Conservation Issues

Lack of Public Awareness of Biological Invasions by Plants

Thomas F. Colton
Biological Science Learning Center
University of Chicago
924 East 57th Street
Chicago, Illinois 60637 USA
tfc1@midway.uchicago.edu

Peter Alpert
Department of Biology
University of Massachusetts
Amherst, Massachusetts 01003-5810
USA
palpert@bio.umass.edu

ABSTRACT: Does the public perceive biological invasions by plants as a serious problem? Our survey of public visitors to a biological laboratory indicated that, even among relatively well-educated people, only a minority supports greater efforts to control invasive plants. Our respondents showed limited familiarity with the concept of biological invasion or the related concept of biodiversity. They were all familiar with the term "weed" and mostly identified non-native, invasive species as weeds. However, they thought of weeds as a backyard nuisance or human health problem rather than as an important environmental problem. We conclude that the public remains largely unaware of the ecologic and economic impacts of biological invasions by plants. We suggest publicizing individual, local cases of invasive species.

Index terms: biological invasion, non-native species, public knowledge, weed

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INTRODUCTION

Biological invasions by plants rank with the world's worst ecological problems (Vitousek et al. 1996; Williamson 1996). Carried inadvertently or intentionally by humans, aggressive non-native species have displaced native plants, reduced habitat suitability for native animals, spoiled pastures for livestock, blocked forest regrowth, and clogged rivers (Drake et al. 1989, Cronk and Fuller 1995, Hobbs and Humphries 1995, Randall 1995, Luken and Thieret 1997). Some non-native plants appear to have wrought long-term changes in habitats by accelerating fire cycles (D'Antonio and Vitousek 1992), altering soil fertility (Vitousek and Walker 1989), or drying up water supplies (LeMaitre et al. 1996). Considerable efforts are underway to control existing invasions. For example, control of *Eichhornia crassipes* (water hyacinth) in California costs nearly $1 million each year (Valerie Van Way, California Department of Boating and Waterways, pers. com.). However, the economic losses from plant invasions dwarf the amounts spent to control them (Stein and Flack 1996). On both economic and ecological grounds, more efforts to control invasive plant species are needed. (Nomenclature follows Hickman 1993.)

Public cooperation is crucial to forestalling and controlling biological invasions by plants. First, unlike any other major ecological problem, a biological invasion can be the innocent handiwork of an ordinary citizen returning from a vacation abroad or ornamenting a garden with an attractive non-native. The infamous spread of *Lythrum salicaria* (purple loosestrife) through the wetlands of the northeastern and midwestern United States is just one of the plant invasions launched across a herbaceous border (Stein and Flack 1996). Second, increased official efforts to control invasions will generally entail some sacrifices. For instance, stricter regulation of the import of non-native species will curtail personal freedom and commerce (Ruesink et al. 1994). Before people can be expected to make sacrifices, they must believe that there is a serious problem.

Does the public perceive biological invasions by plants as a serious problem? We investigated this question as part of an evaluation of public knowledge, to be used in designing an educational video on biological invasions by plants. We focused our survey on plants because that was the subject of our video; biological invasions by animals also constitute a significant problem.

METHODS

We tried to aim our survey at a winnable segment of the public—that is, one that would be relatively sympathetic to environmental concerns and receptive to public education but still reasonably large. We administered a 20-minute, written questionnaire to 206 visitors to the University of California Bodega Marine Laboratory (100 km north of San Francisco, California) during August 1996. Visitors, who are mostly residents of northern California, come individually or with an organized group, such as a school or a seniors' group, to take one of the lab's public tours. We selected our sample by inviting all those

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aged 13 years or older who visited the lab during a period of four successive weeks to complete a questionnaire. Of those who did, 28% were of high-school age (13–17), 9% were 18–30 years old, and 61% were over 30 (2% did not indicate their age). Virtually all of those over 22 years old were high school graduates (99%) and had completed some college (93%); most were college graduates (60%). Our respondents were thus relatively well-educated.

To analyze responses by age and education, we divided our sample into three groups, youths (13–17 years old, 58 respondents), adults (over 17 years old) that were not college graduates (61 respondents), and adults that were college graduates (83). To check whether people were giving careful and complete written replies, we administered some questionnaires verbally and wrote down the responses ourselves. There were no obvious differences between written and verbal responses.

We couched our questions in familiar terms, so that everyone could respond. For example, because we doubted that everyone would understand the term "invasive, non-native plant," we asked questions about "weeds." Like most popular terms, "weed" means different things to different people, including different biologists and managers (Randall 1997). However, the variety of questions gave ample scope for people to indicate any knowledge they may have had about plants as invasive species. To help widen the scope for responses, we allowed people to word their answers to most questions themselves, instead of providing them with a menu of alternative answers.

For questions that asked people to name individual weeds, we tried to interpret the common names people gave in terms of the species they were most likely to refer to. For instance, we took "dandelion" to refer to *Taraxacum officinale*, which is common in lawns, rather than to local native species of *Taraxacum*, which most people rarely encounter. On the other hand, we considered "clover" to refer to a mix of natives and non-natives, because both native and non-native species of *Trifolium* are conspicuous in northern California.

The questionnaire asked visitors to list three weeds, describe a typical weed, name the kinds of places where weeds grow and the factors that cause them to spread, list the problems that weeds cause them personally and the problems that weeds cause for society or the environment, say whether there should be more efforts to control weeds, score their level of interest in learning more about various aspects of weeds, and list any good things about weeds. To find out how much people know about which species are native and which are not, we asked them where five locally common plants come from. To test public knowledge of some concepts related to biological invasion, we asked people if they were familiar with the terms biological invasion, native species, and biodiversity, and, if so, to say what each term called to mind. Last, the questionnaire asked people for their age and educational level.

RESULTS

Nearly everyone (90%) was able to think of one or more weeds. People listed mostly non-natives (Table 1: at least 67% of responses) but seemed to be really thinking of plants that invaded their lawns and that prickled them on walks in the country. This was consistent with the replies to the question about where weeds grow: gardens, yards, or lawns (73%); everywhere (29%), a relatively accurate response for coastal California (Rejmánek and Randall 1993); and fields (21%). The most mentioned weeds were dandelion (53% of respondents), crabgrass (27%, *Digitaria* sp.), thistle (19%, non-native species of *Cirsium*, *Carduus*, and related genera), foxtail (13%, *Hordeum murinum* ssp. *leporinum*), and yellow star thistle (11%, *Centaurea solstitialis*), all non-natives. Together with bermuda grass (*Cynodon dactylon*) these were also the weeds most frequently named as personal problems.

Most people did not name any non-native plants that actually cause serious problems, that is, plants that public agencies target for weed control (Table 1). Of the nine problem non-natives that people did list, four were prickly (thistle, yellow star thistle, purple star thistle [*Centaurea calcitrapa*], and Russian thistle [*Salsola kali*]), two were agricultural pests (Johnson grass [*Sorghum halepense*] and nutgrass [*Cyperus esculentus*]), one was aquatic (hydrilla [*Hydrilla verticillata*]), and three were morphologically unarmed but very successful invaders of natural terrestrial habitats (iceplant [*Carpobrotus edulis*], pampas grass [*Cortaderia jubata*], and beach grass [*Ammophila arenaria*]).

People did list some native species as weeds (Table 1). About 5% of their replies referred unambiguously to natives. A further 5% could have referred either to non-natives or to natives. Among the native species named as weeds were species injurious to humans (poison-oak) as well as some innocuous wildflowers (Indian paintbrush). Natives were also included in the "literal" replies (19%)—those names that contained the word weed, such as jimson weed, seaweed, and milkweed. Some peo-

Table 1. Summary of the responses to the survey question, "Please list three weeds." Total listed = 480.

	Percent of Total	Number of Kinds
Exotic:		
Lawn weeds	38	5
Serious problem weeds	18	9
Other exotics	11	17
Native	5	17
Mixed exotic and native	5	5
Names containing "weed"	19	18
Unknown or vague	5	12

ple apparently took "weed" to mean "wild" or simply took a "weed" at its word.

Respondents characterized a typical weed in many different ways. The largest single group (42%) thought of weeds as growing fast, spreading quickly, or persisting. Smaller numbers of people characterized weeds as prickly (14%), green (11%), ugly (10%), or growing where they are not wanted (16%). Almost no one (2%) thought of weeds as non-native; at least as many people (6%) characterized them as native or simply as wild. When asked how weeds spread, most people answered that wind (57%) or animals (43%) did it. Only 35% wrote that people spread weeds. Very few people (4%) associated weediness with the ability to spread vegetatively. The popular concept of "weed" thus seemed to include "invasive" but not "non-native," and most people failed to blame themselves for invasions.

Weeds enjoyed a mixed reputation for good and evil. Most people (77%) said that there were some good things about weeds: weeds control erosion (36%); they are attractive (35%); and they provide food (26%) and habitat (19%) for animals, and medicine and food for humans (12%). At the same time, most people said that weeds cause them problems (73%) and cause problems for society or the environment (71%; Table 2). For adults, the salient environmental problem was health, especially allergies. Young people were more concerned about effects on native species, a response that might reflect growing emphasis on environmental education in grade schools. Fewer than 20% of the respondents in any age-education group noted that weeds cause problems for agriculture or for natural resources, including ecological systems. There were no strong differences between adults with and without a college degree.

People were divided on the question of whether there should be more efforts to control weeds. Forty-one percent said yes, 30% said no, and 29% said that they had no opinion. The most frequently suggested method of control was herbicide (12% of respondents), but 7% specified that herbicides be environmentally safe or not be used at all. Other suggested methods were to deploy insects as biological controls, plant natives, restrict the import of non-natives, educate the public, and cut, pull, plow, and burn the weeds.

We chose five locally common species to test how well people knew whether plants were native or not (Table 3). The one native was redwood (*Sequoia sempervirens*), the California state tree. The four non-natives included one tree, eucalyptus (*Eucalyptus* spp., mostly *globulus*), species from Australia that have been widely planted and become invasive, and one shrub, Scotch broom (*Cytisus scoparius*, but also used commonly to refer to related species), European species that have escaped from cultivation as ornamentals to form large stands on hillsides and along roads. The other two non-natives were an aquatic herb called water hyacinth (*Eichhornia crassipes*), a South American species that is a major pest in the nearest large river delta, and a terrestrial herb, beach grass (*Ammophila arenaria*) a rhizomatous grass from northern Europe that has been widely planted to stabilize coastal sand dunes and now dominates virtually all the coastal foredunes from northern California to Washington.

Nearly everyone correctly identified redwood as native. Most people also knew that eucalyptus is not native and comes from Australia. Only half even thought they knew whether the other three plants were native or not; they were mostly right about water hyacinth being non-native, but wrong about beach grass being native. The public can therefore learn whether a particular plant is native or not, at least if it is a big tree. But people may little suspect than an invader is non-native once it has

Table 2. Summary of responses to the survey question, "Do weeds cause problems for society or the environment?" Values are percent of respondents.

		Adults		
	Youths	Not College Graduate	College Graduate	*P* (G-test)
Yes	65	74	74	> 0.1
Specific problems most often listed:				
Health	4	42	32	< 0.001
Native species	21	6	13	0.05–0.01
Natural resources	9	17	15	> 0.1
Aesthetic	19	9	13	> 0.1
Agriculture	7	13	14	> 0.1
Fire	4	6	9	> 0.1

Table 3. Summary of responses to the survey question, "Where do these plants come from?" Values are percent of responses. The correct response (native versus non-native) is in boldface. The percent of responses that correctly identified the specific region from which each non-native comes is in parentheses.

	"don't know"	"California"	"elsewhere"
redwood	4	**92**	4
eucalyptus	8	18	**74** (56)
water hyacinth	48	9	**43** (2)
Scotch broom	48	14	**38** (3)
beach grass	43	43	**15** (1)

thoroughly taken over a natural landscape, as *Ammophila arenaria* has done on dunes.

Imagining that "biodiversity" was by now a household word, we were surprised to discover that only college graduates generally claimed to be familiar with the term, and that even they mostly lacked a clear idea of what it means (Figure 1). Overall, people were no better acquainted with "biological invasion." In contrast to these two concepts, "native species" was widely understood, perhaps because it is such an intuitive combination of two ordinary words.

It does appear that the public would like to hear more about "weeds." Almost all of our respondents (89%) said they were "somewhat" to "strongly" interested in learning more about the subject. Of the eight aspects of ecology, control, and economics we listed, people were most interested in "what you can do to get rid of weeds" (75% answered "yes" or "strongly yes") and "what weeds do to the environment" (75%), and least interested in "how weeds spread" (64%) or "how weeds affect biodiversity" (61%). Adults were more interested than youths (G-test of interest level by age group for each aspect: each $p < 0.05$). Having a college degree did not make adults any more or less interested.

DISCUSSION

If our sample reflects, or, as we guess, overestimates the general public awareness of biological invasions by plants, then we conclude that the public does not perceive biological invasions to be a serious problem. Most people do not understand the concept of biological invasion. The popular concept of a "weed" corresponds closely to the notion of an invasive plant, but few people think that weeds cause problems in agriculture or natural resources management, and only a minority supports more efforts to control weeds.

Why are people not more aware of the major economic and ecologic impacts of invasive plants? Our survey hints at three likely reasons. First, people do not feel these impacts directly. The impacts of weeds that people did frequently cite were invasions of gardens, allergies, and "stickers"—all ones that they probably personally felt. A respondent who made his living maintaining golf courses, and thus did feel an economic impact of weeds directly, was one of the few to mention their economic costs.

Second, people have not been told about the impacts. Most people did not appear to know about the invasive plants in the area that do have serious economic or ecological effects, or else seemed to know about the plants but not the effects. Only 18% of the plants people listed as weeds were targets of public weed control programs, and most people failed to identify three out of four of the most conspicuous local invaders of natural and seminatural lands as being non-native. In the case of one of these invasive plants, beach grass, most of those who were familiar with the plant thought it was native. This species has replaced most of the natural sand dune vegetation in northern California, and it appears that, for lack of information to the contrary, people accept the invaded condition as natural.

Third, people may not think of the net ecological impacts of invasions as bad. One-third of those surveyed felt that at least some weeds were attractive and control erosion. These opinions can hardly be faulted: invasive species such as water hyacinth and scotch broom were imported precisely because people found them attractive. One of the reasons that beach grass is so effective at eliminating native dune communities is because it is so much better than local dune species at stopping the movement of sand. Moreover, some of the likely negative impacts seem to be less apparent to people. For instance, based on our sample, most people may not be in a position to weigh the virtues of beach grass against its negative effects on biodiversity because they do not understand the concept of biodiversity.

What do these results imply for environmental management and conservation? First, if most people do not directly feel the more serious impacts of biological invasions, then they will only become aware of them by being actively told. Since this does not seem to have effectively happened so far, there is a clear case for more public education about biological invasions

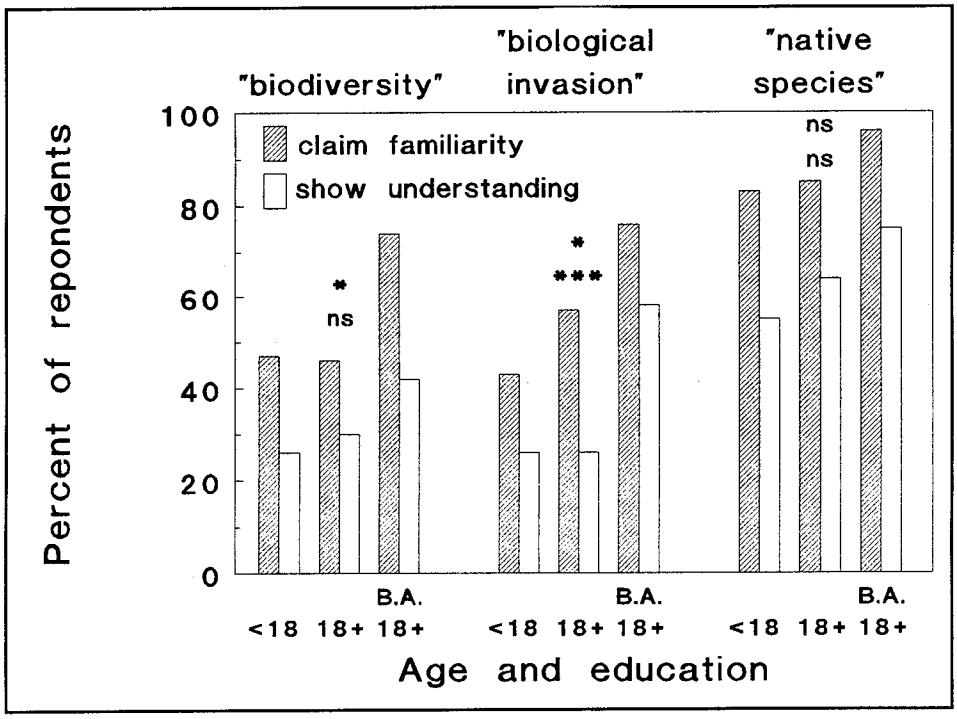

Figure 1. Public understanding of "biological invasion" and related terms. For each term, symbols show probability (G-test) that age and education groups did not differ for familiarity (top symbol) or understanding (bottom symbol): ns = > 0.05, * = < 0.05, * = < 0.001, B.A. = college graduate.**

by plants. Differences between the responses of different age and education groups suggest that the concept of biological invasion is being taught or at least learned at the college level. However, the negative impacts of invasive species on economic and ecological systems are not being learned at any level.

Because some people see some invasive species as attractive or useful, efforts to eradicate them may not merely fail to inspire cooperation but may actually arouse opposition. For example, a recent program to remove eucalyptus from an island in San Francisco Bay was opposed by a number of local citizens. Administrators of individual programs to control invasive plants should consider prefacing action with education about the impacts of their target species.

Given that public education about biological invasions by plants is needed in general and as a component of individual control projects, the next question is how to design it. Our results suggest including five concepts to help correct public misconceptions or fill in gaps in public awareness: (1) the plants that people already think of as weeds are invasive species; (2) many places people think of as natural have become dominated by invasive plants; (3) some of these invasive species are costing society millions of dollars; (4) some of the most costly invasions have been sown, however innocently, by ordinary people; (5) although some invasive plants may be beautiful, they often displace native flora and fauna of greater beauty or utility.

Our enthusiasm for more public education about biological invasions is tempered by the finding that, in the case of the concept of biodiversity, a relatively massive educational effort does not appear to have yielded a commensurate level of public understanding. Our survey indicates that people may respond more to concepts presented in the context of their personal experience. We therefore suggest publicizing individual cases of biological invasion in the regions where they are taking place. Some newspapers and magazines have featured such articles (e.g., an article on *Lythrum salicaria* in the Boston Globe in 1997). Barrett's (1989) semi-popular article on aquatic weeds contains several case histories that could be given individual, local treatment. This approach should lend itself to use by individual control programs as well as in broader educational efforts. We hope it will help raise what we have found to be a low level of public awareness about the major economic and ecological problem of biological invasions by plants.

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Thomas F. Colton is a senior lecturer in the Biological Sciences Collegiate Division at the University of Chicago, where he develops and teaches labs for undergraduate courses in biological diversity, physiology, and biomechanics. As a community ecologist, he has tested predator-prey models in aquatic systems.

Peter Alpert is an associate professor of biology at the University of Massachusetts at Amherst. His interests include the biology of clonal plants, the integration of conservation and development in low-income countries, and biological invasions by plants.

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