

What's Wrong with Exotic Species?

On the morning of December 19, 1997, Isabel, Yoyo, and Sydney—three young trumpeter swans following two ultralight aircraft across the Chesapeake Bay—landed near the Blackwater National Wildlife Refuge on Maryland's Eastern Shore. The three cygnets had adopted the French-made Cosmos ultralights as "mothers" to learn a 102-mile migration route to the Bay from a facility near Warrenton, Va., where the swans had hatched from eggs brought in from Canada. Defenders of Wildlife, using the "imprinting" technique made famous in the movie *Fly Away Home*, hoped to lure trumpeters to the Chesapeake region, where they had not been seen for nearly 200 years. About a year later, the environmental group, using the same technique, attempted to lead seventeen young trumpeters from western New York to the Eastern Shore. A spokesman for the group said that trumpeter swans would "help increase diversity" in the "critically important wetlands of the Chesapeake Bay."

While Defenders of Wildlife tempted trumpeters to the Chesapeake, wildlife officials in the region were trying to eradicate or at least to control over 2,000 mute swans that had proliferated there since 1960, when a few escaped from a private preserve. Because the State of Maryland lists swans as a protected species, wildlife officials use humane ways to control mutes, for example, vigorously shaking (or "addling") their eggs. "The potential for reproduction is out of control," says Doug Forsell, a biologist who works for the Chesapeake Bay office of the U.S. Fish and Wildlife Service. "The mute is a varmint species that we're going to have to spend a lot of money controlling."

It costs a lot of money to bring trumpeter swans to the Bay and to get rid of mute swans already there. What is the difference between the two breeds? Actually, they have much in common. Mute and trumpeter swans are usually monogamous and breed annually after reaching maturity. Clutch sizes vary but may average about 5 eggs. From March to May, during breeding and brooding season, both kinds of swans become fiercely territorial, chasing away any bird larger than a swallow and defending their eggs against predators. Swans are voracious vegetarians, often overgrazing marshlands. Unlike certain fish, such as striped bass, but like many waterfowl, such as Canada geese,

swans have no natural instinct to migrate. Both mute and trumpeter swans will take up year-round residence in a pleasant environment unless their parents teach them a migration route—and even then, they sometimes stay put. At least eight states are home to significant non-migratory populations of trumpeters, which in some instances have displaced mute swans from nesting places. Mutes and trumpeters occasionally interbreed and hybrids have been observed.

How do mute swans differ from trumpeters? The orange bill of the mute swan provides an easy way to tell the birds apart; a black fleshy knob extending from the base of its bill is another. Trumpeters are slightly larger—the males or cobs can weigh as much as 30 pounds and their wingspans measure up to seven feet. The mute grunts while the trumpeter trumpets. From the perspective of environmental policy, though, the crucial difference may be historical. Mute swans hail from Eurasia, where they were domesticated by royalty, while trumpeters are native to North America.

Does this historical fact, however, justify efforts to rid the Bay of the interloper and to restore the ancestral breed? Suppose that fossil or other records were suddenly to reveal that mutes, rather than trumpeters, inhabited the Chesapeake region centuries ago. Would volunteers then addle the eggs of trumpeters while ultralights helped mute swans fly home to the Chesapeake Bay?

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Last February President Clinton signed an "Invasive Species Executive Order" directing federal agencies to begin what Agriculture Secretary Dan Glickman called "a unified, all-out battle" against the spread of alien species in the United States. Praising the order, Interior Secretary Bruce Babbitt observed, "There are a lot of global bioinvasive hitchhikers, and now is the time to take action. The costs to habitat and the economy are racing out of control." Federal agencies require enormous budget increases to fight alien species. "New resources are needed now," Babbitt declared, "and this order opens the door to accomplish just that."

Critics often accuse federal agencies, such as the Department of Defense, of exaggerating threats in

order to increase budgets. During this century, the Forest Service requested and received tens of billions of dollars to fight forest fires. Today, scientists regard fire as a natural and necessary part of forest ecology and suspect that Smokey Bear has done more harm than good. Federal agencies could spend as many billions to control alien species as they have spent to control forest fires. Yet, the movement of species has been a constant occurrence in natural history—like the occurrence of fire. Before we commit a lot of (taxpayer) money to controlling exotic species, it might be helpful to understand why we should treat alien creatures any differently than we treat native species.

Those who call for additional resources to fight exotic species typically defend their position by pointing to examples of non-native species, such as the

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zebra mussel, that have had costly or disruptive effects. Examples, however, are not arguments. Every barrel contains bad apples. One cannot condemn an entire group because of the offensive qualities of a few individuals. To justify a generalization one has to show that the bad apples are characteristic or representative of the group—for example, that exotic species are much more likely than native ones to cause ecological damage or economic harm.

In fact, native species can be every bit as harmful as non-native ones. Throughout the Chesapeake region, annoying mosquitoes have served as vectors of disease. Mosquitoes were active when Captain John Smith explored the area. A nasty jellyfish, ubiquitous in the Chesapeake Bay from June through September, stings anyone foolhardy enough to enter the water, which is the reason few swim in the Bay during the hot summer months. This horrid creature, albeit native, seems to have no important function, ecological or otherwise, other than stinging people. The dinoflagellate *Pfiesteria piscicida* metamorphoses into vegetative life forms, which spread toxins responsible for killing millions of fish. Then these strange plants again transform into large amoebae to eat the fish. Dubbed the “cell from Hell,” *Pfiesteria* do not hail from Dante’s *Inferno* but have lived for millennia at the bottoms of rivers such as Maryland’s Potomac.

While it is easy to accuse alien species of causing economic and ecological harm, it may be harder to make the case against them in comparison with native species that fill a similar niche. Mute swans, which are exotic to North America, may indeed destroy by over-

grazing wetland grasses in the spring and summer months. They overgraze these grasses, however, not because they are mutes but because they are non-migrating swans. Trumpeter swans, albeit native, pose much the same problems of overgrazing and territoriality when they are year-round residents of temperate environments. When the trumpeters introduced to the Bay by the ultralights failed to migrate in the spring—the first group back to Virginia and the second group back to western New York—wildlife authorities became concerned. These swans were all put on trucks and driven to these destinations.

Non-native species, like native ones, can be harmful, beneficial, or both. The most notorious invader, the zebra mussel, apparently immigrated in the 1980s to the United States by way of Europe from the Caspian Sea and now reproduces prodigiously in the shallower waters of Midwestern lakes, including the Great Lakes, and in tributaries of the Mississippi. Industries have to take expensive steps to keep these creatures from colonizing intake pipes used for water works and power plants. On the other side of the ledger, the zebra mussel, a filter feeder, is credited with clearing the water column of excess nutrients and associated algae resulting from municipal waste discharge and agricultural runoff. Lake Erie, which had once been given up as dead by eutrophication, is now clear of the organic matter that had been choking it, wholly because of the mussel.

Biologist Douglas Hunter notes that the mussel gathers these excess nutrients into particles it deposits at the bottom of lakes and rivers to form excellent habitat for insect larvae, leeches, snails, and other invertebrates that larger fish, such as yellow perch, feed upon. As a result, the charter fishery in Michigan’s Lake St. Claire, for example, saw the catch of yellow perch increase five-fold from 1990 to 1996. The work this mussel performs in clearing the water column and enhancing benthic invertebrate communities seems little less than miraculous. The benefits of zebra mussels are ignored, however, because it is an “alien” species.

Many fish, such as Pacific salmon in the Great Lakes, and several aquatic plants, such as purple loosestrife, were introduced into lakes and estuaries for ornamental and other economic purposes. (Loosestrife provides honeybees, which are also exotic species, with high-quality nectar for honey.) The common carp, released into the Chesapeake watershed by the Fish and Wildlife Service in 1876, now abounds in the tributaries. On a summer evening, you can join hundreds of residents of the District of Columbia fishing at Haines Point on the Potomac River. It is largely the carp that you will catch. Similarly, brown trout were successfully introduced to establish a sports fishery in the upper Bay and its tributaries. The Office of Technology

Assessment reports that the effects of a species can also vary with the eye of the beholder: "While many State fish and wildlife managers firmly support stocking with certain non-indigenous fish, some experts consider the practice detrimental."

Many alien—as well as native—species can be easily and cheaply controlled when a use is found for them and they are hunted or harvested for that use. Swans are valuable for their feathers. In Virginia, which does not list mute swans as a protected species, wildlife officials do not regard them as a problem. "Mutes that wander there probably get shot during the hunting

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season," Doug Forsell acknowledges. Hunters drove the trumpeter into local extinction in the eighteenth century. The rule in Maryland against hunting swans—more than their fecundity—may result in the need (or, for wildlife officials, the opportunity) to spend taxpayer money to control them in other ways, such as adding their eggs.

Uses could be found for other invasive aliens. Consider the recently arrived green crab that overflows lobster traps in New England. This creature is abundant in the Sea of Japan, where people harvest it as a delicacy, thus keeping its numbers in check. "The green crab isn't a pest in Japan, where they put it in miso soup," Armand Kuris, a zoologist at the University of California in Santa Barbara, points out. The problem with green crabs in New England is not necessarily that this species is alien to our ecosystem; the problem may be that it is alien to our cuisine.

The rapa whelk, also native to Japan, has been found in the saline Virginian waters of the Chesapeake, where it competes with local whelks—including the knobbed whelk, the lightning whelk (which is left-handed), and the channeled whelk—and may prey upon the remaining populations of native oysters. In Asia, the rapa whelk is hunted as a delicacy. "Rapa whelks are harvested for their meat and shells in Korea; indeed, they are considered overfished there," writes Scott Harper of the *Virginia-Pilot*. "While smaller, native whelks also are caught by Virginia fishermen, it remains unclear if . . . Americans would take to the larger species as a seafood." To control the green crab and the rapa whelk, executive orders may be less effective than recipes.

An Analogy with Human Immigration

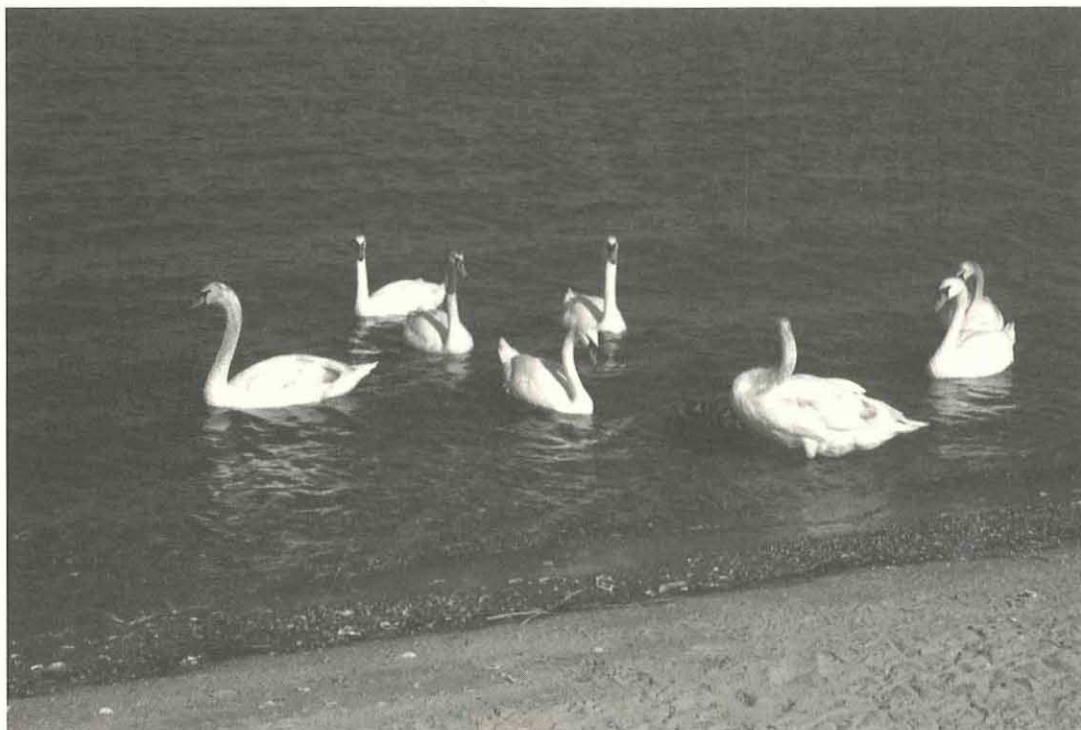
Throughout our history, nativists have sought to close the door on foreigners who wanted to migrate to the United States. Typically, nativist groups support their xenophobia with examples of individual immigrants who turned out to be criminals or who went on public welfare. The anti-immigrationists may tolerate migratory workers who do not become permanent residents and may also allow admission of a few newcomers with special talents and abilities who will assimilate into existing cultural and social systems. Xenophobes argue, however, that liberal immigration policies allow an influx of uncontrollable foreign elements that threaten the integrity of our American way of life.

One would reply to nativists that we are a nation of immigrants. Only Amerindians count as indigenous peoples—and even their ancestors, by some accounts, immigrated across the Bering Straits about 10,000 years ago, which is recent in evolutionary terms. One would also point out to the nativist that while a few members of Irish, Italian, Jewish, and other immigrant groups have been bad apples, the vast preponderance have contributed to the well-being—political, economic, and cultural—of this nation. One can hardly imagine what the United States would be like—or indeed, imagine it existing at all—without immigration.

Likewise, in many places one can hardly imagine the landscape without alien species. Virtually everything down on the farm is an exotic: of all crops, only sunflowers, cranberries, and Jerusalem artichokes evolved in North America. Corn, soybeans, wheat, and cotton have been imported from some other land. Cattle came from Europe. Rockfish—or striped bass as they are known outside Maryland—are native to the Bay but have been introduced up and down the Atlantic and Pacific coasts for sport and commercial fishing. More than 90 percent of all oysters sold in the world are produced by aquaculture, and almost the entire oyster industry on the West Coast is based on a species imported from Japan.

Our culture assimilates foreign influences—who would live in a community without pizza or a Chinese restaurant? Our landscape likewise has assimilated and benefited from foreign ecological influences. Kentucky identifies itself as the "Bluegrass State," for example, but bluegrass immigrated from England. On occasion, alien species outcompete and thus replace native ones, but in the vast majority of instances, newcomers contribute in the sense that they add to the species richness or diversity of local ecosystems.

Those of us who support liberal immigration policy concede that some newcomers have been undesirable, e.g., thieves, murderers, arsonists, or vagrants. However, from the premise that a person is no good *and* an immigrant, it does not follow that a person is no good *because* he or she is an immigrant. One still has to



*Mute swans swimming in the Chesapeake Bay off Hooper Island.
Photograph by Paul Fofonoff, Smithsonian Environmental Research Center. Used with permission.*

show a connection between the characteristic of being a foreigner and the characteristic of being a nuisance. To make this connection in the ecological context, those who seek funds to exclude or eradicate non-native species often attribute to them the same disreputable qualities that xenophobes have attributed to immigrant groups. These undesirable characteristics include sexual robustness, uncontrolled fecundity, low parental involvement with the young, tolerance for "degraded" or squalid conditions, aggressiveness, predatory behavior, and so on.

This kind of pejorative stereotyping may be no more true in the ecological than in the social context. The Pacific oyster, although better at fending off naturally occurring disease, does not differ from the native variety in tolerating more polluted conditions. The zebra mussel has spread widely, but this suggests only that it found a niche to occupy, not that it dispossessed other creatures. Ecologists worry that "weedy" species will dominate, but what is wrong with that as long as they rarely eliminate native creatures? What defines "weediness" other than that certain species succeed globally, like Taco Bell?

Immigration and Ecological Disintegration

About 40 years ago, Charles Elton, a British ecologist, published the influential book *The Ecology of Invasions by Animals and Plants*. There he argued that "we are living in a period of the world's history when the mingling of thousands of kinds of organisms from different parts of the world is setting up terrific dislocations in nature." This statement is true in the most literal sense: species that migrate are dislocated. Elton thought that this kind of dislocation produced disorder in the ecosystems in which "mingling" occurs. Ecologists following Elton have accused immigrant and invasive species of upsetting, disrupting, and destroying ecosystems. Biologist Michael Soule, for example, has said that invasive species may soon exceed habitat loss and fragmentation as the principal cause of "ecological disintegration." Three ecologists have recently written, "Symptoms of degrading ecosystem conditions include the prevalence of exotic species . . ."

If the presence of exotics constitutes a criterion of environmental degradation, then it is not surprising that they should be seen as its cause. But the statement that exotics cause degradation amounts to no more than a trivial tautology if "deteriorated" means

"infested by exotics." Similarly, ecosystems that have already become "degraded" may be more prone to be invaded. Once again, the presence of exotic species cannot be taken as a cause but only as a consequence (and perhaps a good consequence) of "deterioration." What is needed is a criterion for ecological degradation that allows one to test (rather than logically deduce) the general statement that colonization causes it. The science of ecology, as we shall see, cannot provide such a criterion because it cannot invoke a purpose or goal in terms of which to evaluate ecosystem structure or function.

Some scientists have suggested that ecosystems have a general purpose or goal, for example, to remain in balance—one species checking another—and will remain in equilibrium in the absence of invasions and other disruptions often caused by human activity. On a Web site about "Marine Bioinvaders," for example, the MIT Sea Grant Program declares of marine species, "In their home environments, these organisms live in balance with their predators, and are controlled by diseases and other ecosystem interactions." MIT warns that in their adopted ecosystems, "controls may not exist to keep populations in check." A "Fact Sheet" issued by the Maryland Sea Grant Program reiterates that species can "move out of their natural ecological fabric—where eons of evolution have established a

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balance, for example, between predator and prey—to an area where they may have no natural competitors or other controls, and may therefore reproduce unchecked."

However, the fear that a species, native or non-native, can "reproduce unchecked" is a false one. Even zebra mussels are controlled in some ways—such as the availability of clinging space. Drum and diving ducks feed on these newcomer bivalves. There are many native species—for example, the wild grapevine that gives Martha's Vineyard its name—that spread around a lot. It seems odd to include pervasive native species as part of the "balance" of local ecosystems while describing pervasive aliens, which may behave the same way, as reproducing "unchecked."

Many ecologists, in any case, scoff at the idea that nature has a "balance" exotics can upset. A new generation, having been unable to observe any pattern or design in nature but only a flux of organism and environment associations undergoing constant change, has become skeptical of any integrative concepts that may

be applied to the hodgepodge of creatures in an environment or ecosystem. Summing up the emerging view, a *New York Times* article carried the title, "New Eye on Nature: The Real Constant is Eternal Turmoil." The article quotes ecologist Steward Pickett, who argued that the balance-of-nature concept "makes nice poetry but it's not such great science." In its traditional formulation, the balance-of-nature theory contends that an ecosystem maintains a dynamic equilibrium to which it returns after being disturbed if it retains the resources for resilience. "We can say that's dead for most people in the scientific community," said Peter Chesson, a theoretical ecologist.

"Certainly, the idea that species live in integrated communities is a myth," Soule acknowledges, thus apparently contradicting his own thought that exotics cause "ecological disintegration." He writes, "So-called biotic communities, a misleading term, are constantly changing in membership. . . . Moreover, living nature is not equilibrial—at least not on a scale that is relevant to the persistence of species." Soule perceptively notes that

the science of ecology has been hoisted on its own petard by maintaining, as many did during the middle of this century, that natural communities tended toward equilibrium. Current ecological thinking argues that nature at the level of biotic assemblages has never been homeostatic. Therefore, any serious attempt to define the original state of a community or ecosystem leads to a logical or scientific maze.

A Test of the Value or Disvalue of Invasions

Do biological invasions damage ecological communities at particular sites? Do they cause the flora and fauna in particular places to deteriorate, for example, by becoming less productive or diverse? To ask this question is to suggest a way to test an answer. Take two marine sites—two estuaries, for example—one of which has been immune to invasions by alien species at least recently and relatively, while the other is a Mecca for them. Can ecologists tell which is which simply by examining the two systems and their species without knowledge of their history? Is there any biological, as distinct from historical, fact that would tip off the ecologist that he or she is studying a colonized and, in that way, corrupted or disrupted ecosystem?

Another test would be to compare descriptions of the same ecosystem before and after invasions, such as the Chesapeake with trumpeters and then with mute swans, for example, or with native whelks and then with the rapa whelk. Is there any way to tell from biological inspection which whelk is the invader and which is native, or which ecosystem has been colonized and which remains in a prelapsarian state? One could hypothesize that the ecosystem with more species is the one that has been colonized—but this

Alien Species and Altered Genes

While we Americans busily seek to keep exotic species from our shores—and to eradicate those already here—Europeans apply the same energy to excluding genetically modified (GM) crops, largely from America, from their fields and foods. European cosmopolitanism tolerates porous borders for the flora and fauna of different regions. The European Union, however, has a *de facto* moratorium on planting GM crops. Americans, in comparison, declare war on alien species but regard with near indifference the conversion of the nation's farmland to GM corn and soybeans. Efforts by activists like Jeremy Rifkin to lead a consumer revolt against "Frankenfoods," while largely successful in Europe, have had little effect in the United States.

Can we explain the different attitudes of the New and Old Worlds to exotic and to engineered species?

The two worlds—Old and New—differ in their images or archetypes of Nature. At first, Europeans who remained at home and those who came to America shared an antipathy toward the wild. When William Bradford stepped from the Mayflower into a "hideous and desolate wilderness," the attitude of the European settler in America was, to quote historian Roderick Nash, "hostile and his dominant criteria utilitarian. The conquest of wilderness was his major concern."

As pioneers, traders, and farmers subdued the wilderness, however, they began to think of it less in utilitarian than in aesthetic terms. As historian Perry Miller explains, "The more rapidly, the more voraciously, the primordial forests were felled, the more desperately poets and painters—and also preachers—strove to identify the personality of this republic with the virtues of pristine and untarnished, or 'romantic', Nature." Writers like James Fenimore Cooper made wilderness a romantic icon in the United States. The idea of wilderness, William Cronon observes, has become that of a pristine sanctuary where "still transcendent nature can for at least a little while longer be encountered without the contaminating taint of civilization."

In America, Cronon argues, the idea of wilderness, by placing the human outside the natural, leads environmentalists to abdicate responsibility for the nature that actually surrounds and sustains them. While Americans zealously protect indigenous species as part of pristine nature, they appear less concerned about the degradation of areas they do not consider natural, such as farms, cities, suburbs, and other places where people live.

In Europe, the idea of a pristine nature has little spiritual or cultural force. The European image of Nature encompasses Wordsworth's Lake District and Monet's garden at Giverny. This image presents a bucolic landscape in which farmers gently till their land and care for their livestock while living in peace with their surroundings. In this pastoral setting, wildflowers, trees, and shrubs grow harmoniously with crops; indeed, sheep graze upon and thus maintain "natural" pastures. The natural landscape is a worked landscape, but one not worked too hard; there is a respect for nature's own rhythms and a willingness to adapt to its spontaneous course.

For Americans, farms do not belong to Nature but to commerce and industry. Americans have sought to conquer—to control utterly—nature in the sense of natural resources, even while fairly worshipping Nature in the sense of the wild. The boundless domestication, indeed, industrialization of agriculture has been accompanied by the fervent protection of wilderness. Despite the lingering force of the Jeffersonian ideal of the "yeoman farmer" and the sentimental appeal of the family farm, Americans are now inured to the idea that agriculture is an industry as technologically driven as any other. American agronomists, infused with the idea of wilderness, wonder whether genetic engineering will so increase yields that agribusiness can feed the world with less acreage and so leave more land for "Nature."

The "technological treadmill" in agriculture, far from being accepted in Europe as business as usual, threatens the very idea of nature—the pastoral farm as depicted, say, in the paintings of Constable. The hatred of agrotechnology as an assault on nature is not new with genetic engineering. Over a century ago, John Stuart Mill condemned a landscape in which "every natural pasture is ploughed up, and scarcely a place left where a wild shrub or flower could grow without being eradicated as a weed in the name of improved agriculture."

Europeans regard GM crops as the last stage in this process: the eradication of nature, or everything lovely and worth protecting about it, in the name of improved agriculture. The same economic and technological forces that destroy Nature as wild and pristine landscape in the United States seem poised to destroy Nature as pastoral landscape in Europe. As Americans try to parry the threat exotic species pose to our image of Nature, so the Europeans respond to the threat GM crops pose to their conception of what is natural.

would suggest that colonization, by increasing diversity, improves ecosystems. The striped bass—introduced from the Chesapeake—is the most abundant game fish in the Sacramento-San Joaquin estuary. Is there anything about the striped bass that suggests its provenance; is there anything about its effects that indicates how long it has been there? Can one tell from inspecting these creatures or these systems whether the striped bass went east or west?

If we take seriously the suggestion that bioinvasors cause ecosystems to deteriorate or decline, then ecologists should have no difficulty telling which systems have been invaded; they can simply observe which have deteriorated or declined. Yet they cannot do this. Biologists cannot observe any differences—including

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signs of imbalance or deterioration—that tell them what proportion of species in an ecosystem have colonized it recently and what proportion have been there for a long time. Nor can they correlate invasion with any negative impact over time—such as loss of biodiversity—since invasions typically add to the richness or species diversity of ecosystems. To be sure, one is more likely to find alien species in disturbed areas, like those near harbors, than in undisturbed areas off unfrequented coasts. This shows only that disturbance leads to colonization, however, not that colonization causes disturbance. At most, ecologists may argue that new arrivals compete with those species that are already there, but they cannot tell us why competition of this sort is ecologically a bad thing. In economic life, competition is regarded as a good thing—even if Toyota sells a lot of cars in America.

Discrimination without Xenophobia

John Elton concludes his study *The Ecology of Invasions by Animals and Plants* with a chapter titled “The Reasons for Conservation.” He gives three that he regards as grounds for excluding alien species: “The first, which is not usually put first, is really religious.” Before Darwin, a religious argument for exclusion might have asserted that humans must not disturb the distribution of species present at creation. We now know that species had been evolving, dispersing, and commingling for billions of years—indeed, more than 99 percent of all species created had become extinct—before human beings arrived on the scene. In order to domesticate nature—to turn wilderness areas into

places where humans can comfortably live—we have had to rearrange Nature’s course, including the distribution of plants and animals. The religious objection that seems most plausible today is one also lodged against genetic engineering—that our assertion of control over nature has become excessive. Rather than acting as stewards of creation, we usurp God’s role as creator.

The second kind of reason, Elton writes, “can be called aesthetic and intellectual. You can say that nature—wild life of all kinds and its surroundings—is interesting, and usually exciting and beautiful as well.” Native and indigenous species, which share a long and fascinating natural history with neighboring human communities, may reward study and appreciation. Moreover, many of us feel bound to particular places because of their unique characteristics, especially their flora and fauna. By coming to appreciate, care about, and conserve flora and fauna, we, too, become native to a place.

Aesthetic and intellectual values attach to species which have become associated with a place—part of its natural and human history. These species, however, need not have evolved *in situ*; they need only have settled in for a long enough time. Many of the alien species among us have become an integral part of our community and our cuisine—cattle, cotton, corn, and striped bass are surely as American as sunflower seeds, cranberries, and Jerusalem artichokes. The importance of shared history does not favor the native over the alien, but settled denizens of both types over the most recent arrivals. We need not be ashamed of our loyalty to the flora and fauna who have become our neighbors over those that aspire to do so; nothing compels us to treat newcomers on equal terms. But many or most of the once-alien species we encounter are not newcomers, and we have as much reason to be partial to the long-resident alien as to the truly native.

As a third reason for excluding or removing alien species, Elton mentions economic costs involving “crops, forests, water, sea fisheries, disease, and the like.” These reasons are perhaps the most familiar, since they are invoked so often in the contemporary debate. Of course, just as economic reasons justify excluding some human immigrants—for example, those known to be criminals—so they justify efforts to exclude known pathogens and other disease organisms. It should be obvious by now, however, that economic reasons cannot sustain the generalizations about alien species that ecological nativists are wont to make. Indeed, many of the most highly regarded species are or were once aliens, and many of the worst nuisances are native residents.

In the Chesapeake, for example, many biologists argue for the introduction of a non-native oyster to restore the commercial oyster fishery, which has been

devastated by a locally occurring disease. A tasty and disease-resistant oyster native to Japan has been introduced successfully in bays across the world, from Australia to France to Washington State, where it supports profitable fisheries. This oyster as well as another from China seem suited to the temperature, salinity, sediment loads, and dissolved oxygen concentrations of the Bay. Why not introduce an exotic oyster to the Chesapeake, where it could assume the ecological and economic functions of the nearly defunct native oyster?

Typically, people worry that an exotic will "take over" or spread without control. "I'm afraid of the new oyster," said Larry Simms of the Maryland Watermen's Association. "What if it takes over everything?" It might be a good thing, however, if the oyster did "take over everything": Imagine how rich watermen might become—and how soon the Bay would return to its prelapsarian clarity—if the new oyster, a filter feeder like the zebra mussel, transformed the excess nutrients now choking the Bay into food for the invertebrates that feed fish.

If we decline to replace the native oyster with the Japanese or Chinese variety, we should recognize that we are making an ethical, aesthetic, or spiritual decision, not just an ecological one. We may wish to respect the attachment of Bay residents to the indigenous oyster, as an intrinsic part of their local historical and cultural heritage. We may fear that we would be "playing God" if we allowed the alien oyster to drive the native variety into extinction, and, perhaps, that we would offend God if we treated the Bay only as a resource for commercial exploitation. In any case, we should acknowledge the moral or religious reasons that may justify a decision to give up what could be the economic and even ecological advantages of a disease-resistant exotic oyster.

Biological and ecological science, to some extent, can describe what may happen if non-native oysters, swans, and so on are allowed to prosper in the Chesapeake Bay, but these sciences cannot evaluate the results. For example, biologists might tell us whether it is easier to teach mute swans or trumpeters to migrate, or whether they will coexist or even interbreed. We may then argue on aesthetic or historical grounds—E. B. White's wonderful book about a trumpeter swan might be relevant—for eradicating the mute and reintroducing the trumpeter. The argument, however, must be explicitly an aesthetic or historical one. Ecology should not attempt to become a normative science.

—Mark Sagoff

A longer version of this essay is forthcoming in Dorinda Dallmeyer, ed., *Values at Sea: Ethics for the Marine Environment* (University of Georgia Press). Sources: Ken Goldman and Bob Ferris, "Fly Away Home, Part II," news release from Defenders of Wildlife, June 30, 1997 (<http://198.240.72.81/pr063097.html>); Pat Durkin, "Big Immigrant Swans Drive Native Species from Feeding Grounds," *Buffalo News*, April 9, 1995 (quoting Doug Forsell); *The Birds of North America* (American Ornithologists' Union, 1992), no. 105 ("Trumpeter Swan") and no. 273 ("Mute Swan"); Karl Blankenship, "A Swan Song with a Happy Ending?" *Bay Journal* (published by the Alliance for the Chesapeake Bay), vol. 7, no. 6, September 1997 (www.bayjournal.com/97-09/swans.htm); The Trumpeter Swan Society Web site (<http://www.taiga.net/swans/>); "President Clinton Expands Federal Effort to Combat Invasive Species," February 3, 1999, White House news release (<http://www.whitehouse.gov/CEQ/020599.html>); Peter S. Goodman, "Pfiesteria Found in Two More Rivers," *Washington Post*, February 26, 1999; Lidija Milic, "Zebra Mussels Beneficial," *Oakland Post*, February 18, 1998 (<http://www.acs.oakland.edu/post/winter98/980218/n5.htm>); U.S. Congress, Office of Technology Assessment, "Harmful Non-Indigenous Species in the United States" (OTA-F-565), 1993; Lori Valigra, "Alien Marine Life Eats Locals for Lunch," *Christian Science Monitor*, February 11, 1999 (quoting Armand Kuris); Scott Harper, "Predators are Breeding in the Bay," *Virginian Pilot*, September 22, 1998 (<http://www.fishingnj.org/artrapawhbk.htm>); Yvonne Baskin, "Winners and Losers in a Changing World," *BioScience*, vol. 48, no. 10, 1998 (quoting David Lodge, a biologist at the University of Notre Dame, who attributes to alien species such qualities as higher fecundity, less parental care, and greater tolerance of degraded conditions); Gordon Orians, "Site Characteristics Favoring Invasions," in *Ecology of Biological Invasions of North America and Hawaii*, edited by Harold A. Mooney and James Drake (Ecological Studies No. 58. Springer-Verlag, New York, 1986) (criticizing the stereotype of alien species); David Quammen, "The Weeds Shall Inherit the Earth," *The Independent*, November 22, 1998 (quoting Michael Soule on "ecological disintegration"); D. J. Rapport, R. Costanza, and A. J. McMichael, "Assessing Ecosystem Health," *Trends in Ecology and Evolution*, vol. 13, 1998 (on symptoms of ecosystem degradation); MIT Web site (<http://massbay.mit.edu/exotic-species/invaders/index.html>); Maryland Sea Grant Fact Sheets (<http://www.mdsg.umd.edu/exotics/index.html>); William K. Stevens, "New Eye on Nature: The Real Constant Is Eternal Turmoil," *New York Times*, July 31, 1990 at C1 (quoting Steward Pickett); Donald Worster, "The Ecology of Order and Chaos," *Environmental History and Review*, vol. 14, no. 1–2, Spring/Summer 1990; Michael Soule, "The Social Siege of Nature," in *Reinventing Nature: Responses to Postmodern Deconstruction*, edited by Michael Soule and Gary Lease (Island Press, 1995); Beth Baker, "Botcher of the Bay or Economic Boon?" *BioScience*, vol. 42, no. 10, Nov. 1992 (quoting Larry Simms).