

# SURVEYS TO DETERMINE THE STATUS OF THE OLYMPIA PEBBLESNAIL (*FLUMINICOLA VIRENS*) AND PACIFIC VERTIGO (*VERTIGO ANDRUSIANA*) ON THE OLYMPIC NATIONAL FOREST OF WASHINGTON

FINAL REPORT FROM THE XERCES SOCIETY TO THE INTERAGENCY SPECIAL STATUS  
SENSITIVE SPECIES PROGRAM (ISSSSP)

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Quinault River, Olympic National Forest. Photo by Candace Fallon/the Xerces Society.

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## ABSTRACT

The Olympia pebblesnail (*Fluminicola virens*) and Pacific vertigo (*Vertigo andrusiana*) are both rare endemic mollusks restricted to montane areas of the Pacific Northwest. In August 2015, Xerces Society biologists surveyed appropriate habitat for these species on the Olympic National Forest. Habitat identified and surveyed included: lakes, rivers, creeks, beaver ponds, and willow and alder riparian areas. *F. virens* specimens were collected from four sites in two different water bodies (Lake Quinault and the West Fork Humptulips River). No *V. andrusiana* specimens were collected during this survey effort; however, the more common *V. columbiana* was collected from three sites, and there is some evidence that *V. andrusiana* is merely an ecotype of *V. columbiana* (see Discussion).

We achieved all major goals of this project:

- Determine criteria for surveying areas for *F. virens* and *V. andrusiana* by mapping potential suitable habitat
- Consult with Olympic National Forest biologists to identify suitable USFS owned habitat near the known collection localities in Washington
- Survey suitable habitat on the Olympic National Forest
- Record all data including documenting where surveys were conducted
- Write a complete report that includes detailed maps of areas surveyed for these two species

We recommend increased survey efforts for *Fluminicola virens* in the Olympic National Forest, particularly within the Quinault River and Humptulips River watersheds. This species is not well known on the Olympic Peninsula, and further documentation of its range and habitats is especially critical for advancing understanding of its status and taking the appropriate conservation measures.

## INTRODUCTION

The purpose of this project was to identify and survey potential habitat and determine whether two species of rare or potentially rare mollusks (*Fluminicola virens* and *Vertigo andrusiana*) occur in suitable habitat within Olympic National Forest lands in Washington. Both of these species are suspected to occur on the Olympic National Forest based on historic records from Lake Quinault (Fig. 1).

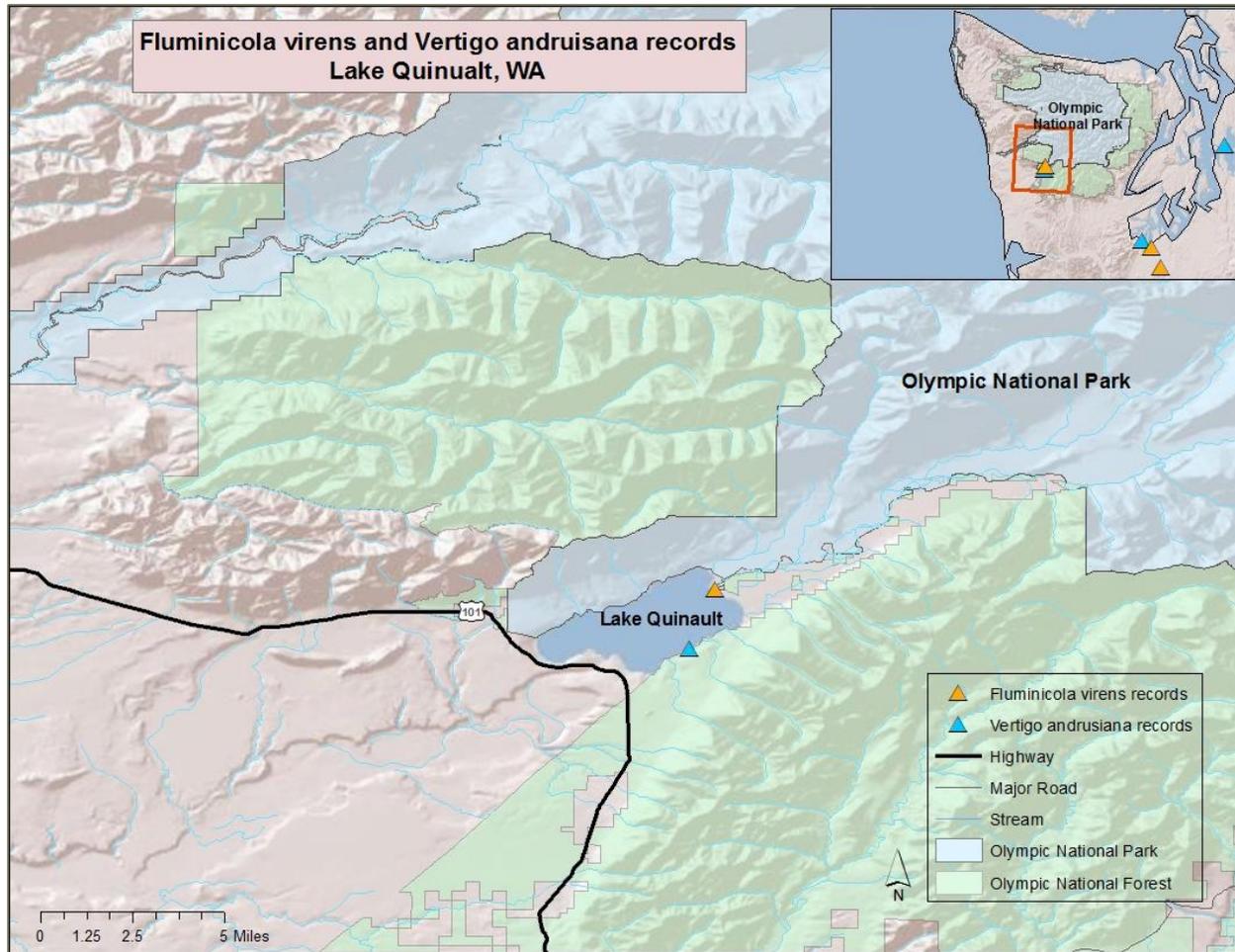


Figure 1: Historic *F. virens* and *V. andrusiana* records near the Olympic National Forest, WA

## FLUMINICOLA VIRENS

The Olympia pebblesnail, *Fluminicola virens*, is a Pacific Northwest endemic aquatic snail known from clear, cold streams with high dissolved oxygen content (Hershler & Frest 1996, Jordan 2013). *Fluminicola* species in general prefer little nutrient enhancement, continual current, and a coarse but stable substrate (NatureServe 2015). *F. virens* has been recorded from a number of freshwater habitat types throughout Oregon and Washington, including medium to large streams with substrates composed of firm mud, basalt cobbles, bedrock, gravel pools, sand, boulders, and/or silt (Deixis 2012). While Hershler & Frest (1996) describe this species' distribution as being restricted to "the Willamette River (and large tributary streams), from Corvallis to its mouth, and the lower Columbia River below Portland," a dozen *F. virens* records exist for southwest Washington as well as the Olympic Peninsula and San Juan Island (10 sites total, see Appendix I). This species is suspected on the Columbia River Gorge National Scenic Area and the Olympic National Forest, the latter based on a 1916 Lake Quinault record (Jordan 2013). *F. virens* has a global rank of G2 (imperiled) and an S2? rank in Washington due to limited distribution in a region that has undergone extensive habitat change due to the construction of dams and siltation from agriculture and logging practices (NatureServe 2015, WNHP 2014). This pebblesnail has an ovate to narrow-conic shell approximately 5.8-12.0 mm high, usually with an eroded spire and whorls 4.5-5.0 (Hershler & Frest 1996). This species is likely active year-round, with known records from January through October.

## VERTIGO ANDRUSIANA

The Pacific vertigo, *Vertigo andrusiana*, is currently known from about 14 occurrences throughout western Oregon and Washington (as well as some records on Vancouver Island, British Columbia). It occurs in forested sites at lower elevations and may be found on trunks and lower branches of trees and shrubs, as well as in the leaf litter below them (Burke 2013). Frest and Johannes (1999) state that this species is frequently found in duff and litter and “rarely found sparingly on deciduous shrubs.” It is suspected to occur on the Olympic National Forest, based on a pre-1948 record from Lake Quinault (Henderson 1929, Pilsbry 1948). *V. andrusiana* has a global rank of G2G3 (imperiled) and an S1? rank in Washington (WNHP 2014). The Pacific vertigo is a tiny terrestrial snail with a total length of less than 3 mm; the shell is cylindric-oblong with a convexly conic, obtuse summit and a cinnamon brown color, becoming paler upwards (Pilsbry 1948). New information acquired during preparation for these surveys indicated that *V. andrusiana* is not a valid species and instead an ecotype of the widespread and common *V. columbiana* (Nekola 2015, pers. comm.). Because of this, in consultation with ISSSSP, we decided to limit our survey effort for the species and focus the majority of our time on our other target species.

## METHODS

### SITE SELECTION

Potential habitat for these mollusks on US Forest Service lands was first determined by mapping known locations in ArcMap 10.3. Olympic National Forest land ownership boundaries were overlaid with a National Hydrography Dataset (NHD) layer for Washington state. We also searched the Xerces Western Freshwater Mussel Database (Xerces & CTUIR 2015) to determine if the freshwater mussels *Margaritifera falcata* (western pearlshell) and *Gonidea angulata* (western ridged mussel) had been recorded from any streams in or near the Olympic National Forest. *Fluminicola virens* is thought to be associated with these species, both of which require cold, clear streams that support trout and salmon populations (Duncan 2008, Frest & Johannes 1995).

All four layers (known locations, land ownership, hydrography dataset, and mussel locations) were converted to KML files and imported to Google Earth, which was used to select potential sites for surveys. We also corresponded with the following mollusk experts and Forest Service biologists to inquire about appropriate habitat and specific site information:

1. Tom Burke (regional mollusk expert)
2. Robert Hershler (Smithsonian National Museum of Natural History)
3. Jeff Nekola (University of New Mexico)
4. Tim Pearce (Carnegie Museum of Natural History)
5. Karen Holtrop (Olympic National Forest)
6. Betsy Howell (Olympic National Forest)

Sites were selected that would provide a good mix of habitat types and elevations to maximize our chances of finding both target species, although sites appropriate for *F. virens* were heavily favored. *Fluminicola virens* has been observed at sites ranging from 30 to 300 meters and appears to be associated with medium-sized rivers. Most records for *Vertigo andrusiana* are not geographically explicit enough to determine elevation, but it appears to be a low elevation species generally found under 100 m. Given the topography of National Forest lands on the Olympic Peninsula, as well as the patchy nature of Forest Service ownership, it was difficult to find many low elevation sites without covering a broad geographic area. Thus, we visited a rather wide range of areas from all

over the peninsula (see Fig. 2), with sites ranging from approximately 90 to 600 meters in elevation (all but two sites were below 400 meters). We also targeted medium-sized rivers (defined as 4<sup>th</sup> to 6<sup>th</sup> order streams), as many prior *F. virens* collections have come from water bodies of this size.

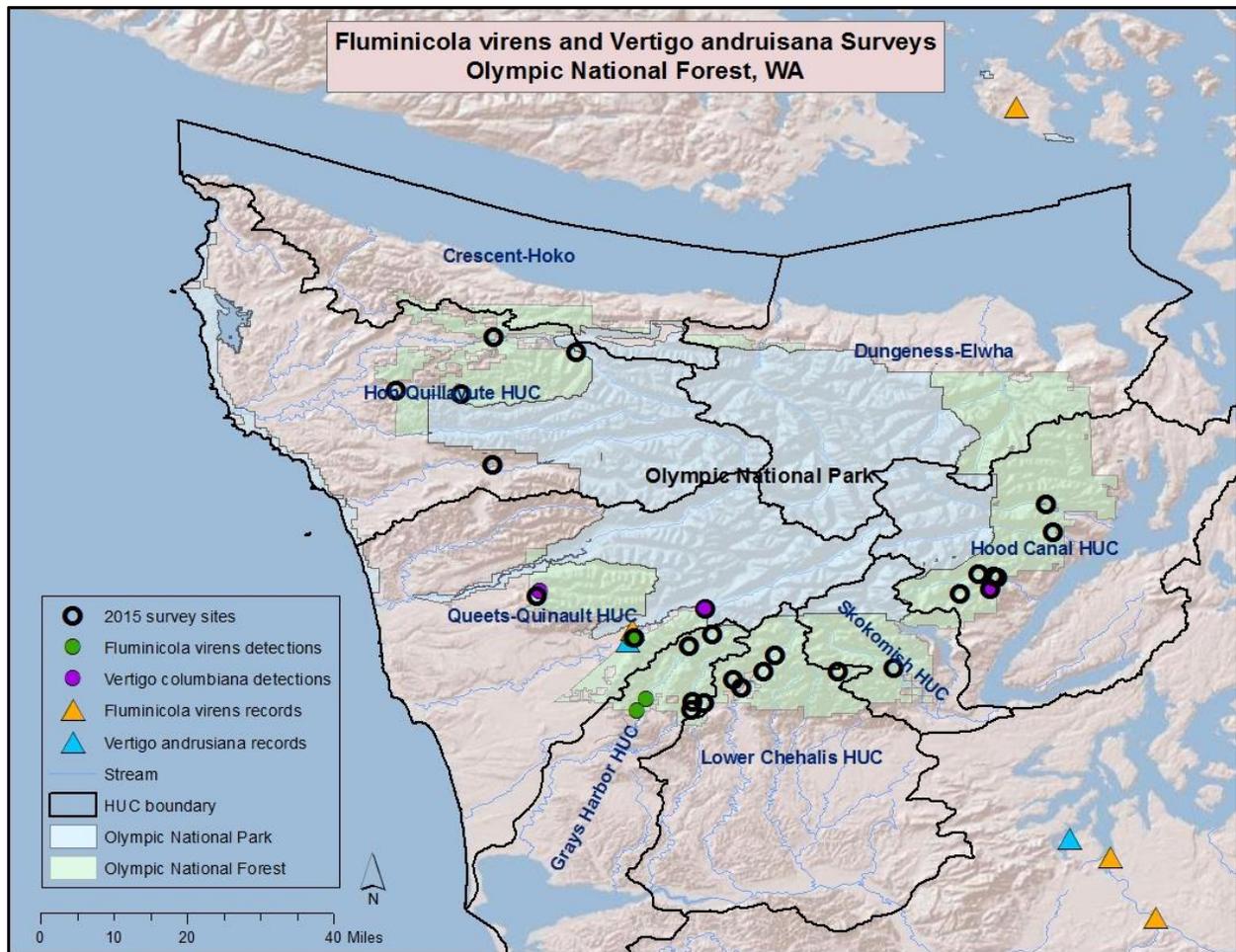


Figure 2: Map of historic sites and 2015 survey areas with target species detection points.

## SURVEY PERIOD

At the time of survey planning, *F. virens* records were from throughout the year and known *V. andrusiana* records were from March, June, and August. To increase our chances of finding both species at the same time, and to ensure that all stream and river habitats had low enough water flows to allow for safe surveying, we planned our surveys for mid-August.

## SAMPLING METHODOLOGY

All sites were surveyed by Xerces biologists using standard survey techniques for aquatic or terrestrial snails, outlined by Duncan (2008) and Duncan et al (2003), respectively. Given the recent finding that *V. andrusiana* is likely an ecotype of the common *V. columbiana*, we focused the majority of our sampling efforts on finding *F. virens*. Both species were collected by simple hand methods. Hershler (2015, pers. comm.) notes that *Fluminicola*

is usually found on rocks (not mud) in flowing waters such as streams and rivers, making hand collection easy. *Vertigo* searches in leaf litter were aided with the use of sieves (as suggested by Nekola 2015, pers. comm.).

Upon arrival at each potential survey area, we spent a few minutes doing an initial assessment to determine if the habitat appeared appropriate for our target species. If so, we continued with a thorough survey; if not, we noted the location and a few brief habitat characteristics and moved on to the next site (note that all sites visited are included in report maps and appendices, regardless of whether a full survey was conducted or not). At each aquatic survey site, we recorded water temperature, substrate type(s), water source, water depth, stream width, and streamside vegetation. At terrestrial sites, we collected similar data but with less focus on aquatic attributes. Site coordinates were recorded using a Garmin Rino 120 GPS unit (NAD83). Specimens were collected by hand or with forceps and placed in plastic screw-cap vials. We focused our collection efforts on the target species but also collected several other mollusk species if they occurred within the target habitat. At several sites we snorkeled to better survey the area. Aquatic specimens were stored in native water, while terrestrial specimens were placed in vials with native vegetation or moss. Surveys began around 8:30AM each day and continued until approximately 6:30PM. The weather during the survey period was primarily dry and sunny, with a few overcast, cooler days toward the end of the week. Daytime temperatures ranged from 60 to 89° F (16 to 32° C).

Back at camp each night we processed the snails by 1) adding crushed menthol crystals to the aquatic specimens or 2) drowning the terrestrial specimens. Snails were relaxed for 24 hours and then transferred to fresh vials containing 95% ethanol as a preservative. Empty shells were wrapped in paper and placed in dry vials.

## DATA ENTRY AND SPECIES IDENTIFICATION

All data for this project were entered into an Excel spreadsheet and copied onto the Forest Service’s Natural Resource Information System (NRIS) data sheets. Elevations were determined from site coordinates using Montana State University’s Graphical Locator (<http://www.esg.montana.edu/gl/index.html>). All material collected for this project was identified by mollusk expert Tom Burke, except for the *Juga* specimens, which were sent to Ellen Strong at the Smithsonian.

## RESULTS

A total of 47 aquatic mollusks and 16 terrestrial mollusks were collected from 33 sites within the Olympic National Forest (Appendix III). Thirty-three *Fluminicola virens* specimens were collected from four sites on two water bodies (Table 1). No *Vertigo andrusiana* snails were found; however three *V. columbiana* specimens were identified from three different sites. See Appendix II for a list of all sites surveyed in 2015. For photos and habitat descriptions, see Appendix IV. Individual site maps can be found in Appendix V.

Table 1: *Fluminicola virens* collection sites

Date	Species	Site Name	Locality	County	No. Collected
11 Aug 2015	<i>F. virens</i>	WF Humptulips River 1	West Fork Humptulips River	Grays Harbor	15 (juv to adult)
11 Aug 2015	<i>F. virens</i>	Lake Quinault 1	Lake Quinault	Grays Harbor	1 adult
11 Aug 2015	<i>F. virens</i>	Lake Quinault 2	Lake Quinault	Grays Harbor	1 adult
11 Aug 2015	<i>F. virens</i>	WF Humptulips River 3	West Fork Humptulips River	Grays Harbor	16 adults

## DISCUSSION

### SURVEYS

Increased survey efforts for *Fluminicola virens* should continue in the Olympic National Forest, particularly within the Quinault River and Humptulips River watersheds. This species is not well known on the Olympic Peninsula, and further documentation of its range and habitats is especially critical for advancing understanding of its status and taking the appropriate conservation measures. Basic research of the habitat, range, life history, and abundance of this species is needed. For example, the two water bodies from which *F. virens* was collected during our 2015 surveys represented surprisingly different habitats (a clear stream and a large, turbid lake). However, both water bodies were relatively warm (17-20° C at the two stream sites and 23° C at the two lake sites) and located at similar elevations (107-122 m.). It is thought that *Fluminicola* species are fairly intolerant of impounded waters and soft substrates as well as of nutrient-enhanced or lacustrine (lake) habitats (Hershler & Frest 1996); however, Xerces staff collected two specimens of *F. virens* from shoreline areas of Lake Quinault, which were characterized by soft substrates and turbid waters. These two specimens were found on submerged logs. At the Humptulips sites, *F. virens* were found along the streambed on bedrock and in looser gravel.

Only two specimens of *F. virens* were found during our surveys in Lake Quinault; however, it is certainly possible that others persist elsewhere in the lake. Given the sheer size of the lake and the mosaic of Forest Service land boundaries in this area, the lake was not comprehensively surveyed. In addition, snail abundance can vary considerably among sites and from year to year (Hershler 2016, pers. comm.), and the finding of only two specimens may not be that unusual.

Of the 28 sites surveyed for freshwater snails, only eight (29%) resulted in collections. Frest and Johannes (1993) note that due to historic and geologic factors in the region, “the freshwater mollusk faunas of larger systems are often not uniform, with particular species and even genera occurring either sporadically throughout or in only certain parts of the system, despite identical habitat being present elsewhere.” Washington’s glacial history has influenced freshwater molluscan fauna, sometimes resulting in lower species diversity and richness in areas affected by recent (geologically speaking) glacial advances (Frest & Johannes 1993). For example, Frest & Johannes (2001) report on an annual freshwater mollusk survey effort in Mt. Rainier National Park, in which 113 sites (out of 208) lacked freshwater mollusks.

Snorkeling may aid surveyors in finding *F. virens* in the future, particularly under more turbid or higher water flow conditions (although at Lake Quinault visibility was so poor that snorkeling was not helpful). While snails were visible from the water surface under the clear conditions we experienced during our surveys along the WF Humptulips River, they tended to be in water depths of 0.5 to one meter. Snorkeling is recommended in medium-sized rivers such as the WF Humptulips. However, larger rivers or medium-sized rivers at higher flow might be hazardous to snorkel. We recommend consulting local flow gages prior to any snorkeling attempts.

*Vertigo columbiana* was not our target species. However, we note that specimens were located in both duff and litter, and on small stems of shrubs or trees. Because of recent drought, most duff and litter at sites was dry and may not have provided typical habitat.

### TAXONOMY

A map of geographic distributions of *F. virens* and the recently described *F. gustafsoni* in Hershler and Liu’s (2012) phylogeny study does not show any records for *F. virens* in the Olympic Peninsula (or beyond the Columbia and

Willamette Rivers and their tributaries). Hershler (2015, pers. comm.) believes the Olympic Peninsula *Fluminicola* may be a separate (undescribed) species. While specimens collected from the Olympic NF during this survey effort fit the morphological descriptions for other *F. virens* throughout their range, revision of this genus is ongoing, and may ultimately change the taxonomy of this taxa in Washington.

During preparation for these surveys, Xerces biologists learned that recent DNA analyses on several specimens of *V. andrusiana* collected from the Olympic Peninsula (including specimens near the historic Lake Quinault locality) show that this species is merely an ecotype of the more common Columbia vertigo, *V. columbiana* (Nekola 2015, pers. comm.). Individuals from sites near Lake Quinault and in Skagit County had both nuclear and mitochondrial DNA that were identical to *V. columbiana* from across its range from Oregon to Alaska (Nekola 2015, pers. comm.).

## MANAGEMENT

Managers should strive to protect all new and known sites and their associated watersheds from practices that would adversely affect any aspect of these species' life cycles. Riparian and aquatic habitat protection, including maintenance of water quality, substrate conditions, and canopy cover (where applicable), would likely benefit and help maintain these species. The Lake Quinault *F. virens* sites are located within an active recreational area (swimming, boating, camping) that likely experiences high visitation pressures in the summer months. In addition, given the potentially patchy distribution of *F. virens* on the Olympic National Forest, we recommend surveying for this species whenever management actions have the potential to influence aquatic habitat on the Forest.

## ACKNOWLEDGEMENTS

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## APPENDIX I: PRIOR SPECIES RECORDS IN WASHINGTON

### FLUMINICOLA VIRENS

Location	County	State	UTM_N	UTM_E	L_Zone	Loc_Acc	Habitat	Elev (m)	Date
Willapa River at Town of Holcomb	Pacific	WA	5157660.9	453000.0	10	MAN4		Unknown	Unknown
San Juan Island	San Juan	WA	5374304.0	493658.7	10	VAGUE		Unknown	Unknown
11 mi. S.E. of Olympia, Deschutes River	Thurston	WA	5196352.5	514453.5	10	MAN6		Unknown	Unknown
Nr. Vancouver	Unknown	WA	5052918.4	523741.5	10	MAN6		Unknown	Unknown
Upper end of Lake Quinault, Grays Harbor	Grays Harbor	WA	5259836.8	436550.1	10	MAN6		Unknown	9-Sep-1916
Columbia River, Abernathy Point, Just W Of Mouth Of Abernathy Creek	Cowlitz	WA	5115224.2	487064.2	10	MAN6	Fresh water	Unknown	14-Nov-1987
Olympia	Thurston	WA	5209400.3	507572.2	10	MAN6		Unknown	pre-1989 date of publication
Greenleaf Creek at Moffett Springs Road bridge. Greenleaf Cr.-Columbia R.	Skamania	WA	5056029.0	581285.0	10	GPS3	Depth 2-12". Medium-sized creek; gravel, some cobble and fine substrate; no macrophytes, some bryophytes and epiphytic algae locally.	49	21-Jan-1990
Moffett Creek at Moffett Springs Road bridge. Moffett Cr.-Greenleaf Cr.-Columbia R.	Skamania	WA	5055743.0	581451.0	10	GPS3	Depth 2-12". Medium-sized creek; mostly mud, with some gravel and cobbles, particularly upstream; Myriophyllum, some Elodea; bryophytes common upstream; some bryophytes and epiphytic algae locally.	49	21-Jan-1990
Columbia River, Abernathy Point, E Mouth Of Abernathy Creek	Cowlitz	WA	5115270.4	487094.1	10	MAN6	Fresh water	Unknown	17-Sep-1993
Greenleaf Creek at Moffett Springs Road bridge. Greenleaf Cr.-Columbia R.	Skamania	WA	5056029.0	581285.0	10	GPS3	Depth 2-12". Medium-sized creek; gravel, some cobble and fine substrate; no macrophytes, some bryophytes and epiphytic algae locally.	49	23-Apr-1995
Moffett Creek at Moffett Springs Road bridge. Moffett Cr.-Greenleaf Cr.-Columbia R.	Skamania	WA	5055743.0	581451.0	10	GPS3	Depth 2-12". Medium-sized creek; mostly mud, with some gravel and cobbles, particularly upstream; Myriophyllum, some Elodea; bryophytes common upstream; some bryophytes and epiphytic algae locally.	49	23-Apr-1995

### VERTIGO ANDRUSIANA

Location	County	State	UTM_N	UTM_E	L_Zone	Loc_Acc	Habitat	Elev (m)	Date
Unknown	Unknown	WA	4774725.1	481821.5	10	VAGUE	Unknown	Unknown	Unknown
Lake Quinault	Grays Harbor	WA	5257244.3	435752.8	10	MAN6	Unknown	Unknown	no data, pre-1948 (Pilsbry's publication)
Seattle, U. of Wash.	King	WA	5278301.9	553050.8	10	MAN6	Unknown	Unknown	pre-Nov 7th 1949 donation date
Olympia, Evergreen State College	Thurston	WA	5213488.7	501608.5	10	MAN6	Maple, salal	Unknown	6 Aug 1979

**APPENDIX II: SITES SURVEYED IN 2015**

<b>Date</b>	<b>Site Name</b>	<b>County</b>	<b>Land Ownership</b>	<b>UTME (NAD83, Zone 10)</b>	<b>UTMN (NAD83, Zone 10)</b>	<b>Loc Acc (ft.)</b>
10-Aug-2015	Jefferson Lake	Mason	USFS	485211.2	5267504.5	30
10-Aug-2015	Elk Lake #1	Mason	USFS	489724.5	5268581.7	23
10-Aug-2015	Elk Lake #2	Mason	USFS	489800.4	5268540.2	50
10-Aug-2015	Hamma Hamma River #1	Mason	USFS	490871.3	5270891.5	24
10-Aug-2015	Hamma Hamma River #2	Mason	USFS	490305.5	5271262.8	30
10-Aug-2015	Lena Creek	Mason	USFS	487988.8	5271824.9	30
11-Aug-2015	Big Creek	Grays Harbor	USFS	451492.9	5248640.1	30
11-Aug-2015	Pothole Meadow	Grays Harbor	USFS	447030.1	5243645.9	30
11-Aug-2015	Go Forth Creek	Grays Harbor	USFS	445350.5	5243881.9	30
11-Aug-2015	WF Humptulips River #1	Grays Harbor	USFS	438343.0	5244586.0	22
11-Aug-2015	Lake Quinault #1	Grays Harbor	USFS	436274.5	5257755.6	7
11-Aug-2015	Lake Quinault #2	Grays Harbor	USFS	436767.2	5258160.4	27
11-Aug-2015	Gatton Creek	Grays Harbor	USFS	436879.4	5258062.8	30
11-Aug-2015	Quinault River #1	Jefferson	USFS	447407.6	5264272.6	19
12-Aug-2015	Quinault River #2	Jefferson	USFS	447224.5	5264249.8	39
12-Aug-2015	Matheny Beaver Pond	Jefferson	USFS	422786.0	5268415.2	30
12-Aug-2015	Bobcat Meadow	Jefferson	USFS	422361.2	5267428.2	300
12-Aug-2015	Hoh River	Jefferson	USFS	416290.1	5296459.6	300
12-Aug-2015	Calawah River	Clallam	USFS	402231.4	5312816.6	23
12-Aug-2015	Rainbow Creek	Clallam	USFS	411896.0	5312023.9	30
12-Aug-2015	Sol Duc River	Clallam	USFS	416810.2	5324350.5	300
13-Aug-2015	SF Sol Duc River	Clallam	USFS	428853.8	5320986.7	23
13-Aug-2015	Dosewallips River	Jefferson	USFS	498089.3	5286956.9	58
13-Aug-2015	Duckabush River	Jefferson	USFS	499172.2	5281074.7	21
13-Aug-2015	Skokomish River	Mason	USFS	475424.3	5251213.5	35
13-Aug-2015	Spider Lake	Mason	USFS	467014.8	5250469.0	20
14-Aug-2015	Wynoochee Lake	Grays Harbor	USFS	456030.1	5250382.1	32
14-Aug-2015	Wynoochee River #1	Grays Harbor	USFS	457721.3	5254081.7	22
14-Aug-2015	Wynoochee River #2	Grays Harbor	USFS	452591.7	5247013.5	16
14-Aug-2015	EF Humptulips River	Grays Harbor	USFS	445121.1	5242141.4	300
14-Aug-2015	Petes Creek	Grays Harbor	USFS	444922.7	5256270.1	30
14-Aug-2015	WF Humptulips River #2	Grays Harbor	USFS	448326.2	5258641.7	300
14-Aug-2015	WF Humptulips River #3	Grays Harbor	USFS	437040.6	5242095.7	16

### APPENDIX III: LIST OF ALL SPECIES COLLECTED BY SITE

Target species and other species of interest are highlighted in green. Note that *Juga* specimens were sent to Ellen Strong at the Smithsonian and were not identified to species for this project.

Date	Site	Species	Quantity	Life Stage
10-Aug-15	Elk Lake 1	<i>Pisidium</i> sp.	5	Adult, juv
		<i>Paralaoma servilis</i>	6	Adult
		<i>Vertigo columbiana</i>	1	Adult
11-Aug-15	WF Humptulips 1	<i>Fluminicola virens</i>	15	Adult, juv
	Lake Quinault 1	<i>Fluminicola virens</i>	1	Adult
		<i>Juga</i> sp.	Unk	Unknown
		<i>Physa skinneri</i>	5	Adult, juv
	Lake Quinault 2	<i>Juga</i> sp.	Unk	Unknown
		<i>Physa skinneri</i>	2	Adult, juv
		<i>Fluminicola virens</i>	1	Adult
	Quinault River 1	<i>Juga</i> sp.	Unk	Unknown
<i>Physa skinneri</i>		2	Subadult	
12-Aug-15	Quinault River 2	<i>Ancotrema sportella</i>	1	Immature
		<i>Nearctula</i> sp.	2	Adult
		<i>Vertigo columbiana</i>	1	Adult
	Matheny Beaver Pond	Family: Polygyridae	1	Hatchling
		<i>Striatura pugetensis</i>	1	Adult
		<i>Vertigo columbiana</i>	1	Adult
	Bobcat Meadow	Family: Polygyridae	1	Juvenile
13-Aug-15	Spider Lake	<i>Juga</i> sp.	Unk	Unknown
14-Aug-15	Wynoochee River 1	Family: Polygyridae	1	Juvenile
	WF Humptulips 3	<i>Fluminicola virens</i>	16	Adult

## APPENDIX IV: HABITAT DESCRIPTIONS

AUGUST 10, 2015

### JEFFERSON LAKE



Target species: *Fluminicola virens* and *Vertigo andrusiana*

Habitat description: This recreational lake was created when a rock dam formed at the Jefferson Creek outlet during an ancient earthquake (USFS 2015). Water levels were quite low during our visit, and tree stumps could be seen jutting out of the lake bottom. Sparse willow and alders were found along the Jefferson Creek inlet (a 4<sup>th</sup> order creek) but no *Vertigo* observed. Rocks in the creek are covered with thick scum – very slick. Elevation and gradient are probably too high for our target species. Elevation: 610 m.

Collections: None. No mollusks observed.



Target species: *Vertigo andrusiana*

Habitat description: Marshy wetland with sedges and abundant reed canary grass and horsetail ferns. Small channels (Jefferson Creek) running throughout the site. Dense willow copses in more upland areas with leaf litter of canary grass and willow. This is a relatively large, flat, open site surrounded on all sides by higher elevation forested hills. A small beaver dam is located near the sample sites; however, it looks unused and is overgrown with plants. Microsites (bases of willows) are full shade, however the leaf litter was quite dry and the greater site area is completely open to the sun. *Vertigo* was found in the leaf litter at the base of one of these willow microsites. We walked upstream of this marshy area along Jefferson Creek for another 20 minutes searching through alder and willow leaf litter but did not observe any other mollusks. Elevation: 380-393 m.

Collections: *Pisidium* sp., *Paralaoma servilis*, and *Vertigo columbiana*.

HAMMA HAMMA RIVER 1



Target species: *Fluminicola virens*

Habitat description: 6<sup>th</sup> order perennial stream. Surveyed two fast flowing riffles along this flat wide river section with an overstory of alder, hemlock, and cedar. Water temperature 12° C. Elevation: 183 m.

Collections: None. No mollusks observed.

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HAMMA HAMMA RIVER 2



Target species: *Fluminicola virens*

Habitat description: 5<sup>th</sup> order perennial stream. This section of river presents a very different habitat than the Hamma Hamma 1 site further upstream. Lots of bedrock and huge boulders - very smooth and worn away. Located just upstream of Rd #2480 bridge (by campground). Overstory of cedar, alder, and bigleaf maple. Multiple riffles and cascades, good oxygenation. Western toad (*Anaxyrus boreas*) observed on river margin. Water temperature 12° C. Elevation: 183 m.

Collections: None. No mollusks observed.

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LENA CREEK



Target species: *Fluminicola virens*

Habitat description: 4<sup>th</sup> order perennial stream. Located at first bridge crossing on Rd 25 past Lena Campground. Surveyed area with riffles, cascades, large boulders and rocks and huge downed trees. This is a large creek with good flow; oligotrophic. Overstory composed of alder, hemlock, and fir. Heavy erosion on banks at bend in creek with large amounts of blowdown. Man-made pool (small rock dam – see photo) located just downstream of main survey area, before bridge. Water temperature 12.5° C. Elevation: 244 m.

Collections: None. No mollusks observed.

AUGUST 11, 2015

BIG CREEK



Target species: *Fluminicola virens*

Habitat description: 5<sup>th</sup> order perennial stream. Surveyed creek at FR 2294 bridge crossing. Overstory of alder (dominant) and cedar. Very little pore space in creek - looks unlikely for mussels, which are thought to co-occur with *Fluminicola*. Caddisflies are abundant in the stream. Low gradient, partially eroded rocks, mostly cobble/gravel/cobble bars. A few small riffles. Little evidence of scouring/flooding. Water temperature 12° C. Elevation: 244 m.

Collections: None. No mollusks observed.

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## POTHOLE MEADOW



Target species: *Vertigo andrusiana*

Habitat description: Very shrubby, overgrown site with few open areas for surveying. Observed two tail droppers (*Prophysaon* spp.) at this site, one of which was on skunk cabbage. Site is densely vegetated with spirea and hawthorn, most of which is shoulder height and taller. Abundant moss carpets the ground and downed logs, although at this time of year it is predominantly dry. Sedges are scattered throughout the understory with some skunk cabbage. Huge downed logs located all along the forest margin. Surveyed some sedge and cascara duff but found only empty pea clam shells. Elevation: 253 m.

Collections: None. No snails observed.

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## GO FORTH CREEK

Target species: *Fluminicola virens*

Habitat description: 4<sup>th</sup> order perennial stream. Briefly stopped to sample this creek at the point just before it enters the Humptulips River (FR 2206 road crossing). It does not look appropriate for our target species. Upstream segment had very cemented sediment and downstream section was routed through a huge culvert (approximately 6 feet in diameter) into a scummy pool with a small side channel. Elevation: 244 m.

Collections: None. No mollusks observed on either side of road crossing.

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WEST FORK HUMPTULIPS RIVER 1



Target species: *Fluminicola virens*

Habitat description: 6<sup>th</sup> order perennial stream. Wide mellow stretch of river with abundant and diverse macrofauna - dragonfly and mayfly nymphs, caddis, stoneflies, sculpins (host fish for mussels), crayfish, and other small fish. Primarily composed of cobble, gravel, and sand with some very loose and unstable cobble on the stream floor. Bedrock is also present in patches. Very low gradient. Many salmonids and sculpins (of varying sizes) observed in survey stretch. River is 20-25' wide and up to 4.5' deep at this site. Riparian trees are composed of alder, bigleaf maple, hemlock, cedar, and fir. This site is full sun to partial sun at river margins. Popular with river rafters (class 2 rapids) - survey site is located at a put-in point with vehicle access. Broad valley with low flashiness and embedding. *Fluminicola* are abundant on bedrock and smaller rocks, particularly in deeper areas. Hundreds of snails present. Three dead sculpin observed, including a large one the size of a fist. Surveyors snorkeled this site to survey deeper waters. Water temperature 20° C. Elevation: 122 m.

Collections: *Fluminicola virens* (15 total, immature to adult).

## LAKE QUINAULT 1



Target species: *Fluminicola virens*

Habitat description: Very large recreational lake with swimming and boating access. Large areas of the lakeshore are rimmed with campgrounds, cabins, and boat docks. Accessed survey area from Falls Creek Campground and surveyed shoreline from boat launch east to private docks along South Shore Road. Lake bottom is thick with sediment. Site is in full sun with some cedar and alder along the shore. Mixed coniferous/deciduous forest, probably logged in past 100 years. Low oxygen saturation with high turbidity. Surveyor snorkeled this site but the amount of sediment in the water made visibility poor. Several specimens were collected from a submerged log, including *Fluminicola virens* and *Juga* sp. Many empty shells and live *Anodonta* were observed tucked down into the sediment. The invasive Asiatic clam, *Corbicula fluminea*, was also observed. Water temperature 23° C. Elevation: 109 m.

Collections: *Fluminicola virens* (1 adult), *Juga* sp., and *Physa skinneri*.

---

## LAKE QUINAULT 2



Target species: *Fluminicola virens*

Habitat description: Sampled another area along Lake Quinault, accessed via Gatton Creek Campground. Habitat here is very similar to Lake Quinault 1 site. Same species encountered, including *Anodonta* and *Corbicula*. Snorkeling was not helpful at this site due to increased wave action and turbidity. Alders and conifers along shoreline. Full sun, low gradient. Water temperature 23° C. Elevation: 107 m.

Collections: *Fluminicola virens* (1 adult), *Juga* sp., and *Physa skinneri*.

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## GATTON CREEK

NO PHOTO

Target species: *Fluminicola virens*

Habitat description: 3<sup>rd</sup> order perennial stream. Very brief stop to check Gatton Creek at S. Shore Rd. crossing. Habitat does not look appropriate for our target species. Elevation: 109 m.

Collections: None. No mollusks observed.

## QUINAULT RIVER 1



Target species: *Fluminicola virens*

Habitat description: 6<sup>th</sup> order perennial stream. Very wide open stream channel with cobble bars and eroded banks. Looks like a very dynamic area that is probably prone to flooding and altering hydro patterns. Rocks are covered with thin film of scum. Rocks in small whitewater/riffle area upstream are covered in blackfly larvae. Deeper reaches of the river were snorkeled, but only one sculpin was observed and no target species. Water temperature 20° C. Elevation: 122 m.

Collections: *Physa skinneri* and *Juga* sp.

AUGUST 12, 2015

QUINUALT RIVER 2



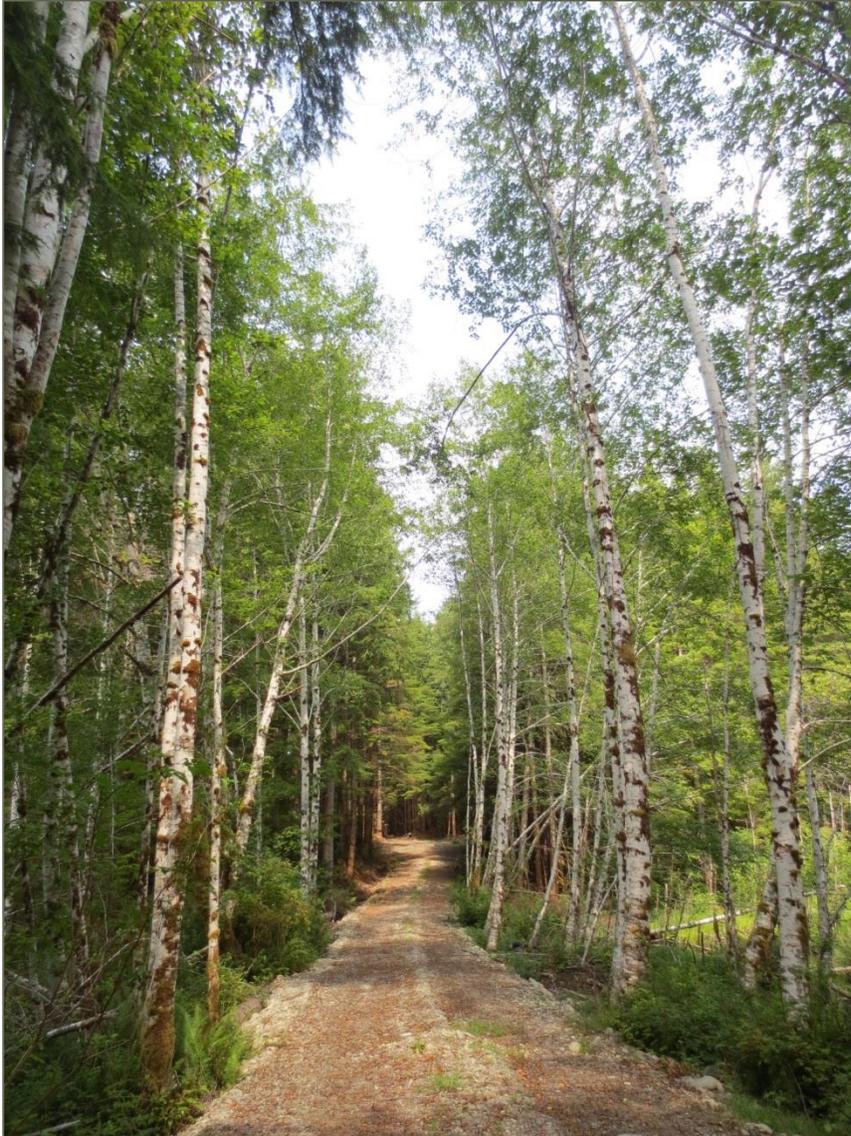
Target species: *Vertigo andrusiana*

Habitat description: Surveyed alder thickets by the river. Three *Vertigo* were found on the underside of dead or dying alder limbs approximately 6-12" from ground with leaf and grass litter below. One of these was found in the forest with a dense overstory; the other two were found along the more open tree line closer to the river. None observed in leaf litter. Elevation: 122 m.

Collections: *Ancotrema sportella*, *Nearctula*, and *Vertigo columbiana*.

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MATHENY BEAVER POND



Target species: *Vertigo andrusiana*

Habitat description: Swampy wetland with alder, hemlock, cedar. Dominant mollusks observed throughout the site were pea clams. Skunk cabbage is scattered throughout. Site is split by a decommissioned FS Rd (#2140-211). Abundant aquatic reeds, sedges, salmonberry. Dragonflies (blue with green racing stripes) also abundant and observed chasing and mating. Elk activity is very apparent and many skunk cabbage leaves have been eaten away. This site is very different from Quinault River alder forest where we found *Vertigo* this morning. Examined tree trunks, branches, cabbage, downed wood, etc. Site is quite deep and swampy in areas so we did not venture into the heart of the swamp. A single *Vertigo* was found on a very small bare alder twig in the leaf litter at base of alder tree directly adjacent to gravel road (upslope of pond). Juvenile rough skinned newt found in same location. Litter slightly moist. Elevation: 293 m.

Collections: *Striatura pugetensis*, *Vertigo columbiana*, and one hatchling from the family Polygyridae.

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## BOBCAT MEADOW

Target species: *Vertigo andrusiana*

Habitat description: Briefly stopped at another meadow with lots of sedges and salmonberry and some young alders. Red legged frogs (*Rana aurora*) present. Does not look appropriate for our target species.

Collections: One juvenile from the family Polygyridae.

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## HOH RIVER

Target species: *Fluminicola virens* and *Vertigo andrusiana*

Habitat description: 6<sup>th</sup> order perennial stream. Stopped at this stretch of the Hoh River very briefly at a boat launch but no mollusks observed in stream or in willows along bank. This site is potentially too large and silty for *Fluminicola*. Very little leaf litter under willows - looks scoured, probably not ideal for *Vertigo*.

Collections: None.

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## CALAWAH RIVER



Target species: *Fluminicola virens*

Habitat description: 6<sup>th</sup> order perennial stream. Cobble and boulder substrate with outcroppings of bedrock. Riffles. Low gradient. Abundant large scraper caddisflies located throughout stream. Small fish and many salmonids present. Water is very warm (22° C) and shallow. Elevation: 127 m.

Collections: None. No mollusks observed.

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#### RAINBOW CREEK

Target species: *Fluminicola virens*

Habitat description: 5<sup>th</sup> order perennial stream. Very brief stop at this tributary to the Calawah River. Jumped out at bridge crossing with FR 29. Does not appear appropriate for our target species. Elevation: 246 m.

Collections: None. No mollusks observed after ~15 minute search.

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#### SOL DUC RIVER

Target species: *Fluminicola virens*

Habitat description: 6<sup>th</sup> order perennial stream. Surveyed a stretch of river that runs along the Klahowya Campground. Large flat river with abundant boulders, bedrock, and cobble. This site has a *Margaritifera falcata* record from 2008; however, no fish or mussels observed. Elevation: 313 m.

Collections: None. No mollusks observed.

AUGUST 13, 2015

SOUTH FORK SOL DUC RIVER



Target species: *Fluminicola virens* and *Vertigo andrusiana*

Habitat description: 4<sup>th</sup> order perennial stream. Surveyed river stretch just upstream of mouth to Sol Duc River. Very large rocks and cobble. High eroded banks. It's likely this river flows very high in storm events. Width 15'. Riffles, pools. Riparian overstory is composed of bigleaf maple, willow, alder, hemlock, and spruce. Water temperature 14° C. Elevation: 365 m.

Collections: None. No mollusks observed.

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## DOSEWALLIPS RIVER



Target species: *Fluminicola virens*

Habitat description: 5<sup>th</sup> order perennial stream. Surveyed stretch of river adjacent to a Forest Service restoration site (see log jam on right side of stream in photo). Substrate is composed of cobble and some boulders and bedrock. This site is very similar to the Humptulips River site. Deep pools are scattered along the more shaded margin with shallow rocky beaches opposite. Wide riffles near log jam. Several sculpin observed and many caddisflies but no mollusks. Bigleaf maple overstory. Water temperature 15° C. Elevation: 122 m.

Collections: None. No mollusks observed.

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DUCKABUSH RIVER



Target species: *Fluminicola virens*

Habitat description: 5<sup>th</sup> order perennial stream. Large rocks, cobble, some sand. River is approximately 30 feet wide and up to one foot deep, deeper in pools. Overstory of cedar, oceanspray, vine maple, alder, and hemlock. Partly shaded. Water temperature 15.5° C. Elevation: 117 m.

Collections: None. No mollusks observed.

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SKOKOMISH RIVER



Target species: *Fluminicola virens*

Habitat description: 6<sup>th</sup> order perennial stream. Surveyed river stretch at Browns Campground. This is a wide, flat stretch of water with abundant cobble bars. Very shallow with some riffles. This site does not look appropriate for mussels (too little sediment) and may be too rocky for our target species. Overstory composed of alder, cottonwood, and fir. Elevation: 183 m.

Collections: None.

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## SPIDER LAKE



Target species: *Fluminicola virens*

Habitat description: Lake characterized by heavy sediment on shore and lake bottom. Surveyed shoreline. Numerous *Juga* shells found on shore and several live individuals were collected from submerged branches. Dozens of old tree stumps jut out from the lake surface. Dragonflies and rough-skinned newts are common. This looks like prime *Anodonta* habitat if there is fish access. Lake is in full sun surrounded by an old growth hemlock and spruce forest. This lake may get a lot of recreational use on weekends. We observed a few campers during our surveys and abundant trash and toilet paper along the upper trails. Water temperature 24° C. Elevation: 427 m.

Collections: *Juga* sp.

AUGUST 14, 2015

WYNOOCHEE LAKE



Target species: *Fluminicola virens*

Habitat description: Surveyed the crumbly edge of this man-made reservoir by the boat access point and farther along to an area with submerged stumps and logs with deep sediment. Lake is very drawn down and this does not look like appropriate snail habitat. Mixed coniferous/deciduous forest located higher up the banks. Water temperature 22° C. Elevation: 243 m.

Collections: None. No mollusks observed.

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WYNOOCHEE RIVER 1



Target species: *Fluminicola virens* and *Vertigo andrusiana*

Habitat description: 5<sup>th</sup> order perennial stream. Flat river segment with expansive cobble bars and riffles. Upslope banks are heavily vegetated with willows. River probably runs high in winter – this site has highly scoured banks and eroded margins. Observed one large western toad (*Anaxyrus boreas*). Four to five large brown slugs were also observed on rocks along river; appear to be non-native. Water temperature 13.5° C. Elevation: 284 m.

Collections: One terrestrial snail collected from willow margin on underside of rotting wood. No mollusks observed in river or tiny seep area flowing into river.

## WYNOOCHEE RIVER 2



Target species: *Fluminicola virens*

Habitat description: 5<sup>th</sup> order perennial stream. Located at bridge crossing for FR22 and the Fish Collection Center, just downstream of the dam. Highly oxygenated, fast flowing water directly below weir with calmer waters downstream. Rocks are covered in thick brown algae/muck. Substrate is composed of boulders, cobble, gravel, and sand. Alders populate the river margins. River is approximately two feet deep in the center. There is a pool located beneath the weir, potentially to slow the flow of water coming through the weir. There is almost no sediment at this site except on river margins. It does not appear to be appropriate for our target species. Water temperature 13.5° C. Elevation: 241 m.

Collections: None. No mollusks observed.

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## EAST FORK HUMPTULIPS RIVER



Target species: *Fluminicola virens*

Habitat description: 5<sup>th</sup> order perennial stream. Surveyed river stretch just downstream of the FR22 bridge crossing. River is up to 5-6 feet deep in pools and approximately 10-15 feet wide. Partial shade from hemlock, alder, and cedar. Low to medium gradient with riffles, glides, cascades, and pools. A social trail runs down to the water from the bridge. Relatively low slope steepness with low embedding. Bedrock and cobble are partially eroded. This section is a river-carved channel of bedrock with some boulders and smaller cobbles in pools. Salmonids were observed in pools, as well as caddisflies. Some downed wood in the river and abundant lush moss on rocks all along the banks. Good grass and forb cover as well. Water temperature 16° C. Elevation: 183 m.

Collections: None. No mollusks observed.

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## PETES CREEK

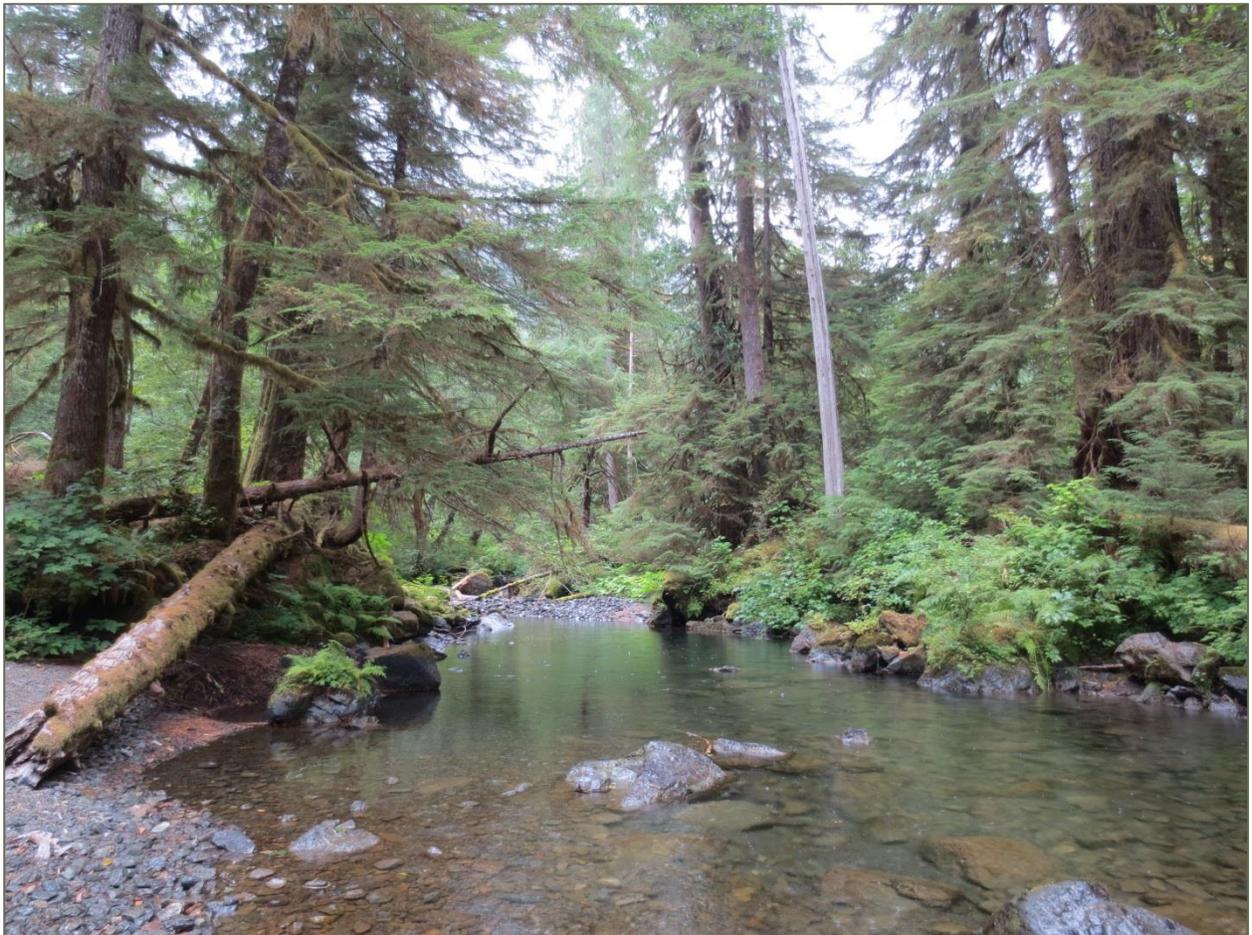
Target species: *Fluminicola virens*

Habitat description: 4<sup>th</sup> order perennial stream. Water in this small creek is very cold. Steep gradient with multiple habitat types and abundant vegetation. Partially to fully shaded with boulders and cobbles. Does not look appropriate for our target species.

Collections: None. No mollusks observed.

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#### WEST FORK HUMPTULIPS RIVER 2



Target species: *Fluminicola virens*

Habitat description: 5<sup>th</sup> order perennial stream. Second stretch of the WF Humptulips River, but very different habitat than our downstream sample site where *Fluminicola* was collected. Water here is a lot colder, and old growth cedar and hemlock overstory is denser. Substrate composed of boulders, cobble, gravel, and sand. Riffles and pockets throughout. Flow is stronger here than Humptulips River 1 site. Elevation: 347 m.

Collections: None. No mollusks observed.

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WEST FORK HUMPTULIPS RIVER 3



Target species: *Fluminicola virens*

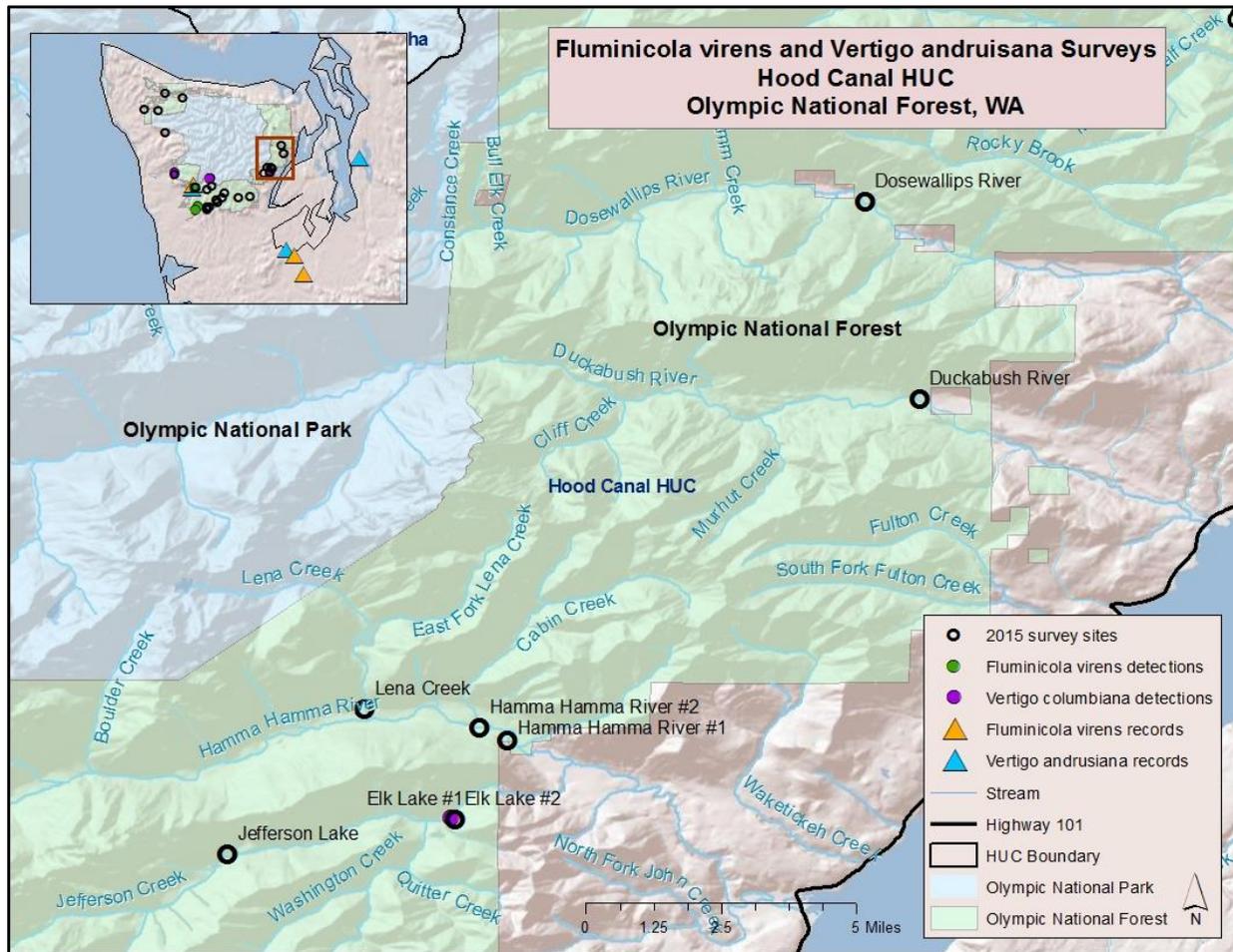
Habitat description: 6<sup>th</sup> order perennial stream. Approximately 2 river miles downstream of first WF Humptulips *Fluminicola* site. Wide gravel and pebble bank at bend in river. Silty bottom below cut bank. Some bedrock. Flat, wide valley. River runs over multiple gravel bars along the bend. *Fluminicola* collected adjacent to two deep pools on opposite bank of river from access point. There is some sediment buildup in the pools and along the shallow rocky lips. Water temperature 17° C. Elevation: 122 m.

Collections: *Fluminicola virens* (16 adults).

## APPENDIX V: SITE MAPS

Below are site maps for each Hydrologic Unit Code (HUC) surveyed, arranged clockwise from the northwest (see map insets for general location on the Olympic Peninsula):

1. Hood Canal HUC (8 sites total)
2. Skokomish HUC (1 site total)
3. Lower Chehalis HUC (5 sites total)
4. Grays Harbor HUC (7 sites total)
5. Queets-Quinault HUC (7 sites total)
6. Hoh-Quillayute HUC (5 sites total)



**Fluminicola virens and Vertigo andrusiana Surveys  
Skokomish HUC  
Olympic National Forest, WA**

