The invasive *Potamopyrgus antipodarum* (New Zealand Mudsnail) in California with data from the Upper Owens River Watershed

Gwen K. Noda

Information current as of June 1, 2007
The New Zealand Mudsnail

• **Background:** Biology, Life History, Ecology

• Potential Impacts

• The Invasion

• Upper Owens River Watershed

• Decon/Control/HACCP & Staying Informed
**Biology, Life History, Ecology**

**operculum (op)** = like a door, closes snail in its shell

**foot (f)** = “sticky”, can hang on in higher flow speeds than native ID snails [S Lysne 3]

**shell (sh)** = highly variable in ornamentation (with or without ridge or keels) & color (brown to black)

**brood pouch** = contains embryos, *distinctive feature* of genus
Biology, Life History, Ecology

Size: ~0.25mm at birth to 12mm adult in NZ & ~5.5mm in US
Longevity: ~18 months in lab – some report 1 yr or 1-2 yrs

Eats various kinds of periphyton (algae on bottom, not filter feeder)
Has 14 species of parasitic castrating trematodes that infect it
Ecology of Parasites

Life cycle of *Microphallus* sp.

- Ducks & wading birds (or mice in lab) contain adult parasite eggs in feces
  
  *(Anas superciliosa – grey duck & *A. platyrhynchos* - mallard)*

**FINAL HOST**

Birds eat snails

**INTERMEDIATE HOST**

NZMS ingest eggs, hatch, 100’s to 1000’s of blastocercariae, develop into metacercariae, encyst

[Lively & McKenzie 1991][Winterbourn 1973]
Abiotic Preferences

Tolerates wide range of abiotic conditions

Temperature:  optimal 18$^\circ$C [M Dybdahl 1] to 21$^\circ$C [D Richards 1]

Salinity:  zero up to 26 ppt, but active/reproduce only up to ~17.5 ppt

Dessication Resistance:  survive out of water 30 hours dry
30-50 days damp [M Winterbourn 1970]
Reproduction

Asexual = parthenogenic = clone themselves, mostly what happens or
Sexual = low % of males in populations, probably only happens in NZ

Ovoviviparous = no eggs, ‘crawl away’ young

Mature (have embryos) around 6 mo. and ~3.5mm & release juveniles at 9 to 12 mo. (W. USA)

~20-120 embryos per female – depends on size of female

Reproduce during winter/spring or spring/summer
Highest Density Estimates

Australia ~60,000/m² [S Loo 3]

Yellowstone National Park ~500,000/m²
Polecat Creek, JD Rockefeller Pkwy ~750,000/m²
Firehole ~300,000/m²
taveled 1 to 2 km in 5 years [M Dybdahl 3]

Snake River survey, ID
4 yrs sampling, 401 miles of river, >3000 samples
NZMS in every sample >1 million collected [ID Power 1]

Upper Owens River ~700,000/m² [G Noda]
Natural Density in MT
Parasites

• Castrating trematode parasites affect NZMS behavior

Infected snails with encysted larvae - forage in early AM hours, coincides with bird feeding time, then go under rocks. Opposite for snails with non-encysted larvae. [Levri & Lively 1996]

• Cloning favored when risk of parasitism low
  [Maynard Smith 1978, Lively 1987]

• Parasite very specific to host (genotype/clone)
  [C Lively & M Dybdahl 2000]
The New Zealand Mudsnail

• Background: Biology, Life History, Ecology

• Potential Impacts

• The Invasion

• Upper Owens River Watershed

• Decon/Control/HACCP & Staying Informed
Potential Impacts

Ecological:
NZMS - are better competitors than some native snails [D Richards 2005]
- change periphyton community [Winterbourn & Fegley 1989]
- are eaten by fish, but don’t provide nutrition [P Dwyer 1]
- sequester energy (carbon) that would go to higher trophic levels [R Hall 2006]

Economic:
- change fish hatchery stocking routes
- public awareness campaign
- monitoring/research
- clog grates of Idaho Power Company
- come out of tap, clog pipes in Australia [S Loo 3]
The New Zealand Mudsnail

• Background: Biology, Life History, Ecology

• Potential Impacts

• The Invasion

• Upper Owens River Watershed

• Decon/Control/HACCP & Staying Informed
Attack of the Clones?
Because they clone themselves, we can do a genetic trace.

USA = 3 clones
   W. USA (2) + Lake Ontario, NY [M Dybdahl 2, D Gustafson website]
   1st W. USA clone prob from Australia or North Island of NZ

Europe = 3 clones
   England + Denmark estuaries + the rest of Europe (generalist)
   [M Dybdahl 1]
   Lake Ontario, NY & England = same clone! (ballast water intro?)

Japan & Tazmania = same clone! (ballast water intro?)
   = probably from North Island of NZ

Australia only known multiclonal population (>1 genotype),
   until 2nd W. USA clone in Idaho 2006
Distribution

Originally from New Zealand...
Distribution

Tasmania and Australia

Australia
1872 & 1895

Tasmania
1882
Europe Invades UK & Australia about same time
First sightings ~1987

Distribution

United States

Distribution of the New Zealand mudsnail, *Potamopyrgus antipodarum*. June 21, 2002
Distribution

California

~1998-9  Owens River

2003   Yolo County, Putah Creek (near Davis)

Santa Clara Watershed

Jan 2006   Piru Creek [CDGF survey team]

Malibu Creek Watershed

May 2006   Malibu Creek (HtB samples 2005)

July 2006  Medea & Las Virgenes Creeks

[SMBRC/HtB survey]
Distribution
Santa Clara Watershed

2006 Jan - CDFG's Heritage & Wild Trout Program field crew found NZMS in Piru Creek while searching for whirling disease

2007 - reports of NZMS in Sespe Creek & Oxnard, but we believe these to be misidentifications of native snails
The New Zealand Mudsnail

• Background:
  Biology, Life History, Ecology

• Potential Impacts

• The Invasion

• Upper Owens River Watershed

• Decon/Control/HACCP & Staying Informed
Study Area

Upper Owens River Watershed
BERKELEY
1. Angelo Coast Range Reserve
2. Chickering American River Reserve
   North Fork Association Lands (satellite site)
3. Hastings Natural History Reservation
4. Jenny Pygmy Forest Reserve

DAVIS
5. Bodega Marine Reserve
6. Eagle Lake Field Station
7. Jepson Prairie Reserve
8. McLaughlin Natural Reserve
9. Quail Ridge Reserve
10. Stebbins Cold Canyon Reserve

IRVINE
11. Burns Piñon Ridge Reserve
12. San Joaquin Freshwater Marsh Reserve

LOS ANGELES
13. Stunt Ranch Santa Monica Mountains Reserve

RIVERSIDE
14. Box Springs Reserve
15. Boyd Deep Canyon Desert Research Center
16. Emerson Oaks Reserve
17. James San Jacinto Mountains Reserve
   Oasis de los Osos (satellite site)
18. Motte Rimrock Reserve
19. Sweeney Granite Mountains Desert Research Center
   Sacramento Mountains (satellite site)

SAN DIEGO
20. Dawson Los Monos Canyon Reserve
21. Elliott Chaparral Reserve
22. Kendall-Frost Mission Bay Marsh Reserve
23. Scripps Coastal Reserve

SANTA BARBARA
24. Carpinteria Salt Marsh Reserve
25. Coal Oil Point Natural Reserve
26. Kenneth S. Norris Rancho Marino Reserve
27. Santa Cruz Island Reserve
28. Sedgwick Reserve
29. VESR - SNARL
   (Sierra Nevada Aquatic Research Laboratory)
30. VESR - Valentine Camp

SANTA CRUZ
31. Año Nuevo Island Reserve
32. Fort Ord Natural Reserve
33. Landels-Hill Big Creek Reserve
34. Younger Lagoon Reserve
Methods

1. Sample a stream with a D-net

2. Snails present or absent?
   - if snails present… go to step 3
   - if no snails observed… go to step 5

3. Take sample with surber sampler to get density count

4. Preserve in 70% EtOH

5. Record location with GPS unit
NZMS Distribution

Red solid circles = NZMS 2002
Black open circles = checked, but no NZMS obs 2002
Red triangle = Big Springs - NZMS confirmed Aug 2003
Red pentagon = downstream of Hatchery - NZMS confirmed Sept 2003
Red rectangle = Alpers Owens River Ranch - NZMS confirmed Mar 2004
Hot Creek Fish Hatchery - NZMS confirmed 2007
The New Zealand Mudsnail

• Background: Biology, Life History, Ecology

• Potential Impacts

• The Invasion

• Upper Owens River Watershed

• Decon/Control/HACCP & Staying Informed
Decon/Control Considerations

Things to consider:
• Small size (0.25 mm to 5.5 mm)

* Operculum to help them survive in damp conditions up to 30 days or so

* Large snails survive dessication better than smaller ones
  [D Richards 2]

* Everybody can transport them
  (fishers, boats & boaters, inner tubers, dogs, kids, construction equipment, etc.)
Staying Informed

New Zealand Mudsnail in the Western USA

www.esg.montana.edu/aim/mollusca/nzms

June 27-28, 2007
5th New Zealand Mudsnail in the W. USA Conference, UC Davis
add “/Abstracts%204%20website.htm” to above for abstracts

ANS Task Force (Aquatic Nuisance Species)
http://www.anstaskforce.gov

Protect Your Waters, Stop Aquatic Hitchhikers!
http://www.protectyourwaters.net
Thanks!!

Lab Assistants
- Dan Dawson
- Dawne Becker
- Tonya Kane
- Debra Hawk
- John Cunningham

Field Assistants
- Ben Rossi
- Sandra South

Guidance, Equipment, Financial Support
- Vicky Huang
- Jeremy Jacquot
- Sandra South
- Alex Gilman
- Dan Dawson
- Debra Hawk
- John Cunningham
- Tonya Kane
Contact Information:

Gwen K Noda
gwennoda@gmail.com
Key

[name, year] = author and year of published journal article

[name, IP] = author of article in press

[name, 1] = presenter from 2001, 1st annual conference
[name, 2] = presenter from 2002, 2nd annual conference
[name, 3] = presenter from the 2003, 3rd annual conference

NZMS in the Western USA Conference in Bozeman, MT
Presenters at the “NZMS in the Western USA” Conferences

Anderson, Mark  National Park Service, Page, AZ
Cada, Chelsea  Montana State University, Bozeman
Chapman, John  Dept of Fisheries & Wildlife, Oregon State University, Newport
Clancey, Pat  MT Department of Fish, Wildlife, & Parks, Ennis
Dwyer, Pat  Fish Consultant, retired USFWS
Dybdahl, Mark  Washington State University, Pullman
Emblidge, Alison  Washington State University, Pullman
Gallagher, Tim  MT Department of Fish, Wildlife, & Parks, Helena
Gustafson, Dan  Dept of Ecology, Montana State University, Bozeman
Hall, Robert  University of Wyoming, Laramie
Hopper, David  US Fish & Wildlife Service, Boise, ID
Kerans, Billie  Montana State University, Bozeman
Loo, Sarina  Monash University, Melbourne, Australia
Lysne, Steve  Dept of Biology, Boise State University, Boise, ID
Pickett, Frank  PPL Montana, Butte
Pitman, Robert  US Fish & Wildlife Service, Albuquerque, NM
Procter, Bettina  US Fish & Wildlife Service, Denver, CO
Richards, David  EcoAnalysts, Inc., Montana State University, Bozeman
Riley, Leslie  School of Biological Sciences, Washington State University, Pullman
Shannon, Joseph  Northern Arizona University, Flagstaff
Shinn, Dianne  Idaho Power Company, Boise, ID
Stanton, Linda  US Fish & Wildlife Service, Bozeman, MT
Sytsma, Mark  Center for Lakes & Reservoirs, Portland State University, OR
Vinson, Mark  Dept of Aquatic, Watershed, & Earth Resources, Utah State University, Logan
Wachsmuth, John  MT Department of Fish, Wildlife, & Parks, Kalispell
Wiltshire, Robert  Federation of Fly Fishers, Livingston, MT
Yundt, Steve  ID Dept of Fish & Game, Boise
References

Trophic Levels, Food Webs

non-native

Rainbow Trout

native

algae