Technical Report 90/6

ILLINOIS NATURAL HISTORY SURVEY

Center for Aquatic Ecology

Ecological Structure and Function of the Major Rivers in Illinois

NSF BSR 86-12107
Final Report

Richard E. Sparks, Project Director

Contributors:
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September, 1990

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FINAL PROJECT REPORT
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PART I—PROJECT IDENTIFICATION INFORMATION

1. Institution and Address	2. NSF Program	3. NSF Award Number
University of Illinois 506 S. Wright Street Urbana, IL 61801	LTER	BSR 86-12107
	4. Award Period From 1/15/87 To 12/31/89	5. Cumulative Award Amount $550,000

6. Project Title
Ecological Structure and Function of the Major Rivers in Illinois.

PART II—SUMMARY OF COMPLETED PROJECT *(FOR PUBLIC USE)*

Biological productivity, as indicated by fish yields, waterfowl concentrations, and mass emergences of aquatic insects (mayflies, caddisflies), varies from place to place and from year to year in large floodplain river systems. The objectives of this research were to record these patterns in the Upper Mississippi River and explain why they occurred. In the spring major annual floods provided access to spawning and feeding areas on the adjacent floodplains for migratory animals. When river flows were low and stable during the summer, aquatic and wetland vegetation flourished, while hydraulic circulation patterns, driven by the main current and winds, distributed organic matter produced in the plant beds to off-shore consumers (fingernail clams and mayflies). These primary consumers in turn attracted bottom-feeding fish and diving ducks. A minor flood in the fall typically made the annual production of moist soil plants available to migratory dabbling ducks. The findings suggest that consumers depend on food produced locally, in the lateral areas of the river-floodplain itself, rather than material transported long distances from upstream sources. The flooding pattern was the main driving variable in the large floodplain river, but in contrast to a small stream, the flood was not a disturbance or reset mechanism--rather, it facilitated lateral exchanges of nutrients, organic matter, and organisms.

PART III—TECHNICAL INFORMATION *(FOR PROGRAM MANAGEMENT USES)*

1. ITEM *(Check appropriate blocks)*	NONE	ATTACHED	PREVIOUSLY FURNISHED	TO BE FURNISHED SEPARATELY TO PROGRAM: Check (✓)	Approx. Date
a. Abstracts of Theses			X		
b. Publication Citations		X			
c. Data on Scientific Collaborators		X			
d. Information on Inventions	X				
e. Technical Description of Project and Results		X			
f. Other *(specify)* Reprints and a video tape have been furnished previously. New reprints are attached.		X	X		

2. Principal Investigator/Project Director Name *(Typed)*	3. Principal Investigator/Project Director Signature	4. Date
Richard E. Sparks	Richard E. Sparks	31 August 19

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PART III -- TECHNICAL SUMMARY

A. INTRODUCTION

A. Scope of the Research

Lotic systems are an integral component of the global environment, and like other open systems, influence and are influenced by adjacent systems. The river systems of the world transport water, sediment, organic matter, and nutrients from the continents to the sea, modifying and/or storing these materials on both short-term and geological time scales, thereby influencing biogeochemical cycles at both the global and continental spatial scales (Richey 1983, Wollast 1983). Major drainage basins can be recognized as the next lower level of landscape. Large drainage basins are further divided into sub-basins, such as the Upper Mississippi River.

The Mississippi River drains roughly 40% of the continental United States or 3×10^6 km^2 of land (Fig. 1). For management and operational purposes, the river has been divided into six sub-basins: the Lower Mississippi, the Ohio, the Missouri, the Arkansas, the Tennessee, and the Upper Mississippi. The fundamental ecological system under study was the Upper Mississippi Sub-Basin, which longitudinally extends from St. Anthony Falls, Minnesota, downstream to Caruthersville, Missouri (Fig. 1). For the remainder of this text, the term Upper Mississippi River includes both the river and the floodplain. Most of our sampling effort was concentrated on Pool 19, with less effort devoted to Pool 26 (which includes a reach of the Mississippi and the lower 80 miles of the Illinois River), and Peoria Pool on the Illinois (Fig. 1). Pool 19 is the oldest navigation pool on the Upper Mississippi, Pool 26 includes a 2-mile reach which is newly impounded, and Peoria Pool on the Illinois is much more heavily impacted by man's activities than the reaches on the Upper Mississippi.

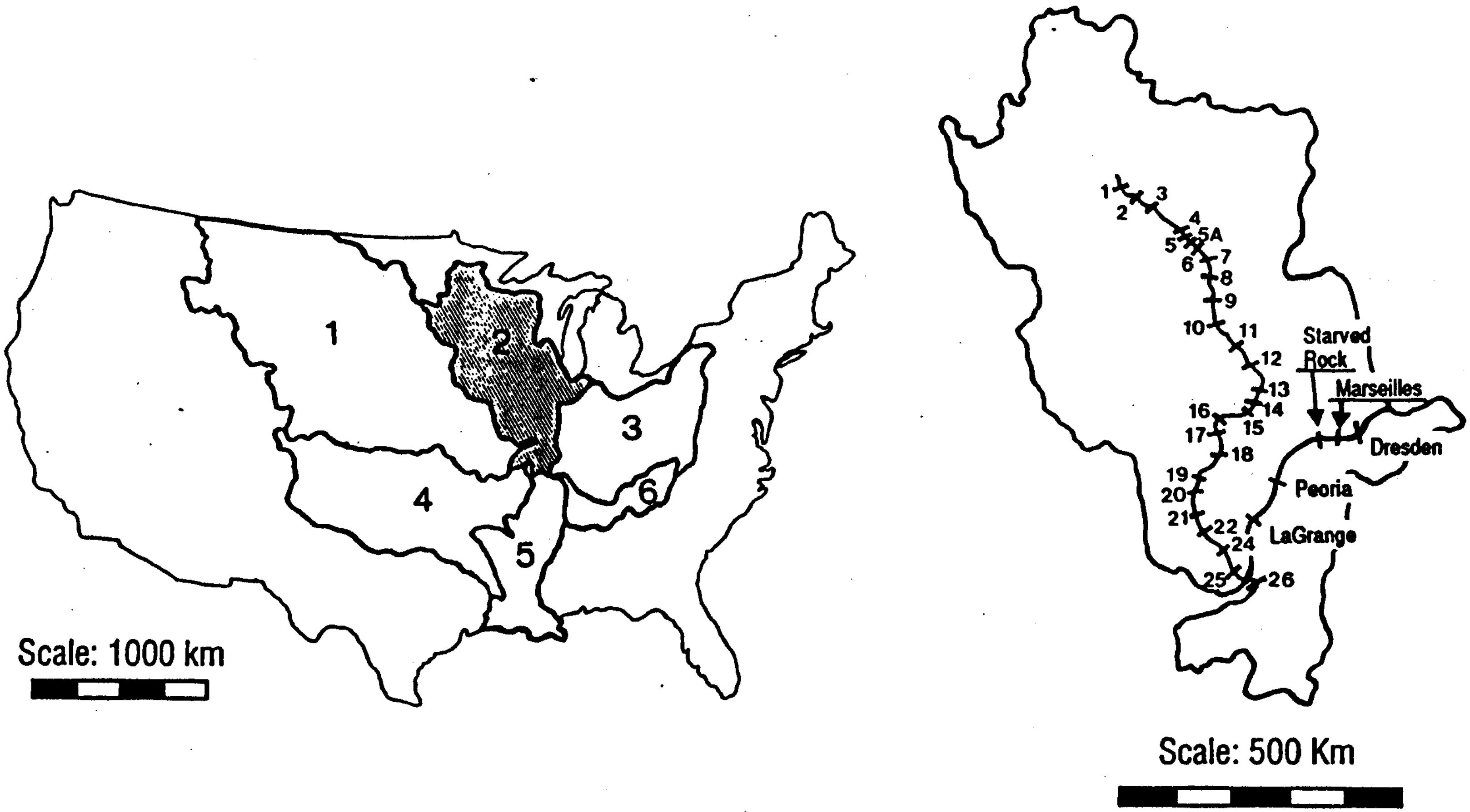


Fig. 1 Map of the six subbasins of the Mississippi River and an enlargement of the Upper Mississippi Subbasin (no.2). The dams on the Upper Mississippi River are numbered; those on the Illinois River are named. The Large River LTER Collected data on three reaches: (1) Pool 19, between dams 19 and 20, (2) Pool 26, between dams 25 and 26, and (3) Peoria Pool on the Illinois River.

2. Goals

The overall goal of our research was to contribute to a holistic understanding of lotic systems by providing insights into temporal and spatial factors controlling ecological structure, productivity, and function of large floodplain-river systems. A further goal was to identify similarities and differences between large floodplain-river ecosystems and other aquatic and terrestrial ecosystems to further promote a basic understanding of ecological systems in general.

3. Importance of Research on Large River Systems

There are several reasons why the study of large-river systems is important. First, with few exceptions (Sedell et al. 1978; Naiman and Sedell 1979; Minshall et al. 1982; Naiman 1935b, Naiman et al. 1987; Davies and Walder 1985), most ecosystem-level research on lotic systems has concentrated on streams and small rivers, which are easily manipulated and sampled (e.g., Wallace et al. 1986). Hence, there is a general dearth of ecological information on large rivers. Second, the information available indicates that rivers with large floodplains operate differently, and must be conceptualized differently, from low-order channels and riparian zones within drainage basins (Junk et al., 1989). Our position is that a holistic understanding of lotic systems will not be achieved by simple extrapolation of information and concepts from low-order streams to high-order floodplain rivers, nor will the extension of ecological theory best be served. Third, the few system-level studies of the largest rivers of the world have focused on the large-scale biogeochemical functions of rivers, such as transport of sediment (Meade et al. 1985), carbon (Richey et al. 1980), or nutrients (Gildea et al. 1986) from land to the sea or on broad relationships between fish yield and such characteristics as floodplain size (Risotto and Turner 1985, Welcomme 1985, Bayley and Petrere, in press). However, internal mechanisms that control production and yields are poorly known and largely unquantified, and prediction of future trends are likely to be erroneous, especially if thresholds exist where system behavior changes.

4. Approach

a. Lateral Spatial Organization

The vast size and complexity of the Upper Mississippi river required that we recognize and incorporate several spatial and temporal scales to put each research element in perspective. We hierarchically divided the upper Mississippi into four spatial levels (Fig. 2) that incorporate lateral (cross-section) system characteristics. The first level is the entire floodplain-river system within the Upper Mississippi Sub-basin (Fig. 2). The second level distinguishes riverine areas (which are permanently inundated and connected to the channels) from the floodplain. There are two distinct types of floodplains within the Upper Mississippi; leveed and unleveed. Leveed floodplains contribute nutrients and organic matter to the riverine subsystem in a manner similar to point-source discharges. With the possible exception of subsurface inputs, man has essentially decoupled leveed floodplains from the riverine subsystem.

Two riverine zones, the main channel and main channel borders (Fig. 2), comprise the third hierarchical level. These two riverine-zones are spatially distinct and have well defined physical characteristics (Jahn and Anderson 1986). Zones could also be subjectively defined within the floodplain subsystem (e.g. distance from bank during non-flood events) but we feel that the floodplain is better viewed as a lateral gradient rather than as a set of physically distinct zones. This does not, however, infer that one cannot find distinct habitat patch types within floodplains. For the above reasons, we only view zones (Fig. 2) as occurring within the riverine subsystem.

Most of our research effort was focused on the riverine subsystem, and its zones and patches, although data were obtained on historical changes in the amount of inundated floodplain (Grubaugh and Anderson 1988) and on the effects of floodplain forest on organic matter transport during floods (Grubaugh and Anderson 1989).

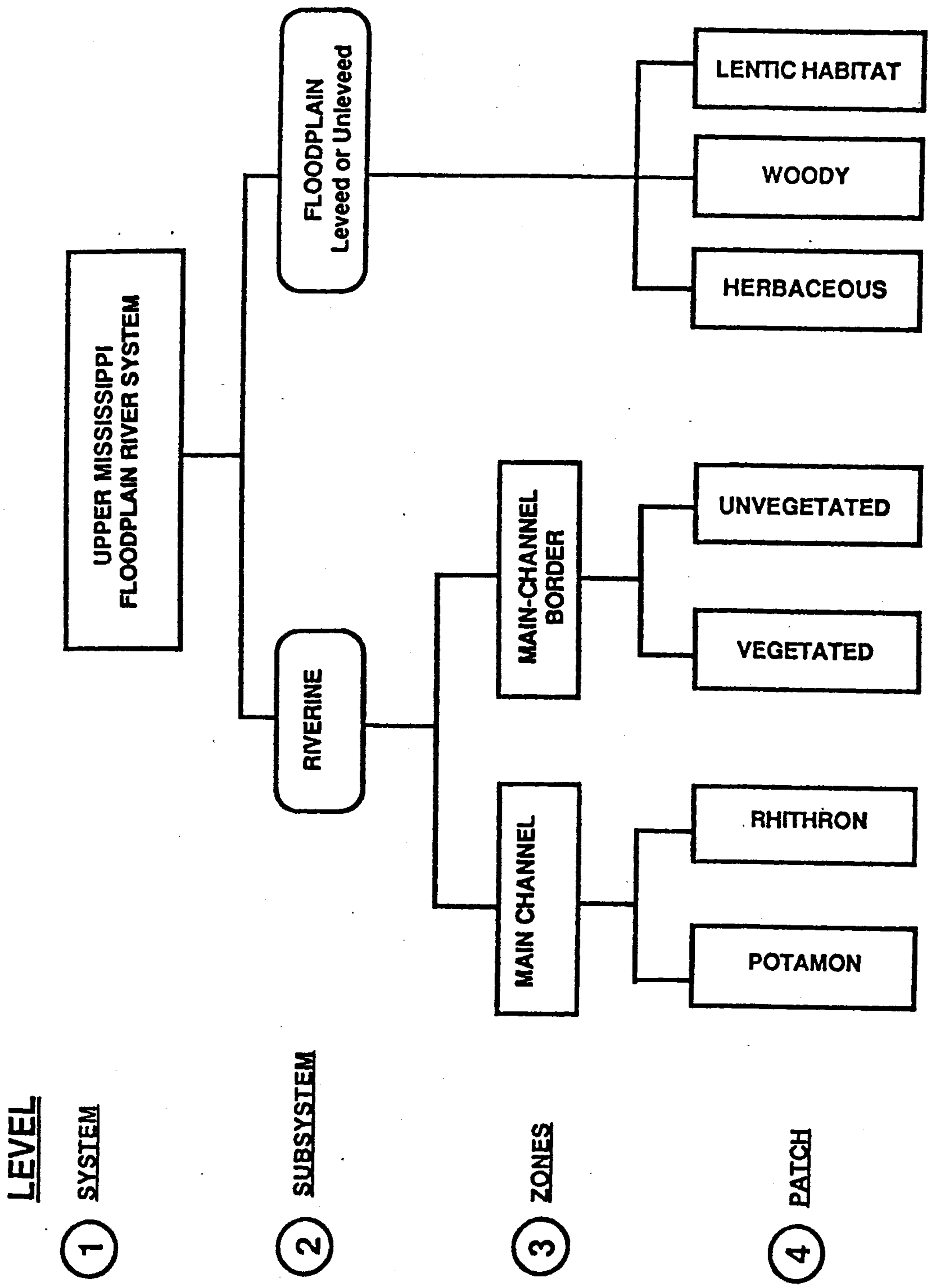


Fig. 2 Hypothesized hierarchical structure of the Upper Mississippi Floodplain River System.

b. Longitudinal Spatial Organization

In addition to this lateral spatial structure, the modern river exhibits a longitudinal (upstream-downstream) structure largely imposed by man (Fig. 3). Despite twenty-six sequentially numbered navigation dams (see Appendix 1 for descriptions) that have reduced riverine characteristics (e.g., stage variation, productive floodplain lakes, and side channels) (Jahn and Anderson 1986), the Upper Mississippi retains a complex longitudinal and lateral mosaic of communities and processes characteristic of large floodplain river systems (Fig. 3).

The U.S. Army Corps of Engineers refers to reaches between one dam and the next as pools (we adopt the same terminology in this report). However, only the downstream portion of each reach is impounded and exhibits lacustrine characteristics. Impoundment is necessary during low flow to maintain a navigational channel. During floods, the gates are out of the water and the low earthen weirs that connect the gates to the far shore are overtopped. Even during low stages, the influence of the dam extends only part of the distance upstream to the next dam, so that each pool has an upstream zone that retains the characteristics of the natural river (multiple side channels and unleveed floodplains including islands) and a downstream zone where islands and floodplains typically have been partially or completely inundated. Although the dams back water over former rapids, torrent-dwellers (several species of caddisflies and midges) still occur on the rock and rubble in the swift waters downstream of dams.

Having described the scope and approach taken in our research, we next describe results in 4 areas: conceptual advances, major findings, intersite activities, and application to river management.

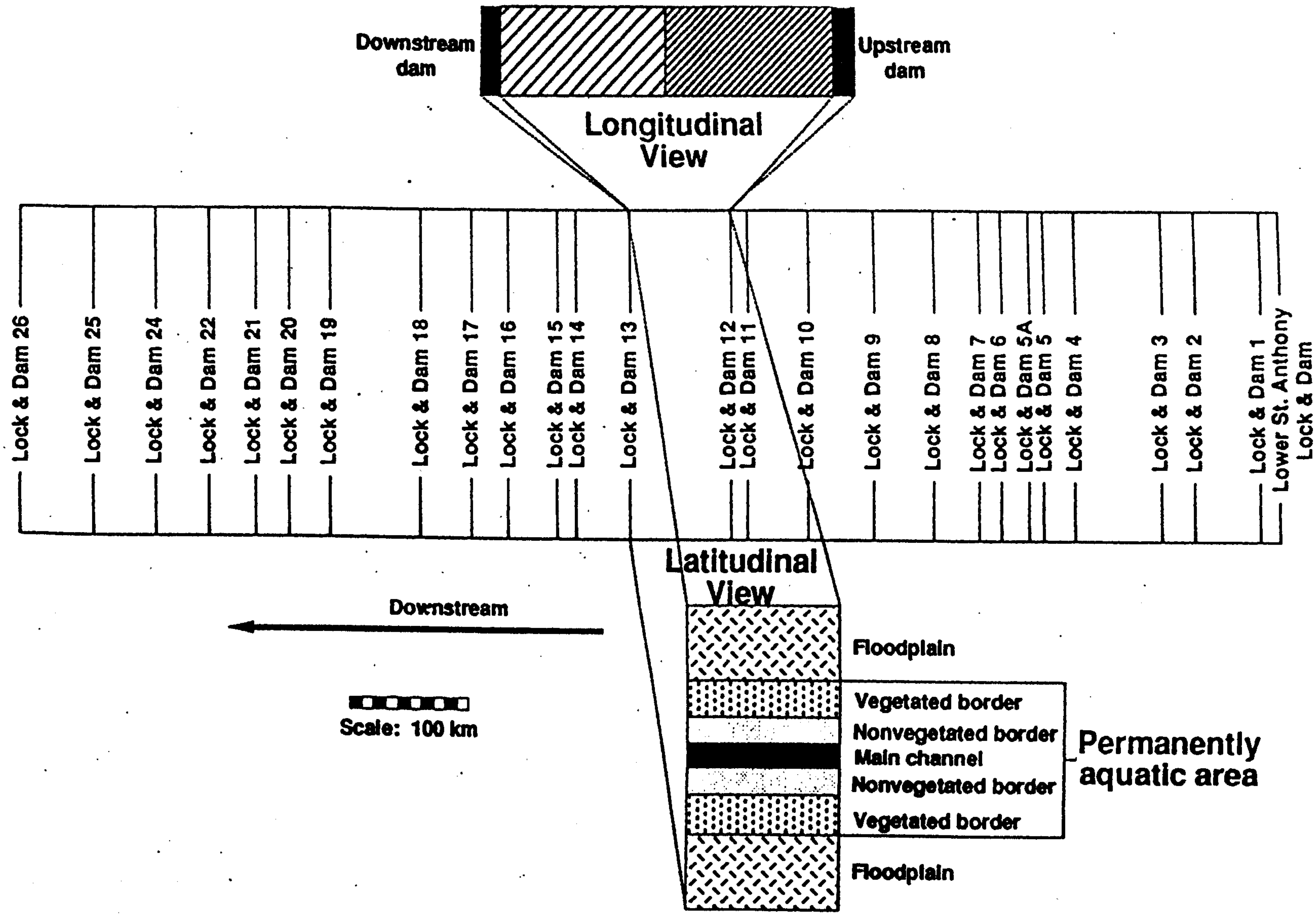


Fig. 3 Longitudinal and latitudinal structure of the Upper Mississippi River. the latitudinal scale is purely schematic and greatly exaggerated relative to the longitudinal scale. The actual width of the river varies from about 500 m (at rocky narrows) to 5 km (including flooded areas). The channel width is also exaggerated: the main channel typically occupies only 3%-6% of the total width of the unleveed parts of the river--floodplain system.

B. RESULTS

1. Conceptual Advances

The main channels of floodplain rivers are important in terms of downstream transport of materials, but our data on distribution and density of populations support the postulate that most biological activity (production, decomposition, consumption) and physical storage or retention of nutrients and organic matter occur in lateral areas. Thus, in marked contrast to the perception of a river as a conduit, our data indicate that large floodplain rivers are more correctly conceptualized as being composed of functionally linked components, beginning at the main channel and progressing laterally through unvegetated and vegetated channel borders, backwaters, and the floodplain. Furthermore, we now hypothesize that the annual spring flood is the system's major physical driving variable that facilitates lateral exchanges of nutrients, organic matter, and organisms (Junk et al. 1989). The focus in large river research is on what the river does for the floodplains and lateral areas, whereas in small streams the focus is on what the catchment or riparian zone does for the channel, where almost all of the aquatic productivity is concentrated (Swanson and Sparks 1990). The riparian zone in a stream is conceptualized as a narrow border which controls the flux of water, sediment, organic matter, and nutrients into the channel. In contrast, the floodplain and lateral areas of a flood river are where the biological action takes place, not just because the these areas are large, in relation to the area occupied by channels, but also because the intensity of activity is greater, due to the predictable wet and dry cycle and the dynamic edge effect, or "moving littoral", which traverses the floodplain (Junk et al. 1989).

In small streams, flooding is typically considered to be a major disturbance, resetting the system (sensu Cummins 1977) by scouring away organisms and accumulated organic matter. In large floodplain rivers, however, we believe that the <u>absence</u> of a spring flood constitutes a major disturbance to system productivity because of the role of flooding in determining the availability of carbon sources to consumers (Sparks et al. 1990).

2. Major Findings

a. Community Structure. Major biotic components and trophic relationships in the permanently aquatic habitats of the upper Mississippi River were identified (Fig. 4; Jahn and Anderson 1986). In contrast to patterns observed in smaller streams (e.g., Vannote et al. 1980), longitudinal differences in community composition were much less pronounced than were lateral differences within a reach (Anderson and Day 1986). Phytoplankton (Engman 1984, Lipsey and Anderson 1988), zooplankton (Pillard 1983), and macroinvertebrate (Day 1984, Jahn and Anderson 1986) communities exhibited subtle longitudinal changes in composition within the same lateral zone (i.e., main channel border, main channel). However, changes in community structure across zones, which are defined by sediment particle size and presence or absence of macrophytes (Anderson and Day 1986), were even more pronounced (Fig. 5). Macroinvertebrate densities were highest at margins of dense beds of macrophytes (Anderson and Day 1986), and waterfowl (Day 1984) and some fish (Koepke 1985) congregated in the same areas.

b. Disturbance. The 1976-1977 drought and associated low flows dramatically affected channel border communities in the Upper Mississippi River. In Pool 19, the surface area of aquatic macrophyte beds tripled in response to low water conditions and reduced turbidity (Fig. 6; Sparks et al. 1987; Sparks et al. 1990). Macrophytes became established in permanent benthic sampling plots, displacing benthic invertebrates and thereby causing reductions in population densities and shifts in species composition within the plots (Fig. 6). After returning to more typical flow regimes, both macrophyte and benthic invertebrate communities have remained relatively stable. These results suggest the importance of flooding in structuring riverine communities.

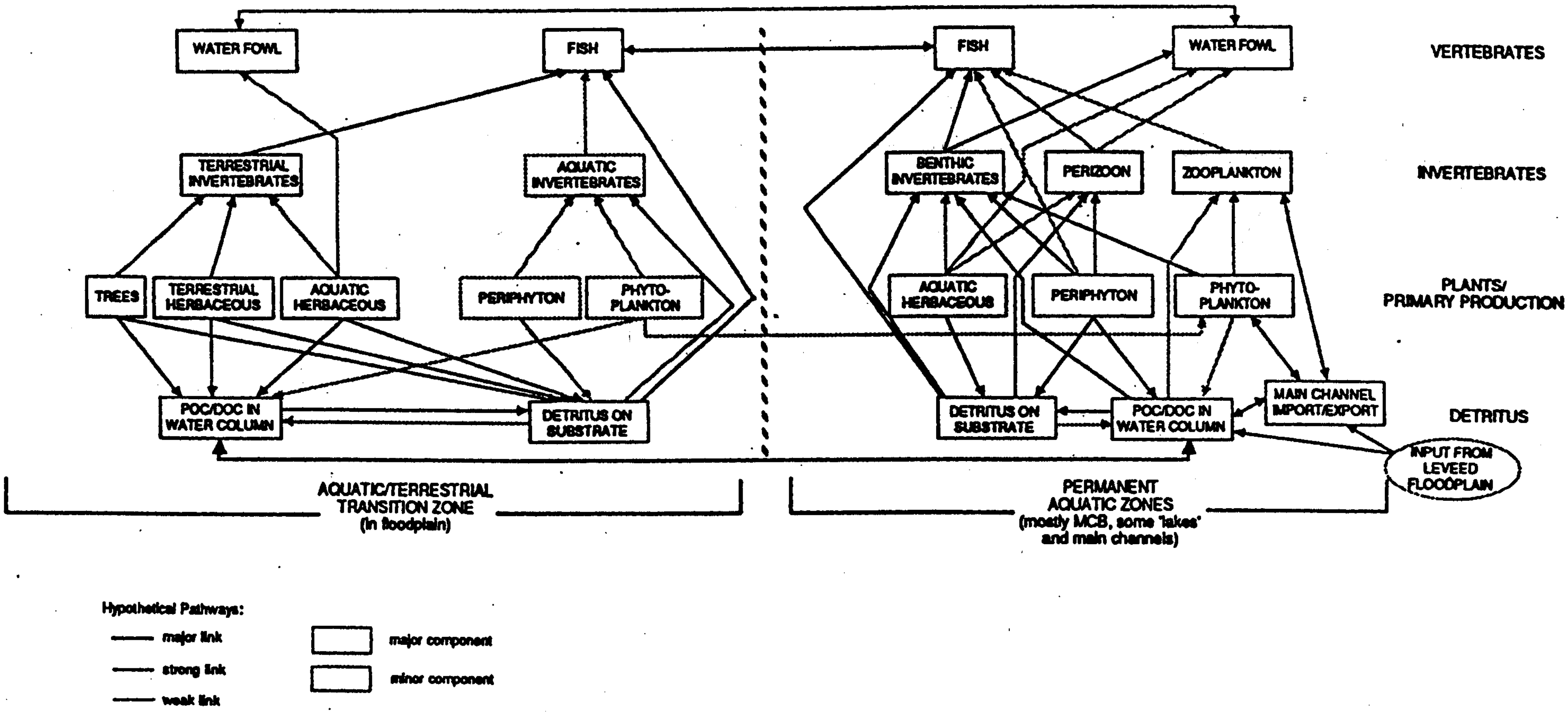


Fig. 4 Proposed carbon or organic matter flow between principal components in the Upper Mississippi floodplain-river system. Arrows crossing between zones reflect movement of biota.

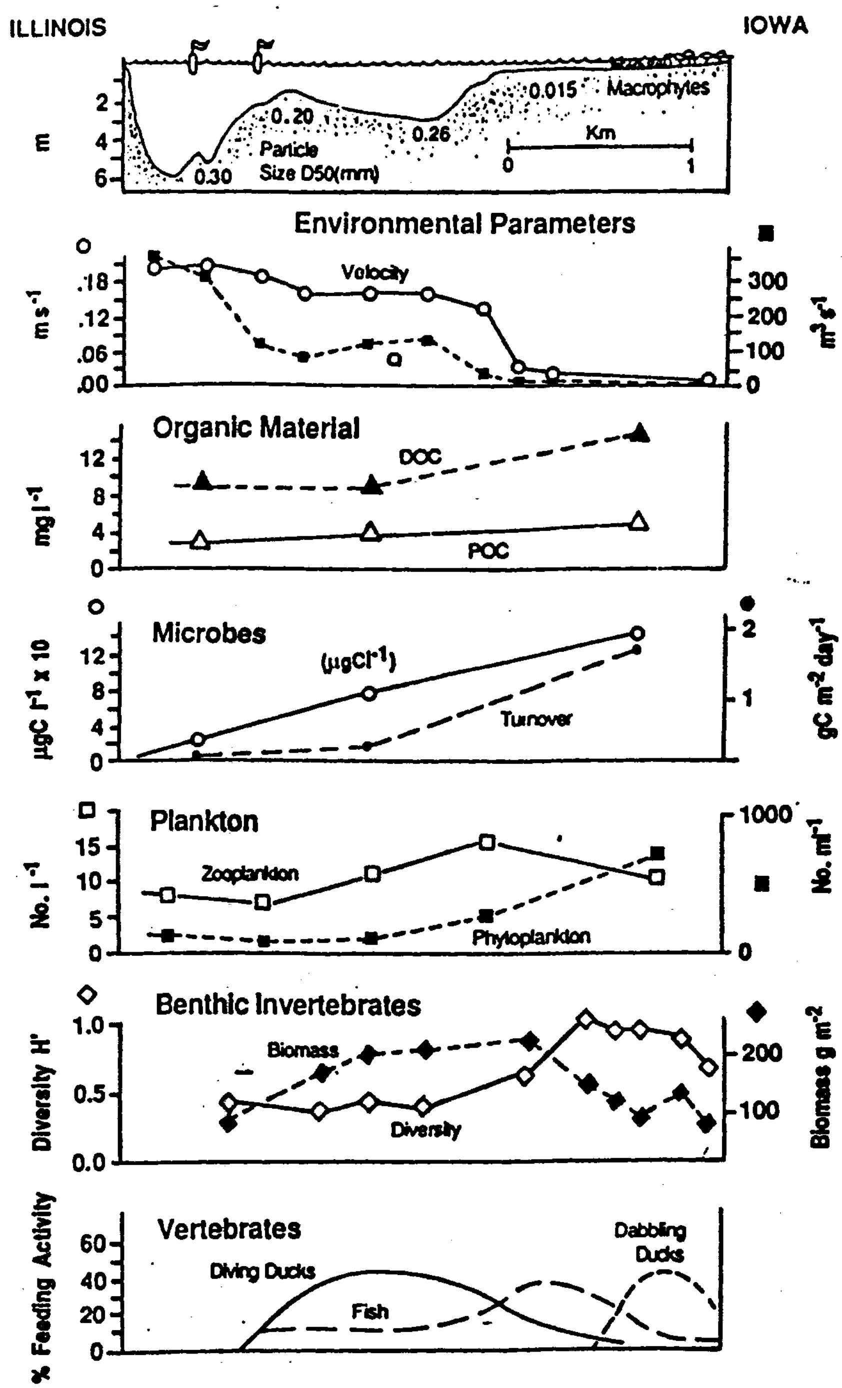
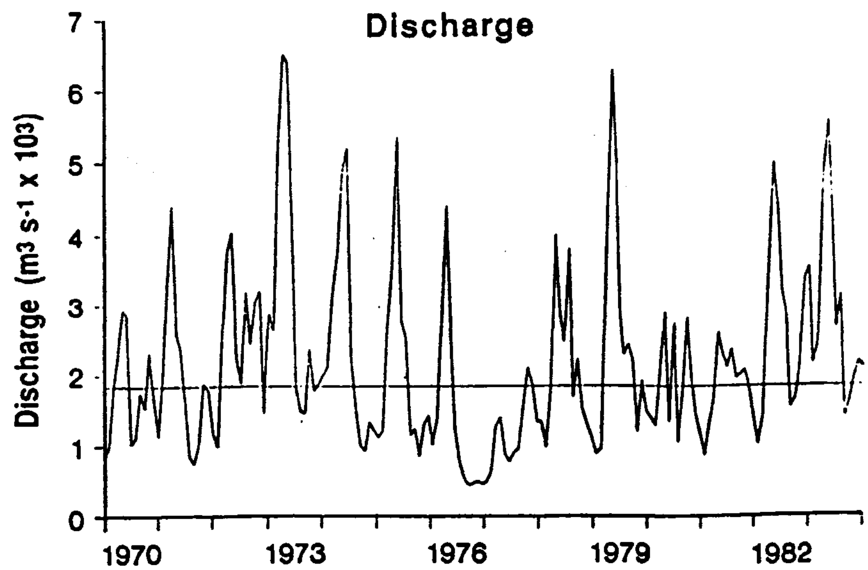


Fig. 5 Latitudinal variation from main channel to main channel border and vegetated channel border habitats in Montrose Flats, Pool 19, Upper Mississippi River.



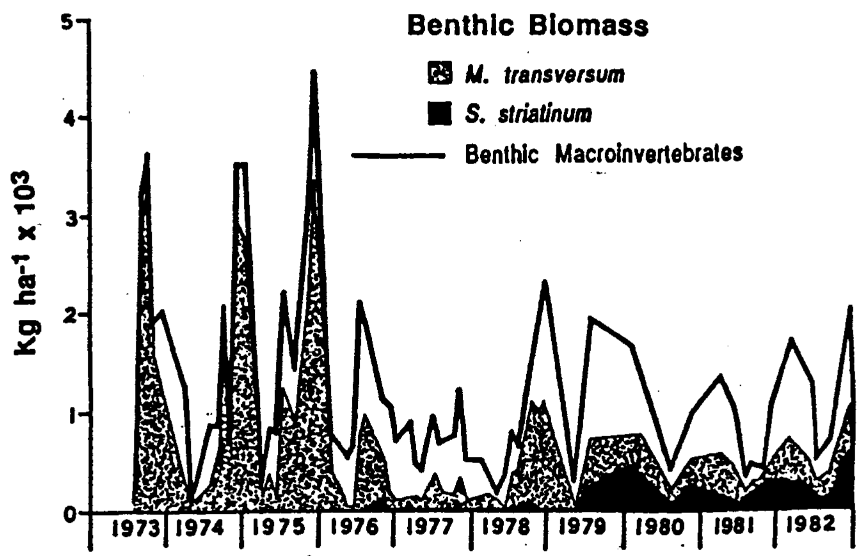


Fig. 6 Discharge hydrograph for the Upper Mississippi River at Keokuk, Iowa 1970-1981 and decline of benthic macroinvertebrate populations and increasing macrophyte beds at Montrose Flats, Pool 19, Upper Mississippi River. Horizontal line on the hydrograph is the mean discharge for the 110-year period of record. Biomass is wet weight, excluding shells of mollusks.

c. Spatial and Temporal Patterns in Production and Carbon Availability. We found dense beds of filtering and collecting benthic invertebrates spatially juxtaposed to beds of aquatic vegetation (Anderson and Day 1986), which suggests that consumers depend on locally-produced carbon. Net primary production of submersed and emersed aquatic macrophytes in Pool 19 is high (Grubaugh et al. 1986), but insufficient to support observed invertebrate populations since it is an order of magnitude lower than microbial and invertebrate respiration (Table 1; Butts et al. 1982, Fremling et al. 1989). Other potential sources of carbon include adjacent floodplains, attached algae and phytoplankton, and inputs from upstream. A substantial quantity of organic carbon is transported in the river (Table 1), but respiration rates of particulate organic matter in transport are very low (Gorden and Henebry, unpublished data), suggesting that this material is of low nutritional quality (Naiman 1983a). During the summer when invertebrate growth rates are high, surficial inputs of organic matter from the floodplain are low (subsurface inputs have not yet been measured). However, substantial inputs of POC from the floodplain occur during the spring flood (Grubaugh and Anderson 1989). This raises the question: do plant beds retain organic matter washed off the floodplain during the spring flood, and is this material slowly conditioned, mobilized, and distributed to consumers during the summer low flow period? We discovered that the main channel current drives large-scale (e.g., 1.2 x 4.8 km) eddies which are capable of distributing dissolved and fine particulate organic matter from nearshore areas to offshore areas inhabited by primary and secondary consumers (Adams 1986). Such eddies retain organic materials for 12-20 days, which is 6-10 times longer than the normal travel time through a pool. Core sampling of river sediments in channel border areas demonstrated that only 2.1% of the total dry weight of sediment is organic carbon (Cahill and Autrey 1987), suggesting that relatively little

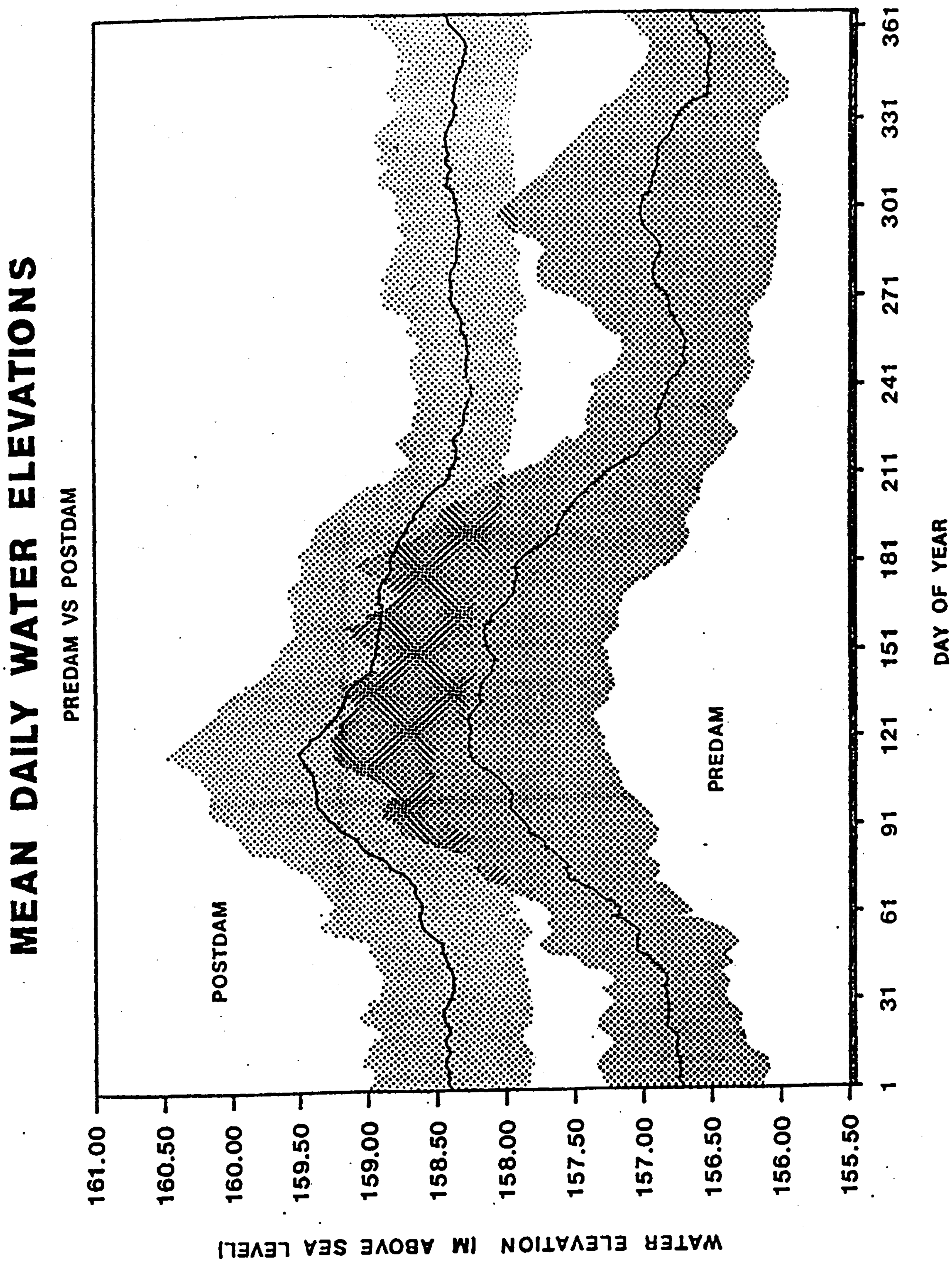


Fig. 7 Generalized hydrograph from Burlington, Iowa, for 34 years before (predam), and 74 years after (postdam) construction of Lock and Dam 19. Shaded areas indicate ± one standard deviation from the mean.

of the riverine-produced carbon is lost to sedimentation. It is either respired on site or transported to adjacent centers of consumption.

Successional changes that have occurred in Pool 19 provide an example of how the spatial association between vegetation and consumers can develop. Three independent estimates of sedimentation rates (cesium 137 and lead 210 dating of sediment cores, interpolation in a time series of bathymetric charts, and derivation from sediment budgets) indicated that prolonged sedimentation raised the bottom of the channel border into the euphotic zone (approximately 1 meter deep) in the 1960's (Bhowmik et al. 1980, Casavant 1985). Aerial photographs take by the Soil Conservation Service showed expansion of plant beds during this period. Large quantities of shell fragments appear for the first time in sediment layers dating from the 1960's, at the same time the plant beds appeared. Diving ducks also began congregating in Pool 19 for the first time during the fall migration in the 60's to feed on fingernail clams, snails, and mayflies (Mills et al. 1966, Bellrose and Havera unpublished data, Sparks 1984, Serie et al. 1983, Thompson 1973). Thus, the temporal pattern parallels the present spatial pattern in suggesting a link between local production and consumption centers within floodplain river systems, although, as explained above, primary consumers are either using what appears to be refractory material from the main channel or a source of nutritional carbon not yet account for. A major objective of future research should be to quantify sources and quality of organic carbon utilized by riverine consumers.

d. Modeling. Most existing simulation models are channel-oriented; they route water and sediments in rivers from upstream to downstream with no consideration of lateral exchanges. We developed and calibrated hydraulic and nutrient transport models that divide the river into "flow tubes", corresponding to the lateral zones, and account for lateral exchanges and retention of dissolved nutrients. Output from these models was used in a carbon flow model which simulated fluxes and accumulation in up to 9 state variables in lateral zones (Sparks et al. 1985).

e. Evaluation of Long-Term Hydrographic Record and Man's Effects. We located and computerized 100 years of river stage and discharge data for Pool 19. Inundation of the floodplain when the dam was completed in 1913 and leveeing of approximately half the floodplain on the Upper Mississippi for agriculture has shortened the duration of the major spring flood and obliterated the "little flood" that occurred regularly in the fall in the pre-dam era (Fig. 7; Grubaugh and Anderson 1988). The fall flood was important to migratory birds; waterfowl managers now use pumps and low impoundments to make the annual production of moist soil plants available to dabbling ducks. The dam has also increased sedimentation rates (Bhowmik et al. 1986), causing a volume loss. The volume loss and decreased floodplain width due to levees have increased the frequency and decreased the duration of major floods. These trends are asymptotic, with most of the changes having occurred in the years immediately following dam construction (Grubaugh and Anderson 1980).

3. Significance of Findings and Suggestions for Future Research.

Despite the close spatial and temporal association between macrophyte and invertebrate beds, the existence of an organic matter transport mechanism, and the small amount of carbon lost to sediments, plant bed primary production appears insufficient to support total annual microbial and invertebrate respiration in Pool 19 (Fremling et al. 1989). As plant bed production would have to increase by an order of magnitude to supply respiration (Fremling et al. 1989) and much of the mainchannel carbon is of low nutritional quality, it seems more likely that another source of nutritious carbon exists. The most likely sources are riverine attached algae, phytoplankton, and the floodplain, although the floodplain appears to export organic materials in a pulse during the spring flood (Grubaugh and Anderson 1989), while riverine respiration remains high during the

Table 1. Annual carbon inputs, burial, use, and downstream loss for Pool 19, Mississippi River.

	kg C x 10^6	Percentage of total input
INPUTS		
Upstream[a]	1,141	85.73
Tributaries[a]	90	6.76
Floodplain[b]	81	6.09
Sewage, industry[c]	0.54	0.04
Aquatic macrophytes[d]	16	1.20
Phytoplankton[e]	2	0.15
Total	1,331	100.00
STORAGE, USE, AND LOSS		
Burial[f]	73	5.48
Respiration[g]	154	11.57
Duck consumption[h]	0.15	0.01
Fish Harvest[i]	0.04	0.003
Downstream[a]	1,322	99.32
Total	1,549	116.39

[a] Based on depth-integrated TOC samples taken on transects from 1982 to 1985 during stable low flows (mid-summer and fall) and during rising and falling stages of spring floods, 1983 and 1985. Tributaries were sampled at the farthest downstream point that was not subject to the backwater influence of the main river. N = 93 for the two largest tributaries, which accounted for 95% of all tributary input. Upstream inputs were measured at Lock and Dam 18 (N = 87) and downstream outputs at Lock and Dam 19 (N = 149). No samples were taken below dams in January and February, so in-pool concentrations of TOC were used.

[b] Differences between depth-integrated TOC samples on transects above and below Burlington Island, November 1984-October 1985 were extrapolated to entire floodplain.

[c] Calculated from monthly 5-d BOD from sewage and industrial plants in 1982.

[d] Production/m^2 calculated from monthly standing crop and leaf turnover of above-ground biomass for the dominant emergents, *Sagittaria latifolia* and *Nelumbo lutea* (Grubaugh et al. 1986) and multipled by total area of aquatic macrophytes.

[e] Product of C content, turnover (Harris and Piccinia 1977), cell volume (Tiffany and Britton 1971), seasonal algal cell counts (Engman 1984), and total pool volume.

[f] Based on an average organic C content of sediments in depositional areas of 2.1% by weight (Cahill and Autry 1987; Cahill et al. 1987) and average annual sediment deposition determined from dated sediment cores (Cahill and Autrey 1987) and a sediment budget (Bhowmik and Adams 1986).

[g] Assumed carbon respired was 3X carbon incorporated in biomass of invertebrates (R.V. Anderson, Biological Sciences Dept., Western Illinois University, Macomb, IL 61455, Unpubl. data) and bacteria (Henebry and Gorden 1988).

[h] Estimated consumption of fingernail clams by diving ducks (Thompson 1969, 1973).

[i] Based on average sport fish harvest in Upper Mississippi River of 8.9 $kg \cdot ha^{-1}$ and on reported commercial harvest of 331 115 kg (annual average 1973-77) in Pool 19 (Rasmussen 1979). Assumed carbon content of fish = 0.10 of wet weights.

entire summer, requiring a constant carbon supply. Resolution of this apparent paradox (seasonally low supply, high consumption) depends on development of techniques for distinguishing nutritious (for animal consumers) and unnutritious carbon, and investigations into patterns of production, transport, retention and utilization of the nutritious fraction, including subsurface seepage from the floodplain to aquatic areas during low flow periods.

Properties of the Mississippi River which may have global significance (rate of water, sediment, and nutrient delivery from the land to the sea) depend on lower level (patch scale) properties which exhibit thresholds and lag effects and which are strongly influenced by variations in the annual pattern of flood and low flow. Continued long-term research is therefore needed to understand both the structure and function of the Upper Mississippi and other large floodplain river systems and their role in regional and global processes.

4. Intersite Activities.

The Large River LTER organized and led the first intersite data management workshop, and published optimal and minimal protocols and site reports on data management (Sinclair 1983; Sinclair and Lubinski 1983). Three of our scientists subsequently participated in a symposium on data management at the North Inlet site and contributed 2 papers to a book, "Research Data Management in the Ecological Sciences" (Brookfield 1986, Risser and Treworgy 1986). We also organized an intersite workshop on sediment transport mechanics and measurement (Adams 1986), and participated in 2 intersite workshops on streams and a third on organic matter in streams and rivers (Webster et al. 1985). A cross-site analysis and comparison of site-specific, year-specific, and complex variation in abiotic and biotic system factors, initiated by Dr. John Magnuson, will include our data on fish populations and edaphic factors in the Illinois River.

5. Transfer of Knowledge

Our senior scientists served on advisory committees and work groups which developed the Long-Term Resource Monitoring Program, Computerized Inventory and Analysis System, and Habitat Rehabilitation and Enhancement Program for the Upper Mississippi River Master Management Program. This is a federally-funded program (a total of approximately $200 million for 10 years), administered by the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service. Two of the LTER PIs, Drs. Anderson and Sparks, direct two of the six field stations participating in the Long-Term Resource Monitoring Program (LTRM). LTER personnel from outside the Large River LTER site also participate in LTRM. Dr. Thomas Callahan, LTER Program Officer for NSF and Ms. Susan Stafford, Data Manager for the Andrews Forest LTER site, serve on the LTRM external review committee. Concepts regarding the importance of the flood pulse and floodplains to the structure and function of large rivers may find their way into policy recommendations via Dr. Sparks' service on the Committee on Restoration of Aquatic Systems, Water Science and Technology Board, National Academy of Sciences. Two of our PIs are on the Technical Liaison Committee to the U.S. Geological Survey for a pilot National Water Quality Assessment Study on the Upper Illinois River, one of only four such surface-water pilot studies established to develop a comprehensive national program. Among the reasons the Upper Illinois was selected were the existing data bases produced by the LTER program.

Information was transferred not only to management, regulatory, and monitoring agencies, but also to the general public, via a 1-hour documentary television program, "Big River of the Heartland", which took 2 years to prepare by WILL-TV, the public television station at the University of Illinois. So far, the program has been viewed widely in the Midwest and has outdrawn 2 major networks when it has been shown on public television stations.

C. SUMMARY

The Large River LTER program collected data which support the concept that most of the biological activity (production, decomposition) in large floodplain rivers takes place in areas lateral to the main channels. The central question was what the river did for the lateral areas (how the annual pattern of high and low flows structured communities and affected the production and distribution of organic matter), instead of the question more commonly asked in small streams: what does the watershed or riparian zone do for the stream?

The temporal and spatial juxtaposition of production and consumption in the Upper Mississippi River indicated that "hot spots" of secondary production are dependent on local sources of primary production, rather than long distance transport of organic matter from upstream sources. The question of why centers of production and centers of consumption did not overlap, but occurred in adjacent patches was explained by the inimical conditions on the bottom in the plant beds, where low dissolved oxygen levels did not permit dense populations of benthic macroinvertebrates to develop. It appeared paradoxical that secondary productivity could be maintained at a high level in the summer despite the seasonally low supply of organic matter from floodplains, tributaries, and phytoplankton. The paradox was partially resolved by the discovery of largescale eddies and other secondary circulation patterns which distribute organic matter from lateral plant beds to offshore consumers. However, plant bed production did not appear adequate to fuel all the respiration and secondary production, and an important remaining question is where this additional organic matter comes from.

The absence of a flood during the drought of 1976-1977 in the upper Midwest was a major disturbance which pushed plant succession forward and altered the structure of benthic macroinvertebrate communities and the feeding patterns of higher level consumers. This contrasts with the situation in small streams, where the flood usually is a disturbance or "reset" mechanism which sets succession back.

The Large River LTER contributed to intersite activities by organizing the first data management workshop and a workshop on sediment transport mechanics and measurement, and participating in 5 other workshops. The principal investigators also serve as technical advisors and participate in the federally-funded Upper Mississippi River Management Program (U.S. Army Corps of Engineers and U.S. Fish and Wildlife Service) and the pilot National Water Quality Assessment (NAWQA) Study on the Upper Illinois River (U.S. Geological Survey). Information about the LTER and the ecology of large rivers was transferred to the public via a 1-hour documentary television program, "Big River of the Heartland."

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PART IV - SUMMARY DATA ON PROJECT PERSONNEL

NSF Division ____________________

The data requested below will be used to develop a statistical profile on the personnel supported through NSF grants. The information on this part is solicited under the authority of the National Science Foundation Act of 1950, as amended. All information provided will be treated as confidential and will be safeguarded in accordance with the provisions of the Privacy Act of 1974. NSF requires that a single copy of this part be submitted with each Final Project Report (NSF Form 98A); however, submission of the requested information is not mandatory and is not a precondition of future awards. If you do not wish to submit this information, please check this box ☐

Please enter the numbers of individuals supported under this NSF grant.
Do not enter information for individuals working less than 40 hours in any calendar year.

*U.S. Citizens/ Permanent Visa	PI's/PD's		Post-doctorals		Graduate Students		Under-graduates		Precollege Teachers		Others	
	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem.	Male	Fem
American Indian or Alaskan Native												
Asian or Pacific Islander												
Black, Not of Hispanic Origin												
Hispanic												
White, Not of Hispanic Origin	6											
Total U.S. Citizens	6				1						7	2
Non U.S. Citizens	1		1		3							
Total U.S. & Non-U.S. ..	7		1		4						7	2
Number of individuals who have a handicap that limits a major life activity.												

*Use the category that best describes person's ethnic/racial status. (If more than one category applies, use the one category that most closely reflects the person's recognition in the community.)

AMERICAN INDIAN OR ALASKAN NATIVE: A person having origins in any of the original peoples of North America, and who maintains cultural identification through tribal affiliation or community recognition.

ASIAN OR PACIFIC ISLANDER: A person having origins in any of the original peoples of the Far East, Southeast Asia, the Indian subcontinent, or the Pacific Islands. This area includes, for example, China, India, Japan, Korea, the Philippine Islands and Samoa.

BLACK, NOT OF HISPANIC ORIGIN: A person having origins in any of the black racial groups of Africa.

HISPANIC: A person of Mexican, Puerto Rican, Cuban, Central or South American or other Spanish culture or origin, regardless of race.

WHITE, NOT OF HISPANIC ORIGIN: A person having origins in any of the original peoples of Europe, North Africa or the Middle East.

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