Exotics in the Chesapeake

UNDERSTANDING SPECIES INVASIONS • FACT SHEET NUMBER TWO

Exotic Animals

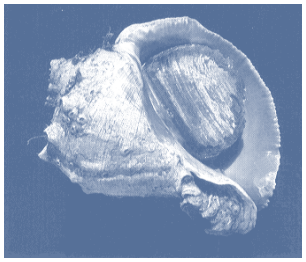
We know that when Captain John Smith first guided the *Susan B. Constant*, the *Godspeed* and the *Discovery* into the Chesapeake in 1607, he initiated a sequence of events that would change the course of the Bay forever. Most of those changes would result from dramatic and obvious actions on the part of the colonists. The cutting down of old growth forests for building materials and agriculture, the resulting soil erosion and silting in of natural harbors, and the burgeoning increase in human population all contributed to the decline of the Bay's naturally resilient ecosystem. Other ecosystem changes were less obvious.

We don't know, for example, what nonindigenous species may have clung to the hulls of the English ships or hitched rides in their solid ballast — and compared to the changes in the land and in the Bay itself (such as the eventual destruction of the estuary's vast oyster reefs) the introduction of a few non-native species may seem inconsequential. But it is clear that the Bay's natural assemblage of plants and animals began to change during the Colonial period, and it has continued to change ever since. As we enter a new millennium we are just beginning to determine what effect exotic introductions may have on the Chesapeake Bay and on the native species that make their home there.

The Bay's Unwelcome Visitors

Determining what animals have come to the Bay since the time of John Smith is a relatively recent task. That effort is now taking place in research laboratories around the Chesapeake, especially at the Smithsonian Environmental Research Center, where scientists have begun to catalog and document organisms that appear to be non-native in the Bay. Some organisms identified in these studies are "suspected" invaders, while others are clear-cut exotics, among them the common carp, the blue catfish, the Asiatic clam, the brackish water clam, the Japanese shore crab, and, as we have recently discovered, the Rapa whelk.

Found now in the southern Chesapeake Bay, the Rapa whelk is a mollusc and a gastropod — a familiar category of invertebrates that includes conchs and snails. Gastropods are so named because of an unusual twist of anatomy — that is, the organ that these molluscs use for locomotion contains the stomach. (Gastropod means, literally, "stomach foot.") First described scientifically in the mid 1800s, the Rapa whelk is native to the Sea of Japan, and it can grow quite large for a mollusc. One specimen found near Hampton Roads, Virginia, for example, exceeded six inches in length. It is not clear at this point how Rapa whelks came to the



RAPA WHELK

Bay, but because they belong to a predatory family of molluscs, resource managers feel considerable uneasiness about their potential impact on native Bay species.

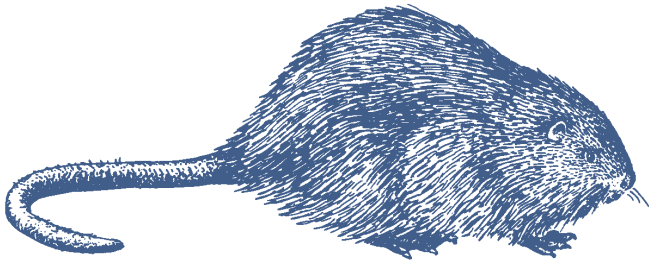
The fact that the prey of the Rapa whelk includes bivalve molluscs — like clams and oysters — causes special concern. With the introduction of the Rapa whelk some fear that we have added yet another biological hurdle to the list of obstacles in the path of the native oyster's slow recovery — a list that already includes pollution, disease and competition from other exotic mollusc introductions. Studies are now underway to determine how far the Rapa whelk has spread in the Chesapeake and what impacts on the Bay's ecology it may have.

Big Bay Invaders

Some animal species that have migrated to the Chesapeake region since time out of mind have more recently taken up permanent residence. While migrating Canada geese are a familiar sight in the Chesapeake, for example, a number of flocks are now resident and most appear to be descended from a Mid-Western subspecies. Likewise, mallard ducks are regular migrants from Canada, but local flocks that stay year-round are often descended from birds raised in game farms, and are a mix of native populations and domesticated ducks.

Two common reasons for the deliberate introduction of an exotic species are for hunting and trapping or for ornamental value. In addition to geese and ducks, a number of plants and animals have been introduced for these reasons, and it is often not apparent to the untrained observer how damaging previous introductions have been — and how risky future introductions may be. Starlings, for example, were introduced into this country by a theater enthusiast who wanted to have every bird species mentioned in Shakespeare's plays present in North America. The unfortunate and unforeseen consequence of this introduction was the decline of the native bluebird, which has been out-competed by the starling for nesting space.

While some Bay invaders appear only to those who fish or study the Bay's waters, others are large enough to be spotted from a passing boat, or even



NUTRIA

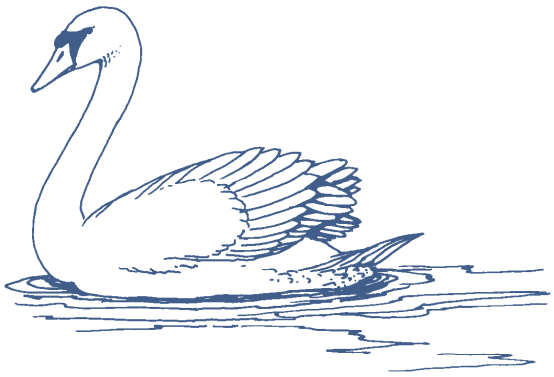
a passing car. Two cases in point: the large, beaver-like nutria, and the strikingly graceful mute swan. Where did these two large exotic animals come from, and what effect might they have on the ecological fabric of the Chesapeake Bay?

Along with rodents like the Norway rat (*Rattus norvegicus*) and the black rat (*Rattus rattus),* nutria (*Myocaster coypus*) are among the few wild non-indigenous mammals found in North America. While rats arrived by accident, nutria were introduced to this continent from South America for fur production, and were first brought to Maryland in the 1940s. Nutria grow to about two feet in length and resemble beavers in size and shape, though their long rat-like tail looks much like that of the native muskrat. Equipped with big incisors and impressive appetites, these large herbivores have created considerable disruption in fresh and salt water ponds, swamps and wetlands. No natural predators have kept their populations in check.

In addition to their disruption of habitat for native species like the muskrat and their voracious consumption of vegetation, damage caused by nutria leads to erosion in environmentally fragile and valuable areas. Nutria interfere with agriculture by disrupting irrigation systems and damaging crops; and by eliminating native vegetation, they may increase the potential for invasion by exotic plant species. Residents of some areas have taken actions against the nutria invasion. In Louisiana, concern about damage to wetlands led to the implementation of a "bounty" system that increased the price of nutria pelts by one dollar. In Maryland, responding to nutria damage on the Blackwater River in Dorchester County, Maryland, state legislators have developed a ten-year plan to eradicate unwanted nutria.

Nutria provide a good example of how exotic species can impact not only their immediate environs, but can also cause harm on a much broader environmental scale. In the Chesapeake Bay, for example, the destruction of marshes by nutria may hamper the critical role of wetlands as filters for nutrients such as nitrogen and harm nursery areas for many fish and wildlife species. Such changes could pose the threat of cascading ecological decline for the estuary's normally resilient natural systems.

Another example may be the imported Sika deer, which has been found to have a significant effect on the marshes at Blackwater Wildlife Refuge and in Chincoteague, Virginia, according to specialists at the U.S. Fish and Wildlife Service. Evidently these deer spend most of their time in the salt marshes at those sites, and much of their diet consists of marsh grasses.



MUTE SWAN

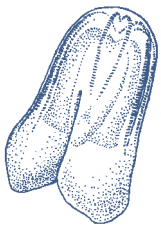
One very large avian species, introduced for its ornamental value, is also creating ecological disruptions in the Chesapeake region — and as far north as Maine and as far west as Michigan. The mute swan (*Cygnus olar*) was introduced into North America in the Hudson Valley region of New York in the 19th century from its native habitat in Europe and Asia. Mute swans are larger than the native tundra swan (up to 25 lbs. versus 16 lbs.) and very aggressive. Male or "cob" swans may prevent other wildlife from using an area up to six acres around their nests in ponds, lakes and marshes. Native waterfowl, including Canada geese, have been killed by mute swans, and they are known to display aggressive behavior toward people in the vicinity of their nests. Once a territory has been established, the mating pair of mute swans will return for many years and in some areas like the Chesapeake will remain throughout the year.

One of the greatest risks of introduction of an exotic species is the potential for loss of native species leading to loss of biodiversity. In the Chesapeake region the only nesting colony of the threatened black skimmer was eliminated by mute swans, and mute swans are known to interfere with nesting of terns (specifically the least tern) on beaches in Dorchester County, Maryland. Mute swan populations in the U. S. have increased rapidly, with numbers exceeding 10,000 in 1993. In Maryland it is expected that by the year 2000 mute swan numbers will exceed 4,000. And while this population may sound finite and manageable — especially when compared with population sizes in the billions for some invaders like the zebra mussel — the combination of the swan's aggression and territoriality makes even a small population of mute swans a serious threat to native species in the sensitive and ecologically valuable marshes of the Chesapeake.

Global Paths of Exotic Species Introduction

Whether the inadvertent introduction of the Rapa whelk or the intentional but misguided introduction of nutria and mute swans, the rapid spread of exotic species demonstrates the dynamic nature of the field of "invasion biology," as scientists have termed the study of nonindigenous species. Yet another example demonstrates how quickly an exotic introduction can change an aquatic ecosystem — and how the Chesapeake Bay not only receives exotic species, but exports them.

The path that carries exotic species travels in both directions, and one might say that what goes around comes around. In the early 1980s ballast water dumped into the Black Sea from a vessel apparently released the comb jelly



COMB JELLY

Mnemiopsis leidyi, a relative of jellyfish and a common inhabitant of the Chesapeake Bay. Comb jellies make their living by eating fish eggs, larvae, tiny crustaceans and other organisms important as food for fish. In less than a decade the mass of *Mnemiopsis* in the Black Sea grew to an estimated one billion tons — a volume nearly equal to the weight of commercial fish harvests worldwide. At the same time, the anchovy catch in the Black Sea dropped to 20 percent of former levels. The explosive growth of the comb jelly in the Black Sea provides one of the most recent and dramatic demonstrations of largely unchecked growth due to a lack of natural predators, diseases or other controls in a new habitat, a key ingredient in the biology of invasive species.

Some Solutions — And More Problems

One solution to the problem posed by introducing invasive species into habitats that lack predators or other controls to keep them in check has been to intentionally introduce another species that preys on the exotic invader. This approach has proven effective in some cases, but in others has compounded the problem — when, for example, the exotic predator turns out to prefer native species over unwanted exotics. Such problems have cropped up around the world. In Hawaii, for example, the mongoose was introduced from Asia to control rats, but it evidently preferred native birds, with unfortunate results.

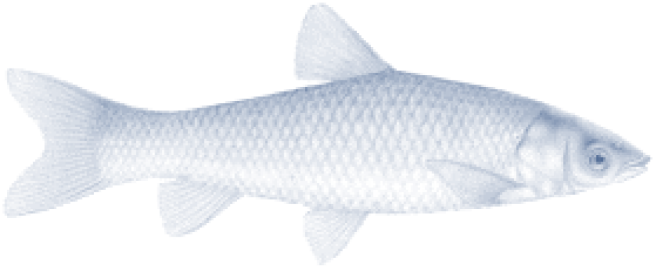
Some have suggested, as a solution to the comb jelly problem in the Black Sea, the introduction of a small edible fish called the butterfish, which would presumably feed on the superabundant comb jelly. Although some argue against the introduction of yet another nonindigenous species, in light of the ecological disaster occurring in the wake of the comb jelly, proponents of the plan view potential negative consequences of introducing the butterfish to be relatively minor. Others, however, argue that this same reasoning has been used to justify other introductions intended to control unwanted species, introductions that ultimately went awry.

Clearly, caution is key when considering the introduction of a nonindigenous species, whether for agricultural purposes, aquatic management or recreational uses, such as the aquarium industry. At times these considerations can become quite contentious, as has happened in the Chesapeake Bay region during the past decade.

The Debate Over Introductions

The grass carp (*Ctenopharyngodon idella*) is a prime example of an exotic introduction for resource management purposes. The grass carp (also known as the white amur) is a native of the Amur River between China and Russia. An herbivorous fish, it boasts specific adaptations that enable it to efficiently consume large amounts of aquatic vegetation. With its voracious appetite and fast growth, the grass carp can serve as an effective biological control agent — an alternative to chemical treatment — for the removal of aquatic plants. As a consequence, the grass carp has been widely introduced in the U.S. as a control agent for unwanted aquatic vegetation.

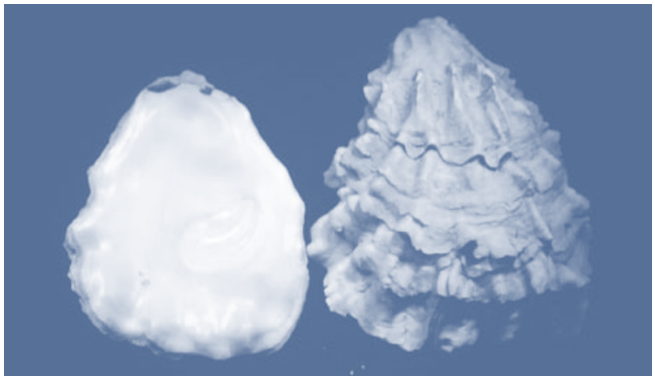
Some argue, however, that the benefits brought by grass carp are overshadowed by potential ecological consequences. For example, while grass carp do effectively remove aquatic vegetation, controlling the extent of that removal is another issue. In some cases grass carp eradicate aquatic vegetation altogether, eliminating the valuable ecological functions that vegetation may provide, including generation of oxygen through photosynthesis, providing food for native herbivores, and creating habitat or cover for young fish, crabs and other species. Because of the risk of escape and the potential for loss of desirable grasses in the Bay, there has been serious concern about the use of grass carp in the Chesapeake watershed.



GRASS CARP

In the Bay basin, Maryland prohibits the use of grass carp, and Delaware currently has a moratorium on its use as well, because of the potential for loss of underwater grasses — which in some areas are in recovery after years of decline. Maryland's neighboring states — Virginia, Pennsylvania and West Virginia — do permit the use of grass carp. Maryland's concerns may be reinforced by the discovery of grass carp in the open waters of rivers like the Potomac that are tributaries to the Bay.

One of the chief concerns in the introduction



PACIFIC OYSTER

of an exotic species, then, is the potential for its release into the environment. Especially serious is the potential for the establishment of reproducing populations of the exotic animal in natural systems, as has occurred, for example, with grass carp. In order to prevent this unwanted reproduction, researchers are experimenting with genetic alteration, including "triploidy" — the manipulation of chromosomes. This technique involves a change in chromosome count brought on shortly after fertilization of the egg, with the result that a fish or shellfish produces three sets of chromosomes rather than the usual two (called "diploid"). This additional set of chromosomes prevents, for the most part, reproduction; however, in the case of the Pacific oyster *Crassostrea gigas* experiments conducted in the York River demonstrated that triploid oysters could apparently revert to the normal chromosome state, thus raising the risk of unintended reproduction. Most states that permit the introduction of grass carp require that they be triploid to avoid the establishment of reproducing stocks, but even in treated carp not all of the animal's tissues will be triploid, so there appears to be some potential for reproduction even in largely triploid animals. Resource managers are therefore extremely careful when considering the use of triploid animals for targeted introductions.

Potentials for the Future

Bay management efforts over the last decade have focused on reducing the flow of nutrients into the Bay. This is a prudent management course because it is clear that high levels of nutrients have caused a number of problems, including the decline of Bay grasses (submersed aquatic vegetation, or SAV) due to shading caused by excess phytoplankton growth, and the lowering of oxygen levels (hypoxia) or even its complete absence (anoxia) — a result of oxygen demand created by decomposing (surplus) phytoplankton.

Management approaches focusing on control of nutrients flowing into the Bay (supply side approaches) have already shown some benefit.

Some scientists argue that management strategies should also include methods that reduce excess phytoplankton or nutrients once they have entered the Bay or its tributaries (demand side approaches). Any discussion of the consequences of excess nutrients and phytoplankton in the Chesapeake should consider that with the demise of the native oyster (*Crassostrea virginica*) in the Bay the capacity of the Bay ecosystem to remove and reduce or eliminate the consequences of surplus phytoplankton growth declined as well. This ecological dilemma has lead to the suggestion that if native oyster populations cannot be restored because of disease, then management agencies should consider the introduction of a non-native oyster, such as the Pacific oyster *C. gigas*. Proponents of this approach argue that restoring the ecological health of the Chesapeake ecosystem outweighs any risks posed by an exotic introduction.

We do know that a very successful oyster industry has grown up around the introduction of the imported Japanese oyster in Puget Sound, and the West Coast oyster fishery — which once ranked far behind the Chesapeake Bay — is now a major source of oysters in the U.S. That fishery stands as

one of the success stories of nonindigenous species management, a winner in the global game of exotic species roulette.

The introduction of an exotic oyster such as *C. gigas* may carry with it an unusual irony, however. Some researchers believe that the oyster diseases MSX (*Haplosporidian nelsoni*) and Dermo (*Perkinsus marinus*) may have been inadvertently brought to the Bay, perhaps on oysters used for planting. If this is true, then earlier importations of non-native oysters may have had a devastating effect. On the other hand, the introduction of a disease-resistant oyster could potentially reestablish healthy oyster populations once again — although with a different species, with unknown effects on the estuary's ecosystem.

It is clear that introductions of non-native species may present problems as much as they may offer opportunities. In particular, the potential for discharging exotic species in ballast water — from microbes to fish — has become a serious concern over this last decade, and efforts have been underway to find new means for stemming such introductions. Federal and state laws also are in place to minimize both deliberate and inadvertent introductions of non-native species to U.S. waters, and to evaluate thoroughly implications of proposed introductions for economic, environmental or aesthetic reasons. No law or regulation, however, can prevent all unwanted introductions, either deliberate or accidental. Only personal responsibility — by shipping companies, aquaculturists, aquarium owners and others — can provide an effective barrier to control invasions of our coastal waters by exotic plants or animals.

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For Further Information

This publication is one of a series of fact sheets on exotic species in the Chesapeake Bay produced for the Chesapeake Bay Program by the Maryland Sea Grant College and the Smithsonian Environmental Research Center. Printed copies of these fact sheets are available at the offices listed below; they are also available on the Maryland Sea Grant web site.

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Smithsonian Environmental Research Center
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Edgewater, Maryland 21037
www.serc.si.edu/invasions/index.htm

Chesapeake Bay Program Office
410 Severn Avenue, Suite 109
Annapolis, Maryland 21403
www.chesapeakebay.net

Selected Web Sites

Aquatic Nuisance Species Task Force:
http://www.ANSTaskForce.gov/

Sea Grant Nonindigenous Species:
http://www.ansc.purdue.edu/sgnis/

Invasive Plants of Virginia:
http://www.state.va.us/~dcr/dnh/invlist.htm
http://www.hort.vt.edu/vnps/invasive.html

National Biological Information Infrastructure:
http://nbii.gov/index/html

Nonindigenous Aquatic Species:
www.nas.er.usgs.gov

Zebra Mussel Clearinghouse:
http://cce.cornell.edu/seagrant/nansc/Products.htm

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