CHAPTER 12

Managing conflict over biological control: the case of strawberry guava in Hawaii

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Introduction

Conflict can be a part of virtually any decision about management of natural resources, not least decisions regarding use of biological control. The shared, public character of natural resources and the permanent, irrevocable nature of biological control releases ensure that many people will have opinions, sometimes strongly held, regarding use of a particular biological control agent in an area they care about. Conflicts associated with the use of biological control have been reviewed elsewhere, along with approaches for resolving conflict and the challenges these present (Turner, 1985; Stanley and Fowler, 2004; Hayes et al., 2008). A variety of conflict-resolution approaches exist; however, the time and effort involved in gathering the necessary data and engaging in the required processes to resolve conflicts tend to be seen as onerous, motivating weed biological control scientists to select only targets with low potential for conflict (Stanley and Fowler, 2004), essentially a strategy of conflict avoidance. In cases where target-based concerns are unavoidable, for example biological control of invasive *Acacia* trees that nevertheless have timber value in South Africa, some programs have focused on biological control agents that minimize conflict, such as seed-feeding agents that limit tree reproduction and spread without harming existing timber stands of the targeted species (e.g., Dennill et al., 1999).

Avoiding targets with potential for high conflict may remain common, but for certain highly damaging invaders with no viable management alternatives, it may be necessary to consider biological control even when it is likely to generate conflict. Discussed here is a case study, strawberry guava (*Psidium cattleianum* Sabine) in Hawaii, in which conflicting views of the targeted plant engendered substantial opposition to biological control. The processes followed and lessons learned may be useful for others considering biological control as a management option for widespread plant invasions in natural areas, especially where there are groups with conflicting interests.

Strawberry guava in Hawaii

Following its introduction into Hawaii in the early 1800s, strawberry guava (Figure 12.1) was cultivated widely in gardens and used occasionally in efforts to reforest degraded landscapes (Degener, 1939; Wagner et al., 1990). Today strawberry guava continues to be planted as an ornamental, and jam from the fruit is sold at farmers' markets. However, it is not cultivated as an agricultural commodity, in contrast with its congener, common guava (*Psidium guajava* L.). Dense stands of strawberry guava infest tens of thousands of hectares of wet and mesic forest on all the major Hawaiian islands, and it continues to spread, potentially affecting an estimated 475,000 hectares, 90% of Hawaii's forests (State of Hawaii, 2011). It is considered a serious threat to native ecosystems and to dozens of threatened and endangered species (Mitchell et al., 2005) owing to its

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Figure 12.1 Strawberry guava, *Psidium cattleianum*, thickets crowd out native forest species in Hawaii. Photo courtesy of Jack Jeffrey.

ability to form dense thickets even in relatively undisturbed wet forests (Huenneke and Vitousek, 1990). Strawberry guava is among the worst invasive species globally (IUCN, 2013), posing a threat to native ecosystems in Florida, Puerto Rico, Reunion, Mauritius, Guam, Cook Islands, Fiji, French Polynesia, Palau, Samoa, and Norfolk Island (Lorence and Sussman, 1986; Tunison, 1991; Space, 2013).

Invasion by strawberry guava has devastating consequences for Hawaiian ecosystems. In addition to loss of habitat for native species, forests dominated by strawberry guava lose more water to evapotranspiration than native forests: 27% more in a recent measurement, equivalent to a loss of 33 cm (13 inches) in annual precipitation from watersheds (Takahashi et al., 2011). Millions of pounds of fallen strawberry guava fruit each year are a primary breeding resource for oriental fruit flies, *Bactrocera dorsalis* (Hendel), a pest of Hawaiian agriculture (Vargas et al., 1989, 1990, 1995). Fruit flies can cause direct yield loss, but even more importantly, their infestation limits possibilities for export of Hawaiian produce to major markets such as California and Japan. Also, sustainable wild harvest and management of Hawaii's high value native hardwood *Acacia koa* A. Gray is impeded by dense stands of strawberry guava, which rapidly colonize areas disturbed by logging and suppress koa regrowth (Dobbyn, 2003; Baker et al., 2009).

Effective management of natural areas invaded by strawberry guava requires repeated mechanical and chemical treatments to reduce its copious resprouting, but such intensive work is not practical across the vast areas of affected forest, much of it in remote, rugged terrain. Population growth rates of strawberry guava can be rapid: studies in native forest at 900 m elevation in Hawaii showed nearly 10% annual increases in strawberry guava stem density and basal area (Denslow et al., unpublished data). Although strawberry guava seeds are short lived (Uowolo and Denslow, 2008), its fleshy fruits are abundant and rapidly dispersed by introduced birds and pigs (Diong, 1982). The invasive success of strawberry guava has been attributed to its broad environmental tolerances, prolific fruit production, frequent vegetative spread, and an absence of natural enemies (Huenneke and Vitousek, 1990; Tunison, 1991).

Strawberry guava was one of the earliest species selected by a multi-agency group established in the late 1970s to identify key pests of Hawaiian forests and develop biological control remedies (Hodges, 1988). Exploration for natural enemies in strawberry guava's

Figure 12.2 *Tectococcus ovatus* scales make galls on young leaves of strawberry guava. Photo courtesy of USDA Forest Service.

Table 12.1 Impacts expected from biological control of strawberry guava.

- *Tectococcus ovatus* scales make galls on young leaves; defoliation is uncommon; wood will not be affected
- Trees will not be killed, but will grow slower and compete less with native plants
- Fruit and seed production will be lower by as much as 90%, slowing invasion into native forests
- Fewer pest fruit flies will be produced in areas with abundant strawberry guava
- Yard trees far from forests may not be affected due to limited dispersal of the scale
- Trees grown for fruit can be protected with common horticultural oil sprays
- Biological control can enhance chemical/mechanical control by slowing regrowth and re-invasion

native range, southern Brazil, began in 1988, and in-depth studies of several potential agents were conducted in Brazil in the 1990s. A leaf-galling scale insect, *Tectococcus ovatus* Hempel (Hemiptera: Eriococcidae) (Figure 12.2), was given top priority for further development and was imported to Hawaii in 1999 for quarantine studies. Impacts of this gall insect on strawberry guava in Brazil indicated that the scale had high potential to reduce the plant's growth and reproduction (Table 12.1). Testing in Brazil, Hawaii, and Florida demonstrated that *T. ovatus* was restricted to a narrow subset of *Psidium* species (Vitorino et al., 2000; Johnson, 2005; Wessels et al., 2007). Furthermore, *T. ovatus* had never been recorded as a pest of any agricultural or ornamental plants, and never attacked common guava, which grows throughout its native range. In 2005, a petition for release of the agent was submitted by the Forest Service to the Hawaii Department of Agriculture, the state agency charged with regulating biological control introductions (Johnson, 2005).

Regulatory review of strawberry guava biological control

The proposed biological control of strawberry guava underwent a state-mandated process entailing review by expert committees, public hearings in each of the four counties, and finally a decision by the Hawaii Board of Agriculture in 2007 to place *T. ovatus* on a list of approved biological control agents. In addition, USDA-APHIS conducted a federal environmental assessment, standard to their review process, which was completed in early 2008 (USDA, 2008). Following these reviews, state and federal permits for environmental release of *T. ovatus* were issued to the Forest Service in April 2008. Throughout these processes, release of the strawberry guava agent was supported by almost all reviewers, with few expressions of concern and very little comment from the public. Release of

T. ovatus was delayed, however, pending completion of a state environmental assessment.

The Hawaii state environmental assessment (EA) process was applied to biological control releases for the first time in 2007. Although federal EAs had been conducted for many years, Hawaii's biological control practitioners decided voluntarily that it was also appropriate to submit proposed releases to the state environmental review process, which is triggered by use of state or county lands or funds, including resources and staff of state agencies involved in releasing biological control agents (Office of Environmental Quality Control, 2004). Two agents to be released against pest insects, plus an agent for fireweed (*Senecio madagascariensis* Poiret) biological control and *T. ovatus* for strawberry guava, were the first biological control agents subjected to this process (Office of Environmental Quality Control, 2008). There was very little public comment on the draft EAs for three of these releases, all proposed by the Pest Control Branch of the Hawaii Department of Agriculture. However, the draft EA for biological control of strawberry guava, submitted at the same time by the USDA Forest Service, received dozens of comments, both in support of and in opposition to the proposed release. The developing controversy over strawberry guava biological control attracted media attention and generated calls to local political leaders. It became evident that a more thorough process of public engagement was needed, and the strawberry guava draft EA was withdrawn for revision (Tummons, 2008).

State of Hawaii EAs are structured much like federal United States EAs, with detailed descriptions of alternative actions, including the proposed action, along with analyses of the expected impacts and proposed mitigation measures associated with each alternative (Office of Environmental Quality Control, 2004). Analyses are required to consider direct, indirect, and cumulative impacts expected from any proposed action. The Hawaii EA differs from the federal EA in some of the specific criteria that must be considered (Table 12.2) before the state can issue a Finding of No Significant Impact (FONSI), which allows a project to proceed without an Environmental Impact Statement. These state criteria emphasize assessment of possible impacts on people – for example through social, economic, or health effects - as well as on the environment. Hawaii also requires each EA to include a cultural impact assessment, analyzing a project's expected impacts on cultural practices and features important to native Hawaiians and other ethnic groups (Office of Environmental Quality Control, 2004).

Proposing release of a biological control agent within the Hawaii environmental review process for the first time presented some unusual challenges. The strong emphasis on considering socio-cultural as well as biological impacts in the state EA process required additional consultations and expertise that were not well developed in the earlier federal EA (USDA, 2008). Furthermore, the environmental review process in Hawaii previously had been applied mainly to commercial or governmental construction or similar projects, with the geographic focus restricted to a particular site. In contrast, biological control releases have nearly always been statewide in scope, with impacts that are intended to extend everywhere the target pest may be found. This geographic breadth also

Table 12.2 Significance criteria specified for evaluation in a State of Hawaii Environmental Assessment: an Environmental Impact Statement is required if, to a significant level of expected impact, a project ...

- **involves** an irrevocable commitment to loss or destruction of any natural or cultural resource
- **curtails** the range of beneficial uses of the environment
- **conflicts** with the state's long-term environmental policies or goals and guidelines as expressed in Chapter 344, HRS, and any revisions thereof and amendments thereto, court decisions, or executive orders
- **substantially** affects the economic or social welfare of the community or state
- **substantially** affects public health
- **involves** substantial secondary impacts, such as population changes or effects on public facilities
- **involves** a substantial degradation of environmental quality
- **is** individually limited but cumulatively has considerable effect upon environment or involves a commitment for larger actions
- **substantially** affects a rare, threatened or endangered species, or its habitat
- **detrimentally** affects air or water quality or ambient noise levels
- **affects** or is likely to suffer damage by being located in an environmentally sensitive area such as a flood plain, tsunami zone, beach, erosion-prone area, geologically hazardous land, estuary, fresh water, or coastal waters
- **substantially** affects scenic vistas and view planes identified in county or state plans or studies
- **requires** substantial energy consumption

tended to increase the required consultations and made analysis more complex.

Although more detailed than the three contemporaneous biological control EAs for the other agents mentioned above, the 2008 strawberry guava EA still fell short as a comprehensive consideration of the many criteria for a Hawaii assessment (Table 12.2), and it lacked a cultural impact assessment. To improve the document, the Forest Service contracted with a professional EA writer with long experience in the Hawaii system to develop the EA. In 2009, consultations with broader segments of the public were begun, including public meetings scheduled in each of Hawaii's four counties and targeted contacts to gather input for a cultural assessment. Meanwhile, the Forest Service and its partners began work to describe to the public more effectively the rationale and goals of the strawberry guava project. Outreach specialists involved in invasive species control and prevention, and many others within the Hawaii conservation community, actively collaborated to convey messages on the importance of managing strawberry guava and the role of biological control. This work was spurred initially by the vigorous campaign of early opponents who noted the inadequacy of the EA and questioned the necessity and safety of attempting biological control (Warner and Kinslow, 2013). Much of the information needed by biological control supporters was already available from previous Forest Service documents, such as "Frequently Asked Questions" on strawberry guava and biological control (USDA Forest Service, 2013a, b), but outreach specialists were able to reformulate this information so that it could be communicated more effectively. Over time, a variety of novel and effective communication pieces were produced by partners outside the biological control community who saw a crucial need to manage strawberry guava (Gon, 2009; Conservation Council for Hawaii, 2010; Hawaii Ecosystems at Risk, 2011).

The controversy following the 2008 strawberry guava EA immediately generated calls to local political leaders. Some responded by scheduling public meetings to share information about the proposed biological control and to hear the opinions of local citizens wanting to offer testimony (Tummons, 2008). The first meeting on Hawaii Island in June 2008 attracted approximately 150 people, and later meetings before the Hawaii County Council were similarly well attended. Hawaii County Council members proposed two resolutions opposing the use of the biological control based on concern over the specificity of the agent and concern that it might evolve to use other plants. One of these resolutions eventually was adopted in August 2009 (County of Hawaii, 2009). In contrast, in March 2009 the Maui County Council adopted a resolution supporting use of biological controls for forest pests, including mention of strawberry guava as a key target for management (County of Maui, 2009). Meanwhile, bills in opposition to strawberry guava biological control were introduced in the state legislature in early 2009, but never received hearings (Hawaii State Legislature, 2009). In the end, none of these legislative actions changed the final decision-making process: whether to permit release of strawberry guava biological control remained a matter before the state administrative branch, pending completion of a state environmental assessment.

The revised Draft EA was completed and published in June 2010. This document incorporated the many statewide consultations over the preceding two years, including inputs from public meetings. It also included recent analyses of remote sensing and other studies of the strawberry guava invasion that strongly documented negative ecological effects of the weed (Asner et al., 2008; Zimmerman et al., 2008; Takahashi et al., 2011), an economic analysis of conventional control methods, and a cultural impact assessment (State of Hawaii, 2010). The Draft EA increased from 33 pages in 2008 to 133 pages in 2010. During the 30-day period for public comment, over 200 respondents sent letters, approximately 2 to 1 in support of biological control (Figure 12.3). According to Hawaii rules for the process, individual responses were written for each comment letter, and the EA was revised a final time and all comments and responses incorporated. This final EA was published in November 2011 with a FONSI issued by the Hawaii Department of Agriculture (State of Hawaii, 2011). Following this decision, the Department then re-issued a permit for release of *T. ovatus*, and in December 2011 the biological control agent was released for the first time from quarantine into the environment on Hawaii Island. Two years later the agent was released at forest sites on Oahu. As of 2014, strawberry guava biological control was established and spreading slowly at multiple sites on these two islands, and efforts had begun to establish it in invaded forests on Maui and Lanai.

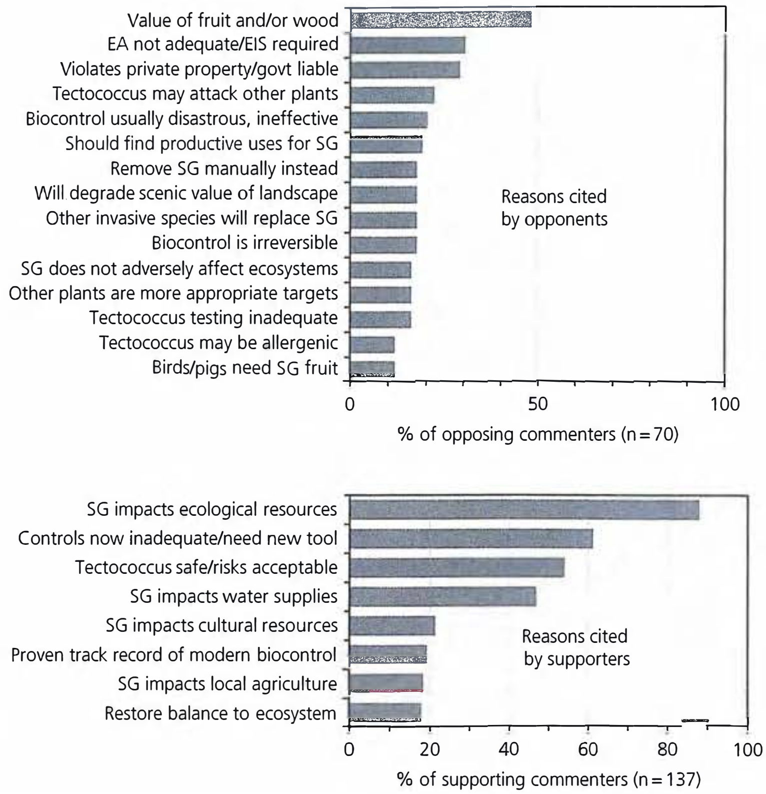

Figure 12.3 Relative frequency of public comments on 2010 Draft Environmental Assessment of proposed biological control of strawberry guava (State of Hawaii, 2011b).

Lessons learned about our public

People in Hawaii are probably unusual compared to most other Americans, in that a great number have at least a passing familiarity with the concept and practice of biological control. This might be expected from the state's very long and active history of biological control introductions: over 700 since 1902 (Follett et al., 2000). Unfortunately, it is failures that come to mind for most residents asked about biological control, with the great majority first citing the nineteenth-century introduction of mongoose to control rats in sugar cane fields. That this introduction was conducted by an individual cane farmer, with little scientific justification and no regulatory oversight, is not at all widely known (Baldwin et al., 1952; Reimer, 2002). Besides the regular visibility of mongoose in the islands and their popularity in local folklore and children's literature, the story of their introduction has great staying power as a cautionary tale about unforeseen consequences of introducing new species to unique island ecosystems. This example has been memorized by generations of Hawaii residents, and it predates by a decade or two the modern era of targeted weed control using specialized natural enemies, inaugurated by Albert Koebele's 1902 introductions of agents into Hawaii from Mexico against lantana (*Lantana camara* L.). There are several recent biological control success stories that could be told in Hawaii (Trujillo, 2005; Hawaii Department of Agriculture, 2010), but none are yet so widely known as to effectively counter the mongoose story.

Negative views of species introductions also predominate in Hawaii because residents are highly attuned to the serious harm caused by invasive species. Many recent invasions – little fire ants (*Wasmannia auropunctata* [Roger]), coqui frogs (*Eleutherodactylus coqui* Thomas), coffee berry borer (*Hypothenemus hampei* [Ferrari]) (Coleoptera: Curculionidae), and axis deer (*Axis axis* [Erxleben]), among others – regularly earn headlines in local newspapers and affect many people's lives very tangibly. Negative attitudes toward invasive species are also well established because of longstanding educational efforts to highlight the problem and build support for enhanced biosecurity. Over the last 25 years multi-agency collaborations have alerted the public to the "silent invasion," and invasive species committees have worked steadily on each island toward control or eradication of the most damaging invasive species (Krauss and Duffy, 2010). So it is a great step forward that most people now understand well that introduced species can have serious ecological consequences. Unfortunately for biological control, most people do not clearly distinguish between the unplanned invasions of species arriving through commerce and the purposeful introductions of natural enemies for biological control of invasive species. Rather, all new introductions are viewed with suspicion and the expectation of bad outcomes. This is only compounded by widespread biases against arthropods and microorganisms, generally regarded as pests, which are the tools of biological control.

These existing biases against introduction of new species lead to the completely understandable default position among the great majority of our public: "Introducing new species is a bad idea, and introducing any new plant pest is crazy." However, almost everyone encountered is also open to asking "why would you ever do such a thing." Curiosity over the seemingly counterintuitive nature of biological control may even increase the likelihood that they will be receptive to an explanation. Usually this opportunity is all that is needed. Once one explains why biological control is necessary and how it is done safely, the typical result is that people move from some level of opposition to some level of acceptance.

Given that most people start from a position of skepticism, it is incumbent on scientists to convey the motives for managing invasive species with biological control. In the case of strawberry guava biological control, one flaw of the initial EA was that it did not adequately describe all the problems caused by this particular invasive plant. Instead of writing for an audience of managers and regulators who understood the issues surrounding strawberry guava, it would have been better to address the general public, who were largely unaware of the plant's impacts. In discussing with Hawaii residents the various motives for pursuing biological control of strawberry guava, it was interesting to see what reasons were most persuasive. For people concerned about native species and Hawaii's forests, the threat of strawberry guava has been generally well understood and was a strong motive for their approval of biological control. However most people did not share a deep appreciation of Hawaii's unique forest biota and instead tended to be moved by human needs such as economic well-being and health. For people generally indifferent to the plight of native forest species, the threats of strawberry guava to water supply and local agriculture – through increases in water loss (Takahashi et al., 2011) and higher fruit fly populations (Conservation Council for Hawaii, 2010) – were more persuasive reasons for management. In addition to making these connections clear, it was important to develop a detailed economic argument for the necessity of adding biological control as a tool for managing strawberry guava, instead of relying on increased efforts with other control methods. The revised EA addressed these points more explicitly and in greater detail and variety. For example, conventional methods of hand cutting strawberry guava and applying herbicide were described and efforts per acre mapped for specific areas, resulting in an overall estimated cost of more than $350 million for initial control of strawberry guava in conservation areas in the eastern half of Hawaii Island (State of Hawaii, 2010).

Another key reason why opinions tended to turn against biological control in Hawaii was because the public generally failed to grasp the concept of host specificity. This is a challenge familiar to all biological control scientists confronted with the question "won't the biological control agent move on to eat something else once its target food is exhausted." Building awareness of the fact that many organisms exist in extremely host-specific relationships is absolutely critical for gaining acceptance of biological control from a skeptical public. Once people recognized evidence of host specificity in everyday examples, most were readily convinced of the value and acceptability of managing invasive species with biological control.

Opponents

A certain segment of the public may remain opposed to using biological control in spite of our best efforts to articulate the economic and ecological justifications and to explain risks and benefits. Motivations of opponents varied in the case of strawberry guava, but seemed to center on valuing the tree, its wood, and especially its fruit for various uses (Figure 12.3). Such concerns over the value of an exotic plant are a common and straightforward source of conflict in weed biological control programs (Turner, 1985). Resolving this source of conflict is possible in some cases; for example, some opponents were persuaded by the explanation that yard trees valued for their fruit and attractive foliage might remain unaffected owing to the limited dispersal ability of *T. ovatus* and by the option to control the insect with horticultural sprays if it did reach their yard trees. The expectation that *T. ovatus* would not kill trees or reduce available wood from existing stands was an important mitigating factor for several common reasons for opposing management with biological control.

The value of strawberry guava fruit appeared to be the most common motivation for people who were actively opposed to biological control (Figure 12.3). People often expressed a fondness for the fruit as an occasional snack or in reminiscence of past experiences collecting and eating it, but less often mentioned it as a food source they depended on regularly. In either case, positive emotional connections with the fruit were the norm, with few people noticing a link between abundant fruit and pest insects. Those most vigorously opposed to biological control argued that, even if currently underutilized, the fruit was valuable as a free emergency food source – famine food, in the event of interrupted supply ships (State of Hawaii, 2011). Hawaii's dependence on imports for about 90% of its food has long been a major concern (Office of Planning, 2012), and arguments for maintaining strawberry guava as a wild food and potential crop appealed to the many proponents of small-scale subsistence agriculture, especially in rural Hawaii county. Strawberry guava fruits also were valued by many pig hunters as a food source for wild pigs, which are harvested as an important subsistence resource by some (Burrows et al., 2007).

Individuals actively opposed to strawberry guava biological control often expressed multiple rationales in addition to valuing the plant (Figure 12.3). Distrust of the science supporting biological control and of the government agencies conducting and reviewing the science were common underlying factors (Warner and Kinslow, 2013). Opponents typically expressed frustration at being left out of the decision-making process concerning biological control, starting with selection of strawberry guava as a target for management. Many complained that they first heard of the proposed use of biological control and the problems caused by strawberry guava after biological control had already been in development for many years and approval of the release of an agent was imminent. Feeling powerless to influence events that seemed to be a foregone conclusion, some opponents became deeply inflamed, and their resentment over lack of engagement resonated with other anti-establishment sentiments (Warner and Kinslow, 2013). For these people, the fact that biological control is a permanent, irreversible, and relatively unbounded form of management became especially objectionable.

With the potential for passions to run high, the most active opponents of strawberry guava displayed remarkable savvy in tapping both emotional and rational arguments to garner support. Examples included a child holding a sign or writing a letter with a message such as "Don't take away my food." Often opponents' message points were poorly supported by facts, but had a strong emotional consistency, typically conveying fear, suspicion, and resentment (Warner and Kinslow, 2013). Such arguments tended to contrast sharply with the relatively dispassionate and factual language of scientists and agencies evaluating biological control. Emotional detachment, a usual characteristic of scientific analyses, in this case tended to widen the gulf between the two sides, adding to the distrust that many opponents felt toward the motives and wisdom of scientists and managers supporting biological control.

Supporters of biological control

Although a great majority of the public was silent and apparently uninterested in biological control of strawberry guava, there were substantial numbers of active supporters. Strong support for biological control came from Hawaii's conservation community, including land managers and biologists who were familiar with the ecological damage caused by strawberry guava and the extreme difficulty of managing it effectively over large areas of native forest. Advocates for release of the biological control agent included the Hawaii Conservation Council, Sierra Club, and, most significantly, the Hawaii Conservation Alliance (HCA), a consortium of public and private agencies working to preserve and restore native ecosystems (Conservation Council for Hawaii, 2010). Unanimity among the diverse members of HCA, ranging from The Nature Conservancy to the Office of Hawaiian Affairs, spoke to the depth of concern over strawberry guava and the support for use of biological control. Strong supporters also included ranchers who were familiar with successful use of biological control for other weeds and some agricultural specialists who were concerned about fruit flies and watershed protection (Conservation Council for Hawaii, 2010).

These various supporters were relatively quiet through the early development of biological control for strawberry guava, with only a few playing active roles in supporting or overseeing biological control research. However, when the proposed biological control came under vocal public criticism beginning in 2008, supporters rallied impressively. Their efforts resulted in a variety of communication products designed to reach the public in ways potentially more effective than the dryly scientific EA and release petition, including videos, blog discussions, online and printed testimonials, letters to the editor, and appearances at public meetings (Medeiros, 2008; Gon, 2009; Corrigan, 2009; Conservation Council for Hawaii, 2010). Through the coordinated efforts of specialists in invasive species control and public outreach, key messages were conveyed widely. By 2010, a broad coalition of active supporters were united behind the necessity of using biological control as a new tool for managing strawberry guava (Figure 12.3). Their many contributions strengthened the Final Environmental Assessment published in 2011, resulting in an evaluation of the proposed biological control release that was more comprehensive ecologically and socially (State of Hawaii, 2011).

Lessons learned about the process

No matter how thoroughly justified and well composed an Environmental Assessment, it will garner complaints from some segments of the population. In the face of opposition to biological control of strawberry guava, the best course of action appeared to be to adhere to a transparent, well established process for consulting public opinion and then provide the results to decision-makers. Designed for this purpose, the Hawaii EA process seemed to work well in the end. Improving the initial strawberry guava EA to meet Hawaii's regulatory laws better required substantial effort. The additional consultations and documentation were much more comprehensive and inclusive than those for previous biological control EAs. It was critical to move beyond the central biological question of host specificity to address thoroughly the impacts of the invader and the expected results of biological control, considered as broadly as possible and from diverse viewpoints.

The work of professionals in EA writing and public outreach was tremendously important to the effort of improving the EA between 2008 and 2010, mainly by broadening and deepening consultations (State of Hawaii, 2010). Public meetings to share information and gather feedback involved teams of ten or more partners in each of four counties. Consultations with Hawaiian cultural practitioners by an experienced specialist were critical to completing the EA's cultural impact assessment. Dozens of scientists and managers from agencies across the state contributed expert opinions or analyses on economic, geographic, and ecological issues, for example interactions between strawberry guava and particular endangered species.

Although it can contribute importantly to sound decision-making, such a thorough EA process will add significantly to the time required to deliver biological control to managers. Our strawberry guava EA process lasted more than three years. In the absence of political and administrative complications that tended to delay research and writing, however, the Hawaii process might have taken only a few months to generate a comprehensive draft EA. The protracted course of the strawberry guava EA probably helped make it more inclusive and thorough, but many consultations could have taken place earlier, while the biological control agent was still in the final stages of testing. Accelerating a multi-disciplinary effort in this way, however, would require truly deft coordination of funds and expertise.

Conclusions

Given the divergent viewpoints on strawberry guava, conflict over biological control was probably unavoidable, and eruption of controversy in the media and local politics may have been inevitable. Release of *T. ovatus* was delayed at least three years as public concerns were addressed through outreach and the environmental assessment process. Surely these challenges could have been handled differently to lessen conflict; but how?

Topics of public concern around biological control of strawberry guava were not difficult to predict. Many of these concerns, such as questions over host specificity, would have applied to any biological control project, and none of the other objections to strawberry guava biological control were unanticipated (Figure 12.3). Proponents of biological control could understand and articulate most public concerns without conducting broad consultations with the public. However, it was the process of consultation itself that was a critical missing piece for many people skeptical of biological control (Warner and Kinslow, 2013). Just being able to hear about and discuss the issue of strawberry guava invasion and the use of biological control was important to many people.

Engagement with the public, especially when there is potential for significant conflict, needs to be broad and early. The case of strawberry guava underlines the desirability of a process to formally establish social consent for selection of a species as a target of biological control at the very beginning of a project (see Chapter 15). Two or three scientists making occasional presentations over a period of years to social organizations, horticultural fairs, and other public events clearly was too limited an outreach effort. Fortunately, the rise of internet-based media has opened a means to reach much larger audiences. Developing and deploying online communications early in a project is now essential. Actually engaging audiences in two-way discussions through social media presents an opportunity that deserves careful consideration. Even when time or institutional barriers prevent the scientists who are developing biological control from using such tools, the opportunity exists to share information with partners who do have time and expertise to discuss the goals and progress of biological control projects with online audiences. Widening the lines of communication gives everyone the opportunity to influence resource-management decisions, and deepening consultations in this way will ultimately strengthen the environmental assessment process.

In the United States and perhaps elsewhere, government-run and government-supported institutions, including those conducting biological control research and regulating its use, are widely viewed with mistrust, which seems unlikely to diminish in the foreseeable future. To overcome this challenge, biological control projects need strong support from independent groups that enjoy greater public trust. The swell of opposition to strawberry guava biological control in 2008 was most effectively countered when individuals and groups from outside the government, who could act as credible messengers, stepped forward in support of biological control (Gon, 2009; Corrigan, 2009; Conservation Council for Hawaii, 2010).

The potential to address issues of trust is an important reason for biological control programs to seek new avenues for public engagement (Warner and Kinslow, 2013). Hayes et al. (2008) described a specific process, based on facilitated face-to-face dialogues, for building trust among concerned groups with regard to biological control in New Zealand. They found that this form of public engagement involved substantial effort – more than initially expected – but that it might prove easier and cheaper in the long run than a less interactive approach. Intensive public engagement by biological control scientists and managers, to be manageable over the long term, certainly needs to be carefully targeted. In working toward conservation of native forests in Hawaii, it makes a great deal of sense to engage with selected small groups of pig hunters and Hawaiian cultural practitioners, citizens whose values are strongly tied to healthy forests but whose views sometimes diverge sharply from those of resource managers. Building relationships and understanding of different points of view can provide a means to get beyond disagreements and work collaboratively on shared interests.

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