Recommendations from the *Xerolenta obvia* (Eastern Heath Snail) Science Advisory Panel

At the time the population of *Xerolenta obiva* was discovered in Belt, MT in 2012 the snails were already abundant. They could be seen clustered on vegetation across local fields and along roads during the seasons when they estivate. The snails are currently a nuisance species in the urban area where they are established but the impact to producers may prove similar to that observed in Australia where a suite of related species are established in grain and pulse fields.

Snail abundance in a Belt, MT hay field was high enough that they filled the swather deck with their shells and fouled the machinery. The movement of snails in hay is a concern as is the possible impact on hay quality, the establishment of *X. obvia* in pulse (pea, bean, lentil, chick pea) fields where the snails and the harvested seeds are approximately the same size. Their presence would add a new management burden to producers who are not currently managing for any mollusk pests. Developing the tools and outreach to producers to protect Montana's crops for export will be necessary if this species spreads into pulse production areas, especially those with no-till practices.

The other known North American populations of this species are in Ontario, Canada and in Detroit, MI. Detroit populations were initially confined to railyards. At the time of this report in 2020, four Michigan counties have confirmed populations with two of the sites being both distant and noncontiguous with the Detroit railyards. The population in Detroit in railyards included freight transport yards where intermodal transfers occurred, moving both containers and snails from rail to roads.

The natural spread of the snails between 2012 and 2020 from Belt, MT has covered a distance of approximately 10 miles through a both their own movement and snails on the edges of their current population building up to densities that are easier to detect. Belt is located in a valley that floods and as snails have been observed being washed into Belt Creek and floating away, their movement is likely being increased with both seasonal and periodic flooding. Movement of vehicles including cars that park in the access areas for public lands near Belt and along rail lines creates opportunities for transport at any time that the humidity and temperatures allow the snails to be active. Bulk transport of soil for building or road projects has established at least three known nearby populations in Great Falls, Monarch, and Highwood ranging from 18-28 miles away.

The expansion of *X. obvia* populations locally in Montana, and further north in Michigan and in Ontario, Canada indicates that the adaptations that allow this species to survive adverse temperatures and low humidity serve to protect it from extreme winter temperatures and weather (Forsyth et al., 2015). Further, this species has established in Dobele, Latvia at 56.63 N and

Baranowitchy, Belarus at 53.09 N where studies indicate continued population expansion (Cehanoviča & Stalažs, 2020; Zemoglyadchuk, 2019).

The Pest Risk Assessment completed by the Canadian Food Inspection Agency (Plant Health Risk Assessment Unit, 2004) assessed that the risk posed by this species was low, identifying that its Mediterranean origin made it unlikely to spread into much of the area considered by the assessment. Based on the robust population expansion around Belt, MT it is now clear that the climate in Montana will not be a barrier.

The following recommendations were discussed in response to the establishment and spread of *X. obvia* in Montana during the December 7-10, 2020 Science Advisory Panel meetings. The experience of managers and producers in Australia with a suite of closely related species, Mediterranean snails *Cernuella virgata*, *Cochlicella acuta, Cochlicella barbara* (Geomitridae) and *Theba pisana* (Helicidae) that have impacted grain and pulse growers in South Australia and surrounding regions was helpful in informing the scale and types of response to consider. The high-density populations of these aggregating snails in Australia led to the development of a suite of management tools that can adapted to US grain, pulse, and canola production which will likely be required if coordinated efforts are not made to limit the spread of *X. obiva* in the US.

Biology

Climate is not a barrier to the spread of Xerolenta obvia in Montana.
The climate matching model previously produced by the USFWS demonstrated that the central Montana region was a close climate match for *X. obvia*. The continued expansion of this species in both Ontario and in Michigan where minimum winter temperatures are substantially colder indicates that the adaptations to surviving harsh conditions allow this species to tolerate winter freezing. The overlap between the predicted range of *X. obvia* and grain, pulse, and brassica growing regions is extensive.

Starting a robust research program to investigate the biology of Xerolenta obvia now will improve management.
The one advantage the US has over Australia in managing new snail species is that the Mediterranean snail species were widely established in Australia prior to the initiation of research programs. Dr. Geoff Baker, a CSIRO who studied snail pests for over three decades strongly recommends initiating a research program now rather than attempting to catch up with the impacts of the snails once they are widespread. As production practices shifted from till, deep mixing to bring up clay, and burning to soil conserving practices of no-till and reduced burning, snails increased their population densities. Identifying effective and economical tools with support producers when this species establishes in grain production areas. The timing of control and detection work should be tied to the annual patterns of behavior of this species in Montana and its response to weather and disturbance. The distribution models previously based on temperature and humidity should be refined using data on soil type to reflect the role of calcium in regulating the growth of this organism.

It is currently unknown if Xerolenta obvia is capable of transmitting vertebrate parasites in North America or the spores of plant diseases. A number of possible parasites were identified in the literature but the presence of this species in wells and gardens is currently a nuisance but may be problematic if the snails are an intermediate host.
In Europe, Xo is known to vector *Protostrongylus rufescens* (sheep lungworm), *Davainea proglottina* (cestode), and *Dicrocoelium dendriticum* (trematode). There are North American counterparts to these

internal parasites. *Protostrongylus stilesi* is known from bighorn sheep in Montana and other western states and snails serve as intermediate hosts (Becklund & Senger, 1967). *Davainea proglottina* is widespread and chicken, turkey, guineafowl, grouse, and other domestic and wild gallinaceous birds including pigeons serve as final hosts. *Dicrocoelium dendriticum* was introduced into the Cypress Hills region of southern Alberta (approximately 120 miles north of the Xo infestation in Montana) prior to the 1980s. Ten to twenty years later, it was found within populations of mule and white-tail deer, elk (*Cervus canadensis*), and beef cattle (Goater & Colwell, 2007; van Paridon, Colwell, et al., 2017; van Paridon, Gilleard, et al., 2017).

Building a better model of where the North American populations of Xerolenta obvia originated will improve efforts to contain their spread and reintroduction.
Initial work conducted by Ian Foley, MT DOA on the genetic barcoding gene CO1 indicated that the Montana population of *X. obvia* is diverse and that the Canadian and Michigan individuals cluster within the local collections. Further sequencing in cooperation Rory McDonnell at Oregon State University using Dr. Bernhard Hausdorf's, University of Hamburg collection may identify markers for identifying source populations and allow containment efforts to become more targeted.

Impacts:

Re-do 2012 Environmental Review based on the larger area occupied, different treatments recommended for landowners, roadsides and different cropping systems, and the impact of IPM measures that include increased till and burning to reduce populations in hay fields.
The past eight years have allowed for more research on the biology of *Xerolenta* in Montana. The ability of the snail to spread both on their own and via movement of materials and vehicles has been documented. The crops in the area that will be impacted by high snail densities and the snails' response to local cropping practices are better known. Hay, grain and pulse crops have expanded in acreage and there is an increasing interest in brassica crops which are vulnerable to the snails both at planting and possibly at harvest. The response of snails to molluscicides in other US control efforts is better known so that the amount and duration of pesticides used can be better calibrated to management goals.

Identify impacted industries, processors, and growers.
A tipping point for producers in Australia was the rejection of a load of barley by Chile in 1984. China has maintained focus on this issue for Australia by imposing strict hygiene standards as low as 1 snail or parts of a snail per 2.25 l. Montana Department of Agriculture and USDA partners are conducting surveys to quickly identify additional populations of invasive pests in production areas to address export concerns and have not found any additional populations of *X. obvia* in fields where grains and pulses grown for export are currently produced. Increasing the awareness by growers and industry associations of the impacts caused by the further spread and establishment of the snail will improve Montana's response.

Support the development of an economic analysis of the spread of this and related species in Montana.
Currently, Montana pulse and grain growers have limited exposure to mollusk pests. Using the four established Mediterranean snail species established in Australia, the estimated cost to producers is an additional $50/hectare to reduce snail presence in fields and grain, pulses, and hay along with crop losses due to snail presence. Mollusks in Australia result in a broad economic impact of $170 million per year. This is the total calculated from field management costs, crop loss, grain value loss, harvest losses/costs. Losses specific to the canola industry were higher $270 million (Nash, 2016).

From the 2019 State Agricultural Review for Montana produced by the USDA:

- 5,450,000 acres wheat
- 3,000,000 acres hay
- 950,000 acres barley
- 1,024,000 acres pulses (lentils, peas, chickpeas)
- 244,800 acres brassica (canola, sugar beets)

Additional costs to Montana growers using the total acreage of the above listed crops of 10,668,800 would be $215,829,824 per year.

Education and Outreach

Work with existing outreach networks and resources to build awareness of the threats posed by this species.
Outreach specific funding is limited so using partners through the Montana Invasive Species Council and experts who work with the affected industries including Extension services to build awareness and motivation for detecting *X. obvia* and taking actions to prevent its spread are needed. Regionally, the Tri-State Commissions for pulse and wheat represent growers who will bear the costs of management should this species become widespread. Generally, the Western Governors' Biosecurity and Invasive Species Initiative should be included in the efforts to increase awareness of this species.

Develop an education campaign to improve understanding of the impact of expanding snail populations on producer operations and export markets.
The impacts from *X. obiva* to producers of grains, brassica crops for oil, pulses, and hay will include direct feeding on seedlings and crops, and the overwhelming impact of the aggregating snails at the time of harvest on the harvesting equipment and the quality of the commodities through contamination with crushed snails. The impact of gastropod pests to Montana crops is currently extremely limited and the spread of this species represents an entirely new class of pest for most growers. Because the impacts will almost entirely fall on producers, informing these industries now both in Montana and regionally on the threat posed by the will improve management decisions that will impact their industries for decades.

Local actions including adding signs indicating the presence of Xerolenta at access points to recreation areas in infested areas should be done to raise awareness of the need to check for and remove hitchhiking individuals.
The experience in the rail yards in Detroit indicated that gravel or paved areas reduce but do not eliminate snail movement. While paving high risk areas may not be feasible for a small municipality like Belt, adding signs to encourage the public to exercise caution and to not move the snails from the areas would be beneficial in raising awareness.

Create a liaison officer modeled after the South Australia Grains Biosecurity Officer.
This position could be funded cooperatively by both the grain growers' association and the government. Their role would be farm visits, education, resource and outreach. Building trust and increasing the likelihood of reporting new pests would be the goal.
Possible funding: Western SARE (Sustainable Agriculture Research and Education) grants program.

Share Montana's recommendations in a format that can inform neighboring states and impacted industries.
The spread of *X. obvia* throughout the predicted range in North America has substantial overlap with grain and pulse growing areas. While the recommendations in this report are specific to the

partners working in Montana, sharing the recommendations along with the concern that the continued spread of this species will substantially impact farming in the West is important to the council. The recommendations should be shared both with invasive species coordinating groups and with journals including the American Malacological Society to raise awareness among specialists working in the region.

Prevention

The movement of snails can occur with any materials transported from areas with established populations. Authority is needed to manage the transport of snails and other invertebrate pests.

Any item left in areas with snails can create a surface for these animals to climb onto and adhere to. Their massing behavior and ability to estivate allows them to survive transport for under adverse conditions for long periods. Cars and trucks parked in sites with snails on the ground or vegetation are a risk, items left in the area for longer times can accumulate more snails and snails have been observed on bee hives, propane tanks, and trash cans all of which are occasionally moved out of the infested areas. Work in the infested areas creates a pathway for snails to be moved on equipment used in maintaining electric lines, installing communications cables and other infrastructure. Following Noxious Weed protocols can reduce the risk posed by equipment and materials moved out of sites with snail populations but there is no authority specifically addressing this species or any other slug or snail pest (gastropods).

Snails should be added to the gravel section being developed for the Montana weed seed free forage program (MDA bill 2021 leg. Session).

Outreach and awareness of public lands users in infested areas is critical but the bulk movement of gravel, road building and maintenance equipment, and materials transport has already been identified as the source for satellite populations of *X. obvia* outside of Belt, MT. Adding snails to the regulations being developed for weed seed free gravel will add a critical tool for managing this pathway.

Non-insect pests are not adequately addressed at a national level.

While insects have had sudden and devastating impacts on US agriculture, slower spreading threats have not received the same level of attention and funding. The relatively slow spread of snails and other gastropods that apparently reduces the sense of urgency for their control also makes eradication programs tractable compared to flying insect pests. The overall level of damage, availability of expertise and control tools and community support make them better candidates for more management resources than they currently receive.

Management:

Build a cooperative management plan for Xerolenta obiva in Montana based on the recommendations in the USDA New Pest Guidelines – Temperate Terrestrial Gastropods, other local response plans for gastropod species, and local priorities.

The lessons learned in the effort to control *X. obiva* in the freight yards and industrial areas around Detroit, MI in part were generalized into a set of USDA recommendations on managing temperate terrestrial gastropods. The general USDA guidelines combined with the recent experience of other snail management efforts can be used to create a specific and current strategy to meet Montana's management goals. The partners for a Montana specific plan would include the city, county, landowners, and state agencies responsible for land management in the affected areas. Funding for planning documents may be available through the Western IPM center.

Control efforts must include a long-term funding source and stable control resources.
The initial results of the work in Detroit were promising. Additional species of pest snails were discovered and three were eradicated. Several small populations of *X. obvia* were removed but once control stopped as funding became limited or site modification failed to be maintained, the populations rebounded. Additional populations of this species have been found in surrounding areas, likely associated with the rail lines and cargo moving out of infested rail yards. The annual operating budget for the ongoing Giant African Snail control in Florida is around $4m/year. Funding sources include Specialty Crop Block grants, other Plant Protection Act funds (USDA 7721) and state match.

Support the continued availability of chemical control tools to contain spreading invasive species.
Concerns over the misuse of Metaldehyde in the UK may lead to restrictions on the availability of this compound for gastropod control. While this does not currently impact the domestic market the lack of an effective tool for eradication and containment efforts for new pests would determine the trajectory of their expansion, leading to potentially preventable new pest species becoming widely established.

Utilize metaldehyde products, reduce the use of iron phosphate for control.
Shifting chemical control in areas where suppression and potentially eradication is the goal from iron phosphate to metaldehyde is recommended. Control of *Achatina fulica* in Florida using iron phosphate formulations led to the dispersal of snails from the treated area and this compound is not as effective. Both small pellet formulations containing metaldehyde for use on adult snails and liquid formulations for juvenile snails that may not successfully feed on the baits were recommended. Specific Categorical Exclusions to use these formulations may be required for the duration of a limited duration, area specific control action. Less toxic products can be used successfully with careful planning and a longer time scale for control. Building community acceptance is a top priority for any control strategy as is knowing the optimal timing and approach based on the biology of the local population.

Vegetation management is necessary when using baits for control work.
If there are other options for feeding, the baits will have reduced effect on the population. Removing refugia, baiting when snails are physiologically active (typically when staring to reproduce), and ensuring careful spacing with calibrated equipment improves the likelihood that the baiting effort will succeed.

The use of the full suite of tools is required to keep snails from reaching densities that make harvesting impossible and to make sure there is uniform use, eliminating refugia properties.
The Australian publications "Bash'Em Burn'Em Bait'Em: Integrated Snail Management in Crops and Pastures" (Leonard et al. 2003) or "Mitigating Snails, Slugs and Slaters in Southern Western Australia" (Smith et al. 2019) are good resources and can be adopted. As farming practices have changed since 2003, a revised version of the integrated snail management publication will be released soon, and the recommendations should be incorporated into training and outreach for local extension and industry education.