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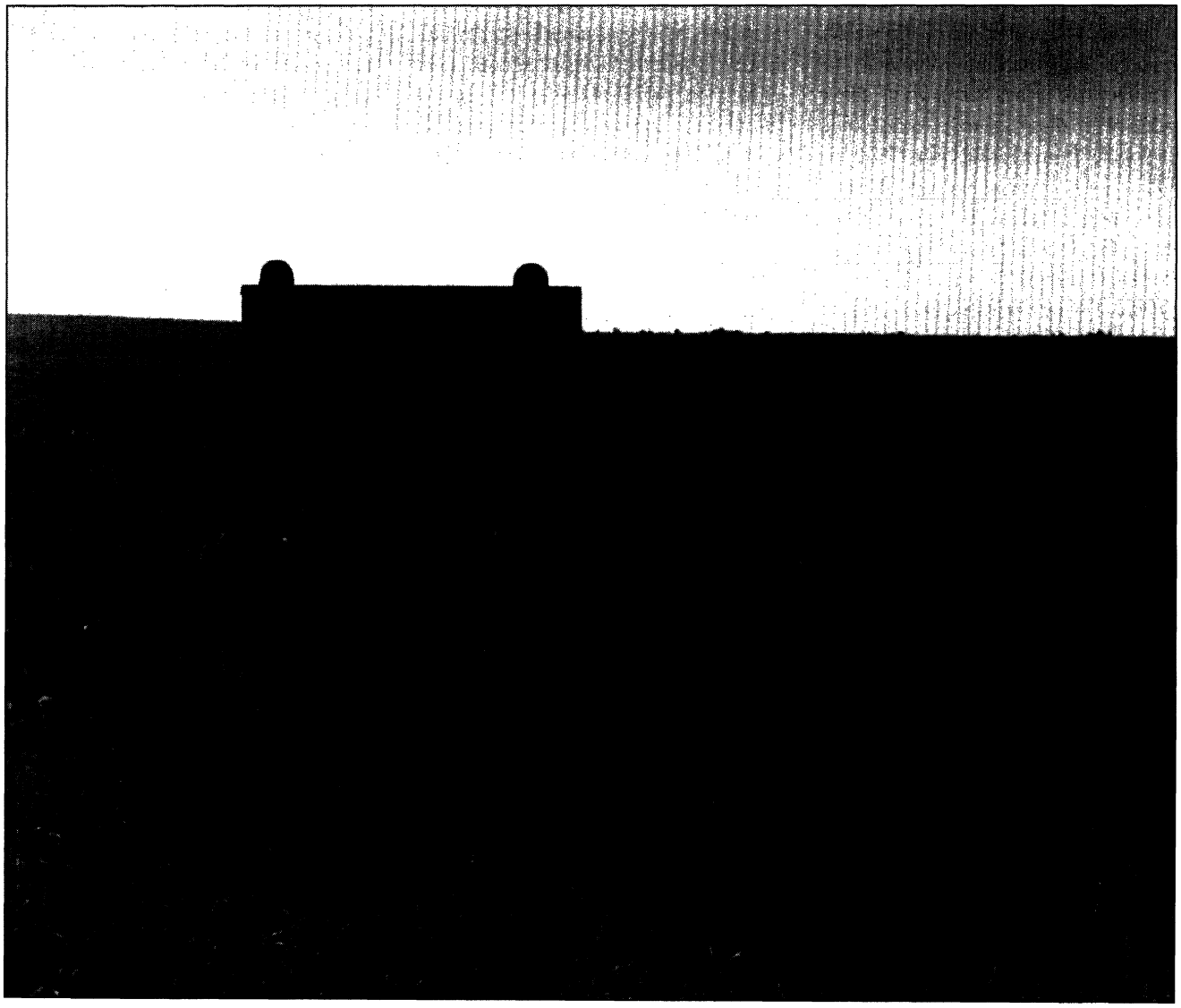


In this Issue

Marine Invasions and the Preservation of Coastal Diversity

by

James T. Carlton

There are more species in Long Island Sound, and in San Francisco Bay, and in Los Angeles Harbor, this year than last year. The same is very likely true for most estuaries, ports, and harbors around the country and around the world which support a steady maritime commerce—a commerce that brings ocean-going ships loaded with plankton-rich ballast (not bilge) water from a foreign port (Carlton, 1985). Every hour an average of more than 2 million gallons of ballast water, meaning 2 million gallons of foreign plankton, are released in U.S. waters (Carlton et al. 1995). Ballast water may be the source of the largest volume of foreign organisms released on a daily basis into American ecosystems.

The results? Not surprisingly, a plethora of species new to American waters has become established due to ballast water release,and it appears that the number is steadily growing. Examples since the mid-1980s include:

- a half-dozen species of Chinese and Japanese copepods (herbivorous zooplankton) are now found from the Columbia River to San Diego Bay;
- the Japanese shore crab *Hemigrapsus sanguineus* is now well-established and rapidly expanding along the Atlantic coast from Chesapeake Bay to Cape Cod;
- no fewer than three species of Eurasian fish, one species of waterflea, and two species of zebra mussels have invaded the Great Lakes;
- the Amur River clam *Potamocorbula amurensis* is now arguably the most abundant organism in many areas of San Francisco Bay;
- the South American mussel *Perna perna* has become established on the Texas Gulf coast, while the Indo-Pacific mussel *Perna viridis* has invaded the lower Caribbean;
- a New Zealand carnivorous sea slug has appeared in south San Francisco Bay and a Black Sea jellyfish has appeared in north San Francisco Bay.

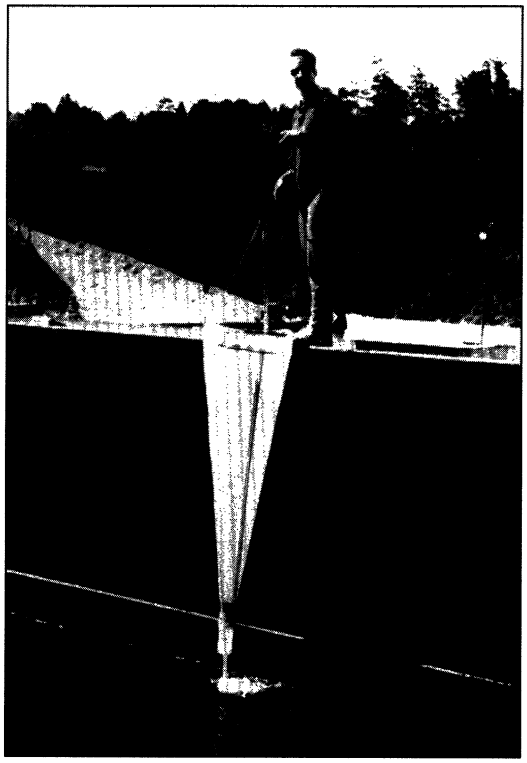
At times, the list appears endless, leaving no coast and no habitat untouched. Hundreds of species are released by ballast every month in coastal Atlantic, Gulf of Mexico, Pacific, Alaskan, and Hawaiian waters. But we remain remarkably uncertain about just how many of these species have become successfully established. Why?

With the exception of the copepods in the above list, all of these examples share one thing in common: they are generally conspicuous, easily recognized, and abundant species. Special attention by interested copepod workers resulted in recognition of exotic species on the Pacific coast—notable is the absence of similar reports from the Atlantic or Gulf coasts. Indeed, the two most common groups of organisms found in ballast water, copepods and diatoms (Carlton and Geller, 1993), are, in general, almost never recognized as ballast water invasions around the world. Nor are very many marine worms (polychaetes), or flatworms, or hydroids, or a host of other smaller but very important invertebrates. In large part this is due to the decline in the number of professional taxonomists in these and other groups who could distinguish native from exotic species, and their replacement by environmental impact assessment taxonomists who do not have the time or resources to explore bestowing other than a local name to a given taxon.

But in part the minimal recognition of the number of invasions that have occurred is also due to the simple lack of coastal exploration by marine natural historians and marine ecologists—a lack that often comes as a surprise to not only the public but to other scientists. The invasion of the Japanese shore crab along the Atlantic coast provides an example. It was first discovered in New Jersey on an invertebrate zoology class trip; it then became generally known to the Woods Hole science community through collections made there by the Children's School of Science, and finally its invasion into Long Island Sound was first noted by bait fishermen.

With the demise of marine taxonomy (National Research Council, 1995) and of

A bulk carrier at a Delaware Bay pier, about to offload several million gallons of ballast water containing stickleback fish, oppossum shrimp, copepods, diatoms, and many other organisms loaded aboard the ship 11 days earlier in the Weser River, Germany. Photo by J.T. Carlton.



A scientist takes a sample using a standard plankton net. Ship's holds can be over 20 meters deep, permitting replicated vertical plankton tows to sample the life present. Photo by J. T. Carlton.

coastal marine exploration, the "take home" message is that we have returned to a period of time when the amateur public can make serious contributions to a knowledge of "what's out there," especially in terms of keeping up with the latest invasions and reporting new invasions.

Invasions of exotic marine animals and plants into American coastal waters are not new. Wooden ships transported innumerable species both in them (as boring organisms) and on them (as fouling communities). In the last quarter of the 19th century, commercial oysters began to be moved around the world in huge numbers. With them came an untold number of epizoic and endozoic species, as well as entire estuarine communities in the mud and seaweed packed with these oysters. The world's oceans began to be biologically homogenized centuries ago. Yet, despite the successful movement of hundreds of species over these decades, the speed of modern ships and the volume of ballast water now carried are two of several factors that may be in the process of successfully overwhelming these earlier centuries of transport in terms of the number of successful invasions.

Effects on Biodiversity

What effects are these invasions having on coastal biodiversity? Biodiversity can change in three ways: species can be added (invasions, natural or human-mediated), deleted (extinctions, also natural or human-mediated), or relative abundances can change (of native species and of previously introduced species). Taken strictly on a species head-count basis (that is, species "richness"), as noted above, there do indeed appear to be more species in a given region after invasions. The evidence for endangerment or extinctions of native marine species at the hands of marine invasions is almost non-existent. This is not to say that it may not have occurred or may not be occurring; a related problem in marine science is that almost nothing is known of extinctions in the ocean below the level of mammals and birds (Carlton, 1993).

On the other hand, there is mounting experimental and empirical evidence that invasions have striking impacts on the proportions of native species. The invader may become, for example, the space-dominant species, or an abundant predator. But for most marine invasions we have only time to record them and move on, in part because there are so many invasions now occurring. The same is true in almost all ecosystems, meaning that most invaders enter a community from which there are no subsequent reports of ecological "cascading" of any kind. This has led more than a few workers to conclude that such invaders have had no impact on the invaded systems, a conclusion that should be drawn, of course, only after species-specific studies, preferably experimental, are conducted.

As these harbor-based biotas begin to build up around the world, a global cosmopolitan marine biotic facies begins to appear, not unlike the earlier development of cosmopolitan terrestrial weed communities. While we seek to preserve aboriginal species diversity, and while we continue to attempt to determine if marine invasions in the ocean are threatening any

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Crewmen removing the hatch from the upper wing ballast tank of a bulk carrier. Plankton samples can be taken through this opening to measure the diversity of life in the ballast water. Photo by J.T. Carlton.

native invertebrates, vertebrates, or plants, we also seek to preserve community (habitat) and ecosystem diversity. It is here, in the preservation and conservation of supra-specific diversity levels, that one of the greatest ecological challenges of marine invasions lies (there being, of course, for some invaders, critical economic, social, industrial, and human-health challenges as well). Ballast water transport is non-selective relative to the habitat diversity or the trophic categories of transported organisms (Carlton and Geller, 1993). With perhaps more than 3000 species a day being transported in ships around the world (NRC, 1995), it would appear to be simply a matter of time before a sufficiently broad array of invasions occurs such that almost every estuarine, near-shore habitat would support some percentage of invasions, thus rendering the concept of preserving aboriginal community diversity mute.

Ballast water invasions continue, and they will continue for some years to come. National and international regulations (largely now voluntary) that call for ballast water management interface with a huge maritime industry that directly involves more than 130 nations, with a staggering variety of vessels of different sizes, cargoes, age, condition, routes, and ballasting requirements. Vessels are being built in 1995 with an expected at-sea life of 25 or more years, without regard to ballast management considerations.

In the U.S., ballast water management guidelines are now in effect, as federal law, in the Great Lakes and in the Hudson River. In these two regions arriving ships must have their ballast water no lower than 30 parts per thousand salinity, and must have exchanged their water if possible on the high seas in depths exceeding 2000 meters. However, problems with open ocean ballast exchange, ranging from limited effectiveness to concerns about crew and ship safety, have arisen. These are leading committees and research groups around the world to look toward more long-term solutions, specifically focused on treatment of the ballast water aboard ship. The U.S. National Research Council's Marine Board has thus formed the "Committee on Ships' Ballast Operations," to meet from 1994-1996, to sort through the more than 50 proposed solutions and recommend pathways to consider.

Commercial Impacts Bring Attention

In 1982, a Soviet research vessel collected a specimen of a peculiar comb jellyfish in the Black Sea that had not been seen in those waters ever before—and thus Russians met the American comb jelly *Mnemiopsis* which, through its huge populations that developed in 1989, and its voracious appetite, have proved to be the near-final blow to the anchovy fisheries of the Sea of Azov. In 1988, a Canadian scientist collected a peculiar clump of mussels from Lake St. Clair in the Laurentian Great Lakes—and thus North Americans met the Black Sea zebra mussel *Dreissena*, which has cast a long and deep ecological and economic shadow across the face of North America's fresh water ecosystems.

Single species insertions into huge and complex ecosystems altered those systems in a matter of months. These aquatic worlds will never be the same again, and ballast water can no longer escape attention, as it largely had for 100 years. In September 1995 the International Council for the Exploration of the Sea (ICES) will host the first international ballast water conference as a session of its annual Statutory Meeting in Aalborg, Denmark, a conference unthinkable only 10 years ago.

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Report From the Field

Assessment of The Invasive Weed Problem on Preserves Across the United States

John M. Randall

SUMMARY

Invasive weeds damage and threaten natural areas throughout North America and around the world. In order to assess the extent of these problems and how they were being addressed on preserves across the U.S. I sent a survey to all Nature Conservancy (TNC) stewards with land management responsibilities and conducted a series of site visits. Ninety-three of the 122 stewards contacted (76%) replied to the survey, reporting weed problems on preserves in 46 states. At least 237 species (197 non-natives) were cited as problems; many of them outcompete native species and/or significantly alter communities they invade. Pest species include ferns, gymnosperms, and flowering plants ranging from annual herbs to perennial herbs, floating, emergent and submersed aquatics, vines, shrubs, understory trees and canopy dominant trees. *Tamarix spp.*, *Centaurea spp*, *Phragmites communis*, *Ailanthus altissima*, *Robinia pseudoacacia*, *Alliaria petiolata* and *Lythrum salicaria* were among the most widespread and serious problems reported. Over 12% of those who responded ranked weeds as the worst management problem they face and another 60% ranked weeds among their top ten concerns. A wide variety of control methods are used but the view that weed control is part of a restoration program is common to these efforts. Most respondents indicated that I could best help them with their weed problems by providing information and advice. A database linking the reported species, preserves where they are problems, the threats they pose at each site, and control methods used against them was developed from the replies. The database will be updated at 2-year intervals and is designed to facilitate the transfer of information on weed biology and control between stewards.

Introduction

Invasive plant problems exist in natural areas across the nation, and have been reported from oceanic islands and continental areas throughout the world with the exception of Antarctica. Problems in the United States are severe across a wide variety of climatic zones and habitat types and the total number of pest species that damage or threaten to degrade natural areas is large. Severe problems are, in fact, so widespread and pervasive that it is far easier to list areas that do not have them; Nature Conservancy stewards have reported severe damage and/or major threats from invasive plants in every large region of the nation except the southern Great Plains. Pest plants also infest other private holdings and federal, state, provincial and local government lands across the U.S. and Canada.

The Assessment

By 1991, The Nature Conservancy's (TNC) staff had come to the conclusion that impacts of plant invasions to native biological diversity were so dire and difficult to address that there was a need for someone who could focus on just that issue. I was hired as the organization's first invasive weed specialist and began work in July 1991. One of my tasks was to systematically assess pest plant problems and control programs on lands managed by TNC throughout the U.S. This was done by mailing questionnaires on invasive weeds to all 122 TNC stewards with land management responsibilities in April 1992. Ninety-three of the 122 stewards polled (76%) returned completed questionnaires or replied by phone. Replies were received from 46 states and at least one steward in each state reported problems. The remaining four states (AK, AL, DE & MS) did not have stewardship programs at the time. California, Florida and Hawaii were the states reporting the greatest number of pests. Hawaiian stewards listed 26 species of concern, only 4 of which were reported from other states.

Severity of the Problem

Seventy-nine stewards ranked weed control relative to other problems they face in their conservation work. Ten (13%) listed it as their worst problem and another 47 (60%) ranked it among their top 10 concerns.

Pest Species Listed

At least 237 pest species were cited; an exact number of species cannot be given because some plants were identified only to genus and others were lumped with related species. One hundred ninety-seven of these are not native to the areas where they are troublesome. Several species included in this category are native to North America but are now invading beyond their original ranges (eg. *Robinia pseudoacacia*, *Hemizonia pungens*). The status of another two species (*Phalaris arundinacea* and *Phyla nodiflora*) is unclear. Forty of the species are generally regarded as native to the areas from which they were reported. For example, *Phragmites australis* is known to be native in the northeast, where it is regarded as a severe problem, and to the west. Another 14 non-native pest species have been reported from TNC preserves informally or in earlier surveys. A database was developed from the survey replies. It links the species reported, preserves where they are problems, the threats they pose at each site, and control methods that have been or are being used against them.

The pests included ferns, gymnosperms, and flowering plants ranging

from annual, biennial and perennial herbs, floating, emergent and submersed aquatics, vines, shrubs, understory trees and canopy dominants. Five species were reported from 10 or more states: *Lonicera japonica* (13); *Alliaria petiolata* (11); *Lythrum salicaria* (11); *Phragmites australis* (10); and *Robinia pseudoacacia* (10). These widely reported species also represent a range of life histories—an understory biennial herb, a vine, two wetland emergents and a canopy dominant. *Tamarix spp., Centaurea spp., Ailanthus altissima, Cirsium arvense, Elaeagnus spp., Melilotus spp.,* and *Sorghum halapense* were among the other widely reported taxa.

A number of species which were reported from few locations or states are probably truly restricted to those areas. For example some of the species reported in Hawaii (eg. *Fraxinus uhdei, Hedychium coronarium*) and south Florida (eg. *Colubrina asiatica*) are unlikely to be troublesome elsewhere. On the other hand, some infrequently reported species, like *Cardaria chalapensis* and *C. draba*, are probably common over large areas. They may not be present in great numbers on other TNC preserves and/or may not yet be recognized as pests by most land managers.

Damage Caused and Threats Posed by Pest Plants

Respondents reported that pest plants damaged property or threatened to do so by altering water tables, altering fire regimes, suppressing native species recruitment and thereby affecting community structure, outcompeting native species (particularly rare species), altering or eliminating habitat for native animals, and providing food and cover for undesirable non-native animals. For example, at several preserves in the Southwest *Tamarix spp.* have lowered water tables. *Alliaria petiolata* and *Vinca major* suppress recruitment of tree seedlings in forested preserves in the Northeast and upper Midwest. Ultimately this will likely alter species composition and structure of the canopies at these sites. *Lonicera japonica* infestations threaten to smother and eliminate populations of rare native species at two sites in South Carolina. *Phragmites australis* and *Lythrum salicaria* are threats to waterfowl habitat in many northeastern and midwestern wetland preserves. Hawaiian stewards reported that feral pigs favor the fruits of *Psidium guajava* and *P. cattleianum* (guava and strawberry guava). The pigs in turn disperse the seeds of these plants and disturb the soil promoting their establishment as well as that of other weeds.

The consensus apparent from questionnaire responses and discussions during site visits is that non-native plants constitute a problem requiring an active response when they 1) move into and/or persist in natural areas we are trying to protect *and* 2) substantially alter the structure or biological diversity of the community or ecosystem functions (eg. fire occurrence and frequency, nutrient cycling, water tables and hydrology). The level and nature of invasive plant control practiced on preserves varies greatly, however. Control measures taken depend not just on the nature and severity of the problems but on resources available, and on the training and experience of local stewards.

Control Plans

Thirty-seven stewards reported that they had or were preparing formal weed control plans or management plans that include weed control. Roughly half of those who considered weeds one of their top 10 concerns had formal control plans. Thirty stewards noted that their formal plans set priorities for controlling particular species or infestations and 24 said their plans set specific goals (eg. reducing the number of non-native pines on the preserve by 50% within two years).

Control Methods Used

Reported control techniques included manual removal, mechanical methods, prescribed fire, judicious use of herbicides, and encouragement of native competitors. Volunteers performed much of the labor in programs involving manual removal or the use of simple tools. The point at which stewards decided non-chemical control options were too costly, disruptive or labor-intensive, and that herbicide use was appropriate, varied. This is in part due to differences in experience and in opinions on the harm or potential harm done to the environment and to human health by herbicides.

Glyphosate (trade names RoundUp and Rodeo) and triclopyr (trade names Garlon and Pathfinder) were the chemicals of choice in most programs that use

Prairie Dock (*Silphium terebinthinaceum*), a native prairie indicator species. Photo by Bob Grese.

herbicides. However, picloram (trade name Tordon) was preferred by some stewards for use against *Euphorbia esula* (leafy spurge) and clopyralid (trade names Stinger and Curtail) was used against thistles (*Cirsium spp.* and *Carduus spp.*) in certain situations.

TNC policy prohibits intentional introduction of non-native biocontrol agents except when specifically authorized by the Board of Governors. An approved release of the black-dot flea beetle (*Aphthona nigriscutis*) was made against leafy spurge (*Euphorbia esula*) at the Pine Butte Preserve in Montana in 1994. Biocontrol agents are also present and active on several other preserves. Biocontrol agent populations and their effects on target plant populations are monitored at Cascade Head Preserve in Oregon (target: *Senecio jacobaea*) and Fairfield Osborn Preserve in California (target: *Centaurea solstitialis*).

The use of native competitors to suppress weedy species was most often reported by stewards with active restoration programs. In a number of cases, different stewards reported using different methods to control the same species. For example, most stewards cut tamarisks and apply the herbicides triclopyr or glyphosate to the cut stumps, but one steward has had success pulling seedlings by hand and another used a bulldozer to eliminate a small thicket.

The majority (54) of stewards who replied said that they carefully consider which species they want in place of the weeds they remove. Forty-four reported that they monitor their weed control efforts quantitatively and/or with photo plots. Only 26 reported monitoring the plants that replace the weeds.

Time and Money Expended on Control

Sixty-three stewards reported that they and/or their co-workers and volunteers devoted a total of 21,412 hours of their time to weed control in 1991. Fifty of these stewards also spent funds totalling $171,128 for weed control. In 1990 the totals were 16,082 hours and $109,560. The increases from 1990 to 1991 are in part real. They are magnified, however, by the fact that some respondents were not at their current posts in 1990 or could not remember how they spent their time and money that long ago. It is clear, however, that TNC stewards are spending increasing amounts of time and money to control weeds each year. This results from the expansion of their overall management programs, new invasions, and the expansion of old infestations, as well as increased awareness of threats posed by pest plants.

Value of Control Efforts

Almost all stewards regarded their invasive plant control efforts as well worth the costs, in terms of time and resources spent and the damage done in the process. The few who were not sure their efforts were worth it had very small control programs. On the other hand, many stewards lamented the fact that they could not do more, most often due to limits on time and/or resources. Many pointed out that if their efforts were discontinued, the infestation(s) would expand rapidly, pushing out desirable species and communities or causing restoration projects to fail. In some cases stewards believe unchecked invasions would so degrade the biota as to render the preserve in question useless for anything but green-space. An invasion of leafy spurge at Altamont Prairie Preserve in South Dakota has in fact drastically reduced that site's value as a preserve. David Breyfogle, the steward responsible for the site, now believes its only real conservation value is as a test site for leafy spurge control methods.

How the Invasive Weed Specialist Can Be of Help

Most stewards indicated that I could best help them in my position as invasive weed specialist by providing information (43) and/or advice (25). Most of these people wanted help with control methods in particular. Seven felt that information/advice on restoration methods accompanying control would be especially helpful, while three wanted information on biocontrol, three on any species showing potential to become weedy, and three more on monitoring weeds. Many stewards offered specific suggestions of ways to organize the information. Twelve emphasized the importance of producing and updating Element Stewardship Abstracts (review articles on species or communities of concern, produced by TNC). Eleven advocated the development of computer databases. Ten requested that weed workshops be organized and seven advised that I actively promote the importance of pest plant problems both within TNC and to other agencies and the public at large. Six asked that I promote research and/or recruit researchers to work on weed problems. Five stewards suggested that I choose a few big projects involving control at a particular location and then help organize and conduct them as models. Four others wanted me to review weed control or restoration plans. Just five people commented on the need for TNC weed policies, three of whom argued they would be of little or no use.

Many other suggestions were made by just one or two respondents but two of these suggestions in particular met with wide agreement when mentioned to others later. These suggestions were 1) that regional weed experts be designated so that stewards might have a more local resource person to look to, and 2) that the Exotic Species Program be built to bring more resources to bear on pest plant problems and address invasions by other organisms.

These responses were used in a review of the Exotic Species Program, to help guide proposals for changes. An updated version of the survey was created and mailed in December 1994, and replies are currently being analyzed. We hope eventually to expand the survey to cover other, non-TNC, areas.

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Opinion

Species Protection and the Free Market: Mutually Compatible

Brian Seasholes

If the measure of success of the Endangered Species Act is the number of species recovered and downlisted, clearly the Act has not been successful. This is especially true on private lands, which constitute 60 percent of the country's land area and contain more than half of all endangered and threatened species. According to Michael Bean of the Environmental Defense Fund, "After close to twenty years of trying to make the Endangered Species Act work...on private lands at least, we don't have very much to show for our efforts other than a lot of political headaches. And so some new approaches I think desperately need to be tried because they're not going to do much worse than existing approaches." (Bean 1994)

The problems on private land stem in large part from the failure of the U.S. Fish and Wildlife Service (FWS) to abide by the Fifth Amendment's admonition "nor shall private property be taken for public use without just compensation." Without secure rights to private property, landowners who wish to derive economic value from their land will have very little, if any, incentive to engage in land-use practices that will be beneficial to endangered and threatened species, because endangered and threatened species currently constitute an economic liability that devalues property. The result is that the minority of Americans who have endangered species on their land are forced to bear virtually all the costs of providing habitat for those species. Just as compensation is paid for public "goods" (highways, public parks and military bases, for example) so too should the FWS compensate private property owners when the protection of endangered and threatened species devalues property. That the FWS treats private land with endangered and threatened species as *de facto* wildlife refuges oftentimes makes those species unwelcome residents.

Perverse Incentives

Ben Cone, owner of 8,000 acres of timber land and mixed hardwood forest in North Carolina, is an example of one person who has run into problems with the Endangered Species Act (ESA). Cone, following the practices of his father, has continued to manage the land primarily for wildlife by planting fodder and setting frequent fires to keep the forest clean of understory. He also harvests some timber by using selective cutting techniques.

Due to his and his father's good stewardship, Ben Cone has attracted a wide range of species to his land, including turkey, quail, deer, wood duck, black bear, dove and the endangered red-cockaded woodpecker. The woodpecker benefited from the frequent fires set to keep the woods clean by getting rid of woody understory. Yet instead of welcoming the woodpeckers as additional assets, Cone views them as liabilities.

When a biologist surveyed the land he found twelve family clusters of woodpeckers. For fear of violating the ESA's "harm" prohibition, Cone is unable to cut the 1,121 acres of trees occupied by the woodpeckers. Without the woodpeckers the land is worth approximately $1.68 million; with the birds, it is appraised at roughly $260,000.

Ben Cone has been penalized for creating and maintaining endangered species habitat. To ensure that he does not have red-cockaded woodpecker problems in the future, Cone has decreased the time rotations on which he cuts trees because the woodpeckers need old pine trees. He has also increased the total number of trees cut. Whereas he used to selectively cut between 50 and 80 acres per year, he is now clearcutting 200 to 300 acres annually. Cone would prefer not to use these land management practices for they are destroying the very habitat he worked so hard to create. Yet he can ill afford the economic costs of having more red-cockaded woodpeckers on his land.

"Despite nearly a quarter century of protection as an endangered species, the red-cockaded woodpecker is closer to extinction today than it was a quarter of a century ago when protection began." The above quote is from a speech by Michael Bean in a closed session held by FWS. Unfortunately, such admissions are rarely heard in public discourse. Bean also noted that "there is...increasing evidence that at least some landowners are actively managing their land so as to avoid potential endangered species problems. The problems they're trying to avoid are the problems stemming from the Act's prohibition against people taking endangered species by adverse modification of habitat. And they're trying to avoid those problems by avoiding having endangered species on their property."

Bean outlined three of the ways land owners are doing this: "deliberately harvesting their trees before they reach sufficient age to attract woodpeckers" (as in the case of Ben Cone); "refraining from using prescribed fire or other measures to reduce or control hardwood understory," a practice that will eventually make the forest unsuitable for red-cockaded woodpeckers; and refusing to grow longleaf pines, the woodpecker's preferred habitat.

The fourth way landowners are getting rid of red-cockaded woodpeckers, which Bean did not mention, is a variation on "shoot, shovel and shut-up." Landowners, or people they hire, are walking private timber lands and cutting down any tree with a hole in it, oftentimes regardless of whether it is used by a red-cockaded woodpecker. They then cut the tree into sections and immediately dispose of the section with the hole. This practice negatively impacts many cavity nesting species besides the red-cockaded woodpecker, including downy, hairy, red-bellied, pileated and red-headed woodpeckers, flickers, screech

owls and flying squirrels. "When a landowner destroys a [cavity] tree there is no way you can police that. The fear and paranoia [of the ESA] is creating a situation where the Act is doing more harm than good," according to Tom Bourland, a forestry and wildlife consultant in Louisiana, who has had extensive experience with the ESA.

"Now it's important to recognize that all of these actions that landowners are either taking or threatening to take are not the result of malice toward the red-cockaded woodpecker, not the result of malice toward the environment," observed Bean. "Rather, they're fairly rational decisions motivated by a desire to avoid potentially significant economic constraints. In short, they're really nothing more than a predictable response to the familiar perverse incentives that sometimes accompany regulatory programs."

This is not solely the case with the red-cockaded woodpecker. "The incentives are wrong here. If I have a rare metal on my property, its value goes up. But if a rare bird occupies my land, its value disappears. We've got to turn it around to make the landowner want to have the bird on his property," observed Sam Hamilton, FWS administrator for the State of Texas. (Carpenter, 1993) The effect of these "wrong" incentives was noted by Larry McKinney, Director of Resource Protection at the Texas Parks and Wildlife Department: "While I have no hard evidence to prove it, I am convinced that more habitat for the black-capped vireo, and especially the golden-cheeked warbler, has been lost in those areas of Texas since the listing of these birds than would have been lost without the ESA at all." (McKinney, 1993) The northern spotted owl has also been the victim of the ESA's perverse incentives. According to the FWS' proposed 4 (d) rule for the northern spotted owl: "The Service believes that many landowners have felt threatened by the current regulations which could be viewed as a disincentive to enhance, restore, or maintain habitat in a condition that is suitable for owl nesting, roosting, foraging, or dispersal. The disincentive stems from the landowners' fears that owls might establish residence on, or move through, their property and impede their ability to manage their timber resources. This disincentive has had the effect of increasing timber harvest of currently suitable owl habitat and younger forests on non-federal lands which are not presently affected by the presence of an owl. With regard to younger forests in particular, this concern or fear has accelerated harvest rotations in an effort to avoid the regrowth of habitat that is useable by owls." (Federal Register, 1995)

Like Ben Cone and other landowners throughout the south, landowners in central Texas and the Pacific Northwest have learned of the ESA's perverse incentives and are engaged in land-use practices to deprive species of habitat. This is the great tragedy of the ESA: because it is harmful to people's property rights it can be harmful to wildlife conservation.

Substantive Reform

If the ESA is to be successful on private lands, then substantive reform must occur. The FWS's ability to regulate land-use on private property needs to be eliminated in all but narrowly defined circumstances. In those rare cases where such regulation for species protection is permitted, the FWS must compensate the property owner for his or her losses. Absent these reforms landowners will still have every incentive to destroy habitat and wildlife; the true costs of saving imperiled species will remain hidden; the FWS will continue to treat private land as if it were public land; and the goal of saving a good portion of this country's imperiled species will remain mired in the same dysfunctional state it is in today.

Were these initial reforms enacted, the proper next step would be to look towards more innovative and flexible approaches to species conservation than federal land-use control. One approach is suggested by Stephen Edwards, Global Support Team Coordinator of the Sustainable Use Initiative at IUCN (the World Conservation Union), who believes "conservation depends on the commitment of the people living with the wild species—not us. In the final analysis it will be those people who make the difference. Not laws, not government policies and not our wishful thinking." (Edwards 1992)

America has a long tradition of private wildlife conservation that exemplifies Edwards' view and should serve as the model for endangered species conservation. For example, in the early part of this century many people thought the wood duck was going to be the next prominent species of American bird, after the passenger pigeon and the Carolina parakeet, to go extinct. Due in large part to the loss of wetland habitat and especially dead trees which provide suitable nesting cavities, the wood duck population plummeted. Concerned groups (the Audubon Society, the Boy Scouts, duck hunting clubs) and ordinary citizens mounted a massive voluntary effort to erect artificial nesting boxes. The effort is still going strong. It has proven so successful that wood ducks are now the second most common species of duck in North America, and the FWS is actually encouraging hunters to shoot more wood ducks and less of other species of ducks that are declining.

Like the wood duck, all three species of American bluebird have been helped by the installation of artificial nest boxes. What started as spontaneous efforts by a handful of individuals has blossomed into two national organizations, the North American Bluebird Society and Mountain Bluebird Trails, many state-based groups and, most importantly, the work of thousands of volunteers who have installed hundreds of thousands of nest boxes across the U.S. As a result, the future for these species is significantly brighter.

Many species of waterfowl have benefited from the pioneering work of the Delta Waterfowl, founded in 1938. Delta's area of concern is the prairie pothole region of the northern great plains and southern Canada, an area which produces 70 percent of North America's ducks on private lands. Much of this area has been under intense pressure from agriculture, and waterfowl have suffered from the draining and filling of potholes. Delta Waterfowl recently initiated their "Adopt a Pothole" program, in which sponsors provide funds ($125/year for a one acre pothole) that are used to protect potholes by contracting with

private landowners and erecting artificial nest structures. The initial results have been extremely encouraging and if expanded, as is planned, could reverse negative population trends for many species of North American waterfowl.

Private conservation efforts have also been successful for non-game species. The preserves owned and operated by The Nature Conservancy (TNC) are bought as real estate with the express purpose of preserving rare species and imperiled habitats. In one of many examples of TNC preserves, land purchased on Cape May in New Jersey helps to protect one of the main migratory corridors for many species of birds including the peregrine falcon.

Even more innovative conservation strategies have been devised in other countries where ownership of indigenous populations of wildlife has proven highly successful. Since Zimbabwe initiated efforts to privatize wildlife in 1975, approximately 13,000 square kilometers have been dedicated to wildlife, and the numbers of cheetahs, elephants, leopards, crocodiles and ostriches have increased. In Papua New Guinea, income generated from butterfly farming has provided New Guineans with strong incentives to keep land planted with native habitat rather than cutting down the forest for timber or planting less biologically diverse monocultures of coffee, cocoa and oil palm. In Scotland, rights to salmon stocks, both when they are in rivers and offshore, are a transferable property right. Owners are free to utilize their stocks commercially with nets or recreationally with rod-and-line. By contrast, in England, the commercial offshore salmon fishery is a common property resource, and it is therefore subject to politicization which has led to overfishing. Scotland has much less overfishing because owners of salmon fishing rights directly experience a negative feedback loop — the devaluation of their property — if they manage their salmon stocks irresponsibly.

Without proprietary rights to wildlife these successful efforts could not have occurred, and as the example of Zimbabwe has demonstrated, individuals have strong incentives to ensure the continued existence of valuable wildlife. If U.S. laws were changed, such successes could be replicated in this country. Some species of endangered U.S. wildlife such as the grizzly bear, the Louisiana black bear, the Sonoran pronghorn, and the Gila trout have close relatives that are highly sought after and legally taken by sportsmen. Were these protected species owned privately, people would have incentives to conserve them and sell the hunting or fishing rights to sportsmen who are all the more willing to pay premium prices for rare trophies.

Beyond the protection of private property and efforts at private conservation, other programs using incentives for endangered species conservation in the U.S. also need to be examined.

The key to long-term protection of wildlife is to look towards true free market alternatives in which individuals are able to exercise proprietary control over plants and wildlife and freely enter into contractual arrangements with others who share a dedication to conservation. While private ownership of indigenous wildlife is a radical proposition for the U.S., it needs to be examined. As a first step the U.S. can make it easier for people to breed imperiled species captively and to have other sorts of proprietary relationships to wildlife such as some form of adoption (the wildlife equivalent of Delta Waterfowl's "Adopt a Pothole" program). Along with this change, the ESA needs to be reformed to compensate private land owners who are unable to use their property or exempt private land use altogether from the Act. Unless and until this occurs, America's proud tradition of private wildlife conservation will be stifled, and as a result we will largely fail to protect this country's imperiled flora and fauna.

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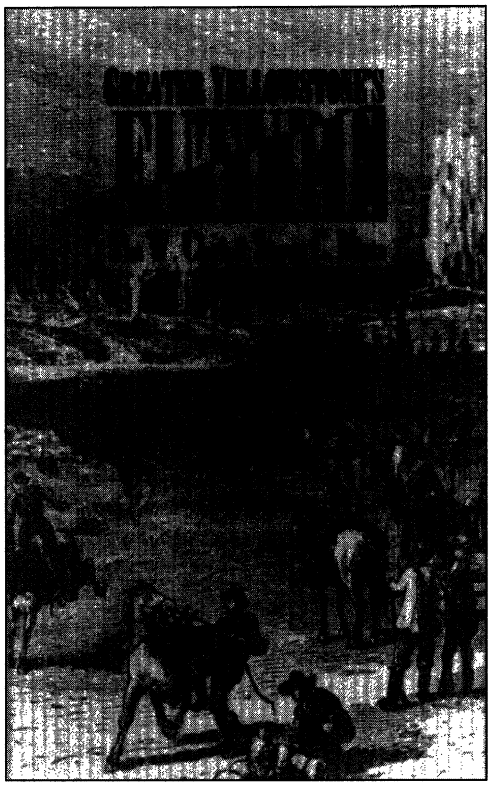
Book Review

Greater Yellowstone's Future: Prospects for Ecosystem Science, Management, and Policy

By Tim W. Clark and Steven C. Minta. 1994. Homestead Publishing. Moose, WY $11.95 160 pp.

Reviewed by David Mattson



The task of managing large complex natural systems to produce varied and seemingly incompatible outcomes is enough to confuse and overwhelm any human participant. If you are furthermore invested in a future that includes primeval ecosystems, then our collective history of managing wildlands will no doubt be discouraging. We clearly need to better understand not just biophysical processes, but also the individual and collective behavior of humans if we are to better manage the complex tasks we have set for ourselves, to preserve the few truly wild places left in the contiguous United States.

Greater Yellowstone's Future: Prospects for Ecosystem Science, Management, and Policy provides a very useful framework for grappling with complex natural resource issues. As important, the authors of this compact book elaborate their conceptual framework around the issue of practicing the much-touted but little-understood business of ecosystem management. The authors argue for the importance of ecosystem management, as ambiguous as it may currently be, to the conservation of Yellowstone's wild things and places. The true value of their book, however, is the unique breadth and depth they bring to this frequently rehashed issue. *Greater Yellowstone's Future* is not just a litany of particulars relevant only to the Yellowstone ecosystem, but rather a model for understanding the practice and problems of ecosystem management in any large controversial arena.

The book logically begins with a primer on history relevant to human use of natural resources in the Yellowstone ecosystem; reviewing laws, resource use patterns, and paradigms. The treatment is necessarily terse, but establishes trends and points of references for cases brought up later. There are similarly terse descriptions of these otherwise complex cases from the Yellowstone ecosystem involving endangered large carnivores, conservation and management of biological diversity, strategic agency planning, fire policy, and wildlife disease. Although the full complexity of these issues is not broached, the cases serve as exemplars of specific points that the authors make in other places.

Greater Yellowstone's Future makes its greatest contributions in chapters that describe key problems facing the implementation of ecosystem management (what the authors call "barriers") and some means to resolve those problems (what they call "bridges"). Anyone who has been involved in resource management probably knows the importance of defining problems in useful and relevant ways. The authors achieve this. Disagreement over temporal and spatial dimensions; disagreement over the nature (i.e., whose definition) of management problems and, in turn, whether ecosystem management is any sort of solution; and the ambiguities and abstruseness of ecosystem theories are all major impediments to the implementation of ecosystem management. Tim Clark and Steve Minta rightly recognize that resolution of these problems does not lie in simply doing more science but rather in changing the behavior of humans and their organizations. The authors do not assert this in terms of getting people to all value the same things, but more helpfully as improvement in people, organizations, management, and science that will allow all of us to better resolve conflicts, achieve specified tasks, and create and use relevant information. For those who do value wild things and places, these kinds of improvements will hopefully allow them to be more effective.

Regardless of your values or interest specifically in the Yellowstone ecosystem, *Greater Yellowstone's Future* is well worth reading. It offers a potentially fresh way of looking at complex resource management issues, and provides a very useful articulation of the problems as well as potential solutions to the practice of ecosystem management everywhere. Aside from all this, its Literature Cited provides a 16 page entree into a wide-ranging body of literature that most biologists and natural resource managers could probably benefit from exploring. Hopefully more of us will be able to contribute to the very practical intellectual exercise that Tim Clark and Steve Minta have undertaken in their book.

David Mattson is a Wildlife Biologist with the National Biological Service at the University of Idaho. He has studied grizzly bears and their conservation in the Yellowstone ecosystem for the last 16 years.

Bulletin Board

Call For Papers

The Organization of Fish and Wildlife Information Managers (OFWIM) requests papers for its 3rd annual meeting, to be held August 5 & 6, 1995, in Fayetteville, Arkansas. The meeting is designed to allow people interested in fish and wildlife information management to gather and exchange new ideas. Papers should be focused on ecosystem management, survey applications, protocols, procedures, species information systems, metadata, emerging and existing standards and/or partnerships. Deadline for abstracts is April 22, with notification of acceptance April 29; final papers will be due July 15.

Abstracts should be roughly 250 words and include mailing address, phone and fax numbers, and email address if available. Send papers to Tom Wilcox, Virginia Department of Game and Inland Fisheries, 4010 West Broad St., Richmond, VA, 23230-1104; phone (804) 367-0909; fax (804) 367-2427.

Conservation Biology Conference

Colorado State University will be hosting the Ninth Annual Meeting of the Society for Conservation Biology, to be held June 7-11, 1995 in Fort Collins. Registration for Society members is $90, for nonmembers is $110, for students $60; there is also a $10 late fee for all registrations after May 1. Symposia covering subjects including Habitat Conservation Planning, Theory and Design of Nature Preserves, Underlying Ecological Principles for the Wildlands Project, and Sustainability and Conservation Biology will be held June 8 and 9, poster sessions will be the evening of June 9, paper sessions and commercial exhibits will be available June 8-10. There will be several field trips offered on June 11.

For general information contact Rick Knight, Department of Fishery and Wildlife Biology, Colorado State University, Fort Collins, CO 80523; (303) 491-6714. For registration information call the Office of Conference Services at (303) 491-7501.

Captive Breeding Guidelines Available

The Aquatic Conservation Network (ACN) has published the 62 page Captive Breeding Guidelines, a document developed by volunteer Conservation Aquarists which exemplifies the role non-scientists can play in the conservation of aquatic life. The Guidelines are an attempt to put into writing ways to involve amateur aquarists in professionally endorsed captive breeding programs.

Cost for the Guidelines is $12, which includes postage (including overseas addresses). Send check or money order to: Aquatic Conservation Network, 540 Roosevelt Avenue, Ottawa, Ontario, Canada K2A 1Z8. For more information contact Rob Huntley at the above address; phone (613) 729-4670; email <ag508@freenet.carleton.ca>

Announcements for the Bulletin Board are welcomed. Some items from the Bulletin Board have been provided by Jane Villa-Lobos, Smithsonian Institution.

Endangered Species UPDATE

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