HABITAT HOTLINE ATLANTIC

Atlantic States Marine Fisheries Commission

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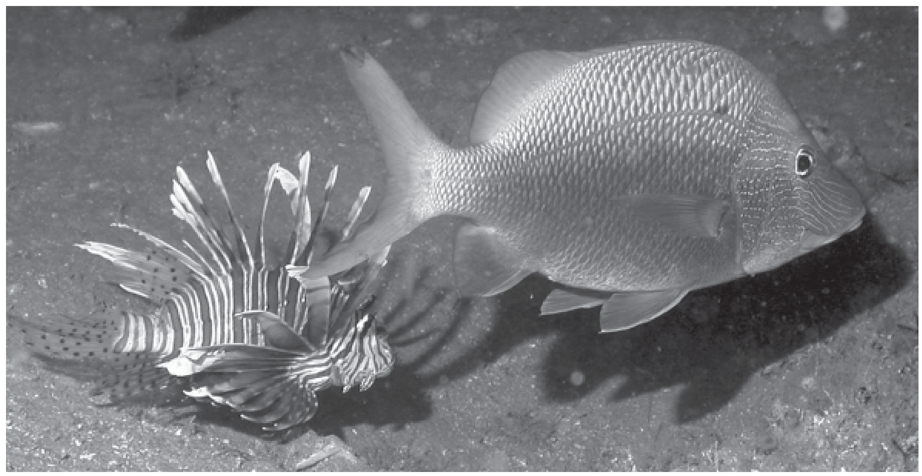
# Invasion of the Habitat Snatchers!

## A Profile on Two Atlantic Coast Invasive Species

### Introduction

Invasive, exotic, nuisance, alien… you are probably familiar with these terms, especially when followed by zebra mussels, Asian oysters, or snakeheads. These invasive species have almost become household terms because of their known or potential impacts to aquatic systems. Two newer invaders of the Atlantic coast, lionfish and sea squirts, are now making headlines, and may gain as much notoriety as the mussels, oysters, and snakeheads. Lionfish and sea squirts have great potential to impact Atlantic coast habitats and ecosystems. Here we provide you with a brief summary of the biology of these species and their potential impacts to Atlantic Coast ecosystems.



Lionfish and scup taken during a research cruise by the NOAA research vessel Delaware II. Photo credit: NOAA Delaware II.

### Lionfish – Beautiful, Dangerous, and Invading

The lionfish (*Pterois volitans**) is a member of the scorpionfish family and is native to the Indian and Western Pacific oceans. In their native range, lionfish are usually found in coral and rocky reefs at depths less than 50 meters. Lionfish shelter under ledges or in crevices in the reefs and fiercely defend their home ranges from other lionfish or other fish. Lionfish stalk and eventually corner prey by expanding their spines and pectoral fins in an aggressive manner. Although lionfish may use their spines to help corner prey, they do not appear to sting prey before eating them. Lionfish eat small fish, shrimp, and crabs.

**Pterois volitans* and *P. miles* are closely related, allopatric species. Here, the 2 are referred to as the *P. volitans* and termed commonly as lionfish.

Lionfish behavior is notably different in its introduced range. In their native range, lionfish are solitary, nocturnal predators. But in the Atlantic, they have been found with full stomachs during the day, suggesting active daytime foraging. Also, lionfish have been observed moving about in groups of two to six, a behavior rare in their native range.

Natural predators of the lionfish are virtually unknown in both native and introduced ranges. Studies on the closely related lionfish (*Pterois miles*) show that the cornetfish, *Fistularia commersoni*, will prey on lionfish. It is thought that cornetfish ambush lionfish from behind, consuming them tail first so as to avoid stings from the venomous spines. It is possible that relatives of the cornetfish found in other parts of the world prey on lionfish. Scientists also suspect that

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**For more information about invasive species, visit:**

www.protectyourwaters.net/impacts.php

www.invasivespeciesinfo.gov

www.anstaskforce.gov/default.php

**Want to know when a new invader comes to your state?**
Register with the Non-indigneous Aquatic Species Alert System online at:
http://nas.er.usgs.gov/AlertSystem/register.asp

some sharks may prey on lionfish as many sharks can consume venomous prey with no ill effect.

The lionfish is notorious for its highly venomous spines. The sting from the spines (any of them) is considered a health emergency, will definitely hurt, and can potentially be fatal to humans. A lionfish sting may cause persistent, intense, radiating pain, tingling sensations, sweatiness, and blistering. More serious reactions may result in systemic responses such as headaches, nausea and vomiting, delirium, seizures, paralysis of limbs, respiratory distress, or heart complications including congestive heart failure, pulmonary edema, and loss of consciousness. Experts warn that divers should avoid interaction with lionfish, as they often approach threats in an aggressive manner with their spines forward. Statistics show the warnings should be heeded – scorpionfishes (of which the lionfish is a member) are second only to stingrays in total number of stings annually worldwide, estimated to be about 40,000-50,000 stings per year.

## The Invasion

Lionfish have been observed off the coast of Florida since as early as 1994. Since 2000, substantiated observations of adult lionfish have been reported in waters from Florida to Cape Hatteras, North Carolina. Juveniles have been found as far north as Long Island and as far east as Bermuda (Hare and Whitfield 2003). Year-to-year observations have varied in number likely because of varying observational effort, yet total observations has increased. Using reported observations alone almost certainly underestimates the number of lionfish living and reproducing in U.S. waters because observations are only counted when confirmed by an expert via a body or a photograph.

## Can Lionfish Extend Their Range?

Kimball et al. (2002) established thermal tolerances for lionfish. Their experiments demonstrated that lionfish generally do not survive in waters with temperatures below $13^0$C ($55^0$F). Below $13^0$C, fish were lethargic, unresponsive to visual stimuli, and would not eat. The average temperature at which death occurred was $10.7^0$C ($51^0$F). Comparing temperatures at which death occurs to average water temperatures in the Atlantic coast waters shows that the northern limit of the lionfish range is most likely Cape Hatteras, North Carolina (Hare and Whitfield 2003, Kimball et al. 2004). This is good news in the sense that juveniles transported by jet stream currents as far north as Long Island will probably not be able to establish adult populations. The bad news is that the southern part of the range may expand. Currently, the southern limit of the introduced range is near Miami, Florida, despite the fact that Gulf of Mexico and Caribbean waters have suitable temperatures to support lionfish populations (Kimball et al. 2004). This southern boundary is most likely a result of the initial introduction site and the lack of southward dispersal mechanisms from this region (e.g. current patterns) (Kimball et al. 2004). It is generally accepted that the establishment of lionfish resulted from aquarium releases (Hare and Whitfield 2003, Kimball et al. 2004). More releases in the Caribbean and Gulf of Mexico could advance establishment of lionfish populations.

## Potential Impacts

It is too early to know exactly how lionfish could affect Atlantic ecosystems but scientists do believe they could change dynamics with both predators and prey (Hare and Whitfield 2003). Potential prey is abundant and lionfish are efficient predators. Lionfish may compete with native species for the same prey. Declining abundances of native species that employ similar ambush style predation techniques (e.g., red grouper, frog fish, scorpionfish) could leave open ecological niches for lionfish to fill (Whitfield et al. 2002, Hare and Whitfield 2003). Forage fish in Atlantic coast ecosystems may not be familiar with the slightly different style of ambush that lionfish employ from those of the native predator species (Whitfield et al. 2002). But without knowledge of dietary preferences and foraging requirements of lionfish, the impacts on prey species are difficult to ascertain. More research on fish that prey on lionfish is also needed. Without knowledge of predators in the native range, or lionfish interactions with predators, it is difficult to make predictions about how lionfish will interact with potential predators in introduced ranges.

# Invasive Sea Squirts – Slimy & Spreading

Another invasive species making headlines throughout the northern parts of the U.S. East Coast is an invasive sea squirt in the genus *Didemnum*. Sea squirts are tunicates, a type of animal that starts life with a primitive spinal cord, an eye, and a heart. Adults have a firm but flexible outer covering, called a tunic (*hence 'tunicate'*). Tunicates may form dense mats made up of thousands of tiny individuals and attach to firm substrates such as gravel, sea scallops, mussels, docks, and other structures. Sometimes they even attach to seaweed.

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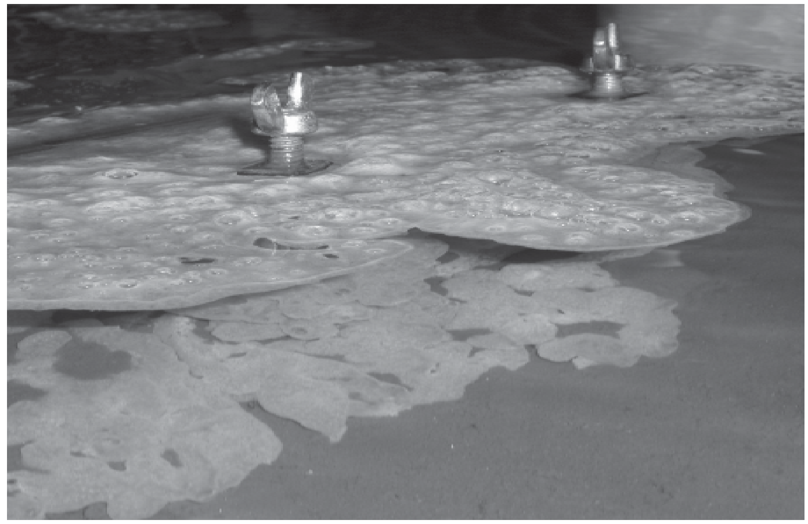
*Didemnum* sp. sea squirts reproduce sexually and asexually. Sexual reproduction produces tadpoles that live only a few hours before attaching to the seabed and forming new colonies. Colonies can also reproduce asexually by budding. This particular species has not been identified down to a species level and for now, is referred to as *Didemnum* sp. Researchers originally thought these sea squirts were native to the North Sea, but more current research suggests that they may be of Asian origin. However, until scientists can identify the squirts down to the species level, researchers will probably not be able to confirm the native range.



Tunicate colonies of *Didemnum* sp. spreading along the bottom of the seawater table and extending upwards through the water column along the underside of the air/water interface. Photo credit: R. Osman (SERC).

## The Invasion - Where Are They Now and Where Are They Going?

The current theory of invasion put forward by researchers and based on the notion of an Asian origin, is that *Didemnum* sp. sea squirts hitched rides on oysters imported for aquaculture from Japan to New England. *Didemnum* sp. can also heavily foul ships, which may facilitate its worldwide spread. Although no one knows when these sea squirts arrived in North American waters, locals from Maine described slimy mats in the Damariscotta River as early as 25 years ago. Scientists now believe these mats were *Didemnum* sp. But the first confirmed observation of *Didemnum* sp. in Maine was in 1993. Invasions have spread to other parts of the world. The squirts were confirmed in New Zealand in 2000, British Columbia in 2003, and Puget Sound, Washington in 2004. They have also been documented off the coasts of California, France, and The Netherlands. On the Atlantic Coast, observations have been confirmed from Long Island, New York north to Eastport, Maine.

*Didemnum* sp. sea squirts thrive in a wide range of marine environments although they prefer waters with temperatures ranging from -2-24$^0$C (28-75$^0$F), and firm substrates, particularly gravel. Unfortunately, these conditions are widespread along the New England coast. Particularly troubling to scientists is that the sea squirts have been found in offshore areas, which were previously thought fairly resistant to invasions because of the adaptations needed to survive in such harsh environments. The U.S. Geological Survey (USGS) and Woods Hole Oceanographic Institute (WHOI) conducted a survey looking for the sea squirts on Georges Bank in 2004 and expanded the survey in 2005 to include more area. In 2005, the sea squirt was mapped over twice the area that it was observed in 2004, a telling number when talking about spread. Although the total coverage of the sea squirt expanded, the populations shifted from very large mat-like colonies observed in 2004, to fewer, smaller, and more spread out populations. Fragmentation of colonies only aids the spread of the sea squirts. Results from a USGS and WHOI research project show that budding dramatically increases in as little as two weeks when small pieces from an existing colony are broken off and removed to a new area. Storm and tidal currents can also help spread colonies into new areas. One limitation to the spread of *Didemnum* sp. is that they cannot settle on moving sand. Thus those parts of Georges Bank and the Mid-Atlantic Bight dominated with sand or mud bottom may be resistant to invasion. At this time it is not known if they can successfully colonize mud habitats found in deep basins in the Gulf of Maine.

## Potential Impacts

One of the biggest concerns is that the *Didemnum* sp. squirts could change seabed communities by smothering finfish and shellfish grounds. Scientists hypothesize that the sea squirt mats could act as barriers between fish and prey that live on the seabed. Areas in Georges Bank with gravel substrate have historically been highly productive fishing grounds, but would also be prime habitat for the sea squirt. Scientists are also concerned that sea squirt mats may be unfavorable for settling larval scallops and fish. The sea squirts aggressively grow over bivalves, and may smother them or interfere with their growth. The sea squirts also have the potential to have cascading economic impacts. Scientists conjecture that if the sea squirts can change the landscape of the sea floor, they could make habitats inhospitable for lobsters, one of New England's most lucrative fishing industries. Aquaculture operations are also at risk. Because the sea squirts will also colonize hard structures, they could overgrow cages causing decreased flushing of water in and out of cages or slower growth of farmed shellfish.

Finding enemies of the sea squirts has not proved fruitful for researchers. Sea squirts will avoid stinging corals and anemo-

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# AROUND THE COAST: SPOTLIGHT ON ZEBRA MUSSELS IN NEW YORK

## Zebra mussels: Changing the face of the Hudson Estuary

A familiar invasive species, zebra mussels, are well known for causing damage to the Great Lakes ecosystem and costing millions of dollars for removal. The indirect impacts that zebra mussels can have on aquatic ecosystems have been difficult to elucidate, but recent research is showing that zebra mussels do have indirect effects on fish communities in the Hudson River estuary in New York.

Zebra mussels first appeared in the Hudson in 1991 and have been a dominant part of the ecosystem since then. In the Hudson River estuary, zebra mussels comprise more than half of the heterotrophic (eat other organisms) biomass, and filter a volume of water equal to all of the water in the estuary every 1 - 4 days during summer. Researchers have determined that zebra mussels can drastically alter aquatic habitats by decreasing phytoplankton biomass by up to 80%, zooplankton biomass by 52-76%, and benthic organisms by 10-40%. Zebra mussels can also dramatically change water clarity, increasing clarity by up to 45%. More water clarity can also lead to increased growth of submerged plants and large algae.

In 2004, two New York Department of Environmental Conservation scientists teamed with an Institute of Ecosystem Studies scientist to evaluate the effects of zebra mussels on fish communities. They hypothesized that zebra mussels might negatively affect the abundance or growth rates of open-water fish such as American shad, blueback herring, alewife, white perch, and striped bass that feed heavily on plankton in the water column. They also conjectured that distribution would shift downriver away from the areas that experienced the biggest changes from zebra mussels. They also hypothesized that other littoral fish species that feed largely on benthic invertebrates (sunfish, carp, smallmouth bass) would show increases in abundance or growth rates, or that their distributions would shift towards the areas with greatest zebra mussel induced changes.

The scientists found that the zebra mussel invasion was associated with big changes to young-of-the-year fish in the Hudson River. Open water fish species declined in abundance, shifted distribution downriver farther from zebra mussel zones, and suffered declines in apparent growth rates. At the same time, species that feed on benthic organisms increased in abundance, shifted their distribution upriver towards zebra mussel zones, and showed trends toward increasing growth rates.

## How do bivalves like zebra mussels affect fish?

Scientists believe that zebra mussels affect fish communities by three main pathways of interaction: grazing of phytoplankton, creation of 'new' habitat, and enhancing littoral production. Zebra mussel grazing reduces phytoplankton, which leads to losses of zooplankton that fish eat. For this chain reaction to occur, zebra mussel grazing must outpace phytoplankton growth, and must overlap in time and space with phytoplankton growth. In the Hudson River estuary, this pathway likely contributed to observed changes in fish communities, notably decreased abundance of open water fish species. Zebra mussel beds also provide food and shelter and can contribute to increased abundance of benthic invertebrates. In this case, the scientists could not determine if this mechanism directly contributed to increases in littoral fish. Finally, decreases in phytoplankton may clear the water enough to benefit submerged plants or algae, the organisms that feed on these plants, and in turn fish that feed on these organisms. This pathway is likely responsible for the observed increases in growth rates and abundance of littoral fish.

## What does this mean for the Hudson Estuary?

The net of effects of zebra mussels on fish communities depends on the strength and balance among all of the interaction pathways described above. In general, open water fish should suffer and littoral zone fish should benefit, as the researchers found in this study. These results have fishery management implications. If observed changes in abundance, distribution and growth of young fish continues into adult populations, it could affect multi-million dollar sport and commercial fisheries. Also, changes to the population dynamics of some species will make it difficult to predict the effects of management actions. Management may become more difficult as decreased abundances and recruitment limit the possible combinations of recreational and commercial harvests and habitat management that will lead to sustainable populations. Thanks to this study and countless others evaluating the impacts of zebra mussels, scientists are teasing out the direct and indirect effects zebra mussels are having on aquatic ecosystems. Research will eventually need to be expanded to other invasive species before their potential threats become real damage.

**Source:** Strayer, D.L., K.A. Hattala, and A.W. Kahnle. 2004. Effects of an invasive bivalve (*Dreissena polymorpha*) on fish in the Hudson River estuary. Canadian Journal of Fisheries and Aquatic Science **61**: 924-941.

## Invasive Species Legislation Update

The direct and indirect costs of aquatic invasive species to the U.S. economy are estimated at billions of dollars per year. In April 2005, Senator Carl Levin (D-MI) sponsored a bipartisan bill (S.770) to amend and reauthorize the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990. The bill is also known as the National Aquatic Invasive Species Act (NAISA).

The NAISA defines 'invasive species' as species that, if introduced into an ecosystem, may cause harm to the economy, environment, human health, recreation, or public welfare. If passed, the NAISA will require the following:

- A screening process for importation of live aquatic organisms;
- Development of sampling protocols, geographic plans, and a budget to support nation-wide ecological surveys to rapidly detect recently-established aquatic invasive species in U.S. waters;
- Dissemination of collected information to federal, state, and local entities;
- Analysis of data collected under the national system of ecological surveys that will help detect and eradicate invasive species;
- Development and implementation of a grant program to fund research and development of environmentally sound, cost-effective technologies and methods to control and eradicate aquatic invasive species;
- Establishment of a grant program to fund researchers at universities and museums to carry out research in systematics and taxonomy.

The NAISA also authorizes interstate organizations that have a federal charter, for purposes of fisheries or natural resource management, to develop and implement regional aquatic invasive species management plans and rapid response activities. S.770 authorizes appropriations to carry out the proposed legislation through 2010. For more information, please visit the Library of Congress THOMAS website http://thomas.loc.gov/.

nes when colonizing new areas, but predators of the *Didemnum* sp. are not well documented. Researchers in New Zealand suggest that seastars, urchins, and chitons will prey on *Didemnum* sp. But in New England waters, crabs and fish that eat larvae of other species of sea squirts do not appear to eat *Didemnum* sp. Oddly enough, another invasive species may be a predator of these sea squirts. Reports from researchers in New Zealand suggest that the common periwinkle, *Littorina littorea*, preys upon *Didemnum* sp. In February 2004, USGS and WHOI researchers documented the common periwinkle preying on *Didemnum* sp. in New England waters. At that time of the year, the sea squirt colonies were relatively weak or dying, and may have been easy prey for the periwinkle. Scientists are continuing research to determine if predation by the common periwinkle occurs when *Didemnum* populations are more active and healthy.

### What Can You Do?

Invasive species always have the potential to disrupt ecosystems and alter local habitats and interactions, but determining what impacts and the magnitude of these impacts is difficult. For both lionfish and sea squirts, it is probably too late to eradicate these species. However, it may be possible to control the spread of these species into new areas. More research into the biology of these species will help us figure out the best way to limit their spread.

While scientists carry out more research, state and federal agencies and non-profit organizations need all the help they can get in carrying out on the ground eradication and restoration efforts. Check with your state natural resources agencies and local environmental groups to see how you can contribute. Many of these agencies and organizations have volunteer programs that help with to help eradication and control programs. Fishermen who pull up a lionfish or other known invasive species, can document the time and location to help scientists understand where the invasive species are living. In some cases, local researchers may ask you to keep the specimen if you have appropriate storage, but always check to find out what information is most useful to them. And remember, our best weapon against invasion is prevention.

**Sources:**


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Science News Online. "A Tiny marine alien is emerging as a coastal grinch." Janet Raloff. Dec. 24, 2005. V. 168, n. 26/27

# IN THE NEWS

## Data Node Established on East Coast

NOAA CoastWatch will establish a data collection node at NOAA's Chesapeake Bay Office in Annapolis, MD in June 2006. The node will collect data that will help to process oceanographic satellite data. The node will provide information to federal, state, and local marine scientists, coastal resource managers, and the general public from Maine to Florida. The node will measure parameters such as sea surface temperature, Chlorophyll-a, and ocean surface winds. Since CoastWatch is a member of the Integrated Ocean Observing System, the East Coast Node will operate in partnership with the Chesapeake Bay Observing System. For more information, contact Shawna.Karlson@noaa.gov. Source: NOAA FishNews.

## Gulf of Maine Species Count Reaches 3,317

The Gulf of Maine Program of the Census of Marine Life along with the Huntsman Marine Science Center of St. Andrews, New Brunswick, announced on January 5, 2006 that the first species count of known species in the Gulf of Maine reached 3,317 species. The number includes both year-round inhabitants and those that use the regional seasonally; 652 fish species, 184 birds, and 32 mammal species. Microscopic plants, including the algaes, were the numerical winner with over 733 different species. Researchers believe the census will significantly contribute to research on climate change and biodiversity, and will provide a baseline against which future censuses can be compared. It will also contribute to both the U.S. and Canadian efforts to shift to ecosystem management. The joint U.S.-Canadian effort is one part of the international Census of Marine Life effort to document the diversity, distribution, and abundance of marine life.

## Delaware Releases Guidebook on Natural Habitat Management of Open Spaces

The Delaware Coastal Programs released a new guidebook to help communities and landowners manage open space. The guidebook offers management options that emphasize natural components of landscapes that include meadow establishment, forestation, creation of streamside or pond buffers, and wildlife habitat. The guide outlines steps community leaders can take to organize their community to accomplish effective open spaces management. The guide also suggest ways to seek funding or technical assistance for restoration projects. Natural habitat management of open space is on of several Green Infrastructure Conservation programs of the Livable Delaware Initiative. The guidebook is free and available online at: http://www.dnrec.state.de.us/dnrec2000/Divisions/Soil/dcmp/.

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