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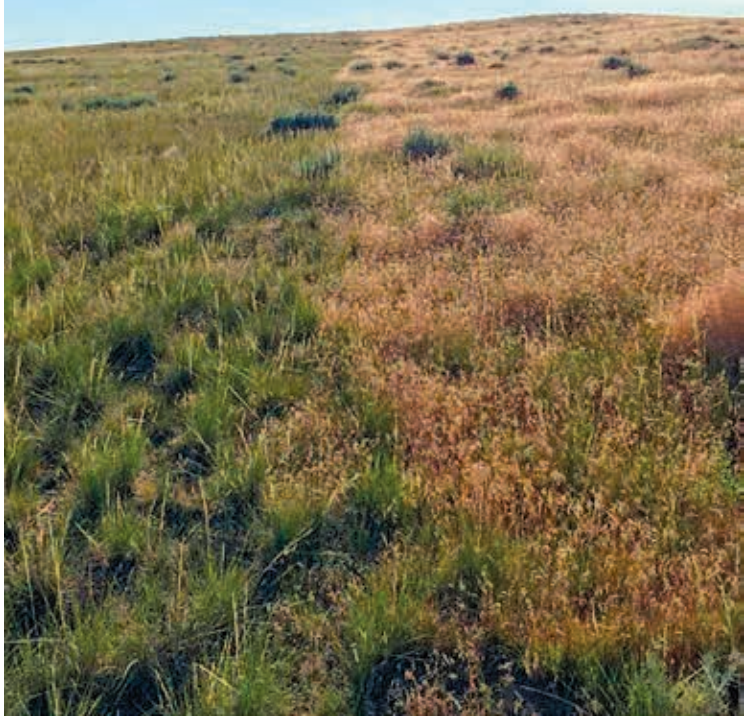
*Biological control agents (bugs) are an essential component of invasive weed management.

Biological Control of Invasive Weeds

Ranchers and rangeland managers pursue biological controls to eliminate the growth of undesirable weeds and plants.

*by **Heather Smith Thomas** and **Brooke Roberts***



This rangeland test plot shows the difference between land treated with biological agents (l) and land left untreated (r) a year following application.

Stopping the prolific spread of invasive weeds can prove challenging, as can eliminating these stubborn intruders in areas they have already dominated. For more than 400 years, thousands of foreign plant and animal species have accompanied humans on their immigration into North America. About one in seven species arriving in the United States pushes aside its native neighbors to establish itself as an invasive specie. Finding successful methods for reigning in these unwelcome intruders surfaces as a concern for ranchers and rangeland managers alike.

Paul Brusven, biocontrol director for the Nez Perce Bio-Control Center in Lapwai, Idaho, defines invasive species as foreign species whose introduction does, or is likely to, cause economic or environmental harm, as well as potentially pose risks to human health.

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>
> — Paul Brusven

"Invasive plants, animals and aquatic organisms have significantly reduced the economic productivity and ecological balance of U.S. agriculture and natural resources," Brusven says. "Many of our invasive weed problems originated in Europe and Asia in a climate similar to ours in North America. In their native lands, they are not weeds — they are part of the natural landscape and evolved through time along with natural checks and balances."

Since those natural checks and balances do not entirely exist on this continent, Brusven cites biological controls as a successful mechanism for managing a number of invasive species upon their arrival in the United States. Essentially, biological control is the process of introducing "bugs" to feed on an invasive species as its natural host.

"Biological control puts the natural enemies — whether plant, animal, or insect — to work against invasive [species]," Brusven says. "Intentional importation and release of carefully selected natural enemies — usually insects — that are host-specific to a targeted weed reduces the vigor and reproductive potential of the non-native weed."

The term "host-specific" is key to successful biological control because it means the control agent will die in the absence of its host weed. "All other plants that are part of the landscape — garden plants, agriculture crops and native plants — will not be harmed by a biological control," Brusven says.

The most common biological control agents used are typically insects, but Brusven notes mites, nematodes and plant pathogens have also been utilized to serve the same purpose.

Brusven holds workshops in the surrounding Pacific Northwest region to involve ranchers in this method of weed control. In that area there is well-documented success in using biological control agents to manage several invasive species including Mediterranean sage, St. Johnswort (Klamath weed), tansy ragwort, Dalmation toadflax and purple loosestrife. Interestingly, biological control agents were successful in controlling invasive plants in rough terrain where other control methods, such as herbicides, mowing, hand-pulling and the replanting of competitive vegetation, were not practical.

While biological control methods can be used independently of other strategies, Brusven recognizes the potential for flexibility in their implementation.

"Biological control agents can also be used in conjunction with other weed-control methods as part of an integrated pest management strategy," he says.

The unique capabilities of biological control methods make them an intriguing option for harnessing the spread and scope of invasive species across the country.

Specific solutions

By attacking the host and targeting specific areas of the plant, such as the seed, stem or roots, biological controls have proven successful in decreasing invasive species' competitive advantage over native vegetation. Different areas of the country present individual struggles with invasive species adapted to the climate and habitat conditions of their respective region. Specific biological control methods directed at particular invasive species and corresponding regions have proven successful.

Yellow star thistle. Brusven cites grazing as an initial approach for controlling the species, pointing to yellow star thistle as a weed ranchers can manage with their herd.

"If ranchers can turn cattle out on these patches in early spring, they will eat a lot of those plants before they get too mature," he notes.

If ranchers are unable to graze the affected patches early enough, Brusven recognizes five different biocontrol agents available for yellow star thistle. All five agents are seed-feeders, meaning the agents consume reproductive tissues and nutrients needed for a weed's seed production.

Leafy spurge. Grazing is also effective in controlling leafy spurge. Sheep and goats can make a substantial difference, especially in large areas where it is difficult to spray with chemicals. Likewise, six different species of Aphthona beetles have yielded positive results as biocontrol methods.

"[The Aphthona beetle] is a type of flea beetle that defoliates the plant," Brusven says. "The larvae develop in the root system of leafy spurge and as the larvae become adults they emerge and start eating the leaves. These beetles have two modes of action — damaging the roots and then defoliating the plant."

"We are also having good luck with a redheaded leafy spurge stem-boring weevil [a type of destructive beetle] called Oberea erythrocephala," Brusven notes. The Aphthona beetle and stem-boring weevils are the two agents typically employed in rangeland and pasture management of leafy spurge.

The root-feeding weevil Cyphocleonus is used to control the presence and growth of the spotted knapweed.

Spotted knapweed. In many arid regions, spotted knapweed has become an established problem. Because spotted knapweed is an extremely tough perennial weed, it is especially difficult to eliminate.

"We now have 11 different biocontrol agents for this invasive plant," Brusven says. "Three are root feeders and the rest are seed-feeding weevils, flies and moths."

Vehicle traffic in the 1960s induced a major invasion of knapweed in eastern Idaho. In the mid-1980s, the Bureau of Land Management (BLM), United States Forest Service (USFS) and several Idaho counties began using the root-feeding weevil Cyphocleonus achates to control spotted knapweed. Brusven credits some of the initial releases as successful.

Agapeta zoegana is a moth used for biological weed control.

"Biocontrol is a sleeper because you don't see an initial dramatic impact like you do with spraying," Brusven says. "It's a long-term solution."

Effective biological control programs often utilize multiple agent species to attack different parts of the weed. "With a biocontrol agent continually hammering at the root system, and another agent hammering the seed, we are slowing the spread as well as interfering with the knapweed's ability to pull up nutrients and moisture due to the root damage," Brusven explains.

Canada thistle. Using multiple agents against this weed results in quicker control but, typically, still requires at least three years to get the agent numbers high enough to reduce a weed population. Biological control agents will never completely eradicate the weeds but can reduce them to a desirable level.

Brusven highlights Canada thistle as a unique example. Because the weed grows in large patches and the plants are interconnected with a rhizome root system, Canada thistle is especially difficult to control. While biocontrol agents for Canada thistle exist, research has yet to show statistically significant evidence these biocontrol agents are effective.

As a result Brusven no longer promotes biocontrol methods for Canada thistle in Idaho. Instead, he recommends the use of other tools like herbicides, mowing and grazing when plants are young. Most grazing animals like to eat the blooms, and allowing cattle to graze at that stage can greatly reduce the seed load.

Russina knapweed. Yet another particularly troublesome invasive species in southern Idaho and numerous other states is Russina knapweed.

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A blunt knapweed flower weevil at work.

Using biocontrol agents

If producers want to find out how to control undesirable plants on their own ranch or range, they must first identify the invasive plant and then determine if there is a biocontrol agent available for that specie. A county or state weed superintendent or Extension office personnel can help identify invasive plants and available control options.

"Idaho is one of the leaders in the nation [for invasive species control], so we have a monitoring system in place for all these different weeds and their biocontrol agents," Brusven says. "Many surrounding states are starting to adopt our type of program."

Every state also has its own Animal and Plant Health Inspection Service (APHIS) office, which is part of the United States Department of Agriculture (USDA) regulatory system. The Nez Perce Bio-Control Center is directly involved with the USDA and APHIS, as its work is partially funded by the USDA, and all biocontrol agents crossing state boundaries require interstate permits managed and regulated through the USDA-APHIS.

Ranchers can obtain biocontrol agents through insectaries and sometimes from county control programs. Costs for biocontrol agents vary and may range from $35 to $200 per release — depending on the insect species and availability. "Releases may be free through educational workshops and collection days," Brusven says.

Brusven advises producers closely follow instructions for releasing insects. "Areas smaller than one acre should not be considered for biological control releases unless the area is environmentally sensitive (special vegetation areas, wetland areas, open water areas) to the other control methods such as chemical spray," he notes.

For a successful release, producers should dump the insects (50 to 1,000 in quantity, depending on the type of insect) at one location on the edge of the weed infestation rather than sprinkling them throughout the area.

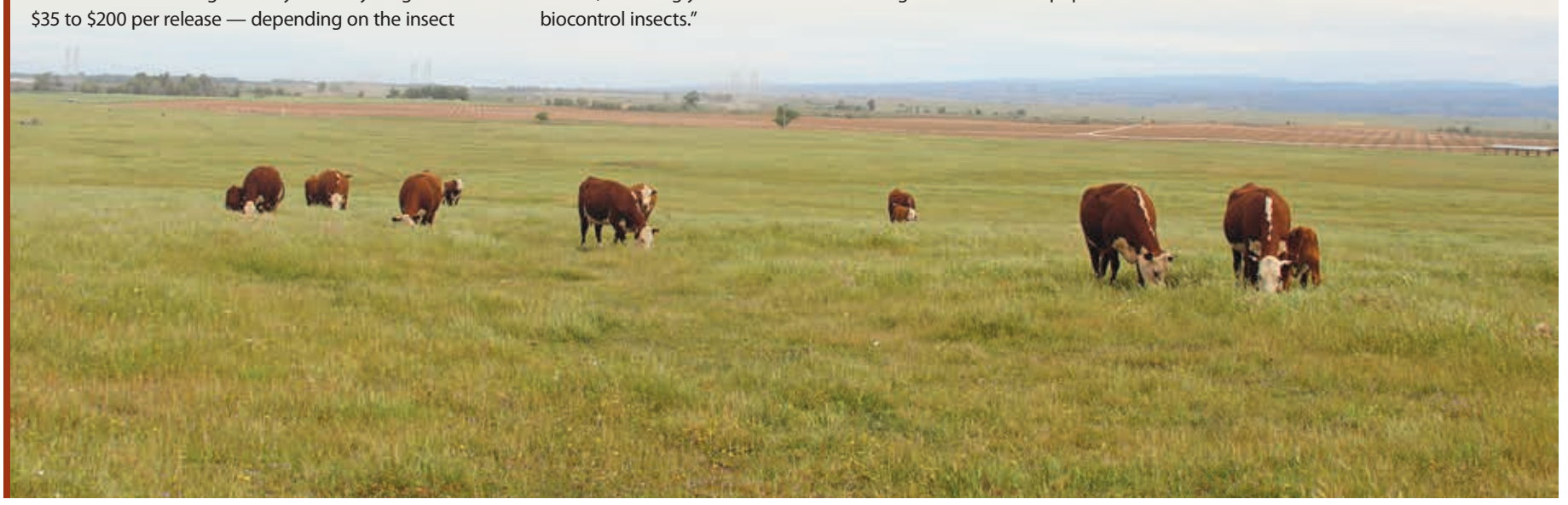
"Keep the initial releases of insects together and concentrated as long as possible after release to promote mating and egg laying," Brusven says. "It is also a good practice to make your releases early in the morning or in the evening when air temperatures are cooler, to increase chances of successful establishment."

Before producers release the insects, Brusven recommends checking the ground within their weed infestation for ants. "If you see a lot of ants, move to another location," Brusven says. "They prey on other insects, including your valuable weed-eating biocontrol insects."

Most biocontrol insects establish best on southern aspects or sites that receive a lot of sun, while weevil biological control agents normally move uphill and in the direction of prevailing winds. Brusven says producers should use these tips to their advantage as they plan where to make an initial release.

Once released, the insects establish on the host weed and continue to multiply over time. "It normally takes three to five years for optimal establishment and a reduction in the weed population — until a balance between the host-specific biocontrol insect and its host weed occurs," Brusven explains.

After the biological control agents are released, producers should not spray directly over this area for at least three years. "The agent needs to be left with adequate food and proper habitat to sustain and build its population," Brusven says. "These insects will die if they do not have their host weed." Brusven recommends leaving at least one acre (and ideally 5 acres) for the new agent to increase in population. However, Brusven says that the perimeter of the release area can be sprayed to keep the weed from spreading while the agent population builds in numbers. **HW**



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Weevils lay their eggs on the leaves of the weed.

"We are now rearing and providing some of the newer biocontrol agents for this weed," Brusven says. "One is called Aulacidea acroptilonica — a gall wasp — and it creates galls on the plant in the junction where the branches come off the main stem."

A second agent, the gall midge, creates galls on the ends of the main and side stems. The galls created by both insects serve to reduce the plant's biomass, therefore reducing the plant's seed load.

"We are starting to get both of these agents established across the state of Idaho, with partners including the BLM, county weed departments, and private landowners," Brusven adds.

Dalmation toadflax. The biocontrol agent for Dalmation toadflax comes to the forefront as a particularly successful biocontrol story. "From 2007 to 2014, we saw a more than 70% reduction [in Dalmation toadflax] across the state of Idaho, which is amazing and a huge success," Brusven says.

Purple loosestrife. Weeds in sensitive areas near streams, wetlands and lakes cannot be controlled with spray chemicals. Purple loosestrife grows in wet areas, but Brusven is armed with a very potent biocontrol agent for the weed.

"We use a little flea beetle called Galerucella calmariensis and G. pusilla that works very well for controlling purple loosestrife," he says.

The Nez Perce Bio-Control Center is also raising a root-feeding weevil of its own. The beetles are reared on an artificial diet and then distributed in Idaho and other states across the country.

Building biological controls

Invasive weeds originally made their way to the United States as seeds attached to immigrants' belongings or clinging to livestock. In order to identify biocontrol agents that are host-specific for a target weed, Brusven says the search needs to start in the homeland of the invasive species.

"Most biological control agents in use today are insects, imported from Europe and Asia," Brusven says. "These agents are thoroughly tested to ensure safety to native plants, agricultural crops or endangered species before we release them here."


Stem weevils bore holes in the leaves and stems of dalmation toadflax weeds.

Because of strict regulations established to prevent invasive species infestation, the cost to study, test and approve a new weed biological control agent is about $1.5 billion.

"These programs have had an outstanding safety record for over 100 years," Brusven says. "For the most part, we've been doing things really well, to make sure the agents we are using are very host-specific to just the target weeds."

While invasive species continue to infiltrate rangelands and pastures alike, biological control methods offer a ray of hope for ranchers and rangeland managers looking to reign in bothersome, undesirable plants. With over 133 weed species targeted from around the world and more than 350 biological control agents introduced in 70 countries, the future for biological control of invasive species appears bright.

"We are seeing increased support of this control method because land managers have realized there are very few effective and sustainable tools other than biological control to manage invasive weeds on large landscapes," Brusven says. HW

Ongoing research

Cheatgrass and medusahead are taking over thousands of acres of ranch and rangeland. BioWest Ag Solutions, a biofertilizers and soil inoculants manufacturer headquartered in Nampa, Idaho, has been working for several years on a naturally occurring bacterium that suppresses cheatgrass. The company has an agreement with the Agriculture Research Service (ARS), an arm of USDA, to produce and to market the ACK55 strain of Pseudomonas fluorescens bacteria. BioWest plans to introduce a liquid product for large-scale application.

This new weapon suppresses and inhibits root growth. Ann Kennedy, Ph.D. recently retired soil microbiologist from the ARS Northwest Sustainable Agroecosystems Research Unit in Pullman, Wash., discovered these helpful bacteria. Her research began more than 30 years ago and is now continued by Mark Weltz, Ph.D., and others at the ARS's Great Basin Rangelands Research Unit in Reno, Nev.

ARS entomologist Brian Rector, Ph.D., has been traveling to France for six months each year to work with the international ARS laboratory in Montpellier, France, to identify natural enemies for medusahead. Rector has identified a few mites showing promise as being host-specific.

As more mites need to be imported to the ARS quarantine laboratory in the United States, it will take a bit more time for Weltz to put a package together to get through APHIS.

"The first set of mites was brought through APHIS to the ARS Quarantine Laboratory at the Western Regional Research Center, but those mites died following a limited amount of testing," Weltz says. "The researchers are going to try and ship more mites and retry the process, while at the same time continuing work in Europe."

Weltz classifies each attempt as a learning experience and hopes to have another biological control for medusahead in the near future. HW


Ann Kennedy, Ph.D., discovered the bacteria responsible for controlling the invasive cheatgrass.