Project Title: Final pre-release investigations of the gorse thrips (*Sericothrips staphylinus*) as a biocontrol agent for gorse (*Ulex europaeus*) in North America

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Amount requested:	Year 1: $38,358	Year 2: $21,068	Total: $59,426
Matching contributions:	Year 1: $25,721	Year 2: $16,733	Total: $42,454

Introduction

Gorse (*Ulex europaeus*) is an environmental weed classified as noxious in the states of Washington, Oregon, California, and Hawaii. A classical biological control program has been applied in Hawaii with the introduction of 4 gorse-feeding arthropods, but only two of these (a mite and a seed weevil) have been introduced to the mainland U.S. The two insects that have not yet been introduced include the gorse thrips, *Sericothips staphylinus* (Thysanoptera: Thripidae), and the moth *Agonopterix umbellana* (Lepidoptera: Oecophoridae). With prior support from the U.S. Forest Service (joint venture agreement # 07-JV-281), we were able to complete host specificity testing of *S. staphylinus* on 44 North American plant species that were on the original test plant list. However, we recently received recommendations from the Technical Advisory Group on Biocontrol of Weeds (TAG) to include an additional 18 plant species for testing. We propose a two-year project to bring this promising biocontrol agent to the release phase by completing the required additional testing, submitting a petition for review, and selecting and surveying release sites.

Objectives

(1) Acquire and grow the additional 18 species of plants recommended by the TAG.
(2) Complete host specificity trials for the gorse thrips on the 18 plant species.
(3) Complete and submit petition for field release of *S. staphylinu*s to the TAG.
(4) Select field release study sites in Oregon, Washington and California and collect pre-release data.
(5) Share information about the gorse biocontrol program with the public.
(6) With anticipated funding from the Oregon State Weed Board in 2011: Rear and release the gorse thrips at sites throughout the Pacific Northwest.

Statement of Funding Need

The research to date has been carried out as a cooperative agreement between the University of Washington and the U.S. Forest Service Rocky Mountain Research Laboratory (RMRL). Funding was initially provided in a two-year contract (July 2007 – July 2009). It was extended for an additional year (to August 2010), but with greatly reduced funding due to budget reductions. As a result, our initial workplan objectives were severely cut back. There is currently no funding to cover the cost of testing of the additional 18 plants that the TAG recommended, nor for release and monitoring of this promising biocontrol candidate. RMRL has indicated that any funding available for next year would be no more than the amount received this year ($25,000) and this funding would be needed to cover the cost of testing the other candidate biocontrol agent (*Agonopterix umbellana*).

Cost share for this project is committed in the form of unrecovered indirect costs at Oregon State University and participation of cooperators, in particular E. Coombs of the Oregon Department of Agriculture. Although it cannot be committed in advance, we also anticipate that funding for release and monitoring activities will be available for this project through the Oregon State Weed Board in 2011, pending approval by USDA-APHIS of *S. staphylinus* for release (see objective 6).

Project Justification

Gorse is a spiny evergreen shrub introduced into North America from Europe in the late 1800's. Today it is listed as a class B noxious weed in 4 states: Washington, Oregon, California, and Hawaii. The plant also occurs in coastal British Columbia, Canada and on the East Coast of the United States from Virginia to Massachusetts. It is most problematic in the Pacific Coastal zones, where it forms dense, inpenetrable thickets in dunes, coastal bluffs, river beds, recreational lands, and forests. It outcompetes native plants and impedes access for humans and larger wildlife. It is a menace for the private landowner. The largest gorse infestations in North America are located in Oregon where a total of over 13,000 net hectares of gorse are distributed throughout 121,000 gross affected hectares, primarily along the coast (Radtke and Davis 2000). California reports over 6,000 hectares of gorse (Hoshovsky 2000). In Washington, gorse is reported from 11 counties west of the Cascade Mountains, with an estimated 300 hectares concentrated in Pacific County (Isaacson 1992). Because gorse continues to spread, these area values may be underestimates.

In cleared areas, gorse grows faster than most timber trees and must be completely removed from a site before planting new trees. Where it grows in the understories of established forests, gorse interferes with cultural operations, increasing pruning and thinning costs (Balneaves and Zabkiewicz 1981). The sharp stiff spines on larger plants make it intolerable as fodder for cattle as well as wild ungulates. Fields that are densely infested with gorse can no longer be used for foraging. With a high oil content in its leaves and stems, gorse is a severe fire hazard in shrublands, forests, and residential communities. In 1936, the entire town of Bandon, Oregon was decimated by a gorse-fueled wildfire, resulting in loss of human life. Radtke and Davis (2000) estimated the economic cost of gorse due to losses in production of pastures and timberland to be $997,000 per year within the state of Oregon alone. This does not take into account the immeasurable losses due to recreational, wildlife, and aesthetic impacts.

The unique ocean spray meadows frequently invaded by gorse in Washington, Oregon, and California are home to many federally threatened and endangered animals including the the Oregon silver-spot (*Speyeria zerene hippolyta*), the Mission Blue (*Icaricia icarioides missionensis*), the San Bruno elfin (*Callophrys mossii bayensis*), the Point Arenas mountain beaver (*Aplodontia rufa nigra*), and the western snowy plover (*Charadrius alexandrinus nivosus*). In Canada, gorse threatens the unique Garry Oak ecosystem on southern Vancouver Island (Clements et al. 2001).

Control of gorse is particularly difficult because it spreads rapidly and re-sprouts from seeds and roots following cutting, fire, or chemical treatment. Seeds remain viable for 30 years in the soil, with one report of viability after 70 years (Zabkiewicz 1976). The plant frequently infests sensitive habitats or rugged terrain where herbicide applications and other treatments are difficult or restricted. Although traditional control methods have been used successfully at some sites, they have been too costly to apply at a regional scale and gorse has continued to spread. This challenging and widespread weed is therefore a good target for classical biological control.

Results of previous host specificity and impact studies

Host specificity. The gorse thrips, *Sericothrips staphylinus*, was previously introduced as a biocontrol agent in Hawaii, New Zealand (Hill et al. 2001), and Australia (Ireson et al. 2008). For these programs, host specificity to gorse was confirmed by testing 128 plant species.

For the North American biocontrol program, we completed testing of 44 plant species on our original test plant list. *S. staphylinus* development occurred on 3 non-target plants at very low levels compared to gorse (Fig. 2). The plant species were *Genista monspessulana*, *Pettaria ramentacea*, and *Vicia tetrasperma*. When provided the opportunity, the F1 generation was not able to reproduce a second time on these plant species. All three plants are introduced and none are considered economically important. The gorse thrips did not develop on any native or economically important plant species.

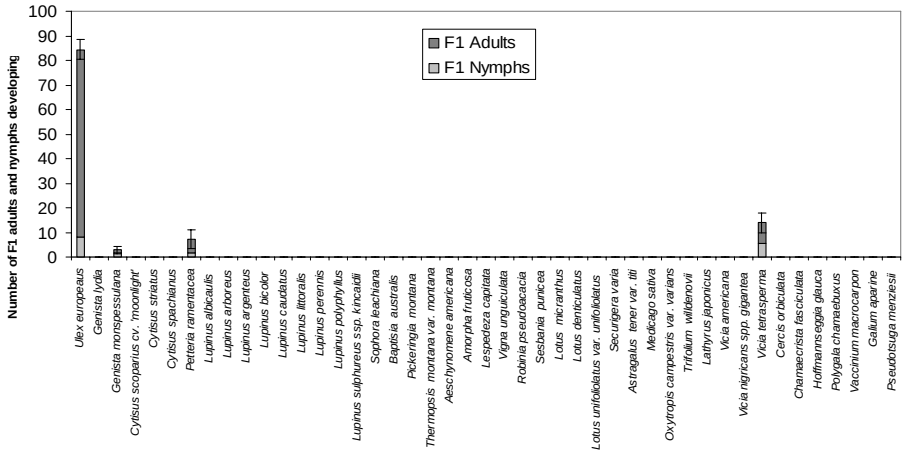

Figure 2. Mean number of F1 adults and nymphs developing following exposure of test plants to 5 pairs of *Sericothrips staphylinus* adults for 10 days. For non-target plants N=6 replicates. For *Ulex europaeus*, N=67.

Impact studies. In a lab setting, we demonstrated that the gorse thrips will kill 5 cm gorse seedlings in 45 to 65 days (Fig. 3). We also found that larger bushes (30 cm at start) exposed to the gorse thrips exhibited significantly reduced growth compared to bushes without thrips.

Mortality took much longer for the larger plants (test is still in progress). These results suggest that the gorse thrips could be particularly effective at controlling the flush of new seedlings that typically arises from the seed bank following clearing of stands, but that mechanical, chemical, or burning treatments may still be needed for the initial clearing of larger shrubs. Using a stage-structured population model, Rees and Hill (2001) demonstrated that control at the seedling stage is a key to reducing gorse populations.

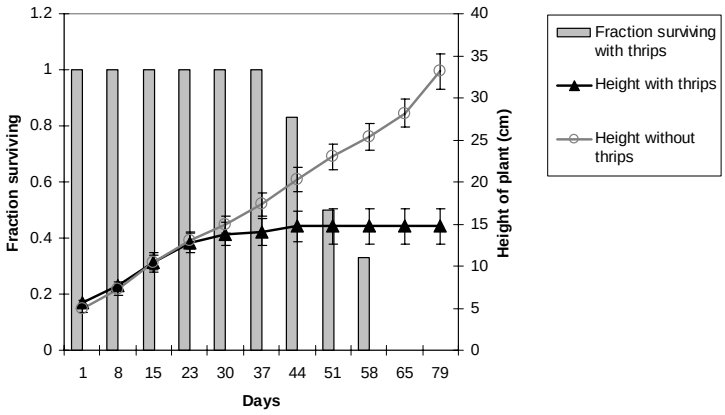

Figure 3. Impact of gorse thrips (*S. staphylinus*) on gorse seedling growth and survival over time. Bars represent the fraction of thrips-infested plants surviving and lines represent plant heights through time. All of the seedlings that had thrips died, while all of the seedlings without thrips survived.

Research Plan

Objective 1. Acquire and grow the additional 18 species of plants recommended by the TAG
The 18 plants that the TAG recommended include a mix of ornamentals, native Pacific Coast and East Coast plants, Canadian plants, and one crop plant. The plant species will be obtained in seed or vegetative form from nurseries, germplasm repositories, or field sites during the spring and summer of 2010. The plants will be grown in a greenhouse in 15 cm pots to a height of approximately 8 to 15 cm (depending on species) prior to bringing them into the quarantine facility for testing.

Objective 2. Complete host specificity trials for S. staphylinus on the 18 plant species
We will use "no-choice" tests to determine potential risks of *S. staphylinus* to the test plant species, using the same methods used for the 44 plants already tested. The potted test plants will be enclosed with a 12 cm diameter and 30 cm tall plastic tube vented with fine mesh screen and pressed 1 cm into the potting soil. Ten pairs of thrips will be placed onto each of 6 replicate plants of each test species along with gorse controls for 10 days. The plants will be maintained for 37 days (one generation time) and the number F1 adults and nymphs (if any) will be counted. Additional preference (choice) tests may be performed as follow-up if any development occurs.

Objective 3. Complete the "petition to release" and submit it for review.
A draft of the petition has already been written following the current guidelines of the TAG. Once the additional plants are tested, we will add those results into the petition and submit it for review. We plan to submit the petition in fall of 2010, which should allow enough review time for a possible field release in 2011.

Objective 4. Select field release study sites in Oregon, Washington and California and collect pre-release data.
During the summer of 2010, up to 20 release sites will be selected in coastal Oregon, Washington, and northern California. Site selection criteria include: (1) relatively high density of gorse to allow rapid thrips population growth; (2) large contiguous stand to allow the insect populations to spread; (3) no plans to treat the site with other control methods for at least 5 years; (4) representation of varying habitats and climates to maximize likelihood of releasing into successful sites. Federal lands will be included among the releases as well as state, county, and private lands. Assistance in selecting and coordinating release sites will be provided by Eric Coombs (Oregon Department of Agriculture), Jennifer Andreas (Washington State Extension), and Baldo Villegas (California Department of Food and Agriculture).

In advance of releases, we will initiate monitoring of the gorse populations at release sites and nearby control sites by establishing permanent 2 x 2 m plots in which we will measure the height, diameter, and seed output of every gorse plant through time. A stage-structured approach will allow us to detect subtle effects and project long term effects of the biocontrol population on the plant population before declines in abundance (or biomass) are visible (see Rees and Hill 2001). In addition, we will record habitat factors that may influence biocontrol performance including soil type, other plant species present, predators present, shade level, wind exposure, latitude, and distance from ocean.

Objective 5: Share information about the gorse biocontrol program with the public.
Throughout the duration of the project period, we will provide information about the biological control program to the public including coastal communities that are a most affected by gorse. In the spring of 2011, we will plan an informational meeting/workshop in Coos County, OR, one of the counties most severely impacted by gorse. Other outreach activities include presentations at the Oregon Noxious Weed Symposium, scientific society meetings, weed groups, etc. We also propose to write an article for the scientific community to be published in peer-reviewed journal such as Biological Control. The article will include the test plant list, host specificity tests, and efficacy experiments.

Objective 6: Rear and release the gorse thrips at sites throughout the Pacific Northwest.
Rearing, release, and monitoring of the gorse thrips will take place only if this insect proves to be host specific and the release permits are issued by USDA-APHIS. We therefore reserve this objective for future project contributions anticipated from the Oregon State Weed Board and other sources in 2011.

Expected Products and Outcome

This project will provide the public with an economical and safe alternative for controlling gorse in the Pacific Northwest. A reduction in the abundance or invasibility of gorse will lead to improved productivity of forests and grazing lands, and improved wildlife habitat and recreation opportunities. Once the gorse thrips is established, the redistribution of insects to other gorse infestation sites will be managed by the Oregon Department of Agriculture, the Washington Department of Agriculture, and the California Department of Food and Agriculture.

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Time Table

Task	Spring 2010	Summer 2010	Fall 2010	Winter 2010-11	Spring 2011	Summer 2011	Fall 2011	Winter 2011-12	Spring 2012
Obtain and grow additional test plants	X	X							
No-choice tests for *S. staphylinus*	X	X							
Select release sites and take pre-release measurements		X							
Incorporate new data into petition and submit to TAG			X						
Write paper for publication, public meetings, etc.				X				X	X
Address any final concerns of the TAG					X				
Measure plants at release sites		X				X			
Initial releases of agent						X			
Quantify growth and spread of agent population						X	X	X	X
Release at additional field sites									X