Biological control of weeds in Hawaiian forests

Position Paper
Hawaii Conservation Alliance

Position statement

Biological control of weeds is an important management tool for conservation of Hawai'i's native forests. Although challenging to implement, biocontrol has a long history of noteworthy successes. When effective, it can provide long-term, large-scale, highly selective control of otherwise intractable weeds.

Summary

Invasive alien plants have caused enormous damage to native Hawaiian ecosystems and continue to threaten remaining conservation lands. A native flora formerly composed of 89% endemic species now includes over 1044 introduced plant species (Wagner *et al*. 1999), of which more than 100 likely are invasive in natural areas (Smith 1985). Species such as Strawberry guava (*Psidium cattleianum*), Christmasberry (*Schinus terebinthifolius*), Fountain grass (*Pennisetum setaceum*), Kahili ginger (*Hedychium gardnerianum*) and Koster's Curse (*Clidemia hirta*) have spread across vast areas, competing with native species and altering ecosystem processes (Vitousek *et al*. 1987). More recent invaders such as Miconia or Velvet tree (*Miconia calvescens*) and Himalayan raspberry (*Rubus ellipticus*) now are established permanently over large areas and predicted to decrease watershed function, restrict access, and negatively impact native biodiversity. The scale of these invasions makes control of weeds using only mechanical and herbicidal techniques risky and prohibitively expensive except in small areas (Tunison & Stone 1992). Carefully chosen biological agents can provide long term weed control at an island-wide scale, including in remote areas.

Hawai'i has a long history of biocontrol

Classical biological control of weeds is the deliberate introduction of exotic herbivores and pathogens to reduce population density and restrict or slow the spread of an alien plant. The efficacy of this approach is based on the hypothesis that many plants are weedy because they have escaped natural enemies in their area of origin, where their densities typically are low (Coombs *et al*. 2004). Biocontrol of weeds has been practiced with great success for over a century in Hawai'i and around the world. Formerly extensive infestations of Prickly pear or Tuna cactus (*Opuntia ficus-indica*), Lantana (*Lantana camara*), Spreading snakeroot (*Ageratina riparia*), Spiny threecornerjack (*Emex spinosa*) and Common St. Johnswort (*Hypericum perforatum*) have been brought under permanent control by biocontrol agents in Hawai'i (Davis *et al*. 1992, Markin *et al*. 1992). Recent introductions appear to be producing similarly successful control of Banana poka (*Passiflora tarminiana*) and Ivy gourd (*Coccinia grandis*) (Trujillo *et al*. 2001).

Biocontrol of weeds follows rigorous protocols

Classical biological control entails exploration in the weed's native range, evaluation of prospective agents for specificity and efficacy against the target weed, and release and monitoring of agents that meet regulatory approval (Coombs *et al*. 2004). Although there are various means of accomplishing these goals, extensive collaboration with scientists based in the weed's country(ies) of origin is optimal for thorough evaluation of potential agents. In-country studies have two important advantages: 1) a high probability that multiple agents, including uncommon species, will be discovered; 2) the capacity to evaluate agents under field conditions. The final stage of pre-release evaluation of agents occurs in quarantine laboratories in Hawai'i

where Hawaiian plant species are tested and agents are screened for hitch-hiking parasites or diseases. Agents are carefully scrutinized by state and federal regulatory agencies and must pass public review before release. Although often neglected historically, sustained post-release monitoring is critical for improving the science of biocontrol and is now mandated for most programs (Balciunas 2004).

Risks of biocontrol can be managed to very low levels

Although biological control sometimes is viewed as having unacceptably high environmental risks (Howarth 1991, Louda *et al*. 2003), the historical record shows that negative consequences have been rare in weed biocontrol and that risks can be reduced to very low levels through careful screening. Out of 117 agents established for control of 55 weed species in the continental United States, Hawai'i and Caribbean through 1994, only 15 agents (13%) have been recorded using native non-target plants (Pemberton 2000). In a few cases impacts on non-target plants have been severe, but more often they have been minor. Most significantly, in all but a single case, biocontrol agents used only close relatives (usually congeners) of the target plant, demonstrating that non-target host use can be predicted reliably using standard screening procedures which emphasize testing of related plants. The record also suggests that the safety of biocontrol of weeds has improved: all cases of non-target host use are for agents introduced prior to 1970 (Pemberton 2000). Non-target effects have arisen in the past principally because native species were not evaluated or their vulnerability was assumed to be low or unimportant. In recent decades, native species have been submitted to the same careful screening that previously focused on crops and ornamentals. Today, emphasis on identifying biocontrol agents that have maximum impact on the target weed is another way that unnecessary introductions are avoided and non-target risks reduced (Balciunas 2004). Conservationists and biocontrol researchers share the goal of sustainable management of invasive species: ultimately, communication and collaboration are our best strategies for insuring that biocontrol is used to maximum benefit and with minimal risk.

Biocontrol is not a solution for every weed

Not all weed problems warrant the investment of resources needed for development of safe and effective biocontrol. Methods such as herbicidal and cultural control may be more appropriate for nuisance weeds confined to disturbed areas such as roadways and poorly managed agricultural land. Weeds that invade native habitats, that have broad environmental impacts and that are intractable using other control methods deserve to be high priority targets for biocontrol. Hawai'i already has enough serious environmental weeds to occupy a large team of biocontrol researchers for several decades. Biocontrol alone cannot possibly keep up with the continuing influx of new alien invaders. Strategies such as pre-importation weed risk assessment, quarantines at ports of entry, and rapid response to incipient invasions are all necessary to prevent "the next *Miconia*." It is also important to recognize that biocontrol alone may not provide satisfactory suppression of some weeds, and that integration of biocontrol and other methods often may be necessary for successful weed management.

Biocontrol yields excellent return on investment

Because the benefits of successful biocontrol can accrue permanently, its economic benefit-to-cost ratio is often highly favorable in comparison to other weed-control strategies. The cost of mounting a complete program of biocontrol for a single target weed has been estimated at roughly $1-2 million (Markin *et al*. 1992). This is a bargain in cases where the costs in damages and alternative control methods mount into millions of dollars annually *ad infinitum*. Even when completely successful biological control is achieved (about 25% of historical efforts; McFadyen 1998), the long-term value of successful control will offset substantially the costs of less successful efforts.

Recommendations

Hawai‘i needs to increase resources for practicing biocontrol.

Successful biological control of weeds depends upon a network of international cooperators, sustained funding of projects for up to 10 years or more, and commitment of trained personnel and specialized infrastructure (quarantine facilities). Although Hawai‘i enjoys broad international respect for its long history of contributions to biocontrol, in recent years our capacity for biocontrol research has not kept pace with invasive species. Today the state is in need of improved facilities and additional biocontrol scientists. Hawai‘i has only three certified quarantine facilities, each small and only modestly equipped, to serve all its needs for both weeds and pest arthropods, in agricultural as well as natural systems. Two facilities are operated by the Hawai‘i Department of Agriculture in Honolulu, one for containing pathogens and one for insects; and an insect containment facility is operated by the USDA Forest Service at Hawai‘i Volcanoes National Park. A new, large, state-of-the-art biocontrol research facility will cost several million dollars, but will greatly improve our ability to target multiple pests and attract more researchers and funding. Furthermore, recent and pending attrition of biological control expertise needs to be addressed by replacing retired personnel and hiring additional specialists if Hawai‘i is to attain a critical mass for highly productive biocontrol research.

Supporting documents and further reading

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First edition. December 3, 2005
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Revision committee: Wilkinson, M.M., Gon, S., Steiner, W. and Puttock, C.F.
HCA review: Full committee 11/2005
HCA approval: Full committee 12/2/2005