The background of the slide is a landscape photograph. It shows a wide valley with a river or stream winding through it. In the distance, there are several mountain ranges under a cloudy sky. The foreground is filled with low-lying, scrubby vegetation, possibly sagebrush, in shades of brown and green.

**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

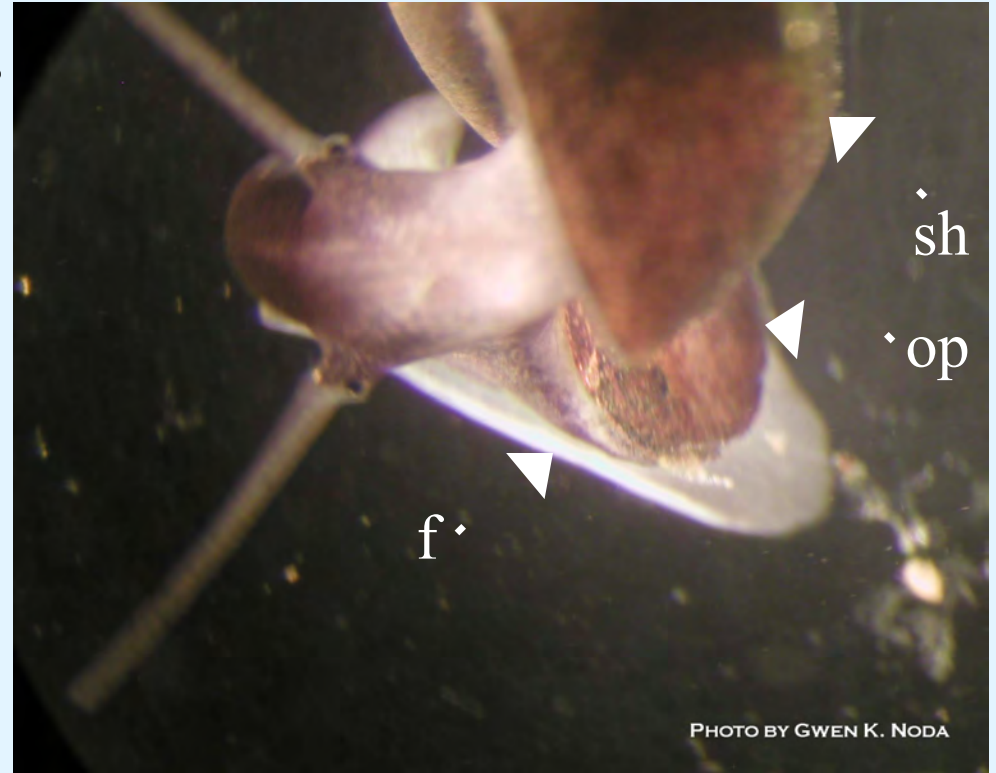
# Biology, Life History, Ecology

**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)

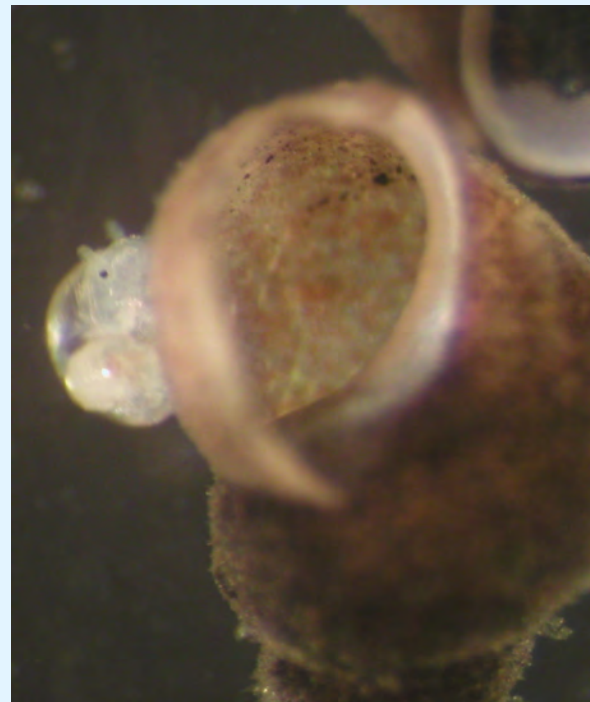
**brood pouch** = contains embryos, \*distinctive feature\* of genus



# Biology, Life History, Ecology

Size: ~0.25mm at birth to 12mm adult in NZ & ~5.5mm in US

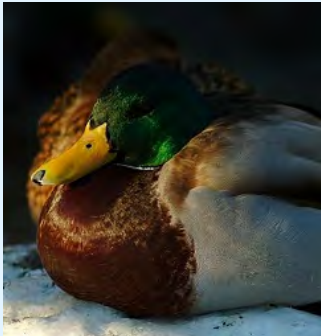
Longevity: ~18 months in lab – some report 1 yr or 1-2 yrs



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.



birds eat snails

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

FINAL HOST

parasite eggs in feces  
into water



INTERMEDIATE HOST

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

# Abiotic Preferences

Tolerates wide range of abiotic conditions

Temperature: optimal 18°C [M Dybdahl 1] to 21°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

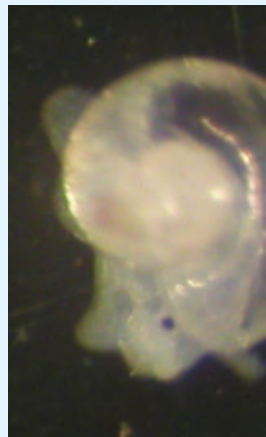
Sexual = low % of males in populations, probably only happens in NZ

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/m<sup>2</sup> [S Loo 3]

Yellowstone National Park ~500,000/m<sup>2</sup>

Polecat Creek, JD Rockefeller Pkwy ~750,000/m<sup>2</sup>

Firehole ~300,000/m<sup>2</sup>

traveled 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/m<sup>2</sup> [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

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# 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:  
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# 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

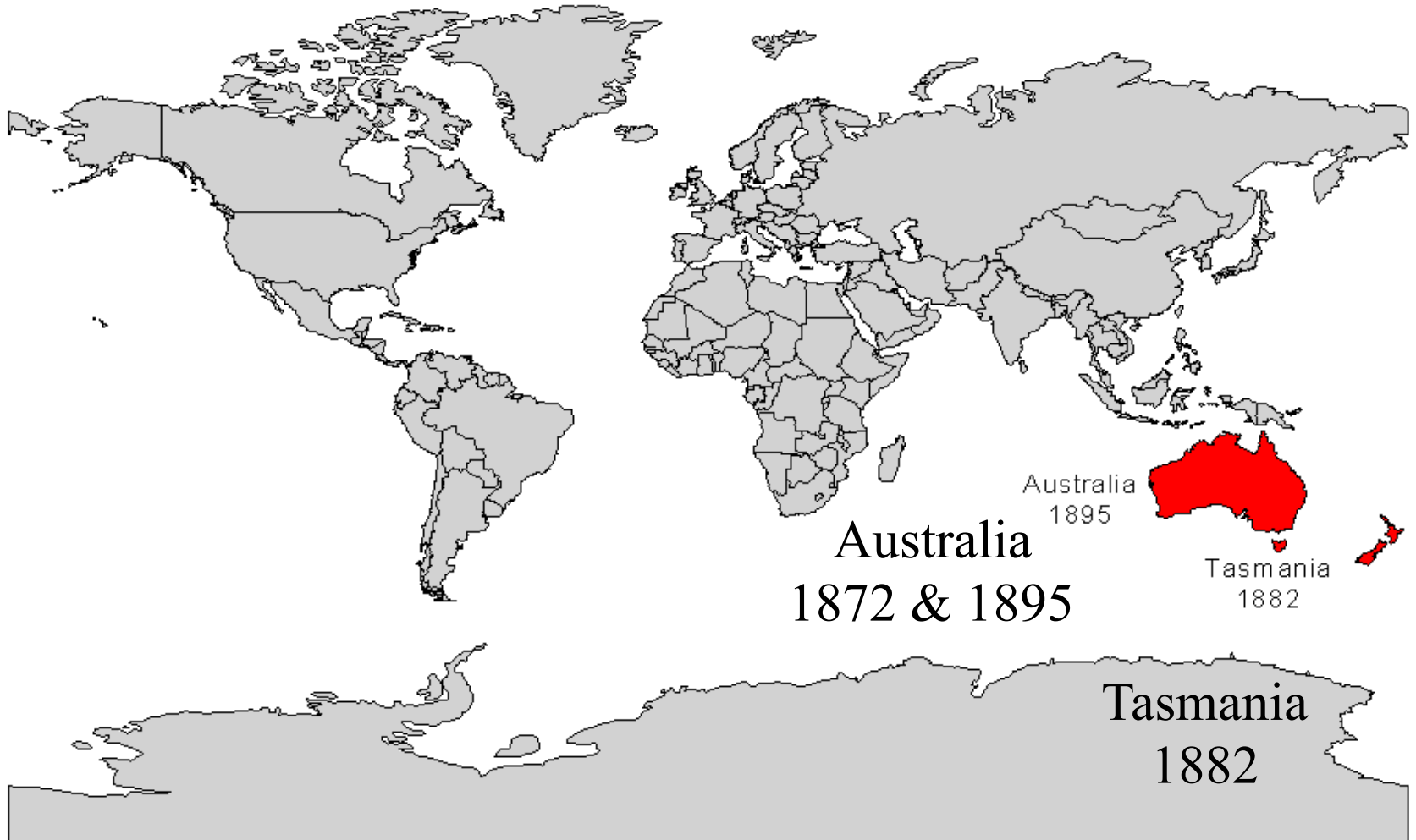
# Distribution

## Originally from New Zealand...



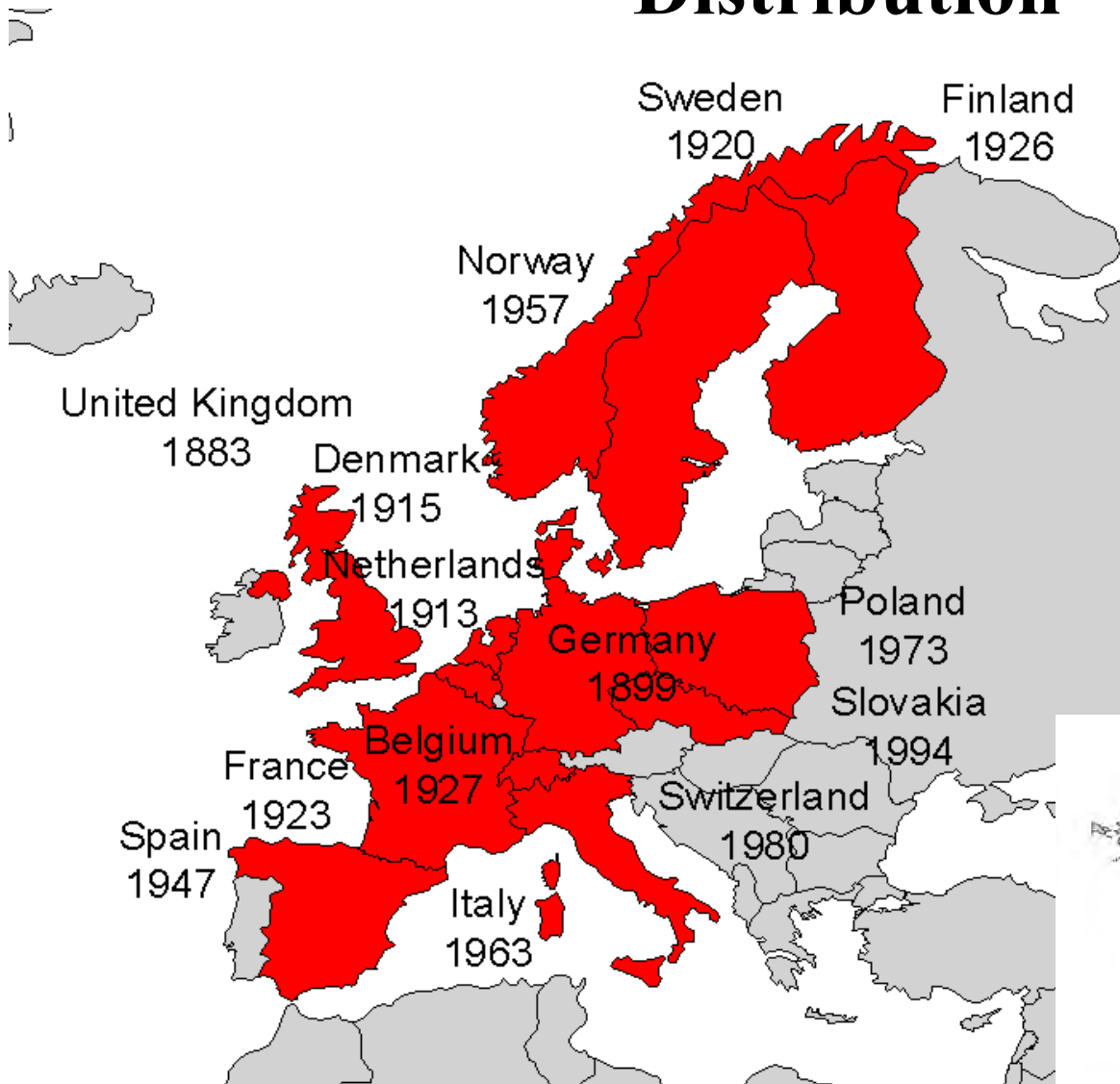
# Distribution

## Tasmania and Australia





# Distribution



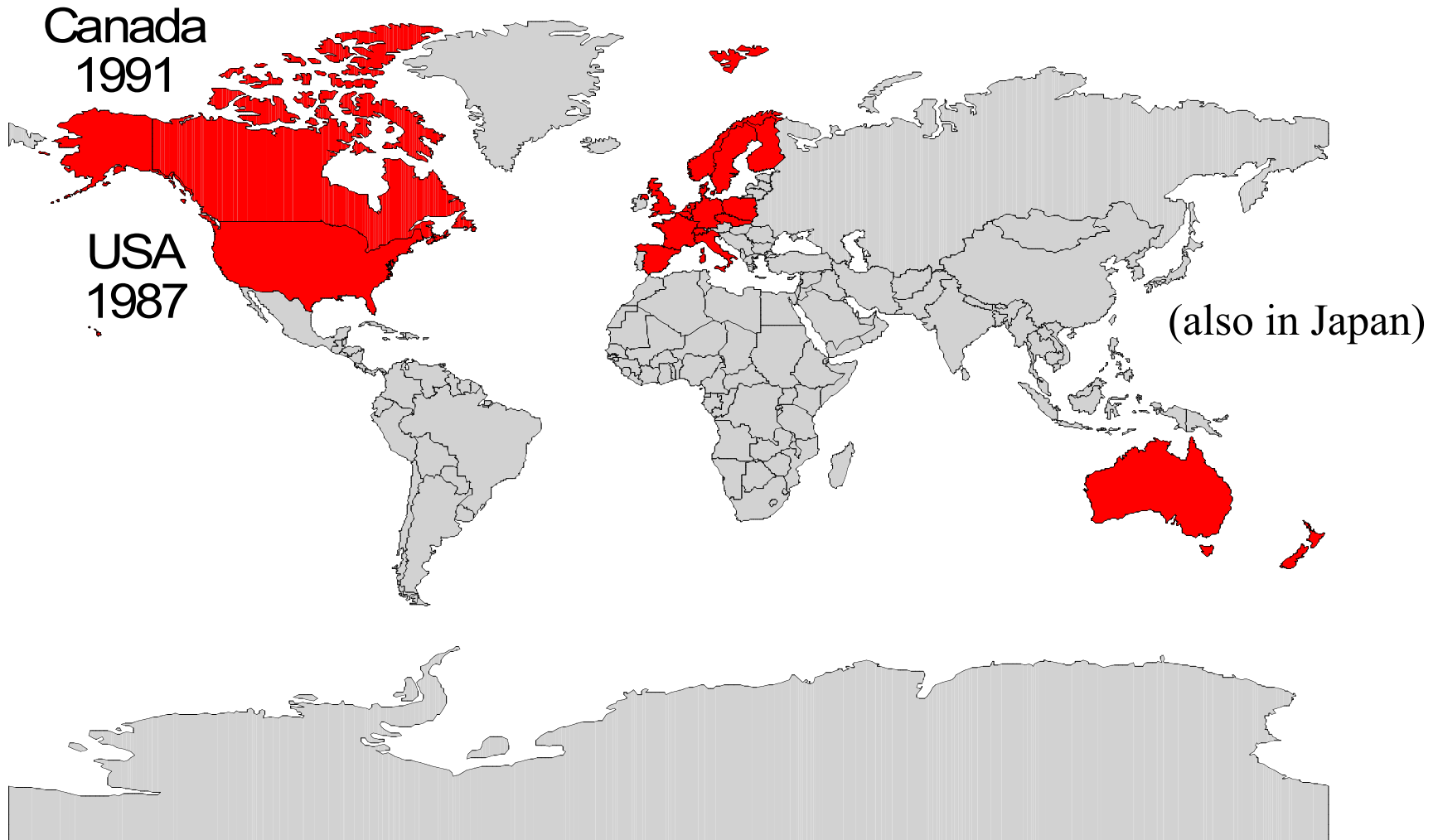
## Europe

Invades  
UK & Australia  
about same time



# Distribution

## North America



# Distribution

First sightings ~1987



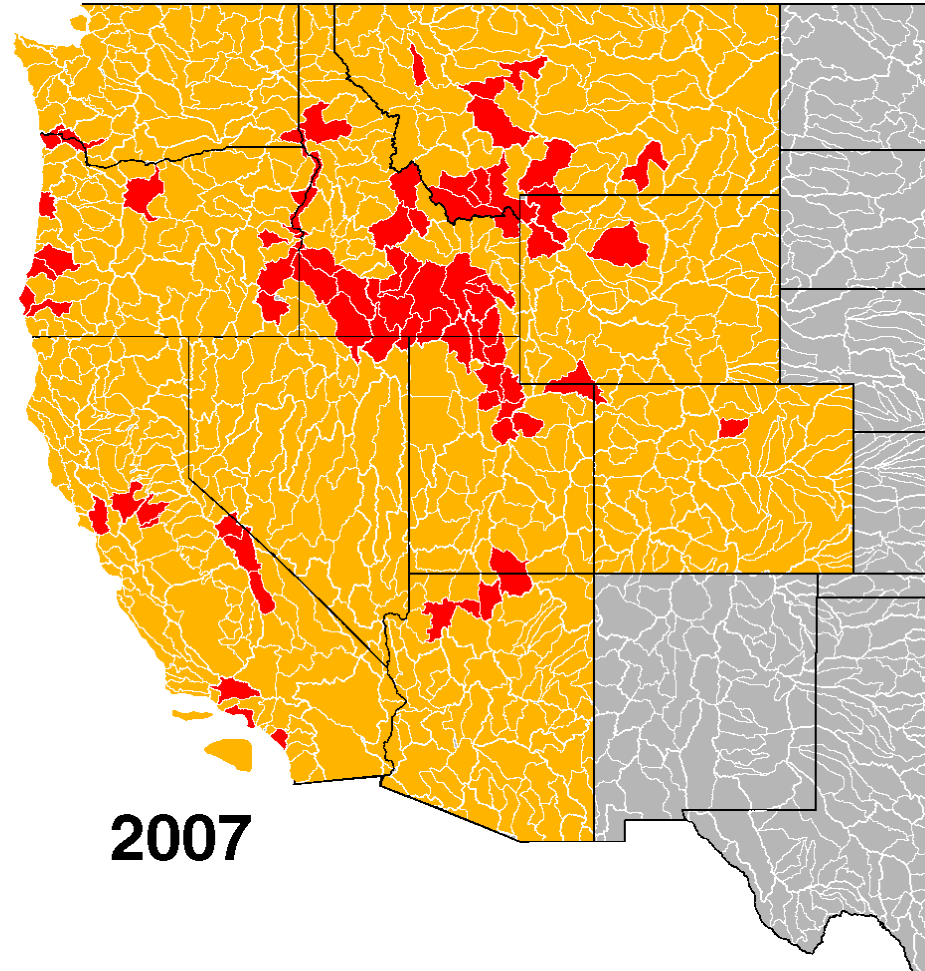
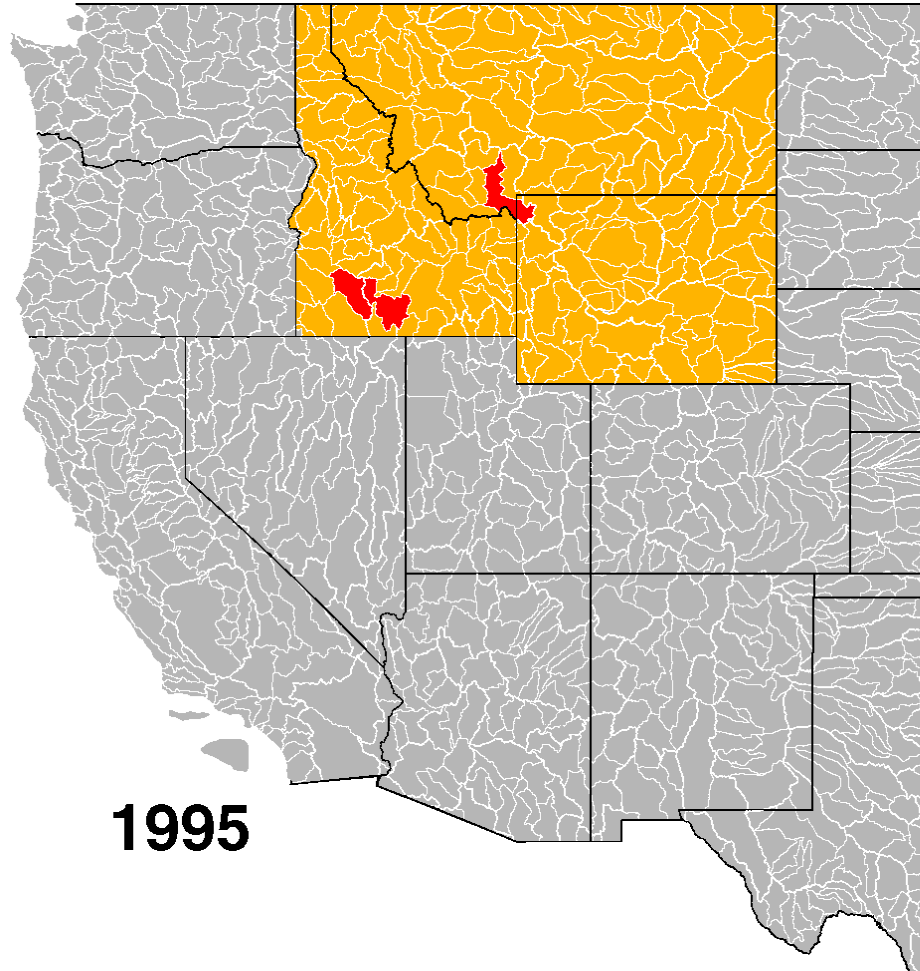
## United States



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

# Distribution

## Western United States



# 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



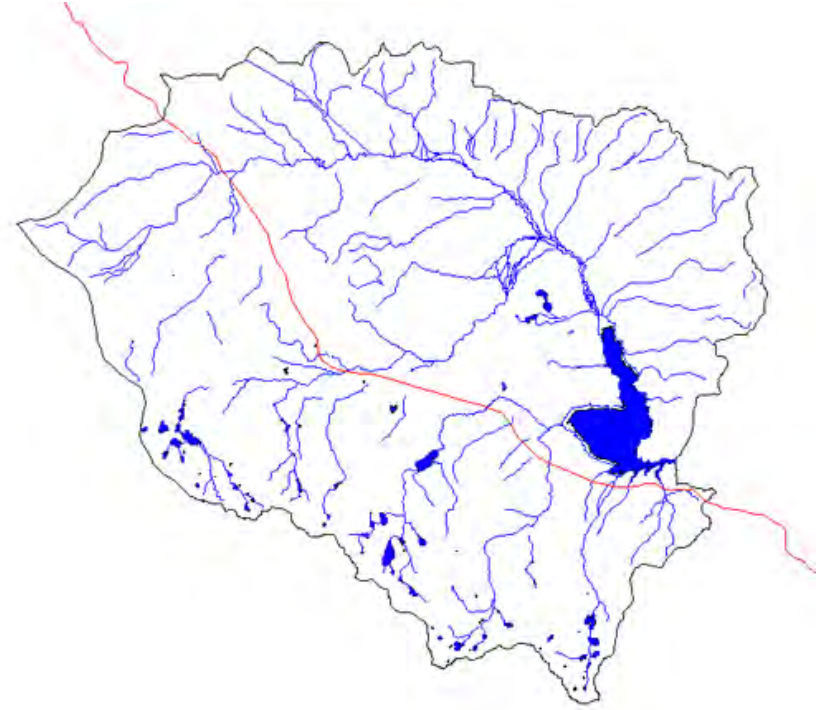
# **The New Zealand Mudsnail**

- Background:  
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# Study Area



**Upper Owens  
River Watershed**





# University of California Natural Reserve System

## 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

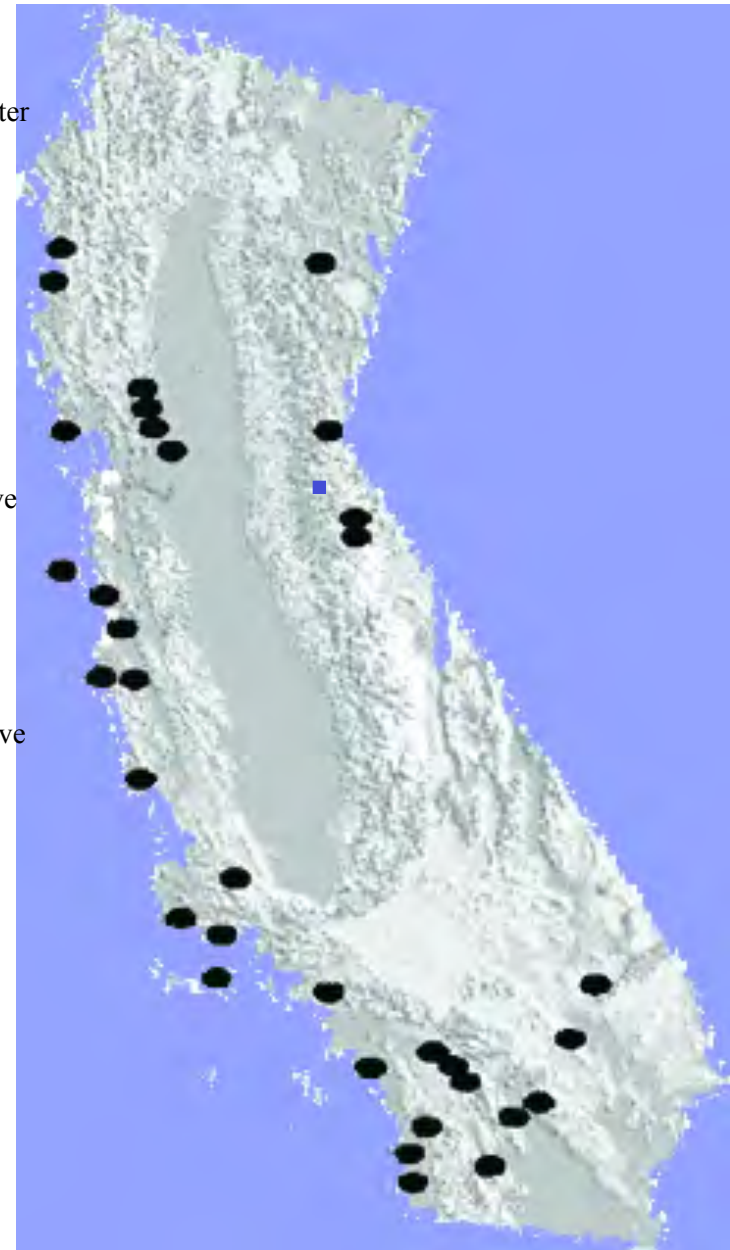
## 29. VESR - SNARL

(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



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



Surber



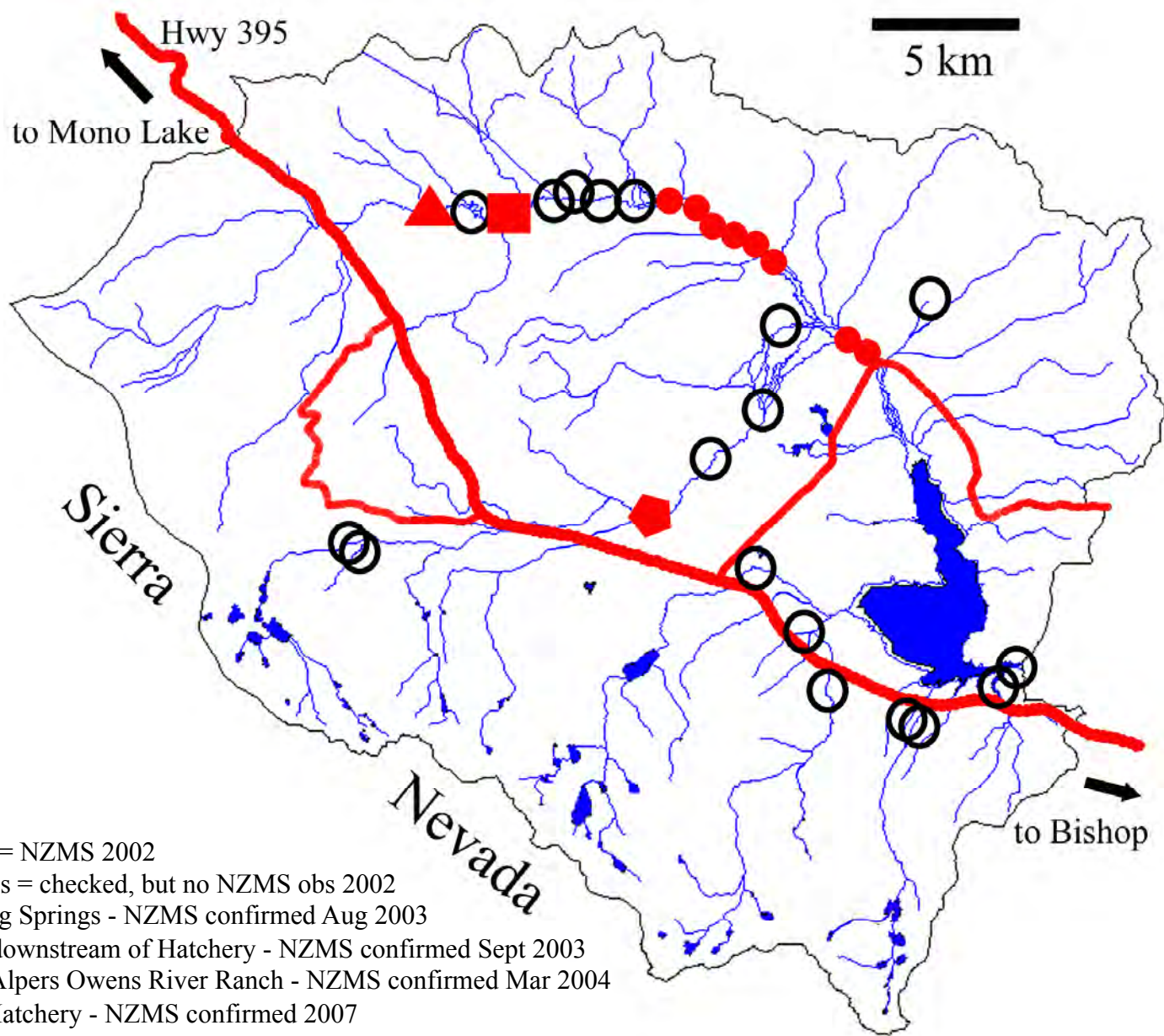
## 4. Preserve in 70% EtOH



## 5. Record location with GPS unit



# NZMS Distribution



# The New Zealand Mudsnail

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# 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



[www.esg.montana.edu/aim/mollusca/nzms](http://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**

**Sandra South**

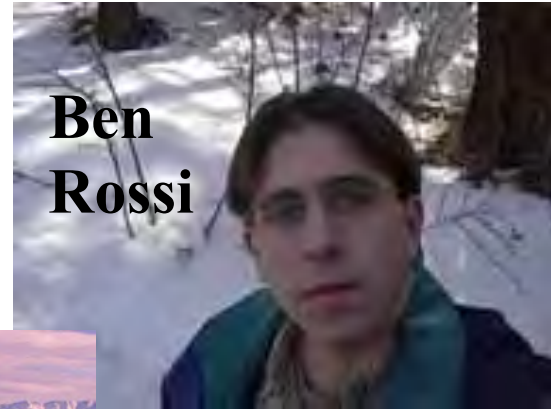
**Vicky Huang**

**Jeremy Jacquot**

**Field Assistants**

**Alex  
Gilman**

**Ben  
Rossi**



**Dan Dawson**



**Tonya  
Kane**

**Guidance, Equipment, Financial Support**

**Debra Hawk**

**Dawne Becker**

**John Cunningham**



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# Key

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

[name, IP] = author of article in press

[name, 1] = presenter from 2001, 1<sup>st</sup> annual conference

[name, 2] = presenter from 2002, 2<sup>nd</sup> annual conference

[name, 3] = presenter from the 2003, 3<sup>rd</sup> annual conference

NZMS in the Western USA Conference in Bozeman, MT

# References

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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

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