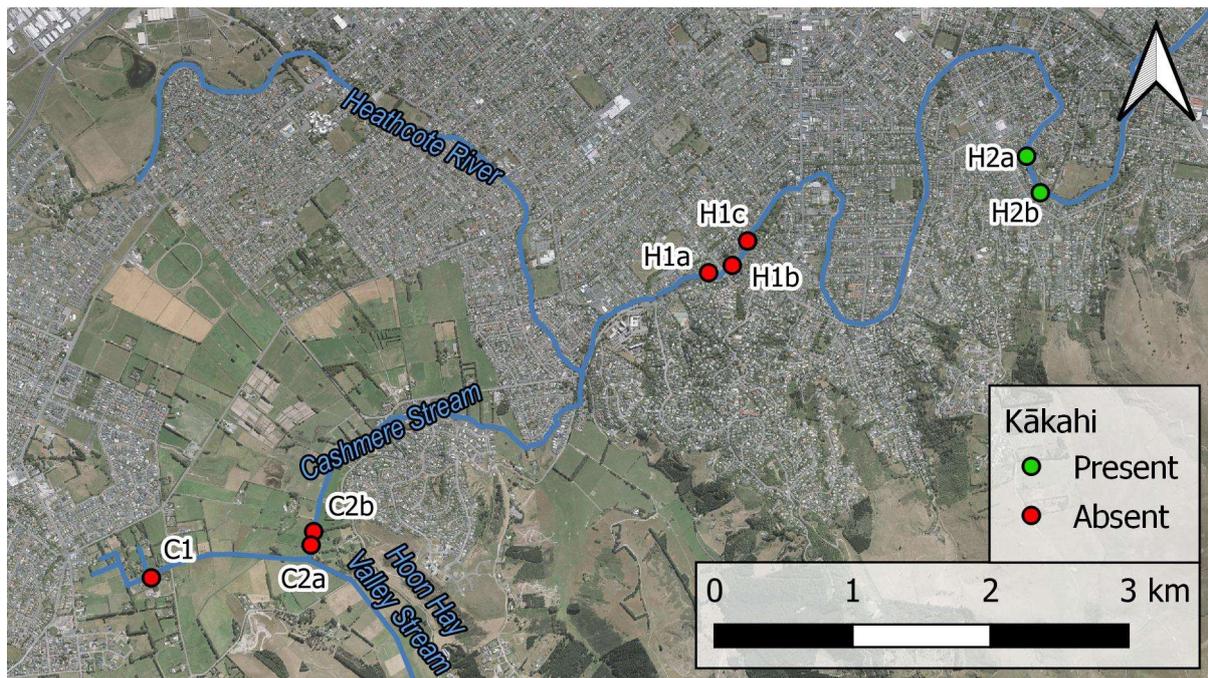


Figure 5: Kākahi survey sites in the Heathcote River catchment.

Kākahi were found in two sections of the Avon River: an upper section near the Botanical Gardens and a lower section near Kerrs Reach. In the upper section, low numbers of kākahi were found from Mona Vale (at the confluence with Wairarapa Stream) downstream to Antigua Boatsheds (Figure 4), although numbers were highest at Sites A5a to A5d, near the Botanical Gardens carpark. Low kākahi numbers were also found in the lower section, which included a site approximately 400 m upstream of Gayhurst Road and a site at the Horseshoe Lake outlet. No kākahi were found at the nine sites searched between these locations, although empty shells were found at three sites near Barbadoes Street.

The Horseshoe Lake outlet site had the greatest densities of kākahi observed during rapid surveys. Kākahi were primarily clustered around the culvert under New Brighton Road (Figure 6), although low numbers of kākahi were also found along the banks and a single kākahi was found on the downstream side of the tide gates. Kākahi were found on the Avon River side of the road culvert and within the culvert itself, although the greatest densities were found along the bed immediately upstream of the concrete lip of the culvert. Poor visibility and deep water (>1.8 m deep) made it difficult to survey along the bed of the channel between the culvert and tide gates. However, inspection of video footage revealed at least 25 kākahi during 20 seconds of filming across approximately 5 m of bed at the upstream edge of the culvert.

The two lower Heathcote River sites were the only places searched outside of the Avon River where kākahi were found. A total of 26 kākahi were found along an 85 m long stretch of river searched at the most downstream Heathcote River site, and another 10 kākahi were found along 225 m of river searched a short distance upstream. Visibility was very poor, so all the searching was done by hand, except for four kākahi that were found above the low tide mark (Figure 7). The lower site was sandier than the upper site and most kākahi were found mid-channel, at depths of approximately 0.5–0.6 m. All kākahi that were recovered were relocated a short distance downstream, along the true right bank of a 20 m reach

extending upstream from the footbridge opposite 350 Riverlaw Tce, with the upstream extent of the reach near 346 Riverlaw Tce (NZTM coordinates: E1572459 N5176701). The kākahi were released over a small area, to provide a better chance of finding them again and confirming their survival in the future.

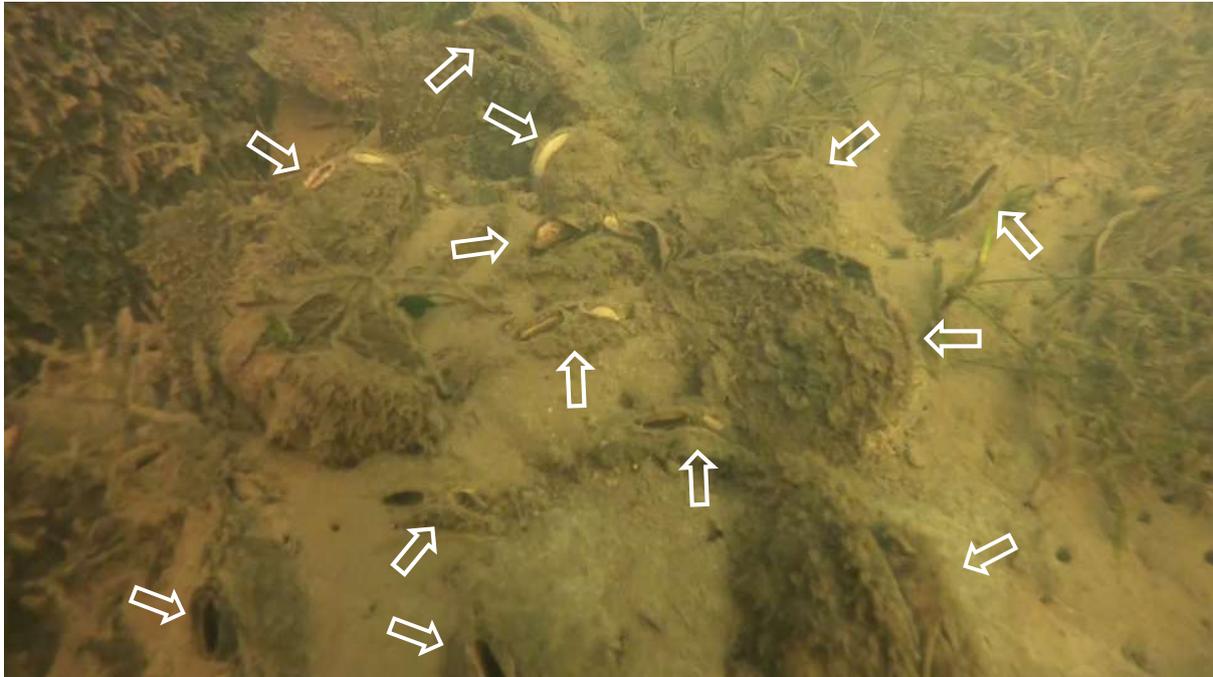


Figure 6: A dense bed of kākahi at the Horseshoe Lake outlet culvert. Arrows indicate individual kākahi.



Figure 7: Kākahi at the Heathcote River at Riverlaw Terrace dredging site, showing an individual above the low tide mark (left) and kākahi before relocation downstream (right).

The 33 kākahi measured from the two Heathcote River sites (H2a and H2b) ranged in size from 55.2 to 98.5 mm, with a mean length of 73.6 mm. This is very similar to a mean length of 75 mm recorded from Cashmere Stream (Instream 2020). Kākahi ages at the Heathcote River sites ranged from 10 to 40 years, with a mean of 18 years, which is also close to the mean of 16 years for the Cashmere Stream kākahi (Figure 8). The age distribution of kākahi from the Heathcote River was skewed towards younger kākahi, with 61% of individuals under 20 years old.

Quantitative surveys were undertaken at five sites in the Avon River. Densities from the quantitative surveys were: zero at the two Mona Vale sites (A1c and A1d, i.e., no kākahi recorded in quadrats); 0.4 per m² at two Botanical Gardens sites (A5a and A5e, i.e., one kākahi per 2.5 m² of search area), and 1.2 per m² at another Botanical Gardens site (A5c, i.e., three kākahi per 2.5 m² of area searched). Mean density at the three Avon River sites where kākahi were recorded was 0.7 kakahi per m². However, only five kākahi were detected from a total of 125 quadrats during quantitative sampling, which means the density estimates are very poor. Density estimates for the two lower Heathcote River sites were 0.02 and 0.7 kākahi per m² (calculated from the length and average width of channel searched), with a mean of 0.04 per m² for the two sites. Kākahi densities in the Avon and Heathcote Rivers were low when compared with data from the Styx River, Cashmere Stream, and elsewhere in the country (Figure 9).

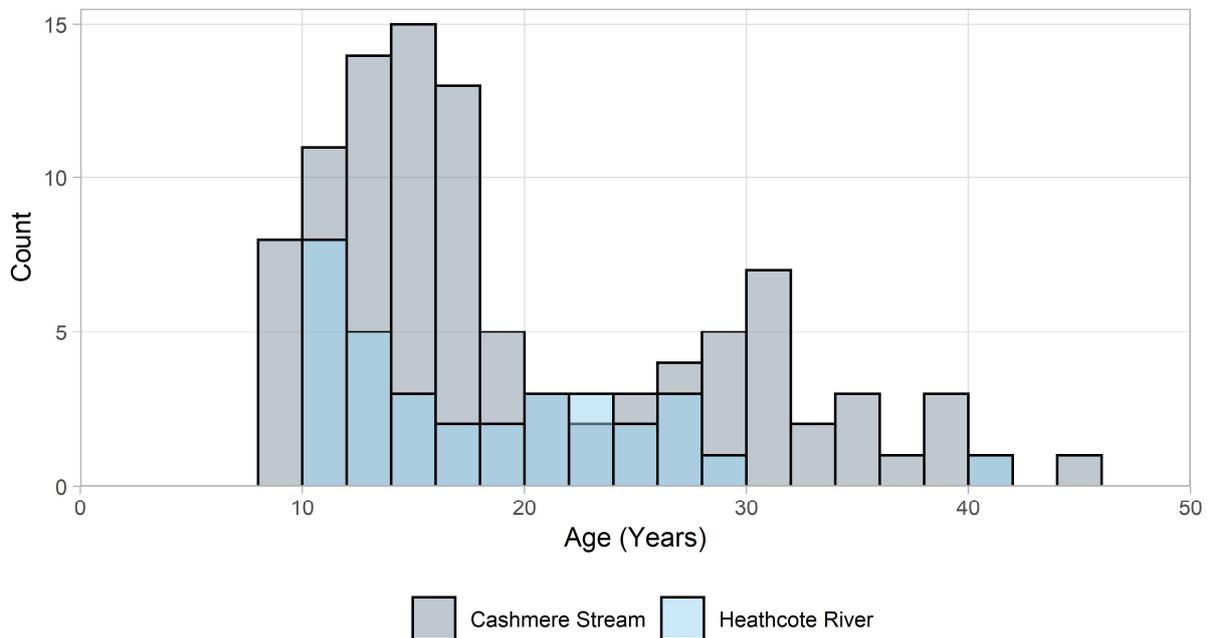


Figure 8: Histograms comparing kākahi age class structure from the two Heathcote River sites with data from Cashmere Stream reported by Instream (2020).

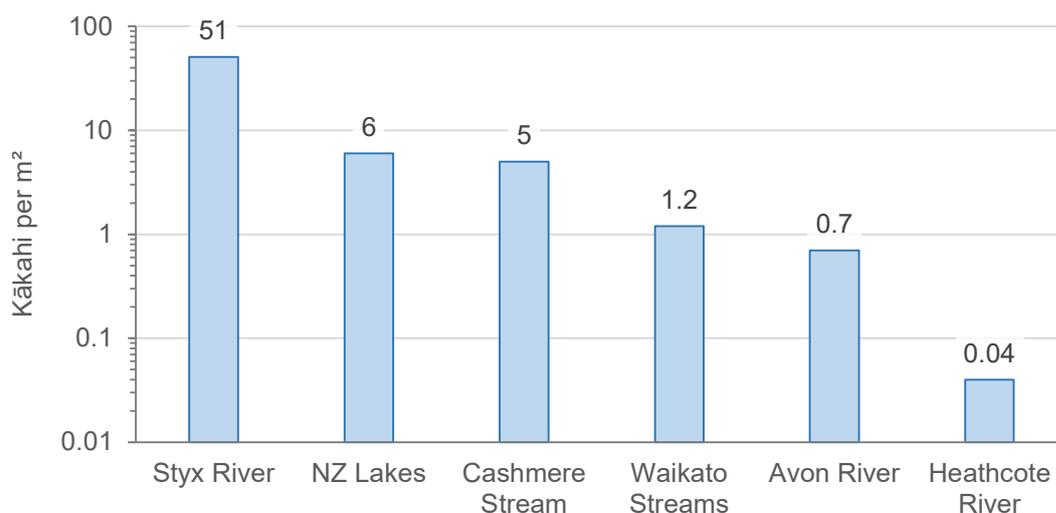


Figure 9: Kākahi densities in the Avon and Heathcote Rivers compared with other New Zealand studies. Densities are displayed on top of the bar for each study. Note logarithmic scale.

There was no clear pattern between kākahi presence or absence and rapid habitat assessment scores (Figure 2). However, there was a general tendency for kākahi to be found in sandy or stony sediments and they were uncommon amongst loose, silty sediments, especially amongst macrophytes. In the Botanical Gardens sites, kākahi appeared to be more abundant around deeper channels and amongst habitat features such as stones and wood.

4. DISCUSSION AND RECOMMENDATIONS

This survey confirmed the presence of kākahi at 17 sites, located in two sections of the Avon River, Horseshoe Lake, and in one area of the lower Heathcote River. Twelve of the 17 sites with kākahi present were at or near the location of previous anecdotal records. The absence of kākahi at some locations with anecdotal records may be because kākahi were either absent or in low densities, so had a low probability of detection. In addition, at sites such as Horners Drain and Cavendish Drain, high macrophyte cover reduced search efficiency and hence reduced the probability of kākahi being detected.

The rapid survey method was useful for quickly assessing kākahi presence at multiple sites. However, for future surveys, we suggest amending the method by counting all kākahi seen during the rapid survey and searching for the entire 30 minutes, rather than just stopping as soon as the first kākahi is seen. That would provide useful data on kākahi abundance, for a relatively small additional effort. For quantitative sampling, we suggest using a larger quadrat size at sites with low kākahi densities, such as those in the Avon River. A quadrat size of 0.1 m² was previously used in Cashmere Stream and it produced sufficient precision to obtain reasonable density estimates (Instream 2020), however it was clearly too small for the low densities observed in the Avon River, with most quadrats turning up zero counts. Quadrat sizes between 0.25 and 1.0 m² are therefore recommended for estimating kākahi densities in sparse populations such as those in the Avon and Heathcote Rivers.

Empty kākahi shells were present, but live kākahi were absent, at three Avon River sites and at two Dudley Creek sites. Empty shells were particularly abundant in the Avon River near Barbadoes Street (Figure 10). Overseas research has shown that freshwater mussel beds can persist for several decades at a given location (Sansom 2018) and the presence of empty shells is considered a good indicator for the presence of kākahi beds nearby (Rainforth 2008). The absence of live kākahi where empty shells are common may therefore indicate that local extinction events may have occurred. However, it is also possible that numerous empty shells are present because they were deposited there by people who collected the kākahi from elsewhere and deposited the empty shells in a different waterway. This is supported by the common occurrence of marine bivalve shells in urban streams in Christchurch (Figure 10).

Based on a study of the European freshwater pearl mussel (*Margaritifera margaritifera*), population viability may occur when at least 25% of the population is younger than 20 years old, because that indicates sufficient recruitment is occurring (Hastie & Cosgrove 2002). Based on length-age regressions using the formula of Ogilvie (1993), 61% of the kākahi measured at the two lower Heathcote River sites were less than 20 years old. While it is tempting to conclude that this indicates a viable population, densities were very low, and the spatial extent of the population is unknown. Further sampling would be required to determine the spatial extent, density, and viability of the Heathcote River kākahi population.

The dense bed of kākahi at the outlet of Horseshoe Lake is noteworthy. Kākahi were most abundant immediately upstream of the concrete lip of the culvert, where they are protected from the shear stresses of tides and floods, as well as human activities such as sediment removal. Based on the presence of kākahi dotted along the base of the banks between the culvert and tide gates, it is likely that kākahi are present upstream of the tide gates, perhaps in high numbers in protected locations. Further kākahi survey effort is therefore warranted upstream of the tide gates.

Kākahi were not clearly associated with any of the measured habitat parameters in the rapid habitat survey. However, low kākahi densities and the relatively homogenous habitat values across the sites made it difficult to detect kākahi habitat preferences in the current study. In Cashmere Stream, kākahi generally favoured deeper channels with more shade, and coarser substrates, with fewer kākahi where fine silts dominated (Burdon and McMurtrie 2009). A more recent survey of Cashmere Stream also found that kākahi presence was generally associated with better quality riparian vegetation, more diverse invertebrate habitats, and greater levels of riparian shade (Instream Consulting 2020). Few other studies have specifically addressed kākahi habitat preferences within rivers or streams. Given their patchy distribution, extensive further research would be required to explain the distribution of kākahi in Christchurch waterways.



Figure 10: Empty kākahi shells in the Avon River near Barbadoes Street (left) and marine bivalve shells in Cashmere Stream near Sutherlands Road (right).

Based on the results presented above, we recommend the following:

- Rapid surveys for kākahi in the Heathcote, Halswell, and Otukaikino Rivers. The Heathcote River is a priority, because limited survey work in the catchment indicates kākahi are present in the river, but their spatial extent and population viability is unknown.
- Surveys would be best done in summer, when the rivers are low and water clarity is best, and after weed clearance, to provide the best view of the bed.
- Searching for kākahi prior to any instream works in areas where kākahi have been found previously or where they may be present, but no search has previously been undertaken (e.g., the Heathcote River).
- Follow-up monitoring of the kākahi relocated in the lower Heathcote River, to check on their survival.
- Survey Horseshoe Lake upstream of the tide gates. This is a priority, given the high densities of kākahi found at the road culvert and the cultural and ecological significance of Horseshoe Lake.
- Undertake regular monitoring of kākahi across the city. They are one of only two 'At Risk' invertebrate species found in the city (kōura being the other species), and they are not detected by standard monitoring undertaken by CCC. Kākahi make for excellent long term biomonitors because they are long-lived and do not move around much.
- Amend rapid survey protocols to search for the entire 30 minutes and count all kākahi seen during the search. For quantitative search methods, increase the quadrat size for sites where kākahi densities are low, such as the Avon and Heathcote Rivers.

5. ACKNOWLEDGEMENTS

Thank you to Katie Noakes and Belinda Margetts from CCC for providing background information and for help sampling the Cashmere Stream sites. Thanks also to Duncan Gray from Environment Canterbury for providing data from a public survey on kākahi sightings. Thanks to the Heathcote dredging team from CityCare and Johnston Civil, for pausing the dredging for a day, to give time to search for and relocate kākahi out of the dredging area. This project was funded by CCC.

6. REFERENCES

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APPENDIX 1: KĀKAHI SIGHTINGS IN CHRISTCHURCH

Table 1: Details of kākahi sightings in Christchurch waterways. Co-ordinates marked with an asterisk are approximate centre points, based on site descriptions.

Waterway	Location	Easting (NZTM)	Northing (NZTM)	Details
Avon River	Mona Vale weir	1568515	5181091	Observed in the weir's trout ladder by McMurtrie & Taylor (2003) ¹ .
Avon River	Near Christchurch Girls High School	1568616*	5180899*	A single mussel was collected by Malcolm Main (pers comm in McMurtrie & Taylor, 2003).
Avon River	Botanical Gardens	1569455	5180349	Live kākahi observed by Boffa Miskell during CREAS survey in May 2020 (pers. comm. Katie Noakes) and previously by McMurtrie & Taylor (2003).
Avon River	Just upstream of Montreal Street bridge	1570129*	5179743*	One observed by Shelley McMurtrie (email from McMurtrie to Michele Stevenson 20 October 2014).
Avon River	Upstream of Band Rotunda (downstream of Colombo Street)	1570728	5180530	Observed by Shelley McMurtrie. Location emailed to Belinda Margetts in October 2014.
Avon River	Downstream of Barbadoes Street, near Salisbury Street	1571447	5180950	Empty shells were common in 2014, no live ones, but no specific survey. Observation from Shelley McMurtrie, location from Duncan Gray.
Avon River	Kerrs Reach (non-wadeable)	1574254*	5181888*	Observed by CCC weed cutting boat contractors on numerous occasions (e.g., email from Katie Noakes 26 September 2019).
Horseshoe Lake	Outlet from Horseshoe Lake, just upstream of New Brighton Road	1574343	5183295	Record of live mussels in 2014, provided by Duncan Gray (data obtained via public survey).
Dudley Creek	Along Banks Avenue, adjacent to Achilles Street	1572926*	5182426*	Empty shells observed during invertebrate sampling by EOS Ecology (McMurtrie & James 2015) ² .

¹ McMurtrie, S. A., and Taylor, M. J. (2003). Ecological assessment of the Avon River mainstem, from Fendalton Road to Fitzgerald Avenue. Report prepared for Christchurch City Council by EOS Ecology and Aquatic Ecology Limited, June 2003.

² McMurtrie, S., and James, A. (2015). Dudley Creek flood remediation: ecological condition of lower Dudley Creek. Report prepared for BECA by EOS Ecology, June 2015.

Waterway	Location	Easting (NZTM)	Northing (NZTM)	Details
Dudley Creek	Adjacent to Stapletons Road	1572186*	5182487*	Empty shells observed by EOS Ecology during site visit in 2015. Site has had substantial instream works since the observation. Record provided by Duncan Gray.
Horners Drain	Along Prestons Road	1570765*	5186400*	Observed by CCC maintenance contractors (email from Katie Noakes 25 June 2019).
Cavendish Stream	In Styx Mill Reserve	1568256*	5187230*	Photo of live mussel provided via email from CityCare contractor Rob Clark to Kirsty Patten at CCC on 3 September 2019.
Halswell Quarry Pond	Pond in Halswell Quarry Park	1565655	5172674	Observed by Nigel Morrith (CCC Park Ranger). Photograph provided, but unclear from email if they were live specimens (email to Katie Noakes from Nigel Morrith, 30 April 2020).
Cashmere Stream	Upstream of Sutherlands Road	1566081	5173981	Empty shells noted during other sampling (Boffa Miskell 2015 ³).
Cashmere Stream	Downstream of Hoon Hay Stream confluence, on Ernst Frei's land	To be confirmed	To be confirmed	No previous mussel observations. CCC interested in surveying, due to potential future realignment.
Heathcote River	Downstream of Barrington Street	1570156	5176178	Empty shells noted during other sampling (Boffa Miskell 2015).
Groynes Lakes	Located with Groynes recreation area.	1568100	5188985	Freshwater Fish Database record from 2006 extracted by Duncan Gray.

³ Boffa Miskell Limited (2015). Aquatic ecology of sites within the Heathcote, Estuary and Coastal, and Avon SMP catchments: informing the comprehensive discharge consent. Report prepared by Boffa Miskell Limited for Christchurch City Council, August 2015.

APPENDIX 2: KĀKAHI SURVEY SITE DETAILS

Table 1: Details of rapid survey sites. Site coordinates are in NZTM format.

Site	Location	Bottom of Reach		Kākahi Presence	Location 1st Kākahi found OR Top of Reach if no Kākahi found	
		Easting	Northing		Easting	Northing
Avon River Catchment						
A1a	Avon River at Fendalton Road	1568253	5181228	Absent	1568263	5181377
A1b	Avon River at Mona Vale	1568323	5181050	Sparse	1568287	5181051
A1c	Avon River at Mona Vale	1568522	5181115	Sparse	1568507	5181100
A1d	Avon River at Mona Vale	1568501	5180956	Sparse	1568477	5181015
A2a	Avon River at Christchurch Girls High School	1568568	5180922	Absent	1568598	5181009
A2b	Avon River at Christchurch Girls High School	1568681	5180851	Sparse	1568591	5180908
A2c	Avon River at Christchurch Girls High School	1568721	5180909	Sparse	1568715	5180889
A3	Avon River at Bealy Ave bridge	1569688	5181280	Sparse	1569604	5181196
A4	Avon River at the Botanical Gardens	1569905	5180870	Absent	1569866	5180935
A5a	Avon River at Botanical Gardens	1569795	5180340	Abundant	1569814	5180340
A5b	Avon River at Botanical Gardens	1569591	5180309	Abundant	1569601	5180308
A5c	Avon River at Botanical Gardens	1569445	5180364	Common	1569445	5180364
A5d	Avon River at Botanical Gardens	1569311	5180447	Abundant	1569311	5180447
A5e	Avon River at the Botanical Gardens	1569209	5179972	Sparse	1569195	5180014
A6a	Avon River at Montreal Street	1569947	5179807	Sparse	1569932	5179811
A6b	Avon River at Montreal Street	1570139	5179740	Absent	1570073	5179752
A6c	Avon River at Montreal Street	1570293	5179838	Absent	1570259	5179798
A7a	Avon River at Colombo Street	1570565	5180526	Absent	1570515	5180463
A7b	Avon River at Colombo Street	1570738	5180517	Absent	1570679	5180584
A7c	Avon River at Colombo Street	1570898	5180479	Absent	1570797	5180475
A8a	Avon River at Barbados Street	1571323	5180783	Absent (shells)	1571287	5180719
A8b	Avon River at Barbados Street	1571458	5180976	Absent (shells)	1571444	5180895
A8c	Avon River at Barbados Street	1571618	5181029	Absent (shells)	1571523	5181042
A9	Avon River at Stanmore Road	1572272	5180806	Absent	1572136	5180789
A10	Avon River at Morris Street	1573362	5181490	Sparse	1573364	5181509
A11	Avon River at Avon Rowing club	1574352	5182051	Absent	1574294	5181910
A12	Avon River at Horseshoe Lake confluence	1574377	5183328	Sparse	1574366	5183289
Ho1	Horseshoe Lake at New Brighton Rd	1574344	5183293	Abundant	1574344	5183293

Site	Location	Easting	Northing	Kāhahi Presence	Easting	Northing
D1a	Dudley Creek adjacent to Stapletons Rd	1572056	5182579	Absent	1571922	5182638
D1b	Dudley Creek adjacent to Stapletons Rd	1572121	5182410	Absent	1572170	5182531
D1c	Dudley Creek adjacent to Stapletons Rd	1572203	5182100	Absent	1572132	5182228
D2a	Dudley Creek at Banks Ave	1572750	5182466	Absent (shells)	1572701	5182369
D2b	Dudley Creek at Banks Ave	1572956	5182401	Absent (shells)	1572882	5182417
D2c	Dudley Creek at Banks Ave	1573083	5182221	Absent	1572992	5182295
Otukaikino River catchment						
G1a	The Groynes	1568007	5188879	Absent	1567901	5188874
G1b	The Groynes	1568152	5188930	Absent	1568084	5188893
G1c	The Groynes	1568244	5189089	Absent	1568200	5189005
Styx River catchment						
Ca1a	Cavendish Stream at Styx Mill Reserve	1568256	5187230	Absent	1568256	5187192
Ca1b	Cavendish Stream at Styx Mill Reserve	1568259	5187274	Absent	1568325	5187199
Ca1c	Cavendish Stream at Styx Mill Reserve	1568233	5187306	Absent	1568145	5187285
Hor1a	Horners Drain at Prestons Road	1570475	5186408	Absent	1570460	5186210
Hor1b	Horners Drain at Prestons Road	1570752	5186407	Absent	1570709	5186405
Hor1c	Horners Drain at Prestons Road	1571041	5186377	Absent	1570964	5186402
Heathcote River catchment						
C1	Thornton Drain at Cashmere Stream confluence	1565959	5173906	Absent	1565917	5173906
C2a	Cashmere Stream downstream of Hoon Hay Valley Drain	1567117	5174146	Absent	1567105	5174088
C2b	Cashmere Stream downstream of Hoon Hay Valley Drain	1567136	5174244	Absent	1567133	5174203
H1a	Heathcote River at Barrington Street	1569999	5176134	Absent	1569957	5176123
H1b	Heathcote River at Barrington Street	1570170	5176188	Absent	1570121	5176155
H1c	Heathcote River at Barrington Street	1570281	5176366	Absent	1570278	5176308
H2a	Heathcote River at Riverlaw Tce	1572304	5176985	Sparse	1572400	5177182
H2b	Heathcote River at Riverlaw Tce	1572403	5176718	Sparse	1572363	5176794