BioInvasions Records (2025) Volume 14, Issue 3: 597–607

Funded by the European Union

Research Article

The gold clams, *Corbicula fluminea* (Müller, 1774) and *Corbicula australis* (Deshayes, 1830) invade Aotearoa New Zealand; first records, biosecurity responses and potential long-term ecological impacts

Calum MacNeil[1], Anjali Pande[2], Joshua Wardle[2], Abraham Growcott[2], Scott Sinclair[2], Rose Somerville[3], Catriona Sinclair[4] and Finnbar Lee[1]

[1]*Cawthron Institute, 8 Halifax Street East Nelson 7010, New Zealand*
[2]*Aquatic Health – Readiness Aquatic Diagnostics, Readiness, and Surveillance Directorate| Biosecurity New Zealand - Tiakitanga Pūtaiao Aotearoa*
[3]*School of Geography, University of Otago, Level 4 Richardson Building, 85 Albany Street Dunedin 9016, New Zealand*
[4]*School of Environment, University of Birmingham, U.K.*
Corresponding author: Calum MacNeil (calum.macneil@cawthron.org.nz)

Citation: MacNeil C, Pande A, Wardle J, Growcott A, Sinclair S, Somerville R, Sinclair C, Lee F (2025) The gold clams, *Corbicula fluminea* (Müller, 1774) and *Corbicula australis* (Deshayes, 1830) invade Aotearoa New Zealand; first records, biosecurity responses and potential long-term ecological impacts. *BioInvasions Records* 14(3): 597–607, https://doi.org/10.3391/bir.2025.14.3.10

Received: 9 January 2025
Accepted: 17 June 2025
Published: 14 July 2025

Thematic editor: Amy Fowler

Abstract

The gold / Asian clam (Bivalvia: Cyrenidae) *Corbicula fluminea* was first detected in the North Island of Aotearoa New Zealand in May 2023. *C. fluminea* which is native to eastern Asia, was detected in the Waikato River, the longest river in Aotearoa New Zealand, which drains Lake Taupō, Australasia's largest lake. Subsequently, in March 2024, another "gold clam" species, *Corbicula australis*, native to Australia, was detected in a man-made lagoon, immediately adjacent to the Waikato River. The population structures of both species, with adults and juveniles present in large numbers, indicate both had been present for several years before first detection. A delimiting survey of *C. fluminea* in the Waikato indicated that the riverine population was significantly more widespread than the initial detection site, unlike *C. australis* which still appears restricted to the lagoon. Despite this, *C. fluminea* has not been detected within Lake Taupō or outside the Waikato catchment. Future plans involve a management strategy targeting containment within the Waikato catchment, along with continued long-term surveillance efforts. The documented worldwide impacts of *C. fluminea* as an "ecosystem-engineer", its ability to thrive in a broad variety of environmental conditions, high reproductive potential and the apparently vacant niche ready to be exploited (with few resident competitors or predators), all indicate it could have the greatest impact of any known freshwater animal invader in Aotearoa New Zealand so far. The long-term impacts of *C. fluminea* in Aotearoa New Zealand will ultimately be determined by how effective management efforts, involving both government and non-governmental entities, are at restricting its distribution and protecting native ecosystems from new incursions.

Key words: Asian clam, Australasia, Cyrenidae, ecosystem engineer, Lake Taupō, Waikato River

Introduction

Corbicula fluminea (Müller, 1774), the gold or Asian clam, is one of the most ecologically and economically damaging freshwater invaders worldwide (Sousa et al. 2008; Crespo et al. 2015; Robb-Chavez et al. 2023) and it has invaded all major continents, except Antarctica (Crespo et al. 2015; Robb-Chavez et al. 2023). This is the most well-known species of *Corbicula*,

a genus of freshwater / brackish water clams or bivalve molluscs, belonging to the family Cyrenidae or the 'basket' clams (*corbis* being the Latin for basket – with reference to the clam's shape). During the last century, *C. fluminea* has spread rapidly from its native range in southeast Asia to North, Central and South America and throughout mainland Europe, including river systems such as the Rhine, Seine and Danube (Minchin 2014). It was detected in the unconnected islands (to mainland Europe) of Great Britain in 1998 (Howlett and Baker 1999) and Ireland in 2010 (Sweeny 2009). This occurred alongside further range expansion in mainland Europe, with for example, new detections in countries such as Greece in 2018, the then southernmost record of *C. fluminea* in the Balkan Peninsula (Sousa et al. 2008; Crespo et al. 2015; Karaouzas et al. 2020).

The continued global range expansion of the clam is the result of interconnected factors, including the effective dispersal abilities of the larvae and its association with many potential human vectors and pathways of varying importance, such as boats or fishing equipment (Lucy et al. 2012; Crespo et al. 2015; Ministry for Primary Industries Technical Advisory Group (MPI TAG) (2023). *C. fluminea* has broad physio-chemical tolerances (Lucy et al. 2012). It is also considered an "r"-strategist, with rapid growth, early sexual maturity and high reproductive potential (including being hermaphroditic and some individuals capable of parthenogenesis), all favouring successful colonisation of new habitats (McMahon 1999; Sousa et al. 2008; Crespo et al. 2015; Lucy et al. 2012; MPI TAG 2023; Winterbourn 2023). *C. fluminea* is also an "ecosystem engineer", capable of significantly altering invaded systems (Crespo et al. 2015). Extremely efficient filter feeding capabilities enable *C. fluminea* to outcompete native bivalves while greatly increasing water clarity of invaded habitats, in addition to altering phytoplankton communities and bottom dwelling plant growth (Lauritsen and Mozley 1989; Lopez et al. 2006). The clam's large population size often dominates the resident macroinvertebrate community in terms of numbers or biomass as it becomes established and significantly alters the benthic substrate (Crespo et al. 2015; Linares et al. 2022). These environmental changes can consequently impact nutrient cycling, benthic macroinvertebrate community structure, pelagic food-webs and the overall trophic dynamics of invaded systems (Phelps 1994; Darrigran et al. 2002; Karatayev et al. 2005; Lucy et al. 2012; Barbour et al. 2013; Linares et al. 2022). In addition, mass die-offs of *C. fluminea* can sporadically occur, which result in rapid deoxygenation and increased levels of ammonia that can have consequences for the entire ecosystem (Sousa et al. 2008; Crespo 2015). Aside from the ecological impacts, both live *C. fluminea* and empty shells have the potential to pose economic risks, by clogging infrastructure systems, such as the intake pipes, vents, heat exchangers and membrane systems associated with water treatment systems and hydroelectric powerplants (Matthews and McMahon

1999; Crespo 2015; MPI TAG 2023). However, these serious impacts have not always been realised or have been minor compared to what was expected (Rosa et al. 2011).

The principal purpose of this paper is to report the circumstances of the first record of *C. fluminea* in Australasia, specifically the North Island of Aotearoa New Zealand, in 2023. Secondary to this, we also report the first record of an Australian native species, *Corbicula australis* (Deshayes, 1830), in Aotearoa New Zealand, in 2024. We also detail the main biosecurity responses to arrival of the *Corbicula* genus in Aotearoa New Zealand and report on the results of surveys and the ongoing biosecurity response strategies, that have resulted from the first detection. We also highlight how the unique and culturally important biological resources of Aotearoa New Zealand could potentially be impacted, if the establishment and spread of an "ecosystem engineer" such as *C. fluminea* is not prevented.

Materials and methods

Biosecurity New Zealand (BNZ), a business unit of the Ministry for Primary Industries (MPI) was the government agency notified on May 1st 2023 in relation to the potential first record of the *Corbicula* genus in Aotearoa New Zealand (https://www.wsp.com/en-nz/news/2023/wsp-ecologists-discover-invasive-freshwater-clam; MPI TAG 2023; Winterbourn 2023; Melchior and Hofstra 2024). The notification was made by consultancy researchers, who had been conducting surveys near a site called Bob's Landing at Lake Karāpiro, a hydro-lake within the Waikato River in the North Island (-37°56'50.714144"N, 175°38'53.42329"E; Figure 1). These workers noted 10 empty shells of an unknown bivalve mollusc at a pier at Bob's Landing on April 19, 2023. The Waikato River is the longest river in Aotearoa New Zealand (452 km) and drains Australasia's largest lake, Lake Taupō (616 km² in area) (MPI TAG 2023; Figure 1). The shells were sent off for taxonomic identification and the first notification was based on these shells being confirmed as belonging to the genus *Corbicula* and the subsequent collection of live samples. Later taxonomic assessment agreed on the species designation of *C. fluminea,* while acknowledging the issues related to the unresolved and complicated taxonomy of the species (MPI TAG 2023).

The early investigation and biosecurity response phases to the detection of *C. fluminea* by BNZ involved delimiting surveys in the Waikato River system, which included visual surveys and eDNA testing (Figure 1). A major surveillance effort involving eDNA testing of over 1600 water samples from 300 sites across Aotearoa New Zealand (North and South Islands) was then undertaken.

In March 2024, *Corbicula australis* (Deshayes, 1830), a native Australian species, was detected for the first time in Aotearoa New Zealand, at a recreational aquapark in a small man-made lagoon, only a few hundred metres away from the main Waikato River (Martin 2024). Morphologically,

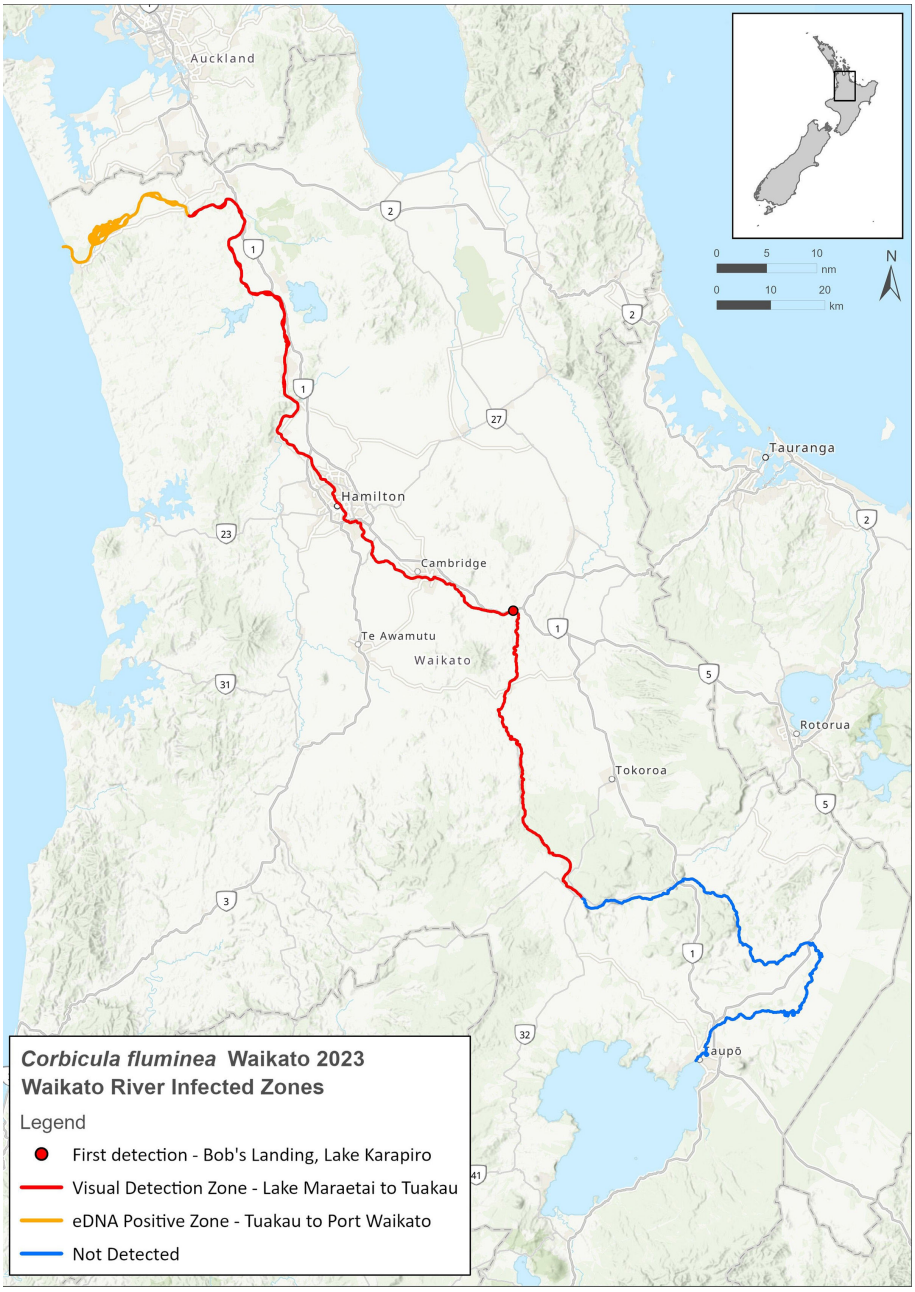

Figure 1. 2023 distribution of *Corbicula fluminea* in Aotearoa New Zealand, showing first detection point, visual detection zone, only eDNA positive detection zone (no visual confirmation so far) and non-detection zone (no visual or eDNA detection) in the Waikato River, in the North Island (inset map). No new sites have been discovered in repeated surveys in 2024. Map courtesy of the Ministry for Primary Industries.

C. australis differs from *C. fluminea*, as it has a thinner, more oval (less triangular) shell with finer concentric ribs (Ponder et al. 2024). Following the detection of *C. australis*, additional surveillance was conducted in the Waikato River and Lake Taupō (Mangoroa & Other Blocks Incorporation 2024).

Results and discussion

Initial delimiting surveys detected populations of *C. fluminea* 1.5 km upstream of Bob's landing (at Horahora domain) and 40 km downstream of the initial detection site (Figure 1). Later surveys conducted as part of

the response then also detected populations of the clam upstream of Karāpiro at Lake Maraetai (Melchior et al. 2023; Winterbourn 2023; Melchior and Hofstra 2024; Figure 1). This represents a significant section of the Waikato River, which is the longest river in Aotearoa New Zealand (452 km), has eight hydro dams and other water infrastructure along its length and drains Australasia's largest lake, Lake Taupō (616 km² in area) (MPI TAG 2023). From the initial detection in May 2023 until December 2024, repeated visual surveys and the nationwide eDNA testing, have not detected *C. fluminea* beyond the Waikato River (https://www.mpi.govt.nz/biosecurity/exotic-pests-and-diseases-in-new-zealand/active-biosecurity-responses-to-pests-and-diseases/exotic-freshwater-clams-corbicula/). The pathway by which *C. fluminea* established in the freshwaters of Aotearoa New Zealand remains unknown but the population structure of the clam at the initial detection site suggests it may have been present for several years, with a wide range of size classes present (MPI TAG 2023; Figure 2).

Concerning surveys for *C. australis* as of December 2024, no further detections of *C. australis* were made outside of the aquapark (https://www.mpi.govt.nz/dmsdocument/67806-Corbicula-fluminea-collaborative-long-term-management-plan). The pathway by which *C. australis* arrived in the aquapark is most likely to be of anthropogenic origin, such as recreational water equipment used in the park, but this has not been confirmed.

A few months after the *C. fluminea* detection in Aotearoa New Zealand, on 22 September 2023, *C. fluminea* was also detected for the first time in Australia, in the Brisbane River (https://www.sail-world.com/news/271662/Freshwater-gold-clam-found-in-Brisbane-River). Despite the native gold clam *C. australis* being common throughout Australia, *C. fluminea* had not been positively identified in Australia before this 2023 report by Biosecurity Queensland. In subsequent surveys, Biosecurity Queensland confirmed it had spread along 40 km stretch of the Brisbane River, suggesting that similar to the Aotearoa New Zealand situation, *C. fluminea* had been established for some time before first detection (https://www.publications.qld.gov.au/dataset/aquatic-invasive-pest-animal-plant/resource/fef33b03-00a0-4140-a15e-3e6db9856c46). Thus *C. fluminea* was confirmed to be present in both Aotearoa New Zealand and Australia in the same calendar year. The pathway by which *C. fluminea* came to Australia is unknown but given the timing it seems plausible that a common pathway of introduction may exist for this species' arrival in Aotearoa New Zealand and Australia.

Corbicula fluminea's impacts on the ecology of Aotearoa New Zealand is currently extremely geographically restricted to a single river and are so far unrealised at a national level. However, it is present in large numbers in at least some of the initial detection sites in the North Island's Waikato River (Martin 2023). Without effective intervention, habitat modelling and the rate of spread and subsequent occupation in other countries suggest it is

Figure 2. 2023 samples of *Corbicula fluminea* from the Waikato River. Top photograph shows showing a typical range of size classes present at collection sites. Bottom photograph shows scale (mm). Photographs courtesy of the Ministry for Primary Industries.

likely that the clam will invade Lake Taupō (Karatayev et al. 2005; Torres et al. 2018; Somerville et al. 2024). Somerville et al. (2024) used a Maximum Entropy (MaxEnt) model to predict habitat suitability across Aotearoa New Zealand for *C. fluminea*. This model was parametrised with over 9500 observations from across the species' native and invaded ranges globally, with climate, environmental and habitat variables associated with the species' distribution. Most areas of highest risk in Aotearoa New Zealand were identified as being in the North Island and indicated there were many suitable areas beyond the Waikato River under current climate conditions. However, the model also showed that increasing water temperatures associated with climate change would increase the area of Aotearoa New Zealand suitable for *C. fluminea* establishment further. Similarly, modelling correlative species distribution and niche conservatism in Aotearoa New Zealand found that niche plasticity in most invasive freshwater species, along with climatic suitability, meant the potential exists for *C. fluminea* to

establish in a wide geographic area of the country (Torres et al. 2018). Such modelling is useful to target resources in terms of surveillance and subsequent efforts at suppression.

Regardless of environmental suitability, the realised niche of *C. fluminea* in Aotearoa New Zealand will be additionally impacted by biological interactions with resident predators and competitors, and the freshwater ecosystems of Aotearoa New Zealand differ significantly compared to the majority of other areas invaded by *C. fluminea* (Drinan et al. 2020). The low native freshwater mollusc diversity in Aotearoa New Zealand will limit competition that could otherwise help prevent *C. fluminea* spread and establishment. Indeed, of particular concern is the potential for *C. fluminea* to outcompete native freshwater mussels such as Kākahi (*Echyridella* spp.), which are also a taonga ("treasured") species for the indigenous Māori people of Aotearoa New Zealand (MPI TAG 2023). *Corbicula fluminea* has far higher reproductive rates and faster growth-rates than Kākahi and are additionally prone to mass "die-offs" that results in ammonia release sufficient to kill some species of mussels in the family Unionidae of which Kākahi belongs (Cherry et al. 2005; Coughlan et al. 2019; Robb-Chavez et al. 2023). Therefore, the density of Kākahi could be significantly reduced in locations if both species are present. Predation pressure on *C. fluminea* populations may also be minimal in Aotearoa New Zealand and that which does occur is likely to come from other introduced species currently regarded as "pests", such as the brown bullhead catfish (*Ameiurus nebulosus*) and koi (*Cyprinus carpio*) (MPI TAG 2023). Such novel interactions between species, and their implications for future spread and impact of *C. fluminea* have not been studied and are poorly understood.

In any country invaded thus far, *C. fluminea* has proved hard to contain or suppress and in all practical senses, impossible to eradicate (Barbour et al. 2014; Aldridge et al. 2015; Coughlan 2019). It is sobering to note that no invaded country has been able to eradicate the clam and, internationally the use of public messaging such as "Check, Clean, Dry" campaigns to slow or control the clam's spread has had limited impact (Darrigran 2002; Lucy et al. 2012; Richardson 2020). Despite the reported difficulties of *C. fluminea* control and management, the discovery of *C. fluminea* in Aotearoa New Zealand prompted the initiation of a biosecurity response, given the vulnerability of the country's freshwater ecosystems, with its low native diversity and unique fauna which developed for millennia in isolation until the 13th century (Champion 2018; MacNeil 2024). The biosecurity response was led by BNZ in partnership with local iwi (Māori tribal units) based in Waikato Region and other central and local governmental and private organisations. River surveys, a controlled area notice (declaring a large part of the Waikato River to be a controlled area, imposing movement controls and establishing biosecurity treatments and procedures to prevent *C. fluminea* spreading), cancellation of recreational events and new public messaging

campaigns represent some of the management strategies implemented since the clam was first discovered (MPI TAG 2023). Along with the revitalised "Check, Clean, Dry" campaign, the biosecurity response in Aotearoa New Zealand also used legal tools under the Biosecurity Act 1993 to enact new controlled areas (https://www.mpi.govt.nz/dmsdocument/67806-Corbicula-fluminea-collaborative-long-term-management-plan). Controlled areas set boundaries to stop movements of risk vessels or goods either into, or out of, infested regions. Water washing stations were developed to help river users meet the requirements of cleaning their vessels before movement. Concerning some specific examples of non-governmental responses, the Te Arawa Lakes Trust is responsible for protecting water quality in twelve lakes in the Rotorua region of Aotearoa, as the lakes are a taonga (treasure) to Māori people of the region (https://www.rotorualakes.co.nz/our-lakes). In response to the threat of *Corbicula* spp. entering such lakes from the Waikato River, the Trust has established its own designated wash stations in addition to "Check Clean Dry" requirements (https://www.rotorualakes.co.nz/freshwater-gold-clam). One particular Te Arawa lake, Lake Ōkataina, also has an automated boat ramp gate for access, which can only be opened after the wash station procedures have been completed, adding another layer of biosecurity (https://www.rotorualakes.co.nz/new-automated-gate-for-accessing-lake-kataina-now-operational.). There are also biosecurity protocols for the continued cultural translocations of eel elvers within freshwaters, Māori initiated eDNA surveillance for *Corbicula* spp. and documentaries discussing the potential impact of this invasion for Māori and the possible responses (https://www.maramatanga.ac.nz/node/2081).

Nationwide surveillance has been undertaken to establish the extent of the clam distribution in Aotearoa New Zealand after the initial detection (https://www.mpi.govt.nz/dmsdocument/67806-Corbicula-fluminea-collaborative-long-term-management-plan). Work is currently underway to operationalise a long-term nationwide surveillance programme, with the objective of early detection of the clam in new areas. Research and trials are being undertaken to develop new tools to prevent further spread (e.g., hot water treatment for boats with a ballast component) and methods to potentially eradicate new, less well established, or contained populations of *Corbicula* spp., if they are detected in the future (MPI TAG report 2023; Melchior and Hofstra 2024; https://niwa.co.nz/news/now-or-never-fight-against-invasive-clam-gets-critical-boost).

Conclusion

The long-term impacts of *C. fluminea* in Aotearoa New Zealand will ultimately be determined by how effective management efforts are at restricting its distribution, suppressing existing populations and protecting unique native ecosystems and fauna from new incursions. A variety of biosecurity strategies are currently underway and are being developed in response to

the 2023 detection of *C. fluminea*. *C. australis* appears, so far, to be restricted to a single site, albeit in the same river catchment as *C. fluminea*. The 2023 detection of *C. fluminea* for the first time in Australia may indicate a common pathway for *C. fluminea* invasion of Australasia as a whole.

Authors' contributions

CM and AP identified the interest to publish these records. All authors read, improved and approved the final manuscript.

Authors' ORCIDs

Calum MacNeil: 0000-0003-0402-9292; Anjali Pande: 0009-0004-9332-7885; Abraham Growcott: 0000-0001-7578-1292, Scott Sinclair: 0000-0002-4566-0593; Rose Sommerville: 0009-0004-5345-9648; Finnbar Lee: 0000-0002-9219-1486.

Acknowledgements

The authors would like to acknowledge the hard work of the biosecurity response team for the months of effort involved in setting up surveillance and control mechanisms after the clam had been confirmed to be present. Thank you to Catherine Duthie of Ministry of Primary Industries (MPI) for reviewing, signing off and organising some of the funding to complete this work**.** Thank you to Navkaran Parmar from MPI specifically for providing the map. The authors wish to acknowledge the reviewers whose constructive comments greatly improved this manuscript.

Funding declaration

Cawthron Institute research was conducted through the Fish Futures MBIE Endeavour programme, contract CAWX2101. MPI provided funding for their employees to complete this work**.** Publication of the study was supported by the European Union's Horizon Europe HORIZONCL6-2024-BIODIV-01 project "GuardIAS – Guarding European Waters from IAS", under grant agreement no. 101181413 (Katsanevakis et al. 2024).

References

Aldridge DC, Aldridge SL, Mead A, Scales H, Smith RK, Zieritz A, Sutherland WJ (2015) Control of freshwater invasive species: global evidence for the effects of selected interventions. The University of Cambridge, UK, 116 pp, https://doi.org/10.13140/RG.2.2.22197.58084

Barbour J, McMenamin S, Dick J, Alexander M, Caffrey J (2013) Biosecurity measures to reduce secondary spread of the invasive freshwater Asian clam, *Corbicula fluminea* (Müller, 1774). *Management of Biological Invasions* 4: 219–230, https://doi.org/10.3391/mbi.2013.4.3.04

Champion PD (2018) Knowledge to action on aquatic invasive species: Island biosecurity – the New Zealand and South Pacific story. *Management of Biological Invasions* 9: 383–394, https://doi.org/10.3391/mbi.2018.9.4.02

Cherry DS, Scheller JL, Cooper NL, Bidwell JR (2005) Potential effects of Asian clam (*Corbicula fluminea*) die-offs on native freshwater mussels (Unionidae) I: water-column ammonia levels and ammonia toxicity. *Journal of the North American Benthological Society* 24: 369–380, https://doi.org/10.1899/04-073.1

Coughlan N (2019) Better biosecurity: spread-prevention of the invasive Asian clam, *Corbicula fluminea* (Müller, 1774). *Management of Biological Invasions* 10: 111–126, https://doi.org/10.3391/mbi.2019.10.1.07

Crespo D, Dolbeth M, Leston S, Sousa R, Pardal MÂ (2015) Distribution of *Corbicula fluminea* (Müller, 1774) in the invaded range: a geographic approach with notes on species traits variability. *Biological Invasions* 17: 2087–2101, https://doi.org/10.1007/s10530-015-0862-y

Darrigran G (2002) Potential impact of filter-feeding invaders on temperate inland freshwater environments. *Biological Invasions* 4: 145–156, https://doi.org/10.1023/A:1020521811416

Drinan TJ, Grainger NPJ, Harding JS, Collier KJ, Smith BJ, Death RG, Makan T, Rolfe JR (2020) Analysis of the conservation status of New Zealand freshwater invertebrates: temporal changes, knowledge gaps, impediments, and management implications. *New Zealand Journal of Zoology* 48: 1–16, https://doi.org/10.1080/03014223.2020.1778044

Howlett D, Baker R (1999) *Corbicula fluminea* (Muller): New to UK. *Journal of Conchology* 36: 83–83, https://doi.org/10.5962/p.408060

Karaouzas I, Zogaris S, Froufe E, Lopes-Lima M (2020) Rival at the gate: first record of the Asian clam *Corbicula fluminea* Müller, 1774 (Bivalvia: Corbiculidae) in Greece. *Knowledge and Management of Aquatic Ecosystems* 421: 24, https://doi.org/10.1051/kmae/2020017

Karatayev AY, Howells RG, Burlakova LE, Sewell BD (2005) History of spread and current distribution of *Corbicula fluminea* (Müller) in Texas. *Journal of Shellfish Research* 24: 553–559, https://doi.org/10.2983/0730-8000(2005)24[553:HOSACD]2.0.CO;2

Katsanevakis S, Zaiko A, Olenin S, Costello MJ, Gallardo B, Tricarico E, Adriaens T, Jeschke JM, Sini M, Burke N, Ellinas K, Rutten S, Poursanidis D, Marchini A, Brys R, Raeymaekers JAM, Noé N, Hermoso V, Blaalid R, Lucy FE, Verbrugge LNH, Staehr PAU, Vandepitte L, de Groot D, Elliott M, Reuver M, Maclaren J, Li M, Oldoni D, Mazaris A, Trygonis V, Hablützel PI, Everts T, Pistevos JCA, Dekeyzer S, Kimmig SE, Rickowski FS, Panov VE (2024) GuardIAS - Guarding European Waters from Invasive Alien Species. *Management of Biological Invasions* 15: 701–730, https://doi.org/10.3391/mbi.2024.15.4.14

Lauritsen DD, Mozley SC (1989) Nutrient excretion by the Asiatic clam *Corbicula fluminea*. *Journal of the North American Benthological Society* 8: 134–139, https://doi.org/10.2307/1467631

Linares MS, Amaral PHM, Callisto M (2022) *Corbicula fluminea* (Corbiculidae, Bivalvia) alters the taxonomic and functional structure of benthic assemblages in neotropical hydropower reservoirs, *Ecological Indicators* 141: 1470–160X, https://doi.org/10.1016/j.ecolind.2022.109115

Lopez CB, Cloern JE, Schraga TS, Little AJ, Lucas LV, Thompson JK, Burau JR (2006) Ecological values of shallow-water habitats: Implications for the restoration of disturbed ecosystems. *Ecosystems* 9: 422–440, https://doi.org/10.1007/s10021-005-0113-7

Lucy F, Karatayev A, Burlakova L (2012) Predictions for the spread, population density, and impacts of *Corbicula fluminea* in Ireland. *Aquatic Invasions* 7: 465–474, https://doi.org/10.3391/ai

MacNeil C (2024) "The absence of normal"; is it time for a Biocontamination Index for freshwater fauna in Aotearoa-New Zealand? *Management of Biological Invasions* 15: 301–311, https://doi.org/10.3391/mbi.2024.15.3.01

Matthews MA, McMahon RF (1999) Effects of temperature and temperature acclimation on survival of zebra mussels (*Dreissena polymorpha*) and Asian clams (*Corbicula fluminea*) under extreme hypoxia, *Journal of Molluscan Studies* 65: 317–325, https://doi.org/10.1093/mollus/65.3.317

McMahon RF (1999) Invasive characteristics of the freshwater bivalve *Corbicula fluminea*. In: Claudi R, Leach JH (eds), Nonindigenous freshwater organisms: vectors, biology, and impacts. Lewis Publishers, Boca Raton, Florida, pp 315–343

Minchin D (2014) The distribution of the Asian clam *Corbicula fluminea* and its potential to spread in Ireland. *Management of Biological Invasions* 5: 165–77, https://doi.org/10.3391/mbi.2014.5.2.10

Melchior M, Williams A, Hamer M, Pingram M, Squires N, Collier K (2023) Distribution and current state of freshwater mussel populations (Kāeo, Kākahi) in Wadeable Waikato Streams. Waikato Regional Council, Technical Report 2022/01, 40 pp, https://doi.org/10.13140/RG.2.2.20612.60801

Melchior M, Hofstra D (2024) *Corbicula fluminea* suppression trial step one: baseline prepared for the Ministry for primary industries June 2024. NIWA Client Report No: 2024165HN June 2024, Project: MPI24205, 59 pp

MPI TAG (2023) Ministry for Primary Industries Technical Advisory Group. Biosecurity response to *Corbicula fluminea* in the Waikato River. Prepared for Biosecurity New Zealand by Technical workstream *Corbicula response*, 32 pp, https://www.mpi.govt.nz/dmsdocument/59086-Technical-Advisory-Group-Report-Biosecurity-Response-to-Corbicula-fluminea-in-the-Waikato-River

Phelps H (1994) The Asiatic clam (*Corbicula fluminea*) invasion and system-level ecological change in the Potomac river estuary near Washington D.C. *Estuaries* 17: 614, https://doi.org/10.2307/1352409

Richardson T (2020) The ecological consequences of nonindigenous *Corbicula fluminea,* establishment on a benthic macroinvertebrate community. *Aquatic Invasions* 15: 382–407, https://doi.org/10.3391/ai.2020.15.3.03

Robb-Chavez SB, Bollens SM, Rollwagen-Bollens G, Counihan TD (2023) Broadscale distribution, abundance, and habitat associations of the invasive Asian clam (*Corbicula fluminea*) in the lower Columbia River, USA. *International Review of Hydrobiology* 107: 179–195, https://doi.org/10.1002/iroh.202202134

Rosa IC, Pereira J L, Gomes J, Saraiva P M, Gonçalves F, Costa R (2011) The Asian clam *Corbicula fluminea* in the European freshwater-dependent industry: a latent threat or a friendly enemy? *Ecological Economics* 70: 1805–1813, https://doi.org/10.1016/j.ecolecon.2011.05.006

Somerville R, MacNeil C, Lee F (2024) Habitat suitability of Aotearoa New Zealand for the recently invaded gold clam (*Corbicula fluminea*). *New Zealand Journal of Marine and Freshwater Research* 59: 762–779, https://doi.org/10.1080/00288330.2024.2368856

Sousa R, Antunes C, Guilhermino L (2008) Ecology of the invasive Asian clam *Corbicula fluminea* (Müller, 1774) in aquatic ecosystems: an overview. *Annales de Limnologie - International Journal of Limnology* 44: 85–94, https://doi.org/10.1051/limn:2008017

Sweeney P (2009) First record of Asian clam *Corbicula fluminea* (Müller, 1774) in Ireland. *Irish Naturalists' Journal* 30: 147–148

Torres U, Godsoe W, Buckley HL, Parry M, Lustig A, Worner SP (2018) Using niche conservatism information to prioritise hotspots of invasion by non-native freshwater invertebrates in New Zealand. *Diversity Distibution* 24: 1802–1815, https://doi.org/10.1111/ddi.12818

Winterbourn J (2023) Guide to the freshwater Mollusca of New Zealand (Fully revised 2021 and updated 2023). Self-published, 2021, 44 pp

Web sites, online databases and software

Mangoroa & Other Blocks Incorporation (2024) Just another invasive problem now in our NZ waterways. 15 July 2024. https://mangaroainc.nz/just-another-invasive-problem-in-our-waterways/. (accessed 20 July 2024)

Martin M (2023) Gold clams "never successfully eradicated elsewhere". Waikato Times. 28 September 2023, https://www.waikatotimes.co.nz/nz-news/350080090/gold-clams-never-successfully-eradicated-elsewhere. (accessed 10 October 2023)

Martin M (2024) Gold clams "never successfully eradicated elsewhere". Waikato Times. 1 May 2024 https://www.waikatotimes.co.nz/nz-news/350261591/clam-infested-aqua-park-remains-closed. (accessed 3 May 2024)

Ponder WF, Hallan A, Shea ME, Clark SA, Richards K, Klunzinger MW, Kessner V (2024) Australian freshwater molluscs. Revision 2B. https://keys.lucidcentral.org/keys/v3/freshwater_molluscs/key/australian_freshwater_molluscs/Media/Html/entities/corbicula_australis.htm (accessed 3 May 2024)