SPECIES FACT SHEET

Scientific Name: *Fluminicola turbiniformis* (Tryon, 1865)
Common Name(s): Turban pebblesnail
Phylum: Mollusca
Class: Gastropoda
Order: Neotaenioglossa
Family: Hydrobiidae

Synonyms: *Amnicola turbiniformis*; *Amnicola turtoniformis*; *Lithoglyphus turbiniformis* (details in Hershler and Frest 1996)

Conservation Status:
Global Status: G3 (last reviewed 08 May 2009)
National Status (United States): N3 (22 October 2003)
State Statuses: S1 (OR)
(NatureServe 2018)

Federal Status (United States): Not listed (USFWS 2019)
IUCN Red List: Not reviewed (IUCN 2019)

Taxonomic Note:

1. *Fluminicola turbiniformis* has been confused with related but separate species *F. modoci* and *F. dalli* (Taylor 1981; Hershler 1999; Hershler *et al.* 2007; see review of other accounts in Hershler and Frest 1996).

2. Phylogenetic analysis has confirmed previous speculations that *Fluminicola* is not a monophyletic genus, meaning that several members are more closely related to other Lithoglyphid genera than to *Fluminicola* members (Hershler and Liu 2012). *Fluminicola* is a polyphyletic assemblage classified as a single genus, pending resolution of the phylogenetic relationships of the poorly known type species (Hershler and Liu 2017). Recent genetic work found that there are 24 *Fluminicola* spp. in the western United States (Hershler and Liu 2017).

Technical Description:

Adult: Freshwater mollusks can be difficult to identify due to their small size, the presence of undescribed species at collection sites, and the variability between live and dead preserved specimens. It is strongly recommended that species identification be based on fresh shell and body features, ideally with the advice of a Hydrobiidae expert.

Members of the genus *Fluminicola*, commonly known as pebblesnails, are part of a diverse group of northwestern North American freshwater snails in the Lithoglyphidae family (Cordeiro 2012; STE 2013). This genus is composed of snails with solid shells characterized by thin periostracums (outer shell layers) and horny operculums (plates that close over the shell opening). In the U.S., most species are small (less than 1 cm in height) and have a conical spire (Hershler and Frest 1996). This genus can be further distinguished by the following characteristics: low conical shells evenly colored in yellow or green, dark pigmented cephalic tentacles (elongate flexible organs on top of head), and distal snouts (Hershler and Frest 1996).

A microscope is required to identify *F. turbiniformis*, as identifications are based on shell and internal soft body anatomy. *Fluminicola turbiniformis* is a small species, usually between 3.1-4.3 mm in height, with derived anatomical conditions that separate it from outgroups and other *Fluminicola* (Hershler and Frest 1996). Sexual dimorphism is pronounced in hydrobiids and females are typically larger than males (Pyron and Brown 2015). *Fluminicola turbiniformis* has an ovate to narrow-conic shell (Hershler 1999). Tryon (1865) originally described *Fluminicola turbiniformis* (under the synonym *Amnicola turbiniformis*) as follows:

> Ovate shell, turbinated, whorls very convex; suture impressed, spire obtuse at apex; nearly four whorls; body large, well rounded a little angulated on the periphery; aperture wide ovate; umbilical opening narrow. Color dark green, light blue within aperture.

Fluminicola turbiniformis has a light gray snout, pale-to-lightly pigmented head, distal lips, and tentacles, and has a medium-brown to black pallial roof and visceral coil; for a full detailed description of *F. turbiniformis* see Hershler and Frest (1996). Specific shell parameters for this species are available in Hershler *et al.* (2007).

Immature: Egg capsules are large and hemispherical in shape (Hershler and Frest 1996).

Life History:

Adults: Members of the genus *Fluminicola* are gill-breathing freshwater snails that have an entirely benthic life cycle (Liu *et al.* 2013). This group inhabits clear, cold, and well-oxygenated flowing waters and prefers hard rocky substrates (Frest and Johannes 1995; Hershler and Frest 1996; Hershler *et al.*

2007). This species has a low tolerance for hypoxia and anoxia. *Fluminicola turbiniformis* prefers springs and spring influenced habitats (i.e., crenophile), adheres to hard surfaces (i.e., lithophile), and grazes on perilithon and periphyton (Frest and Johannes 1995). *Fluminicola* species are often dominant in their community and serve as primary grazers; they can make up more than half of the invertebrate biomass at a site, which is important for food web dynamics (e.g., food source) and nutrient cycling (e.g., grazing) (Johnson *et al.* 2013). *Fluminicola* feed by scraping bacteria, diatoms and other perilithic organisms from rock surfaces, and may occasionally feed on aquatic plant surfaces (Duncan 2008).

Fluminicola spp. reproduce sexually and are typically semelparous (i.e., reproduce once in a lifetime). Adults copulate between February and May; eggs are laid roughly one month after mating, usually between March and July (Frest and Johannes 1995). The individual life span of this species is likely short, lasting approximately 1-2 years, with 90% population turn over per year (Frest and Johannes 1995; Furnish and Monthey 1998). This species has been collected from April through November (GBIF 2019).

The capacity for this species to disperse is low. *Fluminicola* species do not disperse widely and therefore have an extremely localized distribution (Furnish and Monthey 1998). The majority of cold-water snails, and in particular perilithon feeders such as *Fluminicola*, can be considered sessile (Frest and Johannes 1995).

Immature: Eggs are laid from spring to autumn in gelatinous capsules attached to plants, stones, or other objects (Duncan 2008).

Range, Distribution, and Abundance:

Type Locality: West side of Steens Mountain, Harney County, Oregon (Tryon 1865; Hershler and Liu 2017).

Range: *Fluminicola turbiniformis* is found in the Northern Great Basin and the East Cascade Range in Oregon, California, and Nevada (ORBIC 2016; Hershler and Liu 2017). *Fluminicola turbiniformis* ranges widely in the northwest Great Basin, from the Lake Abert basin east to the Quinn River basin and south to the Walker River basin (Hershler 1999). It was once probably very common in Oregon, Nevada (Frest and Johannes 1995), and northeastern California (Tryon 1865). Records of *F. turbinformis* have been reported from Lake Abert, Warner Lakes, and Guano watersheds in Oregon, from Pyramid-Winnemucca Lake

watershed in Nevada, and from Honey-Eagle Lakes watershed in California (NatureServe 2018).

Distribution: The species has been documented in Harney, Jefferson, and Lake Counties in Oregon and in Humboldt, Lyon, and Washoe Counties in Nevada (ORBIC 2016; GBIF 2019). In California, *F. turbiniformis* has been recorded in Alpine, Butte, Lassen, Modoc, Mono, Nevada, Placer, Plumas, Shasta, Sierra, Siskiyou, and Tehama Counties (Tryon 1865; Hershler 1999; GBIF 2019).

BLM/Forest Service Land:

Documented: *Fluminicola turbiniformis* has been documented on the Fremont-Winema National Forest (in Lake County), the Deschutes National Forest (in Jefferson County), and Lakeview BLM District (in Lake County) land. The Deschutes National Forest sites were discovered in the mid-1960s (1964, 1967), and were revisited in 2019 to determine if this species is present at these locations. Collections made at these locations in 2019 were determined to be *F. multifarius*. At this time, the Forest does not consider *F. turbiniformis* to be currently documented.

Suspected: This species is likely to occur at additional sites within the Fremont-Winema National Forest and Lakeview BLM Districts. Although there are sites in Roaring Springs in the Catlow Valley, Burns BLM District personnel have indicated that no similar habitat is present on BLM land ownership, so the species is not suspected to occur on Burns BLM land.

Abundance: Abundance estimates and population numbers are limited for this species, but *F. turbiniformis* was probably once very common in its original range (Tryon 1865; Frest and Johannes 1995). However, Frest and Johannes (1995) suggest that this species has declined in Oregon and Nevada and now occurs in very few sites in these states. *Fluminicola turbiniformis* records with count data range from 1-1,000 individuals (Xerces Society 2017, *unpublished data*). Based on these occurrence records, it appears this species can be locally abundant.

Habitat Associations:

Members of the *Fluminicola* genus prefer clear, very cold, well-oxygenated flowing waters (Frest and Johannes 1995; Hershler and Frest 1996; Hershler *et al.* 2007; ODFW 2019). *Fluminicola turbiniformis* in particular is found in small-to-large oligotrophic springs (Frest and Johannes 1995), heliocrene springs,

and rheocrene springs (GBIF 2019). This species prefers habitats where a basalt bedrock substrate dominates; it can be found on or near gravel, cobbles, sand, or mud (Frest and Johannes 1995; GBIF 2019).

Habitat preferences, determined by where this species was collected, include cold spring complexes with many runs that are surrounded by semiarid sage scrub (Frest and Johannes 1995) or willow (*Salix*) and aspen (*Populus*) (GBIF 2019). This species is associated with abundant yellowcress (*Rorippa*) and monkey flower (*Mimulus*) and has been collected on watercress-like vegetation (Frest and Johannes 1995; GBIF 2019). Additional vegetation that may be associated with *F. turbiniformis* habitat preferences include: water hemlock (*Cicuta*), abundant nettle (*Urtica*), and smaller amounts of horned pondweed (*Zannichiella*), common duckweed (*Lemna minor*) and star duckweed (*L. trisulca*) (GBIF 2019). *Fluminicola turbiniformis* has been collected at elevations between 1,688-4,450 m (~5,538-14,600 m) (GBIF 2019).

Threats:

Fluminicola turbiniformis has a relatively stable short-term population trend (≤10 percent change); however, long-term trend predictions are variable and range from a decline of 30% to an increase of 25% (NatureServe 2018). The variability of population trends may be a result of this species' specialized habitats, which can be degraded by human use and modification (Frest and Johannes 1995). The American Fisheries Society (AFS) recently rated *F. turbiniformis* a vulnerable species because it is a species that is imminently likely to become threated throughout all or a significant portion of its range (Johnson *et al.* 2013). In Oregon, *F. turbiniformis* is an ODFW Conservation Strategy Species (CS) and is considered threatened or endangered throughout its range (ORBIC 2016).

Freshwater gastropods like *F. turbiniformis* are highly susceptible to habitat loss and degradation (Johnson *et al.* 2013). Geothermal development, dams, groundwater withdrawal, pollution (e.g., salts, metals [copper, mercury, zinc], untreated sewage, and agricultural runoff), road construction, and invasive species all likely have a negative impact on the habitats needed by *Fluminicola* species. *Fluminicola turbiniformis* requires cold, oligotrophic spring habitats; these habitats are both specialized and limited. Oligotrophic springs in semiarid sage scrub are at risk and declining primarily due to grazing, geothermal development, and spring diversion and drawdown (Frest and Johannes 1995). Preventing or mitigating water diversions and maintaining

appropriate water flow and quality may mediate negative effects of land use. Climate change could also impact this habitat. Trends such as an increase in air temperature in the region, decreased precipitation, and altered precipitation patterns are predicted for this region, all of which could degrade habitat by altering discharge, flow, and evaporation (Ficklin *et al.* 2013). Use of known population areas by the public may also result in trampling and water quality reductions. These factors threaten remaining habitat for this species.

Freshwater gastropods have the highest modern extinction rate of any organism, likely due to their endemism, limited dispersal abilities, and high susceptibility to habitat loss and degradation (Johnson *et al.* 2013). Small *Fluminicola* snails, such as *F. turbiniformis*, are sensitive to pollution, siltation, warming, and hypoxia (Frest and Johannes 1995). This species requires intact and undisturbed spring influenced habitats with very cold, clear waters. Major threats to *F. turbiniformis* include the diversion of springs, drawdown of groundwater, grazing, and geothermal development (Frest and Johannes 1995). Additional threats include dredging, mining, road construction, or other activities that may lead to sedimentation and nutrient inputs, all of which can alter substrates and reduce egg survival (ODFW 2019). Preventing or mitigating water diversions and maintaining appropriate water flow and quality may mediate negative effects of land use. Invasive species, such as *Potamopyrgus antipodarum* (the New Zealand mud snail), threaten native hydrobiid populations in the western United States (Pyron and Brown 2015). *Potamopyrgus antipodarum* was first detected in Oregon in 1997 and has since been observed in 24 drainage areas (i.e., Hydrological Unit Codes (HUCs) (U.S. Geological Survey 2019).

Conservation Considerations:

Research: Previous genetic analysis has confirmed speculations that the *Fluminicola* genus is paraphyletic (species in this genus have evolved from separate origins) and in need of taxonomic revision (Hershler and Liu 2012). Efforts to better understand this group in the Rogue-Umpqua, upper Sacramento River, and Snake River watersheds have been extensive, utilizing both morphologic characteristics and genetic analyses; these analyses and others should continue to provide additional insight (Hershler *et al.* 2007; Hershler and Liu 2012; Liu *et al.* 2013; Hershler *et al.* 2017; Liu and Hershler 2019). Continuing to resolve taxonomic uncertainty associated with *Fluminicola* as a group is imperative to identifying distinct species and populations to

accurately assess which populations are, and which are not, in need of conservation efforts.

Research is needed to determine species-specific criteria, including basic biology and life history traits of *F. turbiniformis*, species distribution, and population trends. Since many mollusks are affected by disturbance and pollution, additional research to assess the response of *F. turbiniformis* to environmental changes will help determine tolerance ranges.

Inventory: Oregon *F. turbinformis* records are from Lake Abert, Warner Lakes, and Guano watersheds (NatureServe 2018). Surveys for this species could occur at and near known sites with suitable habitat on the Fremont-Winema National Forest (Lake County), Burns BLM District (Harney County), and Lakeview BLM District (Lake County). It is likely that undetected populations of *F. turbiniformis* exist within appropriate habitats. In particular, it is likely that appropriate habitat and new populations may be found in southern Oregon.

Additional monitoring could include habitat quality assessments such as water temperature, DO content, sedimentation levels, nitrogen and phosphorus levels, and stream flow (Furnish and Monthey 1998) in order to better identify habitat associations of this species.

Management: Management could include maintaining and conserving currently available intact habitat and populations of *F. turbiniformis*. Freshwater gastropods, including *Fluminicola* species, are highly susceptible to habitat loss and degradation (Johnson *et al.* 2013). Management to limit causes of habitat loss and degradation to streams and rivers is crucial to protecting these populations. In particular, land managers could limit waste water discharge and agricultural runoff as well as new construction of dams or other structures (Duncan 2008). These activities negatively impact water quality by adding nutrients and other pollutants, slowing water flow, and reducing oxygenation (Duncan 2008). To help preserve current populations of *Fluminicola* species land managers could maintain water quantity and quality, native plant communities, and original streambed substrates (Furnish and Monthey 1998).

Limiting water diversions and grazing in area of spring runs, which reduce water quantity and may add sediment, nutrients, and other pollutants to water, is also recommended. To further preserve habitat for this species, avoid new construction of structures that slow water flow and cause reduced oxygenation, and limit water withdrawal from aquifers that sustain spring flow.

Version 2:
Prepared by: Katie Hietala-Henschell and Dolores Weisbaum
The Xerces Society for Invertebrate Conservation
Date: May 2019

Reviewed by: Candace Fallon
The Xerces Society for Invertebrate Conservation
Date: June 2019

Edited by: Rob Huff
Conservation Planning Coordinator, FS/BLM
Date: January 2020

Version 1:
Prepared by: Nancy Duncan
Bureau of Land Management
Date: April 2008

Reviewed by: Rob Huff
Forest Service Region 6 and BLM Oregon/Washington
Date: March 2011

Recommended citation:

Hietala-Henschell, K., D. Weisbaum, N. Duncan, and R. Huff. 2019. Interagency Special Status/Sensitive Species Program (ISSSSP) Species Fact Sheet: *Fluminicola turbiniformis*. USDA Forest Service Region 6 and USDI Bureau of Land Management Oregon State Office. 19 pp. Available at: https://www.fs.fed.us/r6/sfpnw/issssp/species-index/fauna-invertebrates.shtml

ATTACHMENTS:

(1) References
(2) List of pertinent or knowledgeable contacts
(3) Map of known records in Oregon
(4) Illustrations of this species
(5) Survey protocol, including specifics for this species

ATTACHMENT 1: References

[BLM] Bureau of Land Management. 2006. Special status animals in California, including BLM designated sensitive species. 3 pp.

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Hershler, R. and H. Liu. 2017. Annotated checklist of freshwater truncatelloidean gastropods of the western United States, with an illustrated key to the genera. Technical Note 449. U.S. Department of the Interior Bureau of Land Management. 152 pp.

[ITIS] Integrated Taxonomic Information System. 2019. ITIS Report: *Fluminicola turbiniformis* Tryon, 1865. Taxonomic Serial No.:70792 [online resource]. Accessed 26 March 2019. Available at: http://itis.gov

[IUCN] International Union for Conservation of Nature. 2019. The IUCN Red List of Threatened Species. Version 2018-2. Accessed 12 March 2019. Available at: http://www.iucnredlist.org

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Map references:

[BLM] Bureau of Land Management. 2018. GeoBOB GIS export provided to Candace Fallon, the Xerces Society, by Chelsea Waddell, BLM Regional GeoBOB and ARIMS Data Coordinator, September 2018.

[GBIF] Global Biodiversity Information Facility. 2019. GBIF secretariat 2017. GBIF Backbone Taxonomy. Checklist dataset. Available at: http://www.gbif.org/species

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[ORBIC] Oregon Biodiversity Information Center. 2018. ORBIC invertebrate GIS export provided to Candace Fallon, the Xerces Society, by Lindsey Wise, Oregon State University ORBIC Biodiversity Data Manager, October 2018.

[USFS] United States Forest Service. 2018. NRM Wildlife Invertebrate Database. Database provided by Carol Hughes, USFS to Candace Fallon, the Xerces Society, September 2018.

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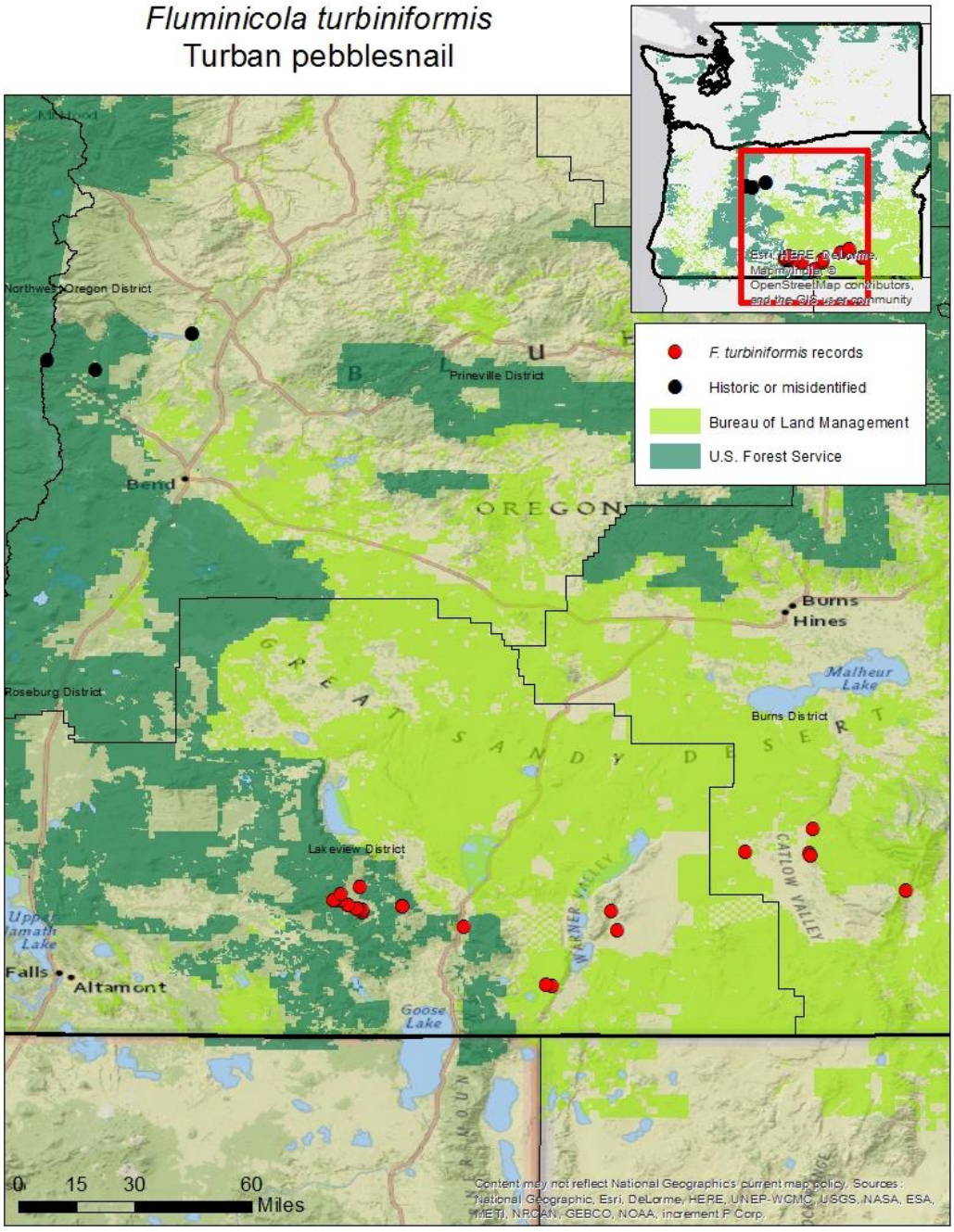
ATTACHMENT 2: List of pertinent, knowledgeable contacts

Ed Johannes, Consultant, Deixis Consultants, Seattle-Tacoma Washington.

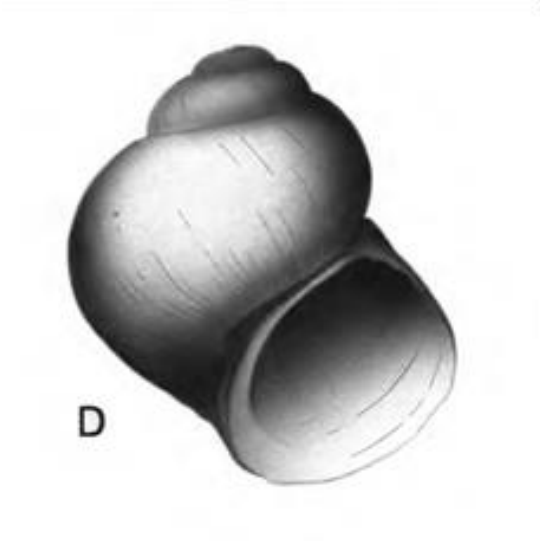
Robert Hershler, Research Zoologist Emeritus, Smithsonian National Museum of Natural History, Washington DC.

ATTACHMENT 3: Map of known *Fluminicola turbiniformis* records in Oregon

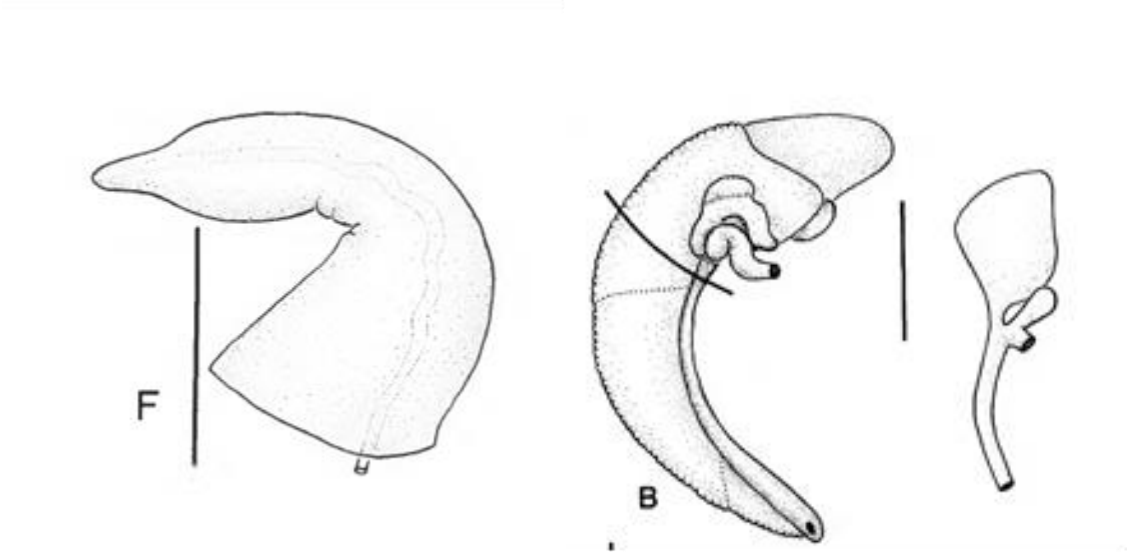


Known records of *Fluminicola turbiniformis* in Oregon, relative to Forest Service and BLM land. Sites shown in Jefferson County were revisited in 2019, and a different *Flumincola* species (*F. multifarius*) was documented instead.

ATTACHMENT 4: Illustrations of this species

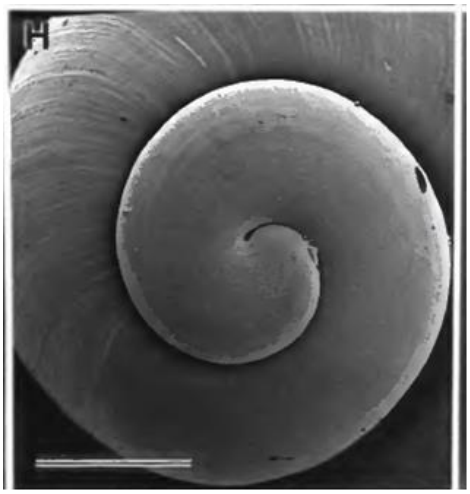


Shell of *Fluminicola turbiniformis*, lectotype, 3.3 mm (ANSP 27779). Used under Fair Use Law, information provided by the National Museum of Natural History, Smithsonian Institution, 10th and Constitution Ave. N.W. DC 20560-0193. Available at: http://www.nmnh.si.edu/.



Reproductive anatomy of *Fluminicola turbiniformis*, male genitalia (left; bar = 0.33 mm) and female genitalia (right; bar = 0.5 mm) (USNM 883470). Used under Fair Use Law, information provided by the National Museum of Natural History, Smithsonian Institution, 10th and Constitution Ave. N.W. DC 20560-0193. Available at: http://www.nmnh.si.edu/.

Opercula of *Fluminicola turbiniformis* (bar = 0.43 mm) (USNM 883470). Used under Fair Use Law, information provided by the National Museum of Natural History, Smithsonian Institution, 10th and Constitution Ave. N.W. DC 20560-0193. Available at: http://www.nmnh.si.edu/.



Shell protoconch of *Fluminicola turbiniformis*, (bar = 250 µm) (USNM 883470). Used under Fair Use Law, information provided by the National Museum of Natural History, Smithsonian Institution, 10th and Constitution Ave. N.W. DC 20560-0193. Available at: http://www.nmnh.si.edu/).

ATTACHMENT 5: Aquatic Gastropod Survey Protocol, including specifics for this species

Taxonomic group:
Aquatic Gastropoda

How:
Please refer to the following documents for detailed mollusk survey methodology:

1. General collection and monitoring methods for aquatic mollusks:

   See documents under the heading "Invertebrates – Mollusks" on the Interagency Sensitive and Special Status Species web page: https://www.fs.fed.us/r6/sfpnw/issssp/inventories/identification.shtml

2. Standard survey methodology that can be used by field personnel to determine presence/absence of aquatic mollusk species in a given waterbody, and to document species locations and habitats in a consistent format:

   - Duncan, N. 2008. Survey Protocol for Aquatic Mollusk Species: Preliminary Inventory and Presence/Absence Sampling. Version 3.1. Portland, OR. Interagency Special Status/Sensitive Species Program. U.S. Department of Interior, Bureau of Land Management, Oregon/Washington and U.S. Department of Agriculture, Forest Service, Region 6. 52 pp. Available at: https://www.fs.fed.us/r6/sfpnw/issssp/species-index/fauna-invertebrates.shtml

   - Inventory and Monitoring protocol page, with NRIS/GeoBOB field forms. Available at: http://www.fs.fed.us/r6/sfpnw/issssp/species-index/fauna-invertebrates.shtml
   - ID services page, with current versions of field tags. Available at: http://www.fs.fed.us/r6/sfpnw/issssp/inventories/identification.shtml

Species-specific survey details:
Fluminicola turbiniformis

How to survey: Aquatic snails may occur in a variety of habitat types, including springs, rivers and streams, and lakes and ponds. Seek out key habitat features known to be utilized by the target species (e.g., small-to-large oligotrophic springs, heliocrene, or rheocrene springs where a basalt bedrock substrate dominates). Record geographic coordinates and key habitat features for each site surveyed. Standardized abundance estimates for this species at new and known sites would assist future conservation efforts, since population size is important in evaluating the stability of a species at a given locality.

A variety of methods may be used to sample for aquatic snails, including hand and dip-net collection, kick-net collection, and the use of surber samplers, grab samples, dredges, and wire-basket benthos samplers. Duncan (2008) outlines methods appropriate for typical aquatic habitats. Sample procedures should limit impacts to sensitive habitats, particularly springs and streambeds. Surveyors should avoid use of chemicals such as bug repellant or sunblock, which may wash off into the water. Surveyors should also take steps to disinfect gear prior to sampling and reduce risk of transferring invasive species among sampling sites (Duncan 2008). More information on invasive species and prevention strategies can be found at: http://www.fs.usda.gov/detail/r6/forest-grasslandhealth/invasivespecies/?cid=stelprdb5302184.

Where: Freshwater snails, especially in the *Fluminicola* genus, utilize fresh water habitats such as springs, streams, seepage areas, and rivers. *Fluminicola turbiniformis* prefers spring habitats. Identifying springs in natural areas that are intact, unpolluted, clear, cold, and with a coarse substrate will provide the most likely species-specific habitat.

Fluminicola turbiniformis has been observed in northern California, Oregon and Nevada. Targeting surveys to occur at known sites and at additional sites with suitable habitat adjacent to areas of detection is recommended. The habitat for *F. turbiniformis* consists of medium to large freshwater springs, with slow to swift currents primarily on coarse substrates in very cold, clear water (Frest and Johannes 1995) with high DO content (Hershler and Frest 1996, Duncan 2008). Vegetation commonly associated with *F. turbiniformis* habitat includes *Rorippa* (yellowcress) and *Mimulus* (monkeyflower) (Frest and Johannes 1995). This species is likely to occur under rocks in the slow to rapid currents of

springs and seeps as, similar to most members of this genus, *F. turbiniformis* are likely lithophiles that graze on periphyton (Frest and Johannes 1995, Hershler and Frest 1996).

Surveys for this species could occur at known sites with suitable habitat on the Fremont-Winema National Forest (Lake County), Burns BLM District (Harney County), and Lakeview BLM District (Lake County).

When: *Fluminicola* spp. are semelparous and therefore surveys should be avoided during population turnover. Population turnover is generally unknown for semelparous species but likely occurs in the spring (Duncan 2008). Surveys for *F. turbiniformis* could occur any time from June through October. Sampling in springs can be conducted any time of year but is recommended early to mid-summer except in grazed areas or areas that may experience late-season impacts. Surveys in flowing waters should be conducted after water levels and flows have decreased and survey conditions are safe. Surveys in lakes or other lentic habitats should not occur during the coldest months to improve detection of bottom-dwelling species. These and other recommendations are outlined further in Duncan (2008).

References (Survey Protocol only):

Duncan, N. 2008. Survey Protocol for Aquatic Mollusk Species: Preliminary Inventory and Presence/Absence Sampling. Version 3.1. Portland, OR. Interagency Special Status/Sensitive Species Program. U.S. Department of Interior, Bureau of Land Management, Oregon/Washington and U.S. Department of Agriculture, Forest Service, Region 6. 52 pp. [Available at: http://www.fs.fed.us/r6/sfpnw/issssp/species-index/fauna-invertebrates.shtml].

Frest, T.J. and E.J. Johannes. 1995. Interior Columbia Basin mollusk species of special concern. Final report: Interior Columbia Basin Ecosystem Management Project, Walla Walla, WA. Contract #43-0E00-4-9112. 274 pp. plus appendices.

Hershler, R. and T.J. Frest. 1996. A review of the North American freshwater snail genus *Fluminicola* (Hydrobiidae). Smithsonian Contributions of Zoology: No. 583. 52 pp.

US Forest Service, Pacific Northwest Region. Invasive Aquatic Species. [Available at: http://www.fs.usda.gov/detail/r6/forest-grasslandhealth/invasivespecies/?cid=stelprdb5302184]