Fact Sheet

U.S. Department of the Interior
National Park Service
Natural Resource Information Division

Freshwater Mussels

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Freshwater mussels (Phylum: Mollusca, Class: Bivalvia; also known as naiads or unionids) have a colorful history, a unique life cycle, and an important role as indicators of water quality. There are approximately 300 North American freshwater mussel species in the United States. The richest aggregations of mussel species in any watershed worldwide are in North America, and the most significant watersheds contain from 40 to 60 species. Most freshwater mussels are located in the eastern United States, including many of the national park areas. The diversity of unionids is greatest in three river basins in the midwestern and eastern United States. Unfortunately, recent surveys show that more than half of the mussel species in the United States are in need of protection. The American Fisheries Society considers 72 percent of these species to be extinct, endangered, threatened, or of special concern (Biggins *et al.* 1997). No other widespread group of animals in North America approaches this level of collapse. As a group, native mussels, particularly the unionids, (superfamily Unionacea) are the most rapidly declining animal group in the United States and constitute the largest group of federally listed endangered or threatened invertebrates (The Nature Conservancy 1996). Some species have been reduced to so few and such small populations that the remaining populations are highly vulnerable to extirpation or extinction from random events such as natural disasters or chemical spills (Biggins *et al.* 1997). In the absence of focused conservation, the extinction of the entire mussel fauna of North America in the next 200-300 years is a real possibility.

Background

General Biology

Mussels are relatively immobile organisms. They inhabit a variety of stable bottoms such as sand, gravel, cobble, boulders, or a combination of these materials. Different species of mussels require different types of substrate (Cummings and Mayer 1992).

Mussels are sedentary filter feeders that not only depend on a stable substrate for burrowing but require good water quality and quantity (flow) for feeding, breathing, and reproducing. They also require an intermediate host, usually a fish, to which the immature larvae attach to complete their life cycle.

Reproduction

Mussels reach sexual maturity when they are 6-12 years old. Most unionids are dioecious, that is, they have separate sexes. The males release sperm into the water and rely on local currents to carry it to the females. The females filter the sperm from the water to fertilize the eggs, which they carry in brood chambers of the gills. When the eggs mature, larval mussels (glochidia) are released into the water column by the inhalent siphon. Although shaped like adults with two valves, these microscopic glochidia have a different internal structure.

One of the most fascinating aspects of mussel biology is the use of a host fish. Incapable of surviving on their own, glochidia must attach themselves to a specific host organism (usually to the fins or gills of a fish). There they remain for varying periods of time before they metamorphose into juvenile mussels, drop off, settle on suitable substrate, and develop into mature adults. The immature mussels will not survive if the glochidia attach themselves to the wrong host or if the required host fish(es) is (are) not present. A species of mussel cannot be maintained where its glochidial host fish is absent. Mussel conservation must therefore include the conservation of the required host fish.

Several species of mussels have developed elaborate techniques to attract fish hosts, which aid in the dispersal of mature glochidia. For example, in some species, the female displays a modified mantle flap that looks like a bait minnow. Others release glochidia packets (conglutinants) of various shapes, sizes,

and colors, designed to attract host fishes. By taking the bait, the fish not only releases the glochidia but increases the chances of glochidial attachment of the glochidia to itself.

The host fish provides the larval mussels with a secure and stable environment for a few weeks until the larval mussels metamorphose, drop off, and function on their own as tiny bivalves. Fish host species also provide the important function of distributing mussel species upstream, downstream, or in both directions from the original location. This is particularly important in river systems where the current would carry the glochidia only downstream.

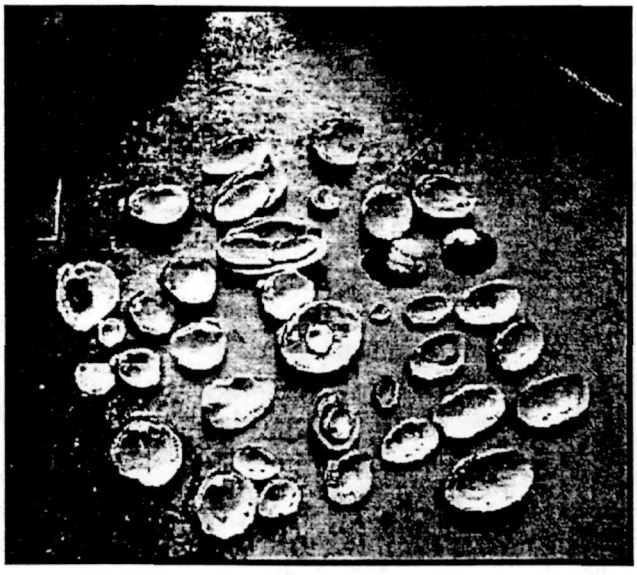
The required fish host species varies and often is very specific. For most mussel species, the required host fish species has not yet been identified. However, the screening of DNA markers is a promising new technique under development.

Reasons for the Decline

The decline of mussels is attributed to sedimentation; pollution, including point-discharge violations; stream-bank erosion and floodplain development; toxic spills; dam construction; dredge, fill, and other channel modifications; population isolation; poaching; and most recently the introduction of the exotic zebra mussel (*Dreissena polymorhpa*), which out-competes native mussels for food and habitat.

Ecological and Economic Benefits

Freshwater mussels provide significant ecological and economic benefits to the nation. Historically, Native Americans recognized the value of freshwater mussels as a food source and for the construction of tools, utensils, and jewelry. At the turn of the century, European settlers began harvesting several tons of freshwater mussels for the pearl button industry, which soon became a multi-million dollar industry (Mueller 1993). Overharvest and the availability of inexpensive plastics drove the pearl-button industry out of production in the 1940s. However, with names such as pigstoe, purple wartyback, heelsplitter, catspaw, and pistolgrip, freshwater



mussels have been of continued interest. By the mid 1960s, the Japanese cultured pearl industry began to expand. Today, thousands of mussels are legally harvested from North American rivers for this multi-million dollar enterprise. On the rise for the same purpose is the illegal harvest of the mussels.

Silent Sentinels

Ecologically, mussels are extremely important to freshwater ecosystems because they form a critical middle link in the food chain. Mussels continuously siphon water from their surroundings, filtering phytoplankton and other microscopic organisms for food that is then converted to tissue. In turn, mussels are fed upon by muskrats *(Ondatra zibethicus)*, raccoons (*Procyon lotor*), herons (Family Ardeidae), shorebirds (Order Charadriiformes), waterfowl (Order Anseriformes), and other aquatic and terrestrial animals.

Mussels are excellent biological indicators in part because of their key position in energy cycling. As a result of their filtering abilities, mussels help to maintain water quality by filtering contaminants, sediments, and nutrients from the water column. The abundance and distribution of mussels can reveal important facts about the overall health of freshwater ecosystems. Mollusks are ideal biomonitors (living organisms as sensors in water quality surveillance) because they are easily collected, sedentary, and long lived (30-80 years) and bioconcentrate or bioaccumulate contaminants (Muir et al. 1997). Because they are sensitive to toxic chemicals and other sources of water pollution, molllusks can serve as an early warning of water quality problems (Biggins *et al.* 1995). Additionally, the shells of mollusks can be analyzed to determine whether and when toxic chemicals were accumulated.

The presence and abundance of mussels or their absence in their historical range are a reflection of the water and habitat quality in an area. As such, mussels are an important ecological component of the nation's lakes and rivers and excellent indicators of water quality.

GLOSSARY

Bioaccumulation or bioconcentration The accumulation or concentration of a substance, like a contaminant, in tissues of living organisms.

Bivalve A mollusk such as a freshwater mussel with a shell that consists of two hinged valves.

Brood chambers The water tubes of the gill(s) where the fertilized eggs develop in the female. Depending on the species, either all four gills, only the outer gills, or specialized parts of the gills are used as brood chambers.

Conglutinants Packets of glochidia that females of several mussel species release. The various shapes, sizes, and colors of conglutinants attract host fishes.

Dioecious Having separate sexes (male and female) for sexual reproduction.

Gills Large sheet-like organs that play a dual role in respiration and feeding. The gills have a mucous lining and are covered by cilia (minute hairlike processes). The cilia help to circulate water and capture food particles. Ciliary tracts move the food to the palps, which surround the mouth. While they develop into glochidia, the fertilized eggs are also retained inside the gills of the female.

Glochidia Microscopic larval stage of the freshwater mussels. Shaped like the adult mussel with two valves but with a different internal structure. Two primariy types: Hookless glochidia that attach to the gill filaments of fishes and hooked glochidia that attach to the fins or scales of fishes. A third, less common type is axe-headed with a flaired valve margin.

Inhalent siphon. A tubular organ in mollusks for the intake of water, which provides oxygen and food particles, and for the intake of sperm. Mature glochidia are released through the inhalent siphon.

Juveniles Glochidia that metamorphosed. During this stage, they drop off their fish host and settle in suitable habitat. The length of metamorhposis is species specific and ranges from 6 to 160 days.

Diver with a square-meter grid for sampling mussel populations

Mantle A sheet of tissue that surrounds the mussel's body and lines the inner surface of the shell. It secretes the materials that form the shell.

Mantle flap Large, often colorful, fish-like structure on the mantle margin of species in the genus Lampsilis.

Metamorphose Changing into a different physical form.

Naiad Common name of freshwater mussels of the Superfamily Unionacea.

Palps Structures that surround the mouth. Food is sorted here. Suitable particles that are received from the gills are taken into the mouth and digested. Non-suitable food is rejected, falls on the mantle tissue, and is transported from the inhalent siphon.

Point discharge pollution Discharge of pollutants by one specific source.

Shell Hard outer covering of the mussel, composed of proteinaceous and crystalline calcium carbonate elements. During winter, growth slows or stops, and rings of darkened lines or ridges form on the outside of the shell. The lines or ridges can be counted to estimate the age of the mussel.

Unionidae One of the freshwater mussel families of the super family Unionacea.

Valve One of two opposing parts of the hard shell. Mussels and clams are bivalved.

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Higgins Pearlymussel (*Lampsilis higginsi*), a federally listed endangered mussel of the Upper Mississippi River System