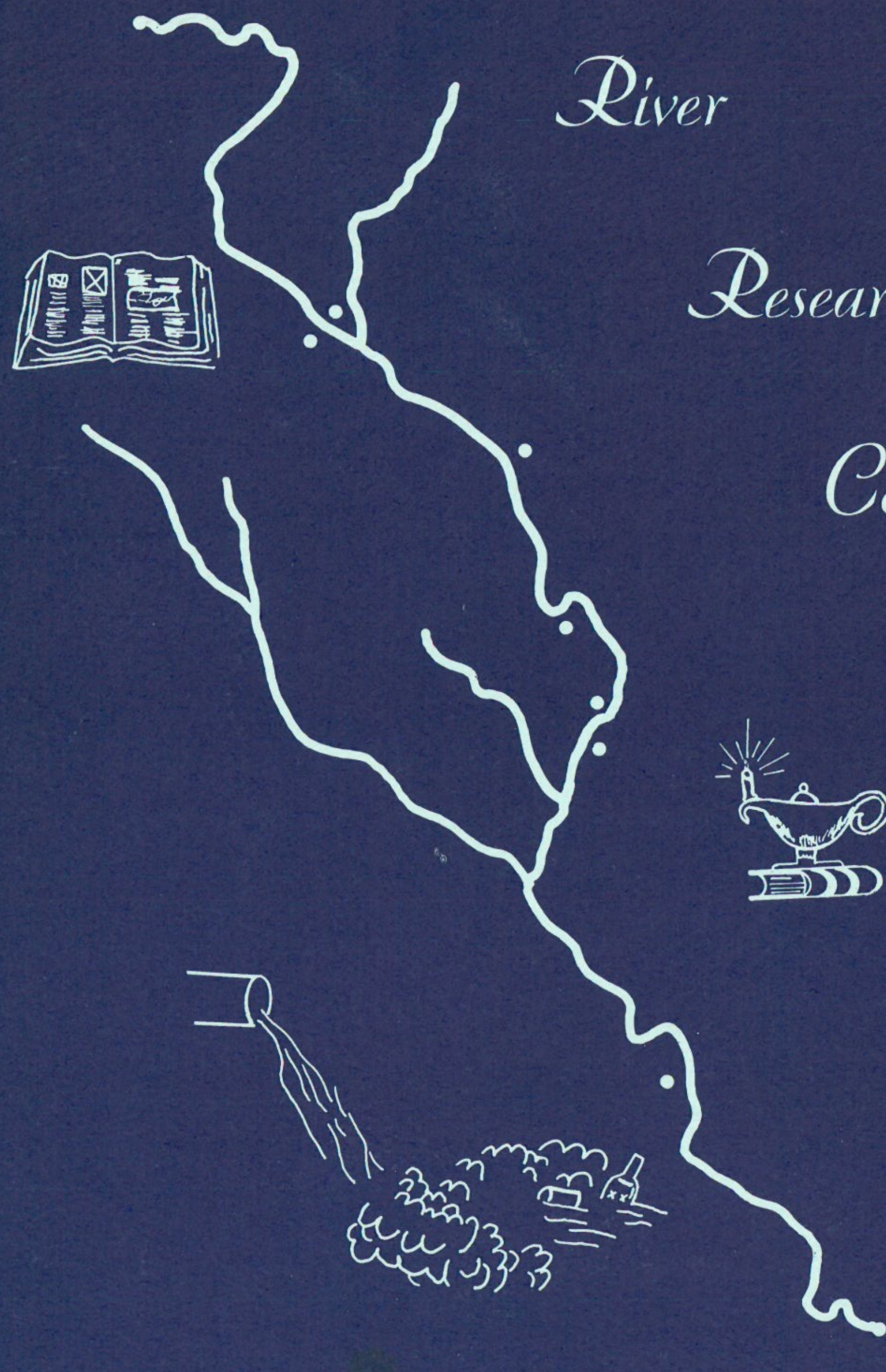
Mississippi River Research Consortium



Transactions of the 2nd Annual Meeting

WISCONSIN STATE UNIVERSITY, LA CROSSE

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TRANSACTIONS OF THE SECOND ANNUAL MEETING OF THE MISSISSIPPI RIVER RESEARCH CONSORTIUM

June 6-7, 1969

Wisconsin State University

La Crosse, Wisconsin

EXECUTIVE COMMITTEE

Thomas O. Claflin, Ph.D. - President

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Symposium — The Biological Effects of a 12-foot deep channel on the Mississippi River

The Panel Members

RAYMOND C. HUBLEY, JR.

Raymond C. Hubley, Jr. is employed by the Bureau of Sport Fisheries and Wildlife and serves as coordinator of the Upper Mississippi River Conservation Committee.

Mr. Hubley attended Wisconsin State Unievrsity at La Crosse and received his bachelor's degree in biological sciences from Winona State College, Minnesota. He later did graduate work at the University of Minnesota and George Washington University.

After serving five years with the Wisconsin Department of Natural Resources as a Mississippi River survey biologist at La Crosse, Mr. Hubley joined the federal Bureau of Sport Fisheries and Wildlife in 1963. In 1964, he attended the Department of the Interior's management training program in Washington, D.C., and subsequently worked in the Department's Lower Colorado River Land Use Office at Yuma, Arizona.

Mr. Hubley returned to the river basin studies program of the Bureau in 1966 and by September 1967, was named to the position of coordinator of the Upper Mississippi River Conservation Committee at Davenport, Iowa.

The Committee is an organization of state and federal conservation agencies from Wisconsin, Missouri, Minnesota, Iowa and Illinois. Its purpose is to promote wise use and conduct joint studies of the upper Mississippi River's fish, wildlife and recreation resources. These activities extend over 900 miles of river from Hastings, Minnesota, to Caruthersville, Missouri.

MACK DIXON

Mr. Dixon was born in Ashland, Kentucky, on 29 January 1931. He served in the U.S. Air Force for four years during the Korean conflict. After discharge from the Air Force, he attended the University of Kentucky and received a B.S. degree in Engineering from that school in 1960. He worked for the Soil Conservation Service in Kentucky on watershed work and various engineering programs prior to joining the U.S. Army Corps of Engineers. From 1963 until 1965 he served in the Planning Branch of the Huntington District, Corps of Engineers. He has been in the Planning Branch of the Rock Island District, Corps of Engineers since 1965 and is presently assigned as coordinator of the 12-foot channel and Year-round Navigation studies.

DONALD V. GRAY

Donald V. Gray, Refuge Manager, Upper Mississippi River Wildlife and Fish Refuge, was graduated from Michigan State College in 1932 with a B.S. degree in forestry.

After spending five and one-half years with the U.S. Forest Service on the Huron National Forest, eastern lower Michigan as a Wildlife Manager, he transferred to the position of Refuge Manager at the St. Marks NW Refuge, Florida in 1938. In 1941 he transferred to the newly established Santee NW Refuge, South Carolina, and left there in October, 1944 to spend 19 months with the U.S. Navy in World War II. All duty with the Navy was spent in the Pacific Theater.

Upon returning from active military duty in 1946, he was assigned to the Horicon NW Refuge in Wisconsin and remained there until October 1949 when he was transferred to the then Lower Souris NW Refuge (now J. Clark Salyer Refuge) and remained there until March 1958 when he assumed his current position in Winona.

KEN SMITH

Gloom on the face of Ken Smith reflects a black mental pool of depressing thoughts about the many obstacles to his personal idea of bliss. His dream of Paradise puts him in a canoe on the Mississippi with a monster bass tearing up the aquatic growth and blistering his reel-breaking thumb, with plenty more hungry lunkers lurking roundabout — and not a towboat in sight!

He's officially concerned as chairman of the Upper Mississippi River Survey Committee of the Izaak Walton League of America. His interest in the outdoors has pushed him into jobs nobody else wanted very much, such as president of the Illinois Federation of Sportsmen's Clubs and secretary of the Illinois Izaak Walton League. He has been a member of the Outdoor Writers Association of America more than 30 years, and about 20 years ago helped found the Outdoor Writers of Illinois — parent organization of the Association of Great Lakes Outdoor Writers.

For 13 years he's been in the advertising department of John Deere in Moline, Illinois. Before that — a dozen years in a Chicago advertising agency, and an earlier dozen on the editorial staff of the Moline Dispatch, where he and Deacon Hagelin founded the still-flourishing outdoor column, Prairie Trails.

WILLIAM H. DIEFFENBACH

Bachelor of Science and Masters of Science in Fisheries Science at Colorado State University, Fort Collins, Colorado.

Employed as Biologist in Water Quality Studies by Missouri Department of Conservation — 3 years.

Presently Water Resources Specialist — mainly coordinating river basin studies with Corps of Engineers and other state and federal agencies.

THE PRESENTATION

Mr. Raymond C. Hubley, Jr.

UMRCC & THE 12-FOOT CHANNEL

Plans for the establishment of a 12-foot channel in the Mississippi River have been pending for many years. On May 19, 1949, the Corps of Engineers presented a summary of such plans to the Upper Mississippi River Conservation Committee. It was explained that Congress had directed the Corps of Engineers to determine the feasibility of a 12-foot navigation channel. The Corps' findings were then to be presented to Congress for their judgment and implementation, if practical. From all appearances, the project did not mature because high development costs at the onset of the Korean War made it economically impractical. Congress has recently appropriated funds to the Corps of Engineers to re-evaluate its 1949 proposal.

The Upper Mississippi River Conservation Committee was very much concerned about the effects of development at that time. We still are!

The development of a 12-foot navigation channel could deplete our existing fishery resources both in quantity and quality.

> Wildlife habitat could be dewatered, flooded, or filled—
> Fish spawning runs impeded and habitat eliminated—
> Flows to backwaters terminated with resultant fish kills—
> Natural scenic areas or historic sites impounded or disturbed by spoil disposal—

These are but a few of the more direct effects. The maintenance of a 12-foot system can also be detrimental.

Our Committee is working to insure that this will not occur. Better still, we are using the positive approach — if there is to be a 12-foot channel project, fish and wildlife and the multipurpose role now being played by the Mississippi should be a primary consideration. Neither the mainstem nor the tributaries should be diminished in value solely for convenient water transportation and waste disposal.

Conservation interests were first informed of the Corps' current re-evaluation activity at a meeting in Rock Island, Illinois on March 26, 1968. District Engineer, Colonel Walter Gelini, of Rock Island District has the Corps field coordination responsibility for the three Corps of Engineers Districts on this study. These include St. Paul, Rock Island, and the St. Louis Districts.

At the Rock Island session, four alternatives for channel development were presented — 3 feet of dredging; 2 feet of dredging and 1 foot of raise; 2 feet of raise and 1 foot of dredging; and 3 feet of raise over the current water levels. For example, development could entail 3 feet of raise in Pool 5, 3 feet of dredging in Pool 19, and 2 feet of dredging and 1 foot of raise in Pool 21.

At this time, it is my impression that each Corps' district is considering recommendations for each pool as proposed in 1949 and modification to their development proposals to assure economic feasibility.

The plan of improvement will probably include some structure modifications, dredging, land acquisition, and the construction of wing dams, revetments, and dikes.

All conservation agencies need to assess their current natural resource stock and be ready to pursue the necessary accommodations. Two questions stand out—

> What do we have today?
> What do we intend to have for fishermen and hunters 20 or 30 years from today?

I don't believe we can afford, nor should we allow resource "accommodation by accident," which occurred in the 9-foot channel development. With imagination and perseverence, conservation interests can be provided for through:

1. Construction of fishing piers or jetties.
2. Development of access areas.
3. Construction of notches or culverts to maintain water flow in backwater areas.
4. Construction of dikes with inlet and outlet water control structures.
5. The use of gabions to contain spoil for dike construction, and for fishery habitat improvement.
6. Selective timber clearing.
7. Landscape treatment of dredge spoil sites through grading and the planting of trees, shrubs and wildlife plants.
8. Acquisition of conservation lands for fish, wildlife, and recreation purposes.

These are but a few of the more important recreational innovations which should be considered with the development of a 12-foot channel.

I think some old-timers feel that the 12-foot channel study is an attempt to renovate an old corpse. Not so! It is significant that navigation structures built in 1930 will have completed their cost-programmed project life by 1980. Also, the Mississippi Valley Association is legislatively potent and is greatly concerned about navigation costs in readjusting tows at the mouth of the Ohio River. They have a strong lobby for 12-foot channel development. Legislative support is already apparent in some states and others are dormant but likely promoters.

Rock Island District Engineer, Gelini, stated that "the 12-foot channel is here — today or tomorrow. It's already in the lower valley and Ohio River." The problem is "how then can we provide for conservation interests in planning for the development of a 12-foot channel?" A few possibilities were mentioned earlier.

To date, several pool study groups have met to explore procedures for evaluation. Wisconsin, Iowa, and Bureau of Sport Fisheries & Wildlife biologists met at La Crosse, Wisconsin. Illinois, Missouri, the Bureau, and the Corps of Engineers got together at Quincy, and again on a Corps towboat in the St. Louis District pools. These field sessions will result in early field coordination and the development of resource reports for each pool.

We have a tight reporting schedule and must not delay in devoting sufficient manpower to meet fish and wildlife needs in the development of the 12-foot navigation channel.

Mr. Mack L. Dixon

Thank You Mr. Hubley. Members of the panel, consortium members, (ladies) and gentlemen. I am pleased to be with you this afternoon and to have the opportunity to participate in this symposium.

As many of you probably know, the authorization from Congress for the Corps of Engineers to undertake the 12-foot channel study goes back a few years to 1943. Work was started on the study in 1944, was continued at irregular intervals until about 1952, and then suspended because of the Korean conflict.

In 1966 Congress appropriated funds to resume the study. One of the first steps prior to resumption of the work was to hold public hearings. Public hearings were held in St. Louis, Missouri; Davenport, Iowa; and Minneapolis, Minnesota, in June 1967.

I would now like to refer to this map of the Upper Mississippi River and to point out the rivers and river reaches being considered in the 12-foot channel study.

a. The Mississippi River from the mouth of the Ohio River to Minneapolis, Minnesota.

b. The Black River from its mouth to a point 1.4 miles upstream.

c. The St. Croix River from its mouth to Stillwater, Minnesota.

d. The Minnesota River from its mouth to Chaska, Minnesota.

A 12-foot channel is being studied on the Illinois Waterway; however, the study will be the subject of a separate report which will be prepared by Chicago Engineer District.

The scope of our study was recently expanded. By Congressional Resolution adopted 10 July 1968, the Corps of Engineers was requested to determine the advisability of providing additional or duplicate locks on the Mississippi River. This study of additional locks has been made part of the Mississippi River 12-Foot Channel Study. The study will consider providing an additional lock to supplement each of the existing single locks. The study of additional locks has not been fully worked out, since it must be integrated into the 12-foot channel plan of study.

Most of the locks on the Mississippi River have a usable lock chamber measuring 110 feet in width and 600 feet in length. With today's powerful towboats pushing larger numbers of barges, it becomes necessary to perform a large number of double lockages. In other words, when a tow is too long to pass through a 600-foot lock in a single lockage, it is necessary to divide the tow and to make two separate lockages. Double locking is time consuming and requires about one hour and 20 minutes. On the other hand, a tow which can be single-locked requires only about 20 minutes. So you can see that there is an advantage to having locks which will accommodate the longer tows.

I would now like to briefly describe the alternative considerations for obtaining a 12-foot channel in the pool or slack-water areas.

a. We will consider dredging the bed of the river to obtain the additional depth. Now, only that part of the river which is considered the navigation channel will be dredged. Generally, a channel width of 400 feet, with additional widths in bends, is maintained on the Mississippi River from the mouth of the Missouri River to Minneapolis, Minn.

b. We will also consider modifying the navigation dams so that the pool level can be raised to obtain the additional depth.

c. We will consider a combination of dredging and pool level raises to obtain the additional depth. As an example, we would consider dredging two feet and raising the pool levels one foot, etc.

Obtaining the required depth on the open-river reach of the Mississippi River from the Chain of Rocks Canal to the mouth of the Ohio River will involve different considerations. The open-river section is unlike the slack-water areas in that it is not a permanent pool created by navigation dams. The problem in the open-river reach is considered to be greater than in the slack-water or pool areas. Contraction is an alternative being considered for providing the required depth in the open-river reach. Contraction involves placing dikes at various intervals along the reach of river. The dikes are generally placed perpendicular to the flow of the river and extend from the shore a distance toward the center of the channel. This method is similar to the use of wing dams on the Upper Mississippi River to obtain a dependable channel before the construction of locks and dams. The St. Louis District is currently studying contraction works on a 14-mile river reach between river miles 140 and 154. The results of this prototype study will aid in determining whether a 12-foot channel can be accomplished in the open-river reach by contraction. In addition to studying contraction works, a system of locks and dams will be considered downstream from St. Louis, Missouri.

Remedial works and relocations are a big item of work associated with pool levee raises. For instance, many miles of railroad and highway parallel both sides of the Mississippi River, and tracks, bridges, and culverts are involved. Consideration must be given to protecting railroads and highways from the effects of wave wash. The effect of pool level raises on drainage districts is another major task, involving studies of the increase in seepage, and the adequacy of existing pumping equipment in the drainage districts. Some farm lands may be rendered unproductive, or less productive, by seepage, and this matter will be given careful study.

If dredging were undertaken to obtain a 12-foot channel, rock would have to be removed from many reaches of the river. The rock generally consists of limestone and/or conglomerate. As an indication of the effort required to remove rock, it is estimated, on a volume basis, that the removal of hard rock would cost approximately 50 times the cost of hydraulic dredging.

One of the questions *always* asked concerning the study is "When will it be completed?" With the added study of additional locks, we know that the study will require a significant amount of additional time. All I can say at this time is that a new time schedule is being worked out.

The 12-foot channel study is quite a large study which involves two Corps of Engineers Divisions, North Central Division and Lower Mississippi Valley Division. At the district level it involves St. Paul District, Rock Island District, and St. Louis District. Each of the three districts is performing the engineering studies and determining costs for the improvement within their respective district. North Central Division is developing the expected benefits pertaining to commercial navigation. In order to determine the economic feasibility of the project, the total benefits which would result from the project will be weighed against the total project costs. If the ratio is less than unity, the project will not be economically justified.

The Corps is making progress on the study. Much time has gone into developing a plan of study to be followed by each of the Corps elements involved in the 12-foot channel study. The study plan, which is essentially completed, will serve as a study guide as well as an invaluable tool in insuring overall consistency in the study. Progress has been made by the districts in laying out the work to be performed, and obtaining needed data. The study of a number of pools has been completed by St. Paul, St. Louis, and Rock Island Districts. North Central Division is progressing on the economics of the study.

The Corps of Engineers established coordination with recreation, fish and wildlife interests very early in the study. A conference was held in Rock Island District in March 1968 with representatives of conservation interests of state and Federal agencies for the purpose of establishing early planning activity on the part of recreation and fish and wildlife interests. The Corps of Engineers has participated in subsequent meetings with these interests. On a number of occasions, Corps of Engineers personnel have toured reaches of the Mississippi River with fish and wildlife interests to answer questions about the river relating to navigation.

We of the Corps of Engineers hold as one of our principal objectives, the best possible development of the water resource to serve the uses and needs of a modern, highly industrialized society, while still preserving fish and wildlife, recreational, and aesthetic factors. These factors are every day becoming more important to everyone. A navigation project need not be inconsistent with the demands of recreation and fish and wildlife, nor need it destroy aesthetic values. We are trying to bring all interests into our planning activities, for no resource program can fully accomplish its purposes without the general consent and cooperation of all the people it is to serve.

In closing, I would again like to say it is a pleasure to be with you this afternoon. I came to La Crosse not only to participate in this symposium, but to learn more about the biological aspects of our river. I look forward to a very fruitful meeting. Thank you.

Mr. Donald Gray

The Upper Mississippi River Wildlife and Fish Refuge was established in 1924 for the general purpose of protection of all native flora and fauna in their typical communities in the valley. Following the establishment of the 9-Foot Channel in the mid-thirties and early forties, the typical communities were changed, but wildlife resources were given full recognition by the Bureau of Sport Fisheries and Wildlife and the Corps of Engineers in formalizing the use of 9-Foot Project lands for wildlife management purposes.

Over the years, the communities have become more or less stabilized, and now with the advent of a possible 3' increase to a 12-Foot Channel, the method of achieving same may have a serious effect on these habitats.

There are three means of creating a 12-Foot Channel—(1) by dredging, (2) by raising pool levels and (3) by a combination of both. In considering these alternatives, I would like to discuss the effects of the dredging alone and the alternative of raising the level of the pools with or without accompanying dredging.

In assessing the general effects on habitat under these two alternatives, let us first consider the raising of the pool levels:

1. Open water areas — increased depths may increase turbidity, cutting down on light penetration which may affect submergent aquatics to their detriment. Increased turbidity may have the effect of removing valuable aquatic plants so necessary to the sustenance of diving ducks particularly and many puddle ducks. In addition, a raise in the pool level may have the effect of creating a reduction in the allowable hunting areas because of the fact that most states prohibit open water shooting, and certainly a raise in the level will extend the amount of area devoid of emergent vegetation.
2. Marshes — raising water levels will result in a loss of some of the present marsh areas that may or may not be compensated for by inundation of the present timber areas. There are no extensive uplands that could form marshes similar to that obtained in the 9-Foot Channel flooding. The new marsh must come then from the flooded timber. While eventually the conversion of timber lands to marsh lands may occur, the loss of the present marsh will be immediate and thus puddle ducks, muskrats, and other wildlife dependent upon marsh habitat will suffer. Bank rats, beaver and other denning animals in the flood plain will be reduced because of increased water elevation flooding out slough banks.
3. Timber lands — there will be a net decrease in the timber lands because permanent flooding above root crowns will kill off many trees. Erosion of islands will occur when trees die and wind and wave action pound on the exposed soil. Windfall will result on edges of

areas not permanently submerged, creating an additional hazard to boat operations and log jams formed in running sloughs further restricting access. The actual populations of furbearers, deer, and rabbit will be greatly reduced ih such flooded areas, and the freeboard above the water areas will be greatly reduced at high water stages, thus exposing wildlife running out of their riverbottom habitat to road kill and increased predator pressure. A serious problem also is the loss in this instance of wood duck nest habitat which would result in a greater concentration of nest sites and increased exposure to predation.

In considering dredging only, the main effect is felt mainly along the main navigation channel. This deposition of large amounts of sand could pose a serious problem. High waters wash large amounts of sand into marsh areas, slough openings and sloughs. Consideration then for protection should be made in critical areas, or it adds nothing to the benefit of wildlife. With protection — either by vegetation or mechanical means such as rip-rap or revetments, it creates new habitat for furbearers, songbirds, and waterfowl nesting. Thus, the greatest hazard to wildlife in increased dredging would be sedimentation in prime marsh areas as well as the placement that might jeopardize fish habitat — particularly in the vicinity of wing dams and slough openings.

Since a diminishment of habitat results in a loss of populations, the net effect of water elevation raises may outweigh the disadvantages of the dredging only problems. We know, of course, now what we have in existence on the river and can predict quite well by dredging, but we can only guess at this point the long range effect, good or bad, of the higher pool levels. Careful decisions must be made in assessing the mode of reaching a 12' Channel so that the wildlife resource will not be unnecessarily damaged.

Mr. Ken Smith

Why don't we (and I mean every agency and individual concerned) take a long hard look at the proposed 12-foot Channel in perspective with all the problems of our Upper Mississippi River — and decide, then, whether spending a huge sum solely for navigation interests is justified?

Maybe the river needs four channels: a sanitary sewer, a storm drain, a barge canal, and a pristine dream stream for wildlife and recreation. You tell me — which would be most important?

The storm drain and sanitary sewer channels would benefit everyone — because pollution control and water management are integral with the problem of total environment.

The recreation-wildlife channel would have broad popular appeal, of course, to fishermen, hunters, boaters, campers and many more. And it would be a literal lifesaver for wildlife.

Historically, the U. S. Engineers have thrown their excellent manpower resources and energies and equipment into construction and maintenance of locks and dams and control and betterment of navigation in the interest of water transportation; and into flood control, primarily through big dams and levees.

But — can't the Engineers change? I quote from the May issue of the Izaak Walton Magazine:

> "A bill that would divert the energies of the Army Corps of Engineers from building dams of questionable value to more pressing problems of water quality improvement has been introduced in Congress by Rep. Henry S. Reuss, Democrat, Wisconsin. . . His bill, H.R. 10316, would authorize the Corps to build 100-per-cent-government-financed facilities to solve the sanitary sewer problems of our big cities; also to do research and development for new methods of sewage disposal."

Why not go a step or two further? I propose that the Engineers and other powers that be look into the matter of pipelines to replace barges as a more efficient and economical transportation method — not only for moving liquid cargoes, but for bulky products such as grain and coal. There's a fertile field for research.

Or . . . would it be feasible to construct a relatively narrow multipurpose channel for commercial traffic and for carrying the effluent from municipal and industrial sewerage systems and the heated discharge from thermal power plants? That ought to keep the channel open all winter.

It would have other benefits too — such as providing efficient means of monitoring waste discharges from specific sources, and preventing spread of major pollutants including hot water to municipal and industrial water intakes and to wildlife and recreation areas.

Barges might be moved by power units on shore-based or overhead tracks, instead of by the big-wake-throwing towboats that now continually menace smaller craft — and might be even more menacing if the proposed 12-foot channel should bring on even bigger tows and greater power in towboats.

Of course, there would be problems of maintaining an optimum amount of water for operating locks, and control and diversion of water from tributaries — but wouldn't this be a worthwhile survey project for the Engineers? Safety, maintenance, and efficiency could all be enhanced — and a lot of credit could be reflected on the Corps.

Back to the question — is the 12-foot channel really necessary? Where does it come in priorities? Is a multi-million-dollar controversial subsidy to a favored segment of transportation (which competes with high-taxpaying rail and highway transportation) really justified? The railways which follow the river could carry much more freight. And highways along the river, including the Great River Road, would benefit with modernizing for safety and capacity—

including addition of lanes to accommodate boat and camping trailers, and turn-offs for scenic views.

Is this 12-foot channel project more important than protection of our environment, when we consider allocations from our already overstrained federal budget? Does anyone know what the 12-foot channel will cost? Are preliminary estimates available before the survey is complete? Are we talking $24 million; or $250 million; or a billion? Or More?

Meanwhile, the current federal allocation for aid in sewage treatment plant and sewerage projects totals $214 million for 50 states — and the share of the five Upper Mississippi states aggregates $27.9 million. Yet, these five states have requested $310 million, and the five-state needs for such facilities for the 5-year period ending in 1973 are estimated at $1,032 million. Isn't pollution control and abatement more urgent and important than a 12-foot navigation channel — in our tax-dollar priorities?

I suggest, too, that the Engineers will do themselves a lot of good in the eyes of the public if they continue to direct their talents to helping in water runoff and erosion control and flood abatement — at the source, in relatively small projects, back on the watersheds. The soil conservation districts have a sound approach. I have a farmer friend who claims that every drop of moisture that falls on his farm stays there. That may not be literally true — but he has solved his erosion and ground moisture problems by following approved conservation practices . . . and his crops, his net worth, and the bass fishing in his ponds are among the most impressive in my circle of acquaintances.

Slowdown of runoff, storage of water in dammed gullies, leveling of fields, good cropping systems — all can help our river. They can reduce flood crests, and keep most of the silt, agricultural fertilizer and pesticides, and feedlot wastes out of the river water. In the long run, they put more money in the farmers' bank accounts, and protect the basic resources for greater food production as world population grows.

I'm sure we all congratulate the Engineers for joining 13 other government agencies in a basinwide study of the Upper Mississippi watershed, to determine the potential of a myriad of small gully-stopping dams and related soil and water conservation and flood-control practices.

Maybe I've strayed away from the discussion topic — the proposed 12-foot channel. Yet, maybe, as I suggested earlier, all of us should be thinking of alternatives — because the question remains: Is the double deep-six channel really necessary? In fact — isn't the present 9-foot channel adequate? And shouldn't we first be doing the research and financing the actions necessary to solve the many other problems that plague our grand old Mississippi?

What I'm saying, in effect, is that the river belongs to everybody — and its future should be shaped accordingly.

Mr. William H. Dieffenbach

In the Missouri-Illinois reach of the Mississippi River, progress on the study of the proposed 12-foot navigation channel has been slow. Several reasons for our "deliberate" pace are apparent. Almost everyone assigned to the study has a full-time job in addition to the study. Secondly, a lack of information from the Corps of Engineers, probably due to other responsibilities, has caused delays. For instance, we have received no information on Pools 20, 21, 22 and 26 — four of the six pools we share with Illinois. We have rather complete information on Pool 25. Most of my remarks are based on data collected from a variety of sources, and concentrated on the proposals presented to us by the St. Louis Corps of Engineers through the Bureau of Sport Fisheries and Wildlife.

Our survey team made up of members of the Bureau of Sport Fisheries and Wildlife, Illinois Department of Conservation, and Missouri Department of Conservation, has all but completed the initial study of Pool 25. Pool 25 is 32 miles long, from River Mile 242 to River Mile 274, and consists of about 15,500 acres of land and water. In the study group evaluation of the two proposals made by the St. Louis Corps of Engineers: (1) 3-feet of dredge; and (2) 3-feet of dredge with channel structures and chute closing structures; we became concerned about the potential increased loss of water area and wet lands from the two proposals.

Proposal 1 (3-feet of dredge) calls for about 2 million cubic yards of initial dredging and about 700,000 cubic yards of annual maintenance dredging. It is obvious that with this type of extensive dredging, the shallow areas would soon be filled if utilized for spoil disposal. The problem of the continued maintenance dredging would make this plan — Proposal 1 — less desirable to navigation interests than Proposal 2.

With this in mind, I will concentrate on Proposal 2. We in Missouri and Illinois have had some experience with the effects channel structures and chute blocking structures have on rivers such as the Missouri, Illinois and Mississippi. The Missouri River is an example of the losses which are incurred to fish, wildlife and recreation interests from this type of navigation project. It is common knowledge that the Missouri River is turbid, but the Mississippi River in our reach also carries a heavy sediment load. A look at the Missouri River could be a valuable tool in predicting the ultimate effect of the two proposals on the fish, wildlife and recreation potential of Pool 25.

What we are talking about is the placement of rock dikes and rock revetments or rip-rap. In Pool 25, the Corps' plan calls for dikes at the upstream end of the pool near Lock and Dam 24 to be 6 feet above normal pool. The heights will successively diminish to a height of 2 feet near the hinge point about half way down the pool and remain 2 feet above the normal pool level through the remainder of the pool. Emergent structures such as those on the Missouri River are designed to constrict the channel and cause sedimentation immediately downstream. In our portion of the river, the bars created by dikes and dredging will grow willows in 2-3 years after emergence and constitute a significant loss of water area, whether it is a marsh, shallow nursery area or a deep chute. Willows are desirable from the Corps of Engineers standpoint to stabilize the deposit and cause further sedimentation. The Missouri River was once called the "Wide Missouri" — and it may have been — but today through bank stabilization and constriction with various types of structures, an estimated *80 per cent of the water and wet areas have been lost.* Data from maps of the 1879 Missouri River and 1967 river indicate the river was once approximately 617 acres to the mile — today there are only an estimated 124 acres of water per mile. This is an area measurement only and does not adequately show loss of quality habitat for fish, wildlife and recreation.

As was pointed out earlier, we in the lower pools have a different river. Our river, the Mississippi River at Hannibal for instance, has a sediment load of 70,000 tons per day. The same river at St. Paul only has 500 tons per day. With this sediment load in mind, let us consider what has occurred in Pool 25 since the lock and dam was placed about 30 years ago. Comparison of hydrographic surveys of portions of the pool indicate the extent of water area losses.

Measurements of the width of the water area at specific locations which were used to give some idea of water area losses are shown in Table B-1. Again in Pool 25 we found the losses in the upper 60 per cent of the pool to be quite large, with the lower reach showing little loss of water area, and in some cases small gain in the open river type area.

Probably more meaningful is the fact that *in Pool 25 we lost 9.8 per cent of the total water volume in an 8-year period* from 1939 to 1947. Data on the per cent of lost volume from 1939 to present are not available. Water area losses, estimated from 1939 and 1968 hydrographic survey maps indicate a loss of 12 per cent of the water area in Pool 25. This is the loss of an estimated 1862 acres in the 15,500 acres in the 29 year period.

An evaluation of the proposed structures for Pool 25 was made by the study group. The preliminary plan calls for 72 wing dikes, 19 chute and side channel closing structures, and many miles of bank stabilization by rip-rap. Blocking or closing structures were evaluated for their potential benefit or harm to fish, wildlife and recreation values. Many were removed from the plan to protect these values. Other structures were evaluated on an individual basis and in certain areas the study group recommended that these be eliminated from the plan because of their highly detrimental effects on fish, wildlife and recreation.

It is our conclusion from the study of Pool 25 that it is necessary to evaluate all other alternatives, including pool raises of various depths. With the long-term implications of continuing fish, wildlife and recreation oriented interests at stake, a full study of all alternatives must be undertaken. This should include mobile bed model studies such as those carried out at the Waterways Experiment Station to determine long-range effects of the Corps' proposals on all interests.

All of us working on the Mississippi River proposed 12-foot channel study hold the fate of the "Father of Waters" in our hands. We must evaluate all possible atlernatives and we cannot afford to ignore one use in favor of another.

TABLE B-1

COMPARISON OF MISSISSIPPI RIVER WIDTH IN POOL 25 FROM HYDROGRAPHIC SURVEYS OF 1939 AND 1968

Location *	Width of River (feet) 1939	1968	Amount of Change (+ or — feet)
Mile 272.2 (Dike)	2,800	1,800	— 1,000
Mile 271.5 (Dike)	2,300	1,900	— 400
Mile 271.0 (90° 52')	2,000	1,700	— 300
Mile 268.6 (Dike)	2,800	1,700 (+ 300' chute)	— 800 to 1,100
Mile 267.7 (Dike)	2,900	1,800	— 900
Mile 267.5 (Dike)	2,600	1,200	— 1,400
Mile 266.2 (Dike)	1,600	1,200	— 400
Mile 261.8 (Dike)	3,000	1,800 (+ 600' chute)	— 600 to 1,200
Mile 257.7 (39° 13')	2,300	2,000	— 300

* Lock and Dam 24 located at Mile 273.5. Little loss of channel width noted below Mile 257 (hinge point of Pool 25 is located at Mile 255.5).

TECHNICAL PAPERS, TITLES AND ABSTRACTS OF PAPERS PRESENTED AT THE MEETING

The History and Construction of Wing Dams, Closing Dams, and Shore Protection on the Upper Mississippi River

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Abstract

Early steamboating on the Mississippi River was difficult and hazardous because of the river's wandering and shallow channel. Because of the wandering of the river, marking a safe channel was futile. The commercial river traffic of the time, consisting of packet boats and log rafts, was in constant trouble with sandbars, snags and boulders. A steadily advancing railroad system also put pressure on river traffic to either become more reliable or become extinct. The only practical channel improvement undertaken prior to 1878 was that of snag and rock removal by government owned and operated boats.

The Congressional Appropriations Act of June 18, 1878, however, authorized the U.S. Army Corps of Engineers to maintain a 4½ - foot channel. This was accomplished mainly by snag and sandbar removal plus limited construction of wing dams, closing dams, and shore protection. The earliest recorded wing dam construction was in the vicinity of Pig's Eye Lake near St. Paul, Minnesota, in 1874.

The Congressional Appropriations Act of September 7, 1890, appropriated money for the construction of additional wing dams, closing dams, and shore protection. It also provided funds to extend the 4½ - foot channel from St. Paul upstream to Minneapolis, Minnesota. This project was virtually completed by 1905.

The river traffic, in the meantime, had evolved into larger and more efficient craft that carried larger payloads and needed more channel depth to operate. The Congressional Appropriations Act of March 2, 1907, provided funds to develop and maintain a 6-foot channel on the Upper Mississippi River. This was to be accomplished through the construction of more wing dams, closing dams, shore protection and by auxiliary dredging. It, however, proved also to be an interim project and became obsolete by the mid-1920's when it became apparent that a 9-foot channel would be a necessity.

The Rivers and Harbors Act of June 3, 1930 authorized the 9-foot channel which is now in use. The Act authorized the construction of locks and dams, additional wing dams, closing dams and shore protection.

Wing dams and closing dams were used originally because of their reasonable cost and the access to the existing channel by commercial craft while the construction was taking place. The major theory behind wing dams was to increase the water flowage down a single channel by placing partial obstructions along the sides of the channel. The increased velocity would then scour the channel and maintain its depth.

Closing dams were constructed to divert water from sloughs and chutes into the main channel thus maintaining channel depth and preventing the river from forming oxbows. Shore protection was used to supplement these dams to prevent the river from eroding the banks. Auxiliary dredging was used to remove unwanted spoil and to reinforce construction of wing and closing dams.

The materials used in the construction of the aforementioned rock and brush structures were readily available. The bluffs along the Mississippi provided the limestone needed. The river islands and banks provided the brush. Manual labor was the chief catalyst.

The rock was blasted loose, broken to size, transported to the river, and loaded on barges for transportation to the building sites. The brush was cut, tied into bundles, and stacked on a brush barge for transportation to the building site.

Actual construction involved the:

1. Construction of shore protection
2. Anchoring of the building boat
3. Pulling barges into position
4. Making a mat on a hopper barge
5. Sinking the mat with rocks
6. Layering with rock and brush
7. Capping the dam with rock
8. Constructing shore protection on the opposite bank of the river

Dredging was done to help maintain the channel. Before 1937, there were three twelve-inch dredges, the "Pelee," the "Cahauba" and the "Vesuvius." These were hydraulic dredges and they were not self-propelled. The "Thompson" was purchased in 1937. It is a twenty-inch self-propelled dredge. It serves 600 miles of the Mississippi River from Minneapolis, Minnesota, southward during the navigable months of the year.

Wing dams have had some desirable side effects which were not foreseen when the structures were built. The rock and brush structures now provide an excellent substrate for many invertebrate animals. The presence of these animals encourages the presence of desirable fish and wildlife that feed on the invertebrates. The dams also provide good fishing areas for sport fishermen.

Analyses of Sedimentation Rate and Accumulation in Navigation Pool No. 7

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Navigation Pool No. 7 is formed by Navigation Lock and Dam No. 7, Dresbach, Minnesota. This pool receives water from the Black River as well as the Mississippi River.

During the summer of 1968, core samples were collected from pool 7. The rate of sedimentation was also determined by placing anchored imhoff cones on the bottom. Samplers were placed in transects throughout the entire pool for 48 hours. The volume of sediment was determined and characterized by particle size. Core samples were analyzed by measuring the particle size for each individual stratum in the core.

Results indicate that the highest sedimentation rates occurred in the large shallow areas most remote from the old river channels.

Sedimentation accumulation however, was not significantly higher in these areas. Several parts of the pool had relatively low rates of deposition but had equal amounts of fine sediment deposited on the bottom. This would indicate that the rate of turnover of clay and silt size sediments is relatively high in the entire pool. The study is planned for continuation.

Sand as a Contributing Factor in the Apparent Elevation of the Mississippi River Flood Plain

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CALVIN R. FREMLING, *Professor of Biology, Winona State College*

Most Americans are aware that municipal, industrial, and agricultural pollutants are serious threats to our lakes, rivers, and streams. Another type of pollutant, however, may be a distinct threat to Mississippi River cities like Wabasha, Fountain City, Goodview, Winona, La Crosse, and Prairie du Chien. Poor land management practices in the Chippewa, Zumbro, Whitewater, Root, Trempealeau, and Wisconsin River watersheds have caused sand to accumulate behind the navigation dams which were constructed by the U.S. Army Corps of Engineers during the 1930's. The dams impound the Mississippi River, thus providing huge settling basins where upstream sand can settle. The sand in the backwaters is augmented by the decaying remains of algae and other life forms which have proliferated because of fertilization by upstream municipal sewage. The sand, silt, and eutrophication products are apparently slowly raising the bed of the Mississippi River. This is indicated by the huge spoil heaps thrown up along the main channel of the river by the Corps of Engineers dredges. Most duck hunters, trappers, and fishermen have noticed the gradual deposition of sand and silt.

It seems likely that the rise in the river bed may increase the severity of floods for the aforementioned cities which are constructed wholly or partially in the Mississippi River flood plain. While perhaps not as immediate a problem as pollution by municipal and industrial sewage, pollution by sand and silt presents a far more incorrectable and irretrievable situation.

We are attempting to learn more about the sand problem by careful study of a small island approximately two miles north of Lock and Dam No. 6 just offshore from LaMoille, Minnesota. We realize that we lack personnel, equipment, funds, and time to study an entire pool. Therefore, we are intensively studying a small area. The island is especially interesting from an ecological standpoint because of its distinctive pattern of vegetative growth. The island exhibits growth in a continuum of ages with the oldest growth at the upstream end and the youngest growth at the lower end. The extreme downstream end of the island is composed of a barren sand flat. It is apparent that the entire sand mass is growing and slowly moving downstream as the upper end of the island is eroded away and then redeposited and augmented on the lower end.

Studies of aerial photographs of the area have disclosed that only the extreme upper tip of the island was in existence in 1940, just three years after Lock and Dam 6 was constructed. Much of the island was laid down between 1940 and 1964, but the photos prove that the island grew over 900 feet in length during the spring flood of 1965. During the 1969 flood, the island grew another 275 feet.

Thus far, we have succeeded in carefully mapping the island and establishing permanent reference points (steel posts). Vegetative transects have been made and the distribution of trees has been plotted. We have already discovered that beaver exert a profound influence on island movement. By cutting large trees on the upper end of the island, they cause clons of shoots to develop. They, in turn, act like a snow fence and cause additional sand to deposit during flood time.

The riverbed surrounding the island has been sounded with sonar gear so that we may detect the rate of movement of the entire sand mass during future floods. Sand grains are being studied to determine their origin. We should be able to determine, for example, if they are from glacial outwash or if they have eroded from the Jordan sandstone.

Limnological Investigation of the Iowa Reach of the Upper Mississippi River

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In spite of recent allegations by the Federal Water Pollution Control Administration to the contrary, the State of Iowa is vitally interested in water pollution control particularly as it concerns the Mississippi River. This paper is not a defense of past action for we defended our position during the April FWPCA conferences at Davenport and Council Bluffs. It is instead the presentation of a Mississippi River study plan which is already underway and will hopefully continue as long as there is a need for water quality investigations.

The guidelines for speakers at this meeting stated that presentations could concern either completed research or research in progress. The limnological efforts of the State Hygienic Laboratory would definitely be in the research in progress category and it is doubtful that our research will ever reach the completed stage. Even after pollution problems are solved by the construction of adequate waste treatment facilities, continued water quality surveillance is necessary to insure that water quality standards are being maintained. Thus, our research is of the applied and never-ending variety.

Before discussing the State Hygienic Laboratory's Limnology program on the Mississippi River, you should be familiarized with the structure of water pollution control in Iowa so that the activities of the State Hygienic Laboratory can be put in perspective. There are three groups involved in water pollution control in our state; these are the Iowa Water Pollution Control Commission, the Water Pollution Division of the Iowa State Department of Health and the Limnology Division of the State Hygienic Laboratory. The Water Pollution Control Commission consists of a group of nine individuals which include the Commissioner of Public Health, the Director of the State Conservation Commission, the Director of the Iowa Natural Resources Council, a staff member from one of the Universities or Colleges of the State who has technical background, training and knowledge in the field of water pollution, the Secretary of Agriculture, and four electors of the State; one representing industry, one representing municipal government, one being an owner-operator farmer, and a representative of the public at large. As of July 1, 1969, this commission will be increased to 11 members by the addition of another public at large representative and the Director of the State Soil Conservation Committee.

The Water Pollution Control Commission is the agency of the state government which makes the final decisions regarding the prevention, abatement or control of pollution of the waters of the State. The arms of the Water Pollution Control Commission are the State Hygienic Laboratory and the Water Pollution Division of the State Health Department.

The Water Pollution Division provides the engineering services and is responsible, among other things, for enforcement of pollution abatement, approval of construction plans for waste treatment facilities and coordinate investigations of alleged pollution cases.

The State Hygienic Laboratory of the University of Iowa provides the analytical service and surveillance of water quality for the Water Pollution Control Commission. The Limnology Division resides in the branch laboratory in Des Moines and consists of an eleven member staff whose activities are devoted almost exclusively to the chemical and biological examination of water. In addition to this staff, there are two Limnology assistants located in Iowa City, plus other technical staff members who are available to work on special analytical and research problems.

The field limnology program on the Mississippi River has been underway for approximately one year. Beginning last summer, weekly sample collections were made at stations located on the Mississippi at Lansing, Dubuque, Davenport and Burlington. Measurements were made of dissolved oxygen, biochemical oxygen demand, fecal coliform organisms, soluble phosphate, ammonia, and temperature. In addition to these measurements, phytoplankton counts were made. This program was carried on through the fall of 1968.

It may be asked why such a surveillance program was not initiated on the Mississippi or other rivers before the summer of 1968. Such activities were historically done by the engineers of the Water Pollution Division up to the last few years when their manpower shortage, plus other responsibilities, prevented them from spending extensive amounts of time doing stream survey work. Field Limnology activities by the State Hygienic Laboratory were only made possible by an allocation of funds through the Water Pollution Control Commission in late 1967 for that purpose. The author joined the staff in September 1968 to guide the efforts of the limnology group.

In September and October of 1968, an extensive study was undertaken to establish the quality of channel water in the Mississippi in the vicinity of the Iowa municipal-industrial complex areas and to gain some knowledge of the contribution of waste discharges to the river. During these surveys, sampling was done at Lansing, Dubuque, Clinton, Davenport and Keokuk.

Again, in February of 1969, while the river was largely under ice cover, it was surveyed for chemical and bacteriological water quality in each of seven major waste discharge areas of Dubuque, Clinton, Davenport, Muscatine, Burlington, Ft. Madison and Keokuk. During these surveys more attention was given to the assessment of the influence of waste effluents on downstream quality rather than the quality of water in the main channel.

These surveys indicated that the overall water quality in the Mississippi was, in general, very good. Some typical results for the two seasons of the year are given in Table 1.

It is evident from the results that some seasonal differences in water quality exist and these for the most part represent the effect of lower metabolic rates of bacteria and phytoplankton and the fact that fewer numbers of algae were present in February as compared to last fall.

TABLE I

Typical Water Quality of the Iowa Reach of the Mississippi During September-October 1968 and February 1969. All values are mg/l Except pH and Fecal Coliforms

	September-October 1968	February 1969
pH	7.5-8.2	6.9-7.2
Dissolved Oxygen	8.0-10.5	8.6-11.9
BOD	1-2	3-4
Organic-Nitrogen	0.85	0.65
Ammonia-Nitrogen	0.08	0.25-0.68
Nitrate-Nitrogen	0.7-1.2	0.8-1.5
Total Phosphate	0.2-0.5	0.3-0.7
Fecal Coliforms/100ml	100-800	200-3600

During the fall survery essentially no changes in water quality were observed between the upper and lower Iowa reach of the Mississippi or, in other words, from Lansing to Keokuk. The February study, however, did indicate some trends of change in water quality between Lansing and Keokuk particularly in the nitrogen series, total phosphates and to some extent the biochemical oxygen demand. It should be pointed out, however, that changes in these parameters could well be influenced by the tributary streams as well as domestic and industrial waste discharges, for under normal flow conditions tributaries are responsible for a doubling in volume of Mississippi between the upper and lower Iowa borders. In general, these tributaries contain much higher loads of nutrients, organic compounds, minerals, and coliform organisms than does the Mississippi itself. This less desirable water quality in tributaries feeding the Mississippi is largely the effect of agricultural land drainage.

The majority of work done before June of 1969 was primarily directed toward the chemical and bacteriological quality of the river and little time was devoted to effects of waste discharges on biological quality. The Limnology Division and the Iowa Water Pollution Control Commission recognize that the biota of such a river are far more sensitive indicators of pollution than are occasional or even frequent grab samples which are analyzed chemically for pollution parameters. It is also recognized that the channel of the Mississippi is not the biologically productive area of the river but that the productive areas occur along the shorelines and in the back waters. Because wastes are most commonly introduced near the river bank and subsequent dispersion of the waste into the total river flow occurs very slowly, the biologically productive areas are more likely to be affected by waste discharges before sufficient dilution occurs. Our study plan for the summer of 1969 places primary emphasis on the examination of the bottom fauna downstream from major waste discharges to determine the presence or absence of a biological effect and the magnitude of the affected areas. These studies will be accomplished by extensive use of the Ponar Dredge for quantitative sample collecting plus a qualitative assessment of the biota found among the rip-rap and debris of the shoreline areas. These collections will be supplemented by the use of artificial substrate samplers as described by Anderson and Mason (1968).

One problem which causes particular concern on the Mississippi is that of waste stimulated slime growths which consist of the bacterium *Sphaerotilus natans* plus associated forms of aquatic fungi. These slime growths, which quickly collect on any submerged object, are a nuisance to commercial and sport fishermen due to fouling of nets and lines. Slimes can be detrimental to aquatic life as well, for they will attach to the exoskeletons of invertebrate organisms as well as the substrates which these organisms inhabit and make the completion of life cycles difficult if not impossible in severe infestations. This, in effect, reduces the food supply of the fish population and may directly affect fish spawning by the adverse effect of slime growths on fish eggs. The Limnology Division intends to make a semi-quantitative evaluation of the prevalence of these slime growths in the areas where they are known to occur. These areas are Dubuque, Clinton, Muscatine, Ft. Madison and Keokuk. This evaluation of slime growths will be made by placing wire mesh collectors at strategic locations both upstream and downstream from waste discharges, making photographic records of slime accumulations after a given immersion time.

It is anticipated that a biological assessment of the river sufficient to evaluate waste discharge effects, can be completed by the end of July. Following the biological study, a chemical and bacteriological water quality study will be initiated in August at a time of low flow and high water temperatures again to evaluate the effects of waste discharges and tributaries on water quality. Twenty-four hour studies will be made to determine the diel periodicity of such parameters as dissolved oxygen, temperature, and pH.

The Limnology Division of the State Hygienic Laboratory is becoming well equipped to carry out such a biological and chemical study of water quality. Our working platform on the Mississippi is a 19 foot work boat which has ample space for carrying sampling equipment, sample storage boxes, and personnel. Continuous monitoring at land based sites for pH, dissolved oxygen, temperature and conductivity can be done with Honeywell unit which may be operated from 110 volt AC house current or from a Chevrolet van equipped with a Honda generator. We also have two battery operated recording dissolved oxygen and temperature probes (Delta Scientific) which can be used in the field.

For continuous temperature recording we have 3 Ryan units which will be used extensively in thermal pollution studies. In the summer of 1968, some background temperature data on the Mississippi was collected and that program will continue this summer anticipating start-up of the Cordova, Illinois Nuclear Power Plant in the near future.

As a field limnology operation, our biggest asset is a laboratory staffed by competent personnel who have extensive experience in the analysis of water and tolerate getting large numbers of samples for innumerable analyses.

In summary, the goal of the Limnology Division of the State Hygienic Laboratory is to provide, by the fall of 1969, sufficient information to the Water Pollution Control Commission to allow them to make an objective judgment of waste treatment needs on the Mississippi River.

REFERENCES

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The Use of Fluorescent Dyes in Water Dispersion Studies

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Abstract

Fluorescent dyes offer an economical and highly accurate method of tracing the movement and dispersion of soluble materials in water. Methods have been developed for use in pollution control and fish control work. The dye of choice for fresh-water studies is rhodamine-WT which can be analyzed in water at less than 1 p.p.b. The velocity, amount of stored water, the volume of flow, and water being added by tributaries all interact to affect the dispersion of contaminants in streams. To accurately determine the movement of any contaminant the dye injection must closely approximate the release of contaminant. Each dye study must be tailored to the specific problem being studied.

If properly designed, a dye study should yield the time of travel, the slope of the concentration buildup, and the duration of the maximum possible concentration. In fish-control work, dye is used to design the application of a toxicant so an effective concentration can be maintained in a stream for the proper length of time.

A Seasonal Study of the Food Habits of Three Game Fish In Pool 6 of the Upper Mississippi River

BROTHER GEORGE PAHL and THOMAS VARCHMIN
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Because of its dynamic characteristics, the Mississippi River affords an interesting situation in which to study the food habits of fish. During the summer of 1966, the spring of 1967, and the autumn of 1968, research was carried out to determine what specifically constitutes the diets of three common game fish—the largemouth bass (*Micropterus salmoides* Lacepede), the black crappie (*Pomoxis nigromaculatus* LeSeur) and the northern pike (*Esox lucius* Linn).

The fish were collected by means of a 230-volt AC shocker in Pool 6 of the Mississippi River between Winona Dam 5A and Trempealeau Dam 6. The stomach contents of the fish were removed by use of a stomach pump and were later analyzed in the laboratory by means of a stereoscope. The results of the study were tabulated as to occurrence of items (number of stomachs in which the item occurred) and number of items (total number of the item found in the stomachs). In some cases, correlation coefficients of diets were computed to determine the similarity, if any, between the food habits of different species of fish.

The result obtained can be summarized as follows:

1. The spring, summer, and autumn diets for each species of fish show utilization of similar items, but to different degrees.
2. The black crappie utilized insects, especially mayfly naiads, as the major diet item in all seasons except autumn. Crustaceans, especially scuds, became the major food item in the autumn.
3. The largemouth bass fed mainly on other fish during the summer and autumn seasons, while insects, especially mayfly naiads, occurred as the more abundant item in the spring. Although insects comprised a significant portion of the largemouth diet in all seasons, as the year progressed they declined in importance until crustaceans replaced them in importance in the autumn.
4. In all seasons studied, northern pike were found to feed almost exclusively on other fish, especially *Pomoxis* (crappies) which occurred in 52% of autumn stomachs.
5. The food habits of fish in the Mississippi River do not differ greatly from the food habits of the same fish in lakes and other river systems.

Pre-dredging Studies at Fort Madison, Iowa

A Summary Report by KENNETH D. CARLANDER
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Based upon field work and theses by
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and J. Douglas Thompson

Proposed dredging of a navigation channel to a Ft. Madison industrial area raised questions as to probable effects on bottom fauna and on the fish and waterfowl of the area. Field studies were therefore conducted from July 1966 to December 1968.

Much of Pool 19 of the Mississippi River, on which Ft. Madison is located, is shallow with extensive mud flats, productive of mayflies *(Hexagenia)* fingernail clams (Sphaeriids) and other bottom fauna. The area below Ft. Madison was found to have sandier substrates and contained higher standing crops of fingernail dams than the other areas.

Nine sampling stations were selected near the site of future dredging and 4 core samples (7.62 cm in diameter) were taken at each station monthly June to December 1967. Additional collecting was done at other sites. The molluscan fauna includes 13 species of gastropods, 7 sphaeriids, and 20 unionids. Qualitatively the unionids were similar to those reported in 1930-31. *Somatogyrus isogonus, Fontigens nickliniana* and *Amnicola lustrica* were the most abundant gastropods and the highest density was 3,125/m^2. *Limno drilus* hoffmeisteri was the most abundant oligochaete. Leech populations, usually less than 1000/m^2, ranged up to 68,000/m^2 in areas with abundant shelter. The chironomid population increased in fall and winter to about 2000/m^2. Caddisflies, *Oecetis* and *Cheumatopsyche,* and mayflies, *Hexagenia,* were moderately abundant.

Standing crops ranged up to 11,000 kg/ha, and up to 120,000/m^2. *Sphaerium transversum* constituted over 80% of the standing crop. On several occasions *S. transversum* populations exceeded 100,000/m^2, which is higher than any published reports we know of. *S. transversum* is a large sphaeriid, sometimes exceeding 14mm long. In June, all clams over 2-3 mm were calyculate, but in September none were. Laboratory observations indicated that newly born young which have a "resting state" before growing become calyculate while those which continue to grow do not form calyculi. *S. transversum* become sexually mature soon after birth (about 2.2mm) and most 5 mm clams are mature. Numbers of embryos increased with clam size to a maximum of 80 embryos. Extra-marsupial and larger intra-marsupial embryos of *S. transversum* and *S. lacustre* were attached to the parent gill by slender filaments, a feature not observed in *S. striatinum.* Some clams born in July grew to maturity and produced young within 33 days. *S. transversum* born in spring or early summer die by late autumn. Those born in autumn overwinter and may survive until late summer.

In frozen-core samples, *S. transversum* were found to a depth 17 cm below the substrate surface, in soft clayey silt. Clams over 2.5 mm long were usually in the top 2.6 cm. Small clams may remain for relatively long periods deep in the substrate in a "resting state." Population expansion of *S. transversum* was greatest from June to August. In August, larger clams began to disappear. In areas of high population, growth may be suppressed with many clams not reaching maximum size. Leeches, *Glossiphonia complanata* and *Helobdella stagnalis,* preyer heavily on clams in some areas. Experiments with enclosures indicated that fish predation is an important factor reducing *Sphaerium* populations. In August many large *Sphaerium* were heavily parasitized with cërariae of trematodes and these *Sphaerium* did not have living embryos. Small oligochaetes, *Chaetogaster limnaei* inhabited the mantle cavities of many *Sphaerium* but their relationship to the host is not known.

Although fingernail clams were eaten by several species of fish they did not seem to be an important source of food for most species.

Pool 19 is an important stopping point for migrating diving ducks. The abundance of fingernail clams is probabily an important factor holding the ducks on this pool each fall and spring. Douglas Thompson estimated 11,150,000 duck-days use of Pool 19, from March 3 to April 19, 1967 and 9,100,000 duck-days between October 11 and December 8. Lesser scaup accounted for about 85% of this usage. At 229 grams (wet weight) of fingernail clams consumed per duck-day, consumption was estimated at 2,500,000 kg in the spring and 2,000,000 kg in the fall. The sphaeriid population of the pool in September 1967 was estimated at 8,600,000 kg, about twice the duck consumption.

A Preliminary Report on the Effects of Thermal Stress Upon Hepatic Catalase Activity of the Channel Catfish, Ictalurus Punctatus

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Supported by The Minnesota Bureau of Commercial Fisheries and Winona State College (Project No. 4-44-R-1)

Abstract

A study of the effects of thermal stress upon hepatic catalase activity of the channel catfish is currently in progress. This study was undertaken in the hope of gaining an insight to the molecular mechanisms of temperature acclimation and thermal death of fishes. Catalase enzyme was selected for the study because of its almost universal occurrence in animals and also because its catalytic properties can be assayed according to standard manometric procedures.

Catalase, like other enzymes, is a catalytic protein of high molecular weight. The enzyme specifically functions in the breakdown of hydrogen peroxide into water and oxygen. Enzymes are highly specific for a particular substrate or group of substrates and therefore exhibit certain well defined physico-chemical characteristics. These characteristics are now being studied and include the following: pH optimum, dependence upon sulfhydryl groups, presence or absence of dialyzable groups, upper thermal tolerance limits, and relative solubility and activity of fractions at elevated temperatures. Information obtained relative to the parameters just described will be employed later in studies of the behavior of the enzyme in catfish living in a thermally polluted environment.

Comparative Toxicology in Fish: Malathion Activation and Degradation Reactions

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I. GENERAL PURPOSE

A study is being made of the biochemical differences between similar species of fish for the purpose of developing species specific toxicants.

It is increasingly of great economic importance to gain the ability to manipulate the population of certain species of animals or plants. Each year many millions of dollars worth of crops are lost to insect damage; undesirable fish take over lakes and streams that otherwise could be important recreational areas, etc.(1)

The means used to control the populations of selected species must be both safe and economical. The ideal would be to be able to either eliminate an undesired species or to promote a desired species without affecting other species in the ecological system even though these may be very closely related in a genetic sense to the "target" organisms.

The high degree of species specificity required suggests that use must be made of the natural biological and/or biochemical differences existing between various species.

There are several approaches to the development of species specific toxicants and these approaches complement one another very well.(2) The approach of this laboratory is suggested by the observation (4) that there is a wide variation in LD50* values for closely related species responding to a given toxicant. In particular, it takes almost three times as much malathion, a commonly used organo-phosphate insecticide, to kill 50% of a population of rainbow trout as it takes to kill 50% of a population of brown trout.

Similar differences exist in LD50 values for other species of fish. Often the differences are very dramatic; e.g. the LD50 for malathion against fathead minnows is 250 times the LD50 for goldfish or 55 times the LD50 for bluegills.(2, 4, 5)

It is proposed that a study be made to determine the reasons for such species specific responses to malathion, and that the techniques developed in such a study be then applied to studies of the several other toxicants which exhibit partial species selectivity. Such information may lead either to the design of toxicants with a much greater degree of species specificity or to the design of synergistic agents that would enhance the species specificity of existing toxicants. (6, 9)

II. SPECIFIC RESEARCH

In particular, with regard to malathion, the following work is in progress.

* LD50: *the dose of a toxicant that will be lethal to 50% of a population within a standard time interval.*

Part A. Study of Kinetics of Inhibition

Organophosphates are known to be toxic to all organisms by virtue of their ability to inhibit a group of neuro-enzymes known as cholinesterases.([3]) *The variation in the response of different species of fish to malathion could be a result of a variation in the degree to which various species' cholinesterases are inhibited by malathion.* A study of the kinetics of inhibition of cholinesterase activity obtained from a variety of species of fish is being made to see if there is any correlation between the kinetic parameters, K_M, V_{MAX}, K_I and the LD50 values of the corresponding species.

Part B. Study of Malathion Activating Reactions

Malathion (I) itself is not toxic to any organism and does not itself inhibit cholinesterase activity. It has been shown[7] that *in vivo* the sulfur on the phosphate atom is replaced by an oxygen atom and that this "activated" product, called maloxon (II) is the toxic moiety (Figure 1).

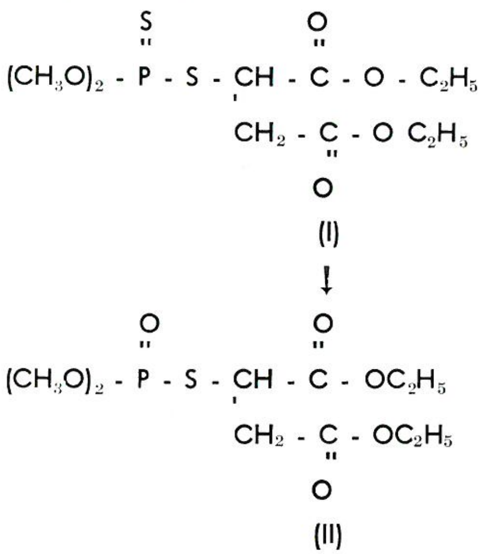

Figure 1

A quantitative thin-layer chromatographic technique for studying this activating reaction has been developed in our laboratory and is being used to study the rate of malathion activation by homogenates and/or by acetone powders of various organs, e.g. brain, liver and kidney, from various species of fish. *It is possible that certain species of fish are more resistant to malathion because they do not activate malathion as rapidly.*

Malathion is known to be rapidly degraded *in vivo* by one of two first steps. In mammals one of the ethyl esters is hydrolyzed (Figure 2). The enzymes that accomplish this reaction have been partially purified from rat liver.[8]

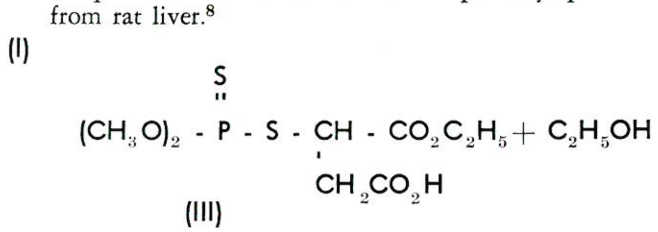

Figure 2

In insects the first degrading reaction is a hydrolysis of the thiophosphate ester([3]) (Figure 3).

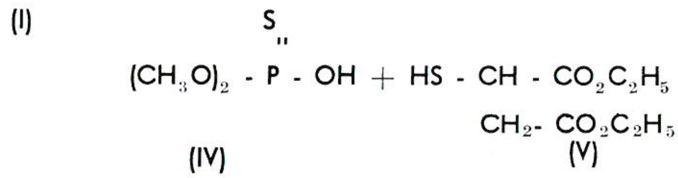

Figure 3

No studies have been reported on the degrading reactions occurring in fish.

We have been synthesizing all of the malathion and maloxon degradation products which might conceivably be formed in any organism and are developing gas chromatographic and thin-layer chromatographic procedures for separating each one of these potential products. We are proceeding now to determine the metabolic pathway and the rate of degradation of malathion and maloxon in various organ extracts from various species of fish. *It is possible that certain species of fish are more resistant to malathion because they degrade the organophosphate more rapidly to nontoxic products.*

III. ACKNOWLEDGMENTS

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CONSTITUTION
OF
THE MISSISSIPPI RIVER RESEARCH CONSORTIUM

ARTICLE I. NAME AND OBJECT

1. This organization shall be named the Mississippi River Research Consortium.
2. The objectives of this organization shall be:
   a. To establish and encourage communication between river scientists and between the scientific community and the public.
   b. To encourage pure and applied research concerning the water and land resources of the Mississippi River and its valley.
   c. To provide an annual meeting where research results can be presented, common problems can be discussed, information can be disseminated, and where river researchers can become acquainted with each other.
   d. To encourage cooperation between institutions and to encourage the sharing of facilities.
   e. To function as an advisory group to other agencies.
   f. To aid in the formation of a concerted and organized research effort on the Mississippi River.

ARTICLE II. ORGANIZATION

1. The organization of the Mississippi River Research Consortium shall be provided for by the enactment of suitable by-laws.
2. The by-laws of this organization shall designate the officers and standing committees, the provisions for the election of the officers, the conduct of meetings and for any other matters which are necessary for the government of this organization.

ARTICLE III. MEMBERSHIP AND DUES

1. The membership of this organization shall consist of any persons who demonstrate an interest in any aspect of the Mississippi River, and who express a desire to join the organization.

ARTICLE IV. AMENDMENTS

1. The constitution or the by-laws of the MRRC may be amended by an affirmative vote of two thirds of the eligible voting members present at the annual meeting.

BY - LAWS
OF
THE MISSISSIPPI RIVER RESEARCH CONSORTIUM

ARTICLE II. ORGANIZATION

Section 1. Officers

A. The officers of the organization shall consist of a President, a President-elect, and a Secretary-treasurer who shall perform such duties as are usually incumbent upon such officers.

B. The officers of the organization shall be elected annually at the annual meeting and shall assume their duties immediately after the close of the last session of the meeting. At least two (2) months prior to the meeting, the executive committee shall appoint a nominating committee of at least three members. This committee shall make at least one nomination for each office and shall submit its report at the meeting. Additional nominations may be made from the floor of the meeting.

C. The president shall not succeed himself.

Section II. Committees

A. The executive committee shall consist of the officers and the most recent past president who maintains his membership.

B. The program committee shall consist of the president-elect and two members appointed by the executive committee. The president - elect shall serve as chairman of the program committee.

C. The executive committee shall appoint such other committees as may be deemed necessary from time to time.

Section III. Meetings

A. There shall be one meeting held in each calendar year.

B. The meeting shall be held in the home city of the president.

C. The time of the meeting shall be established by the executive committee at the meeting one year prior, upon approval by two-thirds of the voting membership.

D. The annual meeting shall include one session designated to transact the necessary business of the organization.

E. Due notice of the annual meeting shall be sent in writing to all members.

F. At the annual meeting, the eligible voting members of the organization shall constitute a quorum for the transaction of business.

ARTICLE III. MEMBERSHIP AND DUES

Section 1. Dues

A. Dues shall be one dollar ($1.00) per year.

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