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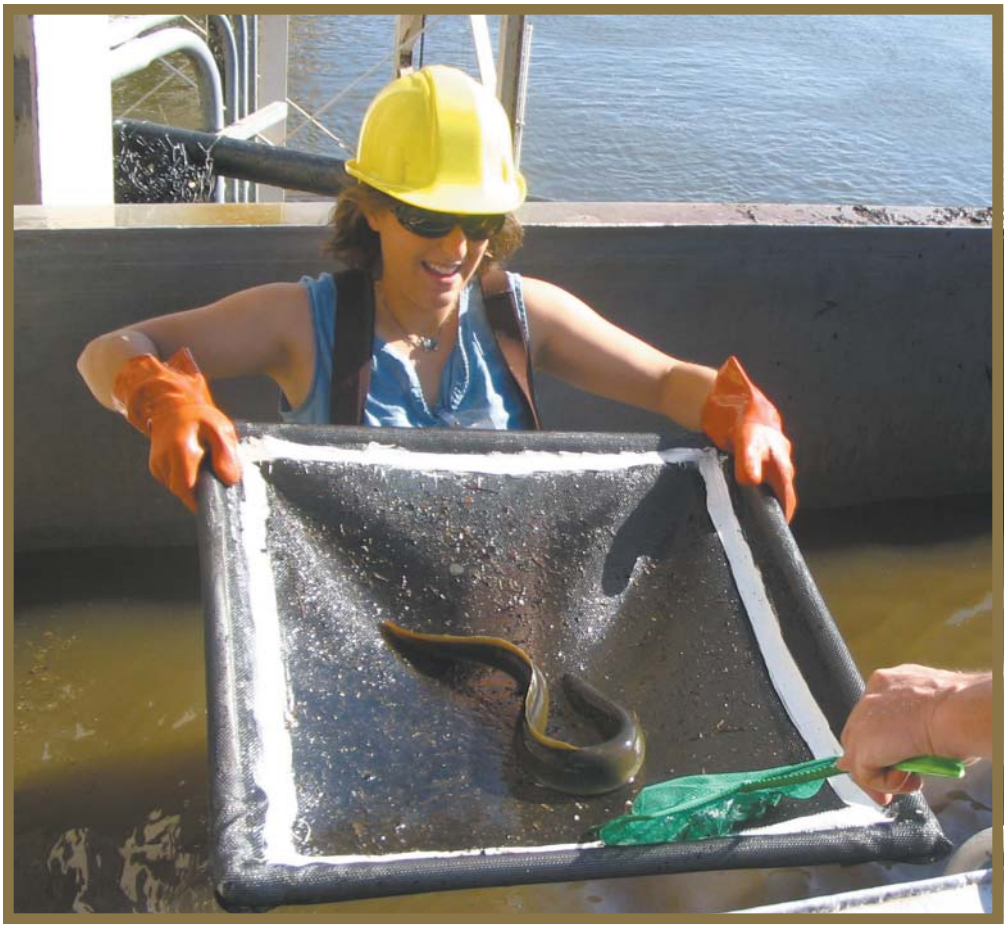

Chekka Lash of the U.S. Fish and Wildlife's Maryland Fisheries Resource Office holds up one the American eels captured in the fish lift at Conowingo Dam on the Susquehanna River. Photo by Kathleen Gaskell

Without a Passage, Eels' Future May Be Dammed

≈ Scientists hope to open way to upstream habitat for declining American eel population.

By Karl Blankenship

They had been on the move for more than a year, covering more than 1,000 miles since being hatched in the middle of the Atlantic Ocean. But for all their swimming ability, the eels, some as little as 4 inches long, just couldn't climb a 100-foot dam.

"Forty-three percent of the habitat in the Chesapeake Bay watershed is on the other side of this," said Steve Minkkinen, head of the U.S. Fish and Wildlife Service's Maryland Fisheries Office, motioning to Conowingo Dam that towered behind him. "And no eels are getting over this."

Minkkinen would like to change that. He and a team of biologists were collecting eel data at the base of the monolith that eventually may help to determine whether efforts should be made to give the eels a hand getting beyond the dam, which has closed all but 10 miles of the Susquehanna River to upstream migration since 1928.

That could include a program to capture, truck and release eels farther upstream. Or, it could mean constructing an "eelway" so the eels could slither past the dam on their own.

See "Demise of eel may have doomed Susquehanna mussels, hurt Bay" on page 3.

It's one of a growing number of projects aimed at getting eels upstream throughout the Bay watershed, which harbors the greatest density of eels along the East Coast.

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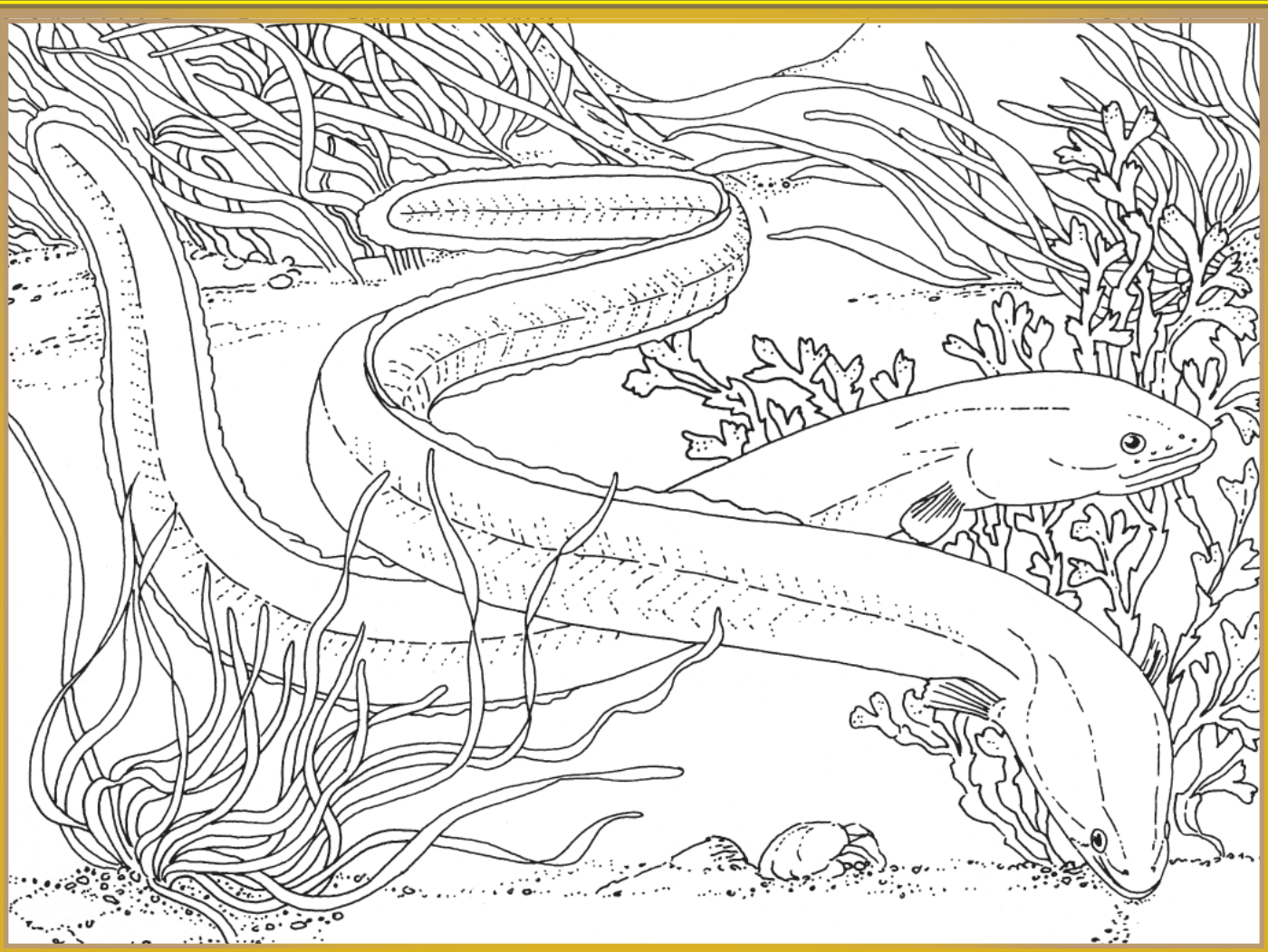

American Eel Life Cycle

American eels are found from the southern tip of Greenland to northeastern South America. They have a catadromous life cycle, spawning in the ocean, then migrating into fresh water, where they spend most of their lives. They are the only catadromous species in the Bay watershed.

Eggs are hatched in the Sargasso Sea and larvae are carried by the Gulf Stream until they are dispersed by currents toward various tributary systems. At around the edge of the continental shelf, the larvae metamorphose into miniature, transparent eels, known as glass eels.

Glass eels, which are 2–3 inches long, enter estuaries and rivers during the winter and spring. As they do, they develop pigmentation and transform into elvers, which are active during the night and burrow into mud during the day.

Some elvers remain in the brackish waters of estuaries, while others continue to migrate upstream. After two or three years, elvers develop additional pigmentation as they transform into yellow eels.

Yellow eels resemble adult eels and attain sizes of at least a foot for males and nearly twice that for females. They may continue to migrate upstream until reaching sexual maturity.

Maturation in the Bay region occurs between ages 6 and 16. Eels mature later—sometimes at 20 years or older—at the northern extent of their range, where they can reach sizes of 3 feet or more.

After they mature, eels begin their trek back to the Sargasso, making a final metamorphosis to become silver eels, which are fatter, have thicker skin and enlarged eyes. They migrate out of tributaries in late summer or early fall.

Eels are believed to spawn in late winter or early spring. A female can typically produce 500,000 to 4 million eggs.

Demise of eels may have doomed Susquehanna mussels, hurt Bay

≈ Fish is favored host of water-filtering shellfish's larvae.

By Karl Blankenship

When dams went up on the Susquehanna nearly a century ago, their impact may have reached far beyond the migratory fish whose movements were blocked.

Recent studies by the U.S. Geological Survey suggest the structures may have also affected the reproduction of a normally abundant species of freshwater mussels—often located far upstream of the dam. The loss of those mussels, and their water-filtering capability, might be affecting water quality both in the river, and the Bay.

"It has potentially enormous significance to the health of the Bay and the river system if this really turns out to be the way I think it is," said William Lellis, who heads the USGS Northern Appalachian Research Lab in Wellsboro, PA.

The developing story, if correct, suggests that when power companies built a series of large hydroelectric dams in the lower Susquehanna during the 1900s, they disrupted a delicate ecological linkage no one imagined at the time.

Biologists at the USGS lab, who research rare and endangered mussels, began examining the issue after they completed a large-scale, two-year survey of freshwater mussels in a 125-mile stretch of the upper Delaware River.

The survey showed that 98 percent of the mussels in the river consisted a single species: Elliptio complanata—not a huge surprise as it's the most common mussel in the Northeast.

But what intrigued the scientists was the scarcity of that species in the Susquehanna basin, where their lab is located. The Susquehanna, Lellis said, has "mile after mile of nothing when it comes to mussels."

Lellis has not completed as comprehensive a survey on the Susquehanna as he heas on the Delaware, but sampling to date shows that while Elliptio is present, it is nowhere near as abundant as in the Delaware. Further, the populations are old—with little evidence of juveniles being produced.

"Anecdotal evidence tells us that there were huge populations of mussels there," Lellis said. "Old timers tell us that all the time."

So he and his colleagues turned their attention to the laboratory. Mussels reproduction requires that their larvae attach as parasites to an intermediate "host" species before they transform into small mussels. Many mussels rely on a few specific host species for that life stage.

Elliptio complanata, is the most common mussel in the Northeast. Photo courtesy of USGS Northern Appalachian Research Lab

Elliptio broadcasts its larvae, called glochidia, into the water along a spiderweb like mucus. In the lab, the biologists found Elliptio glochidia attached to only a few species of fish, and only at relatively low numbers. Some of those, such as brook trout, lived only in restricted areas of the river—not the mainstem where the bulk of the mussel populations would be expected.

But the scientists found two species to which Elliptio attached in huge numbers—lake trout and American eel. Lake trout are not found in the Susquehanna.

American eel are native to the Susquehanna, but they were largely removed from the river when dams were built in the early 1900s.

As a result, Lellis hypothesizes that the lack of a large Elliptio population in the Susquehanna—and the apparent lack of reproduction—may stem from the closure of the river to eels.

Supporting evidence comes from surveys near the lab in Pine Creek, a tributary to the West Branch of the Susquehanna. "We have seven mussel species in Pine Creek, and we found evidence of reproduction in most of the species except Elliptio, which is even more compelling because the other species are much rarer," Lellis said.

Elliptio still persists because mussels can potentially live for more than a century. Also, although the Susquehanna was closed to eel migration with the completion of the Conowingo dam in 1928, eels remained in the rivers for years before dying out. In addition, the Pennsylvania Fish and Boat Commission conducted a stocking program in the 1970s and 1980s.

The mussel may also persist because they might use other, less effective hosts. But building the huge population seen in the Delaware may require large eel populations, Lellis said.

If the connection between eels and Elliptio is true, the impact goes beyond those species.

Lellis calculated the Delaware River had about 2 million mussels per mile, mainly Elliptio, and those mussels could filter 0.5–1 gallon of water per hour. That extrapolates to the potential of filtering between 2 billion and 4 billion gallons of water per day—or six times the average daily summer flow.

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The Elliptio complanata, in this photo are spawning.

Photo courtesy of USGS Northern Appalachian Research Lab

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"It shows to me that there is potentially enormous filtration capacity in a functioning healthy system," Lellis said.

If a larger mussel population once had a similar impact on the Susquehanna, their loss could have been a blow to both the river and the Bay. The mussels pull particles out of the water and—like oysters in the Bay—deposit material they don't consume as "psuedofeces" on the river bottom, where they remain.

That removes sediment and nutrients from the water. Bacteria quickly consume any nutrients associated with the psuedofeces so they don't flow downstream, Lellis said. "The amount of psuedofeces they produce is enormous," he said.

While Lellis has suggested an explanation for the mysterious demise of mussels in the Susquehanna, he cautioned that the case it not yet closed. "We have some intriguing pieces of information that could be put together to make a particular story," he said, "but an additional piece of the puzzle, or a rearrangement of the puzzle, could tell us a different story."

If the story holds up under more study, Lellis said it may be a reason to find a way to give eels a helping hand up the river. "If the upper Susquehanna has lost a significant freshwater population due to a human activity, then the ecological services that they once provided have also been lost, and that may have been huge," he said. "And the river, and ultimately the Bay, may be really suffering for it."

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In 2003, the first eelway in the watershed was completed by Allegheny Energy Supply at its Millville Dam, the first blockage on the Shenandoah River upstream of the Potomac. Since then, more than 6,000 eels have passed the structure, and this summer the company will open an eelway at the next dam, located 45 miles up the river at Warren.

In Maryland, the first eel passage was expected to go in this summer at the Unicorn Dam on a tributary to the Chester River.

Other eelways are being planned for the Patapsco River.

In all, plans to improve passage for eels is under way for about 10 dams in the Bay watershed, mostly in the Potomac watershed, said David Sutherland, a biologist with the USF&WS Chesapeake Bay Field Office who heads the Bay Program's Fish Passage Taskgroup.

"It's on everybody's radar screen," Sutherland said. "There's no question about that."

That's because the scientists believe the species, once so abundant it accounted for a quarter of the fish biomass in many freshwater streams, is in dire condition.

The Atlantic States Marine Fisheries Commission, which regulates migratory fish along the East Coast, completed an American eel stock assessment this year which stated that abundance had declined "dramatically" since the mid-1990s and the population was "at or near documented low levels."

"If this decline continues, there is a realistic possibility that the species cannot maintain a healthy and viable population throughout its historic range," the stock assessment report said.

In the Virginia Institute of Marine Science Trawl Survey, the average eel catch per tow was 4.16 between 1979 and 1997, but since then it has dropped sharply. In 2004, the average was 0.43 per tow—a tenfold drop.

Nowhere have eel numbers been in more of a free fall than at the Moses Saunders Dam on the St. Lawrence River, where the number using the eelway has declined from more than a million annually in the early 1980s to fewer than 4,000 a year since 1998.

Federal agencies, in a response to a petition, are reviewing whether the species should be protected under the

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Why Is The Eel Population Declining?

No one is certain exactly what has caused the recent drop in American eel populations. But scientists suggest a number of potential factors:

≈ Steady harvest pressure on eels even as populations declined. Because they spawn in the ocean–then die–all harvests take place before eels reproduce.

≈ Blockages to upstream habitats. Eels are hindered, or blocked altogether, from 84 percent of their historic habitats in Atlantic Coast tributaries.

≈ Downstream mortality at hydroelectric dams as adult eels migrate out of rivers during spawning migrations.

≈ Degradation of freshwater habitats.

≈ Contaminants may impact the reproductive success of eels. Eels have a high bioaccumulation rate and are long-lived, and can therefore build up high concentrations of chemical contaminants. Those pollutants also tend to accumulate in their reproductive organs.

≈ Changes in oceanic conditions. Changes in the strength of the Gulf Stream or in ocean temperature may influence larval drift and the migration of glass eels as they head toward tributaries. Because the population is a single spawning stock, it is particularly vulnerable to any drastic oceanic variation.

≈ Impact from parasites. A nonnative parasite has infected the swim bladders of many eels in the mid-Atlantic region. While not generally fatal, it could affect the swimming ability and survival rate of the eels.

– *Source: Atlantic States Marine Fisheries Commission*

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Endangered Species List. A decision is expected this summer.

No one knows why American eels have declined so rapidly. Multiple factors are suspected, but a contributing factor is thought to be habitat lost to dams and other barriers to migration. According to the stock assessment report, an estimated 84 percent of the eel's historic habitat along the Atlantic Coast has either been blocked altogether, or rendered partially inaccessible.

Recent research suggests that more than just the eel have suffered. Biologists with the U.S. Geological Survey suspect the lack of eels has also severely reduced populations of freshwater mussels in the Susquehanna River, potentially reducing their ability to filter the water and remove sediment and nutrients.

Unlike fish, eels can slither out of the water and climb over, or crawl around, small blockages, although that can be difficult and makes them vulnerable to predation. Large structures, such as Conowingo, are complete blockages.

Ironically, Minkkinen's crew was working just a few hundred yards from a $10 million fish elevator constructed at Conowingo in 1991. But it does eels no good at all. "The problem with all the passages on the East Coast," Minkkinen said, "is they were designed for alosids" such as shad and herring.

Shad migrate mostly during the day and follow strong flows upstream, often in the middle of the channel. Eels, by contrast, migrate mostly at night, and tend to move along the sides of the river where currents are slower. In the Susquehanna, surveys found no eels upstream of Conowingo.

Huge numbers of eels once moved up the Susquehanna. A survey in 1905 estimated that about 100,000 were harvested in Pennsylvania. In the recent surveys, no eels were found upstream of Conowingo Dam on the river. Photo by Kathleen Gaskell

> *"The problem with all the passages on the East Coast is they were designed for alosids (shad and herring)."*
>
> — Steve Minkkinen
> U.S. Fish & Wildlife Service

Huge numbers once moved up the river; a survey in 1905 estimated that about 100,000 were harvested in Pennsylvania. Little concrete information is available about how many eels may bump up against the dam nowadays, though.

That brought Minkkinen and his crew, for the second straight year, to the base of the dam where they collected eels captured in a huge fish trap built at the west side of the dam.

The eels were netted out of the trap, and placed in a bucket filled with water that Minkkinen had treated with a mild sedative so they could be measured by biologists—they truly are slippery as an eel. "It's impossible to handle them

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if you don't sedate them," Minkkinen noted.

After being measured, a small clip was made in the fin of each eel so if recaptured, it would not be double-counted in the survey. They were then released back at the base of the dam, to find habitat to live out their lives far short of their goals.

The day's count totaled 40, a figure that Minkkinen considered surprisingly high as it was still more than a week before the darkness of the new moon, which typically coincides with the peak of eel migration. All of last spring's sampling collected only 251 eels.

The survey is the first step in an effort to determine how many eels are coming up the river, exactly where along the river they migrate, and when their migration peaks.

Eventually, that information would be critical if serious efforts were made to reopen the territory beyond the dams to eels.

The good news, Minkkinen said, is that compared the multimillion effort to build mechanical fish elevators at the dams for shad, an eel passage would be far less costly. An eelway consists of little more than a ramp with a trickle of water sliding down. The eelway at the Millville Dam on the Shenandoah cost $75,000.

"I think we can entertain having passages for American eel for really low costs," Minkkinen said.

Getting the fish upstream would not necessarily solve their problems, though. Years in the future, when they are much larger, the eels would need to migrate out to spawn.

These elvers were captured in the fish trap at Conowingo Dam. Photo by Kathleen Gaskell

Stuart Welsh, of the U.S. Geological Survey's West Virginia Cooperative Fish and Wildlife Research Unit, has begun examining downstream migrations of eels at dams on the Potomac to determine when—and how—they move downstream. Factors such as light, water temperature and phases of the moon may all play a role.

At Millville, the dam owners cut power production at night during the fall migration season to allow for unfettered eel movements through the dam's power turbines.

As concern about eel populations grow, more utilities may be asked to do the same.

"If the hydroelectric industry could obtain information that suggested this window of downstream movement is narrower, they could reduce the amount of time they have to shut down their facilities," Welsh said.

Research on eels is critical. In its stock assessment, the ASMFC had called for efforts to gather new information. Although it concluded that populations had fallen sharply, the commission also said data was so poor it was difficult to make management recommendations.

But after centuries of neglect, Minkinnen said he is glad the eel is finally getting some attention.

"Because of their body shape, a lot of people have negative connotations about them—they associate them with snakes," he said. "Now we have an opportunity to help them out."