Biological Control and Invasive Species Management in the United States:

A Student Debate

Jeffery K. Tomberlin

Since 1993, graduate students in entomology or a related discipline have organized and participated in a debate hosted at the national meeting of the Entomological Society of America. Topics selected are generally of current interest to the students, as well as to the entomology community and the public. Huberty (2003) provides a summary of the debate guidelines, which traditionally have been very structured. The topics and the position of argument (pro vs. con) were randomly assigned to the debate teams.

Four questions regarding biological control and invasive species in the United States were selected as topics for the debate held at the 2000 joint meeting of the Entomological Society of America, the Entomological Society of Canada, and the Societe d'Entomologie du Québec, Montreal, Canada. For each topic, there is a nonbiased introduction, followed by pro and con summaries. Because of space constraints, each team was allowed 500 words to summarize their position in publication. Consequently, some positions may be more thoroughly developed than others.

TOPIC

Classical Biological Control of Exotic Insect Pests Involves Unacceptable Ecological Risk to Native Insect Species

Introduction

Fred Gould
Department of Entomology, North Carolina State University

Since the 1930s, there have been numerous textbook examples of biological control efforts gone amok. The extinction of more than six reptile species due to the introduction of the mongoose for biological control and the havoc wrought by the cane toad in Australia are often cited.

Historically, the major nontarget problems caused by classical biological control of insect pests were associated with vertebrates. Entomologists often pointed to the differences between insects and vertebrates as a reason for less concern with insect biological control agents. Furthermore, entomologists also cited improvements in prerelease screening tests that checked for the host range of biological control agents. In 1983 and again in 1991, F. G. Howarth called on entomologists to reexamine the potential for nontarget effects that could result from release of insects as biological control agents. Howarth was especially concerned about the potential of exotic herbivores, predators, and parasites to attack endemic or endangered species. He presented several cases in which there was some evidence that insect species used for biological control had caused damage to nontarget species.

Since Howarth challenged what he believed was complacency on the part of entomologists, a cadre of entomologists, ecologists, and conservationists have begun to conduct more detailed experimental analyses of the hypothesis that biological control agents do not cause environmental damage. Biological control practitioners also have increased efforts at testing the host range of species being considered for use. Furthermore, federal regulatory practices related to introduced biological control agents are being reassessed.

Beyond scientific inquiry and assessments, the debate about the potential negative effects of biological control has moved into the public arena. Many practitioners of biological control who consider themselves to be environmentalists have been astonished by the public criticism leveled against them by other environmentalists. After decades of their "labor of love" to replace the use of broad-spectrum pesticides with natural control agents, many biological control practitioners believe that their accusers are misdirected or disingenuous. Some of the public critics believe that biological control is the most powerful under-regulated environmental technology in the United States, and that, for defensible or indefensible reasons, the practitioners have been ignoring a critical issue. Of course, many biological control practitioners and environmentalists do not hold such polarized views.

In preparation for this debate, the students have been examining the information on nontarget effects for a few months. Notice that the focus of this debate between the University of Maryland and the University of California at Davis is limited to ecological risks associated with biological control of exotic insect pests and not with the control of weeds. The debate also focuses on classical biological control as contrasted with augmentative releases or practices that enhance the conservation of biological control species in managed systems. It was our hope that the audience, and perhaps even the debaters themselves, would leave the forum with a deeper understanding of the issues involved.

Pro Position

Scott M. Ferrenberg, Ethan C. Kane, Andrew H. Smith, and Mark E. Suarez
University of Maryland

Given the growing potential for introductions of invasive species, comprehensive management strategies must be devised. Some advocate classical biocontrol as the best alternative for combating invasive species. Although biological control has been effective in certain situations, it is our position that this approach poses unacceptable risk to native insects.

The characteristics that make insects ideal models for evolution and genetic studies, including high fecundity, short generation times, and high dispersal ability, should also raise concern when contemplating their release as biological control agents. Successfully introduced agents typically are permanent additions to the environment, and as such, they may cause irreversible, negative effects (Elliott et al. 1996).

Sufficient examples of nontarget effects exist, warranting concern (Simberloff and Stiling 1997). Strong (1997) notes that 32% of the 115 parasitoids introduced into Hawaii attack native insects other than their intended targets. Similarly, Hawkins and Marino (1997) report that 16% of parasitoids introduced into North America have colonized native hosts. Additionally, the tachinid fly, *Bessa remota* (Aldrich), which was introduced into Fiji, parasitizes only nontarget organisms (Howarth 2000).

Another example, involving a European tachinid fly, *Compsilura concinnata* (Meigen), which is used to control gypsy and browntail moths [*Lymantria dispar* (L.) and *Euproctis chrysorrhoea* (L.)] in North America, also demonstrates nontarget effects. Lacking synchronization with its target pests, this agent attacks nontargets during three of its four generations in a year (Howarth 2000). Studies link this tachinid to the decline in giant silk moths, *Rothschildia jacobaeae* Walker, in northeastern North America (Howarth 2000). There is also evidence that *Coccinella novemnotata* Herbst, a native coccinellid, has declined as a result of the introduction of *Coccinella septempunctata* L. (Elliot et al. 1996).

Biological control advocates state that nontarget effects are minor, but little effort has been directed at measuring the long-term impacts of such events (Strong 1997). Howarth (1983, 1985, 1991) has argued that biological control introductions have likely caused extinctions of nontarget organisms. Limited knowledge about arthropod assemblages prior to introductions of control agents limits our ability to assess nontarget effects and extinctions.

Not only can classical biological control result in trophic alterations, but the overwhelming percentage of classical biological control attempts have failed to achieve an economically effective level of pest control. From 1880 to 1998, there were more than 4,500 classical biological control attempts, and only about 10% of these led to some level of pest management (Gurr and Wratten 2000). Given the high stakes of invasive species scenarios, a control methodology as unreliable and as risky as classical biological control is not our best primary option.

Not only can classical biological control result in trophic alterations, but the overwhelming percentage of classical biological control attempts have failed to achieve an economically effective level of pest control.

Con Position

David R. Haviland, Kirsten A. Copren, Cheryle A. O'Donnell, and Tamara L. Roush
University of California, Davis

Classical biological control is one of the most under-appreciated and under-valued control tactics available for the management of exotic insect pests. The potential specificity, permanence, and affordability that this tactic offers make it a primary candidate in any integrated pest management (IPM) strategy. When executed properly, economic control can be exerted on extremely injurious exotic pests with minimal risks to native insect species.

Pressures from exotic pests constantly influence agricultural and urban environments. Pimentel et al. (1999) estimated that 4,500 arthropod species have been introduced into the United States. This report predominantly includes accidental introductions that were unscreened, not researched, and often imported unknowingly by people ignorant of ecological and environmental issues. Many of these introductions represent enormous risks to

native insect species, risks that justify consideration of classical biological control.

Risks associated with the importation of natural enemies can be minimized through appropriate preintroduction assessment processes. These procedures weed out candidate organisms that possess the potential to shift hosts, expand beyond desired geographical ranges, or negatively affect endemic or endangered insects. These processes also separate the modern era of biological control from the often-criticized early period of ad hoc introductions. Currently, to properly assess risks, researchers must possess, at minimum, knowledge about the biology of the control agent, including host range and specificity. Decisions are made only after all available options, such as cultural and native biological control, are considered.

Given the right conditions, with the proper control agent, there is no other tactic that can equal the effectiveness of classical biological control. This tactic is unparalleled for its ability to permanently correct invasive pest problems without insecticide use.

The risks of not implementing classical biological control should also be considered. This is particularly true with the use of default insecticide applications. Risks from insecticides on native insect species far outweigh the risks of biological control, especially with properly screened introduced organisms. Imagine the worldwide citrus industry without the vedalia beetle, *Rodolia cardinalis* (Mulsant), to control cottony cushion scale, *Icerya purchasi* Maskell. Industry survival would have required an arsenal of insecticides. Similarly, without the introduction of *Encarsia inaron* (Walker) for ash whitefly, *Siphoninus phillyreae* (Haliday), management, recreation areas and urban landscapes in many U.S. cities would still be applying insecticides repeatedly.

Given the right conditions, with the proper control agent, there is no other tactic that can equal the effectiveness of classical biological control. This tactic is unparalleled for its ability to permanently correct invasive pest problems without insecticide use, as well as its capacity to do so in a manner that is efficient, economic, and safe to native insect species.

Acknowledgment

We thank Les Ehler and Michael Parrella for their helpful comments in the preparation of our statement. Also, we thank the University of California, Davis, Department of Entomology for funding our attendance at the debate.

TOPIC

Classical Biological Control of Exotic Weed Species Involves Unacceptable Risk to Native Plant Species

Introduction

Will K. Reeves
Clemson University

Since the invention of agriculture and agricultural trade, exotic plants have been introduced into nonnative habitats by human activities. Most exotic plants do not survive, but some become "weeds" after introduction. These weeds are rather broadly defined as any noxious, unsightly, or unwanted plant. Some weeds are endemic species, but up to 75% of the problem weeds in the United States are considered exotic plants (Delfosse 1988).

Mechanical and cultural agricultural practices or herbicides have dominated the traditional methods of weed control. Biological control is another option, which is most often considered for weed control when pest plants are not localized or traditional methods give inadequate results. Most biological control programs are conducted on extensive, low-value lands (i.e., range lands) where traditional control practices are prohibitively expensive. In addition to saving money, the public often perceives biological control as an environmentally friendly alternative to chemical control (Louda et al. 1997). Government agencies that favor chemical reduction also support biological control (Malakoff 1999).

Biological control is a component of most IPM strategies. By definition, IPM does not rely on a single control method to reduce pest species below an acceptable damage level. In classical biological control strategies, self-reproducing populations of herbivores are established to control target weeds. These herbivores reproduce and redistribute themselves into new weed populations. Chemical control practices are usually reduced or eliminated.

Classical biological control using herbivorous insects has been successful in reducing weed populations (e.g., Klamath weed) (Crawley 1989); however, the eventual fates of exotic herbivorous species are hard to predict. By definition, a successful classical biological control program must leave viable exotic herbivores and weeds in the ecosystem. The ecological effects of these introduced herbivores cannot be fully determined before release. For example, the flowerhead weevil, *Rhinocyllus conicus* Froeh, was released to control the Russian thistles and now is attacking other native and exotic thistles (Louda et al. 1997, Strong 1997).

Numerous other examples exist of introduced biological control agents attacking nontarget native plants or feeding on unexpected food sources (Howarth 1991). The risks of introducing populations of exotic herbivores must be considered against the environmental and economic costs of targeted weed species. Biological control is a "hit-

or-miss" method of pest control, and less than one-third of the introduced herbivorous species have become established in the United States (Malakoff 1999). Only 20–40% of all biological control strategies for exotic weeds have been successful (Louda et al. 1997). Still, successful biological control can be more effective than herbicides and costs less to maintain. If exotic herbivores are prolific and host-specific, the benefits of biological control agents can exceed the effectiveness of other control methods.

Critics of classical biological control often refer to the apparent lack of regard for the environment when biological control species are released (Howarth 1991, Strong 1997). Their opponents counter by arguing that stringent host specificity tests as well as ecological and economic evaluations are undertaken before release (McEvoy 1996, Malakoff 1999). Evidence indicates that some introduced weed-controlling species have caused ecological disasters (Howarth 1991). Even some highly successful biological control campaigns have suffered negative publicity when control agents escaped laboratories before their intended release (Finkel 1999). The ecological damage caused by failed biological control agents must be considered when any new agent is proposed.

Biological control will remain a component of IPM. Like most pest management practices, there are no simple solutions that lack pitfalls. All complications must be considered carefully before new biological control agents are released. Strict laboratory and field tests must be done to determine the ecological risks involved with introduced biological control species. If herbivorous species are not an environmental risk, then the costs and benefits of their use as a biological control agent must be considered.

Factors that place native plant species at risk include genetic change, dispersal of the weed control agents, and greatly limited prerelease studies.

Pro Position

Melissa M. Willrich, Boris Castro, and Jeff Gore
Louisiana State University

Biological weed control is often considered to be a safe and effective way to provide permanent control with little or no damage to nontarget organisms and no ecological disruptions (van den Bosch and Messenger 1973, DeBach 1974). However, numerous examples exist of biological weed control agents damaging nontarget plants. Factors that place native plant species at risk include genetic change, dispersal of the weed control agents, and greatly limited prerelease studies.

Biological control agents must adapt (genetically) to become established and persist permanently in a new environment (Ehler 1991). Sometimes this is accomplished because selection pressures are removed when the agent is taken from its native habitat (Dethier 1952). *Chrysolina quadrigemina* (Suffrain) was successfully released in California and provided good control of Klamath weed, *Hypericum perforatum* L., by 1956 (van den Bosch and Messenger 1973). When this insect was found damaging the ornamental *H. calcynum* L. in 1976, it was attributed to evolution of a host race (Andrés 1985). Harris (1990) proposed that selection for host strains may occur when the agent experiences improved survival on a marginal host, for example, *Teleonomia scrupulosa* Stål temporarily attacking sesame, *Sesamun indicum* L., after defoliating lantana, *Lantana camara* L.

One desirable attribute of an effective natural enemy is the ability to disperse; however, the inability to restrict dispersal of a permanent agent places native plants at risk. *Cactoblastis cactorum* Bergman was released in 1957 in the Leeward Islands to control *Opuntia* spp. (van den Bosch and Messenger 1973). In 1989, this moth was observed in the Florida Keys feeding on the endangered *Opuntia spinosissima* (Martyn). This example demonstrates that even if thorough prerelease studies are conducted, predicting negative effects from unforeseen dispersal of the biological control agent to new areas is difficult and risky.

No absolute tests unequivocally anticipate the outcome of inserting a novel species into an ecosystem or likewise determine whether native plant species will be affected by the release of biological control agents (Zwolfer and Harris 1971). Tests are carried out in artificial environments (i.e., cages, petri dishes); therefore, the ability to accurately predict weed control agent behavior in the target habitat is difficult. Prerelease studies are being expanded for phylogenetic testing; however, negative (nontarget) effects on the plant ecosystem may not be readily evident for 20–30 years.

In a recent survey, biological control experts were asked to identify issues of most concern and the challenges they face in implementing classical biological control programs. Of the 115 surveyed, 80% indicated as the issues of most concern: (1) inability to predict nontarget negative impacts and (2) lack of post-release evaluations (Marshall W. Johnson, University of California at Riverside, unpublished data, 1995). In conclusion, it is estimated that less than 40% of introduced agents against weeds and insects result in substantial control (Thomas and Willis 1998). Our position is

that this level of possible success is not high enough to justify the potential long-term risk to nontarget plants associated with introducing biological weed control agents.

Acknowledgment

The authors thank Gene Reagan and Seth Johnson for their help and guidance in preparing our argument and this manuscript.

Con Position

David W. Held, Jerome A. Gels, Eric J. Marsland, and Marissa L. Griffin
University of Kentucky

Exotic weeds can completely impact all biotic and abiotic components of native ecosystems, greatly diminishing the abundance and survival of native species (Mack et al. 2000). Failure to control invasive weeds can result in severe global consequences, including loss of agricultural, forestry, and fishing resources (Mack et al. 2000). The environmental consequences of allowing exotic plants to proliferate are profound, and the benefits associated with the judicious selection of a classical biological agent far outweigh any risks.

Classical biological control of invasive weeds uses exotic herbivores from the same habitat as the problem weed. In the United States, successful use of classical biocontrol agents for weeds range from 41% exerting some control to 20% yielding significant control (Harris 1993, Louda et al. 1997). Significant control of rampant exotic weeds is difficult to achieve through other conventional means. Compared with other methods, the minimal nontarget effects and low input solutions achieved by successful classical biological control make it an environmentally and economically sound alternative.

A cautious selection process reduces the environmental risk associated with importing an exotic herbivore to control an alien weed (Harris 1993). Although host switching by a control agent is the predominant concern associated with classical weed biological control, 600 examples throughout the world show that control agents have remained within their predicted host range (Harris 1993). Furthermore, there are only eight recorded instances in which biological control agents have attacked plants other than their initial targets (McFayden 1998). Of these, five were known to attack native plants within the same genus of the target plant. At the time of introduction, however, the other plants were not considered to be economically important. By today's screening criteria, these insects would have been eliminated as candidates for use, and these problems would not have occurred (McFayden 1998).

Success, economics, and sustainability suggest that classical biological control remains the best option for the control of exotic weeds.

Eliminating exotic insect herbivores as potential control agents for invasive weeds is not an option. The successful control of alligator weed, *Alternanthera philoxeroides* L., and klamath weed, *Hypericum perforatum* L., through classical biological control illustrates the failures associated with cultural and chemical control, reiterating why classical biological control is such an important tool. The extensive and remote coverage of these weeds rendered cultural control too expensive and futile (Harley and Kassultke 1971, Julien and Chan 1992). Herbicides used to treat alligator weed were not only ineffective and costly, but also reduced nontarget native flora (Julien and Chan 1992). Simultaneously, Alligator weed was becoming resistant to herbicides and thus out-competed native plants (Julien and Chan 1992). Other methods, which use native herbivores to control exotic weeds, have been unsuccessful (Harris 1993, McFayden 1998). Success, economics, and sustainability suggest that classical biological control remains the best option for the control of exotic weeds.

TOPIC

Local Communities Should be Able to Block Efforts to Control Invasive Exotic Species within Their Boundaries, if They Consider the Methods to be Used Unacceptable

Introduction

Boris Castro and Jeff Gore
Louisiana State University

Many insects, weeds, and plant pathogens have been either purposely or accidentally introduced into the United States (Horsfall 1983). Upon arrival, some of these organisms have become established and caused economic or ecological damage. Pimentel et al. (2000) estimate that exotic species are responsible for more than $138 billion in losses and control costs annually. Invading species that become established often proliferate rapidly and become devastating pests (Horsfall 1983, Mack et al. 2000). Mack et al. (2000) attributed success of exotic species to three factors. These include (1) loss of biological constraints, (2) utilization of a vacant niche, and (3) lack of community species richness.

Control of exotic species is an often difficult and controversial subject. Several methods have been used to manage exotic species in the United States, and citizens have opposed some of these methods. Perhaps the most publicized method for controlling exotic species has been eradication efforts. Eradication efforts have been very effective in some instances and disastrous in others. The eradication of the screwworm fly, *Cochliomyia hominivorax* (F.), is one of the most successful

examples of an eradication effort (Simberloff 1997). The sterile male release technique used in this program has been adopted for other eradication efforts because of its widespread success. Sterile males of the Mediterranean fruit fly, *Ceratitis capitata* (Wiedemann), were released for eradication in California, but reinfestations of the Mediterranean fruit fly in the state caused this program to be far less successful than the screwworm project. Applications of malathion were made to help eradicate the Mediterranean fruit fly, despite opposition from the public (Kahn et al. 1990).

In 1957, Congress authorized $2.4 million dollars to begin eradication of the red imported fire ant, *Solenopsis invicta* Buren (Lofgren 1986). Initial eradication efforts used widespread applications of heptachlor, an insecticide that is very toxic to nontarget organisms, including humans. Wildlife and cattle died as a result of the initial applications (Davidson and Stone 1989). Florida and other states withheld matching funds, and heptachlor applications were discontinued. Eradication attempts against the red imported fire ant were continued with the development of mirex bait. Mirex residues, however, were found in many nontarget organisms; and the U.S. Environmental Protection Agency canceled mirex's registration in 1977 (Lofgren 1986). The cost of these eradication efforts was approximately $200 million; and the fire ants' range actually expanded during the time of treatment (Davidson and Stone 1989). The range expansion was primarily due to mirex adversely affecting native ant species, thereby reducing competition with red imported fire ants.

Other control methods include maintenance control (Schardt 1986), ecological restoration (Randall et al. 1986), and biological control (Center et al. 1986). Maintenance control has been very effective against exotic weed species. In Florida, multiple chemical and mechanical control tactics are used to maintain water hyacinth, *Eichhornia crassipes* Solms, and hydrilla, *Hydrilla verticillata* Royle, below damaging levels (Schardt 1986). These kinds of programs have been successful and experienced little public opposition.

Ecological restoration is perhaps the most complete and ecologically sound method for reducing effects of exotic species. This kind of control is used primarily in natural areas following disturbances that are not likely to be reversed without intervention (Cairns 1986). The ultimate goal of this kind of program is to allow native species to replace exotic species (Randall et al. 1986). One example of this involves suppression of wildfires. In areas where wildfires are common, the organisms in that habitat are adapted to (and often benefited by) fire. Consequently, when wildfires are suppressed, exotic species can invade the habitat, leading to changes in the ecosystem. If wildfires are encouraged in these habitats, invading species will usually be reduced (Ewel 1986).

Another example involves mine reclamation. Mining sites have been heavily disturbed and are very susceptible to invasion by exotic species. The result of mine reclamation projects may be ecological restoration or replacement with a new habitat (Randall et al. 1986).

Classical biological control is based on the premise that an exotic species' population is not regulated by biological constraints that are present in its native habitat. With classical biological control, the native habitat of the exotic species is explored for natural enemies, which are then imported and released into the new habitat (DeBach 1974). Classical biological control has been used successfully against insects, plant pathogens, and weed pests. The most successful and well-known case of classical biological control involved importation of the vedalia beetle, from Australia to control the cottony cushion scale in California citrus (Caltagirone and Doutt 1989). This method is very logical; however, some oppose the importation of another exotic species, fearing unknown effects.

All of the control measures mentioned here have benefits and risks. Among these measures, eradication is the most controversial method for controlling exotic pests. These programs can be very expensive, and in general, the probability of success is small. However, certain organisms are good candidates for eradication. This was particularly true of the screwworm fly. Information about the biology and mating habits of this pest was essential to the success of the program. In contrast, methods used in red imported fire ant eradication were inappropriate and not well studied; and disastrous effects could have occurred.

The most successful and well-known case of classical biological control involved importation of the vedalia beetle, from Australia to control the cottony cushion scale in California citrus

In conclusion, any method used to control an exotic species is likely to be criticized by some individuals. Different people will have different views as to the importance of controlling pests. In general, public perceptions of risks associated with a control measure (or an exotic species) will likely be different than the risks perceived by scientists and researchers (Higley et al. 1992). The Biological Control Act of 1984 (Anonymous 1984) was enacted in Australia in response to conflicting interests about biological control of the weed *Echium plantagineum* L. This act allows for public review of biological weed control programs before release of the biological control agent (Goeden and Andrés 1999). Certainly, local communities should be able to voice their concerns about control measures within their borders; however, allowing local communities to block control efforts is a much deeper concern that should be closely evaluated.

Pro Position

Michelle G. Colacicco, R. Chitkowski, and Austin Jenkins
Department of Entomology, Clemson University

Communities should have the right to reject or limit eradication and control programs because

mandatory participation in pest management programs can adversely affect local areas. Taking away the rights of the local constituency to evaluate the programs that are enacted within their boundaries degrades the integrity of the community. Local areas must be empowered to evaluate proposed pest management programs and alter them to meet the needs of their citizens. Ultimately, if the majority of community members deem a proposed program unacceptable, they should be able to block control programs within their boundaries.

Health problems and monetary losses often result from eradication programs. For example, the medfly eradication programs in California and Florida led to apprehension and mistrust in local communities (Kahn et al. 1990). Residents exposed to pesticide sprays suffered from respiratory, gastrointestinal, dermatological, and neurological disorders (Shafey et al. 1999). In addition to these health problems, some pesticide applications damaged private property; In California, 14,000 claims for automobile paint damage cost the state taxpayers $3.7 million (Myers et al. 1998).

To be effective, any management effort should fall within a centrally managed framework where coordination, regulation, and accountability maximize the probability of effective control.

Community members should have the opportunity to evaluate proposed management programs for potential negative impacts. If the impacts or risks of a proposed eradication program outweigh the benefits, community rights should prevail and must be considered by planners.

Management of invasive species can include cultural and habitat modifications. The implementation of these programs has the potential to economically injure local industries and communities. For example, the boll weevil eradication program forced farmers to alter their farming practices by requiring them to participate in timed spraying, habitat destruction, and trap cropping (Myers et al. 1998). All of these control measures required time and money that could have been used to maintain farms. Local communities should be able to evaluate and, if necessary, veto programs that require unacceptable cultural modification, monetary loss, or habitat destruction.

Some individuals, industries, and communities can benefit from exotic species that are considered pests by others. Because most exotic pests cannot be totally eradicated, a universally enforced eradication or control program can affect communities that benefit from exotic species. Exotic "pests" have been beneficial in certain situations. Data has accumulated suggesting that the red imported fire ant can be a valuable beneficial in some agricultural systems and to pest control operators. (Vinson 1997, Meyers et al. 1998, McGriff and Ruberson 1999). Communities should be able to determine whether a targeted species is a pest to their citizens.

In summary, community opinions and rights must be considered during all stages of a control program. When a community will be harmed from a program, it should have the right to refuse to participate.

Con Position

Patrick S. Duetting, Mary M. Gardiner, Addie R. Polerstock, and April A. Stehr
Department of Plants, Soils, and Entomological Sciences, University of Idaho

Exotic invasive species cause serious economic, biological, health, and social problems. After habitat destruction, non-native species are the second largest threat to biodiversity (Devine 1999). In the absence of natural enemies, exotic species gain a competitive advantage over native species. This may result in an irreversible impact on ecosystem function; therefore, control demands a plan based in sound biology.

Local communities should not be able to block efforts to control invasive exotic species because complete implementation of an area-wide management plan executed along biological boundaries is essential. If the invasive species is not managed throughout the invaded region, control efforts will fail because of pest refuges in unmanaged areas. Individuals remaining in these refuges can comprise metapopulations—populations that are linked by dispersal (Husband and Barrett 1996, Gillman and Hails 1997). Re-establishment subsequent to local extinction is possible because of the potential for dispersal of local breeding populations (Hanski and Simberloff 1997). Movement from unmanaged areas allows recolonization and spread. If a local region within the target area is not included, the entire control program will not be effective.

Furthermore, plans developed for release and management of biological control agents are based on modern scientific theory and research and are in accordance with EPA and USDA guidelines (U.S. Congress, OTA 1993). Communities have the opportunity to be involved in the development of these plans. An appropriate framework exists for determining whether control tactics pose acceptable risks.

To be effective, any management effort should fall within a centrally managed framework where coordination, regulation, and accountability maximize the probability of effective control. Without oversight, exotic invasive species can expand in range outside the political boundaries of a local control program. Instead of leaving control of exotic invasive species to local communities, interagency cooperation, public education, and public involvement should be encouraged.

Control of invasive species should operate under a strong body of law. Exotic invasive species should be considered pollutants comparable with

oil spills, hazardous waste discharges, or other events that damage public environmental resources. Control of these species is done for the good of the people and should not be blocked by local interests. The maintenance of the health and quality of ecosystems and the preservation of biodiversity are within the public domain and should be acknowledged as a public right.

Acknowledgments

We thank Nilsa Bosque-Perez and Mark Schwarzlaender for their time, guidance, and support throughout the preparation of this debate. We thank Sanford Eigenbrode, Joseph McCaffrey, Frank Merickel, and Jack Brown for their comments and input.

TOPIC

Because Increasingly Open Trade Increases the Risk that Invasive Exotic Species will be Introduced into the United States, an Environmental Impact Assessment (EIA) Should be Required Prior to Approval of all Formal International Trade Agreements

Introduction

Scott M. Ferrenberg, Ethan C. Kane, Andrew H. Smith, and Mark E. Suarez
Department of Entomology, University of Maryland

Throughout history, exchange of goods has played a major role in shaping societies. Traditionally trade has been considered beneficial for the involved parties. Not only can trade bolster the economic situation of nations, it also can diversify available products and encourage cultural exchanges. As a result, the standard of living is generally increased within the trading nations and the benefits of trade are often considered to be far greater than any potential negative consequences. Seeking these benefits and economic improvements, many nations lobby for various degrees of free trade, or for the exchange of goods and commodities in the absence of tariffs, taxes, and embargoes.

There can also be, however, nonbeneficial effects associated with trade. Recently, concerns have centered on the environmental effects of free trade and typically have been directed toward the means of production and differing environmental policies between countries. One consequence environmentalists anticipate is the movement of producers to those countries with the lowest environmental standards, where goods can be manufactured at cheaper rates with minimal focus on reducing pollution. Such considerations are valid; however, the environmental impacts of trade are not constrained to industrial pollution and resource use, and the effects of intentional and unintentional movement of biota must be included among the concerns.

When introduced either accidentally or intentionally, organisms that are not native to a region out-compete native species for available resources, reproduce prolifically, and dominate regions and ecosystems are labeled invasive species. In general, translocation tends to free species from the ecological pressures imposed upon them by competitors and natural enemies. Left unchecked, invasive species have the potential to transform entire ecosystems, as native species and those that depend on them disappear.

The anthropogenic movement of species is not a new phenomenon. Whether planned or unplanned, introductions of species into North America have been occurring since the pre-Columbian age. Some species were intended for release, some escaped from captivity, while others came as hitchhikers on commodities or as stowaways aboard transport vessels. Although detrimental effects of introductions have been recognized in the past, they were typically dismissed as an unfortunate side effect of economic progress. As ecological appreciation and understanding have burgeoned, many people have come to realize that these seemingly innocuous introductions may indeed have grave consequences for the health of our ecosystems and the functions that they perform.

As the desire to curb the introduction of invasive species has grown, so too has the concern that the trend toward increased free trade holds the possibility for greater movement of exotic species. In 1994, Canada, the United States, and Mexico ratified the North American Free Trade Agreement (NAFTA), establishing a 15-year timetable to eliminate almost all trade barriers between the three countries.

The immediate economic gains that trade agreements will garner for participating nations are investigated before ratification. Because it is difficult to quantify species losses, species reductions, and habitat destruction into dollar amounts, the economic impacts of environmental degradation have received little or no attention during formal trade agreements. So that environmental issues are no longer ignored, some have proposed that Environmental Impact Assessments (EIAs) be completed by the United States before any new trade agreements are ratified. An EIA is a systematic examination of the likely effects of development proposals on the environment before the beginning of any activity. The actual term is derived from Section 102 (2) of the National Environmental Policy Act (NEPA) of 1969 (Anonymous 1969). The result of an EIA is assembled in a document known as an Environmental Impact Statement (EIS) that considers the positive and negative effects of a particular project on the environment.

Whether or not EIAs are the best tool for stemming the flow of invasive species into the United States is the subject of a loquacious and, at times, acrimonious debate. Given current trends toward increasingly open trade, and the subsequent risk of invasive exotic species introduction into the United States, should an EIA be required before approval of all formal international trade agreements?

Pro Position

Robert C. Venette, Woodward D. Bailey, Daniel A. Fieselmann, and Juli Gould
U.S. Department of Agriculture, Animal and Plant Health Inspection Service

More than 50,000 nonindigenous species occur in the United States (Pimentel et al. 2000). Many of these organisms were unwittingly brought to the United States in the course of conducting international trade (Ruesink et al. 1995). The resolution raises the challenge of simultaneously facilitating international trade and safeguarding American agriculture and native ecosystems from the establishment of non-indigenous species. This challenge is part of the mission of USDA's Animal and Plant Health Inspection Service (APHIS).

To help fulfill its mission, APHIS uses ecological risk assessment. Risk assessment evaluates the likelihood of a species becoming established and the consequences of its establishment. Such assessments provide a basis for an EIS but are narrower in scope. This shift in focus remains within the spirit of the debate and raises two questions: Should we use risk assessment when conducting international trade? If so, why?

The international community answers "yes" to the first question. The Agreement on the Application of Sanitary and Phytosanitary Measures (or SPS agreement) structured under the World Trade Organization establishes basic rules for food safety and animal and plant health (FAO 1996). The SPS agreement recognizes that trade regulations may be necessary to protect human, animal, or plant health, but prohibits the use of unsubstantiated claims of risk as a trade barrier. Risk assessments and resulting regulations must be based on science (FAO 1996). Formal trade agreements such as NAFTA include similar SPS language. Risk assessments generally do not pertain to the development of such large trade agreements, but become pertinent when specific commodities are discussed during bilateral trade negotiations.

At least three reasons account for the broad support of risk assessment. First, most nations recognize that the best defense against the establishment of exotic pests is preventing them from arriving in the first place. Experience demonstrates that eradication of an established population can be exceptionally difficult (Myers et al. 2000). Second, risk assessments allow countries to target safeguarding efforts. Given the enormous number of potential invaders, adequate time and resources do not exist to detect each potential pest as it arrives in a new country. Thus, available resources are better used if they can be targeted against those species that pose the greatest risk. Finally, risk assessments may reveal that certain organisms are not likely to become established in specific parts of the world (Roberts et al. 1998). As a result, new trade opportunities may arise that would be economically beneficial. In summary, risk assessments provide a vital tool to facilitate safe international trade and to protect agriculture and natural resources from risks associated with exotic pests.

Con Position

Gabriella M.G. Zilahi-Balogh, Joan M. Clarke, Jarrod Leland, and Lois Swoboda
Department of Entomology, Virginia Polytechnical Institute

Requiring an EIA before Congress could approve an international trade agreement would be costly and time-consuming. Congress is already mandated by its constituents to consider issues of public concern such as the environment. Would this process be improved by instituting an additional layer of bureaucracy?

Under the National Environmental Policy Act (NEPA) (Anonymous 1969), only the requirement of an EIS is enforceable. An EIS is merely a procedural requirement that does not mandate an outcome (Plater et al. 1994). This requirement may result in distracting environmental groups, but not in real change that would protect the environment. This kind of assessment would not be practical for an entire trade agreement. Specific measures are needed to reduce introductions of invasive exotic species. Requiring an EIA would only divert resources from tasks that could otherwise be used to reduce the risk of introducing invasive exotic species into the United States.

Measures are already in place to reduce the risk of invasive species introductions. The APHIS–Plant Protection Quarantine (APHIS–PPQ) was delegated by Congress as the primary Federal agency responsible for preventing the entry and establishment of invasive plant pests into the United States. Quarantine and inspection requirements provide the framework for regulation of movement of commodities across United States borders (NPB 1999). Quarantine pests are identified through a pest risk analysis process. Economic and environmental concerns are considered in the pest risk analysis procedures (FAO 1996, NPB 1999).

Globalization of trade has influenced international phytosanitary trade requirements. The World Trade Organization (WTO) and the Food and Agriculture Organization of the United Nations (FAO) are the primary sources of international agreements on plant protection in the context of international trade. Being a member country, the United States participates through APHIS–PPQ in setting international plant health standards and in trade negotiations with partners worldwide (NPB 1999). Rather than spending resources on EIAs, directing them toward APHIS would improve the safeguarding system already in place.

Debate Participants

Clemson University

R. Chitkowski is an M.S. student working with Sam Turnipseed in cotton.

Michelle G. Colacicco completed her M.S. in December 2000. She examined habitat selection by the red

imported fire ant under the direction of Peter Adler and John McCreadie.

Austin Jenkins is an M.S. student working with Sam Turnipseed and Mike Sullivan in cotton.

Will K. Reeves is a Ph.D. student researching Tabanidae under the direction of Peter H. Adler.

Louisiana State University

Boris A Castro is a Ph.D. candidate examining IPM in corn and sorghum under the direction of Thomas J. Riley.

Jeff Gore is a Ph.D. candidate examining IPM in cotton under the direction of Roger Leonard.

Melissa M. Willrich is an M.S. candidate studying integrated pest management (IPM) strategies in soybeans under the direction of David J. Boethel.

North Carolina State University

Fred Gould received his Ph.D. from the State University of New York at Stony Brook in ecology and evolutionary biology.

University of California at Davis

Kirsten A. Copren is a Ph.D. candidate studying the behavior, genetics, and taxonomy of termites under the direction of Rob Page.

David R. Haviland is an M.S. candidate studying integrated pest management strategies in sugarbeets under the direction of Larry Godfrey.

Cheryle A. O'Donnell is a Ph.D. candidate studying the systematics of Thysanoptera under the direction of Michael P. Parrella, Peter S. Cranston, and Penny J. Gullan.

Tamara L. Roush is a Ph.D. candidate examining the genetic mechanisms of resistance in grapevine, *Vitis* sp., to grape phylloxera under the direction of Jeffrey Granett and M. Andrew Walker.

University of Idaho

Patrick S. Duetting is an M.S. student working with Sanford D. Eigenbrode on tritrophic interactions among pea aphids, the entomopathogenic fungus *Pandora neoaphidis*, and peas.

Mary M. Gardiner is an M.S. student working with James D. Barbour on the response of the predatory mites *Galendromus occidentalis* and *Neoseiulus fallacies* to *Tetranychus urticae*.

Addie R. Polerstock is an M.S. student working on the mating behavior and physiology of *Anopheles gambiae* mosquitoes with Marc J. Klowden.

April A. Stehr is an M.S. student working with Joseph P. McCaffrey on a degree-day model for the cabbage seedpod weevil, *Ceutorhynchus assimilis*, in winter canola, *Brassica napus*.

University of Kentucky

Jerome A. Gels is an M.S. candidate examining horticulture entomology under the direction of Daniel A. Potter.

David W. Held is a Ph.D. candidate examining horticulture entomology under the direction of Daniel A. Potter.

Eric J. Marsland is a Ph.D. candidate studying medical-veterinary entomology under the direction of Stephen L. Dobson.

Marissa L. Griffin is an M.S. candidate examining biological control in field crops under the direction of Ken V. Yeargan.

University of Maryland

Scott M. Ferrenberg is an M.S. candidate studying population and community ecology under the direction of Robert F. Denno.

Ethan C. Kane is an M.S. candidate studying systematic entomology under the direction of Jeff Shultz.

Andrew H. Smith is an M.S. candidate studying biological control under the direction of Dale Bottrell.

Mark E. Suarez is a Ph.D. candidate examining termite biology and population genetics under the direction of Barbara L. Thorne and David J. Hawthorne.

United States Department of Agriculture

Woodward D. Bailey received his Ph.D. from North Carolina State University specializing in insect physiology and biochemistry.

Daniel A. Fieselmann received his M.S. from the University of Maryland specializing in regulatory entomology and IPM.

Juli R. Gould received her Ph.D. from the University of Massachusetts specializing in biological control.

Robert C. Venette received his Ph.D. from the University of California-Davis specializing in invasion biology.

Virginia Polytechnical Institute

Joan Marie Clark is an M.S. student in biological control under the direction of Paul Semtner.

Jarrod E. Leland is a Ph.D. student examining biological control with microbes and is under the direction of Donald E. Mullins.

Lois E. Swoboda is a Ph.D. candidate conducting research in urban/structural pest entomology under the direction of Dini Miller.

Gabriella Zilahi-Balogh is a Ph.D. candidate conducting biological control research and is advised by Loke T. Kok and Scott M. Salom.

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Jeffery K. Tomberlin received his Ph.D. from the University of Georgia specializing in decomposition ecology. He is currently an assistant professor and extension specialist in the Department of Entomology at Texas A&M University.