Invertebrate Drift in Streams

Anglers have long known that many stream fish feed extensively on animals drifting downstream on the surface or in the water column above the stream bottom. Most invertebrates (primarily immature stages of aquatic insects) that live on or in the bottom of streams and rivers can be found, at least occasionally, in the water column as they are transported downstream by the current. Drift is the term used both to describe these animals while they are in the water column and to refer to the process of being transported downstream. Despite the apparent importance of drift as a source of food for fish, little research had been done until about thirty years ago when two discoveries stimulated interest. First, most animals drift with a distinct periodicity. As a result, the number of animals in the drift is much greater at night than during the day. Second, the number of animals drifting past a given point during a 24-hour period can be appreciable, often greater than the number on the stream bottom immediately upstream of the sampling point. These observations raised several questions: Why do many species drift with diel (day-night) periodicities? How do animals enter the drift? Are they passively washed off rocks by current or do they actively launch themselves into the water column? Why do animals drift? What is the importance of drift in the population ecologies of animals that drift and of fish that consume drifting animals?

Fish are effective consumers of drifting invertebrates during the day but less so at night. Consequently, researchers have speculated that nocturnal drift evolved in many species to minimize the risk of being eaten by drift-feeding fish. Two lines of evidence support this hypothesis. First, small invertebrate species and small size classes of larger species tend to be less preferred prey of fish and often exhibit aperiodic drift. More convincing is the observation that strong periodicities are rare in fishless streams; however, invertebrates that exhibit no periodicity in fishless streams show strongly nocturnal drift in streams where drift-feeding fish are present.

Research on the evolution of diel drift periodicities does not answer the question of why animals drift, which is strongly tied to the question of how animals enter the drift. Although both passive and active entry likely occur, recent research supports the hypothesis that drift-entry is predominantly active and that this behavior is often associated with searching for food. Research is underway to determine if and how food abundance and body size interact to affect the probability that an individual will enter the drift.

Animals rarely drift when food is readily available, but the probability of drifting increases exponentially with decreasing food abundance. Relationships such as these are being incorporated in simple colonization models to predict how animal densities on bottom substrates should change and equilibrate with changes in the surrounding environment and on the substrates. The models are tested in the field using time-lapse video cameras with infrared light sources (because insects, like humans, cannot see infrared light) so that animal behavior can be monitored during the day and night.

How interactions with other members of the stream community (e.g., competitors, predators) influence drifting is also being addressed. Competitors have been found to have a marked influence on drift, largely by affecting the availability of food for other individuals. By influencing drift rate, competitors can potentially affect food availability for drift-feeding fish and, consequently, the population dynamics of the animals with which they compete. Documenting the importance of these interactions in the structure of stream communities remains a major challenge to stream ecologists and requires continued modelling and experimentation.

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Environmental Management of the Upper Mississippi River

In October 1986 Congress approved the Master Plan for the Management of the Upper Mississippi River System, which includes the Illinois River and the navigable portions of the Kaskaskia. The Plan is the first in the nation to address conflicting federal mandates for large interstate rivers and to redress habitat degradation caused by alterations within the rivers and their drainage basins.

Programs based on this model are now proposed for the Missouri and Ohio rivers.

As stipulated in Public Law 99-662, The Secretary [of the Army], in consultation with the Secretary of the Interior and the states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin, is authorized to undertake ... (A) a program for the planning, construction, and evaluation of measures for fish and wildlife habitat rehabilitation and enhancement; (B) implementation of a long-term resource monitoring program; and (C) implementation of a computer inventory and analysis system.
The Plan grew out of a deadlock between navigation interests and the U.S. Army Corps of Engineers on one side and conservation advocates and the U.S. Fish and Wildlife Service on the other. At issue was the replacement of the locks and dam on the Mississippi River at Alton, a choke point for barge traffic moving upstream of St. Louis on both the Mississippi and Illinois rivers. Navigation interests wanted the new locks to have a much greater traffic-carrying capacity; conservationists, on the other hand, argued that existing traffic was already adversely affecting fish and wildlife and that the new locks should have no greater capacity than the old. After a lawsuit in the U.S. Federal Court in Washington, D.C., in 1974 and debate in Congress, a compromise was reached in the 1986 Master Plan.

Developers of the Plan recognized that existing information on the Upper Mississippi River was insufficient to determine the environmental impact of increased barge traffic and an associated increase in river terminals. Instead of waiting for this information to be collected, however, they compromised, allowing construction of the replacement locks and dam to begin but at the same time authorizing programs that would collect the needed information.

Two of these programs, the Long-term Resource Monitoring Program and the Computerized Inventory and Analysis System, document upstream/downstream and year-to-year trends in selected natural resources of rivers. Short-term studies relate environmental effects to causes. The third program, Habitat Rehabilitation and Enhancement, evaluates restoration techniques in areas where fish and wildlife habitats have become degraded.

The ten-year Plan has yet to reach its authorized budget of $20 million per year, but Congress has increased appropriations for it each year since 1986. The budget for 1990 is $14.9 million. Although the total cost of $200 million is large, it is only a fraction of the $1 billion price tag on the new locks and dam at Alton. Ideally, these programs will continue beyond the authorized ten years, perhaps through a combination of state and federal funding and user fees. Only after initial investigations determine what restoration methods are feasible can the work of rehabilitation begin. In addition, the rivers will continue to change and the data base is likely to prove increasingly useful in the future.

The Natural History Survey and several other Illinois agencies have been closely involved with the Master Plan from the initial fact-finding associated with the court case, through the early planning stages, to its implementation. The River Research Laboratory at the Survey’s Stephen A. Forbes Biological Station on the Illinois River at Havana is part of a network of six state-operated field stations that collect and analyze data on fish populations, vegetation, and water quality for the Long-term Resource Monitoring Program. In addition, Survey research biologist Pamela Tazik is an advisor on vegetation sampling at the station operated by Western Illinois University at Cuivre Island on the Mississippi.

Together the six stations collect data from seven major reaches—the first year-round biological sampling at a scale commensurate with the size of the Upper Mississippi River System. Each reach includes permanent channels and lakes and transition zones on the floodplains that alternate between wet and dry. The sampling sites represent the spatial heterogeneity that is characteristic of large, complex river-floodplain systems. The temporal scale, too, is appropriate for the system under study: ten years is long enough for trends to emerge from the “noise” of short-term variations.

In addition to comparing patterns in field data and elucidating causes by correlation, researchers will monitor one or more habitat rehabilitation projects in each study reach. In the process, they will collect data before, during, and after large-scale experimental manipulations. Such manipulations are common in ecological studies of small streams but not in larger systems with their conflicting uses and diverse management.

The cooperative, cost-sharing agreements among the many state and federal agencies are one of the remarkable aspects of the rehabilitation and monitoring programs. The Master Plan for the Management of the Upper Mississippi River System with its programs of habitat rehabilitation, long-term monitoring, and computerized analysis will contribute to our understanding of large floodplain rivers and should help state and national entities to manage the competing uses of the river resource.

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The Zebra Mussel: Exotic Invader

Exotic or nonindigenous species play a significant role in the changing biodiversity of Illinois and the world. While some introduced species may be perceived as successes, the vast majority have proved detrimental to native plants and animals. The sea lamprey and Asian clam (Corbicula), for example, invaded our inland waters and cost taxpayers millions of dollars in attempts at eradication and control. Yet another exotic, the zebra mussel (Dreissena polymorpha) has entered portions of the Midwest and now threatens to spread into Illinois.
The zebra mussel, a small mollusk native to the Black, Caspian, and Azov seas of Eastern Europe, is 1–2 inches in length and resembles the common blue mussel (Mytilus edulis) of U.S. coastal waters. Although variable in color, the zebra mussel is typically cream-colored with brown bands, hence its common name. Its presence raises immediate concern because of its negative effects on the native biota and on water supply (treatment plants, power plants, and other facilities that use surface water). Potential costs associated with the Dreissena invasion have been estimated at $500,000,000 a year for the next ten years.

Zebra mussels were first discovered in North America in June 1988 in southern Lake St. Clair between lakes Huron and Erie. The introduction most likely occurred in 1985 or 1986 with the discharge from ocean-crossing ships of freshwater ballast that contained the free-swimming zebra larvae. The mussel now infests lakes St. Clair and Erie and has spread into the western end of Lake Ontario. In the spring of 1989 a few mussels were found on a navigation buoy in Green Bay, Lake Michigan.

The expansion of populations of zebra mussels in Europe and in the Great Lakes is attributed to high fecundity, the presence of a free-swimming larval stage, and the lack of predators. Tough fibers, called byssal threads, enable these mussels to attach to solid objects and form large, dense colonies. Common objects for attachment are rocks, intake pipes, buoys, and boat hulls but also include freshwater mussels, crayfishes, and even each other. Colonies of over 100,000 individuals per m² have been reported. Zebra mussels filter large amounts of water under optimal conditions, and rates of approximately 1 liter per day per mussel have been reported. As filter feeders on plankton, they could have a devastating effect on the food source of many fishes and other species.

Because of the ability of the zebra mussel to attach to nearly any submerged object, it is expected to expand its range rapidly in the United States and Canada, moving out of the Great Lakes and into any number of streams. Following its arrival in Lake Michigan, it will likely invade the Upper Mississippi River Basin via the Chicago Sanitary and Ship Canal and Illinois River. To date no reports of the zebra mussel in Illinois waters have been made, but its arrival appears to be a foregone conclusion.

Attempts to eradicate this pest have proved unsuccessful in Europe, and control methods—biological, chemical, and physical/mechanical—have met with varying degrees of success. Biological control includes the use of natural predators such as fishes (e.g., the mollusk-eating freshwater drum), diving ducks, and crayfishes. Although relatively promising as a control measure, predation has not been effective in eliminating zebra mussels. Chemical control, including the use of chlorine, tributyl-tin-oxide, copper, cyanuric acid, ozone, and ammonium nitrate, has been used but is potentially dangerous to the environment. Physical and mechanical control measures consist of sealing pipes, using deep water intakes, introducing heat treatment, using micro-screens to filter larval mussels, and flushing and scraping pipes to remove attached mussels.

To prepare for the invasion of the zebra mussel and its consequences, the Survey formed an interdisciplinary task force, composed of sealing pipes, using deep water intakes, introducing heat treatment, using micro-screens to filter larval mussels, and flushing and scraping pipes to remove attached mussels.

To prepare for the invasion of the zebra mussel and its consequences, the Survey formed an interdisciplinary task force, sent representatives to a national symposium on the zebra mussel, and conducted an exhaustive literature search to obtain background information. Nearly 300 scientific publications and reports, mostly European in origin, were reviewed. Although the Survey is prepared to provide information related to this problem, it is unlikely that Survey scientists or anyone else will be able to eliminate the zebra mussel from North American waters or to control its expansion for an indefinite period. Expansions of other nonnative species that eventually proved to be pests—the common carp, house mouse, house fly, European starling, and house sparrow—could not be stopped, and their populations are controlled only through expensive and time-consuming methods. Unfortunately, the zebra mussel is likely to do a great deal of environmental and economic damage and, based on the management history of similar pests, we will be able to do little by way of intervention.

Many other potential pests are available for introduction into North America, especially from Europe where species have adapted to degraded environments and would be able to outcompete native North American species. One of the challenges of the next decade is to foster a new appreciation of the value of a healthy environment, especially one dominated by native species, and to develop legislation that will prevent the introductions of exotic species.

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Corn Rootworm Bibliography Updated
The northern and western corn rootworms are the most serious insect pests of field corn in the Midwest and Canada. Costs for soil insecticides to control larval damage to the root systems of corn and aerial sprays to reduce beetle damage to corn silks, when combined with the associated crop losses, can approach $1 billion annually. Currently, soil insecticides for corn rootworm control are applied each...
year to 50–60 percent of the corn acreage in the United States, and corn has replaced cotton as the crop receiving the largest amount of insecticides.

In 1974, the Survey published a bibliography of the northern and western corn rootworm. An update through 1976 followed in 1977. In the thirteen years since that publication, the literature on these two insects has grown immensely. Because ready access to this extensive literature is essential if researchers are to develop new control tactics, Eli Levine and Siu Yau Chan undertook the task of updating those earlier bibliographies. Their work has recently been released as Biological Notes 135, *A Bibliography of the Northern and Western Corn Rootworm: An Update 1977 through 1988*. Unlike its predecessors, this publication features an index of key words that permits quick retrieval of desired references. Copies of this bibliography as well as the two earlier publications (Biological Notes 90 and 101) may be obtained from the Survey. The cost of each is $2.00.

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