PEST RISK ASSESSMENT FOR THE STATE OF OREGON:

Theba pisana (Muller) – White Garden Snail and Other Terrestrial Snails Exotic to Oregon

PEST IDENTITY:

Scientific Name: *Theba pisana* (Muller)
Phylum: Mollusca
Class: Gastropoda
Family: Helicidae
Common Name: White Garden Snail

Other Terrestrial Snails Exotic to Oregon (partial list):

Scientific Names: *Achatina fulica* Bowdich, *Bradybaena simularis* (de Ferussac), *Cepaea hortensis* (Muller), *Cepaea nemoralis* (Linnaeus), *Cernuella cisaplpina* (Rossmaessler), *Cernuella virgata* (da Costa), *Cochlicella barbara* (Linnaeus), *Eobania vermiculata* (Muller), *Helix pomatia* Linnaeus, *Monacha cartusiana* (Muller), *Otala lactea* (Muller), *Papillifera papillaris* (Muller), *Rumina decollata* (Linnaeus), *Trochoidea elegans* (Gmelin), *Xerolenta obvia* (Menke), and *Xerotricha conspurcata* Draparnaud.

Phylum: Mollusca
Class: Gastropoda
Families: Various
Common names: Various

RISK RATING SUMMARY:

Relative Risk Rating: Very High
Numerical Score: 22 (maximum 25)
Uncertainty: Low

PEST BACKGROUND:

The white garden snail is just one example of many exotic snails posing threats to Oregon's agriculture, ecosystems, water quality, and human health. Consequently, exotic snails will be treated as a set of pests in this risk assessment.

Like most other exotic snails, white garden snails feed on a wide variety of plants, including cereals, vegetables, fruits, herbs, and many ornamentals, destroying seeds and seedlings, stunting growth, and reducing yields. Not only do they directly damage the plants they feed on but the wounds they create allow plant pathogenic fungi to infect plants. Exotic snails can also be vectors of various plant pathogens. Their mucus trails can contaminate grains, vegetables, fruits, and herbs. In large numbers, their bodies and shells can be contaminants in mechanically harvested crops. When very abundant their bodies and shells clog or break harvesting equipment.

White garden snails and other exotic snails can also be intermediate hosts and vectors of animal and human parasites, such as sheep lungworm, *Protostrongylus rufescens*, and the roundworm causing eosinophilic meningitis, *Angiostrongylus cantonensis*.

White garden snails and other exotic snails that become firmly entrenched in Oregon may start expanding into native habitats and affecting native snail and slug populations through competitive exclusion and the introduction of exotic snail and slug parasites and diseases. Several species, such as *Rumina decollata*, also prey upon other snails and could cause native species to decline.

White garden snails on thistle.

SPREAD POTENTIAL TO OREGON: VERY HIGH (numerical score 5)

White garden snails, and other exotic snails, can easily be introduced into Oregon. This is particularly true of those exotics with established populations in states adjacent to Oregon, such as California and Washington. White garden snails are established in California, as are *Cernuella virgata*, *Otala lactea*, and *R. decollata*. *Cernuella virgata* is also established in Washington, although efforts are under way to eradicate that infestation. Those species not known to be established in nearby states or in North America, such as *Achatina fulica* and *Cochlicella barbara*, presumably represent less risk. However, global trade can easily introduce such species, as well as lesser known Asian species, into Oregon (see "hitchhiking" and "pets" below).

There are several main ways through which white garden snails and other exotic snails could be brought to Oregon. "Hitchhiking" is probably the most likely means by which most exotic snails can be transported. Exotic snails are intercepted with depressing regularity with commodities on which they have crawled or sought shelter in. These include being on and in containers, miltary cargo, heavy machinery, granite and

marble, pottery, tiles, and, of course, wooden pallets and crating (Robinson in prep.). Even when items have been stored for long periods in conditions inhospitable to snails, such as on asphalt docks, in warehouses, or in ship holds, many exotic snails, including white garden snail, can survive in a state of "suspended animation" called aestivation.

Exotic snails are frequently intercepted on imported agricultural commodities upon which they feed. These include cut flowers, on which white garden snails have frequently been intercepted (Robinson in prep.) and nursery stock (ODA unpublished data, Robinson in prep.). Potting media associated with nursery plants also provide ideal shelter for exotic snails, including their eggs (ODA unpublished data).

People intentionally (and many times illegally) import exotic snails. This is one of the most worrisome avenues of introduction. With the advent of the internet (which is very difficult to regulate), many exotic snails are being offered for sale as pets, such as the giant African snails, *Achatina fulica* (madaboutsnails.googlepages.com). Such

"Pet" giant African snails.

snails are also promoted as good subjects for school projects. As long as they are never released and promptly killed once the projects are completed, there is no problem. However, more often than not, teachers are too soft hearted and send the snails home as pets with the students, who then often release them.

Some snails are highly prized as human food and there are many businesses offering them for "heliculture", the farming and raising of snails for food (for instance, www.manandmollusc.net). The European brown garden snail (generally known as *Helix aspersa*), a significant garden pest and a major quarantine pest, was intentionally introduced into Oregon as a source of "escargot", which at that time quarantine regulations permitted. This is no longer legal. White garden snails are not particularly prized as escargot, but are offered as subjects for heliculture (www.manandmollusc.net), increasing the risk that the species could be illegally imported into Oregon.

Some exotic snails could be illegally imported into Oregon for use in controlling exotic plant eating slugs and snails, such as European brown garden snail. *Rumina decollata* is being promoted as a "snail destroyer" that is a more environmentally benign and non-toxic alternative to slug and snail poisons, especially with regard to European brown garden snail control (for example, at www.growquest.com/snail_ destroyer.htm). As well as being an exotic not known from Oregon, this species poses a significant economic and environmental threat. This snail is not exclusively predatory and can be a plant pest when too few prey are available. It also feeds on a wide variety of slugs and snails and could be a threat to native species (http://nis.gsmfc.org/nis_ factsheet.php?toc_id=158). Native species of slugs and snails are important parts of Oregon's healthy native ecosystems, providing "services" such as dispersing seeds and fungal spores, eating organic debris, providing food for other animals, and being part of Oregon's

unique biodiversity. A similarly predatory snail, the rosy snail (*Euglandina rosea*) was imported from the southeastern U.S. to several Pacific and Indian oceanic islands (including Hawaii) as a control for giant African snails. Not only did it not control giant African snails, but it proceeded to decimate native tree snails, causing the extinctions of such snails in French Polynesia (www.issg.org/database/species/ ecology.asp?si=92).

ESTABLISHMENT POTENTIAL IN OREGON: VERY HIGH (numerical score 5)

Oregon is clearly suitable for the establishment of exotic snails. This has been shown with the establishment of European brown garden snail, wrinkled dune snail, *Candidula intersecta* (Poiret), and the garlic glass snail, *Oxychius alliarus* (Miller), among others. A recent survey of container yards and other commodity "hubs" conducted by ODA foud additional species of exotic snails previously unknown from Oregon (ODA unpublished data). Fortunately, with the exception of the European banded wood snail, *Cepaea nemoralis*, those species are all believed to be economically and ecologically harmless. However, these data underscore the ease with which exotic snails could establish in Oregon.

The native range of white garden snail includes southwestern England and Wales, Ireland, western France, Switzerland, and the Mediterranean Basin. Climates and habitats similar to many in Oregon can be found within that range. Suitable Oregon habitat for white garden snail, as well as other exotic snails, is not limited to the moist areas west of the Cascades. Species that require relatively moist conditions can survive in irrigated sites and along bodies of water. For instance, European brown garden snail was found flourishing alongside a stream next to an irrigated industrial park in Prineville (ODA unpublished data). White garden snail, as well as some other exotic snail species, have adapted to dry climates by climbing foliage and trees during hot, dry spells and can aestivate until moist conditions return. Such speciecs can become severe pests in dryland cereal and forage crops, as is the case with white garden snails in southern Australia (Baker 2002, Baker and Hopkins 2003). It is likely that white garden snail could establish throughout much of eastern Oregon.

White garden snail shells showing variation in color. Color variation is linked to blending in with the local vegetation, such as more stripes in grassy areas and more blotches in sandy areas.
Image: El Rincon Del Malacalogo.

As previously mentioned, exotic snails can be easily introduced into Oregon. Once here, they can readily establish because there is little finanacial support for exotic snail detection. Furthermore, the methods available for snail detection are poor, consisting of manual search or trapping with pitfall traps or "slug blankets" (ODA 2009). This means that snail surveys cannot be effectively conducted over large areas. Many

snails are also very difficult to identify, often requiring dissection to confirm their identities. There is almost no taxonomic support for snail identification. USDA has one snail identifier, who is overwhelmed with samples submitted through port and customs interceptions. Even if an exotic snail is detected and identified before it has become widely established, it is extremely difficult to eradicate snails. Eradication projects targeting exotic snails in other states use combinations of mechanical food and shelter plant removal, herbicide treatments to further reduce food plants, burning food and shelter plants, removing shelter such as rocks and concrete slabs, crushing snails with soil compactors, burying snails in feet of soil, laying down salt barriers, and, of course, using snail poisons. One Australian manual dealing with exotic snail management says it all with the succinct title of "Bash 'Em, Burn 'Em, Bait "Em" (Baker and Hopkins 2003). All these methods have drawbacks and some are extremely expensive.

ENVIRONMENTAL IMPACTS TO OREGON: HIGH (numerical score 4)

Exotic snails like the white garden snail can directly affect Oregon's environment through the damage they cause to native plants. White garden snail may pose a particularly great threat because these pests can achieve huge populations. It is believed

White garden snails.
Left hand image: snailseyeview.blogspot.com

that many exotic snails only do well in habitats altered by human activity, such as crop lands and gardens. If the white garden snail and other exotic snails behave like this, their effect on native plants may be minor or modest. The exceptions to this may be threatened or endangered plant species that are now restricted to human altered habitats or that are in the vicinity thereof. Threatened and endangered plants are also inherently more vulnerable because their populations are often small, scattered, or in very restricted areas and habitats. White garden snail appears to prefer dry and warm conditions, so Oregon's oak habitats, particularly on south and west facing slopes and in southern Oregon, may be susceptible to invasion by this species. White garden snail has invaded similar native habitats in Australia (Baker 2002). It may pose a particular threat to Willamette Valley prairie endemic plants, such as the threatened Kincaid's lupine (*Lupinus sulphureus kincaidii* (Smith) Phillips (Oregon Natural Heritage Information Center 2007), one of the primary host plants of an endangered butterfly, the Fender's Blue (*Icaricia icarioides fenderi* Macy).

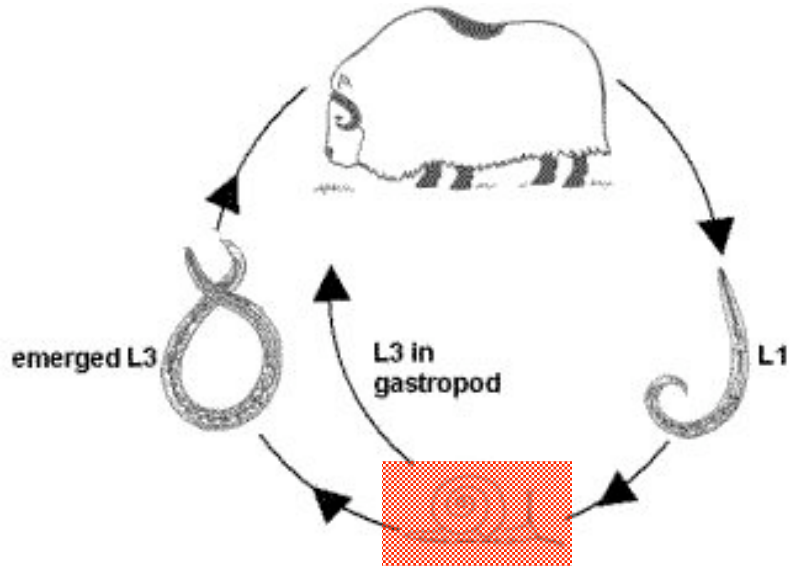
Kincaid's lupine.

Fender's blue.

There may be similar impacts upon native slugs and snails. Exotic species have often been shown to compete with native species, to the detriment of the natives. If the virtual absence of most native molluscs from habitats severely altered by human activities (ODA unpublished data) is because those habitats are not suitable for native species, then exotic snails may not be a competitive threat. On the other hand, if native species are absent at least in part due to exotic competitors, then native populations could be affected if exotic species expand into native habitats. The same would be true if *Rumina decollata* or other predatory snails became established. If exotic predatory snails confined their depredations to human altered habitats, the impact on native species would be minor. If they expanded into native habitats, the picture could be quite different, especially for the several species of threatened and endangered native terrestrial snails (Oregon Natural Heritage Information Center 2007). In Australia, white garden snail has invaded native habitats, such as dry forests and coastal dune communities (Baker 2002).

Exotic snails have their own set of diseases and parasites (Baker 2002, Baker and Hopkins 2003), some of which are not known to occur in Oregon. If these organisms were introduced along with their exotic snail hosts, they could also attack native species. Misguided individuals could also intentionally introduce exotic snail diseases and parasites, similar to the risks posed by the "snail destroyer" promoters.

Snails, including many that are in the same family as white garden snail, are intermediate hosts for a wide variety of parasites of mammals and birds (Soulsby 1968). Many of these parasites are not found in Oregon or the United States (Soulsby 1968). Their hosts include wildlife, such as many ungulates (hooved mammals), predators, and waterfowl. For instance, infestation rates can reach 100% in bighorn sheep with similar parasites (Kistner et al. 1977) and may be responsible for catastrophic population declines. Exotic parasites could not only be introduced and carried by new exotic snails but, once established in Oregon, these parasites could then be carried by native and previously present exotic snails.



Life cycle of a native lungworm in muskox. Note the snail at the bottom of the figure. The lungworm stage emerging in the feces of the muskox is not infectious to other muskox. Only the stage emerging within or emerging from the snail can infect other muskox.
Image: yourYukon.

If exotic snails destructive to crops and ornamentals become widely established in Oregon, especially species such as white garden snail which form conspicuous masses on plants and structures, an inevitable response will be increased application of molluscicides (snail and slug poisons) to reduce or prevent damage. Molluscicides are poisonous to all terrestrial molluscs and if widely applied could decrease native populations of slugs and snails. Reduced populations of native molluscs may then cause reductions in populations of the many native predators of terrestrial molluscs, such as several genera of ground beetles (Thiele 1977). Since widely used molluscicides like metaldehyde are toxic to mammals and birds, relatively large scale poisoning of wildlife, pets, and livestock could occur.

zenstoves.net

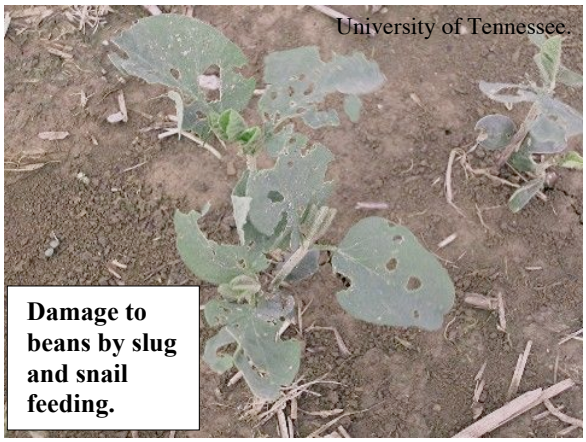
Dobbies.com

A particularly disturbing consequence of widespread molluscicide use could be contamination of watersheds and ground water through runoff. While commercial and

agricultural use could probably be controlled to some degree, the same would not true of use in residential areas. Wells and low lying wetlands would be particularly vulnerable.

ECONOMIC IMPACTS TO OREGON: VERY HIGH (numerical score 5)

The white garden snail is considered to be one of the most serious molluscan agricultural pests in the world (Robinson in prep.). Damage to crops and ornamentals from exotic snails and slugs already established in Oregon is great. Exotic molluscs are probably the number one pest of residential ornamental and vegetable gardens. They are also major pests of seed production and several other crops. Establishment of new exotics will only make the situation worse. The total value of Oregon's greenhouse, nursery, field, seed, fruit, berry, and vegetable crops was $3,177,109,000 (ODA 2009).



Damage to beans by slug and snail feeding.

Almost every aspect of that production could be affected by white garden snail and other exotic snails. In Australia, white garden snails reduced yield in livestock forage by 23-83% and destroyed up to more than 98% of wheat seedlings (Baker 2002). In addition, there will be increased costs associated with controlling these pests. Not only will producers have to reduce direct damage but they will also have to keep snail populations low enough that produce won't be contaminated by mucus, bodies, or shells. White garden snail contamination of crops reduced grain value by as much as 25% (Baker 2002). As previously mentioned, snail control methods can be complicated and expensive. For instance, windrowing, one method used in Australia to control white garden snails in crops, cost about ten Australian dollars per hectare (Baker 2002).

There will also be economic consequences for the livestock industry, which in Oregon in 2007 had a value of $1,058,061,000 (ODA 2009). As previously mentioned, snails are intermediate hosts and vectors of a wide variety of parasites affecting mammals and birds, many of which attack livestock and fowl (Soulsby 1968). Widespread exotic snails could increase the incidence of such parasites already present in Oregon (such as sheep lungworm) by being more abundant than native snails or by being better carriers of those parasites. The vast populations that white garden snail can develop could certainly increase the prevelance of infested snails. New exotic snails could also be the means of introduction of new parasites which would then be transmitted to livestock and fowl by these snails. Not only would there be additional diseases but there could be increased regulatory action regarding possible contamination of meat animals. Livestock are also very reluctant to eat pasture and feed contaminated with snail mucus and may refuse it

altogether, as in cases where white garden snails have become very abundant (Robinson in prep.). Between forage removal and mucus contamination, carrying capacity of pasture in Australia was reduced by as much as 25% by white garden snail infestation (Baker 2002).

Many exotic snails, especially those associated with dry and grain production areas, such as white garden snail, can survive dry, hot weather by becoming inactive ("aestivating") and climbing onto foliage or other positions off the hot ground. When abundant, they often form great masses. When they mass on crops, especially grains and grapes, they can clog and damage harvesting and processing equipment, as well as contaminating the harvest (Baker 2002, Baker and Hopkins 2003, Sanderson and Sirgel 2002).

White garden snail aestivating.


White garden snails mass aestivating .
Image: kreta-umweltforum.de

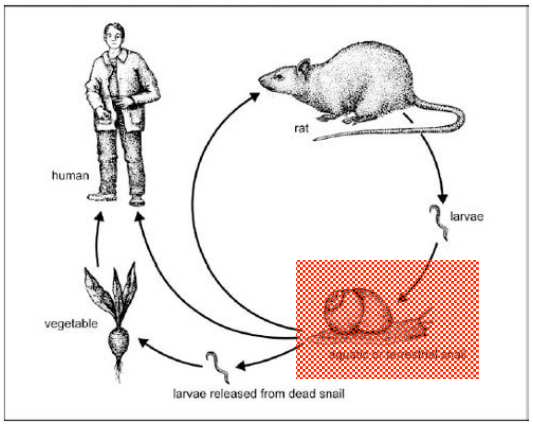
The presence of exotic snails in Oregon, especially species such as white garden snail not previously present, as well as previously established that became widespread, could have significant regulatory consequences for Oregn's crop and horticultural export markets, which in 2007 were valued at $778,665,000 (ODA 2009). Eleven states have exotic snail quarantines on the import of agricultural commodities and almost all states have general quarantines on "excessive numbers of agricultural pests" associated with commodities. Similar regulations exist with other countries which are trade partners with Oregon. White garden snail is specifically mentioned in many of those quarantine regulations.

Last, but certainly not least, widespread exotic snails, such as white garden snail, will lead to the costs associated with repairing or mitigating ecological damage. Preventing white garden snails and other exotic snails from damaging or destroying threatened and endangered plants, such as Kincaid's lupine, could be very costly. This is also true of controlling exotic predatory snails preying upon threatened and endangered terrestrial molluscs. Protecting and restoring wildlife populations affected by snail-vectored parasites (both native and exotic) will also be costly, challenging, and, ultimately, perhaps impossible. Containing and mitigating molluscicide watershed and ground water pollution caused by molluscicide runoff could also be extraordinarily difficult and expensive.

HEALTH IMPACTS TO OREGON RESIDENTS: MEDIUM (numerical score 3)

Not only are snails intermediate hosts and vectors of non-human animal parasites and pathogens but they also play the same role with human parasites and pathogens. One example is the rat lungworm, *Angiostrongylus cantonensis*, a roundworm that can infect humans as well. When infecting humans, these roundworms cause angiostrongyliasis,

which is a form of menigitis and can be fatal (www.dpd.cdc.gov/dpdx/HTML/angiostrongyliasis.htm). This pathogen can be found in Africa, the West Indies, Caribbean islands, Hawaii, and elsewhere. There are at least three other species of *Angiostrongylus*, found in Australia, Costa Rica, and Malaysia, that can also infect humans. As indicated in the life cycle below, humans can become infected in two ways: eating or handling raw or live snails and eating produce contaminated with snail mucus (immature roundworms can be very numerous in snail mucus). Although giant African snails have received the greatest notoriety as vectors of these roundworms, many other smaller exotic snails, including members of the same family as white garden snail, are known to be carriers for these parasites as well. As with wildlife parasites, once established in Oregon, *Angiostrongylus* and other human parasites could be vectored by native and previously established exotic snails. White garden snail is known to be an intermediate host for at least one human parasite, a flukeworm, *Brachylaima* sp., which can cause severe intestinal disorders if infested snails are eaten (Baker 2002).



Life cycle of the rat lungworm, *Angiostrongylus cantonensis*.
Image: Center for Disease Control.

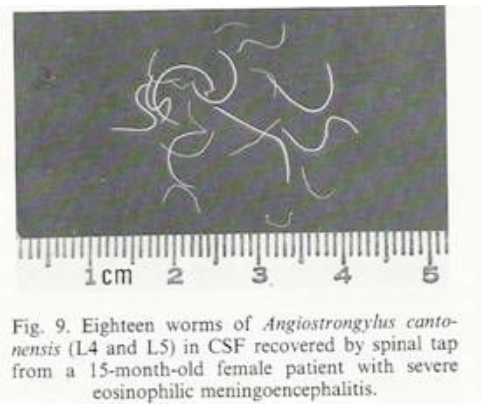


Fig. 9. Eighteen worms of *Angiostrongylus cantonensis* (L4 and L5) in CSF recovered by spinal tap from a 15-month-old female patient with severe eosinophilic meningoencephalitis.

Adult rat lungworms (up to 1 inch long) extracted from the spinal cord of a young girl.
Image: Center for Disease Control.

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3/31/2009