New Zealand Mudsnail Risk Analysis for Arizona

Name
New Zealand mudsnail (NZMS: *Potamopyrgus antipodarum*) Family Hydrobiidae

Source information on description, life history, reproductive strategy, environmental tolerances, preferred habitat, distribution, and known/potential impacts from:
http://www.esg.montana.edu/aim/mollusca/nzms/ and **http://nas.er.usgs.gov/**

Description
New Zealand mudsnails are small, operculate snails, which usually display right-handed coiling and 7 to 8 whorls. The average size is approximately 5 mm; maximum size is approximately 12 mm. Shell colors vary from gray and dark brown to light brown (USGS 2002). These snails have a calcified operculum that fits tightly over the shell opening.

Life History
New Zealand mudsnails, an aquatic gastropod, feed on dead and dying plant and animal material, algae, and bacteria (USGS 2002). Mudsnails have no natural predators or parasites in the western USA where they have been accidentally introduced (ESG Montana website), and there is no evidence to suggest that predation effectively controls populations of mudsnails once they are established. In the USA, some fishes have been observed to consume mudsnails, however their anatomical adaptations (operculum) allows them to pass through the guts many fishes undigested and unharmed. It has been suggested that Catostomid and some Cyprinid fishes, which possess pharyngeal teeth, may be capable of consuming and crushing the shell of this species. However, in many streams where NZMS have invaded in North America – principally trout streams, fish lack these specialized adaptations to effectively feed on operculate snails (Procter et al. 2006). Growth rates: depending on size, individuals can grow 0.1mm/day at 21^{o} C under laboratory conditions (Richards et al. in prep.)

Reproductive Strategy
New Zealand mudsnails appear to principally reproduce parthenogenically in known USA populations. Mudsnail populations consist mostly of asexually reproducing females that are born with developing embryos already present in their reproductive system. Males rarely appear in USA populations, and populations appear to represent three distinct 'clonal' groups – an eastern USA group, a western USA group, and an apparently distinct clonal group found in the Snake River in Idaho.

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Size at sexual maturity: in western USA reaches sexual maturity at 3.0 mm. Larger NZMS produce more offspring (Richards et al. submitted). Their densities are usually highest in systems with high primary productivity, constant temperatures, and constant flow (ESG Montana website).

Number of young and brooding time: ranges from 20-120 embryos per female (Richards unpublished data; Winterbourn 1970). Cohorts of young are born every three months in NZ (Winterbourn 1970), but it appears that mudsnails can bear young at any time of year in spring habitats western USA (Richards unpublished data), but in most systems production appears to peak during summer and autumn (Richards, Kerans, Gustafson, Shinn, pers. comm.).

Environmental Tolerances and Restrictions

New Zealand mudsnails can tolerate a wide range of water temperatures (except freezing), salinity, and turbidity in clean as well as degraded waters. In moist conditions, this snail can withstand short periods of desiccation (USGS 2002). Evidence suggests that mudsnails tolerate up to 17-24% salinity (Bondesen and Kaiser 1949).

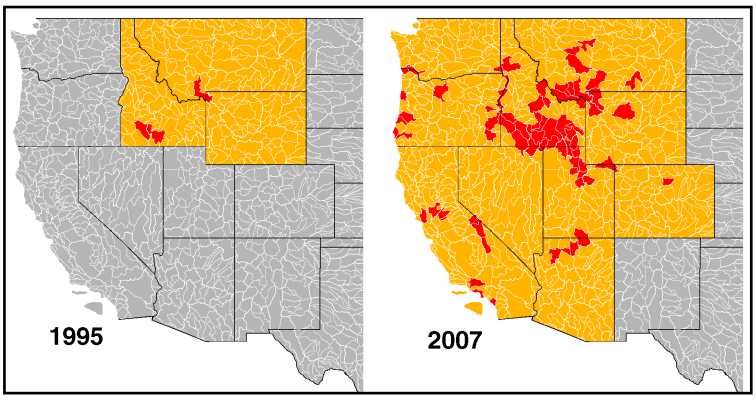
Preferred Habitat

This species can be found in all types of aquatic habitats from eutrophic mud bottom ponds to clear rocky streams (USGS 2002).

Distribution

- **Native Range:** The freshwater streams and lakes of New Zealand and adjacent small islands; it is naturalized in Australia and Europe
- **Expanded Range in United States:** Idaho, Montana, Wyoming, Utah, Colorado, Washington, Oregon, Nevada, California, Arizona, and New York
- **Expanded Range in Canada:** Ontario and British Columbia

The pathway for arrival of this aquatic snail in the USA is speculative. The Eastern clonal group may have arrived with ship ballast in the Saint Lawrence River or the Great Lakes, having been transported from Europe or Australia. The Western clonal group may have arrived in the transport water of live sportfish imported from infested waters in New Zealand, Australia, or Europe.



This snail was first discovered in the middle portion of the Snake River in Idaho in 1987. Since then, they have been found in the Madison River and several other rivers in and near Yellowstone National Park. They have also been collected from southwestern Lake Ontario, New York, the Welland Canal and northeastern Lake Ontario, Canada. Additional populations were discovered near the mouth of the Columbia River in Oregon in 1997 and the Owens River in

California in 2001. In California, these snails have since spread by 2005 to the Calaveras, Mokelumne and Napa rivers as well as Hot, Rush and Putah creeks spanning both sides of the Sierra Nevada Mountains (Hosea and Finlayson 2005). In March 2002, NZMS were documented in the Colorado River just below the Glen Canyon Dam in northern Arizona (USGS 2002). It appears that the species may have been present as early as 1996, but either escaped detection or was misidentified until its identity was confirmed in 2002. The snail has dispersed downstream through Grand Canyon, and in 2009 was documented in Lake Mead.

Current Status in Arizona
Colorado River below Glen Canyon Dam, Lee's Ferry reach and Grand Canyon, and in Lake Mead. New Zealand mudsnails have not been detected below Hoover Dam. No specifically targeted surveys have been conducted elsewhere in Arizona to determine their distribution.

New Zealand mudsnails are already listed as Restricted Live Wildlife in Arizona, per R12-4-406.

Pathways
Mudsnails will passively move into connected waterways, reservoirs, and ponds (USGS 2002).

The long-range dispersal of NZMS is restricted to transport in water or damp media. The operculum forms a tight seal, and NZMS have been reported to survive out of water for several hours (Gangloff 1998). The survival of NZMS increases if kept in damp media such as a wading boot; Winterbourn (1970) reported 50% survival after 25 days in damp media. It is likely that their spread within California and from Idaho to Montana and Wyoming were the result of unintentionally being transported on damp media such as wading gear (Hosea and Finlayson 2005). This is the likely pathway for this species to be introduced into other waterways within Arizona.

Known/Potential Impacts
Impacts of NZMS can fall into three categories: competition with and competitive exclusion of aquatic grazers (primary consumers); biomass/nutrient sequestration; and reduction in growth of higher level consumers (predators - fishes) in aquatic systems. Evidence suggests that New Zealand mudsnails, due to their potentially high population numbers and virtually invulnerability to natural controls, will: out compete native gastropods (Richards 2003); spatially exclude other grazing aquatic organisms by their high density (Cada 2003); and competing with other macro-invertebrates for periphyton (Gangloff 1998, Cada 2004). It is also possible that very dense snail populations may have a significant adverse impact on available nutrients in streams. These dense populations can consume significant nutrients (food) in an aquatic ecosystem and, because the snails are relatively immune to predation, sequester those nutrients making them unavailable to other species in the food chain. Mudsnails are capable of passing through the digestive canal of many fishes, alive and intact (Bondesen and Kaiser 1949; Haynes et al. 1985). New Zealand mudsnails even when consumed, become a "trophic dead end" with fish receiving little, if any nutrition from feeding on them (Vinson 2004; Ryan 1982). This will ultimately have a significant adverse impact on the fish populations through reductions in nutritious benthic invertebrate fauna to the benefit of low-nutritional value mudsnails (Hosea and Finlayson 2005).

Densities have reached over 300,000 individuals per square meter in the Madison River, Montana. A species as prolific as this may compete for food and space occupied by native snails.

There is some evidence in their native range that trout may avoid these snails as a prey (USGS 2002).

Benefits
None.

Effective Treatments
Based on research and recommendations in the U.S. Forest Service Technical Guidelines for AIS Prevention 11-08 document, the following treatment methods are effective at killing NZMS when cleaning equipment from infected waters:

- Direct exposure to 120°F wash water for a minimum of 5 minutes
- Dry in direct sunlight for 48 hours
- Exposed to a 5% cleaning solution of quaternary ammonia (6.35 oz Quat 128/1 gallon water) for a minimum of 10-15 minutes

Recommendation
Through Arizona Game and Fish Department Directors Order {A.R.S. §17-255.01(B)}, list New Zealand mudsnail (NZMS: *Potamopyrgus antipodarum*) as an aquatic invasive species in Arizona, with subsequent affected waters listing and mandatory conditions for movement.
{Editors Note - List affected waters for New Zealand mudsnail as the Colorado River below Glen Canyon Dam, Lee's Ferry reach and Grand Canyon, and in Lake Mead. The effective treatments for quagga/zebra mussels already approved in Directors Order #3 are sufficient to control and kill New Zealand mudsnails as well, so no change in those cleaning protocols are needed.}

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