SPECIES AT A GLANCE

New Zealand Mudsnail

Jane and Michael Liu, Oregon Sea Grant

REPORT THIS SPECIES! Oregon: 1-866-INVADER or OregonInvasivesHotline.org; **Washington:** 1-888-WDFW-AIS; **California:** 1-916-651-8797 or email invasives@dfg.ca.gov; **Other states:** 1-877-STOP-ANS.

New Zealand mudsnails are a highly invasive species of freshwater mollusk of the family Hydrobiidae, also known as spring snails. While some species in the family Hydrobiidae are sensitive to water quality and environment, New Zealand mudsnails are tolerant of a wide variety of habitats. Because of their ability to clone themselves and maintain high reproductive rates, these animals have rapidly spread throughout the western United States. Some estimates indicate that one female can clone and produce over 312,500,000 offspring in one year. It takes only one aquatic hitchhiker to start an invasion!

Species in the news

Ecology graduate student Val Brenneis studies the effect of invasive New Zealand mudsnails in Youngs Bay, near Astoria, Oregon.

Learning extensions

On the Trail of the Snail

Resources

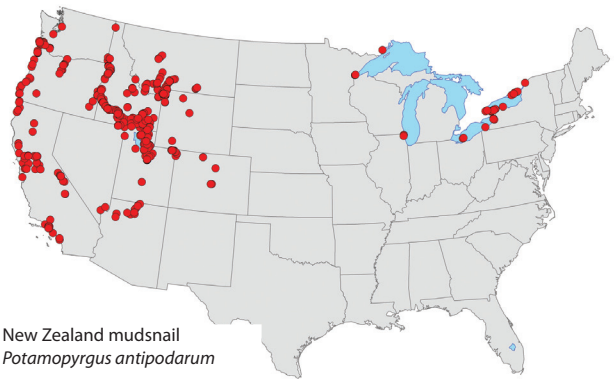
Distribution information: http://rivrlab.msi.ucsb.edu/NZMS/index.php

Why you should care

People provide pathways for spreading New Zealand mudsnails. Mudsnails can dramatically impact the bottom of the food chain by dominating primary consumption in aquatic communities they invade. Through sheer numbers, their dense populations outcompete native invertebrates for periphyton (food—algae and diatoms) and can cause problems in industrial facilities that become infested. They are a poor source of food for fish; fish will actually lose weight on a diet of mudsnails.

How they got here and spread

The New Zealand mudsnail was introduced to the Snake River in Idaho with a shipment of trout eggs from New Zealand intended for sport-fishing hatchery operations. They spread into relatively pristine areas, such as Yellowstone National Park. New Zealand mudsnails have been shown to spread independently upstream through locomotion. They are spread through contaminated recreational equipment (boots and waders, lifejackets, kayaks, etc.), birds, and the digestive tracts of fish.



New Zealand mudsnail
Potamopyrgus antipodarum

Left: Data on map represents established population and species occurrence data. Map created 10/11.

What you can do

a. Scrub (with a stiff bristled brush) and thoroughly rinse your boat, trailer, boots, fishing or kayaking/rafting gear, scientific instruments etc. before exiting an infested area.

b. Allow everything to dry in low humidity for at least 24 hr before entering another body of water.

COOL FACTS

New Zealand mudsnails have an unusual form of reproduction called parthenogenesis—females reproduce by cloning themselves. They can pass through trout alive after being eaten. Their operculum, a tough "trap door" at the opening of the shell, can be closed, which allows them to survive out of water for several days.

New Zealand Mudsnail

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Potamopyrgus antipodarum

Synonyms: *Hydrobia jenkinsi (Smith 1889), Potamopyrgus jenkinsi (Smith 1889)*

INTRODUCTION

The New Zealand mudsnail is a small, aquatic snail most commonly found in freshwater lakes, rivers, and streams. Its name is misleading, as the mudsnail is normally found on hard debris, rock, and gravel surfaces. Its shell has five to seven whorls (a whorl is a single complete turn in the spiral growth of a shell), which distinguishes it from native spring snails, which generally have fewer than six whorls. At maturity, the shell is 0.5 to 6.0 mm in length (roughly equal to the diameter of a pencil eraser). New Zealand mudsnails reach sexual maturity and can begin reproducing when they are 3 mm in length (about the size of a sesame seed). Color varies from gray to light or dark brown, depending on the population. The species is parthenogenic and reproduces prolifically. In extreme cases, habitat densities can reach as high as 300,000 snails per square meter, with the snails comprising most of the invertebrate biomass.

New Zealand mudsnails are very tolerant of different habitats because they possess an operculum (a movable cover to the opening of their shell), which allows them to seal themselves safely inside. Once the shell is sealed, they can survive temporarily in extreme conditions, including ingestion by a fish!

NATIVE AND INVASIVE RANGE

The New Zealand mudsnail has spread from New Zealand to freshwater environments throughout the world. Its current distribution includes Australia, Europe, Asia, and North America. First discovered in the United States in 1987 in the Snake River near Hagerman, Idaho, they are now locally abundant in many western rivers. The mudsnail's European distribution and its adaptability to diverse climatic and environmental conditions indicate a potential to spread throughout the United States.

WEST COAST DISTRIBUTION

In less than 10 years, New Zealand mudsnails have spread to every state in the western United States, including Colorado. New Zealand mudsnails' inability to withstand freezing temperatures and low calcium content has limited their spread in some of the higher elevations.

ECOLOGY

Life cycles and migration patterns

The New Zealand mudsnail is able to reproduce in two ways. Although it can reproduce sexually in New Zealand, invasive populations tend to consist of self-cloning, live-bearing females that yield 20 to 140 offspring per brood, with brooding occurring up to four times per year. They reproduce extremely fast and are capable of dominating local ecosystems in a short period of time. In its native range, the New Zealand mudsnail does not exhibit such invasive properties because populations are kept at bay by a number of parasites. As a result of the parasite, native New Zealand mudsnails don't reproduce by self-cloning, but by mating sexually. As many as 14 trematode worms in New Zealand parasitize New Zealand mudsnails, while several native fish species frequently eat them.

Habitat modification and food webs

New Zealand mudsnails often dominate a wide range of benthic habitats, including silt, sand, gravel, cobbles, vegetation in slow-moving waters, lakes, reservoirs, and brackish estuary waters. They can tolerate up to 12 parts per thousand in salinity, and have been found at depths of 4–45m in the Great Lakes. They tolerate a wide range of temperatures (from near

freezing to 28°C) and water quality: they can thrive in turbid and degraded conditions (including sewage)! The highest densities of mudsnails occur in systems with high primary productivity, constant temperatures, and constant flow. New Zealand mudsnails feed on diatoms, attached periphyton, and plant and animal detritus that is a critical component of primary productivity and an important part of the food chain.

HOW THIS SPECIES GOT TO NORTH AMERICA

In the mid-1980s, the New Zealand mudsnail was introduced to the Snake River in Idaho with a shipment of trout eggs for sportfishing hatchery operations from New Zealand. Once introduced, they spread rapidly by human activities and established in high numbers within Yellowstone National Park.

The mudsnail was introduced separately to Lake Ontario, which borders New York State and Ontario, Canada, through ballast water discharge from European-running cargo ships.

HOW THIS SPECIES SPREADS

Once introduced, New Zealand mudsnails can spread quickly as a hitchhiker on aquatic plants, fishing gear, boots, boat trailers, or in live wells or water tanks. Recreational fishing and boating, aquatic monitoring, and hatchery and aquaculture operations all provide potential ways for mudsnails to become introduced to new rivers and lakes. New Zealand mudsnails often attach to aquatic plants. Infested plant fragments are moved by boats that were not cleaned properly.

The problem of "hitch a ride" is magnified by the mudsnail's ability to survive extreme conditions. New Zealand mudsnails are very small (about the size of a pencil eraser) and can easily be overlooked for weeks. They can survive for up to two weeks in wet or damp conditions before being exposed and introduced to new settings.

COOL FACTS

New Zealand mudsnails can pass through a fish digestive tract unharmed and produce viable offspring within several hours.

New Zealand mudsnails have an unusual form of reproduction called parthenogenesis. This means that females reproduce by cloning themselves. It is believed that most of the Western populations of New Zealand mudsnail all came from two females, resulting in only two genetic forms in the west. In fact, males of the species are extremely rare in western North America.

ECOLOGICAL IMPACTS

New Zealand mudsnails dominate invaded communities and negatively impact native organisms. Dense populations (up to 750,000 per m^2) have been documented in Yellowstone River in Wyoming. Tremendous densities of New Zealand mudsnails could impact the periphyton and benthic organisms that form the base of the food chain. They can consume up to 95 percent of the diatoms, attached periphyton and detritus that are the primary food sources for native aquatic invertebrates. Higher trophic levels, dependent on native species for food, may be adversely affected. New Zealand mudsnails themselves are a poor food source and a 2008 study confirms that North American trout fisheries face potential negative impacts from New Zealand mudsnail invasion. This study shows that Rainbow trout fed an exclusive

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New Zealand mudsnails reproduce through parthenogenesis and bear live young. Above: Note the embryos in the bottom whorl of the shell. Right: Embryos released after a snail dissection.

and unlimited amount of New Zealand mudsnails lost 0.14–0.48% of their initial body weight per day. The same study also documented that brown and rainbow trout collected from the wild (from the Green River in Utah) with New Zealand mudsnails in their stomachs were in poor condition compared to fish without them. Decreases in fish growth rates and populations have also been reported in the Yellowstone river and other affected rivers. Only a few native species (sculpins and crayfish) prey on New Zealand mudsnails; so far, no parasites have been found in them. This suggests that it is a lack of natural predators ("ecological release effect") that may be contributing to the invasive success of New Zealand mudsnails in the United States.

ECONOMIC IMPACTS

The economic impacts of New Zealand mudsnails are not well understood. However, adverse impacts on recreational fisheries could impact tourism in affected areas. New Zealand mudsnails have the potential to infiltrate water systems and clog water pipes and meters, causing costly damage through the process of biofouling. They could also impact important commercial species, such as Chinook salmon and rainbow and steelhead trout on the West Coast.

CULTURAL SIGNIFICANCE

New Zealand mudsnails generally go unnoticed due to their small size. However, ecosystem effects associated with mudsnail invasions can lead to social impacts, such as loss of recreational activities caused by damage to fish populations and their growth rates.

LAWS CURRENTLY IN PLACE

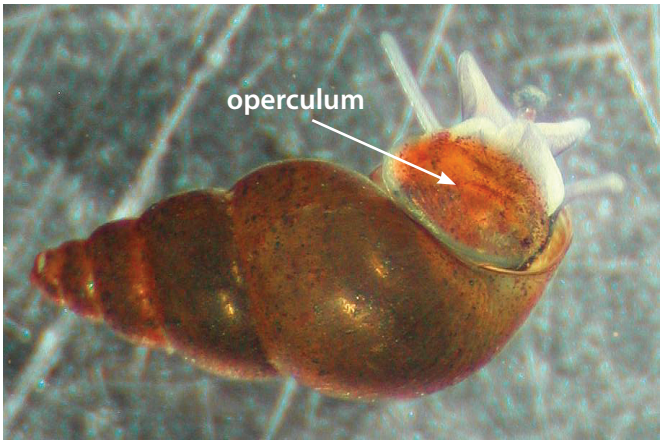
The New Zealand mudsnail is on the Washington Detection and Response List. The state intends action to be taken to detect and eradicate or control species on this list if found.

In Oregon, New Zealand mudsnails are a prohibited species and require a permit to possess alive.

In California, New Zealand mudsnails are classified as a "prohibited" species, and are therefore illegal to possess and/or transport live.

MANAGEMENT STRATEGIES

Education and prevention through inspection and cleaning of gear are the main methods of reducing or slowing the spread of New Zealand mudsnails. Native fish, such as sculpins and native crayfish, are able to consume New Zealand mudsnails. Currently, a research program is in place to develop biological control using a highly specific trematode parasite from New Zealand, including testing to be sure that it cannot infect native spring snails. Also, Oregon Sea Grant is working with an evaluative model to estimate risk and cost from the spread of invasive species. Using this tool, Sea Grant may be able to predict and develop useful management strategies.



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The New Zealand mudsnail's operculum (shown above) allows it to survive several days out of water and being ingested by a fish.

WHAT YOU CAN DO

* **Report any New Zealand mudsnail sightings:** In Oregon, call 1-866-INVADER or go to OregonInvasiveHotline.org; in Washington, call 1-360-902-2700; and in California, call 1-916-651-8797, e-mail invasives@dfg.ca.gov, or visit http://rivrlab.msi.ucsb.edu/contact.php. In other states, contact the National Invasive Species Hotline: 1-877-STOP-ANS.
- **Rinse** all equipment after use (boats, trailers, boots, fishing gear, scientific instruments, etc.). **Remove** aquatic plants, fish, animals, and mud from boat, motor, trailer, and equipment. Have two sets of equipment so that you can treat and quarantine one set between uses.
- At a minimum, **scrub and rinse** field gear, especially soles and lacing.
- OR **freeze gear, or rinse and scrub it** with hot water—at least 70° degrees C**. Dry or chemically treat equipment before use in new areas.** Further guidelines are currently being researched.
- Treating gear with copper sulfate or cleaners with benzlyammonium chloride (such as Formula 409®) will kill New Zealand mudsnails. However, these treatments can also kill native organisms and contaminate water. Exercise extreme caution in applying these chemicals. For more information on chemical control, refer to "How to Prevent the Spread of New Zealand Mudsnails through Field Gear," produced by Oregon Sea Grant. http://seagrant.oregonstate.edu/sgpubs/onlinepubs/g10001.pdf
- Encourage or become active in stream enhancement and restoration projects to improve the health and resilience of watersheds. Exercise caution, however, to prevent the introduction of New Zealand mudsnails through restoration activities.

INFORMATION GAPS

- Biological control options, such as mudsnail parasites native to New Zealand, are unlikely to exist in nonnative ecosystems. However, parasites native to New Zealand and purposefully brought into nonnative environments may provide biocontrol opportunities if the parasites do not harm native organisms. Researchers are exploring options.
- Ecosystem impacts of the New Zealand mudsnail in new environments are poorly understood and significant research is needed to develop effective control or containment strategies.

REFERENCES

Buttermore, Roger. 2004. *Update on New Zealand Mudsnail Occurrence and Issues.* Lecture. Lower American River Task Force Meeting.

Chan, S. S., R. D. Draheim, P. Heimowitz, and S. Johnson. 2006. "New Zealand Mudsnails: How to Prevent the Spread of New Zealand Mudsnails." Oregon Sea Grant.

Hall, R. O., M. F. Dybdahl, and M. C. Vanderloop. 2006. "Extremely high secondary production of introduced snails in rivers." *Ecological Applications* 16:1121–1131.

Levri, E.P., A.A. Kelly and E. Love. 2007. The invasive New Zealand mud snail *(Potamopyrgus antipodarum)* in Lake Erie. *Journal of Great Lakes Research* 33: 1–6

Lively, C. M. 1987. "Evidence from a New Zealand snail for the maintenance of sex by parasitism." *Nature* 328:519–521.

_____. 1996. "Host-parasite coevolution and sex." BioScience 46:107–113.

_____. 2001. "Trematode infection and the distribution and dynamics of parthenogenetic snail populations." *Parasitology* 123:S19–S26.

New Zealand Mudsnail. UC Santa Barbara River Lab. 2010. http://rivrlab.msi.ucsb.edu/NZMS_data/mudsnail.php

New Zealand Mudsnail Fact Sheet. 1994. Colorado Division of Wildlife. http://wildlife.state.co.us/SiteCollectionDocuments/DOW/WildlifeSpecies/AquaticNuisance/NewZealandMundsnail_factsheet.pdf

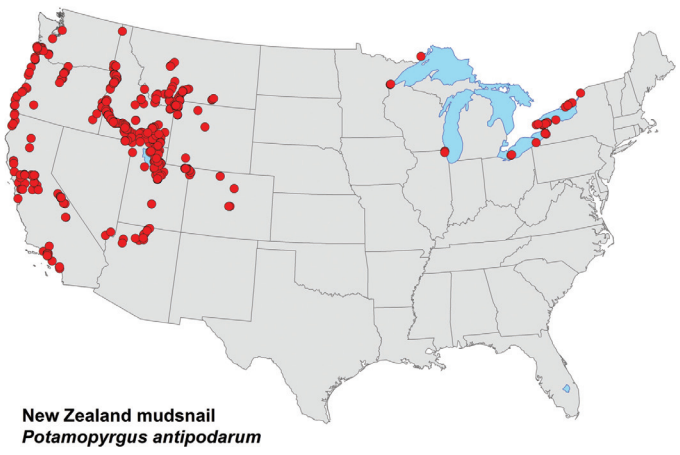
New Zealand Mudsnail Management and Control Plan Working Group. 2007. "National Management and Control Plan for the New Zealand Mud Snail." www.anstaskforce.gov/Documents/NZMS_Mgmt-Control_Final.pdf [last accessed October 2011]

Richards, D. C., L. D. Cazier, and G. T. Lester. 2001. "Spatial distribution of three snail species, including the invader *Potamopyrgus antipodarum*, in a freshwater spring." *Western North American Naturalist* 61:375–380.

Richards, David C. and Gary T. Lester. 2003. *Survey of the invasive New Zealand Mudsnail, Potamopyrgus antipodarum in the Silver Creek drainage in and around The Nature Conservancy's Silver Creek Preserve, Idaho, USA*. The Nature Conservancy. EcoAnalysts, Inc.

Schreiber, E. S. G., P. S. Lake, and G. P. Quinn. 2002. "Facilitation of native stream fauna by invading species? Experimental Investigation of the snail, Potamopyrgus antipodarum (Hydrobiidae) with native benthic fauna." *Biological Invasions* 4:317–325.

Schreiber, E. S. G., G. P. Quinn, and P. S. Lake. 2003. "Distribution of an alien aquatic snail in relation to flow variability, human activities and water quality." *Freshwater Biology* 48:951–961.



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Vinson, M.R., M.A. Baker. 2008. Poor Growth of Rainbow Trout Fed New Zealand Mud Snails (Potamopyrgus antipodarum). North American Journal of Fisheries Management. 28:701–709

Zaranko, D. T., D. G. Farara, and F. G. Thompson. 1997. Another exotic mollusk in the Laurentian Great Lakes: the New Zealand native *Potamopyrgus antipodarum* (Gray 1843) (Gastropoda, Hydrobiidae). *Can. J. Fish. Aquat. Sci* 54:809–814.

ADDITIONAL RESOURCES

Montana State University's "New Zealand Mudsnails in the Western United States." www.esg.montana.edu/aim/mollusca/nzms/utah-sep2004.pdf

UC Santa Barbara's New Zealand Mudsnail page. http://rivrlab.msi.ucsb.edu/NZMS/

USGS New Zealand mudsnail factsheet. http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=1008

"New Zealand Mudsnails: How to Prevent the Spread of New Zealand Mudsnails." http://seagrant.oregonstate.edu/sgpubs/onlinepubs/g10001.pdf

"Warning Mudsnails!" A Web site produced to provide information about New Zealand mudsnails and the threat of invasive species to creeks, streams, and lakes in southern California. http://mudsnails.com/index.html

News article: "Dreaded Snails Find Seattle Creek." www.king5.com/news/local/Dreaded-Snails-Find-Seattle-Creek-122989143.html

Miller, Henry. 2002. "Attack of the clones dates back to 1980s or earlier: New Zealand mud snails are so tiny, they're hard to notice, but they clone by the billions." Statesman Journal, Salem, Oregon. www.statesmanjournal.com/article/20080210/INVASIVE06/802100305/Attack-clones-dates-back-1980s-earlier

"Ecology graduate student Val Brenneis studies the effect of invasive New Zealand mud snails in Youngs Bay, near Astoria, on the local food chain." www.statesmanjournal.com/apps/pbcs.dll/article?AID=/20080210/VIDEO17/302110001

Powerpoint showing how hatcheries are treating water to prevent New Zealand mudsnail introductions: www.esg.montana.edu/aim/mollusca/nzms/Nielson_Presentation.pdf