

# **Mussel survey techniques and results of 2006 surveys in the Umpqua Basin, Douglas County, OR.**

**Nancy Duncan, Interagency Mollusk Specialist  
Roseburg District Bureau of Land Management, Roseburg, OR 97470**

## **Abstract**

In order to determine regional trends in populations for native freshwater mussels, population demographics will need to be monitored in regional river basins throughout the Northwest. The South Umpqua has not been surveyed extensively, but the few sites for the western pearlshell (*Margaritifera falcata*) that have been located in previous years do not have many individuals and juvenile recruitment seems to be lacking, making this river an ideal candidate for monitoring. During the summer of 2006, we inventoried portions of the South Umpqua River to locate at least two substantial beds of mussels which could be used for demographic monitoring. In addition, we tested several survey methods during our inventory, in order to refine the federal Aquatic Survey Protocol, which is currently being revised. Approximately 11.5 miles (415 acres) of river were inventoried, using an intuitive-controlled search method which covered all portions of the aquatic habitat except for deep water (>10 ft) and hazardous areas such as waterfalls, chutes and dams. Only four populations with more than 20 individuals were located in the South Umpqua which would be suitable for monitoring, all located above Days Creek. Survey methodology improvements were made during the course of the inventory, including the use of inner tubes for transportation and ease of viewing in shallow water, and underwater photography to document habitat conditions and population densities at newly discovered sites. Statistical monitoring methods proposed in the survey protocol using weighted 5 m<sup>2</sup> rope grids proved difficult to handle in even moderately fast water, and did not prove to be useful for detecting or estimating population densities for rare and widely separated colonies of mussels as they occurred in this basin.

## **Introduction**

Freshwater mussels are a critical part of aquatic ecosystems, filtering water and providing calcium sequestering which buffers the acidity of streams and rivers. They are dependent on salmonids for dispersal and recruitment of juveniles to the population, and thus are threatened where fish populations are declining. They also provide food resources to a wide variety of wildlife as well as being of cultural significance to Native Americans. Mussels are the longest-lived animals in the northwest, living up to 120 yrs, and growth patterns in their shells provide a historic record of conditions in watersheds prior to modern records.

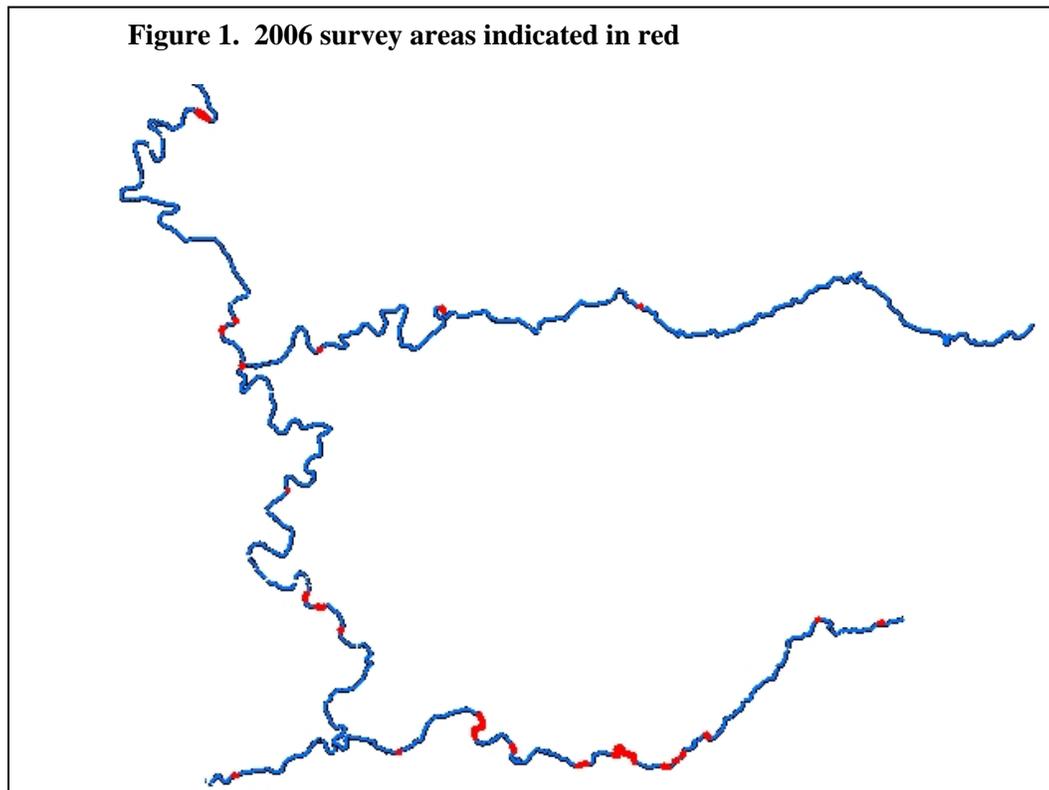
Freshwater mussels are among the most threatened group of species in the United States: 200 of 300 freshwater mussels in North America are TE or at risk. This group of species has long been known to function as “canaries in a coal mine” for rivers, where mussel health and abundance reflect early changes in water quality and habitat conditions. Monitoring the demographics of mussel populations can provide information on population trends and provide biotic indicators of the functional condition of the aquatic ecosystem.

The Northwest Native Freshwater Mussel Workgroup, of which I am a member, is currently in the process of designing and implementing a regional monitoring plan for the Northwest. Index plots will be designated in major watersheds where mussel populations will be monitored regularly to determine changes in population density, condition and age class distribution. As part of this effort and in combination with my duties as regional mollusk specialist for the federal land management agencies, I am in the process of revising the federal aquatic mollusk presence/absence survey protocol and developing a monitoring protocol which can be used at

these index plots. The experiences gained this summer during the inventory of the South Umpqua River have helped to refine these protocols and have suggested several improvements for their application in Northwestern waters.

## Study Area

We inventoried approximately 11.5 miles of river habitat during July and August of 2006. Portions of both the North and the South Umpqua Rivers were surveyed, as well as three segments of the Umpqua main stem below the junction of the two forks (Figure 1). The majority of the survey effort was concentrated in the upper South Umpqua River, above Days Creek. One site on Cow Creek, a major tributary to the South Umpqua, was also searched.



Access to the river was problematic, as much of the land adjacent to it is in private ownership. Segments of river to be surveyed needed to have both put-in and take-out access, so that surveyors could swim downstream and not fight the current. Since only  $\frac{1}{2}$  to  $\frac{3}{4}$  mile of river could be searched thoroughly during a typical 2-3 hour survey, this access issue limited the number and location of potential survey areas. In cooperation with private citizens and the Cow Creek Band of the Umpqua Tribe of Indians, we were able to secure access to several stretches of river otherwise unavailable to us that contained large populations of mussels. Although the selection of survey areas was not random, we feel that they are a good representation of the range of habitats available in this river and the relative numbers of populations found in them.

The average width of the river increased from 15 meters above Tiller, to 90 meters at River Forks, to over 150 meters at the Bullock Bridge in the main stem. Average depth (during August low water) ranged from a few inches in rapids and wide cobble reaches to deep bedrock trenches and holes over 50 feet deep. Current velocity ranged from standing water in pools, to rapids and

falls with velocities of more than 10 meters per second.

## **Equipment and Methods**

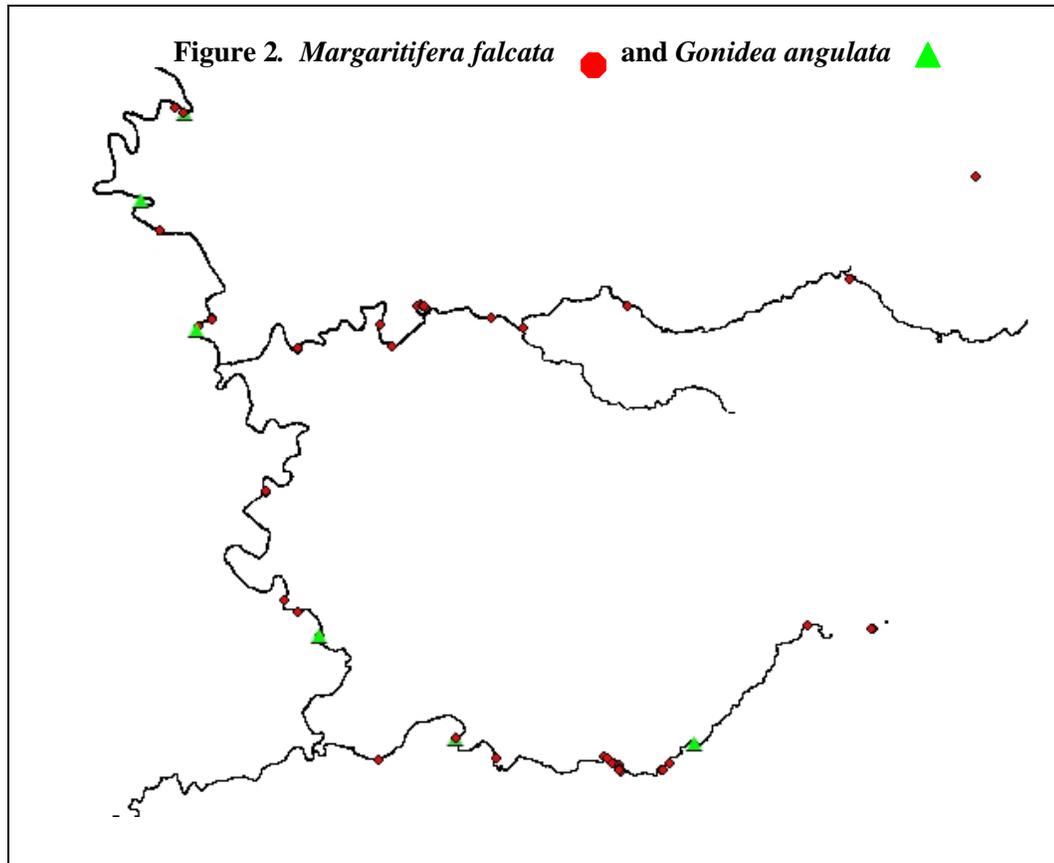
The majority of the surveys were conducted with a team of three surveyors, one of whom was trained in water rescue. Once a segment of river had been identified and access obtained, surveyors would put in at the upstream end of the segment and float/swim downstream to the take-out point, surveying all potential habitats in between. Snorkeling allowed surveyors to visually inspect all areas less than 10 feet in depth; deeper areas were too dark to search visually and several attempts to free dive and hand grab samples from the bottoms of deep trenches did not produce any results. In the upper South Umpqua, where the river averaged 20-30 meters in width, three surveyors could completely survey about ¼ mile of river per hour.

Since some portions of the upper South Umpqua are quite shallow at this time of year, inner tubes were employed to allow surveyors to float over shallow areas and visually scan the bottom with mask and snorkel without disturbing the substrates. Areas of shallow riffles or fast water could be safely traversed without harm on a tube. Without a tube, a swimmer would have to push or drag himself in shallow water over rocks on his belly, or attempt to crawl or walk over slippery rocks where he couldn't float. These tubes also functioned as safety floatation devices in the event that a surveyor became tired or cold. Tubes were tethered to the surveyors' feet to allow them to be towed while swimming in deeper water and gear could be strapped to them, freeing the surveyor's hands.

Other equipment used included dry bags in which dry clothes, laminated field forms and photographs, GPS unit and collection containers were carried. By setting the GPS unit's track log ON and attaching it to the top of a tube, we were able to collect a record of the survey path, and to document the extent of occupied sites simply by swimming slowly around them. Such sites were also documented with waypoints collected at the center of the areas. Even though the water temperature in the upper South Umpqua was generally in the 70s at this time of year, there were many deeper, colder areas and we found that the use of a wetsuit (either a "shortie" or a combination of that and a long-sleeved jacket) provided extra warmth and protection from abrasions, and allowed surveyors to extend their time in the water before becoming too cold and tired. Gloves with rubber palms protected our hands, especially in fast water. In order to see the river bottom in rapids for instance, a surveyor would have to turn around and ease himself slowly downstream feet first by holding onto rocks, or crawl back upstream underwater once he had floated past. Swim fins provided extra power for fighting the current or for swimming more quickly through slow moving water.

All mollusk species located were recorded. When shells were encountered, they were collected as vouchers, and GPS point coordinates collected. When live populations were found, they were documented on field forms and their locations recorded with GPS coordinates and sketches on the laminated aerial photographs carried with us. Estimates of the size of the occupied area and density of individuals were recorded, as well as the proportion of three size classes (<1", 1-3", and >3"). Habitat conditions such as water depth and current velocity, as well as substrate type were also recorded. Underwater photographs of several of these sites provided a good record of site conditions and population density. Several of these photographs also inadvertently captured images of local fish species which may prove to be hosts. Vicinity photographs documented the locations of occupied beds with reference to landmarks above and below water.

## Results



### *Margaritifera falcata* populations

#### Upper South Umpqua

We surveyed approximately 7.5 miles of river within the portion of the upper South Umpqua above Days Creek. Within that reach, a total of 31 new sites for *Margaritifera falcata* were recorded. (Figure 2) Most of these represent single individuals or small groups, widely separated from each other by large unoccupied stretches. There were only four colonies found that contained more than 20 individuals. These occupied areas ranged in size from 10-40 m<sup>2</sup> with densities of 10-80 animals per square meter. The largest and most densely occupied site was located opposite and downstream from the mouth of Coffee Creek, where many individual animals were found scattered between cobbles in clean sand and denser groups reaching densities of 80 animals per square meter were found in areas protected by boulders and sedge clumps. Two other colonies were located within a mile of this site, both above and below Coffee Creek, which had densities of 10-20 animals per square meter and occupied smaller areas of about 10 square meters each. The fourth large colony was found above Days Creek, approximately ½ mile below Beale's Creek. This site was approximately 40 square meters in size with a density of 20 animals per square meter.

Surveys in the upper South Umpqua recorded very few individuals in size classes less than 1" in length. At the majority of sites, only mature individuals greater than 3" were found. In the larger colonies, the smaller size classes (<3") represented less than 5 % of the population. Interestingly,

one small site of 16 individuals above Tiller had almost 25% of its population in this size class. In general, it seemed as if the smaller size classes became more abundant in the higher reaches of the river, however exhaustive sampling with sediment sampling may have revealed more of these cryptic size classes in the lower reaches.

### Lower South Umpqua

We also sampled 7 separate stretches of the South Umpqua totaling approximately 2 miles between Days Creek and the junction with the North Umpqua. Five new sites with live animals were recorded, but this portion of the South Umpqua did not contain any large colonies; a typical site consisted of a single animal or a clump of less than 10. These animals were all in the largest size class >3". The river bottom was often smooth bedrock, with areas of cobble between, or long stretches of cobble shallows with very little sand. In most of these surveyed areas, the river was wide and rather slow, and filamentous algae was abundant. Even in faster water, sediment and algae could be seen thickly covering the cobbles. Water temperatures were slightly warmer than higher in the basin. Near the confluence with the North Umpqua, we discovered a patch of freshwater sponge usually found in warm ponds or lakes, and the surface of the water in this area contained so many aquatic plants that swimming became difficult.

### North Umpqua

We surveyed three areas in the North Umpqua during 2006, totaling less than a mile, including two areas that had been surveyed in previous years. All of these areas contained large colonies of mussels. While occupied areas did not include the entire river bed and were more common in protected side channels, colonies were so extensive that it became impractical to delineate their boundaries. Densities ranged from 20-200 animals per square meter, from scattered clumps of individuals found tucked behind rocks in the sand and to densely packed areas where all the available substrate was covered by animals. All animals were at least partially embedded in sand substrates and none were found to be fixed to rock surfaces. All size classes were seen, with the smallest (<1") comprising about 1% of the population.

The water temperature was significantly colder in the North Umpqua as compared to the South, averaging around 65 degrees F. Most sites can be characterized by moderately fast water, having large cobble/boulder substrates with animals bedded in clean sand between them. Water depth at these sites ranged from a few feet to over 2 meters. No animals were found in deeper bedrock channels in the main current, and seemed to prefer more sheltered situations in side channels and behind rock outcrops and willow or sedge clumps.

### Main Stem Umpqua

The portion of the Umpqua below the confluence of the north and south forks was surveyed in only three areas. None of these areas were completely covered, as river depth and current velocity in the main channel was too hazardous. Surveys in these stretches were limited to areas within 20 feet of the shore. In all areas surveyed, we found many large mussel colonies. Occupied areas covered from ¼ to the entire river bottom in these near-shore areas. The densest colonies were found in sites where water had just passed over rapids or riffles. The densities ranged from 20-200 animals per square meter. In the lower survey area near the Bullock Bridge the river is very large and wide. Dead shells and recently killed animals were found in large concentrations where they had been drifted up into cobble bars in slower backwaters. It is unclear whether this mortality represents a single event, such as gravel dredging, which occurred upstream from this site and altered the river flow pattern, or whether this is a normal

accumulation of mortalities in a large river at the end of a long summer. The two larger size classes were seen, with 5% in the 1-3" category. The largest individuals seen during this year's survey were recorded here (>20 cm).

### ***Gonidea angulata* populations**

We located three new sites for *Gonidea angulata* (western ridged mussel), extending the known distribution of this species in the South Umpqua to 5 miles upriver from Tiller. Although no live animals of this species were found, underwater site photographs seem to show one animal in a group of *Margaritifera* which has a much paler mantle, and may be a single live *Gonidea* specimen. All shell vouchers collected from this area measured less than 3" except for one above Tiller which measured almost 4" in length. One additional shell voucher was collected above Bullock Bridge in the main stem of the Umpqua. This shell was sub-adult and quite worn. No *Gonidea* have been recorded from the North Umpqua in three years of surveys.

### **Other species recorded**

Several other aquatic mollusk species were documented during the surveys conducted during 2006 in the Umpqua basin. Native aquatic snails, including *Juga*, *Fluminicola* and *Lanx* were recorded. *Juga silicula shastaensis* (or similar undescribed species?) appeared to be the most common snail species in both forks of the Umpqua as well as the main stem, occurring almost everywhere in a relatively even distribution and sometimes in great numbers. *Fluminicola species nov.* (Umpqua pebblesnail) was recorded from several sites in the South Umpqua, but seemed to occur in more widely spaced colonies, and in a variety of substrate and habitat types. *Lanx subrotunda* (rotund lanx) was only found in the North Umpqua, on cobbles and bedrock where the water was fast, cold and clear.

The exotic bivalve species, *Corbicula fluminea* (Asiatic clam) was documented at all 7 samples reaches of the lower South Umpqua below Canyonville, in the Umpqua main stem and in Cow Creek. None were documented in the North Umpqua at the three sites visited. The farthest upstream site in the South Umpqua was at Canyonville Park. This species seems to favor sand and gravel bars in warmer slow-moving water and dead shells were evident on most beaches in these areas.

### **Sampling techniques**

We tested the current revised survey protocol for aquatic mollusks during our inventory of the river (Duncan, 2006a). In this protocol, at least 1/3 of each of the available habitats and substrate types are searched during a visit to determine presence/absence. In order to test the validity of this method for detecting rare species, one surveyor following this protocol would intuitively search 1/3 of each habitat type in a designated stretch of river, and then the other two surveyors would repeat the survey of that stretch, covering all of the habitats. In areas with very widely spaced individuals or clumps of animals, the 1/3 survey method was successful in finding most of the sites, but a single person was unable to cover both sides of a river if the current was even moderately fast without backtracking and swimming against the current. Consequently, this method missed some sites which the 100% survey did not. As surveyors became more experienced in recognizing favorable habitats and locations, they were able to focus on the best habitats and were more successful at finding sites. During the final days of surveys, the 1/3 method was as effective as the 100% method, due to the increased ability of the surveyors to focus on the best habitats.

We also tested the use of a 5m<sup>2</sup> rope grid, placed at randomly selected locations along a transect and sub-sampled with .25 m<sup>2</sup> quads, for measuring population densities in a stretch of the South Umpqua where one large population was found. This method has been used in rivers of the Midwest for mussel sampling (Piette, 2005). The rope grid was made from ¾" buoyant plastic rope, weighted at the corners and at 1 meter intervals on each side with 10 or 14 ounce lead weights. Transporting this grid to the sample sites while swimming and deploying it on the river bottom proved to be problematic, as the weights and rope became hopelessly entangled in the current. Once it had been finally placed and anchored on a sample site, however, the placement of the quads within it and the subsequent counting of animals in each quad was not difficult. Use of snorkel and mask while floating on an inner tube proved helpful to reduce disturbance of sediments while counting. The sampling quad was made from ½" PVC pipe, fitted with plugs to allow it to be floated or filled with water and submerged (Figure 3). We found that submerging it worked best, however the unevenness of some substrates prevented it from laying flat on the bottom. Holding the quad frame floating on the surface while sighting down through it to count was an alternate method that was more practical, but it was somewhat difficult to hold in one place and did not work in water more than a few feet deep.

**Figure 3. Floating/submersible PVC quads and orange rope grid in place for sampling.**



The overall design of randomly selected grid positions as described in the Draft Statistical Monitoring Protocol (Duncan, 2006b) did not work well for measuring the density of this population. Since the extent of the occupied site was approximately 30' x 5' on one side of the river, the randomly selected location of the grid in this area (right, left, or center of the river) had a one in three chance of missing the population entirely. In addition, the starting point for the grid placement and the distance between grids in subsequent sections could result in the grid being placed either upstream or downstream from the population even if it was on the correct side of the river, again missing the population entirely. If the population distribution within the survey area was more uniform or there were more occupied sites in the survey area, this sampling method may have been more effective, but it did not provide an accurate measure of this population's density. A different sampling design is needed for monitoring such isolated, small, clumpy populations, perhaps using more numerous, smaller grids, or limiting sampling to the immediate area where a known population has been found.

Species locations, abundance and site conditions, including substrate type, water depth and speed, etc., were recorded on survey field forms and sketched on aerial photographs. Site density was estimated to the nearest 10/ square meter and occupied extent was recorded in square meters. Where populations occurred as widely separated colonies or clumps, their precise locations were difficult to document in writing, except as GPS points, and many times an aerial photograph was difficult to correlate with the view from in the water. Even a 3 meter error in GPS coordinates

could result in a recorded point not actually reflecting the exact position of a colony. Reference points above water were needed in order to be able to precisely relocate a site. The use of an underwater camera allowed us to capture a visual record of the substrate and density of individuals at a given site quite well, and had the added advantage of recording shell condition and other details that were not recorded in writing. The inclusion of an above-water vicinity photo, which indicated the location of a site with reference to features such as predominant rocks and trees, proved to be a valuable aide for relocating sites and analyzing habitat selection by the species at a larger scale. For instance, one photo showed that a population was located where the upwelling cold water from a deep area upstream was being turned by an underwater cobble bar on one side of the river and driven up towards the opposite bank, picking up speed as it approached a narrow rapids. This cold, fast current kept the sand substrates clean and presumably provided better water quality at the site. Such insights proved very effective in forming a search image for potential suitable habitats elsewhere.

## Summary

Our survey of the Umpqua basin for aquatic mussels in 2006 was very informative. We not only documented the (quite different) use of the north and south Umpqua by *Margaritifera falcata*, we did succeed in finding several populations in the South Umpqua that will be suitable for more detailed monitoring, as part of the regional effort to document trends in demographics for the species. We have verified the effectiveness of the methodology in the federal presence/absence survey protocol and have developed several alternative methods and improvements for use in the future monitoring protocol.

Cooperation with private land owners was critical to the success of this survey. Special credit goes to the Cow Creek Band of Umpqua Tribe of Indians for granting access to several sections of river which had historic mussel harvest use, and which proved to still contain some of the largest populations in the South Umpqua basin. The Partners of the Umpqua Rivers also assisted this effort by providing an additional surveyor who was trained in water rescue who gave us an extra safety factor, especially important when working under hazardous conditions far from help in remote stretches of the river.

## References

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