Design by Stefania M. Padalino.
Cover photos: top three photos by D. L. Gustafson; bottom two photos by Jane and Michael Liu.

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IF YOU FIND MUDSNAILS

If you suspect you have found mudsnails, collect 5 to 10 individuals and place them in a plastic bag into which you have sprinkled water. Check against the simple traits above and on this Web page to confirm identification: http://www.esg.montana.edu/aim/mollusca/nzms

Please save the samples and contact the Oregon Invasive Species Council (1-866-INVADER or online at oregoninvasiveshotline.org) and one of these specialists:

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To order copies of this brochure, call 541-737-4849 or e-mail Oregon Sea Grant, sea.grant.communications@oregonstate.edu. You can also download a pdf at http://seagrant.oregonstate.edu/sgpubs/onlinepubs.html

New Zealand Mudsnails

How to Prevent the Spread of New Zealand Mudsnails through Field Gear

This brochure is a guide for field detection and for treating field gear to prevent the spread of New Zealand mudsnails. It is intended for researchers, monitoring crews, watershed survey groups, and anyone else who travels frequently between aquatic or riparian locations.

Second Edition
February 2010

Devils Lake, Oregon, is heavily infested with New Zealand mudsnails. Prevent the spread of New Zealand mudsnails by cleaning gear and boats and not moving water from infested waters into new bodies of water. (Photo by Jane and Michael Liu.)

INTRODUCTION

The New Zealand mudsnail (*Potamopyrgus antipodarum*) is an introduced aquatic species that has invaded estuaries, lakes, rivers, and streams in Washington, Oregon, California, and many other states in the western U.S. It was first noted in North America in the late 1980s in the Snake River and has since spread throughout the West.

The small size (< 5 mm), cryptic coloration, and ability to survive out of water for weeks make the New Zealand mudsnail an ideal hitchhiker.

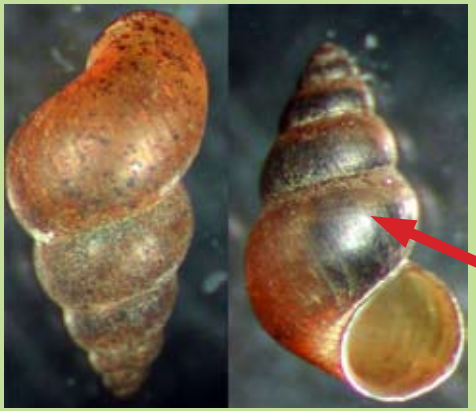
Range expansion of the mudsnail has been unwittingly hastened by anglers, hunters, and field personnel—in other words, people who frequently move between streams and lakes in watersheds, hauling wet waders, nets, and other gear with them. Once the mudsnail is established in a new habitat, it is impossible to eradicate it without damaging other components of the ecosystem. Thus, inspecting, removing, and treating gear before moving to a new water body is the most effective means of preventing the spread of mudsnails.

Snails can be inadvertently transported in bootlaces (center—note different color). (Photo by Jane and Michael Liu.)

The New Zealand mudsnail is often less than 5 mm long. (Photo by Jane and Michael Liu.)

IDENTIFYING THE NEW ZEALAND MUDSNAIL

Size: A mature snail is usually less than 5 mm (.2 in) long. (Photo by Jane and Michael Liu.)



Shape: Shell is elongated and dextral (its whorls or spirals lean toward the right). Snail typically has between 5 to 6 whorls on its shell. (Photo by D. L. Gustafson, http://www.esg.montana.edu/aim/mollusca/nzms.)

Color: Most snails have a light- to dark-brown shell that may appear to be black when wet. (Photo by Jane and Michael Liu.)

Embryos: Upon dissection, mature snails will have brooded embryos. (Photo by D. L. Gustafson, http://www.esg.montana.edu/aim/mollusca/nzms.)

Operculum: The mudsnail operculum (a rounded plate that seals the mouth of the shell when the animal's body is inside) can be seen on live snails but is not easily visible on dead or preserved snails. (Photo by D. L. Gustafson, http://www.esg.montana.edu/aim/mollusca/nzms.)

chloride [DDAC]). Formula 409® Cleaner Degreaser Disinfectant has been proven effective for killing mudsnails at 50% dilution.

- The compounds Quat 128® and Sparquat 256® are commercial disinfectants with an active ingredient (QAC) similar to that of Formula 409® Cleaner Degreaser Disinfectant, which has proven effective for killing mudsnails and other aquatic invasive species (see the table on the foldout page for dilution rates).
- Many household bath and kitchen disinfectants contain quaternary ammonium compounds (check the label for active ingredients containing alkyl dimethyl benzylammonium chloride [ADBAC]; diecyl dimethyl ammonium chloride [DDAC]).

These and other chemical treatments are constantly being evaluated and are updated online at seagrant.oregonstate.edu/themes/invasives/

Fishing docks and boats are potential conduits for spreading the New Zealand mudsnail. (Photo by Jane and Michael Liu.)

This test chamber contains a New Zealand mudsnail with chemical test solution. (Photo by Robert Hosea.)

CAUTION

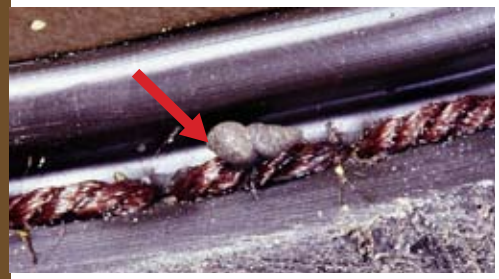
Treating field gear with chemical methods may result in unintended contamination of the environment. In particular, extreme caution must be taken to avoid contamination of waterways and wetlands. DO NOT rinse your treated gear in a water body.

Treating rubber gear or boots with Formula 409® and other disinfectants with QACs may result in surface cracking of the rubber and loss of water repellency. Chemical methods are not always effective in killing mudsnails. Always scrub your gear and consider using physical methods before resorting to chemical methods. For more information on the testing of chemical treatment methodology, see R. C. Hosea, and B. Finlayson, 2005, *Controlling the Spread of New Zealand Mud Snails on Wading Gear,* Administrative Report 2005-02, Rancho Cordova, California: Resources Agency, California Department of Fish and Game.

THE MUDSNAIL PROBLEM

The New Zealand mudsnail is a threat to our waters. By competing with native invertebrates for food and habitat, it has a detrimental impact on fish populations, vegetation, and other native biota.

Mudsnails can tolerate a wide range of habitats, including brackish water, and are found living in high densities (often over 400,000 snails/sq meter) on many different substrates (rock, gravel, sand, mud, vegetation, and even the shells of other organisms).



Mudsnails can attach to the seam of a stream boot. Unintentional transport from one stream location to another by hitchhiking on waders or wading boots is one of the primary vectors for spreading New Zealand mudsnails. (Photo by Jane and Michael Liu.)

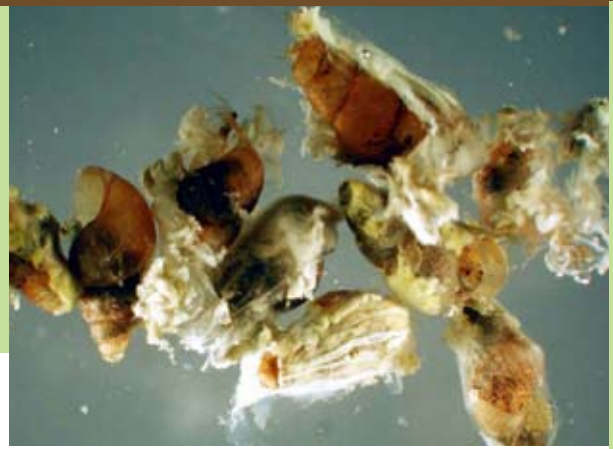
The biology, ecology, and distribution rate of the mudsnail suggest that many habitats are suitable for further expansion.

Mudsnail populations in the West are self-reproducing brooders; they clone themselves and retain the embryos inside their shell until they are large enough to release. Also known as parthenogenesis, this reproductive technique means that a single mudsnail can rapidly colonize a new location.

Mudsnails are easily transported to new habitats by recreationists and field crews because the snails readily attach to or are wedged into the many cracks, crevices, and crannies presented by waders, boot soles, nets, and buckets. New Zealand mudsnails can live for weeks in damp, cool conditions; can easily survive on field gear for long periods of time; and can be transferred to a new environment when that gear is reused.

1995 2001 2009

These maps show the spread of the New Zealand mudsnail from 1995 to 2009 in the western U.S. New Zealand mudsnails have recently been found in parts of the Great Lakes region. (Maps courtesy of Amy Benson, U.S. Geological Survey.)



Mudsnails can pass through the intestinal tract of a fish. Almost half the mudsnails survived this trip. (Photo by M. Vinson, http://www.esg.montana.edu/aim/mollusca/nzms.)

PREVENTION

To prevent the survival of mudsnails on field clothing and equipment, you will need first to clean your field gear and then to treat it, using either the physical or chemical methods listed below. We recommend the following steps:

1. **If possible, keep several changes of field gear for use in different bodies of water.**
2. **Clean all gear before leaving a site, scrubbing with a stiff-bristled scrub brush and rinsing with water, preferably high-pressure. This is often the simplest and most effective for prevention.**
3. **Inspect gear before it is packed for transport. Visible traces of sand, mud, gravel, and plant fragments are signs that gear has not been properly cleaned and mudsnails may have been retained.**
4. **Select a treatment method in addition to scrubbing and rinsing if mudsnails are present or suspected to be present.**

- **Freezing, hot water, or drying treatments** are recommended over chemical treatments because they are usually less expensive, more environmentally sound, and possibly less destructive to gear. However, most physical methods require longer treatment times and often cannot be performed in the field.
- **Chemical treatments** require a 10-minute soak in a special solution (see "CHEMICAL," page 5). After chemical treatment, gear must be rinsed thoroughly with tap water away from all bodies of water, and all soak solutions and rinse water must be properly disposed of.

PHYSICAL

These methods for cleaning gear are effective as well as environmentally sound. Use *one* of the following methods:

- **Freeze your gear for a minimum of 4 hours to kill all mudsnails. Freezer temperatures should be at 26°F (-3°C) or below.**
- **Soak gear in a bath of hot water (at least 120°F, 46°C) for 10 minutes. This method is not advised for Gortex.**
- **Dry your gear before reuse. A drying time of at least 48 hours under low humidity is recommended to remove all pockets of dampness. Gear must be completely dry for a minimum of 24 hours. Check to ensure that boots are totally dry.**

CHEMICAL

Common disinfecting cleaners containing quaternary ammonium compounds (e.g., alkyl dimethyl benzylammonium chloride [ADBAC]; diecyl dimethyl ammonium chloride [DDAC]) are effective for decontaminating gear. Disinfectants listed below will kill other aquatic invasive species but may not result in 100% mortality (see table on foldout page).

Gear should be soaked in *one* of the following solutions for 5 minutes and then rinsed thoroughly with tap water, away from the water body. Store and dispose of solution and used rinse water properly.

- **Commercial disinfectant solutions containing quaternary ammonium compounds (QAC) (e.g., Formula 409® Cleaner Degreaser Disinfectant, alkyl dimethyl benzylammonium chloride [ADBAC]; diecyl dimethyl ammonium**

The toe of this rubber wader boot has cracked after being exposed to repeated applications of benzethonium chloride. (Photo by Robert Hosea.)

A worker filters the cleaning solution after removing wading gear. (Photo by Robert Hosea.)

MUDSNAIL LOOK-ALIKES

Figure 1. *Comparison of the New Zealand mudsnail* (Potamopyrgus antipodarum) *with three freshwater snails native to the Pacific Northwest. From left to right: New Zealand mudsnail, a pond snail* (Family Lymnaeidae), *two pebblesnails* (Fluminicola sp.), *and two rock snails* (Juga plicifera).

Several freshwater snails native to the Pacific northwest are commonly misidentified as New Zealand mudsnails (*Potamopyrgus antipodarum*) (see Figure 1). "Pebblesnails" (*Fluminicola*) can be distinguished by its more-rounded, globose-shaped shell (vs. the conical New Zealand mudsnail) and a bottom whorl that is proportionally larger than its upper whorls (as compared to the New Zealand mudsnail, which tends to have more-uniform whorls). Air-breathing "pond" snails (*Lymnaeidae*) can also be very small, like New Zealand mudsnails, but they lack an operculum. "Rock" snails (*Juga sp.*) can be as small as New Zealand mudsnails when juveniles, but they grow to be much larger (up to 2.5 cm; New Zealand mudsnails are no larger than 6 mm). When small, *Juga plicifera* can be distinguished by its grooved whorls; however, other species of Juga such as *Juga silicula* can have smooth whorls similar to the New Zealand mudsnail.

Figure 2. *Comparison of the New Zealand mud snail (three snails on right) with* Assiminea parsitologica *(three snails on left). Both invasive snails might be found together in brackish-water estuaries.*

In estuaries, New Zealand mudsnail habitat overlaps with another nonnative invasive snail, *Assiminea parisitologica*, which is an intermediate host to the human lung fluke parasite, first discovered in Coos Bay, Oregon, in 2007. *Assiminea parisitologica*, native to Japan, occurs more frequently in higher saline to brackish waters, while the New Zealand mudsnail, native to New Zealand, occurs in brackish to freshwater environments. *Assiminea parisitologica* can be distinguished by its globose shape, larger bottom whorl, and a white tip (see Figure 2). *Assiminea parisitologica* is also a high-alert invasive species that should be reported. *Remember: report any species you suspect could be invasive.* It is better to have a suspected report than to miss a new infestation!

Aquatic Invasive Species of Concern, and Current Methods for Disinfection of Gear and Equipment

(Adapted from USDA Forest Service Region 4 Guidelines for disinfecting fire equipment, summarized by Cynthia Tait: http://www.fs.fed.us/r4/resources/aquatic/guidelines/aq_invasives_interim_fire_guidance08_final.pdf)

NOTE: A more complete—and continuously updated—table is available online at seagrant.oregonstate.edu/themes/invasives/

Decontam. Method	Whirling Disease	New Zealand Mudsnails	Chytrid Fungus	Zebra/Quagga Mussels	Didymo	Eurasian Watermilfoil
Hot water or freezing	90°C (195°F); 10 minutes	46°C (120°F); minimum of 5 minutes -3°C (27°F); > 4 hours	60°C (140°F); minimum of 5 minutes	≥ 60°C (140°F) water for minimum of 1 minute Freezing may be effective, but not tested	60°C (140°F); 1 minute	No data, but likely effective
Drying	Be dry for 24 hours, in sunlight best	Be dry for 48 hours, in sunlight best	Be dry for 3 hours, in sunlight best	3–5 days, in sunlight best	Be dry for 48 hours, in sunlight best	No data, but likely effective
Bleach (e.g., Clorox® or equivalent bleach product) 6% sodium hypochlorite (NaClO)	For 10 minutes: 1% bleach solution (500 ppm NaClO) • 1.1 liquid oz bleach per gallon water • 2.2 Tbsp liquid bleach per gallon water • 0.9 gallons each per 100 gallons water	Not effective at the necessary concentrations without risk of damaging gear and equipment	For 10 minutes: 7% bleach solution (0.4% NaClO) (>3,500 ppm NaClO) • 9 liquid oz bleach per gallon water • 7 gallons bleach per 100 gallons water	Gear rinsed with 0.5% bleach solution (250 ppm NaClO) • 0.6 liquid oz bleach per gallon water • 1.1 Tbsp liquid oz bleach per gallon water • 0.5 gallons bleach per 100 gallons water	For 1 minute: 2% bleach solution (800 ppm NaClO) • 1.8 liquid oz bleach per gallon water • 3.6 Tbsp liquid Clorox per gallon water • 1.4 gallons Clorox per 100 gallons water	No data, but likely effective
Quaternary ammonium compounds (QAC) (e.g., alkyl dimethyl benzylammonium chloride [ADBAC]; diecyl dimethyl ammonium chloride [DDAC])	15-minute exposure 4.4% Quat128® (1,500 ppm QAC active ingredient) • 6.1 liquid oz. Quat 128 per gallon of water OR 3.1% Sparquat 256® • 4.1 liquid oz. per gallon water	10-minute exposure 4.6% Quat 128 (1,570 ppm QAC active ingredient) • 6.4 liquid oz. Quat 128 per gallon of water OR 3.1% Sparquat 256 • 4.3 liquid oz. per gallon water OR Dilute 1 part Formula 409® Cleaner Degreaser Disinfectant to 1 part water	30-second exposure to 0.015% Quat 128 (5 ppm QAC active ingredient) • 1/8 tsp per gallon water	No published data, but likely effective	No published data, but likely effective	No data