USDA Animal and Plant Health Inspection Service
U.S. DEPARTMENT OF AGRICULTURE

Plant Protection and Quarantine
Biological Control Program Annual Report
Fiscal Year 2024

Agency Contact:

Office of the Deputy Administrator

Plant Protection and Quarantine

Animal and Plant Health Inspection Service

United States Department of Agriculture

Drawing by Joel Floyd USDA Retired

Executive Summary

This annual report describes the major accomplishments and activities for the Animal and Plant Health Inspection Service (APHIS), Plant Protection and Quarantine (PPQ), Biological Control program in fiscal year (FY) 2024. The report highlights the program's mission and operating principles, and key PPQ priority pest and program level accomplishments. The report highlights outreach efforts, subject matter expert committee affiliations, and provides appendices that list current biological control targets including agents, the stage of project development, and a list of Plant Protection Act (PPA), section 7721, Plant Pest and Disease Management and Disaster Prevention Program supported biological control projects. This report presents key accomplishments and highlights for Field Operations implementation efforts, Science and Technology's (S&T) research and methods development work, and Pest Exclusion and Import Programs recent biological organism permitting actions. The PPQ cross functional working group developed a revised stakeholder canvassing process that solicits biological control project opportunities from industry and external partners, ensuring the program effectively understands challenges, prioritizes target pests, promotes biocontrol, and efficiently uses program allocations. In FY 2024, the program provided oversight for both insect and weed biological control activities. Field Operations provided funding and oversight for 29 cooperative agreements with organizations in 20 different states that rear, release, and monitor the establishment and impact of 14 biological control agents that attack two invasive arthropods and 14 exotic weeds. S&T provided funding for four cooperative agreements with four organizations in the United States and Switzerland which will evaluate potential agents, develop insect rearing methods, rear, release, and monitor known agents targeting three insects and 10 weeds. In addition, S&T worked on, provided subject matter expertise, oversight, and coordination for 22 projects with other programs that have a biological control component (e.g., PPA 7721, Emerald Ash Borer, Spotted Lantern Fly, and Box Tree Moth). Together, these activities and efforts demonstrate consistent progress towards the future and sustainability of the PPQ Biological Control program and the facilitation of environmentally sustainable pest management solutions that will help mitigate the economic and environmental impacts of invasive plant pest species.

Contents

Biological Control Cross Functional Working Group

The Biological Control cross functional working group's (CFWG) goal is to increase the cohesion, efficiency, and effectiveness of the PPQ Biological Control program. The Biological Control CFWG coordinates activities related to the PPQ Biological Control program across four PPQ core functional areas (CFAs):

- Emergency and Domestic Programs (EDP), Biocontrol, and Forest, Wood, and Rangelands Pests (BFWRP) – Ron Weeks
- Field Operations (FO) – Keith Colpetzer
- Science and Technology (S&T) Domestic and Emergency Scientific Support (DESS) – Tara Holtz and Eric Rohrig (s*eparated from federal service*)
- Pest Exclusion and Import Programs (PEIP), Permitting and Compliance Coordination (PCC) – Bob Pfannenstiel (*retired*) and Helmuth Rogg (s*eparated from federal service*)

Program Mission and Operating Principles

The PPQ Biological Control program promotes, facilitates, develops, and delivers safe and effective biological control through partnerships with other Federal, state, tribal, and private organizations. Organizations can use biological control alone or in combination with other control tactics to help reduce the economic losses and negative impacts of non-indigenous, invasive pests to America's agricultural production and natural areas.

The program invests in the discovery, development, and deployment of new, non-native agents (i.e., parasitoids, predators, herbivores, or pathogens) and through surveys, basic research, and methods development that locate and exploit biological control agents. The program supports the development of more efficient and improved operational methods for biological control implementation. PPQ's PCC manages the compliance activities required under the authority of the Plant Protection Act for approval of PPQ 526 permits for the importation, interstate movement, and environmental release of biological control organisms of plant pests and weeds.

Limited resources and the continued pressure of invasive pests on American agriculture and natural resources make it impractical for PPQ alone to maintain the necessary resources, infrastructure, space, and scientific expertise to effectively sustain the overall Biological Control program. PPQ's Biological Control program actively seeks and maintains partnerships with tribal governments, state agencies, federal agencies, and universities to be better prepared, equipped, and more efficient in carrying out the agency's biological control mission.

PPQ uses cooperative agreements, inter-agency agreements, and Memoranda of Understanding (MOU) to facilitate and sustain PPQ's biological control projects. These partnerships establish mutual cooperative relationships which PPQ and interested partners can use to develop, implement, and advance the Biological Control program. PPQ's consultation and active collaboration with these partners include discussions and determinations of cost-sharing,

prioritization of target pests, availability of funds, infrastructure issues, and leveraging of other resources.

The program uses significant PPA 7721 funding to complete biological control projects. PPA 7721 projects ranged from native natural enemy surveys, completion of host range testing, rearing of non-target hosts for testing, development and approval of a first-time release permit, rearing and development of rearing systems for targets and/or hosts, initial release and data collection protocols, and field establishment verification studies after first time releases.

In FY 2024, USDA APHIS approved 33 PPA 7721 biological control projects totaling $6,165,997 in funding (see Appendix B List of FY 2024 PPA 7721 biological control projects).

Key Program Highlights

Strategic Plan

PPQ's Biological Control Strategic Plan describes the program's mission, vision, and strategic milestones. The strategic plan includes specific goals, objectives, and deliverables to accomplish the agency's biological control regulatory functions and program mission. These strategic goals provide a traceable framework to ensure that the PPQ Biological Control program is responsive, sustainable, efficient, measurable, and valued by PPQ and its stakeholders. It provides five long-term goals with supporting objectives, and deliverables. The plan can be found on the PPQ Biological Control internet site.

New Canvassing Engagement Documents

S&T designed new canvassing documents to inform stakeholders and to assist them with providing suggestions to PPQ of pest species for consideration as potential targets for biological control. The documents include a new canvassing engagement letter and two associated forms:

1) The Biological Control Target Canvassing Questionnaire is the form that stakeholders use to suggest pest species for consideration as targets of future programs. S&T formulated the questions to help stakeholders assess pest impact potential and to gather information (reports, references, survey data, other documents) to support their target suggestion. PPQ uses the information when evaluating and assessing the suggestion.

2) The Biocontrol Target Ranking Form lists PPQ's current targets and allows surveyed participants to rank each species as low, med, or high priority to them.

   Thirty-five percent of those surveyed in FY 2024 suggested PPQ focus on previous or current target species. Based on results, it appears that many stakeholders are not aware that biocontrol is already available or that PPQ is developing biocontrol programs for the pests they suggested.

PPQ will use results to target outreach efforts on available agents, and keep stakeholders up to date on current targets, which may reduce repeat suggestions and/or increase suggestions of new or emerging pests. Additionally, the results provide feedback to the Biological Control Program to compare against PPQ's priorities.

New Objective Evaluation and Assessment Tools

The Biological Control CFWG is collaborating with S&T's Plant Pest Risk Analysis (PPRA) to develop objective evaluation and assessment tools to assist in the prioritization of target pests. The tools will provide a systematic and transparent process for assessing potential candidates for biocontrol funding. Identifying, selecting, and testing potential biocontrol agents is a lengthy and costly effort. Using evidence-based assessment tools to evaluate criteria such as a non-native species' current distribution, potential spread, negative impacts, and management difficulty will provide enhanced target selection saving valuable time and resources later. PPQ is developing a Weed Status Assessment, for weed species, and a Biocontrol Feasibility Assessment, for insect pests, and will incorporate it into the CFWG's biocontrol program prioritization process.

Weed Status Assessment (WSA)

The WSA evaluates the U.S. status of weeds that may be potential targets for biocontrol. The WSA will feature two different ranking tools: a species ranking tool and a state ranking tool. These tools are currently in the testing phase, with an estimate completion of late 2025. This is the first national quantitative status assessment and one of the few that considers agricultural and socioeconomic impacts of invasive weeds. Furthermore, the WSA process also includes the development of an environmental suitability model that describes the U.S. regions that are suitable or likely to be suitable for plant establishment based on three factors: plant hardiness zones, Koppen-Geiger classes, and total annual precipitation.

- The species ranking tool evaluates plant status at a national level by pooling information about the following four elements: distribution and abundance, biotic potential, impacts, and difficulty of control. It considers multiple factors for each of these elements. PPQ then compares the element scores to those of other major-invaders, minor-invaders, and non-invaders to characterize and rank the overall status of the species in the United States. PPQ can use the results of the species ranking tool to identify and prioritize potential candidates for biocontrol work.
- The state ranking tool evaluates four factors (status, distribution, impacts, and control) and assigns a status score for each state and territory. This data is subsequently mapped across the United States to illustrate the variation in species status throughout the country. In addition to published and online sources of information, the state ranking tool will incorporate information from the state canvassing efforts. The results of this tool can help identify which U.S. regions are most heavily impacted by the invasive weed and would be potentially good targets for initial release of biocontrol agents.

Biocontrol Feasibility Assessment (BFA)

The BFA is currently in the conceptualization/pre-development stage with an estimated completion date of mid-2026. The BFA will include three stages: 1) Preassessment; 2) a modified Objective Prioritization of Exotic Pests (OPEP) assessment; and 3) a biocontrol feasibility/potential screening process. The preassessment will be an initial screening to determine whether the insect is a candidate for further evaluation. PPQ is currently establishing Stage 1 criteria. In stage 2, PPQ will use a modified OPEP assessment to prioritize insect pests present in the United States according to their agricultural and environmental impacts. Considerations will include damage to crops, environmental effects, distribution, and spread. It will also consider factors such as current management strategies, host range, pest status, research significance, and eradication efforts.

The OPEP model is a validated approach for predicting the impacts an exotic pest is likely to have when introduced into the United States. Various PPQ programs use it to prioritize resource allocation for preparedness activities of pests not yet found in the United States. A modified approach to this prioritization will allow S&T to prioritize resources for insects according to their observed impacts. PPQ will not further consider in the BFA pests that cause low levels of damage or are already successfully managed in the United States. PPQ will further assess pests that cause higher levels of damage in Stage 3 through a biocontrol feasibility/potential screening process. The Biological Control CFWG will work with PPRA to establish evaluation criteria and weights, considering factors such as biocontrol agent availability, ecological compatibility, non-target effects, and cost-effectiveness. The final categorization will use a consistent and transparent approach to categorize insects according to relatively high, moderate, or low suitability for biocontrol programs.

Partnership to Advance Biological Control

APHIS has been partnering with CABI International to identify new biological control agents for the management of invasive plant species in the United States. APHIS is benefitting from the unique expertise that CABI International offers by conducting foreign exploration to identify biological control agents, testing host specificity, and evaluating the likely impact to the target weeds. During 2024, APHIS supported research to advance biological control work on nine weeds (Dyer's woad, *Isatis tinctoria;* Field bindweed, *Convolvulus arvensis;* Garlic mustard, *Alliaria petiolate*; Hoary cress, *Lepidium draba*; Orange hawkweed, *Pilosella* spp.; Perennial pepperweed, *Lepidium latifolium*; Russian knapweed, *Rhaponticum repens*; Swallow-worts, *Vincetoxicum* spp., and Yellow toadflax, *Linaria* spp.). Also, this year, CABI continues to be instrumental in conducting foreign exploration for biological control agents against Box tree moth, *Cydalima perspectalis*.

New Opportunities and Challenges with Biological Control Industries

In July of 2024, the Biological Control CFWG initiated conversations with the Association of Natural Biocontrol Producers (ANBP) to look at potential ways PPQ and ANBP may work together to help support biological control programs. For example, mass rearing agents as a service for PPQ at a lower cost than traditional non-commercial collaborators or by taking over mass rearing themselves for profit which will in turn free PPQ funds for other projects. The ANBP is a professional trade organization that supports and promotes the use of invertebrate biocontrol organisms. They represent North American and International producers of agents with overarching goals to advocate for research and technology transfer to industry, methods development and quality assurance in mass rearing, and delivery of agents to the end user. ANBP has produced "Guidelines for Purchasing and Using Commercial Natural Enemies in North America". This guide covers all North America and includes all ANBP member companies in the region as well as the agents they sell.

Outreach and Education

S&T Hosts Symposium Celebrating Scientists

On November 12, 2024, at the Entomological Society of America annual meeting in Phoenix, Arizona, S&T hosted a symposium celebrating recently retired S&T scientists Juli Gould and Hannah Nadel and their careers within S&T supporting work on biological control and insect rearing. The symposium provided an overview of PPQ's biocontrol and rearing programs and results from research supporting rearing invasive moth pests, PPQ's emergency response programs, identification of intercepted insects in wood-packing materials, developing an artificial diet rearing system for emerald ash borer, and biological control of emerald ash borer, shot hole borers, box tree moth, and Spotted lanternfly.

PPQ Participates in the First National Forum on Biological Control

During the week of March 11-15, 2024, biological control experts across PPQ participated in the First National Forum on Biological Control in Annapolis, Maryland. Over 90 participants, ranging from Federal, state, international, university, and nonprofit organizations, vested in biological control attended the forum. The forum provided for the exchange of the latest advancements in weed and arthropod biological control research, shared challenges, opportunities to collaborate, and areas to optimize efforts for maximum efficacy. PPQ identified central themes and areas for continued focus, such as proactive approaches to biological control of invasive pests, roles of social scientists in advocating for societal acceptance of biological control, use of genetic and molecular tools for biological control delivery and host range testing, and the need for increased monitoring and impact studies and shared communication of results.

Training on Fungal Pathogens for Asian Citrus Psyllid Biocontrol

During the week of February 27, 2024, S&T staff located in Edinburg, Texas, coordinated and received a comprehensive training course on fungal pathogens to control the Asian citrus psyllid. S&T hosted an entomologist with Jaronski Mycological Consulting who provided the training and is part of collaborative efforts with S&T aimed to identify effective biological control agents

that PPQ can use to manage the vectors of citrus greening, thereby reducing the economic impact of the invasive species on the citrus industry. The course covered various aspects of fungal pathogen management, including isolation, culturing, quality control and viability, application methods, and field bioassay assessments.

Below are additional program outreach and education accomplishments completed this year.

- Booth, T.C. and Dodge C. "Update on biological control of emerald ash borer." Future of Brown Ash: Weaving Indigenous Knowledge and Western Science to Promote Resilience Amidst Emerald Ash Borer Invasion. The University of Maine held the colloquium on Oct 8, 2024, in Orono, ME.
- Booth, T.C., Morris, T.D., Fierke, M.K., Clifton, E.M., Dodge, C., Gould, J. "Research updates on biological control of emerald ash borer." Entomological Society of America Annual Meeting. Phoenix, AZ. Nov 12, 2024.
- Booth, T.C. "Research updates on EAB forested IPM study." S&T Forest Pest Methods Laboratory Annual Research Review. Buzzards Bay, MA. Dec 11, 2024.

Committee and Expert Group Activities

Biological Control CFWG members served as APHIS PPQ Biological Control representatives in the North American Plant Protection Organization (NAPPO) Biological Control Expert Group – "Revision of RSPM 26 - Certification of commercial arthropod BCAs or non-*Apis* pollinators moving into NAPPO member countries". The CFWG's work strengthened international collaboration and development of regional standards that support and facilitate the use and development of biological control pest management solutions in North America.

Biological Control CFWG members also served as APHIS PPQ Biological Control experts and Technical Advisory Group (TAG) members at the 2023 Hybrid Annual TAG Meeting. PPQ provided guidance to researchers and expert advice on recommendations for or against the release of biological control agents, based on considerations of potential non-target impacts and conflicts of interest.

FY 2024 Portfolio of Biological Control Targets, Agents, and Stage of Project Development

See Appendix A

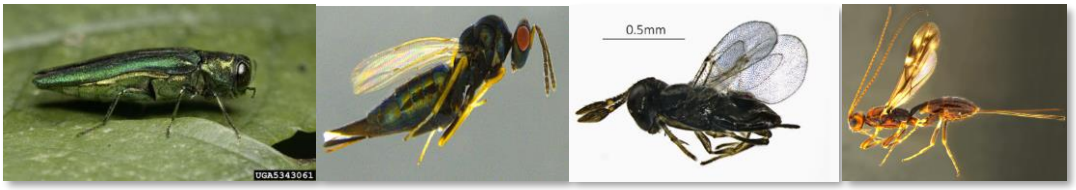
FY 2024 List of PPA 7721 Biological Control Projects Supported

See Appendix B

Key PPQ Priority Pests

PPQ's Biological Control program provides scientific and technical support for specific pest biological control programs funded by PPQ under other funding lines. With many years of experience and partnership connections on these types of programs, the PPQ Biological Control community of scientists can assist in the development and completion of these programs.

Emerald Ash Borer



The emerald ash borer (EAB, *Agrilus planipennis*) is a destructive wood-boring pest of ash trees (*Fraxinus* spp.). EAB was first found in Michigan in 2002. Today, EAB is in 37 states and the District of Columbia. Exploration for EAB natural enemies in China, Russia, and Korea has yielded several hymenopteran parasitoids, and four species have been approved for release as biological control agents of EAB in the United States.

Customer Service

- EAB online reports have increased each year since beginning in 2020. EAB online reports received 169 reports from October 2023 to September 2024.
- In FY 2024, PPQ received 348 EAB hotline calls; PPQ receives an average of 450 calls annually.
- In FY 2024, 9,163 subscribers received four EAB Program Reports created and issued by APHIS' Legislative and Public Affairs.

Releases

Since APHIS began the rearing and release program in 2009, over 9 million parasitoids have been released in 482 counties in 32 states, District of Columbia, and Canada.

In FY 2024, PPQ released parasitoids in 166 release sites (two in Canada and 164 in the United States). Of which, 29 releases were in new counties.

Table 1. Biocontrol Agents Released

Biocontrol Agents	**Amount Released in FY24**	**Amount Released over life of the Program**
Oobius agrili	197,500	2.6 M
Spathius agrili	6,465	474,000

Spathius galinae	86,880	699,000
Tetrastichus planipennisi	13,7752	5.6 M
Total	**428,597**	**9.3 M**

Recoveries

To date, parasitoids have been recovered in 274 counties in 23 states: Colorado, Connecticut, Delaware, Illinois, Indiana, Iowa, Kentucky, Louisiana, Maine, Maryland, Massachusetts, Michigan, Minnesota, Missouri, New Hampshire, New Jersey, New York, Ohio, Pennsylvania, Rhode Island, Tennessee, Virginia, Wisconsin, and in 2 Canadian provinces: Ontario and Quebec. This means the wasps are establishing, reproducing, and killing EAB.

- Confirmed *Spathius agrili* establishment in Tennessee, marking the first establishment of this parasitoid, first released in 2007, in the United States.

S&T EAB paper published

- Morris, T.D., Gould, J.R., Booth, T.C., Miller, F.D., Kaltenbach, J., Fierke, M.K. (2024). Managing emerald ash borer in urban forests: Integrating biocontrol and insecticide treatments. Biological Control, 199: 105658.
- Morris, T.D., Gould, J.R., Fierke, M.K. (2024). Field phenology of emerald ash borer (Coleoptera: Buprestidae) parasitoids in New York State. Environmental Entomology, 53(4): 532–543.

Spotted lanternfly

Spotted lanternfly (SLF, *Lycorma delicatula*) is an invasive planthopper that feeds on a wide range of plants, including grapes, hops, stone fruits, and hardwood trees. When spotted lanternfly feeds, it excretes a sticky, sugary fluid that causes sooty mold, which can further damage plants. Its preferred host is tree of heaven (*Ailanthus altissima*), and today 18 States have some degree of infestation.

Research continues for rearing methods development, life history and host specificity for *Dryinus sinicus* a nymphal parasitoid of SLF. S&T has observed some attacks in conservative no-choice testing but none of these attacks have resulted in parasitism. For any non-target species attacked, S&T is conducting further choice testing. Studies are ongoing.

PPQ partners completed survey work in Japan to evaluate the invasive SLF populations there and the role, if any, of parasitoids. Results show that SLF populations in Japan have been slow to establish; however, populations are increasing. No evidence found of impactful parasitoids.

S&T is planning for new collaborations to do surveys of SLF populations in northern Vietnam to evaluate other candidate biological control agents.

Box Tree Moth

Box tree moth (BTM; *Cydalima perspectalis*) is an invasive pest that can damage and potentially kill boxwood (*Buxus* species) plants. The caterpillars are ravenous feeders, and heavy infestations can completely defoliate host plants. After consuming all the leaves, they feed on the bark which eventually kills the plant. Boxwoods are a popular ornamental evergreen shrub common to many landscape environments in the United States.

CABI Switzerland led investigations for the parasitoid complex of BTM in South Korea. Of the eight primary larval parasitoids shipped to the CABI quarantine in Switzerland, two parasitoid species are now established in the quarantine laboratory and undergoing host specificity testing. Initial results show that one of them, the ichneumonid wasp *Eriborus* sp. (Campopleginae), had high levels of parasitism observed in the field and may be a good candidate for classical biological control of BTM in North America. This most promising parasitoid was shipped to S&T to initiate host range testing with native Lepidoptera and assess potential non-target effects. S&T has maintained a colony of *Eriborus* sp. since Dec 2023.

In 2024, S&T field-collected and reared 28 species in 12 families of non-target moths for host specificity testing, including four native crambid species. Scientists completed host specificity testing for eight species in six families of non-target moths. They further initiated host specificity testing for an additional five species in four families of non-target moths. Results to date indicate that *Eriborus* sp. will not attack other families of Lepidoptera but will attack other crambid species besides box tree moth.

S&T and collaborators will need to conduct choice testing and natural history comparisons to determine the environmental impact of *Eriborus* sp. on non-target crambids in the United States.

Citrus Greening and Asian Citrus Psyllid

Citrus greening, also called Huanglongbing (HLB), is a bacterial infection of citrus plants. It is one of the most serious citrus diseases in the world. Once infected, most trees die within a few years. In the United States, citrus greening is spread by a tiny insect called the Asian citrus psyllid (ACP; *Diaphorina citri*).

In 2024, S&T produced 1,247,200 *T. radiata* for releases in Texas, Louisiana, and Mexico. S&T completed all goals of the methods development for rearing and releasing *Tamarixia radiata*. Calendar year 2024 was the last full year of PPQ funded release in Texas, Louisiana, and Mexico border areas. PPQ is winding down production in 2025 and will cease new releases in April 2025. A comprehensive rearing, release, and monitoring manual for *T. radiata* is available for stakeholders upon request. Since 2013, PPQ mass-produced over 7 million beneficial insects, reflecting a strong commitment to sustainable pest management and international collaboration. When including earlier efforts, the cumulative total exceeds 18.7 million insects. Work also continued evaluating the impact of entomopathogens for the integrated biological control of the ACP in the Lower Rio Grande Valley of Texas. Two commercially available mycopesticides of ACP were evaluated in the laboratory and field at varying rates, with BioCeres being most effective in field trials and higher rates being most effective at reducing nymph survival.

In California, S&T and Citrus Research Board worked in partnership to evaluate methods for area-wide control of ACP in residential areas next to commercial citrus by managing Argentine ants, which tend and protect ACP and disrupts biological control. When Argentine ants are removed or not present, biocontrol of ACP by naturally occurring natural enemies can increase by 50 – 99%.

Japanese beetle

Japanese beetle (*Popillia japonica*) is a destructive turf, grass, and plant pest. Beneath the soil, growing grubs gnaw on grass roots causing turf to brown and die. Adult beetles feed on more than 300 ornamental and agricultural plants. This beetle, native to Japan, was first discovered in the United States in New Jersey in 1916. Since then, the beetle has spread throughout most of the Eastern and Central United States.

Ovavesicula popilliae is a microsporidian that infects both Japanese beetle larvae and adults.

S&T is collaborating with ARS's National Center for Agricultural Utilization Research, conducting metagenomics sequencing and characterization of the pathogen.

Establishment or presence of *Ovavesicula* has been verified at 11 airports at risk to transport Japanese beetle via air cargo operations to uninfested Western states; five of these airports continue to conduct pathogen releases and are monitoring for establishment.

Roseau Cane

Roseau cane (*Phragmites australis*) is a plant at the mouth of the Mississippi River. Roseau cane provides habitat for wildlife, reduces storm surge and maintains channel navigation. In the fall of 2016, outbreaks of the roseau cane scale (*Nipponaclerda biwakoensis*) were found associated with die-offs of the cane over thousands of acres at the mouth of the river.

Using molecular analyses, S&T detected a high degree of genetic diversity, suggesting the presence of seven cryptic species within the *Aprostocetus* genus. One of these species, referred to as *Aprostocetus* sp. 7, was detected in autumn 2023 in Louisiana. S&T maintains a continuous laboratory colony of *Aprostocetus* sp. 7. Using this colony of *Aprostocetus*, S&T developed host range testing methods and have tested 14 non-target species spanning the families *Aclerdidae, Coccidae, Diaspididae, Pseudococcus,* and *Monophlebidae*. Three more replicates are needed to complete our battery of testing to include triplicate tests for each species. To date, no non-target species have been attacked. Work in collaboration with University of Massachusetts Amherst toward identifying *Aprostocetus* sp. 7 is underway using a combination of morphological and molecular techniques. Work in collaboration with Louisiana State University AgCenter toward evaluating the role of *Aprostocetus* sp. 7 in the field is underway.

Field Operations

During FY 2024, Field Operations provided funding and oversight for 29 cooperative agreements with organizations in 20 different states that rear, release, and monitor the establishment and impact of 14 biological control agents that attack two invasive arthropods and 14 exotic weeds.

Common Crupina

Common crupina (*Crupina vulgaris*) is a federally listed noxious weed that forms dense stands, displaces native vegetation, and reduces the value of range and pastureland, as the mature plants are not palatable to most livestock. During FY 2024, cooperators used funds to propagate and release spores of the fungus, *Ramularia crupinae*, and to investigate factors that contribute to infection and could improve future release methods.

Flowering Rush

Flowering rush (*Butomus umbellatus*) is an aquatic invasive weed from Eurasia that has established populations in the Great Lakes and areas of the Pacific Northwest. Unchecked growth of flowering rush displaces native vegetation, reduces biodiversity, interferes with recreational opportunities, and reduces the amount of irrigation water available to farmers. APHIS began investing in biological control of flowering rush during FY 2024. Cooperators used funds to prepare facilities and sites to rear and release *Bagous nodulosus*, a semi-aquatic weevil that feeds exclusively on the leaves and rhizomes of flowering rush.

Garlic Mustard

Garlic mustard (*Alliaria petiolata*) is a Eurasian forb that has invaded forest understories throughout the Northeastern, Midwestern and Northwestern United States. Garlic mustard reduces the abundance and diversity of native species through competition and by releasing chemicals from its roots that inhibit the growth of other plants, including oxygen producing and carbon sequestering forest trees. During FY 2024, APHIS cooperators used funds to prepare facilities and sites to rear and release *Ceutorhynchus scrobicollis*, a weevil whose larvae feed on and develop in the petioles, growing points, and root crowns of garlic mustard.

Gorse

Gorse (*Ulex europaeus*) is a spiny, woody, perennial that is extremely flammable, has fueled catastrophic fires around the world and in the United States, and is established in the northeastern United States from New York to Virginia and on the west coast from Washington to southern California. In FY 2024, APHIS cooperators used funds to rear and release 9,600 *Sericothrips staphylinus*, a thrips that feeds exclusively on gorse, into three states. In the past four years, cooperators have confirmed establishment of gorse thrips in the United States and have seen initial impacts to the target, as the thrips populations slowly increase in size and density.

Hoary Cress

Hoary cress (*Cardaria draba*) is a long-lived and drought resistant perennial that spreads rapidly, occurs almost everywhere in the United States, forms dense monocultures that displace native vegetation, and contains chemicals that irritate the mucus membranes of grazing animals. During FY 2024, APHIS' cooperators reared and released 457,750 *Aceria drabae*, a mite that causes galls to form on the buds and developing flowers of hoary cress, into six states. Galls stunt plant growth, and galls on the flowers prevent seed production. Since the first release into the environment in 2019, cooperators have shown that the mite can survive harsh winter conditions, like those that occur in Montana. Montana was, in fact, able to collect galls from three established sites and redistribute them to 47 points in state and one cooperator in a different state during FY 2024.

Houndstongue

Houndstongue (*Cynoglossum officinale*) is a shade-tolerant perennial that invades disturbed areas and outcompetes native vegetation. In addition to those invasive characteristics, the plant causes issues when mixed with hay because it contains phytochemicals that cause liver disease and even liver failure in animals that consume too much of it. Its spiny seeds create problems for ranchers trying to market wool and fur as they must spend extra time and money removing these burs before selling the animal fiber. The burs are also known to damage livestock when they become lodged in the livestock's eyelashes. APHIS' cooperators mapped houndstongue infestations and ranked them in terms of suitability for releasing *Mogulones borraginis*, a weevil that feeds exclusively on the flowers and developing seeds of houndstongue.

Knotweeds

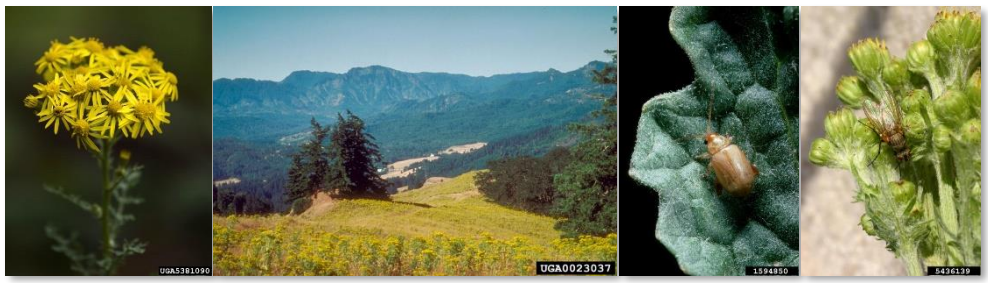
Bohemian, Giant, Japanese knotweeds (*Fallopia* x *bohemica*, *Fallopia sachalinensis*, and *Fallopia japonica*) are three robust perennials that occur almost everywhere in the United States, except the arid southwest, spread rapidly from rhizomes and cuttings, form dense thickets that

displace native vegetation, reduce biodiversity, and are very difficult to control. APHIS cooperators released the Murakami line of the knotweed psyllid, *Aphalara itadori*, a psyllid that feeds exclusively on Bohemian, Giant, and Japanese knotweeds, for the very first time into eight new states during FY 2024. Collectively, APHIS' cooperators reared and released 313,718 psyllids into ten states during FY 2024.

Swallowworts

Black and pale swallowworts (*Cynanchum louiseae* and *Cynanchum rossicum*) are perennial vines that have invaded fields and forests in the northeastern United States and have been found as far west as Nebraska and Kansas, with satellite populations in California, and as far south as Missouri and Kentucky. These species can form dense stands that displace native vegetation and alter the composition of animal communities. Black swallowwort is a particularly disturbing ecological threat as researchers have shown that it stimulates monarch butterflies to deposit eggs; even though, monarch larvae cannot complete development on this plant. APHIS' cooperators reared and released 15,775 *Hypena opulenta*, a Ukrainian moth whose larvae feed exclusively on black and pale swallowworts.

Tansy Ragwort



Tansy ragwort (*Senecio jacobaea*) is a Eurasian weed that has established populations in the northeastern and northwestern United States. It is toxic to livestock, and while animals usually avoid eating it, livestock can become sick and die when this weed is mixed into hay and other food. APHIS' Cooperators in Alaska continued to build capacity with state officials, as they explore agents with potential for release into Alaska. This investment explores whether the chrysomelid, *Longitarsus jacobaeae*, and the root-maggot, *Botanophila seneciella*, are good candidates to release for control of tansy ragwort in Alaska.

Yellow Starthistle

Yellow starthistle (*Centaurea solstitialis*), an annual forb that forms dense monocultures, is present in almost every state, displaces native vegetation, reduces biodiversity, reduces the value of range and pastureland, and is toxic to horses. APHIS' cooperators focused on rearing *Ceratapion basicorne*, a weevil whose larvae feed and develop in the root crown of yellow starthistle. In FY 2024, cooperators from Oregon State University received and started rearing the weevil, cooperators from the Oregon Department of Agriculture successfully reared seven adults that produced 42 eggs, cooperators from the Colorado Department of Agriculture produced 193 adults, and cooperators from the California Department of Food and Agriculture produced another 100 adults.

Yellow Toadflax

Yellow toadflax (*Linaria vulgaris*) is a short-lived and drought resistant perennial that occurs almost everywhere in the United States. Yellow toadflax spreads rapidly, forms dense monocultures, displaces native vegetation, and reduces the value of range and pastureland, as cattle generally avoid eating it. APHIS' cooperators established *Rhinusa pilosa*, a weevil that induces galls on the stems of yellow toadflax, for the first time at two sites in South Dakota and two sites in Colorado. These sites complement the multiple sites established in Montana last year. APHIS' cooperators will collect galls from established sites and redistribute them to other sites and cooperators in the future. Collectively, APHIS' cooperators reared 851 *Rhinusa pilosa* during FY 2024.

Olive Psyllid

Olive psyllid (*Euphyllura olivine*) is a serious pest of olives that was first detected in California in 2007 and is known to reduce crop yields by up to 60% in the Mediterranean basin. In FY 2024, APHIS' cooperators reared and released 96 *Psyllaephagus euphyllurae*, an encyrtid wasp that attacks and kills olive psyllid. Cooperators also imported 340 mummified olive psyllids to introduce new adults into the existing breeding colony.

Spotted Wing Drosophila

Spotted wing drosophila (*Drosophila suzukii*) is a vinegar fly that damages healthy berries, cherries, grapes, and other soft tree fruit by cutting slits into the fruit to deposit eggs. In FY 2024, APHIS' cooperators reared and released 302,010 *Ganaspis kimorum*, a parasitoid wasp that attacks spotted wing Drosophila, into five states. Cooperators also collected fruit, allowed parasitoids to emerge from the fruit, and identified the parasitoids that emerged from the fruit to better understand the distribution of *G. kimorum* and the adventive parasitoid, *Leptopilina japonica*, in the United States.

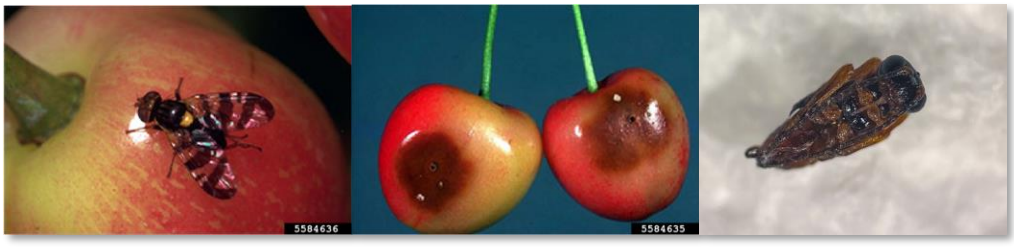
The Montana Biocontrol Coordination Project (MBCP)

Field Operations continued supporting the MBCP, which organized 42 events during FY 2024 where 340 volunteers collected nearly 800,000 beneficial insects and redistributed them across 40 counties in Montana, 12 other states, and three tribal nations. The eight beneficial insects collected and redistributed by MBCP help control four invasive weeds. The MBCP also organized 23 biological control outreach events and monitored the establishment, impact, and health of biocontrol agents at 70 sites throughout Montana. The MBCP is working to establish field insectaries and redistribute *Aceria drabae* for control of hoary cress, *Mogulones borraginis* for control of houndstongue, and *Bagous nodulosus* for control of flowering rush.

Science and Technology

In FY 2024, the program supported the coordination of research projects against 33 targets. Scientific research is focused on advancing research and data collection to support U.S. permitting of 19 potential agents and on advancing methods development for rearing and release of 24 agents. Below we highlight a handful of S&T led projects.

European Cherry Fruit Fly



European cherry fruit fly (ECFF; *Rhagoletis cerasi*) is a serious pest of cherries. The fly damages ripening fruit, causing it to rot and fall off the tree. ECFF is found throughout Europe and in parts of West and Central Asia. It can spread to new areas through the transport of infested fresh cherries, soil, or fruit from host plants. Canada confirmed the fly at several sites in

Ontario in 2016, the first record of it in North America. It has been in the United States since 2017, when we detected it in New York.

Collaborators at Cornel University are exploring a variety of types and levels of biological control against EECF in the New York region. They have collected 750 pupae from honeysuckle in 2023 and overwintered under laboratory conditions. The pupae were monitored the following summer for fly or parasitoid emergence. Of these pupae, 427 (57%) eclosed as adult ECFF and no parasitoids emerged. Un-eclosed pupae and one pupa had a hymenopteran parasitoid (species currently unknown). In 2024, our collaborators also collected soil from underneath sweet cherry trees and tested it for the presence of entomopathogenic nematodes as potential agents to test on ECFF pupa. All locations surveyed were positive for nematodes and 25 candidate biological control isolates were confirmed by inoculating fresh wax worms with isolated nematodes extracted from soil samples.

Chinese Privet

Chinese privet (*Ligustrum sinense*) was introduced into the United States in 1852 for use as an ornamental shrub. It is used for hedge and mass plantings, and sometimes as single specimens for its foliage and its profusion of small white flowers. It continues to be widely sold in the nursery and gardening industry. Escapes from cultivation are aggressive and troublesome invasives, often forming dense thickets, particularly in bottom-land forests and along fencerows, thus gaining access to forests, fields, and rights-of-way.

Working in conjunction with Louisiana State University this project aims to characterize the herbivores and pathogens associated with Chinese privet and to determine the U.S. distribution of the seed weevil *Ochyromera ligustri*, a potential biocontrol agent for this invasive weed. Although our collaborators did not find seed weevils in Florida, multiple moth larvae were collected and reared for identification. Collaborators found two species of moths (*Argyrotaenia amatana* and *Palpita kimballi*) attacking Japanese privet in south Florida. *Palpita kimballi* is a new host recorded for Japanese privet.

South American Tomato Leafminer

S&T supported work at University of California Davis that evaluated the biological control potential of California predatory mirids against the invasive tomato South American tomato leafminer (SATL, *Phthorimaea absoluta*, formerly *Tuta absoluta*).

Collaborators conducted monthly mirid sampling at fields throughout the Central Valley during the tomato growing season. A potential mirid biological control agent, *Engytatus* sp. (*varians* or *modestus*) was found. Experiments are underway to determine which *P. absoluta* life stages are most susceptible to predation by this mirid species, as well as the mirid's preference for *P. absoluta* compared to an alternate prey option (the whitefly *Bemesia tabaci*). This type of foundational knowledge about native predators is an important step towards the proactive biological control of this destructive pest

Brazilian Peppertree

Brazilian pepper tree (*Schinus terebinthifolia*) is invasive because it's a fast-growing, resilient plant that outcompetes native species, forming dense thickets that shade out other plants and disrupt ecosystems. Brazilian pepper tree can alter natural fire regimes, potentially leading to more frequent and intense wildfires. A thrips, *Pseudophilothrips ichin*i (Thysanoptera: Phlaeothripidae), was permitted and released in 2019 as the first biological control agent for this invasive weed in Florida, USA. The thrips feed on flushing leaves that are produced during the vegetative season of the host.

S&T developed a comprehensive field monitoring program across 5 locations in South Texas (Hidalgo County, 3 in Willacy County, and 4 in Cameron County) to gather baseline data prior to *P. ichini* releases and assess post-release impacts on Brazilian peppertree (BPT) populations. S&T produced 201,877 *P. ichini* from October 1, 2023, to September 30, 2024, through optimized rearing techniques. S&T released 135,362 *P. ichini* at 8 sites in Hidalgo, Cameron, and Willacy counties between October 1, 2023, and September 30, 2024, and shipped 63,000 *P.*

ichini to the US Army Corps of Engineers during FY 2024 to support their Brazilian peppertree management projects.

Shot Hole Borer

The polyphagous shot hole borer, *Euwallacea fornicatus*, and *Fusarium euwallaceae*, a fungus it carries, are an exotic pest complex causing dieback and mortality to numerous native and ornamental hardwood trees and shrubs in southern California.

S&T is continuing to work to identify an effective biological control agent for shot hole borer (*E. fornicatus*). S&T maintains a laboratory colony of prospective biocontrol agent *Phymastichus nudusdraco* since February 2023. The colony was initiated from wasps originating from Taiwan. We are testing three species of non-target ambrosia beetles under laboratory conditions for use in host specificity testing. Collaboration of S&T with the University of California, Riverside (UCR) resulted in a submitted manuscript for taxonomic description of *P. nudusdraco*. (Husein, D., Triapitsyn, S.V., Liu, F.L., Liao, Y.C., Dodge, C.E., Tuan, S.J., Stouthamer, R. and Rugman-Jones, P.F. (2025). Description of a new species of *Phymastichus* (Hymenoptera: Eulophidae), a parasitoid of adult shothole borers *Euwallacea* spp. (Coleoptera: Curculionidae) in Asia. Journal of Asia-Pacific Entomology, 28(1): 102360).

Spotted-Wing Drosophila

Spotted-Wing Drosophila (SWD, *Drosophila suzukii*) is a serious pest of cane berry, blueberry, cherry, and stone fruit crops due to its ability to lay eggs in ripening, undamaged fruit. It invaded California in 2008 and has established throughout the state and much of North America.

S&T established laboratory colonies of SWD and its biological control agent *Ganaspis kimorum* (formerly *G. brasiliensis* G1) at the Salinas, CA laboratory to support a classical biological

control program as part of a national effort to manage SWD. Over 1500 *G. kimorum* have been reared in Salinas since October 2024, and the colony will be further scaled-up into a mass-rearing system.

S&T will work with California Department of Food and Agriculture, USDA ARS, and University of California cooperators to release mass-reared agents in SWD-impacted regions of California and evaluate establishment and impacts.

Pest Exclusion and Import Programs

Pest, Pathogen, and Biological Control Permitting (PPBP) Unit

In FY 2024, PPBP continued to review and process petitions for approval for the release of biological control agents. These petitions were submitted by stakeholders and are at different phases of the review and approval process. The following are highlights:

The Environmental Assessment (EA) for the release of *Bagous nodulosus* to control flowering rush is out for public comment at the end of FY 2024. We do not expect negative comments, and we believe that release should be authorized in FY 2025.

APHIS received three petitions for new weed biocontrol agents in FY 2024. *Lygomusotima stria* was petitioned as an agent against old-world climbing fern, an invasive weed in the Everglades, a new biotype of *Agasicles hygrophila* against alligator weed, and *Ceutorhynchus constrictus* against garlic mustard. These petitions are either under review by the Biological Control Technical Advisory Group or are having biological assessments prepared. There was also a petition submitted for the release of *Metaphycus macadamiae* for control of the Macadamia felted coccid in Hawaii. An additional petition for release of *Aprostocetus nitens* for control of Erythrina gall wasp in Hawaii is under review by APHIS.

The Biological Assessment (BA) for *Eucryptorrhynchus brandti* for control of tree of heaven is under review by the U.S. Fish and Wildlife Service in FY 2024; the BA's for *Agasicles hygrophila* against alligator weed as well as the agents for control of old-world climbing fern are being prepared. The EA's for *Euchryptorrhynchus brandti* for control of tree of heaven and a combined EA for *Callopistria exotica*, *Lygomusotima stria* and *Neostrombocerus albicomus* against old-world climbing fern have been completed. APHIS is waiting for additional data on *Ceutorhynchus cardariae* against hoary cress species in preparation for writing a biological assessment.

Tribal review was completed for *Ceutorhynchus scrobicollis* for garlic mustard in FY 2024. Tribal consultation packages for *Dichrorampha aeratana* for oxeye daisy and *Aphalara itadori* for knotweeds in Alaska are being prepared.

There are three Tribal reviews being developed, one for *Aceria angustifolia* against Russian olive, another for *Mogulones borraginis* against houndestongue and finally one arthropod biocontrol, *Apanteles opuntiarum* against *Cactoblastis cactorum*.

The package for *Aceria salsolae* against Russian thistle has been sent to Regulatory Analysis and Development and the Notice of Availability of an EA is awaiting publication in the Federal Register.

Petitions for two agents against Chinese tallow are still under review, and we are awaiting additional data.

Appendix A: FY24 Biological Control Target, Agent, and Stage of Project Development

X= Current stage of support, Y= Yes, N= No, Y-H= Yes - Hawaii only, Y-R= Yes - Research only, N-W = not approved for interstate release -within State movement only

TARGET PEST/*BC Agent*	**Pre-Approval Testing**	**Permitting Review**	**Approved for Release**	**Methods Development**	**Rearing & Release**	**Field Coll. & Redistribute**	**Post-release Monitoring**	**Technology Transfer**
INSECTS								
Asian Citrus Psyllid								
Tamarixia radiata			Y		X		X	X
Bagrada bug								
Gryon aetherium	X		N-W			X		
Brown Marmorated Stink Bug								
Trissolcus japonicus	X		N-W			X		X
Coffee Berry Borer								
Phymastichus coffea			Y-H	X	X			
Box Tree Moth								
On -going exploration								
Cactus Moth								
Apanteles opuntiarum	X	X	N					
Emerald Ash Borer								
Oobius agrili			Y	X	X		X	X
Spathius agrili			Y	X	X		X	X
Spathius galinae			Y	X	X		X	X
Tetrastichus planipennisi			Y	X	X		X	X
***Erythrina* Gall Wasp**								
Aprostocetus nitens		X	N					
Harrisia Cactus Mealybug								
Anagyrus cachamai	X		N					
Anagyrus lapachosus	X		N					

X= Current stage of support, Y= Yes, N= No, Y-H= Yes - Hawaii only, Y-R= Yes - Research only, N-W = not approved for interstate release -within State movement only

TARGET PEST/*BC Agent*	**Pre-Approval Testing**	**Permitting Review**	**Approved for Release**	**Methods Development**	**Rearing & Release**	**Field Coll. & Redistribute**	**Post-release Monitoring**	**Technology Transfer**
Invasive Shot Hole Borers								
Phymastichus sp.	X		N	X				
Eucosmophorus sp.	X		N	X				
Japanese Beetle								
Istocheta aldrichi			Y			X	X	X
Tiphia vernalis			Y			X	X	X
Ovavesicula popilliae				X	X	X		
Olive Psyllid								
Psyllaephagus euphyllurae			Y	X	X			
Roseau Cane Scale								
Aprostocetus sp.	X		N					
Spotted Lantern Fly								
Dryinus sinicus	X		N					
Spotted Wing Drosophila								
Ganaspis brasiliensis			Y	X	X			
Russian Wheat Aphid								
Aphelinus hordei			Y	X	X			
WEEDS								
Air Potato								
Lilioceris egena			Y	X	X			
Lilioceris cheni			Y				X	X
Brazilian Peppertree								
Pseudophilothrips ichini			Y		X		X	
Calophya latiforceps			Y	X				
Canada Thistle								
Puccinia punctiformis		X	Y-R	X				

X= Current stage of support, Y= Yes, N= No, Y-H= Yes - Hawaii only, Y-R= Yes - Research only, N-W = not approved for interstate release -within State movement only								
TARGET PEST/*BC Agent*	**Pre-Approval Testing**	**Permitting Review**	**Approved for Release**	**Methods Development**	**Rearing & Release**	**Field Coll. & Redistribute**	**Post-release Monitoring**	**Technology Transfer**
Cheatgrass								
N/A onoing exploration								
Common Crupina								
Ramularia crupinae			Y-R	X	X			
Common Reed								
Archanara geminipunctata	X		N					
Chinese Tallow								
Bikashi collaris		X	N					
Gadirtha fusca		X	N					
Dyer's Woad								
Ceutorhynchus peyerimhoffi	X		N					
Ceutorhynchus rusticus	X		N					
Field Bindweed								
Melanagromyza albocilia	X		N					
Microsphecia brosiformis	X		N					
Flowering Rush								
Bagous nodulosus			Y	X	X			
Garlic Mustard								
Ceutorhynchus constrictus	X		N					
Ceutohynchus scrobicollis		X	N					
Gorse								
Sericothrips staphylinus			Y		X			
Hawkweeds								
Aulacidea pilosellae	X							
Aulacidea subterminalis			Y				X	X
Cheilosia urbana			Y	X				
Hoary Cress								

X= Current stage of support, Y= Yes, N= No, Y-H= Yes - Hawaii only, Y-R= Yes - Research only, N-W = not approved for interstate release -within State movement only								
TARGET PEST/*BC Agent*	**Pre-Approval Testing**	**Permitting Review**	**Approved for Release**	**Methods Development**	**Rearing & Release**	**Field Coll. & Redistribute**	**Post-release Monitoring**	**Technology Transfer**
Aceria drabae			Y	X	X			
Ceutorhynchus cardariae	X		N					
Houndstongue								
Mogulones borraginis	X		N					
Mogulones crucifer	X		N					
Knapweed - Russian								
Aulacidea acroptilonica			Y					X
Pseudorchestes sericeus	X		N					
Jaapiella ivannikovi			Y					X
Knotweeds								
Aphalara itadori			Y		X			
Old World Climbing Fern								
Callopistria exotica		X	N					
Neostromboceros albicomus		X	N					
Oxeye Daisy								
Dichrorampha aeratana		X	N					
Perennial Pepperweed								
Ceutorhynchus marginellus	X		N					
Russian Olive								
Aceria angustifoliae		X	N					
Russian Thistle								
Aceria salsolae		X	N					
Uromyces salsolae	X		N					
Starthistle - Yellow								
Ceratapion basicorne			Y	X	X			
Swallow-wort								

X= Current stage of support, Y= Yes, N= No, Y-H= Yes - Hawaii only, Y-R= Yes - Research only, N-W = not approved for interstate release -within State movement only								
TARGET PEST/*BC Agent*	**Pre-Approval Testing**	**Permitting Review**	**Approved for Release**	**Methods Development**	**Rearing & Release**	**Field Coll. & Redistribute**	**Post-release Monitoring**	**Technology Transfer**
Hypena opulenta			Y			X	X	
Tree of heaven								
Verticillium nonalfalfae	X		N					
Eucryptorrhynchus brandti		X	N					
Toadflax - Yellow								
Mecinus heydeni	X		Y					
Mecinus janthinus			Y					X
Rhinusa pilosa			Y	X	X			

Appendix B: FY24 PPA 7721-funded biological control projects.

State	Project Title	Org Type
CA	Proactive classical biological control of South American tomato pinworm in California	State
DE	Advancing establishment of an introduced parasitoid for biocontrol of *Drosophila suzukii* in mid-Atlantic states	Federal
FL	Establishment and evaluation of Brazilian peppertree biological control	Federal
FL	Biocontrol of the mango anthracnose disease using continuous precision delivery of an antagonistic fungus	University
FL	Black bean bug natural enemy evaluation	State
FL	Biological control of cactus moth, *Cactoblastis cactorum* (Berg)	State
FL	Fast tracking rearing methods development and evaluation of the most promising cogongrass (*Imperata cylindrica*) biological control candidates	Federal
FL	Establishment and evaluation of air potato biological control	State
FL	Registration of *Verticillium nonalfalfae* to control tree-of-heaven, the preferred host of spotted lanternfly	Private
FL	Evaluating predatory mirids as biological control agents for the South American tomato leafminer in U.S. tomato fields	Federal
HI	Field testing of bait stations containing a fungal pathogen to control invasive fruit flies	University
ID	Nez Perce Tribe bio-control project-noxious/invasive weed survey and control	Tribe
IL	Detecting and tracking infection by the biocontrol pathogen, *Ovavesicula popilliae*	Federal
KY	Potential of a sterilizing virus to suppress or eradicate old world bollworm	Private
MA	Introduce the microsporidian pathogen, *Ovavesicula popilliae*, to Western states for long-term suppression of Japanese beetle	Federal
MA	Evaluating *Aprostocetus* sp., an adventive parasitoid of invasive roseau cane scale in Louisiana	Federal
MA	Classical biological control of the box tree moth	Federal
MD	Field release and evaluation of *Ramularia crupinae* for the management of noxious *Crupina vulgaris* populations	Federal
MD	Regional to national post-release evaluation of emerald ash borer biological control	University
NC	Assessing and establishing biological control agents for the emerald ash borer in North Carolina	University
NJ	Evaluation the effectiveness of biocontrol agents in protection of North American ash against emerald ash borer in the mid-Atlantic	University
NM	Mass rearing, establishment and integrated management of biological control agents for hoary cress in New Mexico	University
NY	Saint Regis Mohawk Tribe EAB mitigation and forest health improvement	Tribe
OH	Evaluating augmentative biological control as a potential management tool against invading scale insects	University
OR	Enhancing areawide biological control of spotted wing drosophila in Oregon	State
PR	Systems approach for the management of coffee berry borer in Hawaii and Puerto Rico with emphasis on biological control	University
PR	Harrisia cactus mealybug biological control	University
TN	Post-release aftermath assessment of biological control of emerald ash borer to enhance mitigation in a Southern climate	University

State	Project Title	Org Type
TX	Citrus endophytes for management of Asian citrus psyllid FY 2024	Federal
TX	Mass production of beneficial insects for the biological control of Brazilian peppertree in Texas	Federal
TX	Development of an environmentally safe, effective biological control method of citrus canker and citrus black spot disease	University
TX	Microbial community management to improve the health and production of *Anastrepha ludens*	University
WA	Muckleshoot Indian Tribe noxious weed control project	Tribe

Appendix C: Photo Credits

Key PPQ Priority Pests and Program Support Section

Emerald Ash Borer

- UGA (EAB) and Theresa Booth USDA and Brighton EAB Lab. *Tetrastichus planipennisi, Oobius agrili, Spathius agrili*

Spotted Lanternfly

- Spotted lanternfly, Emelie Swackhamer, Penn State University, Bugwood.org https://www.forestryimages.org/browse/image/5573236
- SLF nymphs on tree of heaven, Richard Gardner, Bugwood.org https://www.forestryimages.org/browse/image/5593888
- *Dryinus sinicus* attacking SLF nymph, Corrine Losch, PPQ S&T FPML

Citrus Greening and Asian Citrus Psyllid

- Citrus greening, Jeffrey W. Lotz, Florida Department of Agriculture and Consumer Services, Bugwood.org, https://www.forestryimages.org/browse/image/5201093
- Asia citrus psyllid, David Hall, USDA Agricultural Research Service, Bugwood.org, https://www.forestryimages.org/browse/image/5006083
- *Tamarixia radiata*, Jeffrey W. Lotz, Florida Department of Agriculture and Consumer Services, Bugwood.org, https://www.forestryimages.org/browse/image/5196067

Japanese Beetle

- Damage caused by Japanese beetle, https://ohiograpeweb.cfaes.ohio-state.edu/ipm/insects/japanese-beetle
- Japanese beetle, David Cappaert, Bugwood.org, https://www.forestryimages.org/browse/image/2106096
- *Ovavesicula popilliae* infecting Japanese beetle. Petti et al, 2012, https://www.sciencedirect.com/science/article/pii/S0022201112002352

Roseau Cane

- Roseau cane, Steve Dewey, Utah State University, Bugwood.org, https://www.forestryimages.org/browse/image/1459445
- Roseau Cane, Travis McMahon, MIA Consulting, Bugwood.org, https://www.forestryimages.org/browse/image/5624814
- Roseau cane scale, *Nipponaclerda biwakoensis*, Knight et al., 2018 https://link.springer.com/article/10.1007/s10530-018-1749-5

Field Operations Section

Common Crupina

- https://images.bugwood.org/
- https://bugwoodcloud.org/resource/files/33592.pdf

Flowering Rush

- https://images.bugwood.org/
- https://www.cabi.org/projects/biological-control-of-flowering-rush/

Garlic Mustard

- https://images.bugwood.org/

Gorse

- https://images.bugwood.org/

Hoary Cress

- https://images.bugwood.org/

- https://www.researchgate.net/figure/A-scanning-electron-microscope-image-of-the-whitetop-gall-mite-Aceria-drabae-which-was_fig4_324991649

Houndstongue

- https://images.bugwood.org/
- https://www.cabi.org/news-article/endangered-weevil-recommended-for-management-of-its-invasive-hostplant-in-the-usa-may-find-plenty-of-new-homes/

Knotweeds

- https://images.bugwood.org/
- https://www.ft.com/content/e1b7d4ea-e61a-11e5-a09b-1f8b0d268c39

Swallowworts

- https://images.bugwood.org/
- https://bugwoodcloud.org/resource/files/27698.pdf

Tansy Ragwort

- https://images.bugwood.org/

Yellow Starthistle

- https://images.bugwood.org/
- http://www.naturabohemica.cz/ceratapion-basicorne/

Yellow Toadflax

- https://images.bugwood.org/
- https://blog.cabi.org/2019/07/10/scientists-release-new-allies-in-the-battle-against-invasive-yellow-toadflax-in-the-rocky-mountains/

Olive Psyllid

- https://www.researchgate.net/publication/282907045_olive_psyllid
- https://images.bugwood.org/
- https://commons.m.wikimedia.org/wiki/File:Psyllaephagus_euphyllurae,_female,_Spain.jpg

Spotted Wing Drosophila

- https://www.cabi.org/news-article/field-cage-study-highlights-safety-of-classic-biological-control-agent-against-devastating-invasive-fruit-fly/
- https://images.bugwood.org/
- https://www.cabi.org/news-article/cabi-joins-forces-in-first-release-of-parasitic-asian-wasp-to-fight-devastating-invasive-fruit-fly-in-switzerland/

The Montana Biocontrol Coordination Project

- https://www.mtbiocontrol.org/

Science and Technology Section

European cherry fruit fly

- Adult ECFF, Alison Morris, Bugwood.org, https://www.forestryimages.org/browse/image/5584636
- Damage from ECFF on cherry, Alison Morris, Bugwood.org, https://www.forestryimages.org/browse/image/5584635
- Hymenopteran parasitoid found attacking ECFF, larvae collected from bush honeysuckle in New York, Amy Roda, PPQ S&T TIML

Chinese Privet

- Bush of Chinese privet, Nancy Loewenstein, Auburn University, Bugwood.org, https://www.forestryimages.org/browse/image/5389541
- Close-up of Chinese privet, Richard Gardner, Bugwood.org, https://www.forestryimages.org/browse/image/5535218

- Adult ligustrum weevil *Ochyromera ligustri* Warner, lateral view. Jon Hart, bugguide.net, https://edis.ifas.ufl.edu/publication/IN620

South American Tomato Leafminer

- Damage caused by the SATL, Metin GULESCI, Bugwood.org, https://www.forestryimages.org/browse/image/5595357
- Larva of SATL in tomato, Marja van der Straten, NVWA Plant Protection Service, Bugwood.org, https://www.forestryimages.org/search?q=Phthorimaea+absoluta
- Tomato bug (*Engytatus modestus*), Whitney Cranshaw, Colorado State University, Bugwood.org, https://www.forestryimages.org/browse/image/5490242

Brazilian Peppertree

- Fruit and leaves of Brazilian peppertree, Stephanie Sanchez, Bugwood.org, https://www.forestryimages.org/browse/image/5473771
- Bush of Brazilian peppertree, Stephanie Sanchez, Bugwood.org, https://www.forestryimages.org/browse/image/5473774
- *Pseudophilothrips ichini* biological control agent of Brazilian peppertree, James P. Cuda, University of Florida, Bugwood.org, https://www.forestryimages.org/browse/image/0002010

Shot Hole Borer

- *Phymastichus nudusdraco* parasitoid of *Euwallacea fornicates*, Husein et al., 2025, https://www.sciencedirect.com/science/article/pii/S1226861524001651
- *Euwallacea fornicates*, Pest and Diseases Image Library , Bugwood.org, https://www.forestryimages.org/browse/image/5488433
- PSHB (*Euwallacea fornicatus*) with frass. Credit: Pia Scanlon, DPIRD, WA. https://www.agriculture.gov.au/about/news/polyphagous-shot-hole-borer

Spotted-Wing Drosophila

- Adult SWD on a raspberry, Hannah Burrack, North Carolina State University, Bugwood.org, https://www.forestryimages.org/search?q=Drosophila+suzukii
- An adult female *Ganaspis kimorum* parasitoid on a blueberry; inserting her ovipositor into the fruit to attack spotted-wing drosophila maggots. https://cals.cornell.edu/integrated-pest-management/outreach-education/fact-sheets/ganaspis-kimorum
- Larvae of SWD in strawberry, Hannah Burrack, North Carolina State University, Bugwood.org, https://www.forestryimages.org/browse/image/5444194