**Rearing and Release of Swallow-wort Biological Control Agents**

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**Amount Requested**
$99,868 over three years. ($37,768 yr. 1, $30,534 yr. 2, $31,566 yr. 3)
Project Leveraging: described in budget.

**Project Goal**

Establish an effective biological control program for swallow-wort species (Apocynaceae: *Vincetoxicum*) invasive in forests and rangelands.

Supporting Objectives

1) Improve laboratory rearing of *Hypena opulenta* allowing field release in experimental and implementation programs.
2) Supplement our laboratory colony of *Abrostola asclepiadis* with new field-collected material from Europe.
3) Complete host range testing and submit TAG release request for *Abrostola asclepiadis.*
4) Improve laboratory rearing of *Abrostola asclepiadis* in preparation for field release in experimental and implementation programs.
5) Release and evaluate *Hypena opulenta* impact on swallow-worts in a field experiment.

**Project Justification**

Populations of European swallow-wort (*Vincetoxicum* species) have become established in North America where there are no effective arthropod herbivores to suppress populations and deter further spread into surrounding environments (Milbrath, 2010; Lawlor, 2000; Sheeley, 1992; Christensen, 1998). The two species of concern *Vincetoxicum nigrum* and *Vincetoxicum rossicum* are now widely distributed along the Atlantic coast of North America, through the Midwest, and well-into the Plains. *Vincetoxicum nigrum* is native to Mediterranean regions of France, Italy and Spain while *V. rossicum* is naturally distributed in southeast Ukraine and Russia. The earliest record of *V. nigrum* in the USA is from Massachusetts in 1854 and *V. rossicum* was first documented in New York in 1897 (Sheeley and Raynal, 1996). Despite the long history of *Vincetoxicum* spp. presence in North America, it has only become a significant problem in recent decades due to range expansion and unhindered population growth (Lawlor, 2000).

Swallow-worts display superior competition for resources among native plants and often form dense monocultures in a variety of habitats (Cappuccino, 2004). Swallow-wort contains the haemolytic glycoside vincetoxin, which is toxic to humans and most other mammals (DiTommaso et al., 2005). In addition to disrupting pastures, swallow-worts are reported as a major pest in tree nurseries and the twining vines of swallow-worts have been documented pulling down small trees and smothering vegetation planted at restoration sites (Christensen, 1998**)** and pine plantations in Ontario (DiTommaso et al., 2005).

*Vincetoxicum nigrum* has become established in 21 states (Fig. 1) and *V. rossicum* is currently distributed in at least ten states ranging from the Atlantic Coast west to Missouri as well as Ontario, Quebec and British Columbia in Canada (Fig. 2).

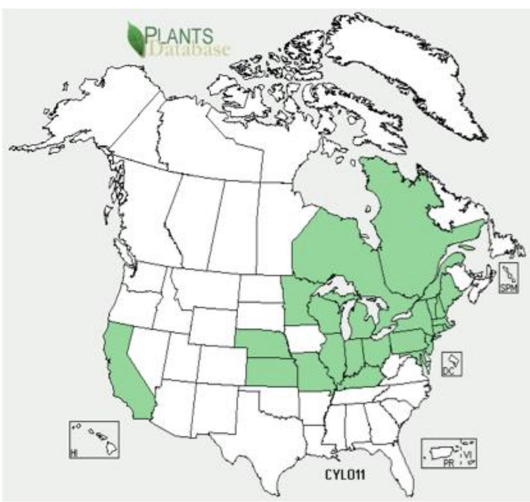


Figure 1: *Vincetoxicum nigrum* distribution in North America. USDA Plants database, 2011

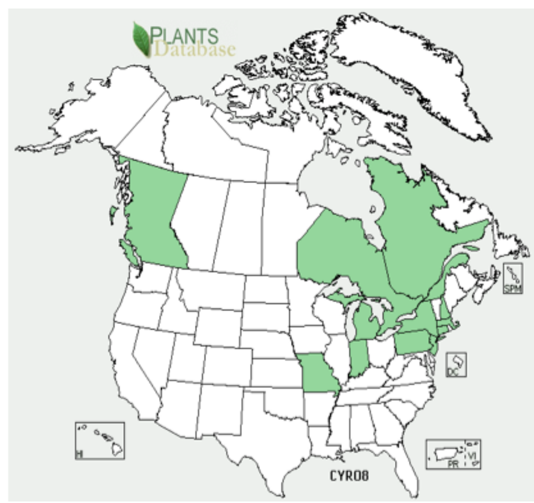


Figure 2: *Vincetoxicum rossicum* distribution in North America. USDA Plants database, 2011

**Effects on Native Plant and Animal Populations.** In North America, *Vincetoxicum* species affect ecosystems by reducing local biodiversity of native plants, vertebrates, and arthropods (DiTommaso et al., 2005). Studies in, Ontario have shown significantly lower arthropod diversity and abundance in old-fields where swallow-wort is the predominate vegetation when compared with nearby old-field sites where native plant species thrive (Ernst and Cappuccino, 2005). There are several indirect and secondary effects of swallow-wort on native species as well. Investigations of grassland bird populations in New York and Ontario have shown reduced breeding and nesting behavior in areas where swallow-wort has formed mono-specific stands (DiTommaso et al., 2005, Miller and Kricfalusy, 2008). There is also evidence of swallow-wort adversely impacting monarch butterfly populations since these butterflies often oviposit on swallow-worts instead of native milkweed species. Monarch larvae cannot survive on swallow-wort so these plants effectively act as a population sink for monarchs (Casagrande and Dacey, 2001, 2007). Swallow-wort may pose an even greater threat through competitive displacement of milkweeds as well as other important host plants of native species (DiTommaso et al., 2005).

Pale swallow-wort overgrowing a pasture in New York (Fran Lawlor, The Nature Conservancy)


Black Swallow-wort overgrowing forest trees. (Leslie J. Mehrhoff, UConn.)

**Alternative Management Options.** Current management practices are limited to manual removal of plants or seedpods, mowing, and applying herbicides (Lawlor and Raynal, 2002; DiTommaso et al., 2005; McKague and Cappuccino, 2005; Averill et al., 2008; Douglas et al., 2009). The only method ensuring long-term control of swallow-wort involves excavation of the entire plant because root crown fragments left behind can root in the soil and produce additional shoots (DiTommaso et al., 2005). Hand picking seedpods from plants is only effective in reducing seed pressure, if it is repeated throughout the growing season (Lawlor, 2000). Mowing has no effect on plant biomass and is only slightly effective at reducing seed production (McKague and Cappuccino, 2005) When the primary aerial stem is damaged on swallow-wort plants, the root crowns readily send up multiple auxiliary shoots which can exacerbate infestations (DiTommaso et al., 2005; McKague and Cappuccino, 2005). In evaluating herbicides against populations of *V. rossicum* in Ontario Christensen (1998) determined that at least two applications of glyphosate were required in mid-June and early August to reduce swallow-wort cover by 90% the following year. In New York, one treatment of triclopyr (1.9 kg ai/ha) reduced *V. rossicum* cover and stem density by 56% and 84% after 2 years (Averill et al., 2008). However, despite encouraging results from one application the authors cautioned that long-term control could only be sustained by repeated applications and active restoration.

Current control measures are only effective in the short-term, require substantial resources or labor and could have collateral impacts on native species in the surrounding habitats (Lawlor, 2000). The use of biological control agents may be the only viable option for long-term reductions in swallow-wort populations.

**Need for intervention.** Although swallow-worts have been in the northeast for over a century, the distribution of these plants and the problems that they cause are rapidly expanding with no evidence that they are approaching their maximum geographic or ecological distribution (DiTommaso et al., 2005). Indeed, "spread of these two [*Cynanchum*] species is expected to increase exponentially as more colonies establish, coalesce and become seed sources" (DiTommaso et al., 2005). Bjeruke (2007) has noted a similar exponential increase in pale swallow-wort in Norway in the past two decades where the plant, introduced in 1865, has gone from being a "rare botanical curiosity" to "an invasive threat to indigenous vegetation". DiTommaso et al. (2005) conclude their 20-page monograph with the statement: "Given the difficulties of control, perhaps the most effective single means of slowing spread and reducing competitive abilities of the [*Cynanchum*] species will be through the development of a biological control program with multiple agents."

**Biological Control Agents.** Field surveys in Europe in 2006 identified five potential biological control agents for *Vincetoxicum* spp.: two leaf feeding caterpillars, two leaf feeding chrysomelid beetles, and a seed feeding tephritid fly (Weed et al. 2011c). In no-choice tests, the chrysomelids were found to feed on native native North American species outside of the genus *Vincetoxicum* (Weed et al., 2011a) The tephritid, *Euphranta connexa* may be host specific and shows potential for reducing seed production. Work has continued with this species at CABI EU-CH to assess its potential at reducing swallow-wort spread (Gassmann et al., 2011). Given the severity of *Vincetoxicum* infestations in North America and the fact that *Vincetoxicum* spp. can reproduce clonally through rhizomes, sexually, or through self-pollination we have focused our attention on the two caterpillars that directly impact plant biomass.

An initial test-plant list for swallow-wort biological control agents was developed by Milbrath and Biazzo (2007) and approved by the USDA Technical Advisory Group (TAG) on Biological Control of Weeds. During the testing process, additional species were added to increase representation in groups of concern and a final list of tested plants includes 83 species (Casagrande et al., 2012).

*Hypena opulenta* (Christoph) (Lepidoptera: Erebidae) was collected from *V. hirundinaria* in Ukraine in a shaded forest habitat (Weed et al 2011c). It is a multivoltine species with overlapping generations (Weed and Casagrande, 2010), indicating that it will inflict sustained attack on *Vincetoxicum* throughout the growing season. Impact studies conducted in containment determined that all tested larval densities (2 to 8 larvae) significantly reduced aboveground biomass, seedpod production and seed production of *V. rossicum* (Weed and Casagrande, 2010). The impact of *H. opulenta* is likely to be dependent on light conditions (Milbrath, 2008), level of herbivory, and plant community composition. For example, the impact of artificial defoliation on growth and reproduction of *V. rossicum* and *V. nigrum* was significantly higher when plants were grown under shade compared to high light conditions (Milbrath, 2008). Host range studies with 83 plant species indicate that this insect is a specialist on *Vincetoxicum* (Hazelhurst et al., 2012). A joint petition for the release of this insect in Canada and the United States was submitted in November 2011. Supplementary data (all favorable) requested by the USDA-APHIS TAG will be submitted in November 2012 with expected approval for release in 2013.

*Abrostola asclepiadis* (Denis and Schiffermüller) is a moth in the family Noctuidae that is broadly distributed across Europe and primarily associated with *V. hirundinaria.* It attacks plants in open and forested habitats (Weed et al., 2011c). *Abrostola asclepiadis* usually completes one generation per year in northern latitudes, but bivoltine populations are known from southern Europe (Förare, 1995; Goater et al., 2003). The larvae of *A. asclepiadis* feed on the leaves of *Vincetoxicum* spp. and impact studies in Europe demonstrated complete defoliation of plants at low larval densities (Weed et al., 2011b). A population collected from *V. hirundinaria* near Kiev in Ukraine was tested with the same test-plant list used for *H. opulenta,* confirming its monophagy for *Vincetoxicum* (Weed, 2010, Hazelhurst, 2012). A draft petition has been prepared for *A. asclepiadis*; however, we have elected to petition for the release of *Hypena* first because multiple overlapping generations are expected to have higher impact on *Vincetoxicum* spp. Both species may, however, be required in North America for suppression of *Vincetoxicum* in all habitats because *Hypena* was initially found exclusively at forested sites in Ukraine (Weed et al., 2011b).

**Approach (organized under objectives)**

<u>**Objective 1.** Laboratory rearing of *Hypena opulenta*</u>. We have reared this insect since 2006, but not focused on mass production needed for field releases. Pupae are best suited for field release and shipping to collaborators. This moth has a facultative diapause that is under photoperiodic and temperature control and we would like to ensure that our material for field releases will complete at least 2 generations per year following release. At present adult emergence is highly variable; a few diapause and others emerge over a period of a month. Asynchronous adult emergence is not conducive to mating and population establishment. This requires a better understanding of the appropriate rearing conditions to ensure that a large proportion of adults emerge from pupation. Additionally, our current rearing methods require live plant material for oviposition and we would like to improve our rearing methods by using artificial oviposition substrates or evaluate an optimal plant size.

Experimental rearing techniques will begin in early spring, maintaining insects in quarantine under long day photoperiods under different temperature regimes with varying cage and plant sizes. We will also attempt to mate adults in smaller containers and then transfer them into cages to decrease adult mortality and improve oviposition success.

**Objective 2.** Supplement our laboratory colony of *Abrostola asclepiadis* with new field-collected material. Our laboratory colony of *Abrostola asclepiadis* has been held in quarantine since 2006 and it should be renewed with new field-collected material. To this end, Drs. Casagrande and Weed will travel to Kiev, Ukraine during mid-June, 2013 and collect larvae of this species from the same location as the initial collection made by Aaron Weed in 2006. We will also collect *A. asclepiadis* from Moutier, Switzerland (near the CABI lab in Delèmont) and in the Ticino region of southern Switzerland. We have permits needed to hand carry these insects and host material back to the URI quarantine laboratory. We will finalize host range testing with the Kiev population (below) and subject the new Kiev population to limited host range testing to confirm that it has the same degree of host specificity as the Kiev population we have previously studied. We will maintain colonies of each population separately to evaluate temperature and photoperiodic effects on voltinism and for eventual field release. The new populations will be evaluated for volitinism – we suspect the Ticino population to be bivoltine and Moutier and Kiev to be univoltine, but it is possible that all populations have a diapause that is facultative like *H. opulenta*. If we can find a strain of *Abrostola* with two or more generations per year (like the Italian strain discussed by Goater et al., 2003) and that is cold-hardy (most likely from Kiev), these traits will likely enhance efficacy of this insect as a swallow-wort biocontrol agent in North America.

**Objective 3.** Completion of host range testing of *Abrostola asclepiadis*. We have already conducted host range testing of this species under no-choice conditions for all the plants on the TAG list except for *Matelea decipiens, Metastelma barbigerum, Metastelma pringlei*, and *Bartonia virginica.* We will test these plants by evaluating feeding and development of 30 larvae originating from at least 5 females as sources for eggs/neonates, and using leaves from at least 5 seed-grown plants for each species.

We will also test the new *Abrostola* colony (collected under Objective 2) to confirm the same host range as previously determined. These tests, as above, will use 30 larvae from at least 5 females and at least 5 plants. Plants used in these tests will include: *Vincetoxicum nigrum*, *V. rossicum, V. hirundinaria, Asclepias syriaca*, *Cynanchum laeve*, *Boehmeria cylindrica, Gonolobus stephanotrichus, Marsdenia floribunda,* and *Apocynum cannibinum.*

**Objective 4.** Laboratory rearing of *Abrostola asclepiadis.* Similar to *H. opulenta*, we have held this species in the laboratory for six years, but concentrated on biology and host range, not mass production. Anticipating eventual field release of this potential biocontrol agent, we will experiment with a range of temperature, lighting, and cage conditions to enhance and facilitate agent production. We will experiment in our quarantine lab with the new Swiss populations as well as the Kiev population in attempting to get a multi-voltine population.

**Objective 5.** Release and evaluate *Hypena opulenta* in a field experiment. Our quarantine laboratory investigations show *H. opulenta* to develop readily on both pale and black swallow-wort grown and tested under light conditions mimicking full sun – open field conditions, but this is at variance with our observation in Europe that this insect is normally found in forested sites (Weed et al, 2011c). Field releases will test the hypothesis that this species will establish in fields and forests in North America. We have demonstrated that *H. opulenta* poses no risk to NA plants, demonstrated its impact to swallow-worts, and submitted a petition to TAG in 2011 for the release of *H. opulenta*. Pending USDA approval, we will release *H. opulenta* as a biological control agent for *V. rossicum* and *V. nigrum* on Naushon Island, MA in 2013. This island will be monitored for agent establishment, impact, and spread.   Naushon has several stands of *V. rossicum* and *V. nigrum* with both species growing in open fields, in the forest, and on forest edge.  We have five years of data from pre-release plots in these stands and this experimental field release will allow us to determine herbivore impact on both plant species under variable light conditions.  We are able to direct swallow-wort management practices for the entire 19 km$^2$ island.  We will continue to collect data on our other long-term sites in RI on

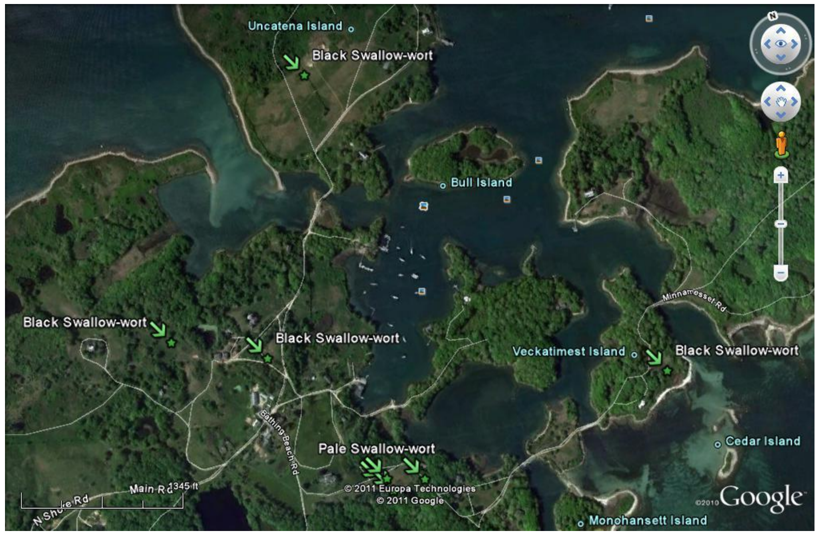


Fig. 5 Swallow-wort sites on Naushon Island, MA.  Release sites include sun and shade plots. We'll also survey distant sites (Uncatena and Veckatimest and a stand near the south end of the island) for agent spread and establishment.

Fig. 6 Pale swallow-wort stand on Naushon Island extending from an open field into a mature forest.  This is a potential release site (labeled Pale in Fig. 5) which we have monitored since 2008.

Conanicut Island, Block Island, and in Charlestown which will serve as controls, and we will evaluate other sites for additional releases.

We plan to release this species on this New England island on the extreme northeastern edge of swallow-wort distribution. With a prevailing fair weather wind from the southwest, it will likely take several years before these insects move significantly west into the mainland of North America. This will allow us time to determine the effectiveness of this agent against both swallow-wort species and decide whether this species will need to be supplemented by other biological control agents in controlling inland swallow-wort populations.

We intend to release *Hypena opulenta* in early June 2013 into forested populations of *V. nigrum* and *V. rossicum* on Naushon. We also plan releases of *H. opulenta* into plots of both swallow-wort species in sunny sites in fields. These release sites will include our long term monitoring open field plots of *V. rossicum* and *V. nigrum*. We plan to release about 500 adults into each of these sites on the island. In addition to the Naushon sites, we have sampled the three RI sites annually since 2008. Initially, we were using two $1m^2$ quadrats per site collecting data on number of stems per $0.5m^2$, number of seedlings per $0.1m^2$, percent cover by *Vincetoxicum* spp., and percent cover of all other plant species within each quadrat. Beginning in 2009, using the same data collection procedures as described previously, we changed to using four $0.5m^2$ quadrats per site in order to coordinate our sampling with that being conducted by Dr. Lindsey Milbrath of USDA ARS. In 2012, we continued the plant sampling as before but we initiated sampling for insects in four additional $0.5m^2$ quadrats, identifying and counting all insects in each sample unit. In each of the insect sampling quadrats we also counted stems and pods, and evaluated 20 leaves for % insect damage. We will continue to collect and evaluate data using the same standardized procedures for all sample sites once the agents are released.

**Expected Project Outcomes**

If no biocontrol agents released, we expect continued swallow-wort range expansion and environmental degradation. Wildlife and native vegetation will continue to be displaced and land managers will continue using conventional control methods that are largely ineffective.

Extensive research on *H. opulenta* has shown that it can only develop on *Vincetoxicum* spp. and poses no risk to native North American plant species. This insect species causes extensive defoliation of *V. nigrum* and *V. rossicum*, reducing aboveground biomass, flowering, seedpod production and number of seeds of *V. rossicum* in the following year. The multiple, overlapping generations of *H. opulenta* are expected to have a substantial impact on *Vincetoxicum* spp. under field conditions – particularly in the shade. Repeated defoliation over several years should facilitate interspecific competition in mixed plant communities and potentially significant reduction in *Vincetoxicum* populations. The field release of *H. opulenta* should allow us to determine if the second species, *Abrostola asclepiadis*, will be needed to further suppress swallow-wort populations in forest and rangeland. With funding through this proposal, we will conduct the necessary research and submit a TAG release proposal for *Abrostola asclepiadis*.

Successful biological control of swallow-worts will have myriad beneficial impacts including increased diversity of plants, birds, and arthropods – including more monarch butterflies. We expect a successful biocontrol program that will reduce swallow-wort infestations, decrease the use of herbicides, and restore native plant communities and ecosystem health.

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**Degrees**

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| 1969 | B.S. | Rutgers University | (Entomology) |
| 1972 | M.S. | Michigan State University | (Entomology) |
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**Professional History**

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| 2001-05 | Chair, Department of Plant Sciences, Univ. of R.I. |
| 1989 - present | Professor of Entomology, Univ. of R.I. |
| 1982 | Associate Professor of Entomology, Univ. of R.I. |
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**Dissertations**

M.S. An approach to Alfalfa Weevil Management in Michigan. Mich St.Univ. 1972. 60p.

Ph.D. Investigations on the Survival and Activity of Adult Cereal Leaf Beetles. Mich. St. U. 1975. 175p.

**Book**

Lashomb, J.H. and R.A. Casagrande, editors. 1981. Advances in Potato Pest Management. Hutchinson and Ross, Stroudsburg, Pa. 288p.

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**Experience:**
1994 to present Manager of Biological Control Programs, University of Rhode Island
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1982 to 1985 Research Assistant, University of Delaware

**Publications:**
Tewksbury, L., M. Gold, R. Casagrande, and M. Kenis. 2005. Establishment in North America of *Tetrastichus setifer* Thomson (Hymenoptera: Eulophidae), a parasitoid of *Lilioceris lilii* (Coleoptera: Chrysomelidae). International Symposium on Biological Control of Arthropods. Davos, Switzerland.

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**Book Chapters:**
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**Education**
Ph.D. Environmental Science, University of Rhode Island (2010)
M.S. Entomology, University of Florida (2003)
B.S. Biology, University of Maine (2001)

**Professional Experience**
2011-Present Research Associate, Dartmouth College, Hanover, NH
2010-Present Postdoctoral Fellow, University of Idaho
2005-2010 Research/Teaching Assistant, University of Rhode Island
2004-2007 Survey Entomologist (Private Consultant)
2006 Biological Control Scientist, CABI-Europe Switzerland
2004-2005 Biological Science Technician, USDA-APHIS
2003-2004 Stewardship Assistant/Survey Entomologist, WBNERR, MA
2001-2003 Extension Assistant, University of Florida
1999-2001 Research Assistant, University of Maine
2000 Vegetable IPM Scout, University of Maine Cooperative Extension
1999 Entomology Intern, Maine Forest Service

**Publications**
Weed, A.S., Schwarzlaender, M. In review. Precipitation and herbivory by a biological control agent influence landscape dynamics of the invasive plant Linaria dalmatica. Journal of Applied Ecology.
Weed, A.S., Ayres, M.P., Hicke, J.A. In review. Consequences of climate change for biotic disturbances in North American forests. Ecological Monographs.
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Weed, A.S., Fasulo, T.R. 2003. Enemies of Mole Crickets Computer Tutorial. UF/IFAS Bug Tutorials. SW-170. A CDROM.
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**Non peer-reviewed articles and reports**
Ayres, M.P., Hicke, J. A. and A.S. Weed. 2012. Section 3.3.3. Insect and Diseases. In Section 2. Effects of Climate Change and Climate Variability, M.G. Ryan and J.M. Vose (eds.) National Climate Assessment 2012.
Weed, A.S. 2010. Biology and Ecology of European Natural Enemies of Swallow-worts (Vincetoxicum) and the Potential for Biological Control. PhD dissertation, Dept. Plant Sciences, University of Rhode Island, 196 pp.
Weed, A.S. 2005. Comparison of aboveground arthropod diversity within pitch pine and scrub oak barrens habitats on Nantucket Island with emphasis on the beetle fauna. Report submitted to Nantucket Biodiversity Survey, 52 pp.
Weed, A.S. and Mello, M. 2005. Summary report of pitfall trapping studies conducted on Nantucket Island in 2004 and 2005. Report prepared for the Nantucket Land Council, 24 pp.

## Budget (three year summary) Requested Funding: $99,868.

Lisa Tewksbury (7.5 months): Salary (3 yrs): $39,145, Benefits: $23,857. Estimate 2.5 person-months per year for grant duration. Remaining effort on this and other biocontrol projects is covered from other funding sources.

Undergraduate Student: Salaries (3 yrs): $27,000, FICA: 2,066. Estimate 10-20 hours during Academic Year, full time in summer.

Foreign Travel: $7,800 will cover travel expenses of Aaron Weed and Richard Casagrande to collect biocontrol agents in Europe (as described under Objective 2).

We have adequate equipment as well as funding for local travel and supplies for this project. This effort will be supplemented by a 1-yr. APHIS award to Lisa Tewksbury which includes partial funding for her salary ($ 4,578), and student labor ($ 2,584) in FY13.

**Matching** (Total URI Match: $61,566)

Waived Overhead: $52,930.

5% Salary and Fringe for R.A. Casagrande: $8,636.

## Timetable (Anticipated funding October 2012-September 2015)

**Research Objective**

*1. Improve laboratory rearing of Hypena opulenta allowing field release in experimental and implementation programs.*

This effort is underway at present and it will continue throughout the duration of the grant using the laboratory colony presently held in the URI Insect Quarantine Laboratory.

*2. Supplement our laboratory colony of Abrostola asclepiadis with new field-collected material from Europe.*

Aaron Weed and Richard Casagrande will travel to Europe in spring of 2013, collecting with CABI colleagues in Ukraine and Switzerland. Material will be sorted at CABI in Switzerland and returned to URI quarantine lab.

*3. Complete host range testing and submit TAG release request for Abrostola asclepiadis.*

This research will begin in spring, 2013 using the colony presently held in URI quarantine and will continue with the new material brought back from Europe under objective 2. Testing should be completed in 2013 field season and TAG request written and submitted in fall, 2013.

*4. Improve laboratory rearing of Abrostola asclepiadis in preparation for field release in experimental and implementation programs.*

This effort will begin in spring 2013 and it will continue throughout the duration of the grant.

*5. Release and evaluate Hypena opulenta impact on swallow-worts in a field experiment.*

*<u>2013 Field Season</u>*

If release petition is approved in time, field-release agents in June, 2013.

(With or without release) sample release and control plots on Naushon, Connanicut, and Block Islands and mainland RI and CT as described in Approach to determine agent establishment, spread, and defoliation. If released, evaluate possible parasitism of *H. opulenta*.

Between seasons: discuss results on agent establishment, spread, and defoliation with European, Canadian and USDA colleagues.

*<u>2014 Field Season</u>*

If agents were not released in 2013, field-release agents in June.

Sample release and control plots on Naushon, Connanicut, and Block Islands and mainland RI and CT as described in Approach to determine agent establishment, spread, and impact. Evaluate possible parasitism of *H. opulenta*.

If agents do not establish from prior release, re-release into selected plots.

Between seasons: discuss results on agent establishment, spread, and defoliation with European, Canadian and USDA colleagues.

*<u>2015 Field Season</u>*

Sample release and control plots on Naushon, Connanicut, and Block Islands and mainland RI and CT as described in Approach to determine agent establishment, spread, and impact.

If agents do not establish from prior release, re-release into selected plots.

Evaluate possible parasitism of *H. opulenta*.

If *H. opulenta* establishes in sun and shade on Naushon and demonstrates potential to adversely impact plants in the field, prepare for further distribution of this agent in USA and Canada.

If *H. opulenta* does not establish in sunny plots on Naushon, possibly release *Abrostola asclepiadis* into long-term plots on Connanicut Island.

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Milbrath L.R. and Biazzo, J. 2007. Proposed host specificity test plant list for testing potential biological control agents of swallow-worts. Unpublished report submitted to USDA-APHIS-PPQ, 41 pp.

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