



November 2, 2004

TO: Richard Marovich
Putah Creek Streamkeeper

Subject: Survey Methods used for New Zealand Mudsnails in Putah Creek, Yolo County, California.

Investigator: Ken W. Davis, aquatic biologist

Aquatic Survey Report:

As the New Zealand Mudsnailed investigations progress in Putah Creek, it has become increasingly evident that the current methodology is not sufficient to produce accurate results in a dynamic ecosystem such as Putah Creek. The waterway is subject to fluctuating water levels, extremely high flows (14,000cfs), storm event drainage from various unregulated tributaries, and a significant number of recreational fishermen who move NZMS around the watershed (Davis 2004). The situation is also complicated by the documentation that NZMS commonly move in the invertebrate drift (Richards, 2001, Davis 2004). The following is a brief description of the survey methodology tested in Putah Creek:



Biomonitorers use a D-Net in Putah Creek.

D-Net: Image left is the typical use of the D-shaped net used to sample riffles and runs. The PVC frame was developed for the Putah Creek project by Ken Davis and Greg Bonovich. The weighted frame placed in front of the net assured that the area to be surveyed was exactly the same for each sample. The area shown is an example of 5 - 12 inch cobble in Putah Creek. Widely used, the results of this methodology is typically represented as NZMS m² which is erroneous as it does not include the vertical dimension which can be from zero to six inches.



Surber Net sits on substrate at research site in Willow Creek. Net will float away even in lower velocities.

Surber Net: Widely used, the Surber Net sits on the substrate and has a built-in frame in front of the net. Benthic invertebrates in the framed area will be washed into the net if the current is sufficient. The net can only be used in shallow water and in areas with limited current. The current can easily carry invertebrates outside the net. Studies have demonstrated that this net can severely underestimate invertebrate density and diversity. (WildCo 2004).



Putah Invertebrate Trap: Trap developed by Ken Davis under contract with the U.S. Bureau of Reclamation. Device was designed to be used in deep water, weed beds, and water conveyance systems such as the Putah South Canal. Filled with a known volume of native gravel, this device is quickly colonized by NZMS and native invertebrates. A study trap was colonized by more than 1800 NZMS in seven days. Advantages: Volumetric, designed to retain NZMS when the trap is retrieved, and is also colonized by native invertebrates. Recommend that it be compared to the larger benthic samplers and conventional sampling methods.

Putah invertebrate Trap partially filled with native gravel.

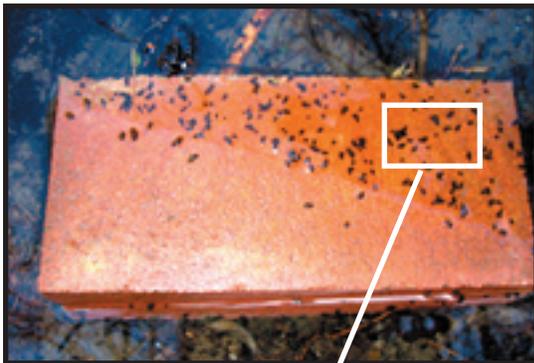


Photo Delineation: Process developed by Ken Davis for use in shallow areas of Putah Creek to obtain a true representation of NZMS per square meter. Once the bricks (of known size) are “Periphytonized”, the snails show prolonged grazing behavior on all surfaces. Photographing the bricks on a regular basis produces a permanent record of the NZMS density. Large files produced by new Nikon technology (RAW files) can produce 140 megabyte files which are easily used in Photoshop to quantify the snail density and relative sizes.



Disadvantages: (1) Fluctuating water levels (as shown in the top photo) can cause interruption in the documentation. (2) Water levels must be relatively shallow. (3) Investigator must be familiar with and possess high-resolution digital camera equipment and Photoshop CS.

Shows photo brick with reduced water level (above) and enlargement (below).

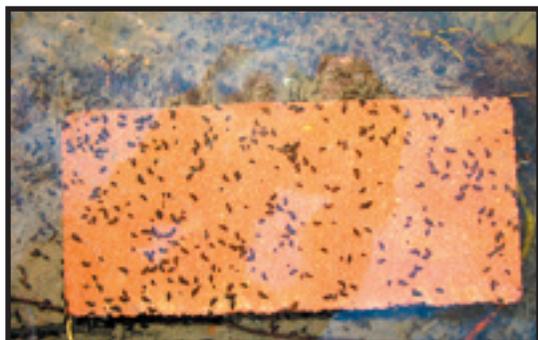
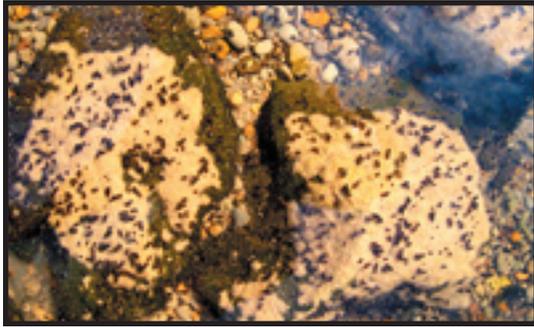


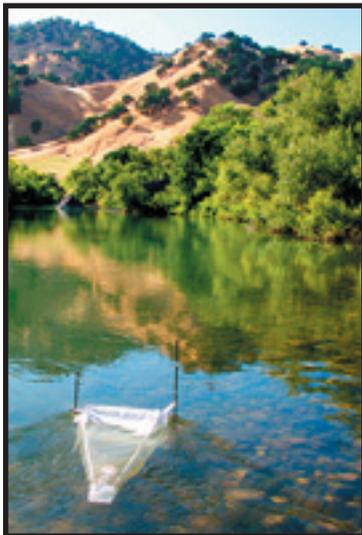
Photo Delineation Sample: The Photo Brick on left shows a count of 21,595 NZMS per m² on 12/22/04. Earlier images showed 6,495 NZMS per m² at this site on 11/22/04. **Note: This site below the Putah Diversion Dam and two others are test sites only.**

Recommendation: That 20 numbered Photo Bricks be placed at least at 5 sites within the NZMS infestation to help monitor the population.



Shows NZMS on algae-covered cobble in Putah Creek

Cobble Photo Sampling: NZMS on natural cobble are photographed and the cobble measured. Same as above, the NZMS in the collection photo shown on the left are grazing on the algae-covered cobble. The original image is 140 megabytes which is easily enlarged in Photoshop CS. Upon enlargement, the snails are easily counted and marked using Photoshop tools. The file provides a permanent record.



Drift net used downstream from major NZMS infestation in Putah Creek.

Drift and Shuck Measurements: Drifting insects are believed to be the primary food source for many salmonids, the measurement of all invertebrates in the drift appears to be an important measurement of the invertebrate population possible impacted by an NZMS invasion. This is complicated by myriad of factors that can affect invertebrate drift such as time-of-day, phase of the moon, water volume, and stage of life cycle.

Image on left is drift net that is set up (six inches off the substrate) in Putah Creek. Left for twenty minute intervals, the Drift Net collects insect larvae, emergers, adults, and shed exoskeletons (shucks) that are floating in the water column.

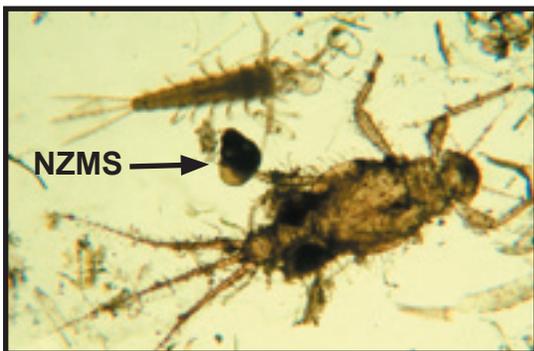


Image shows part of a drift sample captured on a sticky trap. Shows NZMS (0.4mm), a Baetis "shuck" (top) and a *Tricorythodes minutus* shuck.

NZMS in the Invertebrate drift: NZMS were determined to be moving in the invertebrate drift (Davis 2004). It was common knowledge that NZMS moved via the drift while attached to leaves and floating wood. Richards (2003) noted that NZMS were the most prevalent invertebrate in the drift in one study in the Snake River. It was not noted (determined?) if the snails were attached to drifting substrate or free-floating.



Shows NZMS floating upside down with neonates attached. © 2004 Ken W. Davis

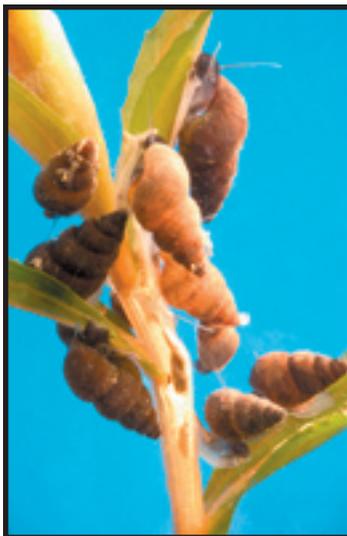
Floating NZMS: In 2004, researchers in Putah Creek noted NZMS floating upside down attached to the underside of the water surface (Davis 2004). The behavior was documented via a series of photographs from above and below the water's surface.



Shows NZMS in aggregations. This behavior is common in some months.

Cobble Measurements: Cobbles are selected at random. A Surber Net is placed immediately downstream from the selected cobble. The cobble is gently lifted and *hopefully the detached NZMS will wash into the net. The remaining NZMS can be washed off the cobble into the net. The cobble is then measured for a NZMS (per square meter) designation.

*NZMS has the tendency to detach from their substrate and drop which can effect the results.



NZMS will graze on a wide variety of substrates including *Potamogeton sp.* shown above.

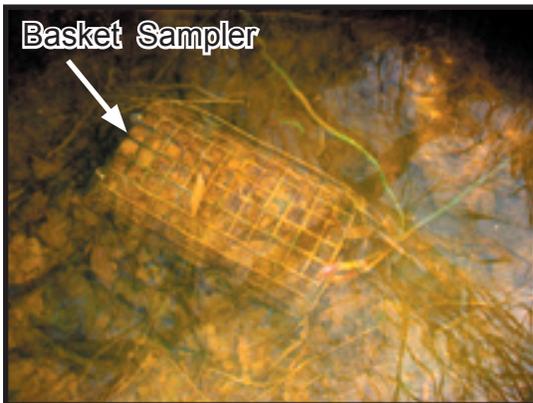
Macrophyte beds: NZMS densities in macrophyte beds can be measured by sweeping an area with a D-Net, capturing the snails and then cutting the vegetations for measurement. The process is complicated by the potential inaccuracy of the sweep and the presence of several species of aquatic macrophytes in Putah Creek. While NZMS appear to prefer one species of macrophyte over the others, there is no documentation.

Limited use of the Putah Creek Invertebrate trap in weed beds suggests that it produces an accurate representation of the NZMS population in macrophyte beds



Image shows NZMS population grazing on submerged Willow roots.

Willow Roots: New Zealand Mudsnails are attracted to the adventurous roots (aquatic) of many willow (*Salix*) species. A D-Net is gently placed under the roots and the roots cut with garden scissors, easily capturing the NZMS that are grazing on the roots. NZMS are counted and roots weighed for a designation of NZMS per kilogram of willow root (damp weight).



Gravel basket placed in low volume, eighteen-inch deep area of Putah Creek.

Benthic Gravel Baskets: Wire baskets (60 Gauge PVC covered wire) are filled with native gravel, placed in random areas of the survey area and chained in place. Baskets provide a consistent volumetric measurement of NZMS and potentially native invertebrate populations. Sculpin (*Cottus*) are routinely caught in this type of benthic sampler. Basket at left has been left in Putah Creek for 28 days at a depth of 40 cm. It will be removed and processed 30 days after immersion in Putah Creek. Yolo Housing augmentation site.

Discussion: Numerous techniques are used by researchers to record the densities of New Zealand Mudsnail infestations. Each technique and device have advantages and disadvantages. Most techniques are specialized and limited for use in a variety of habitats. We have noted that NZMS quickly colonized (graze on?) any new substance placed in Putah Creek. During the Emergency Delineation (Bergendorf, 2004) we found numerous items in a variety of habitats that were covered with NZMS. Those items included beer cans, bottles, socks, blankets, tires, boards, cement, and a paper bag that were covered with NZMS. In a search to find one technique that might have the potential to measure NZMS densities in various habitats, the “quick colonization” observation drove the development of the Putah Invertebrate Trap. A variety of designs were tested with a simple result in mind: “Did NZMS colonize the substrate in the trap?” It was noted that a large number of NZMS and native invertebrates quickly colonized the baskets loaded with native gravel. It appears from numerous field tests that native invertebrates typical of each test habitat colonized the traps within thirty days of placement. Those habitats included: riffles, runs, aquatic weedbeds, leaf beds, root wads, pools, Lake Solano, cement forming the base of the Putah Diversion Dam, and Putah South Canal (**Note: to date, no live NZMS has been found in the Putah South Canal by any method**).



Recommendations:

1. The use of gravel baskets appears to have advantages over techniques currently employed to investigate the movement and relative densities of New Zealand Mudsnail infestations. While the process is more labor intensive than other methodology, the results are less likely skewed by investigator error or inconsistency.

2. Conditions permitting, that 20 photo bricks be placed at five sites within the New Zealand Mudsnail infestation in Putah Creek. It appears that this technique is effective, inexpensive, offers a permanent record of NZMS densities at certain sites, and can be used to estimate the physical sizes of the snails. For example, observations and limited photos of these photo bricks (and previously used tiles) show that the female NZMS in Putah Creek produce young constantly throughout the year. Using 20 numbered photo bricks at five sites would provide a visual record of the infestation which would be easily accessed by off-site investigators.

All images © Ken W. Davis

NZMS Survey Method	Habitats of Use										
	Riffles	Runs	Pools	Weed Beds	Lake	Canal	Sand Bar	Mud	Shallow	Deep	Concrete Structure
Cobble Count	X										
Cobble Photo	X								X		
Macrophyte Count				X	X						
Drift						X				X	
Salix Root Count			X		X					X	
Photo Brick		X					X	X	X		
Surber Net	X						X		X	X	
Dredge			X		X			X		X	
D-Net	X	X		X		X			X		
Putah Trap	X	X	X	X	X	X	X	X	X	X	X
Gravel Basket	X	X	X	X	X	X	X	X	X	X	X

Submitted by: Ken W. Davis