SPRING, 1989

News from..

Hudsonia

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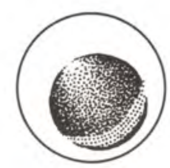
TRIBUTARIES

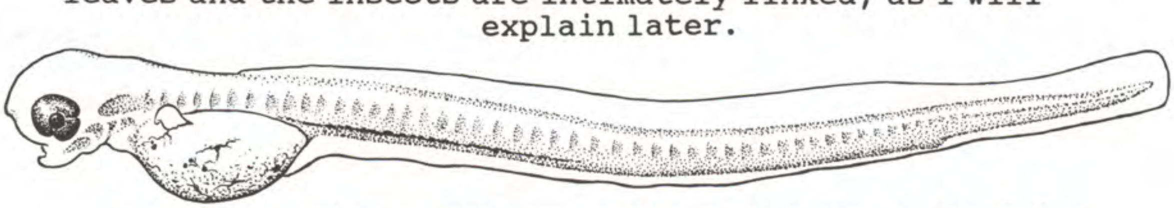
"You cannot step into the same river twice."

More than 2500 years ago, the philosopher Heraclitus offered these seemingly simple words, betraying a keen understanding of the dynamics of river systems. Rivers are always in flux, changing with time and space. Anyone who has ever lived near a river has noticed some of these changes, the rise and fall of its water level, the many ways in which clouds, sun, snow and rain affect its vistas, the seasons of its wildlife. On a less obvious level, rivers also undergo changes in animal and plant composition, nutrient levels, and many other chemical, physical, and hydrological factors. These are intricately linked in highly dynamic systems in which a change in one factor may influence many others. As our knowledge of rivers increases, the elegance of Heraclitus' statement delights us again and again.

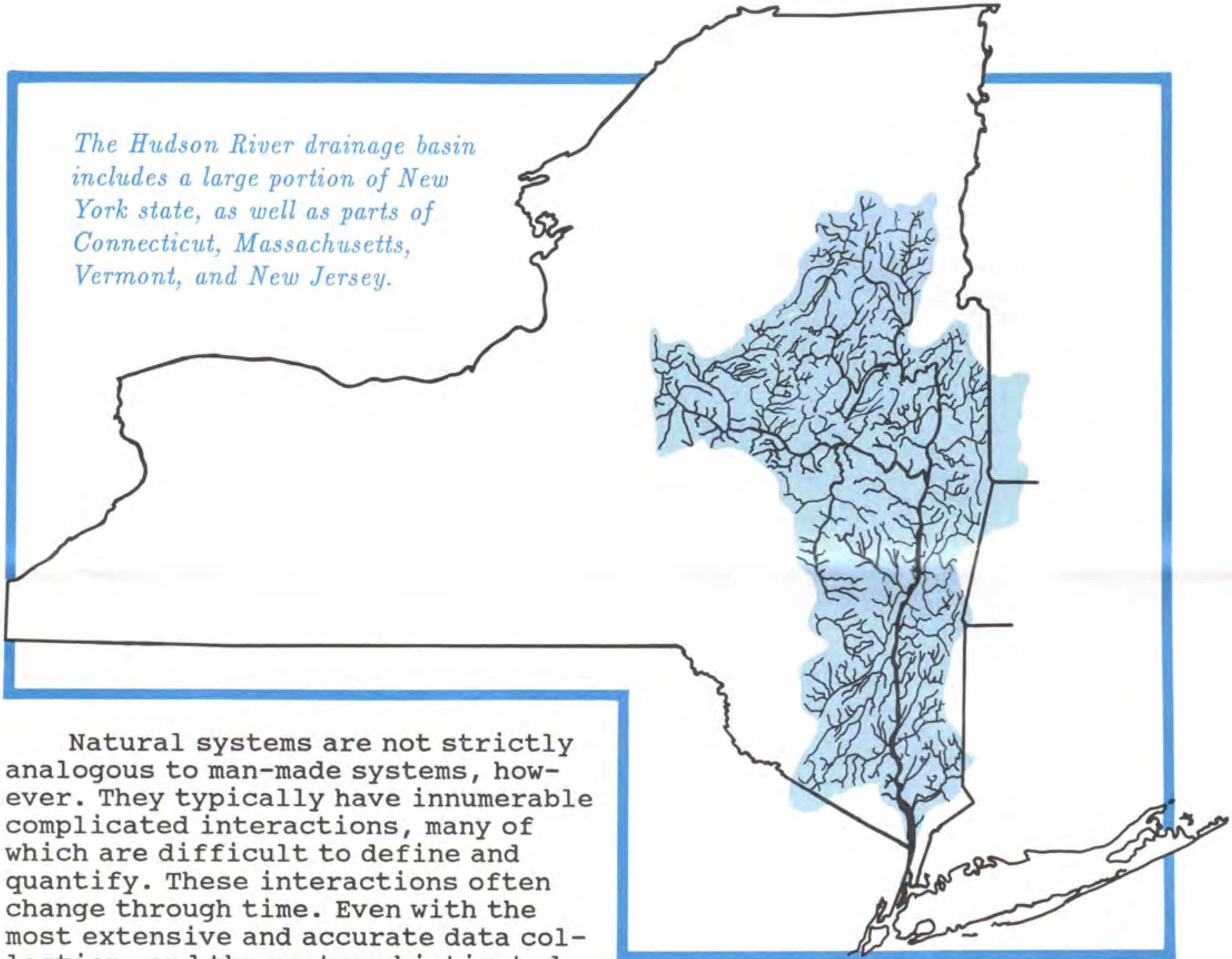


Rivers as Systems

Ecologists are finding it increasingly informative to take a "systems analysis" approach to studying rivers. This means viewing entire river systems, including their tributaries and surrounding terrestrial drainage basins, as complex assemblages of components. This approach was originally developed by engineers to describe complex mechanical and electrical systems. As applied to rivers it allows ecologists to break down the whole into manageable parts that can be meaningfully studied. For example, one person may study the role of dead leaves in tributaries while another studies the types of insects and other invertebrates found in the same streams. It soon becomes obvious that the leaves and the insects are intimately linked, as I will explain later.



Every spring, millions of fish eggs and larvae drift down to the Hudson.



The Hudson River drainage basin includes a large portion of New York state, as well as parts of Connecticut, Massachusetts, Vermont, and New Jersey.

Natural systems are not strictly analogous to man-made systems, however. They typically have innumerable complicated interactions, many of which are difficult to define and quantify. These interactions often change through time. Even with the most extensive and accurate data collection, and the most sophisticated models of river systems, we can often only crudely approximate what happens in the real world, and our knowledge has varying degrees of predictive value.

Heraclitus' Challenge

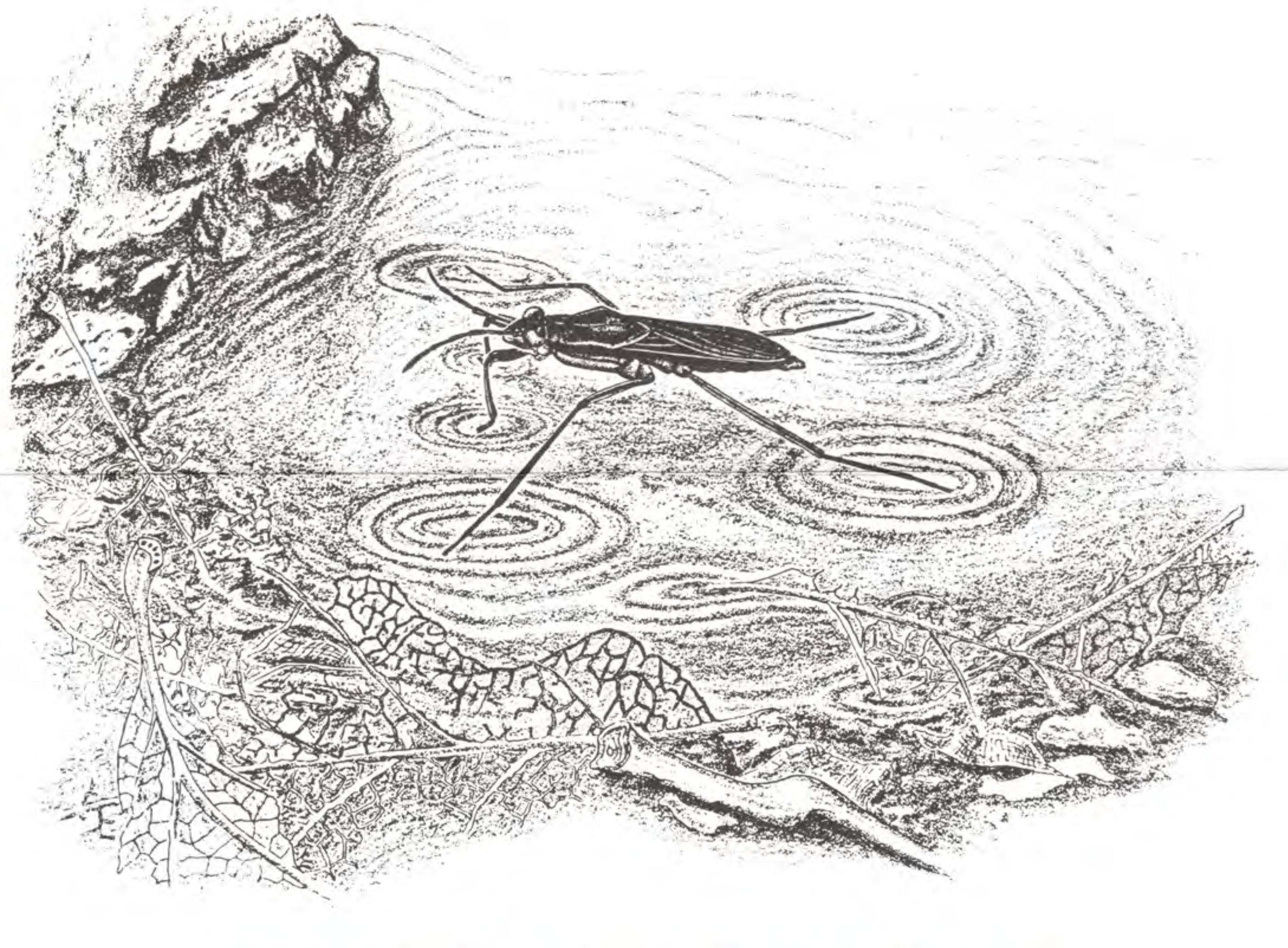
It is this very complexity that provides a constant challenge to Hudson River ecologists. In the BATH project (Baseline Assessment of Tributaries to the Hudson), Hudsonia scientists are studying three tributaries in the mid-Hudson area, Fishkill, Moodna, and Quassaic Creeks. To get a better idea of the nature of each of these streams, our workers sample and analyze various components, including temperature, water chemistry, diatoms, invertebrates, fish, shore vegetation, and surrounding geology. They take samples three times in a year at 8-12 stations in each creek. Shore vegetation and geology are less formally dealt with by walking or canoeing the entire length of the stream and consulting soil maps. Data are computerized in a way that allows streams to be numerically compared and contrasted both with one another and with themselves at any station or collection time during the year. Later on, we can add similar data from other tributaries to this data bank and we will eventually have a much more comprehensive view of the Hudson River Basin.

Analyses like these allow scientists to recognize and assess changes in streams due to man-made influences or other factors. To some degree, they can predict the effects of common land-use practices that impinge upon rivers and advise how to mitigate them. For example, great quantities of aluminum floc were being dumped into Crum Elbow Creek on the east side of the Hudson. This was the result of a drinking water treatment process. Many people were concerned that it could be quite harmful to downstream areas and that extensive and costly rehabilitation of the stream might eventually be necessary. However, a Hudsonia study showed that two characteristics of Crum Elbow Creek worked to its advantage. First, the creek has a steep gradient, so the floc washes out relatively quickly, especially during the spring floods. Second, the pH of the water is about neutral and it is well-buffered (the acidity or alkalinity does not change easily). Thus the aluminum does not readily form compounds toxic to animals and plants the way it would if the waters were more acidic. So in this case, once the dumping stops, little will need to be done to reclaim the creek.

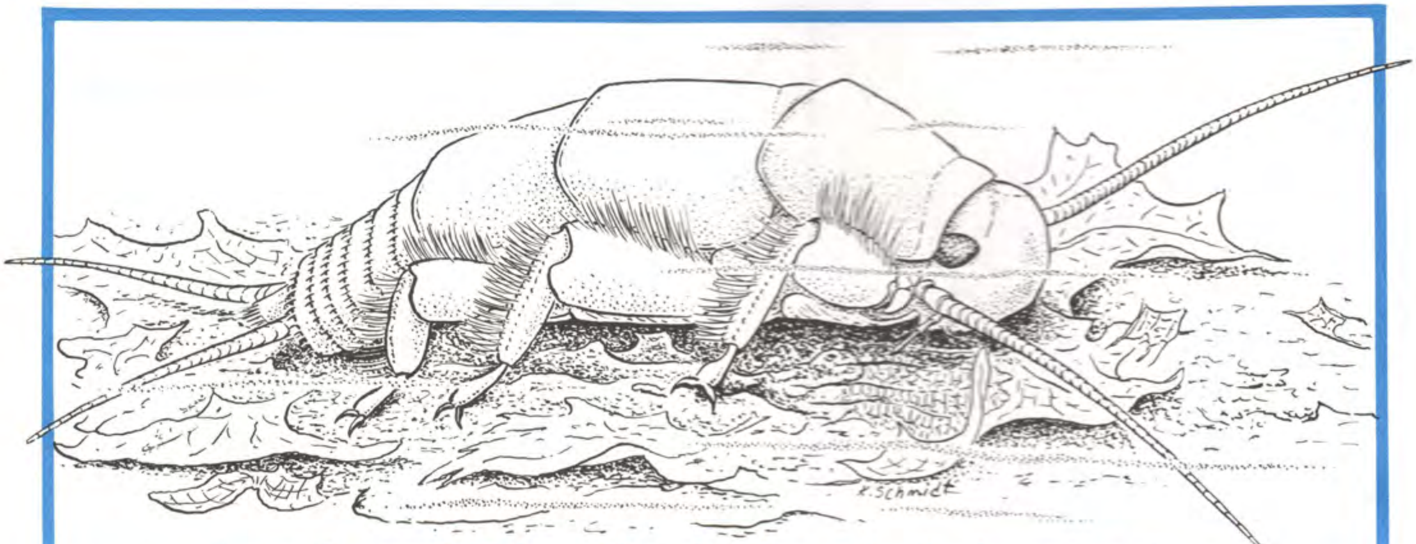
Tributaries Contribute

This brings up another important function of tributaries. Each tributary is affected by the nature of its drainage area and literally carries the influence of that drainage area into the Hudson River. If the aluminum floc washes out of Crum Elbow Creek, where will it go? Right into the Hudson. Heavy metals and other chemicals from manufacturing and dumps, run-off of fertilizers and pesticides from agriculture and lawns, sewage, and silt from poorly managed construction sites may all ultimately end up in the Hudson.

While most people are familiar with these sources of pollution, we are often less aware of the more natural and beneficial ways that tributaries influence the Hudson. Each



A water strider glides on the surface film in a small backwater.



A stonefly nymph (Peltoperlidae) shredding and eating leaves in a stream.

tributary adds its own special brew of minerals and nutrients to the main river. The unique character of the water of each tributary is determined by the physical features of its drainage basin and the type of rocks and soil in its terrain. These, in turn, are partially responsible for the types of animals and plants found in and around any given stream.

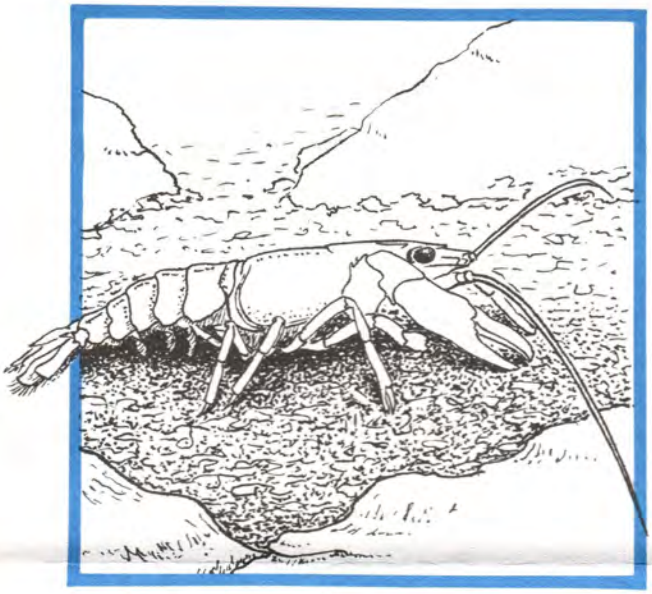
Tributaries are also the source of much of the productivity of the Hudson, supplying nutrients that nourish plants and eventually other organisms in the food web. This happens in various ways. Algae reproducing in tributaries are washed into the river. Also, and perhaps most importantly, "detritus" falls into the stream. Detritus includes leaves, insects, and all organic (carbon-containing) matter that can be broken down into food by bacteria and animals. A tremendous amount - up to 99 percent - of the energy input into a stream can come from leaves and other detritus.

People seldom think about leaves floating downstream as such an important energy source for the river. How does a leaf turn into food, or energy? After it falls into a stream, it is colonized by bacteria. Next, it is shredded by certain invertebrates, stoneflies and craneflies among them, and isopods. Each leaf-feeding animal has its favorite leaves, and the animals found in a stream will be determined in part by the types of leaves available. These animals are nourished by both the bacteria and the leaf itself. Others, such as mayflies, freshwater limpets, and snails, graze on algae. These shredders and grazers in turn will feed the fish, wildlife, and even humans that consume food from the stream. Some portion of the productivity resulting from leaves and algal growth will be transported downstream to the main Hudson, often in strange ways.

Gently Down the Stream

A curious phenomenon begins shortly after dusk each night, that of insect drift. Insects that would normally hold fast to the substrate during the day gently let go and float downstream. No one really understands why this happens. In streams containing fish, it usually occurs in the couple of hours following dark and then slows down. In fishless streams, it seems to occur all the time. Although many of the insects are snatched up by fish, many more eventually end up in the Hudson River.

Fish eggs and newly hatched fish larvae also drift downstream. A team of Hudsonia scientists sampled



A crayfish

16 tributaries for fish eggs and larvae in the spring of 1988. These were caught after dark in fine nets. Some 23 species were caught this way, the most common being alewives, white perch, and white suckers. In one incredible 20 minute sample in Crum Elbow Creek, 30,000 alewife eggs were caught in three nets! This, of course, was only a fraction of the number actually drifting down the stream at the time because the nets did not cover the whole width and depth of the stream.

The Tragedy of the Commons

Because tributary waters, with all their bounty and curses, are relentlessly swept into the river, the Hudson can be thought of as the sum of its tributaries. Every land use decision has an effect downstream, even though it may only result in an imperceptible change in water quality. In the past, many insults to rivers have been the result of ignorance or of narrow self-interest. Because of the nature of rivers, the people responsible for poor management practices rarely had to live with the consequences. Many are catching up with us now, and are threatening our drinking water, fisheries, flood control, agriculture, and our recreational waters. Garrett Hardin wrote about this type of problem in 1978, in a paper entitled "The Tragedy of the Commons". He described a scenario in which many herdsmen graze their cattle on a common pasture. For years, the number of cattle does not exceed the capacity of the land to support them. Then one herdsman determines that it would be advantageous to add another animal to his flock, thereby increasing his wealth. This does not affect the commons much, until other herdsmen do the same. Soon the commons are overgrazed, and the cattle begin to die. The herdsmen realize too late that they have brought tragedy upon their entire tribe by the cumulative effect of many small decisions.

Can We Do Better?

Few societies have the knowledge, the wealth, the motivation and the wisdom to overcome problems like these. In the Hudson Valley at this time there are many people and organizations passionately interested in revitalizing the river and managing it well, so that all may benefit. Creative and cooperative solutions to problems caused by necessary and common land use practices are not unheard of and are not always prohibitively expensive. For example, along rural streams, the trampling of shore vegetation by livestock is a frequent cause of bank erosion and then siltation and warming of streams. This is usually followed by the loss of species downstream. Several farmers along the Little Hoosic River in Rensselaer County allowed a 150 foot strip of marginal pastureland to be used as a buffer zone. Trout Unlimited erected fences along the banks and planted willows. Additional funds for the project were provided by regional and local conservation organizations. Through this innovative approach, the stream is now regaining its health.

Planners divide streams into three categories for management purposes: rural, suburban, and urban. These take into account historical use, present need, and the specific character of each stream. They determine the best uses to which a stream can be put and try to balance the often conflicting needs of the surrounding population. Planners are then able to recommend "Best Management Practices" for a particular tributary. Implementation of these plans requires cooperation between government agencies, businesses, homeowners, and towns. The shining example of what can be done in an urban setting is the River Walk in San Antonio, Texas. Forty years in the planning and execution, it is now a national attraction that is an economic boon to the city, featuring stores, boat rides, recreation, pleasing architecture and historical preservation, and at the same time serves a flood control function.

With the 1988-1989 drought, many people are realizing how dependent we are upon the Hudson. Now more communities are faced with the prospect of drinking the river water this summer. Before, it was easy to think that certain aspects of the river were dispensable. Did we really need a sturgeon fishery? So what if a few people can't swim in the Hudson! But now it is obvious that what is healthy for the sturgeon and the swimmers is really necessary for all of us in the long run. By respecting the creeks that flow through our backyards, we can help avoid a tragedy of the big commons, the Hudson River estuary.

Acknowledgements

We thank the following organizations for supporting our stream research: The Hudson River Improvement Fund, The Hudson River Fishermen's Association, and The Hyde Park Fire and Water District. This article was written by Kathleen A. Schmidt, with help from Jay Shiro Tashiro, Erik Kiviat, and Robert E. Schmidt; drawings, design, and formatting by Kathleen A. Schmidt; produced by Kathy Anne Schmidt.

Our Thanks to the Following Sponsors:

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