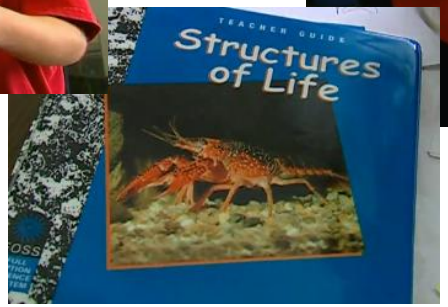
Biological Supply and Freshwater Invasive Species: A Crayfish Case Study from the Pacific Northwest



Eric R. Larson

elarson@sheddaquarium.org

Daniel P. Haerther Center for Conservation and Research,

***John G. Shedd Aquarium**, Chicago, IL*

Environmental Change Initiative, ***University of Notre Dame***

Shedd AQUARIUM

ENVIRONMENTAL CHANGE INITIATIVE

Freshwater Invasive Species

Canal building

Shipping

Bait bucket

Biological supply?

?

Biological Supply and Freshwater Invasive Species

Species Invasions from Commerce in Live Aquatic Organisms: Problems and Possible Solutions

REUBEN P. KELLER AND DAVID M. LODGE

428 BioScience • *May 2007 / Vol. 57 No. 5*

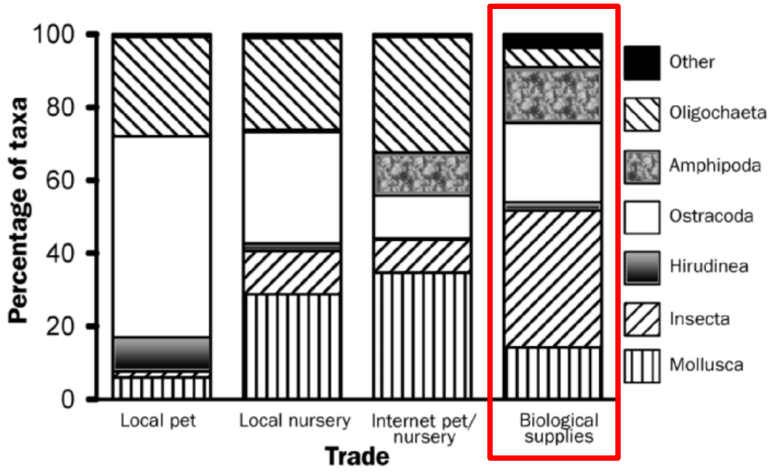


Figure 3. Average taxonomic diversity of contaminant animals recovered from purchased plants from local pet stores, local nursery stores, Internet-based pet and nursery vendors, and biological suppliers.

Table 2. Nonindigenous species (not including contaminant species) purchased in the Great Lakes region that already have populations established in the Laurentian Great Lakes basin.

Species	Trade	Native range	Great Lakes impacts	Temperate zone impacts
Plants				
Cabomba caroliniana (Cabomba)	Nursery	South America	No	Yes
Egeria densa (Brazilian waterweed)	Pet	South America	No	Yes
Eichornia crassipes (water hyacinth)	Pet, nursery	South America	No	No
Glyceria maxima (tall mannagrass)	Nursery	Europe, Asia	No	Yes
Hydrocharis morsus-ranae (European frog-bit)	Nursery	Europe, Asia	Likely	Yes
Iris pseudacorus (yellow iris)	Nursery	Africa, Europe, Asia	Yes	Yes
Lysimachia nummularia (moneywort)	Nursery	Europe, Asia	Yes	Yes
Marsilea quadrifolia (water shamrock)	Nursery	Europe	No	Yes
Mentha aquatica (water mint)	Nursery	Europe	No	No
Myosotis scorpioides (water forget-me-not)	Nursery	Europe, Asia	Yes	Yes
Myriophyllum aquaticum (parrot feather)	Pet, nursery	South America	Likely	Yes
Myriophyllum spicatum (Eurasian watermilfoil)	Pet, nursery	Africa, Europe, Asia	Yes	Yes
Najas minor (lesser naiad)	Pet	Africa, Europe, Asia	No	Yes
Nymphoides peltata (yellow floating-heart)	Pet, nursery	Europe, Asia	No	Yes
Pistia stratiotes (water lettuce)	Pet, nursery	South America	No	No
Potamogeton crispus (curly-leafed pondweed)	Pet, nursery	Africa, Europe, Asia, Australia	Yes	Yes
Trapa natans (water chestnut)	Pet	Asia	Likely	Yes
Typha angustifolia (narrow-leaved cattail)	Nursery	Europe	Yes	Yes
Fish				
Ameiurus melas (black bullhead)	Biological supplies	North America (including Great Lakes)	No	Yes
Carassius auratus (goldfish)	Pet, nursery	Asia	Yes	Yes
Cyprinus carpio (common carp, koi)	Pet, nursery	Europe, Asia	Yes	Yes
Gambusia affinis (mosquitofish)	Bait	North America	No	Yes
Micropterus salmoides (largemouth bass)	Live food	North America (including Great Lakes)	No	Yes
Misgurnus anguillicaudatus (Oriental weatherloach)	Pet	Asia	No	Unknown
Notemigonus crysoleucas (golden shiner)	Bait	North America (including Great Lakes)	No	No
Pimephales promelas (fathead minnow)	Bait, biological supplies	North America (including Great Lakes)	No	No
Mollusks				
Corbicula fluminea (Asiatic clam)	Nursery	Asia	Yes	Yes
Crayfish				
Orconectes rusticus (rusty crayfish)	Bait	North America	Yes	Yes
Procambarus clarkii (Louisiana crayfish)	Biological supplies	North America	Likely	Yes

Source: Information on Great Lakes impacts for plants, Czarapata 2005; for fish, Fuller et al. 1999; for mollusks, McMahon 2000; for crayfish, Lodge et al. 2000.

Biological Supply and Freshwater Invasive Species

Oregon Sea Grant

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Helping schools become part of the solution

Contact: Tania Siemens

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Watershed and Invasive Species Education Program

Teachers, students create, learn and share about invasive species

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Sam Chan

samuel.chan@oregonstate.edu

Pat Charlebois

charlebo@illinois.edu

Illinois-Indiana Sea Grant

Biological Supply and Freshwater Invasive Species

Invasive crayfish in the Pacific Northwest

- Are organisms being introduced by biological supply?

- What is the potential extent of the problem?

- What are some solutions (and their complications)?

Native species pilot program?

2001

Washington Department of Fish and Wildlife biologist (**Karl Mueller**) finds red swamp crayfish *Procambarus clarkii* in urban lake near Seattle (Pine Lake)

The Seattle Times | LOCAL NEWS

Louisiana red swamp crayfish changes life in a Sammamish lake

PREV 1 of 5 NEXT

By Sonia Krishnan
Seattle Times Eastside bureau

The problem of the invasive crayfish in Sammamish's Pine Lake probably started innocently enough.

Perhaps a fisherman tossed his live bait in the water years ago. Or a child decided to set her aquarium creatures free.

However the Louisiana red swamp crayfish ended up in the lake, Karl Mueller is certain of one thing: They are overrunning the native signal crayfish at a fast clip.

And that shift is changing the entire freshwater ecosystem of the lake, he said.

Similar to later *P. clarkii* invasions in Wisconsin, Illinois

MILWAUKEE · WISCONSIN
JOURNAL SENTINEL

1,200 invasive crayfish captured in Germantown pond

By Lee Bergquist of the Journal Sentinel Oct. 1, 2009

2007

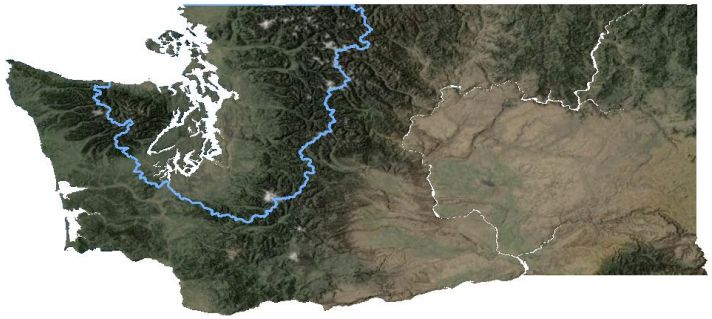
I started my PhD to investigate distributions, impacts of invasive crayfish in Seattle area with **Julian D. Olden**

INVASIVE

Procambarus clarkii

NATIVE

Pacifastacus leniusculus



Where established? **11 lakes**

Where present? **53 lakes**

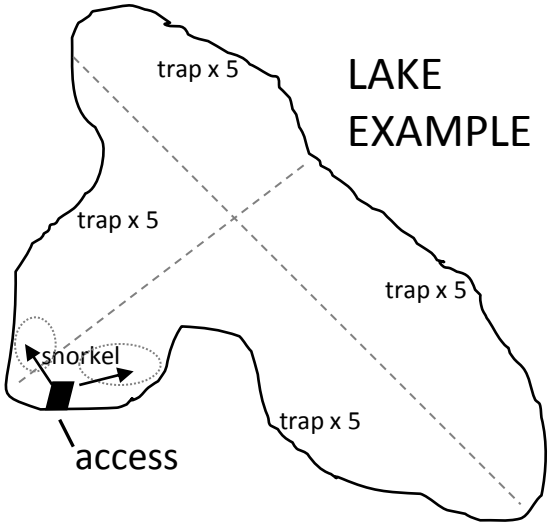
4 lakes 3 species

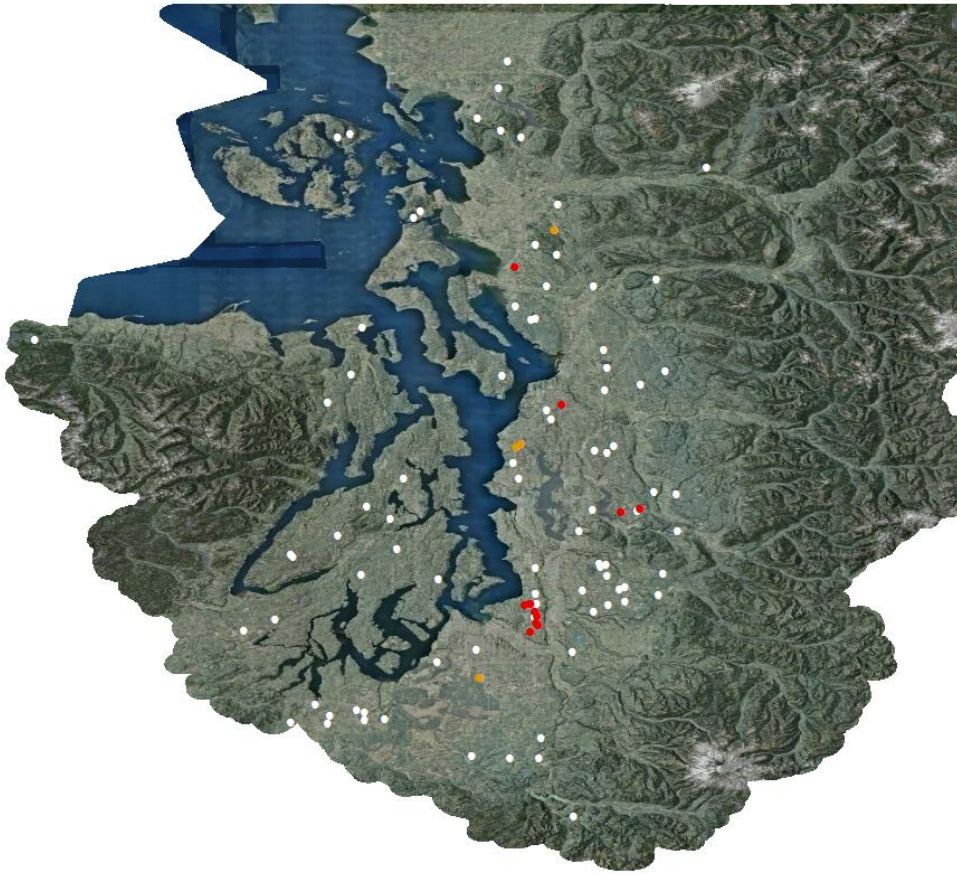
vulnerable?

vulnerable?

Orconectes virilis; Orconectes sanbornii;
Procambarus acutus

100 lakes surveyed 2007-2009





2009

Orconectes rusticus discovered west of Continental Divide for first time

John Day River of Oregon

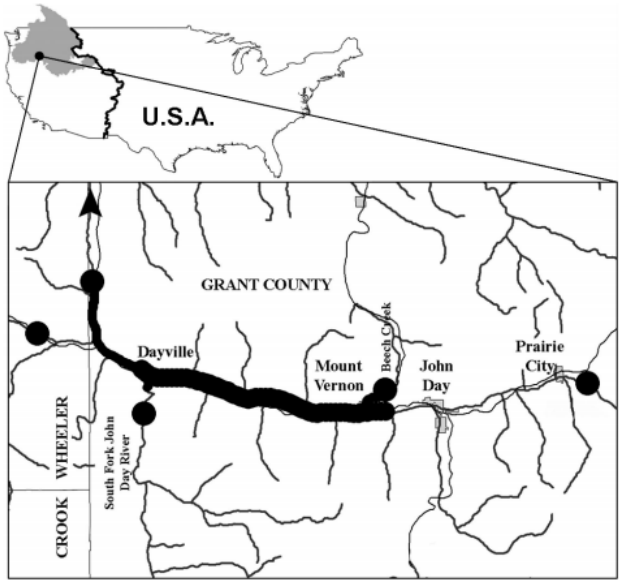


Fig. 1. Known *Orconectes rusticus* (Girard, 1852) distribution in the John Day River of Grant County, Oregon, U.S.A. (represented by the thick black line). Black dots delineate the survey area, and the arrow indicates the direction of river flow. Inset illustrates the Columbia River Basin (gray shading) and the Great Continental Divide (thick black line).

FIRST RECORD OF *ORCONECTES RUSTICUS* (GIRARD, 1852) (DECAPODA, CAMBARIDAE) WEST OF THE GREAT CONTINENTAL DIVIDE IN NORTH AMERICA

BY

JULIAN D. OLDEN[1,3]), JEFFREY W. ADAMS[2]) and ERIC R. LARSON[1])

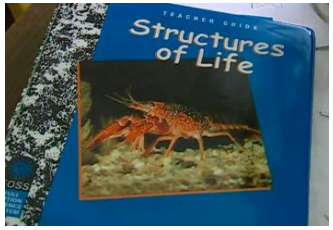
[1]) School of Aquatic and Fishery Sciences, Box 355020, University of Washington Seattle, Washington 98195, U.S.A.

[2]) Washington Sea Grant, Box 355060, University of Washington Seattle, Washington 98105, U.S.A.

Where are all of these invasive crayfish coming from?

How do crayfish get introduced?

banned in WA State
no bait shops sold crayfish



little to no crayfish
in pet shops

Strecker et al. 2011 *Fisheries*

rumor that lots of schools in
Seattle area were using live crayfish

I visited a school near U Washington campus…

… that had three non-native species on site

Procambarus clarkii

Orconectes virilis

Orconectes rusticus

"We really like these (O. rusticus) because they're the natives."

We found rusty crayfish were being sold by a local (WA) biological supply company; teachers were inferring that they were natives.

Sam Chan (OR Sea Grant) invited to his 4th grade daughter's "spring release party," to empty aquariums into creek in Corvallis – observes rusty crayfish in classroom.

What freshwater species are schools using?

How commonly are they used?

Where are they coming from?

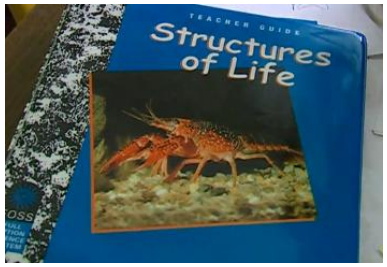
Do schools know what they have?

Do schools know how to care for, dispose of these organisms?

Sea Grant

Teacher, school district surveys

Science curriculum developer and biological supply company outreach



Primarily <u>elementary schools</u>
e.g. 2nd, 4th, 6th grades
Not <u>generally</u> high school (specialist) science teachers, not for dissections

Full Option Science System (FOSS)
- Structures of Life
- Animals 2 x 2

Live animals for behavioral observations – e.g., *"how are crayfish and snails different?"*

60% of Washington schools using crayfish
600+ per semester per school district

~1/3rd of teachers we surveyed (WA) had released organisms (undefined taxa)

From teacher focus group meetings:

"… there was an article in the newspaper about four years ago about Pine Lake … and we cringed because we knew it was our district … that we caused this problem, ***there are crayfish in there that were released on purpose with the best intentions by the high school*** *and they are now taking over …"*

High school science teacher released excess *P. clarkii* in Pine Lake (first known invasion in state) for years

What happens to biological supply organisms after use?

I. Why aren't these laboratory animals being **euthanized** at end of use?

Elementary school teachers; 40% of surveyed will not euthanize under any circumstances

III. Organisms **adopted** by students?

Some schools, teachers release organisms to student care at end of school year under written & signed "adoption" agreement that they won't be released (hard to say if followed)

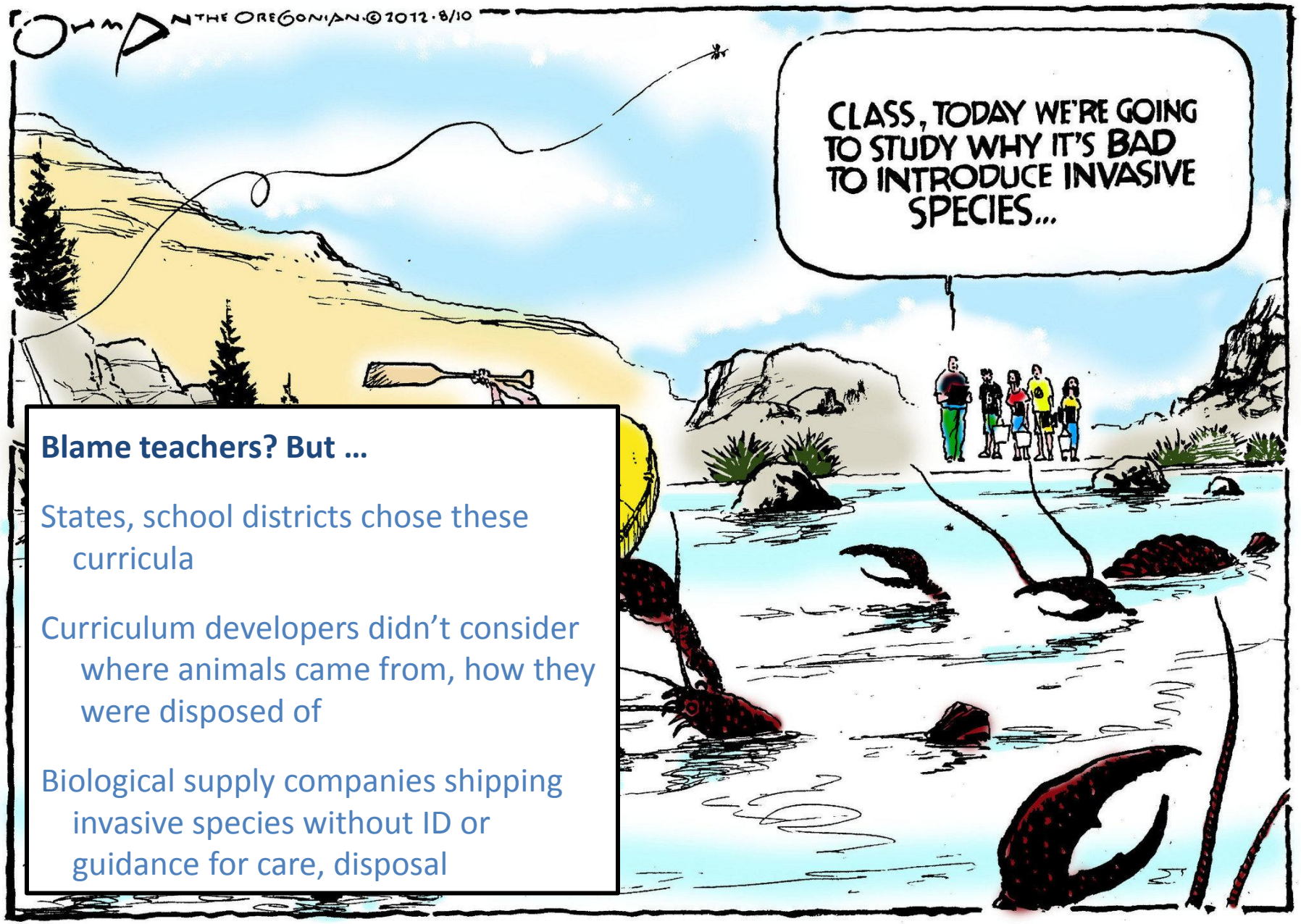
II. Why aren't these organisms being **reused?**

Larger or wealthier school districts have "science distribution centers" that handle ordering and distributions of organisms, keep them over summer for reuse. **Rural or poorer school districts more likely to rely on drop shipments directly to teachers without oversight.**

IV. Direct **releases** by teachers, students

See: "release party" intervention by Sam Chan, OR Sea Grant

Suspected in case of *O. rusticus* invasion in Oregon



Blame teachers? But …

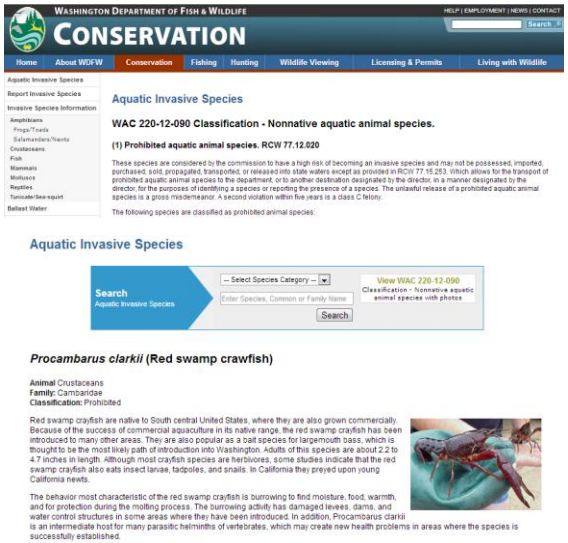
States, school districts chose these curricula

Curriculum developers didn't consider where animals came from, how they were disposed of

Biological supply companies shipping invasive species without ID or guidance for care, disposal

Regulatory impasse in Washington State

"These are state prohibited species; they can't be shipped to or possessed in WA."



"We are committed to these science curricula for years; we have nothing to replace these activities with. We have to have crayfish."

SEATTLE PUBLIC SCHOOLS

Learning and Leadership
Tacoma Public Schools

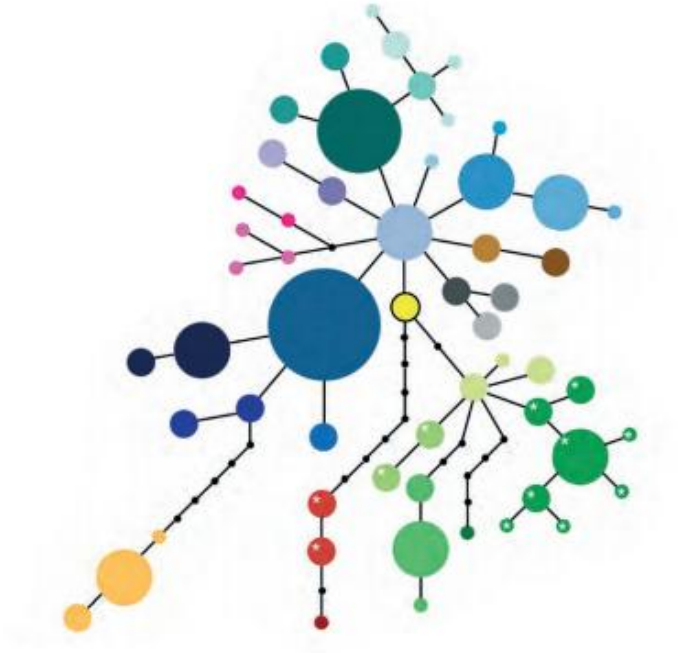
EVERETT PUBLIC SCHOOLS

Compromise: *"Can we use a native species substitute?"*

"Washington State has one native crayfish"

Signal crayfish, *Pacifastacus leniusculus*

A major invader globally!
(But it's "our" invader)



With massive intraspecific genetic diversity; do we want to be shipping, potentially releasing these in the Pacific Northwest, either?

Freshwater Biology (2012) **57**, 1823–1838 doi:10.1111/j.1365-2427.2012.02841.x

The signal crayfish is not a single species: cryptic diversity and invasions in the Pacific Northwest range of *Pacifastacus leniusculus*

Native Species Pilot Project

Can we get native crayfish?

✓ commercially harvested in WA, OR

=

Do native crayfish survive in the "classroom"?

45 Days *P. clarkii* **57%** survival

P. leniusculus **34%** survival

Do native crayfish survive shipping?

dry?
NO

ice?
NO

water?
YES ✓

Now what?

- Invasive species issue
- Animal welfare issue
- Teachers, students unhappy when animals die

COMMERCIAL HARVESTER

COMMERCIAL HARVESTER

COMMERCIAL HARVESTER

Organisms in use restricted at biological supply company level (i.e., no *O. rusticus*)

Know what is being shipped, sold to your state

BIOLOGICAL SUPPLY COMPANIES

Biological supply companies should include information on identity, care, disposal of species

SCIENCE DISTRIBUTION CENTERS

Science distribution centers should reclaim & reuse organisms

ELEMENTARY AND MIDDLE SCHOOLS

Science teachers informed on invasive species issues (role for science curriculum developers)

TEACHERS

No “adoption” to students or “release parties”

STUDENTS

LOCAL WATER BODIES

Where schools and freshwater habitats are in proximity, prioritize outreach and signage

Important Notice!

Do NOT release classroom organisms into the wild. In some states, it is illegal to release organisms, even indigenous species, without a permit. The intention of these laws is to protect native wildlife and the environment.

When classroom activities are finished, the organisms can be:

- Kept in your classroom
- Donated to another classroom or Science Department
- Donated to nature center
- Humanely disposed of by freezing.
- We do not recommend home adoption by students as the organisms often go from home to the wild.

Resources Available through Sea Grant

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samuel.chan@oregonstate.edu

Pat Charlebois

charlebo@illinois.edu

Illinois-Indiana Sea Grant

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AIS Toolkit for Teachers

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The Aquatic Invasive Species Menace to the West Toolkit

The Aquatic Invasive Species Menace to the West Toolkit is a set of fun, challenging, and inspiring lessons and activities that build on STEAM (Science, Technology, Engineering, Art and Math) principles and are designed to help kids understand what invasive species are, how they affect the environment, and what we can all do about them. The toolkit contains lesson plans, powerpoint presentations, a species resource guide and a species acitivty guide. The toolkit highlight 10 aquatic invasive species that are relevent for students on the west coast, including California, Washington, and Oregon.

AIS Activity Guides

These guides can be used as a set or individually set to enhance student understanding of specific marine invaders. Assign assessment questions as homework, or use them for classroom discussions or evaluation tools.

Title	Resource Sheet	Activity Guide
Asian Carp	pdf | text	pdf | text
Zebra & Quagga Mussels	pdf | text	pdf | text
New Zealand Mudsnails	pdf | text	
Brazilian Elodea and Hydrilla	pdf | text	
Crayfish	pdf | text	
Caulerpa	pdf | text	

Lesson Plans

» **NEW: Mussel Quarantine Model.** In this lesson students learn the life cycle of the zebra and quagga mussels, their impact on natural systems, and the risk of transport through boaters' habits. Students will take the role of a boater to use a model for determining how long to quarantine their boats.
  » Teacher and student pages - accessible .pdf

» **Stone Soup: Invasive Species Cartooning** - Students will develop and apply reading, language arts, and science processes to analyze comics, and demonstrate writing skills in creating their own comic about a local invasive species.
  » Teacher pages - accessible .pdf
  » Student pages - accessible .pdf

STONE SOUP BY JAN ELIOT (7/31-8/3/13)


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Questions?