REVIEW AND DISCUSSION OF BIOLOGICAL INVESTIGATIONS IN THE LOWER MISSISSIPPI AND ATCHAFALAYA RIVERS

by

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ABSTRACT

Biological studies in the main channels of the lower Mississippi and Atchafalaya Rivers below Cairo, Illinois, were summarized and reviewed with regard to their scope, methodology, and salient findings. The study area has received much less attention than the reach above Cairo, but 67 references were found to contain at least some direct mention of lower Mississippi/Atchafalaya River biota. Fishes are the best-known and most extensively studied organisms, although few intensive, standardized studies were found. The plankton community has received the most intensive study, largely through the National Water Quality Network program. Benthic invertebrates, commercial crustaceans, and aufwuchs are the least-known organisms, although certain recent studies have revealed general community/substrate associations.

INTRODUCTION

The lower Mississippi River is usually defined as the reach extending 954 stream miles from Head of Passes, Louisiana, to the mouth of the Ohio River at Cairo, Illinois. Since it normally receives a substantial percentage of Mississippi flows, artificially diverted via the Old River Control Structure, the 135-mile Atchafalaya River should logically be included in any discussion of North America's largest river.

This paper is intended as a brief review of biological investigations in the main channels of the lower Mississippi/Atchafalaya Rivers. Tributaries and floodplain habitats such as swamps, oxbows, and sloughs are not considered. To provide as thorough a coverage as possible, extensive use is made of reports, theses, and other documents which are not formally-published in technical journals. Due to their number and the frequent necessity of citing these unpublished materials, it seems advisable to deviate from the suggested format and treat all references alike. It is hoped that our Literature Cited, used in conjunction with reference materials in the classical taxonomic works, will provide the first comprehensive and relatively accessible bibliography on the aquatic biota of the Mississippi/Atchafalaya Rivers.

LITERATURE REVIEW

Viosca (1927) and Gunter (1952, 1956, 1957) discussed the importance of the lower Mississippi River as a natural resource and called attention to possible adverse effects of flood control programs. Gunter (1956:8) noted, "No one actually knows what is now in the river for a biological study of it has never been made..." Until very recently most biological research in the Mississippi River had been restricted to its middle and upper reaches (Helm and Boland 1972). Chief impetus for this attention was the formation, in 1943, of the Upper Mississippi River Conservation Committee (UMRCC). Comprised of representatives from state conservation commissions and various federal agencies, the UMRCC was convened to coordinate research and management of fish and wildlife resources of the river from Hastings, Minnesota, to Caruthersville, Missouri (Smith 1949).

A comparison of Helm and Boland's (op. cit.) bibliography (600+ titles) with that presented below will emphasize the relatively infantile state of knowledge of the biology of the lower Mississippi/Atchafalaya Rivers. Figure 1 and Table 1 summarize the geographical, topical, and temporal distribution of biological investigations in the

area under consideration. In the upper 854 miles of the Mississippi River the distribution of fish collecting stations alone shows few gaps exceeding 20 stream miles and most sites represent repetitive sampling with various gears (Smith et al. 1971:4, fig. 2).

Plankton

The National Water Quality Network (NWQN) was established by the U.S. Public Health Service in November, 1957, to gather data on the major waterways of the United States. Three NWQN stations are located along the lower Mississippi River, at West Memphis, Arkansas; Delta, Louisiana (opposite Vicksburg); and New Orleans, Louisiana. Potamoplankton taken during the early years of semi-monthly sampling were reported by the Public Health Service (USPHS 1960, 1961, 1962, 1964), Williams (1962, 1964, 1966), and Williams and Scott (1962). Weber (1971) produced a key to the common diatom genera of the U.S. and sumnarized findings on their occurrence and abundance in more recent years at NWQN stations. The Environmental Protection Agency (1972) reported on 48 months of plankton samples in continuing the reconnaissance of the lower Mississippi.

In the early years of NWQN sampling 3-liter subsurface grabs were taken. Diatoms and other algal genera were enumerated in one liter, diatom species were identified in another, and invertebrate animals were identified in the remaining liter of sample. Differential counts of total plankton genera in Sedgewick-Rafter and specially-designed chambers were made at 100X. Diatom species were identified using Hyrax mounts at 970X. There is no detailed account of the handling of recent samples in the laboratory, but it is assumed that procedures approximate those outlined in Weber (1973).

Shindala et al. (1970) collected plankton at two depths from five stations near Vicksburg, Mississippi, by pumping 70 liters of water through a #20 net twice monthly. Total counts of phyto- and zooplankton in 10 fields of a Sedgewick-Rafter chamber were made at 100X.

Anonymous (1972, 1973c) reported on three months of sampling in 11 stations near Grand Gulf, Mississippi, using a Van Dorn water sampler and a Clarke-Bumpus "net" for zooplankton; their laboratory procedures were not described. Near Waterford, Louisiana, a "brief preliminary survey" of planktonic organisms was conducted in July, 1971 (Anon. 1973b); no account of their methods (field or laboratory) was given.

Bryan et al. (1973a,b) reported on plankton collected near the surface twice monthly from April through December, 1972, at nine stations near St. Francisville, Louisiana (River Bend Study Area). Phytoplankton samples were 2- to 4-liter subsurface grabs; zooplankton samples were taken by a Clarke-Bumpus (C-B) sampler fitted with a #20 (0.079 mm mesh) net and meter-net (0.505 mm mesh) towed at the surface. Water volumes of 0.6-98.0 m^3 were filtered by these gear. Phytoplankton taxa were enumerated by individual cell counts after examining 60 Whipple disc fields in a Sedgewick-Rafter chamber at 400X. Microzooplankton (i.e., protozoans, rotifers, and copepod nauplii) were enumerated by survey counts of 1 ml in Sedgewick-Rafter chambers at 100X. The entire contents of meter-net filtrates were examined and macrozooplankton counted, whereas the larger zooplankters in C-B sample filtrates were enumerated according to the method of Weber (1973).

Dotson (1966) collected 100 liters of water from each of nine stations in the Grand Lake area of the Atchafalaya Basin on an irregular basis from September, 1964, to May, 1965. Some stations were visited frequently over a 2- or 3-month period, while others were rarely sampled. In some stations only surface samples were taken, while at others samples were taken at several depths. All samples were filtered by #25 silt bolting cloth. Ten Whipple disc fields were counted in a Sedgewick-Rafter chamber at 100X. Colony counts or arbitrary cell volume unit counts, were reported.

Bryan et al. (1974) sampled surface phytoplankton by 2-liter grabs at 11 stations in the Atchafalaya Basin. Semi-monthly visits were made from August, 1973, through February, 1974. The samples were sedimented for 24 hours and centrifuged according to the method of the American Public Health Association (1971). Individual cell

counts for each taxon were reported after examining 60 Whipple disc fields in a Sedgewick-Rafter chamber at 400X. Zooplankton was sampled at the Atchafalaya Basin stations by 3-minute tows with half-meter (#20 mesh) and meter-nets (#0 mesh) at approximately 2 knots. Samples were counted using a modification of the methods recommended by Weber (1973). These modifications were necessary because of the tremendous volume of suspensoids in the filtrate of samples from most habitats.

The aforementioned studies showed that diatoms (especially *Cyclotella* and *Melosira* spp.) generally dominate the phytoplankton populations of the lower Mississippi River, with certain chlorophytes (especially *Scenedesmus* spp.) contributing significantly. Short-term blooms of blue-green algae (*Oscillatoria* and *Anacystis* spp.) were witnessed in early and late summer, 1972 (Bryan et al. 1973a). In the Atchafalaya River diatoms also dominated, although chlorophytes were more speciose. Microzooplankton populations were comprised mainly of rotifers (especially *Keratella, Branchionus*, and *Polyarthra* spp.); immature copepods; and cladocerans (especially bosminids), respectively. But rotifers, copepod nauplii, and bosminid cladocerans rarely appeared in meter-net samples. The latter primarily included larger cladocerans (daphnids, sidids, holopedids); adult copepods; decapod crustacean and fish larvae; and drift organisms (mainly insect larvae). These findings corroborate the conclusion of Ahlstrom (1969), that no single gear can give an adequate appreciation of the zooplankton.

Benthic Invertebrates, Commercial Crustaceans, Aufwuchs

The larger invertebrate animals which live in association with the bottom or free submerged substrates are the most poorly-known organisms of the lower Mississippi/Atchafalaya Rivers (Fig. 1, Table 1). Classical references on the taxonomy of North American invertebrates contain occasional mention of the occurrence of various forms in our study area. Only six studies involving repetitive, standardized sampling of benthic invertebrates, commercial crustaceans, and/or aufwuchs were found.

Gunter (1937) reported on nine months of experimental funnel-trapping of river shrimp (*Macrobracium ohione*) in the Mississippi River near Baton Rouge, Louisiana. His catches were much greater in warm than in cold months. Sex ratio of shrimp in his samples varied, depending upon whether the females were ovigerous, although there were always many more females than males.

Cauthron (1961) used baited, cage-type traps in a one-year study of invertebrates in the Mississippi River near Baton Rouge. He identified 40 lower taxa from six animal phyla, most of which were probably representative of aufwuchs and/or drift communities.

The Grand Gulf, Mississippi, baseline survey (Anon. 1972, 1973c) included benthos sampling with a Shipek Grab and trap studies of river shrimp. Three general macrohabitats were recognized: (1) open channel areas with course, shifting sand substrates having few benthic macroinvertebrates; (2) steep clay banks with benthic communities dominated by burrowing mayfly larvae; and (3) quiet backwater areas with soft, fine-grained substrates, inhabited mainly by oligochaetes and dipteran larvae.

The Waterford, Louisiana, study (Anon. 1973b) recorded river shrimp and blue crabs in trawl samples and used a diver-operated suction device for benthic sampling. Two benthic assemblages were recognized: a community dominated by oligochaetes in the "fine brown ooze" of low-current areas and a mayfly-mollusk assemblage associated with clay substrates in high-current areas.

At River Bend (near St. Francisville), Louisiana, a fully-weighted Petersen Grab was used monthly to sample at five stations across five Mississippi River transects (Bryan et al. 1973a, DeMont and Sheppard 1973). At least 31 lower taxa, representing five invertebrate phyla, were recorded. Community/substrate associations similar to those reported at Grand Gulf were observed, with greatest diversities and densities at nearshore stations and extremely sparse populations in midstream areas. Changes in faunal composition and relative abundance occured in winter/spring (high-water) versus summer (low-water) periods.

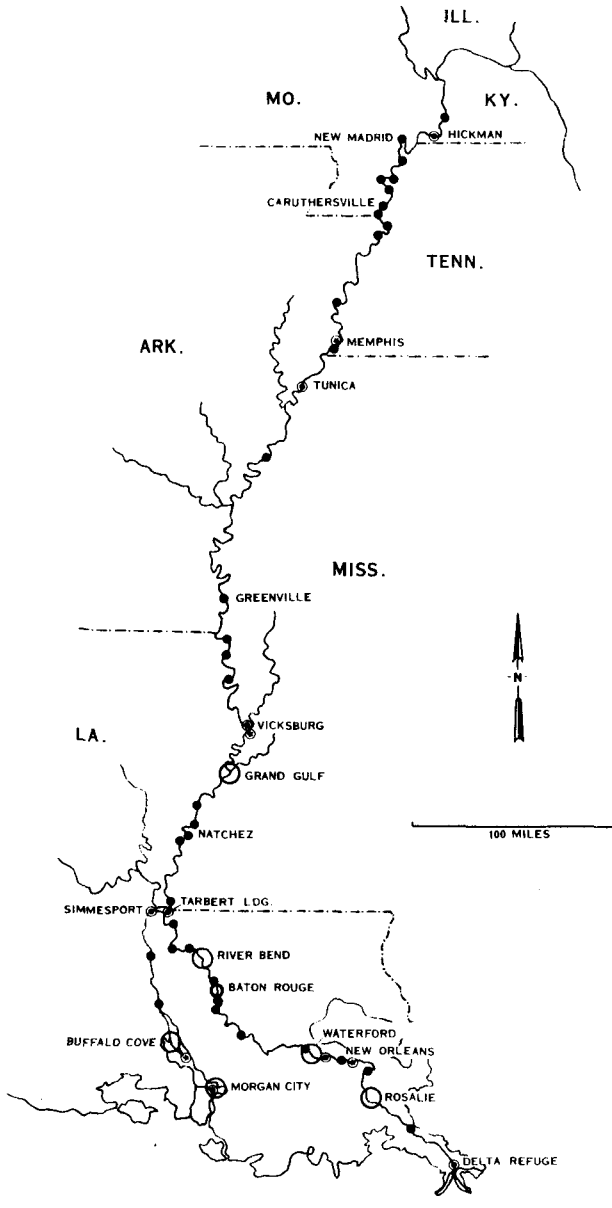

Figure 1. Distribution of biological investigations in the lower Mississippi/Atchafalaya Rivers. (• = isolated fish collection records; = repetitive fish sampling; = plankton studies; = benthos studies; = holistic studies.

Petersen Grab samples were taken near each shoreline and at midstream across nine transects along the lower Atchafalaya River, Miles 55 to 115 (Bryan et al. 1974). Forty lower taxa representing six phyla were recorded. The relatively complex hydrography of this region resulted in the occurrence of a greater variety of substrates, but the same general community/substrate associations were encountered as in the aforementioned studies of the main Mississippi channel.

Fishes

The most extensively-studied organisms in the lower Mississippi/Atchafalaya Rivers are the fishes. As noted by Bryan et al. (1973a:E-40), however, there is still pitifully little information on even the economically-important species. Forty-five documents were found to contain at least some reference to the presence of specific kinds of fishes in the lower Mississippi mainstem and/or the Atchafalaya River. Hay (1881) and Bean (1884) have been cited by some modern authors as including references to lower Mississippi River fishes, but upon close insepction neither proved pertinent to the river *per se*, or even to the drainage.

Many of the classical works on North American ichthyology mention the occurrence of various species in the lower Mississippi River without reference to documented collections (e.g. Rafinesque 1820; Forbes and Richardson 1908, 1920; Hubbs and Lagler 1948, 1958; Trautman 1957; Moore 1957, 1968). Several regional studies include allusions to the presence of certain fishes in the lower Mississippi and/or Atchafalaya Rivers without noting precise localities (Jordan 1884; Hussakof 1911; Fowler 1933, 1945; Gowanloch 1933; Hildebrand 1933; Russell 1936; Lambou 1963; Lantz 1973; Anon. 1973a).

Most of the locations marked on Figure 1 and identified in Table 1 are the sites of isolated fish collection records, reported mainly in the taxonomic or zoogeographic literature (see citations in Table 1). There is considerable redundancy in this literature, in the sense that many of the distributional records, reported under separate titles, stem from a few isolated collections housed in the ichthyological museums of the following institutions: Academy of Natural Sciences of Philadelphia; Illinois Natural History Survey; Mississippi Game and Fish Commission; Northeast Louisiana State University; Tulane University; United States National Museum; University of Alabama; University of Kansas; University of Michigan; and University of Texas. Although unreported in formal publications, additional collections of fishes from the lower Mississippi/Atchafalaya Rivers are deposited at Louisiana State University (Museum of Natural History and Fisheries Collection); the University of Louisville; the University of Missouri; and the University of Tennessee (Knoxville).

Only four studies have involved repetitive sampling of fishes with relatively standardized methods in the lower Mississippi/Atchafalaya Rivers. Anonymous (1969:159-213) used gill, trammel, and hoop nets eight times annually, 1966 through 1968, at seven stations (Fig. 1, Table 1). Although each station included at least some netting sites in main channel habitats, the bulk of sampling effort was exerted in backwaters, sloughs, and other waters directly-connected with the rivers. The report concluded (p. 166) that a "favorable commercial and sport fish population" then existed in the lower Mississippi/Atchafalaya Rivers. It was felt that gill and trammel nets were more efficient than hoop nets for river sampling.

Table 1. Historical review of biological studies of the lower Mississippi and Atchafalaya Rivers.

Location	River Mile(s)	Subject Area Plankton	Benthos+	Fishes	Source(s)
MISSISSIPPI MAINSTEM					
Below Wolf Island, Mo./Ky.	930*			X	Suttkus and Clemmer (1968)
Hickman, Ky./Mo.	920-926			X	Anonymous (1969); Pflieger (1971)
New Madrid, Mo./Ky.	890*			X	Pflieger (1971)
Tiptonville, Tenn./Mo.	874*			X	Barnickol and Starrett (1951); Bailey and Cross (1954); Pflieger (1971)
Stewart Towhead, Mo./Tenn.	870*			X	Pflieger (1971)
Little Cypress Bend, Mo./Tenn.	865*			X	Pflieger (1971)
Island No. 14 Chute, Mo./Tenn.	858*			X	Pflieger (1971)
Caruthersville, Mo./Tenn.	846*			X	Barnickol and Starrett (1951); Bailey and Cross (1954); Pflieger (1971)
Brasher, Mo./Tenn.	835*			X	Gilbert and Bailey (1962); Bailey and Allum (1962)
Wright's Point, Ark./Tenn.	820*			X	Black (1940); Gilbert and Bailey (1962)
Barfield, Ark./Tenn.	810*			X	Black (1940); Hubbs and Black (1947); Olund and Cross (1961)
Butler, Ark./Tenn.	777*			X	Tulane Univ. Fish Collection
Memphis, Tenn./Ark.	735*	X		X	Hay (1883); Hubbs and Black (1947); USPHS (1960); USPHS (1961); Gilbert and Bailey (1962); USPHS (1962) Williams (1962); Williams and Scott (1962); USPHS (1964); Williams (1964); Williams (1966); Weber (1971); EPA (1972); Univ. Tenn. Fish Collection
Tunica, Miss./Ark.	682-697			X	Anonymous (1969)
Fair Landing, Ark./Miss.	633*			X	Buchanan (1973a,b)
Greenville, Miss./Ark.	540*			X	Cook (1959)
Wilson Point, La./Miss.	500*			X	Gilbert and Bailey (1962); Douglas (1974)
Opposite Lake Providence, La./Miss.	485*			X	Suttkus and Clemmer (1968); Swift (1970);

					Douglas (1974)
Alsatia-Salem Bend, La./Miss.	470*			X	Douglas (1974)
Vicksburg, Miss./La.	432-452*	X		X	Hay (1883); Hubbs and Black (1947); Cook (1959); USPHS (1960); USPHS (1961); USPHS (1962); Williams (1962); Williams and Scott (1962); USPHS (1964); Williams (1964); Williams (1966); Suttkus and Clemmer (1968); Anonymous (1969); Shindala et al. (1970); Weber (1971); EPA (1972); Conner and Guillory (1974); Douglas (1974)
Grand Gulf, Miss./La.	405-408*	X	X	X	Cook (1959); Anonymous (1972, 1973c); Conner and Guillory (1974); Douglas (1971)
Waterproof, La./Miss.	381*			X	La. St. Univ. Fisheries Collection
Fairchild's Bend, La./Miss.	372*			X	Douglas (1974)
Natchez, Miss./La.	363*			X	Hubbs and Black (1947); Cook (1959); Suttkus and Clemmer (1968); Douglas (1974)
Willetts, La./Miss.	357*			X	Douglas (1974)
Coochie, La./Miss.	316*			X	La. St. Univ. Fisheries Collection
Tarbert Landing, Miss./La.	300-310			X	Anonymous (1969)
Opposite Old River, La.	298*			X	Swift (1970); Gilbert and Bailey (1972); Douglas (1974)
Iowa Point, La.	279*			X	La. St. Univ. Fisheries Collection
St. Maurice Towhead, La.	271-273			X	La. St. Univ. Fisheries Collection
River Bend Study Area, La.	256-266	X	X	X	Bryan et al. (1973a,b); DeMont and Sheppard (1973); Conner and Guillory (1974); Guillory (1974); Douglas (1974)
Baton Rouge, La.	228-236		X	X	Gunter (1937); Cauthron (1961); Suttkus and Clemmer (1968); Douglas (1974)
Ben Hur Borrow Pit, La.	219*			X	Robichaux (1961)

Plaquemine Ferry, La.	208*			X	La. St. Univ. Fisheries Collection
St. James Borrow Pit, La.	156*			X	La. St. Univ. Zoology Dept.
Waterford, La.	130*	X	X	X	Anonymous (1973b); Gulf South Research Inst.
Norco, La.	128*			X	Gilbert and Bailey (1962); Suttkus and Clemmer (1968); Swift (1970); Douglas (1974)
Luling, La.	117-125			X	Anonymous (1969)
New Orleans, La. (Huey P. Long Bridge)	106*				Gilbert and Bailey (1962)
New Orleans, La. (Carrollton Bend)	104	X		X	Bailey and Cross (1954); USPHS (1960); USPHS (1961); USPHS (1962); Williams (1962); Williams and Scott (1962); USPHS (1964); Williams (1964); Williams (1966); Weber (1971); EPA (1972)
English Turn, La.	80*			X	Tulane Univ. Fish Collection
Rosalie, La.	61*	X	X	X	Gulf South Research Inst.
Pointe a la Hache, La.	48*			X	Suttkus (1956); Gilbert and Bailey (1962); Douglas (1974)
Delta National Refuge, La.	3*			X	Kelley (1965); Douglas (1974)
ATCHAFALAYA RIVER					
Simmesport, La.	0-6			X	Gunter (1938); Anonymous (1969)
Melville, La.	30*			X	Evermann (1899); Gilbert and Bailey (1962)
Near Henderson, La.	60*			X	Gilbert and Bailey (1962); Snelson (1973)
Buffalo Cove Study Area, La.	72-95	X	X	X	Bryan et al. (1974)
Grand Lake, La.	95-100*	X			Dotson (1966)
Morgan City Study Area, La.	110-115	X	X	X	Evermann (1899); Anonymous (1969); Bryan et al. (1974)

+Includes benthic invertebrates, commercial crustaceans and aufwuchs.
*Approximated by present authors.

At Grand Gulf, Mississippi, seines, trammel nets, gill nets, hoop nets, and trawls were used monthly at eight stations for a year, although only the first three months of data were discussed in Anonymous (1972, 1973c). Fifty-five species were recorded during this study, with greatest diversities and numbers occurring in quiet backwater samples. Manuscripts containing additional information are under preparation (Bruce Turner, pers. comm.).

Anonymous (1973b) reported on a preliminary survey of fishes near Waterford, a few miles upstream from New Orleans. Gill nets and trawls were used in nine days of sampling in July, 1971. Fourteen species, including three marine forms, were taken. Longer-term studies have been conducted at this site, but the results are as yet unpublished.

Bryan et al. (1973a) and Guillory (1974) reported on 15 months of sampling with seines, trammel nets, and hoop nets in the vicinity of St. Francisville, Louisiana. Guillory (op. cit.) prepared a table summarizing all known records of fishes in the lower Mississippi River, 77 of which were encountered during his study. He found diversity to be inversely related to discharge, except during the spring, 1973, flood, when numerous fishes of floodplain swamps and tributary habitats were displaced into the main river channel. Relative abundance of fishes was generally highest in the spring, mainly due to recruitment of young into populations.

Bryan et al. (op. cit.) presented a brief synopsis of reproductive data and a discussion of general trophic relations, based in part on local observations. Onset of spawning was generally 1-3 months earlier than reported for the same species in more northern latitudes; in some species the entire reproductive schedule appeared to be advanced as compared with northern populations, while in others the spawning season began earlier and was comparatively protracted. Stomach contents of certain economically-important fishes suggested that all the major benthic organisms were widely used as food, especially burrowing mayfly nymphs.

Two study areas in the lower Atchafalaya River were studied for nine months using seines, trammel nets, and hoop nets (Bryan et al. 1974). Seventy-seven species, including eight marine forms, were encountered. Reproductive and food habit data were also gathered.

DISCUSSION

Although there has been occasional overlap in methodology, biological research in the lower Mississippi/Atchafalaya Rivers to date consists largely of a hodgepodge of localized, inconsistent studies. Relatively wide geographic coverage with standardization of procedures seems to have been attained only when the topic of study was limited (e.g., plankton, NWQN studies; commercial and sport fishes, Anon. 1969).

On balance, it appears that we have accomplished little more than a cursory inventory of the biota and a gross appreciation of its spatial and temporal distribution in main-channel habitats. When one considers that identifications, aside from the fish work, have usually been carried only to the generic or higher levels, even this qualitative component of our knowledge loses some of its significance.

Many of the more recent studies, to be sure, have generated quantitative data, often by means of some of the most sophisticated, reliable techniques available. But what these numbers mean in the context of a constantly-fluctuating system is as yet poorly understood. It is apparent from some of the longer-term studies cited above that seasonal visits to large river channels, without several years of intensive background sampling, are of limited value as baseline surveys. Sampling of the biota in such systems should be at least semi-monthly, if not weekly. Otherwise, short-term "normal" changes in populations will go unnoticed and may be misinterpreted in the future. Moreover, the simplistic approach of sampling only one community (extrapolating trophic exchanges from other circumstances) or sampling with only one type of gear will usually lead to misunderstandings of natural events in a system.

In short, we are inclined to disagree with Bardach (1972:6), who feels that enough information is at hand to engage in predictive modeling of human impacts on river ecosystems. This may be true of some northern salmon and trout streams, where experience has accumulated for decades, but it can scarcely apply to the lower Mississippi/Atchafalaya Rivers. Hynes (1970:110-111, 246-247, 255, 313-318) noted several crucial gaps in the knowledge of stream biota in general, most of which are compounded in large, turbid rivers.

Because of the awesome logistical and methodological problems of sampling in large rivers, with the attendant expense, relatively intensive, holistic studies have only recently been initiated in the lower Mississippi/Atchafalaya Rivers. Such studies began, of course, only by virtue of the National Environmental Policy Act (NEPA), and they are localized in areas where major industrial and/or engineering developments are planned. Ambiguities in the NEPA requirements have understandably led to vacillation on the part of sponsors and planners of the holistic studies as well as the agencies responsible for evaluating the research. We therefore applaud the recent movement by various governmental and private organizations to develop generally-applicable criteria for environmental baseline and other ecological studies.

The apparent success of the Upper Mississippi River Conservation Committee leads us to conclude that formation of a similar consortium could greatly facillitate future research and management of natural resources along the lower Mississippi Valley.

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