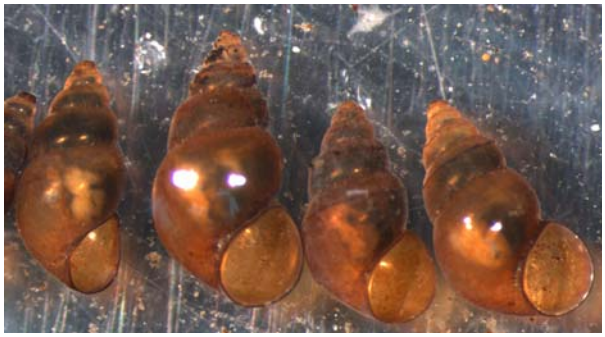
Fisheries and Oceans Canada | Pêches et Océans Canada
Science | Sciences
National Capital Region
Canadian Science Advisory Secretariat
Science Advisory Report 2010/065

# SCIENCE ADVICE FROM THE RISK ASSESSMENT OF NEW ZEALAND MUD SNAIL (*Potamopyrgus antipodarum*) IN CANADA



*Specimens of New Zealand mud snail collected near Port Alberni, BC Sep. 2007. Photo by G. Gillespie.*

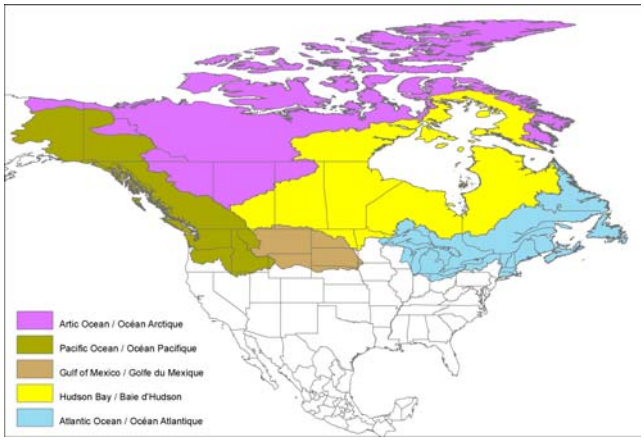



*Figure 1. Freshwater drainage regions in Canada used in the risk assessment of New Zealand mud snail. (Figure from Therriault et al. 2010).*

## Context :

*New Zealand mud snail (Potamopyrgus antipodarum) is a small freshwater gastropod. This New Zealand native has been introduced to Australia, Asia, Europe, and North America where large populations exist in streams in the western United States. In 2006, New Zealand mud snail was discovered in Port Alberni, British Columbia and had been reported from Lake Ontario as early as 1991. This snail now has been reported in every Great Lake except Lake Huron and, recently, was reported from nearshore (<2m) waters in a tributary of Lake Ontario. Given the potential for non-indigenous species to have substantial negative impacts on Canadian ecosystems, Fisheries and Oceans Canada's Centre of Expertise for Aquatic Risk Assessment (CEARA) determined that there was need to complete a national risk assessment to determine the potential risk posed by New Zealand mud snail to Canadian aquatic ecosystems (Figure 1). This risk assessment provides science-based guidance to resource managers for the development and implementation of management options. The assessment was undertaken with the aid of an extensive literature search and the use of ecological niche modeling to predict the potential range of the New Zealand mud snail in Canada. A draft risk assessment research document was peer reviewed March 24-25, 2010 in Ottawa, Ontario according to Canadian Science Advisory Secretariat (CSAS) peer-review guidelines and the final research document (Therriault et al. 2010) reflects input from this workshop. A proceedings document (DFO 2010) capturing the discussion of this workshop also is available.*

## SUMMARY


- The non-indigenous New Zealand mud snail (*Potamopyrgus antipodarum)* was discovered in British Columbia in 2006 but had been reported from Lake Ontario in 1991.
- A number of life history traits enable New Zealand mud snail to be very effective invaders including: high fecundity; asexual reproduction; low susceptibility to predators; and tolerance to a wide range of environmental conditions.
- Many vectors and pathways associated with the introduction and spread of these small snails have been identified but there is high uncertainty associated with the importance of each. Most introduction pathways are human-mediated so outreach efforts should be directed here to minimize further introduction/spread.
- Ecological niche modeling and water chemistry inferred from bedrock geology suggest the probability of establishment (survival and reproduction) is very high for a substantial portion of Canadian fresh and brackish waters (exception being the Arctic) despite the potential for models of this type to underestimate the potential distribution of an organism.
- The probability of arrival was generally high to very high with the exception of the Arctic and Atlantic coastal waters where it was deemed this probability was low. However, the probability of a widespread New Zealand mud snail invasion generally was low to moderate with the exception of the Gulf of Mexico drainage (high) and the Great Lakes/St. Lawrence (very high: snail already in much of this unit).
- Potential impacts of New Zealand mud snail were derived from the limited literature and expert opinion and are expected to vary with the density of established populations. Generally biological impacts of a widespread invasion were considered very low/low with the exception of freshwater biodiversity where the impact was deemed higher (moderate).
- The overall risk posed to Canadian aquatic ecosystems by New Zealand mud snail was determined to be low to moderate but with very high uncertainty.
- To reduce the uncertainty associated with this risk assessment, additional research on the biology of Canadian populations of New Zealand mud snail is required, especially to better characterize impacts on our ecosystems.
- Although the overall risk was deemed relatively low based on a widespread New Zealand mud snail invasion in each of the assessed units, it is likely the risk at smaller spatial scales (not considered in the risk assessment) could be substantially higher.


## INTRODUCTION

Aquatic invasive species (AIS) pose a substantial risk to native biodiversity and can compromise ecosystem function. The Government of Canada (CCFAM 2004) defines invasive alien species as “those harmful alien species whose introduction or spread threatens the environment, the economy or society, including human health”. To guide management actions, a risk assessment can be used to identify higher risk invaders, important vectors for introduction and/or spread, and potential impacts if introduced.

The New Zealand mud snail (*Potamopyrgus antipodarum*) has an extensive global invasion history, including Europe, Australia, Japan, the western United States and the Laurentian Great Lakes (e.g., Proctor *et al.* 2007). More recently, this gastropod has been reported from coastal waters of British Columbia and shallower waters and tributary streams in the Great Lakes. Based on its global invasion history and invasive life history characteristics (asexual reproduction, broad environmental tolerances, etc.) this species was identified as a priority

species by DFO's Centre of Expertise for Aquatic Risk Assessment (CEARA) and a national risk assessment was initiated. The draft risk assessment research document was peer reviewed according to Canadian Science Advisory Secretariat (CSAS) peer-review guidelines at a national advisory meeting held in Ottawa, Ontario March 24-25, 2010. Based on input at this meeting a CSAS Research Document containing the Risk Assessment for New Zealand mud snail (*Potamopyrgus antipodarum*) in Canadian Waters (Therriault *et al.* 2010) and an accompanying CSAS Proceedings Document (DFO 2010), were generated.

# RISK ASSESSMENT

## Biology

The New Zealand mud snail is a small freshwater gastropod in the family Hydrobiidae. It has a relatively elongate shell with five to seven whorls coiled dextrally that may or may not possess a keel and an operculum that can be closed to prevent desiccation if removed from the water or digestion if ingested by fishes or waterfowl. Maximum size is generally 5 mm in North American populations, but has been reported to 12 mm in its native range. Although males exist in its native range, all introduced populations in North America are comprised of asexually reproducing female clones with eggs that mature and hatch in a brood pouch and the young crawl away. Females mature in three months in native populations and produce 20-120 young per brood with up to six generations possible in a single year. In invaded areas, peak densities of 50,000 to 800,000 snails $m^{-2}$ have been found but in the Great Lakes, densities are considerably lower (10 to 5000 $m^{-2}$).

New Zealand mud snail occupies primarily freshwater habitats including lakes, ponds, springs and streams but also is found in brackish estuaries. This species is a general grazer that can be found on a number of substrates including mud, aquatic macrophytes, clay, concrete, fine cobble and fine sand. Preferred food includes periphyton, macrophytes and detritus, although it will readily graze on green algae or diatoms. It is preyed upon by fishes (e.g., salmonids, percids, cottids) and waterfowl. As expected for a global invader, New Zealand mud snail has broad environmental tolerances, although the optimum range for growth, reproduction and population increase is considerably smaller (Table 1).

*Table 1. Summary of critical physiological tolerances of New Zealand mud snail (from Therriault et al. 2010).*

| Parameter | No Potential for Adult Survival | Little Potential for Egg Development | Moderate Potential for Nuisance Infestation | High Potential for Massive Infestation |
|---|---|---|---|---|
| Calcium (mg Ca/L) | <2 | 2-4 | 4-7 | 7-? |
| pH | <6.0? | 6.0-6.8 | 6.9-7.5 | 7.5-8.5? |
| Alkalinity (mg CaCO/L) | <10 | 10-50 | 50-100 | 100-350 |
| Hardness (mg $CaCO_3$/L) | <10 | 10-50 | 50-100 | 100-350 |
| Temperature (°C) | <0 and >35 | 0-15 and 30-35 | 15-20 and 26-30 | 20-26 |
| Conductivity (µS/cm) | <25 and >46,000 | 25-200 and 25,000-46,000 | 200-1,200 and 9,000-25,000 | 1,200-9,000 |
| TDS (mg/L) | <17 and >30,800 | 17-130 and 16,800-30,800 | 130-800 and 6,000-16,800 | 800-6,000 |
| Salinity (‰) | <0.01 and >30 | 0.01-0.1 and 15.0-30.0 | 0.1-2.0 and 5-15 | 2.0-5.0 |

## Potential Routes of Introduction and Vectors of Secondary Dispersal

Ballast water has been suggested as the vector responsible for introducing New Zealand mud snail in the Great Lakes similar to other species that have arrived from European ports. Contaminated aquaculture gear from Australia has been hypothesized as the vector responsible for introductions to streams in the western USA but substantive evidence is lacking.
There are at least 30 potential vectors of secondary introduction and spread identified for New Zealand mud snail and the relative importance of these vectors will vary among regions and depending on the location of the source populations.

## Predicting Potential Suitable Habitats

Ecological niche modeling was used to predict the potential distribution of New Zealand mud snail within North America. This method uses the current distribution and environmental variables such air temperature, elevation, and precipitation to identify habitats similar to ones where the snail currently is found (Figure 2). It is probable that New Zealand mud snail has not reached its maximum distribution (and thus ecological niche) such that this type of modeling could underestimate the potential distribution.

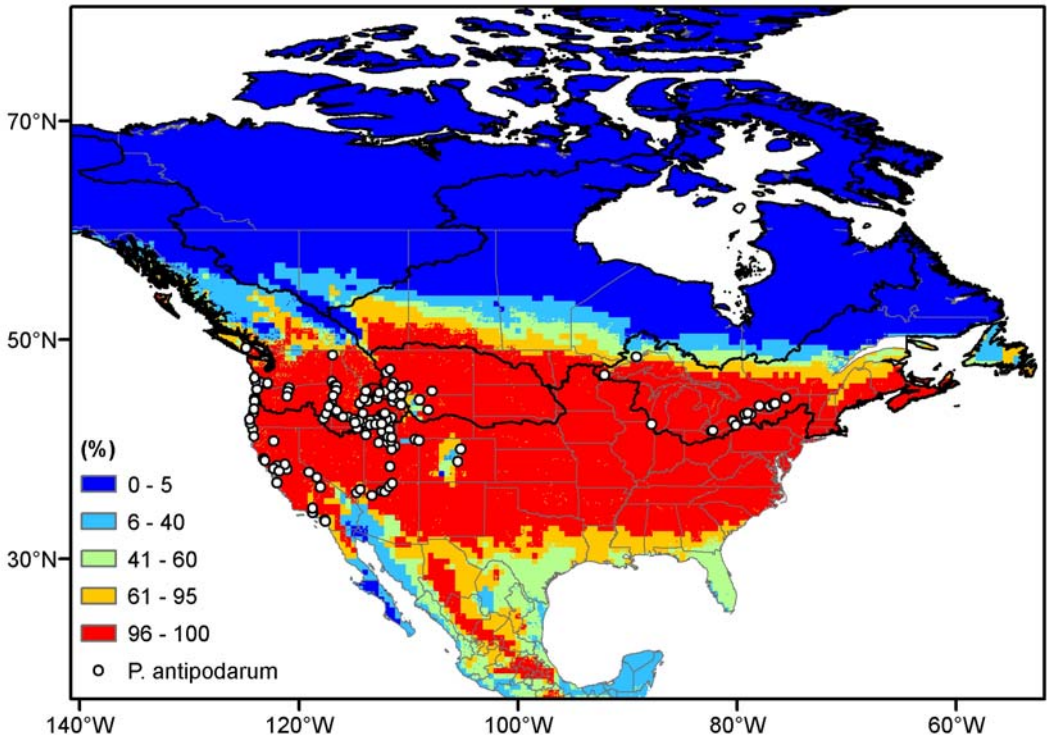



*Figure 2. Potential distribution of the New Zealand mud snail predicted by ecological niche model based on its current known distribution in North America. Circles represent known occurrences. (from Therriault et al. 2010). Red indicates the highest habitat match for the species.*

## Risk Posed to Regions of Canada

Given considerable heterogeneity across Canada and potential differences in vectors and impacts; risk was assessed for eight major regions of Canada: Great Lakes/ St. Lawrence River; Pacific Coastal; Atlantic Coastal; and the five remaining major freshwater drainages (Figure 1). However, it should be noted that risk at smaller spatial scales (not considered here) could differ markedly and should be considered when developing specific management options.

For each assessment unit the probability of arrival, survival, reproduction, and widespread invasion were determined. Similarly, the impact of a widespread invasion was determined for a number of ecological endpoints for each assessment unit. Overall risk was determined using a risk matrix to combine the probability and impact of a widespread New Zealand mud snail invasion. Generally, the overall risks were determined to be low to moderate but uncertainty was high to very high (Table 2).

*Table 2. Overall level of risk with associated uncertainty (in parenthesis) for each ecological endpoint and each region as based on a risk matrix (from Therriault et al. 2010).*

| *Region* | *Biodiversity* | *Habitat* | *Aquaculture* | *Commercial Fisheries* | *Recreational Fisheries* |
|---|---|---|---|---|---|
| Great Lakes / St Lawrence | Low (High) | Low (High) | Low (Moderate) | Low (High) | Low (High) |
| Pacific Freshwater | Low (Very High) | Low (High) | Low (High) | Low (High) | Low (High) |
| Arctic Freshwater | Low (Very High) | Low (High) | Low (High) | Low (High) | Low (High) |
| Gulf of Mexico | Moderate (Very High) | Low (Very High) | Low (High) | NA | Low (High) |
| Hudson Bay Freshwater | Moderate (Very High) | Low (High) | Low (High) | Low (High) | Low (High) |
| Atlantic Freshwater | Moderate (Very High) | Low (High) | Low (High) | Low (High) | Low (High) |
| Pacific Coastal | Low (High) | Low (High) | Low (High) | Low (High) | Low (High) |
| Atlantic Coastal | Low (Very High) | Low (Very High) | Low (Very High) | Low (Very High) | Low (Very High) |

# CONCLUSIONS AND ADVICE

## Conclusions

- Overall risk posed to Canadian aquatic ecosystems by New Zealand mud snail was determined to be low to moderate with high to very high uncertainty. The highest risk was identified for biodiversity in the Gulf of Mexico, Hudson Bay, and Atlantic drainages. However, risks at smaller spatial scales could be substantially higher.
- This species already is present in the Great Lakes and Pacific Coastal waters and ecological niche models suggest that the distribution of this species could increase in Canada.
- Limited benthic sampling targeting gastropods exists in Canadian freshwaters so the distribution of New Zealand mud snail in Canada could be broader than identified here. Monitoring efforts targeting this species are required to confirm this.
- Limited published information exists on impacts of New Zealand mud snail invasions and expert opinion suggests impacts will vary with the density of populations. Similarly, basic biological information is lacking for Canadian New Zealand mud snail populations. Additional research would lower the uncertainties associated with components of the risk assessment.
- Ideally, this biological risk assessment would feed into a broader risk analysis framework that would include socio-economic considerations.

## Advice

- Efforts should be directed to reduce the uncertainties identified in the risk assessment. This would include additional research on the biology/ecology of this species in Canada, especially as it pertains to introduction, differing population densities, and impacts.
- Systematic monitoring, preferably by trained taxonomists, would refine our understanding of the distribution of this species in Canada and could help clarify potential dispersal vectors.
- Education and outreach should focus on the human-mediated dispersal vectors identified for New Zealand mud snail. Further, a communication tool would allow those most likely to encounter the species to be able recognize and report it.
- Although the overall risk of New Zealand mud snail was considered low to moderate depending on the ecological endpoint and assessed region, the risk at smaller spatial scales (not assessed here) could be substantially higher.

## SOURCES OF INFORMATION

This Science Advisory Report has resulted from a Fisheries and Oceans Canada, Canadian Science Advisory Secretariat Pacific National Advisory meeting of March 24-25, 2010 on the Biological risk assessment of New Zealand mudsnail in Canada (Centre of Expertise for Aquatic Risk Assessment – CEARA). Additional publications from this process will be posted as they become available on the DFO Science Advisory Schedule at http://www.dfo-mpo.gc.ca/csas-sccs/index-eng.htm.

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