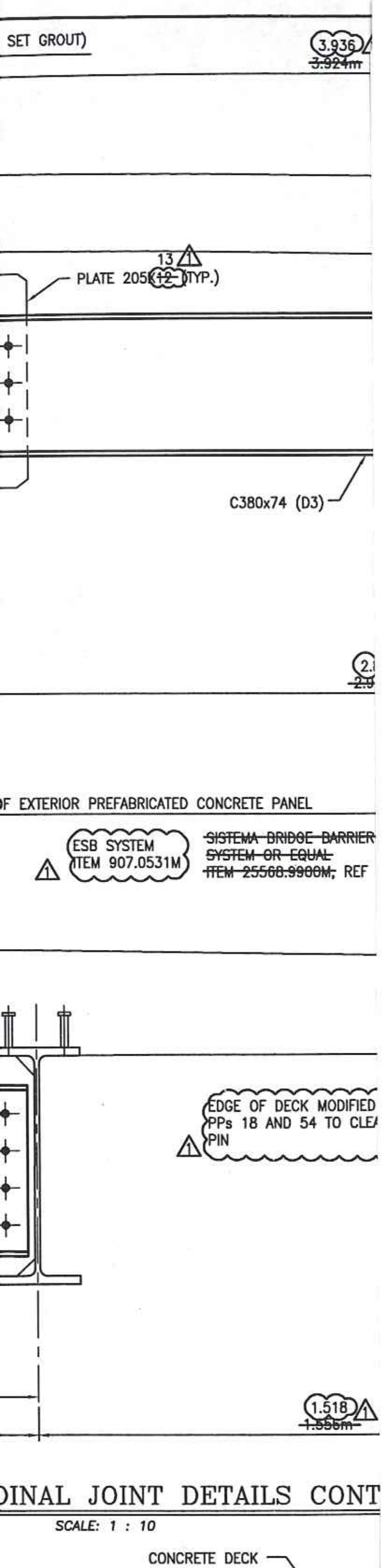


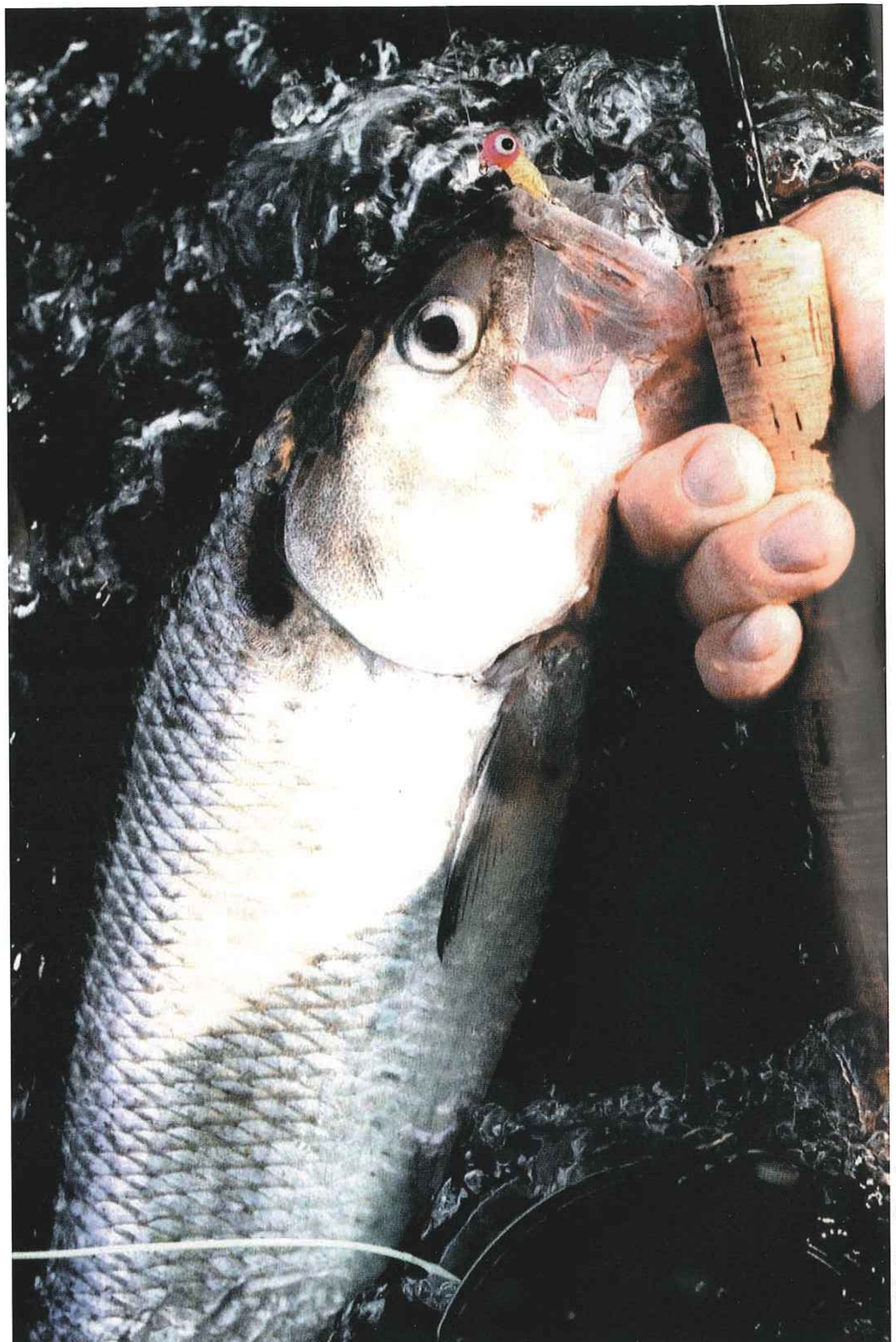


Photo © by Brian Wiprud

Match the Hatch for Shad

Do shad actually *eat* flies — or just react to them?

by Brian M. Wiprud

The title question does not have a definitive answer, but there is ample evidence and professional opinion to suggest that shad actually attempt to eat a fly or lure, rather than hitting at it defensively, or even out of some murky feeding instinct. If so, and the prey can be identified, fly fishermen should be able to effectively "match the hatch" and turn what is now potluck into something more akin to a science.

Boyd Kynard is a Fisheries Biologist at the Conte Anadromous Fish Research Center in Turners Falls, Massachusetts. An authority on shad migration, he leans toward the probability that shad are reacting to a feeding instinct.

"When adults enter the river in April-early May, there are few zooplankton. [It] would not be a good evolutionary strategy to delay migration and feed on these few zooplankton, but some shad could harbor an instinctive response to strike (attempt to feed) on a fast moving object. Based on the present information, a feeding response is most likely the root cause of the dart strike."

As to the premise of defensive or agonistic behavior, Boyd said, "No one has studied the behavioral interactions among individual shad. Do they have agonistic interactions to determine position in the school, etc.?...We don't know if they have an agonistic response toward anything." Much less a shad fly.

I contacted John Walter III of the Department of Fisheries Science, Virginia Institute of Marine Science, Gloucester Point, Virginia, and explored this issue. A marine biologist, he has studied shad feeding in the ocean, as well as shad migration.

"These questions bring up an unresolved issue of whether feeding during the spawning migration represents 'impulsive' or 'defensive' strikes rather than actual feeding behavior. Anadromous fishes — shads, salmonids, lampreys, etc. — have often been lumped into a single life history strategy called anadromy, and behavior patterns of one species have been wrongly attributed to other disparate species. Feeding behavior during the migration is a good example. Pacific salmonids and lampreys become non-trophic and lose the ability to digest food during the migration. These species also die after spawning. Atlantic salmon and shad do not lose the ability to feed and they may or may not die after spawning. The cessation of feeding during the migration is not irreversible and must be due to either a lack of suitable food due to a separation from oceanic food sources, a behavioral change either due to a focus on migrating or spawning, or a combination of the two."

But do shad actually recognize a fly or dart as something to eat, say, the same way a trout recognizes a mayfly, caddis or stonefly? John explained the shad marine diet.

Does Size Matter?

"American shad consume some fish but feed mainly on planktonic crustaceans such as copepods, mysid shrimp and euphausids (krill). The size of shad prey is generally much smaller than the size of the lures commonly used. Copepods are

Photo by Bill Byrne

Shad fishing on the Connecticut River is a rite of spring for thousands of sportsmen.

generally less than 1 mm. Mysid shrimp may be as large as 15 mm, slightly smaller than most shad darts. Shad spoons likely resemble small fish."

When one compares shad flies and darts with the copepods, mysids and krill, the resemblance is more than passing. For example, certain features like round heads, spare tails and pink coloration are strongly evocative of the copepod shape and reddish oil seen through their transparent carapace. The two-tone, cone-shaped darts resemble the shape of krill and mysid shrimp, and often match them in color since organic matter these animals ingest looks bright green or chartreuse through the carapace.

Could the shad's lack of parallax vision and thus inaccurate depth perception be a factor? A small object up close looks large, thus the shad may not be sensitive to the disparity in size.

John considered this idea. "Perhaps. But maybe actually the size of the shad lures are not that much different than other shad prey such as mysids, krill and sand shrimp that may reach 5-6 mm in length. So I think the disparity in size between copepods (prey that are probably consumed more in a filtering capacity) and shad darts may be explained by the fact that other prey commonly taken is larger. This larger prey most definitely would have to be attacked, as it could attempt to avoid the predator, thus the shad could not simply filter the water unless prey concentrations were extremely high. They are in some areas, but probably a shad has to spot and chase down the larger prey as it would a shad dart...Color may indeed play an important role in prey choice but it is very hard to say what exactly its role is. Either it can match a specific prey or it can serve to increase the visibility of the lure. I think that at different times both strategies may work."

John also pointed out that color would make less difference the deeper the fly is fished (it gets dark down there), but as the photos reveal, light at shallower depths would reveal color through the transparent body of the plankton. The bright fluorescent colors used in shad lures of all types open the possibility that shad might be attracted to plankton that phosphoresce.

"Shad prey may bioluminesce, especially oceanic euphausids and some copepods," John commented. "This may attract shad to feed on them, especially at night or in low light levels, though many other planktonic life forms that shad do not feed on also produce light. I think most crustaceans bioluminesce the color of fireflies. It would be very interesting to try night fishing for shad with small glow-in-the dark flies.'"

While a remote possibility, the freshwater prey of shad fry might also resonate with adult shad as food targets. Boyd Kynard identified the primary river food source as plankton called *Cladoceran bosmina*. They bear a resemblance to copedods, but without any tail. I asked John to expound on the coloration of these small crustaceans.

Color, Eyes and Current

"Most crustacean prey of shad have little bright coloration or are reddish to orange due to pigments and oil droplets in their body. It is likely that the shapes and perhaps colors of lures do match the natural prey. Shad probably think they are eating some krill-like crustacean," John added. "If indeed they do prefer the ones with eyes, perhaps it would be neat to try a shad dart with a single black dot on the top of the jig head, as copepods have only one eye. Mysid shrimp and krill have two eyes and are much closer to the size of the shad dart. The shape, color and action of the lure likely mimics some crustacean, ether copepods, mysids or krill. These prey species span a size range from less than a millimeter to larger than 5 cm, so they are well within the range of prey naturally consumed by shad."

The observation about eyes is one often noted by shad anglers. Large eyes, or any eyes at all, don't add to the attraction of a shad fly, and are not a usual component of the vast array of fly and dart patterns. Many contend that an eye actively detracts, but its been my personal experience that the small black dot suggested by John is preferable to none at all.

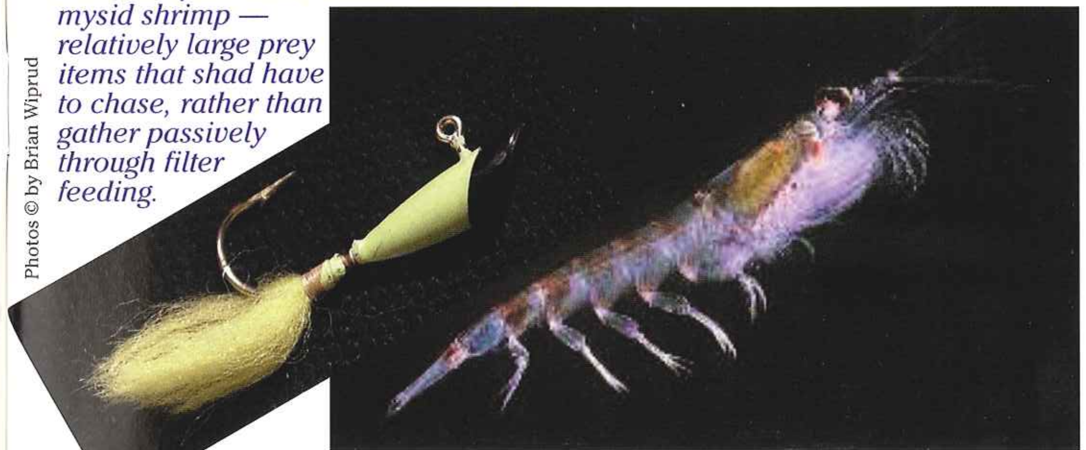
One of the most integral aspects of river fishing for shad is that they seem to strike a fly only at certain places in the flow, and almost always where there is some substantial current. I asked John whether turbity and current played a factor in how and where shad feed in the ocean.

"Turbidity likely has an effect upon feeding, but various studies conflict upon exactly how. Likely turbidity reduces the ability to particulate feed and makes filter feeding a more advantageous strategy. As to the relation of prey and currents in the ocean, oceanic currents and ocean circulation determine the distribution of water masses, nutrient availability and ultimately the zooplanktonic food of shad. If you look at a satellite sea surface map you can see great differences in the sea surface temperatures due to oceanic currents. Often it is where temperature breaks occur that large concentrations of oceanic life occur. It is likely that shad seek these temperature breaks and areas of upwelling due to higher concentrations of prey. Currents also carry along prey in rivers so, yes the association between shad and currents in rivers and in the ocean may be similar."

This leads us directly into the issue of temperature. Anglers know that shad are slow to hit below the 12°C/54°F, and effectively cease to hit once river temperatures exceed 24°C/75°F. I asked how this corresponds to shad feeding behavior in the ocean.

Cone-shaped shad darts resemble mysid shrimp — relatively large prey items that shad have to chase, rather than gather passively through filter feeding.

Photos © by Brian Wiprud



American Shad: A Fish Success Story

Shad Passed at Holyoke Dam

Year	Shad
1975	110,000
1976	350,000
1977	200,000
1978	140,000
1979	260,000
1980	380,000
1981	380,000
1982	290,000
1983	530,000
1984	500,000
1985	480,000
1986	350,000
1987	280,000
1988	290,000
1989	350,000
1990	360,000
1991	520,000
1992	720,000
1993	340,000
1994	181,000
1996	276,000
1997	299,000
1998	316,000
1999	194,000
2000	225,000
2001	273,000
2002	**376,000**
Average:	**327,143**

Unlike the Atlantic salmon which was driven to extinction in Massachusetts, the American shad was able to persist through colonization and the Industrial Revolution. The salmon needed to reach shallow, cold, gravel-bottomed streams in to order to dig nests and spawn, so when the mainstem of the Connecticut River was dammed at Turners Falls in 1798, the salmon disappeared shortly thereafter.

Shad, in contrast, spawn in open water in wide, slower reaches of rivers. Dams limited and/or eliminated access to this habitat as well, and on the Connecticut River, shad were eventually restricted to habitat below the Enfield Dam in Windsor Locks, CT. While this was only a fraction of their historical habitat (which extended to Bellows Falls, VT), it was enough for a small population to hang on until we began to build fishways and restore runs in the 1960s. The Enfield dam fell into disrepair and was breached by floodwaters in the 1970s, making the Holyoke dam the first upstream obstacle on the river. A fishlift was installed there in 1975, and since that time between 100,000 and 700,000 shad have passed upstream to spawn each spring (see table).

The number of shad passed upstream is variable for a number of reasons, the first of which is their life history. Shad spawn in the river in June. A female releases 100,000 to 500,000 eggs into the water to be fertilized by several males. Adult shad return to the ocean soon after spawning. The transparent fertilized eggs are carried downstream and the larvae hatch in 4 to 12 days. Juvenile shad spend their first summer in freshwater. By autumn, the young shad gather in schools and swim to the ocean. They will live in the ocean from three to six years, then return to freshwater to complete their life cycle.

The environment can affect this life history at any stage: a flood right after spawning may sweep many eggs out to sea before they can hatch, a summer drought can restrict feeding opportunities for the juveniles, and conditions in the ocean can affect survival to adulthood.

Another factor in the variable numbers of shad passing through the fish lift is our technology. The number of fish counted passing the Holyoke dam each spring is not directly proportional to the population of shad in the river. The fishlift can run only when the river flow is below 40,000 cfs, and when it is running, there is a maximum number of fish that can be physically lifted in a single day. When the water temperature gets too warm, the shad will quit swimming and spawn wherever they are. In a season with lots of rain and snow melt, the river flow will be high for a long time and the number of lift days will be reduced. This will result in a lower number of fish being lifted than in a season with moderate flows, when the lift can operate most of the time. In a normal year, we feel that we lift about half of the total CT River population of shad at the Holyoke facility. This is just right because we estimate that about half of the available spawning habitat lies upstream of Holyoke.

The future looks bright for shad on the Connecticut River. Thanks to new requirements in the federal hydroelectric license issued for the Holyoke dam, more water will be spilled over the dam during the passage season. This will help shad migrate up to the dam and into the fishlift. Further, the lift itself will be rebuilt to increase its capacity and allow it to operate at higher river flows.

— Caleb Slater
Anadromous Project Leader,
MDFW

"I captured feeding American shad in the ocean at bottom temps of 9.4-13.2°C. They are most frequently caught in the ocean at between 7°C and 13°C. Peaks of upstream migration are at 10-15°C. Temperatures are likely higher in the rivers than on oceanic feeding grounds."

Shad appear willing to take flies at higher temperatures in the river than they would normally in the ocean. Whether this difference is circumstantial or definitive is an open question.

Empty Stomachs?

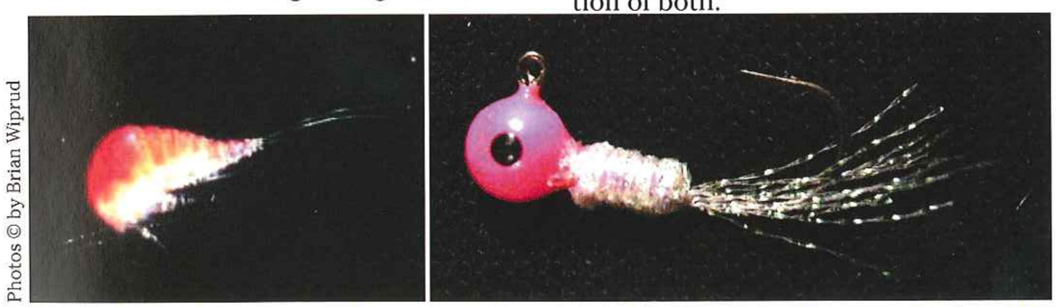
The deductive reasoning most often applied by anglers as to whether shad are willing to feed in the river is that shad stomachs and digestive tracks are almost always empty, although just last year I had an upriver shad defecate in the net. Dr. Jill Leonard, a postdoctoral researcher at the USDA/ARS Thad Cochran National Warmwater Aquaculture Center in Mississippi, has done some stomach sampling of shad along the East Coast, and had some interesting insights on shad feeding.

"I did some work in the Connecticut River taking shad apart and I also found some food in some shad stomachs. I never did much with the data, but I would say generally that they are certainly capable of eating (unlike some spawning salmonids that break down their digestive systems). They were generally less likely to have food in the gut the farther upstream that I sampled them (makes sense if it is ocean-based food) and most of what I found was only recognizable as either phytoplankton (green stuff) or zooplankton (brown stuff). I don't really know whether this food was from river feeding or from the ocean, although I would think that some of the fish had been in the river long enough to have emptied their guts of ocean food (that's a guess). Maybe both sources. I also found occasional other flotsam including fish scales and grass that could have been ingested accidentally or on purpose, but was almost certainly from the river (not ocean).

I will say that some fish I sampled near shore off New Jersey (in the ocean) also had food in the guts and it did not look a lot different from the fish in the river. I never analyzed it for type. Also, I spent a bit of time trying to get migratory adult shad (from the river) to survive in an artificial seawater system and I could get a few of them to start feeding again on brine shrimp."

John Walter noted, "What is interesting and more perplexing is that in the freshwater spawning areas I found an almost complete absence of food in the stomachs. Several explanations may account for this. It may be due to an absence of suitably-sized prey. Larger planktonic prey is far less abundant in freshwater rivers. Since shad will strike at lures during this time and will feed on insect hatches if they occur, it may be that the proper food does not exist for shad on the freshwater spawning areas. This fits into the theory of anadromy that one environment, the river, is beneficial for juveniles, and another, the ocean, is more beneficial for adults. Thus since one environment better serves the needs of different life history stages of the animal, it migrates.

The other explanation may be that shad willingly cease to feed on available prey either because their time and efforts are consumed by reproduction or for other reasons such as so as not to eat their young. Other fish cease to feed during spawning, so this is not an unlikely explanation. Probably it is a combination of both."



Photos © by Brian Wiprud

"Round heads, spare tails and pink coloration are strongly evocative of the copepod shape and reddish oil seen through their transparent carapace..."

Then there's the issue of shad as a school. It has been my experience that shad are unlikely to hit lures when they are in small bunches, but much more likely to do so when in large congregations. On occasion, I've put a side scanning sonar on a tripod and found that the shad hit well until the pods of fish thin as midday progresses. I asked John whether this feeding behavior mimics that of shad in the ocean.

"Shad captured in a trawl net often all have a single type of food, indicating that they have been feeding on a concentration of a single prey source. This indicates that they are likely feeding as a school. They can feed in one of two ways: either as filter feeders, passively straining food with the gill rakers, or as particulate feeders, actively snapping at larger, visible prey. In the ocean shad feed from the bottom to the surface, depending on the distribution of prey. They probably do not feed, as they have been observed to in rivers and as young, on insects above or immediately on the surface of the water because there are no 'hatches' of insects in the open ocean. Insects exist in the open ocean, but mostly as strays from terrestrial sources."

All of this begs the question of whether migrating shad actually benefit from eating, and whether those that eat even a little bit along the route have improved

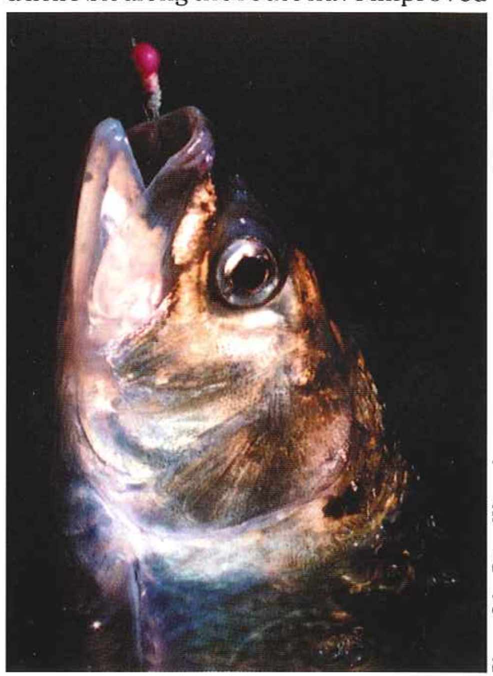


Photo © by Brian Wiprud

chances of survival and a return to the ocean.

"I think the most interesting question of shad feeding during the spawning migration is whether this represents true 'feeding' from which shad derive energy, or whether it is solely an instinctual response as it is in Pacific salmon. After following fish during the entire course of the spawning migration from the ocean to freshwater, I found that shad fed in the coastal ocean, and throughout the brackish estuary. Though the intensity of feeding did not appear as high as in the natural oceanic feeding environment, the feeding appeared directed and of a higher level than would be observed if they were just passively filtering water or instinctually reacting to prey. Unlike salmon, shad retain the ability digest and assimilate food during the anadromous migration, and I believe that this limited feeding may serve to mitigate the tremendous energy expenditures experienced during the spawning migration."

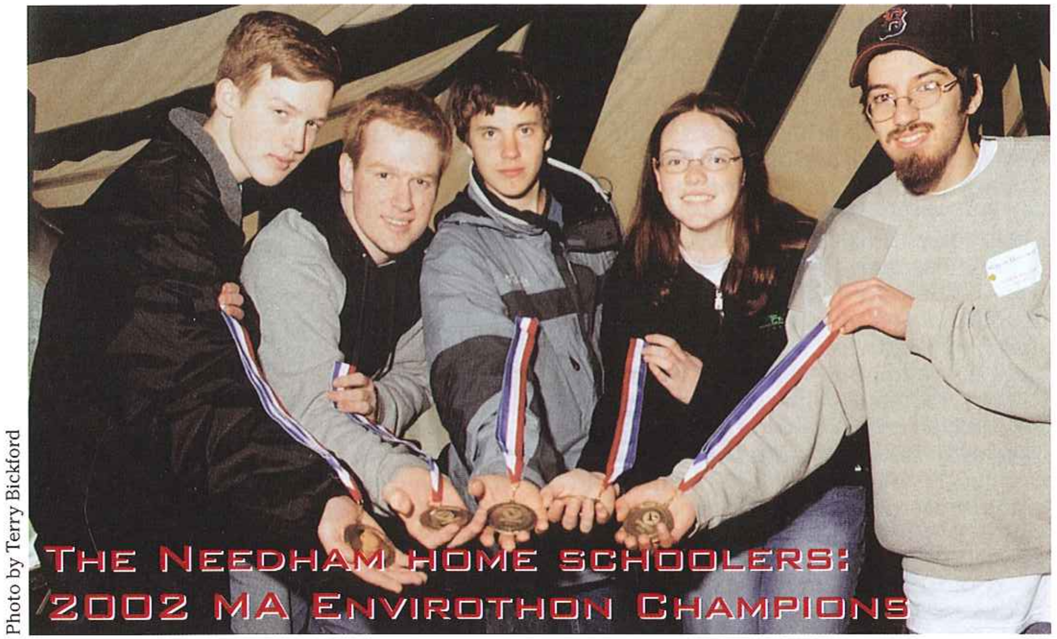
Much of this discussion, while based on field data and observation, is still just speculation. But there is enough evidence of all kinds to indicate that shad aren't an unsolvable puzzle, and that they may indeed be selective, targeted feeders, more like trout than Pacific Salmon. There's likely a reason shad don't like eyes, that the shad dart shape is effective, that big tails can be a turn off, and that certain colors work when others won't. Fly tyers in particular should consider making flies that are more prey specific to improve their catch and entice the all-too-common "fish that won't hit" into taking your fly. I have been tying prey specific flies so for several years, with mixed but generally positive results. Some flies — like the simple pink, round-headed Zsa Zsa — were devised in ignorance, but worked so effectively and often, and to the exclusion much else, that there had to be a reason. And as it turns out, the resemblance of the Zsa Zsa to a copepod is quite close. So there's room for experimentation and discovery in shad fishing. Take the initiative and try tying up some plankton patterns!

Brian M. Wiprud is a New York City angler, fly tyer and author of the novels ***Sleep with the Fishes*** *and* ***Pipsqueak****. Many of his past fishing articles and fly patterns are available on his website, www.wiprud.com.*

ENVIROTHON

by Michelle Robinson

The "Environmental Olympics" of Massachusetts offers rewards that benefit all of us.



THE NEEDHAM HOME SCHOOLERS: 2002 MA ENVIROTHON CHAMPIONS

Photo by Terry Bickford

The scene is a flurry of activity: groups of students scurrying from one tent to the next with looks of determination and excitement on their faces, anxious coaches following the action, harried officials consulting time sheets, cheerful guides herding and directing, austere judges reviewing instructions, loudspeakers blaring announcements. What's all the fuss about? Is this some sort of road race? No, it's an intellectual challenge, a battle of the minds. It's the Massachusetts Envirothon!

The Envirothon is North America's leading high school environmental education program, created to promote environmental awareness in today's youth. Its purpose is to "cultivate a desire to increase knowledge of the natural environment through competitive events, develop a greater appreciation for our dependence on the natural environment, provide students with experience in environmentally-orientated activities and problem solving, and lastly to promote a sense of personal stewardship of natural resources."

This superlative environmental program culminates in an annual event, where teams of students from across the state compete in five environmental fields. The winning team heads to the international Canon Envirothon and earns a chance to claim the international title. Over half a million high school students participate in the international event.

The Envirothon, originally coined as the "Environmental Olympics," was founded in 1986. Similar to the passion encountered in sporting events, the spirit of Envirothon competition stimulates students and sparks their desire to develop a better understanding of their natural environment. Since Massachusetts first became involved in 1987, each subsequent year has lured an increasing number of motivated, often brilliant students, and now over a thousand compete annually.