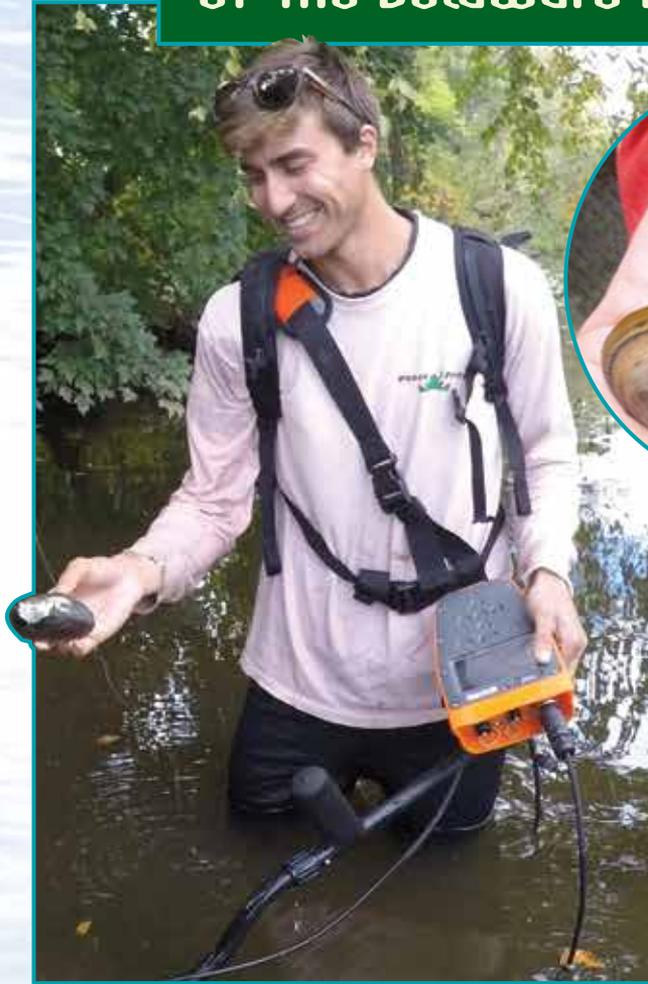


Freshwater Mussels of the Delaware Estuary



*Identification Guide &
Volunteer Survey Guidebook*



Connecting people, science, and nature
for a healthy Delaware River and Bay

MAP OF THE DELAWARE ESTUARY



The Delaware Estuary portion of the Delaware River Basin spans 134 miles from the head of tide at Trenton, NJ to the mouth of the Delaware Bay. An estuary is a tidal waterway where fresh and salt water mix.

Table of Contents

Introduction	2-3
Why Mussels Need Our Help	4
Freshwater Mussel Life Cycle	4-5
The Volunteer Mussel Survey Program	6-8
How to Survey Mussels	9-11
Mussel Identification	12-20
The IMPOSTERS!	21
Mussel Fun Facts	22
What You Can Do to Protect Mussels	23



You cannot tell a mussel by its color. These are all the same species!



Introduction

Walking along a stream in the Delaware Estuary, you could find some of the most at-risk animals in North America. At first glance, you may think you are looking at a rock on the creek bottom. But if you are lucky, you will actually be face-to-shell with a freshwater mussel.

Once plentiful in both numbers and species, freshwater mussels are now facing an uncertain future in our local streams and rivers. Approximately 12-14 native species once lived in streams that drain to the tidal Delaware River. But today only one freshwater mussel species is easily found in these waters, and they are not often found in large numbers. Most streams that were once home to giant beds of mussels now have none at all.

Why the decline? Polluted water, toxic spills, over-harvesting for bait, loss of forests along streams, loss of fish hosts needed for reproduction, and dams that block fish passage can all play a role in the loss of freshwater mussel species and populations.

Whatever the exact causes, streams without mussels are at a serious disadvantage. Mussel beds provide valuable “ecosystem services”, or natural benefits such

as strengthening streambeds by keeping soils in place and providing food and habitat needed by other animals and plants.

Most importantly, mussels are filter-feeders that “clean” the water in which they live by removing solids such as dirt, algae and other pollutants. They suck water in, trap the solids, and then release filtered water back into the environment. Each mussel filters several gallons of water every day. One mussel bed studied in Southeast PA was found to remove 26 metric tons (the weight of 5 or more elephants!) of solids from the water in a single summer season.



Both tanks of water were collected from the same stream. Several mussels were placed in the tank on the right. In less than 2 hours, the water in the tank with mussels is visibly clearer than the tank with no mussels.

Why Mussels Need Our Help

There are over 300 species of freshwater mussels native to North America — more mussel species than anywhere else in the world!

But freshwater mussels are the most at risk animal group in the US. About 75% are defined as species of “concern” by the state and federal governments, and many are listed as threatened or endangered.

Historically, over a dozen species of mussels were found in streams throughout the Delaware Estuary. However, recent studies show that only a few species remain in PA, NJ, and DE. Most notably amongst them is the Eastern Elliptio. Where mussels persist populations are typically patchy and below historically abundant levels.



Freshwater Mussel Life Cycle

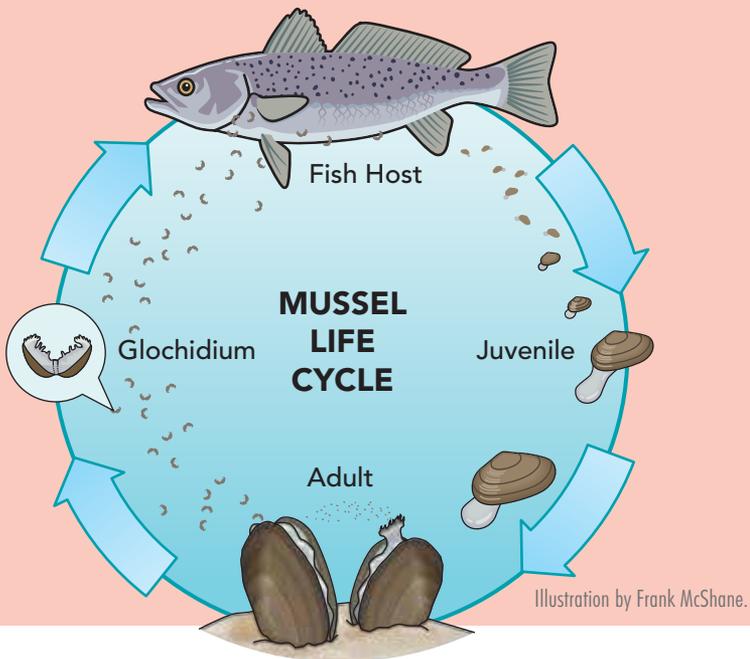
The life cycle of the freshwater mussel is far more interesting than you may think!

Sperm from male mussels are released into the water and then drawn in by female mussels. Fertilized eggs in females develop into larvae, called glochidia (“glo-kid-ee-ya”).

When a suitable fish comes along, the larvae are released, and sometimes spit at the fish by the mother mussel. Some of the tiny baby mussels clamp onto the gills or fins of the host fish, and hitch a ride for a week or so while they change (metamorphose) into juveniles that look like tiny adults. When ready, the baby mussels release from the fish host and sink to the stream bottom to begin their long lives in the streambed. Some mussel species can live for up to one hundred years.

Every species of mussel depends on a particular species of fish. Without the right fish hosts, baby mussels cannot survive. Anything that is harmful to fish can therefore have an impact on mussels.

You can learn more about the importance of mussels and local research at www.delawareestuary.org.



The Volunteer Mussel Survey Program

The Partnership for the Delaware Estuary (PDE) is working with watershed organizations and academic partners to return freshwater

mussels to streams that can support them. We need your help to identify streams that have mussels present, as well as those with no mussels at all, to determine where our efforts can be focused. With trained volunteers, many more stream miles can be examined in less time than it would take for PDE to cover alone.

Partners and volunteers can play an important role in helping scientists target locations and monitor the health of these extremely threatened animals. In some cases, scheduled training with PDE scientists and watershed professionals can be arranged before volunteers hit the streams to ensure a thorough understanding of methods for finding mussels, proper handling of live mussels, species identification, data reporting, and safety.

For more information on the PDE mussel survey volunteer training, or to report mussel survey results, please see www.delawareestuary.org/activities_volunteer_mussels.asp



Ready to Look for Freshwater Mussels?



Safety First!

Any activity that takes place in or near water should never be done alone. Participants should travel in groups of at least two or more people. At least one person should stay on land and keep track of all participants in the water. Children must be supervised at all times.

Never go into a stream that is flooded or moving rapidly due to rain or melting snow. Be aware that water currents can be powerful even in normal conditions. Stream bottoms can be unpredictable with deep pits and drop-offs. Do not go into the stream if you cannot swim.

Be aware of slippery stream and streambank conditions. Other hazards are poison ivy, briars, rocks, sharp objects such as broken glass, and deep mud. Be respectful of wildlife in the area, and do not trespass on private property. Avoid any water in conditions that seem unsafe.

IMPORTANT Volunteer surveying...we just want the data!

Scientists want information about the mussels you find, but you cannot harm or collect live animals. You should collect information only — descriptions and pictures — so that trained scientists can verify your discoveries. State and federal law protects many of the mussel species in the area, prohibiting harm to the animals or possession of their shells. Because some mussels you find may be endangered, please do not share their location with people who are not participating in the survey. PDE will share non-sensitive information with the public on our website.

Planning and Preparation:

Searching for mussels can be an enjoyable, wet or dry experience. Those who prefer to stay dry can walk along the edge of the stream and look for empty shells to identify.

In shallow water, tall boots or hip waders will keep you dry as you walk the stream in search of mussels. A bucket with a clear bottom or a clear plastic container can give you a good view of the streambed.

In or out of the water, mussel spotting is best in clear weather conditions with little or no breeze to disrupt the surface of the water. Keep the sun at your back. Polarized sunglasses and a hat can help reduce glare. The water should be clear and calm for optimal viewing and safety conditions.



Items useful for mussel surveying include:

1. This handbook
2. Printed data sheets from www.delawareestuary.org and/or a notebook for observations
3. Digital camera
4. Water shoes with closed toes, or wading boots to protect feet from sharp objects and shells in the stream
5. Rubber gloves to protect hands from sharp objects
6. Clear baking pan or plastic container, or bucket with clear bottom if available
7. Towels, dry shoes and dry clothing
8. First Aid Kit
9. Cell phone and emergency contact information, including location of the nearest emergency medical treatment facility
10. GPS if available



Remember: Tread softly
and handle minimally



How to Survey Mussels:

1. Download a data sheet from www.Delawareestuary.org/musselsurvey.
2. Choose a section of creek to survey. Do not trespass on private property. Always walk upstream (against the current), so cloudy water stays behind you.
3. **Fill out Section 1 of the data sheet.** This section is VERY important. If you have a GPS, record a beginning point.
4. Decide what type of search you will do:
 - Shoreline Search** — Most effective when water levels are low. Walk along the shoreline and look for shells that have washed up or were discarded by predators.
 - Wading Survey** — Use polarized sunglasses, or a clear bottomed bucket or plastic container in shallow waters. This method is better than shoreline surveys because you can find live animals more easily.
5. **Look for mussels:** If wading, zig-zag to cover the bottom of the area you are surveying. Mussels may be visible on the stream bottom, or slightly buried in the silt or sand. You may only see a black line, which is the gap between their shells. If you find a mussel, search the area to see if there are any others, since they tend to congregate.

6. When removing mussels from the streambed to identify and photograph, be gentle! When you are done, gently place the mussel back on top of the mud, it will bury itself back into the sand. **Fill out Section 2 of data sheet.**
7. If you have a GPS, record the location. Take 3 pictures of the mussel on a light background (such as the palm of your hand). Use a macro setting (flower icon) on your camera to capture the best detail. If you have an empty shell, photograph it inside and out. Record which pictures they are on the data sheet.
8. Return the mussel to the place you found it. Lay the mussel gently on its side so it can bury itself. If you lose track, place the mussel on top of sand or mud in slow moving water.
9. Record the number of empty shells and live mussels on your datasheet. For empty shells, note if the shell halves are still connected to each other.
10. When you stop surveying, **fill in Section 3 on the data sheet.** Describe the place that you stopped surveying, and if you have a GPS, record an end location and at least 2 pictures of the end site. Some smart phones have GPS capabilities. Estimate the length of stream you covered and the amount of time you spent.
11. Go over the data sheet and make sure you have filled in all possible information before leaving.
12. Upload information from the data sheet and pictures to www.delawareestuary.org or give it to your coordinating organization if applicable. **Be sure to submit data sheets for searches that did not turn up any mussels or shells.** This will help identify streams in need of mussel restoration.

**Remember: Tread softly
and handle minimally**





How Mussels Live in Streams

Some species of mussels can be found crawling across the stream bottom leaving tracks, but mussels are most often found partially buried. The posterior end (see page 12) of the mussel usually sticks above the mud or sand because this is how they feed and breathe. The hinge (area where the two shells attach) is often found below the surface of the stream bed.

How mussels "bury" themselves in the streambed:

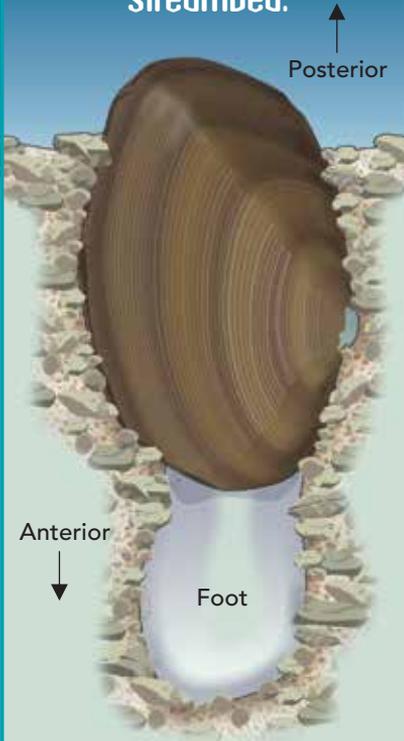


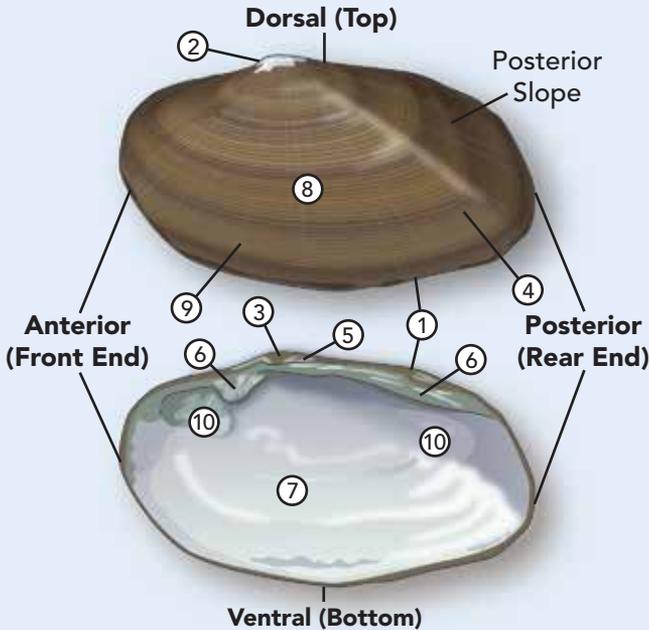
Illustration by Frank McShane.



Pictures of mussels in streams. They often look like rocks.

Mussel Identification

MUSSEL BODY FORM

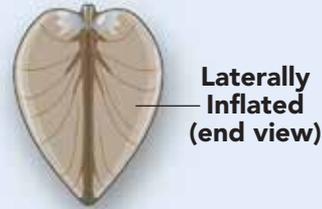
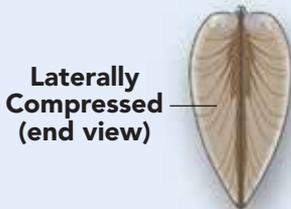
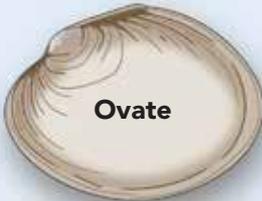


- 1. Valves** – The official name for the two sides of the mussel shell
- 2. Beak** – Raised and usually eroded area along the dorsal edge
- 3. Umbo** – Area where two shell valves meet
- 4. Growth Rings** – Lines on the outer shell showing periods of the mussel's growth
- 5. Hinge Ligament** – Area of connective tissue between the two shells
- 6. Hinge Teeth** – Shell projection that helps align valves together when closed
- 7. Nacre** – Smooth material on the inside of the shell
- 8. Periostracum** – Dark colored coating on the outside of the shell
- 9. Shell Rays** – Faint lines that radiate outward from the beak, perpendicular to the growth lines
- 10. Adductor Scars** – Scuffed area of inner shell where muscle attaches to shells

Mussel Identification

COMMON SHELL SHAPES

In searching for and identifying freshwater mussels, it is helpful to understand some technical words that scientists use for identification purposes.



LEFT VALVE VS. RIGHT VALVE

Beak Toward Right →

← Beak Toward Left



Mussel Identification

Every mussel is precious! As you gain experience and become better at spotting live mussels, avoid unnecessary handling, and watch your step—one species is nicknamed the “heelsplitter” for a good reason! Plus, scientists suspect that trampling by people kills many mussels.

Note that shell colors vary even within a species, and often get darker with age. It can be very difficult to accurately identify the mussels you find. In many cases, expert opinions are needed to determine an exact identification.

STATE CONSERVATION STATUS OF FRESHWATER MUSSEL SPECIES

		Common Name	Scientific Name	DE	NJ	PA
RARIETY STATUS:	Unknown Status	Alewife Floater	<i>Anodonta implicata</i>	■	■	■
		Brook Floater	<i>Alasmidonta varicosa</i>	■	■	■
	Common	Creepers	<i>Strophitus undulatus</i>	■	■	■
		Dwarf Wedgemussel	<i>Alasmidonta heterodon</i>	■	■	■
	Rare	Eastern Elliptio	<i>Elliptio complanata</i>	■	■	■
		Eastern Floater	<i>Pyganodon cataracta</i>	■	■	■
	Imperiled	Eastern Lampmussel	<i>Lampsilis radiata</i>	■	■	■
		Eastern Pearlshell	<i>Margaritafera margaritafera</i>	■	■	■
	Threatened/Endangered	Eastern Pondmussel	<i>Ligumia nasuta</i>	■	■	■
		Green Floater	<i>Lasmigona subviridis</i>	■	■	■
	Extinct	Tidewater Mucket	<i>Leptodea ochracea</i>	■	■	■
		Triangle Floater	<i>Alasmidonta undulata</i>	■	■	■
		Yellow Lampmussel	<i>Lampsilis cariosa</i>	■	■	■

Alewife Floater

Anodonta implicata



Size Up to 6 inches long

Shape Elongate

Exterior Color Variable; yellow, green, usually black or brown

Interior Color White sometimes with a pink or coppery color

Distinctive Features Long and round, like a cigar, thick shell at anterior end only

Habitat Silt, sand and gravel

Rarity Extremely rare in DE, was believed locally extinct in PA, but was recently discovered at many sites in NJ and PA

Brook Floater

Alasmidonta varicosa

Size	Up to 3 inches long
Shape	Subovate to subtrapezoidal
Exterior Color	Yellowish-green to olive/brown Usually has numerous green rays
Interior Color	White with often a coppery color
Distinctive Features	Numerous dark colored rays
Habitat	Coarse sand and gravel, moderate stream or river flow
Rarity	Extremely rare, endangered in DE & NJ, critically imperiled in PA



Creeper

Strophitus undulatus



Size	Up to 4 inches
Shape	Subovate to subtrapezoidal
Exterior Color	Brown to black with green possible
Interior Color	White or bluish white
Distinctive Features	Long and chubby like a cigar, often the shell will feel hairy when the mussel is alive and wet
Habitat	Sand and fine gravel
Rarity	Extremely rare in DE, rare in NJ

NOTE: The photos of mussels throughout this section are not life-size. Please refer to the size information provided for a more accurate reference.

Dwarf Wedgemussel

Alasmidonta heterodon

NATIONALLY
DON'T TOUCH!
ENDANGERED

Size Up to 2 inches

Shape Elongate to subtrapezoidal

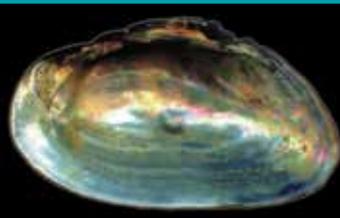
Exterior Color Yellow/brown, olive/brown or black/brown

Interior Color White or bluish white sometimes with yellow

Distinctive Features Wedge-shaped at posterior end

Habitat Mud, sand and gravel

Rarity Nationally endangered



Remember: Tread softly
and handle minimally

Eastern Elliptio

Elliptio complanata



Size Variable, up to 5 inches long

Shape Subtrapezoidal

Exterior Color Tan to dark brown or black

Interior Color Pearly pink sometimes purple with brown/gold/white

Distinctive Features This is our most abundance species within the estuary, this species can be found in all types of river bottom, but is referred to as a "bank climber"

Habitat Often fine silt or fine sands but can be found in clay, mud gravel or cobble

Rarity Most common

Eastern Floater

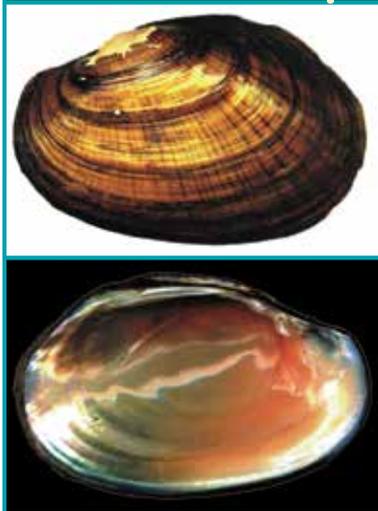
Pyganodon cataracta

Size	Up to 6 inches, rarely larger
Shape	Elongate to ovate, often chubby
Exterior Color	Yellowish-green to greenish brown in young. Dark brown/black in older and larger mussels
Interior Color	Bluish white
Distinctive Features	Very thin shelled and fragile, gently rounded shell
Habitat	Sand or mud in slower flowing water
Rarity	Uncommon in most areas, rare in PA



Eastern Lampmussel

Lampsilis radiata



Size	Up to 6 inches
Shape	Subovate to ovate
Exterior Color	Yellowish to brown or olive
Interior Color	White, possibly pink
Distinctive Features	Dark rays may be numerous and prominent
Habitat	Wide variety of substrate, but seems to prefer sand and gravel
Rarity	Endangered in DE, threatened in NJ, imperiled in PA

Eastern Pearlshell

Margaritifera margaritifera

Size	Up to 6 inches
Shape	Elongate
Exterior Color	Light brown to dark black
Interior Color	White
Distinctive Features	Banana shaped
Habitat	Firm sand, gravel or cobble, likes cold water
Rarity	Imperiled in PA, no data for DE or NJ



Eastern Pondmussel

Ligumia nasuta



Size	Up to 5 inches
Shape	Elongate and subtrapezoidal
Exterior Color	Dark olive green to brown
Interior Color	White to pink/purple
Distinctive Features	The posterior end (see page 12) is pointy or blunt
Habitat	Various substrates especially sand in slower flowing water
Rarity	Endangered in DE, threatened in NJ, imperiled in PA

Green Floater

Lasmigona subviridis

Size Up to 3 inches

Shape Subovate or subtrapezoidal

Exterior Color Yellow green to dark brown with numerous green rays

Interior Color White to blue

Distinctive Features Small, and very thin-shelled species

Habitat Fine gravel or sand in slower flowing waters

Rarity Endangered in NJ, imperiled in PA, likely extinct in DE



Tidewater Mucket

Leptodea ochracea

Size Up to 4 inches

Shape Ovate

Exterior Color Yellow-brown or olive

Interior Color Whitish pink to salmon

Distinctive Features Possibly lines or rays radiating from the hinge, often confused with Yellow Lampmussel

Habitat Various substrates including silt, sand, gravel, cobble, and clay

Rarity Endangered in DE, threatened in NJ, thought extinct in PA until recent discoveries

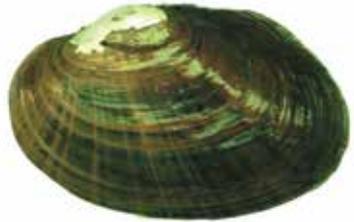


Triangle Floater

Remember: Tread softly
and handle minimally

Alasmidonta undulata

Size	Up to 3 inches
Shape	Subovate
Exterior Color	Yellow/green to green/brown or black
Interior Color	Light pink to blue/ pink
Distinctive Features	Shell is smooth and often shiny
Habitat	Most often in sand and gravel
Rarity	Threatened in NJ, rare in PA and believed extinct in DE



Yellow Lampmussel

Lampsilis cariosa



Size	Up to 5 inches
Shape	Ovate
Exterior Color	Yellow to yellow/brown
Interior Color	Blue, white, rarley pink
Distinctive Features	Possible rays radiating from hinge along dorsal margin, often confused with Tidewater Mucket
Habitat	Silt and sand, sometimes gravel and cobble
Rarity	Endangered in DE, threatened in NJ, rare in PA

The IMPOSTERS!

These are **NOT** mussels, they are non-native species of clams. It is helpful for us to know where these clams are. Please record data if you find these but don't spend time measuring them and take only one picture of them.

Asiatic Clam

Corbicula fluminea

Size	Fairly small, up to 1.5 inches usually dime size to thumbnail sized
Shape	Ovate, with possible point at the hinge
Exterior Color	Yellow, cream, tan, sometimes dark brown and black
Interior Color	White to shiny light purple
Distinctive Features	A non-native clam, large numbers of them are found in our waterways, shells are thick with distinct growth bands



Rangia Clam

Rangia cuneata

Size	Up to 4 inches long
Shape	Ovate
Exterior Color	Pale brown to cream
Interior Color	White with sometimes coppery tones
Distinctive Features	Thick shell sometimes used for road building and mistaken for marine clams, can tolerate slight salty water



Mussel Fun Facts:

- Native Americans used freshwater mussel shells to make tools and jewelry.
- Before the use of plastics, mussel shells were used to make buttons for clothing.
- Freshwater, or 'cultured' pearls, are harvested from oysters that have been seeded with small bits of freshwater mussel shell.
- Freshwater mussels are food for many other animals including fish, mammals and some birds.
- Mussels can live to be 100 years old.
- Since most mussels live a long time, they are easily affected by polluted water. This makes them good indicators of the health of a stream or river.
- Over 300 mussel species are native to North America, more species than anywhere else in the WORLD!



What You Can Do to Protect

Freshwater Mussels

Everything we do on land has an impact on clean water in our streams and rivers, and the living creatures that depend on them.

- Never use freshwater mussels as bait for fishing.
- Minimize or eliminate the use of chemicals, pesticides, and fertilizers in and around your home.
- Volunteer and support streamside restoration to plant trees, shrubs, and other plants. Healthy forests along streams stabilize banks, prevent erosion, and provide cooling shade for freshwater mussels during hot summer months.
- Support projects that restore in-stream habitats for fish and promote fish passage, such as dam removal.
- Never mow to the edge of a stream on your property.
- Do not allow farm animals to trample stream banks or the streambed.
- Keep structures, brush piles and other disturbances away from local waterways, and support protection of streamside buffers and wetlands.
- Remember – only rain should go down the storm drain! Dumping oil, trash and anything other than water in a storm drain will pollute local waterways.
- Help with volunteer mussel surveys (see page 6).
- Avoid trampling mussels when walking in streams.



Mussels come in all shapes and sizes!

Credits for photos for mussel guide:

L. Subviridis – Green Floater – ©AMNH-CBC / C. Snyder.

Brook Floater, Creeper, Dwarf Wedgemussel, Eastern Pearlshell, Triangle Floater, Eastern Lampmussel – Maine Department of Inland Fisheries and Wildlife. Permission given by Ralph Brissetta on March 20, 2012.

All other photos courtesy of PDE.



Partnership for the **DELAWARE ESTUARY**

The Partnership for the Delaware Estuary (PDE), through a multi-tiered approach, is working to rebuild mussel populations in the Delaware Estuary. With a goal to restore native species in their native waters, PDE aims to rebuild mussel beds and oyster reefs that will provide cleaner water for everyone.



Online Data Portal: <http://delawareestuary.org/mussel-survey-program>
and Scientific Studies: <http://delawareestuary.org/node/202>



Partnership for the
**DELAWARE
ESTUARY**

Partnership for the Delaware Estuary, Inc.
110 S. Poplar Street, Suite 202
Wilmington, DE 19801
1-800-445-4935
www.DelawareEstuary.org

The Partnership for the Delaware Estuary, a National Estuary Program, leads science-based and collaborative efforts to improve the tidal Delaware River and Bay, which spans Delaware, New Jersey, and Pennsylvania.



**Funding for this brochure was provided by the
U.S. EPA in support of the National Estuary Program**



The Geraldine R.
DODGE
FOUNDATION



**PHILADELPHIA
WATER**
EST. 1801

