12-1-1977

Distribution of Fishes in the James River in North Dakota and South Dakota Prior to Garrison and Oahe Diversion Projects

Dean S. Elsen

DISTRIBUTION OF FISHES IN THE JAMES RIVER IN NORTH DAKOTA AND SOUTH DAKOTA PRIOR TO GARRISON AND OAHE DIVERSION PROJECTS

by

Dean S. Elsen

Bachelor of Science, University of Nebraska, 1975

A Thesis

Submitted to the Graduate Faculty

of the

University of North Dakota

in partial fulfillment of the requirements

for the degree of

Master of Science

Grand Forks, North Dakota

December
1977

This Thesis submitted by Dean S. Elsen in partial fulfillment of the requirements for the Degree of Master of Science from the Universit of North Dakota is hereby approved by the Faculty Advisory Committee under whom the work has been done.

Chairman

Dean of the Graduate School

Permission

e DISTRIBUTION OF FISHES IN THE JAMES RIVER IN NORTH DAKOTA AND SOUTH

TA PRIOR TO GARRISON AND OAHE DIVERSION PROJECTS

rtment Biology

ee Master of Science

In presenting this thesis in partial fulfillment of the requirements for a graduate degree from the University of North Dakota, I agree that the Library of this University shall make it freely available for inspection. I further agree that permission for extensive copying for scholarly purposes may be granted by the professor who supervised my thesis work or, in his absence, by the Chairman of the Department or the Dean of the Graduate School. It is understood that any copying or publication or other use of this thesis or part thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of North Dakota in any scholarly use which may be made of any material in my thesis.

Signature Dean S. Elsen

Date December 5, 1977

ACKNOWLEDGEMENTS

The U. S. Bureau of Reclamation, Department of the Interior, pro-
ed funds for this research. I would like to thank Dr. John Peters,
S. Bureau of Reclamation, for his interest in and support for a study
the distribution of James River fishes.

I give special thanks to Dr. John B. Owen, who acted as major advisor
principal investigator throughout the project. Gordy Russell and Dr.
n first realized the need for a study of the distribution of fishes
ng the entire length of the James River. Further appreciation is ex-
ssed to Dr. Joe. K. Neel and Dr. Paul B. Kannowski for reviewing the
sis and contributing valuable suggestions for its improvement. I am
teful to Dr. James C. Underhill, University of Minnesota, for identi-
ation and comments on several species. Special thanks is due Eric Bakk
ily the best field worker I could have wished for.

Members of the U. S. Fish and Wildlife Service, the U. S. Bureau of
lamation, the North Dakota Game and Fish Department, The South Dakota
artment of Game, Fish, and Parks, and South Dakota State University
iewed a rough draft of a report on the James River fish and offered
e constructive criticism. The North Dakota Game and Fish Department
the South Dakota Department of Game, Fish, and Parks gave assistance
cooperation to this study. Special thanks is extended to Mr. Dale
egar, North Dakota Game and Fish Department for assistance, informatio
encouragement in the project. I thank Jim Ragan, Gene Van Eeckhout,

g Hansen, Ron Catlin, and Tom LaFaive for observations on the fishes ng the James River. Personnel at Arrowwood National Wildlife Refuge an d Lake National Wildlife Refuge permitted camping, provided information gave assistance. Dennis Tol, South Dakota State University, and ry Lockard, U. S. Fish and Wildlife Service, provided data and comments James River fish species.

Many people living along the James River allowed access to the river, cussed fishing, offered ice water, permitted camping, and provided othe rtesies. I hope the fishes in the James River will always have good ghbors in the landowners and sportsmen who use the river.

TABLE OF CONTENTS

List of Figures

ABSTRACT

Forty-one species of fish representing 12 families were collected in mer, 1975, from the James River basin in North Dakota and South Dakota. additional 18 species and two additional families were reported by othe: estigators. Only three species were present in the headwater region. er species appeared downstream in progressive additions to the head- er assemblage. Some species differed from the general addition pat- n and showed a localized habitat preference. Siltation, nutrient d, low-head dams, and loss of streamflow are believed to have changed river and affected fish species. Winterkill conditions under no or flow limited the number of fish species in the upper portion of the er. The addition of diverted water to the James River will reduce per- s of low flow, and fish species may occupy portions of the upstream er in which their present survival is impossible or seasonally limited. se may be transferred to the Red River of the North (Hudson Bay drainag ough the irrigation connection at Oakes, North Dakota. Fifteen James er species do not occur in the Red River of the North.

Introduction

The canals and wasteways of the U. S. Bureau of Reclamation's Gar-

Diversion Unit (GDU) are proposed to connect all major drainage bas-

n North Dakota (Figure 1). Water from Lake Sakakawea on the Missouri

would be delivered to Lonetree Reservoir, which would be used for

atory storage. Canals are planned to carry water to the Sheyenne and

s Rivers, tributaries of the Red River of the North (Hudson Bay drain-

A feeder canal is planned to supply water to the Devils Lake system,

sed basin. An additional feeder canal is planned to deliver water to

ames River, a tributary of the Missouri River. Water would be trans-

d from the James River to the Wild Rice River (Red River tributary)

gh a pumping station, canal, and storage reservoir near Oakes.

Canals and wasteways involved may transport aquatic organisms from

rainage or sub-basin to another. Introduction of new species may dis-

established aquatic ecosystems. Added water would change present pat-

of streamflow in receiving waters. Water quality would be altered

il leaching in irrigation areas.

A series of studies determining the current distribution of fishes

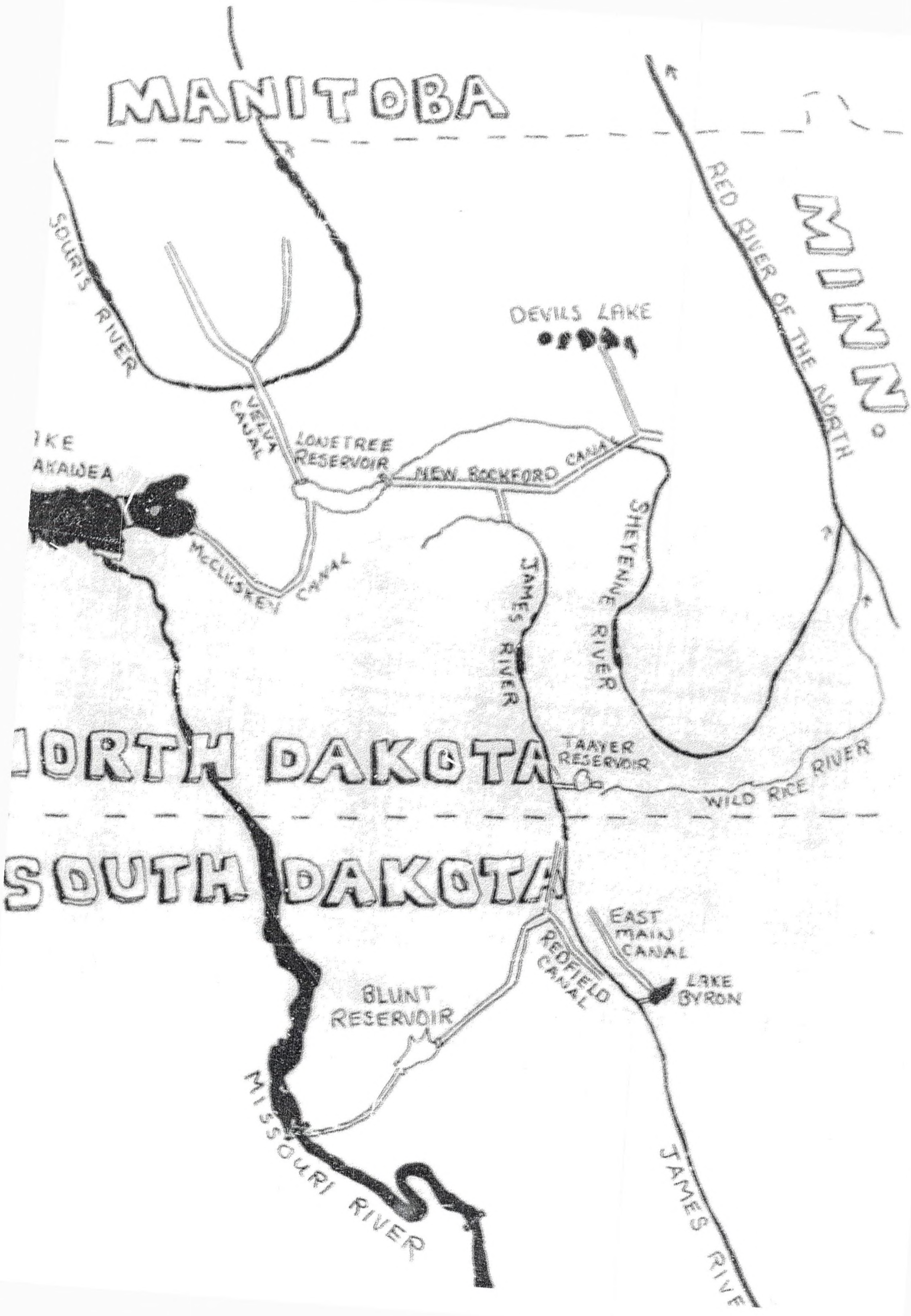
ch basin affected by the irrigation project has been performed. Rus-

(1975) listed the fishes in each basin. Reports to the U. S. Bureau

clamation were made concerning fishes in the southern section of the

ct (Owen and Russell, 1975a), the central section of the project (Owen

ussell, 1975b), and in the northern section of the project (Owen and



MANITOBA
MINN.
RED RIVER OF THE NORTH
SOURIS RIVER
DEVILS LAKE
VELVA CANAL
LONETREE RESERVOIR
NEW ROCKFORD CANAL
McCLUSKEY CANAL
JAMES RIVER
SHEYENNE RIVER
NORTH DAKOTA
TAAYER RESERVOIR
WILD RICE RIVER
SOUTH DAKOTA
EAST MAIN CANAL
REDFIELD CANAL
LAKE BYRON
BLUNT RESERVOIR
MISSOURI RIVER
JAMES RIVE

Russell, 1975c).

A major interbasin connection would occur at the Oakes area where James River fishes may be transferred to the Wild Rice River. Two sources of fish species available for transfer are fishes currently in the James River near Oakes and fishes that would be transported through the distribution system downstream through the feeder canal. Another potential source of transferable fishes may be those species currently in the lower James River in South Dakota (Russell, 1975; Owen and Russell, 1975a).

Present flows in the James River in North Dakota and northern South Dakota are reduced to zero during periods in many winters and some summers. There are a number of low-head dams on the river, and during periods of low flow, much of the James River consists of a series of long pools behind the dams. The low-head dams are not physical barriers to upstream fish movement at all times, because, during high flow periods, water flows over or around the dams. There are several fish species in the James River in South Dakota listed in Bailey and Allum (1962) which are not found in the North Dakota portion of the river. Apparently, ecological conditions currently prevent some species from moving upstream and becoming established in the North Dakota portion of the James River.

Garrison Diversion operations would increase the duration and volume of flows in the James River. Altered streamflow patterns may affect fish distribution, and some species now confined to lower reaches of the river may appear upstream in the Oakes area.

The Oahe Diversion Unit in South Dakota is also proposed to divert Missouri River water to the James River. Although no major transfer of fish species between basins would occur, the fishes in the James River in South Dakota would be affected by increased streamflow, altered water quality, and any bank structure changes such as channelization.

Very little information is available on distribution, limiting factors, and general ecology of stream fishes in North Dakota. I undertook this study to determine the fish species inhabiting the James River and their ranges, concentrating on species downstream from the Oakes area and those James River species not present in the Red River of the North. Distribution and ecology of fishes in streams affected by the irrigation projects should be studied in order to: (1) record species and distribution before land barriers that have separated fish species are crossed, and (2) assess impact of the various alternatives of the proposed irrigation projects.

Description of the area

The James River drainage is located in the Central Lowlands province of the upper Great Plains (Rothrock, 1943). The area is often referred to as the glaciated drift prairie. Overall the James River basin has a total land area of about 21,000 square miles, 8,400 in North Dakota and 12,600 in South Dakota. The maximum width of the basin is about 100 miles, and the overall length of the basin is about 350 miles from north to south (Figure 2).

The area was once covered with prairie grasses interrupted by trees along stream courses and marsh vegetation in low areas. Today, the land is used for a mixture of pasture and cultivated dryland crops such as wheat, oats, and hay. Some irrigated corn is raised in the southern part of the basin. The river banks support a mixed Gallery Forest except in the headwaters region and in cleared areas where cultivation is practiced to the river bank. Aquatic vegetation is most abundant at the headwaters region and on National Wildlife Refuges. During high water periods, the river broadens onto shoreline vegetation.

The James River basin has a continental climate of hot summers and cold winters. The basin is semi-arid to subhumid with a mean annual precipitation of 16-18 inches in central North Dakota (Omodt, et al., 1968), and precipitation up to 20-22 inches annually in southeastern South Dakota (Westin, et al., 1967). Most of the precipitation comes in the spring and early summer. Rainfall is variable and often localized. Winters are severe

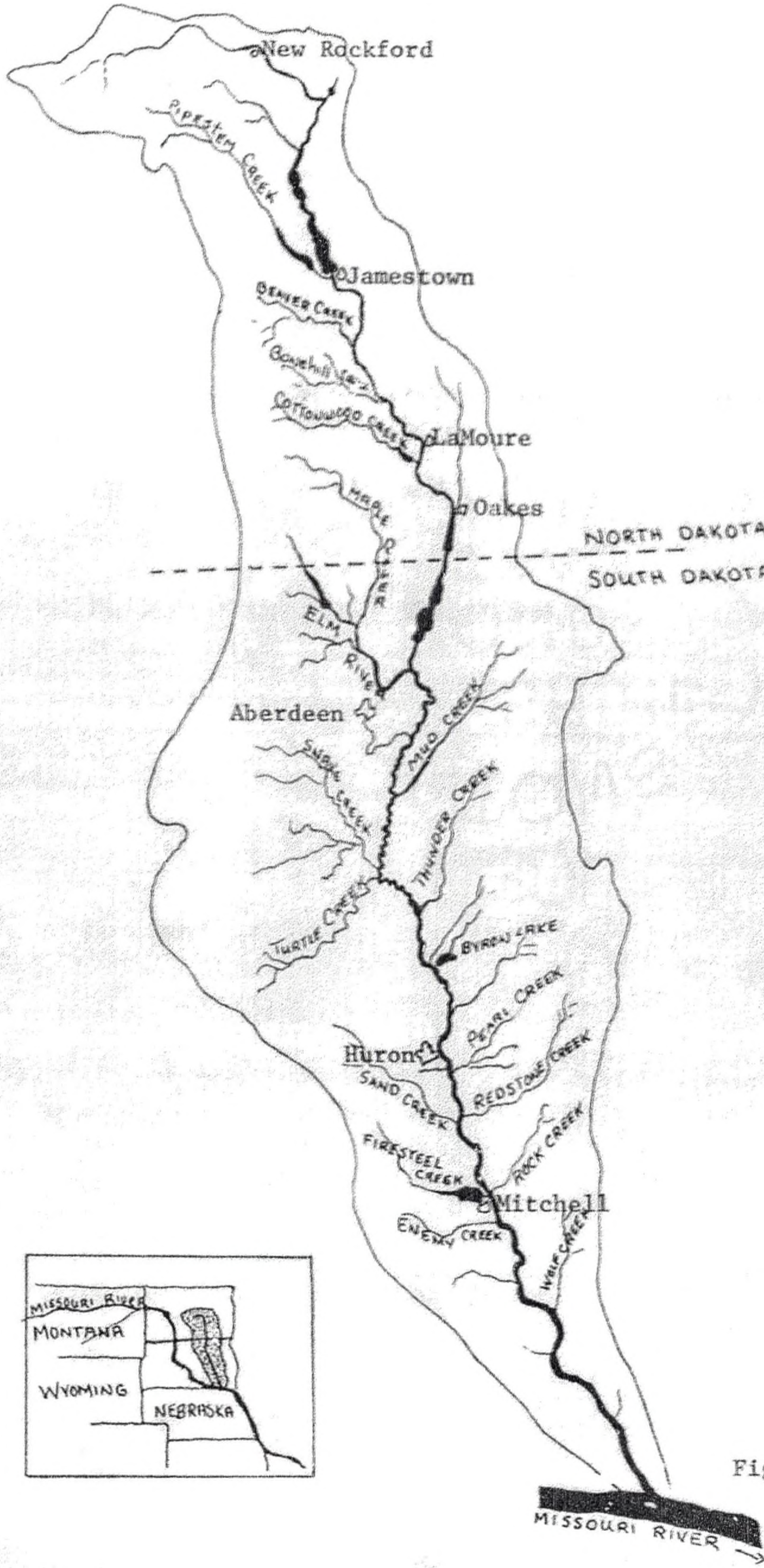


Figure 2. James River Basin

with extended periods of below-freezing weather. Snow cover and winter freeze-up occur usually from middle or late November until March or early April in North Dakota. Although still cold, winters in southern South Dakota are less severe.

The leveling action of glaciation has created a relatively gentle slope throughout the basin. Lakes, marshes, and ponds receive much of the surface runoff. The James River flows along the axis of the basin with tributaries reaching into the undulating prairie.

The river drops about 360 feet in the 260 river miles in North Da-kota, and 100 feet in the 450 river miles in South Dakota. The slope of the channel is 2.5 feet per mile near the headwaters, 0.5 feet per mile in the Lake Dakota area in the central part of the basin, and 0.2 to 0.4 feet per mile in the remaining South Dakota portion.

The James River begins west of Fessenden in Wells County, North Da-kota where it is a series of intermittent pools much of the year. The river broadens into a wide, shallow marsh near Bremen. Downstream from Bremen, the channel is more distinct and forms a series of riffles and pools. In Arrowwood National Wildlife Refuge, the river broadens and forms three shallow lakes and a marsh. The river is impounded further south by Jamestown Dam, providing a 13,200 acre reservoir for recreation and water storage.

Below Jamestown Reservoir, the river flows through pasturelands until it reaches the old Lake Dakota region beginning near Ludden, North Dakota. This is the bottom of ancient "Lake Dakota" which was formed south of the last glacial sheet (Rothrock, 1943).

Dakota Lake National Wildlife Refuge, North Dakota, and Sand Lake National Wildlife Refuge, South Dakota, are situated in the low-lying level terrain of the old glacial lake bed. The river is impounded by a low-level dam in the Dakota Lake National Wildlife Refuge and by two control structures in Sand Lake National Wildlife Refuge.

The James River below Sand Lake National Wildlife Refuge meanders widely in the southern portion of the old Lake Dakota bed. The meanders become more gradual near Huron, South Dakota, and the river continues south until reaching the Missouri River just east of Yankton, South Dakota.

The river is impounded in many places in South Dakota by low-head dams with heights ranging from 1 to 15 feet. The James River Diversion Dam 18 miles north of Huron is 15 feet high and is the largest concrete structure on the river in South Dakota. Other sizeable dams in the lower river include a structure 9 feet high in the Spink County recreation area and the 9-foot-high 3rd Street Dam in Huron. A large rock dam at Milltown is 8 feet high and rock dams at Wolf Creek and Olivet are 6 feet in height.

Streamflow in the James River is affected primarily by melting snow in spring and by rainfall. Peak stream discharges are usually the result of early spring snowmelt. Streamflow is greatly diminished during the summer unless large rains occur. Extended periods of low flow often occur in the North Dakota portion and in much of the South Dakota portion of the river. During the dry months of some summers, the river becomes a series of pools. The flow in tributaries after local rains sometimes produces a reversal in the James River's normal flow. Streamflow from October to March is usually very meager.

Natural flows in the James River would be affected by two proposed water diversion projects. The Garrison Diversion Unit would release water through the James River feeder canal near New Rockford. The flows in the James River downstream from the James River feeder canal would be a composite of natural flows, releases, and return flows from irrigation areas. Water is planned to be removed from the James River at the Oakes pumping plant for the east Oakes irrigation area. Return flows and operational waste resulting from excess water in canals would enter the Wild Rice River and provide a possible linkage for the passage of fishes. Releases and return flows are predicted to add streamflow to the James River below Oakes, with an annual average return flow of about 3600 acre-feet expected to accrue to the James River at the North Dakota-South Dakota border (U. S. Bureau of Reclamation, 1976). During the months from September through February the composite monthly median flows in the James River at the border are predicted to be approximately 3 times greater than the historical median (U. S. Bureau of Reclamation, 1976). Total Dissolved Solids (TDS), sulfates, and hardness concentrations are predicted to be increased by the Garrison Diversion Unit (U. S. Bureau of Reclamation, 1976).

The Oahe Unit in the James River drainage in South Dakota is planned to supply Missouri River water for irrigation on both sides of the river between Columbia and the James River Diversion Dam north of Huron. Streamflow in the James River would be affected by releases for dilution flows and by return flows from irrigation. Average monthly streamflows in the James River in the section receiving flows and in downstream areas are predicted to be increased during the months of August through February (U. S. Bureau of Reclamation, 1975). Average monthly Total Dissolved Solids will be increased, particularly during winter months (U. S. Bureau of Reclamation, 1975). Several options are under consideration for using the James River to transport the irrigation water from the proposed Oahe Unit. One option involves channelization, shortening the river from about 110 miles to 54 miles to permit more rapid movement of water.

Literature Review

Previous Fish Collections

Early fish collections in the James River in North Dakota were made by Woolman (1896), Hankinson (1929), and Hubbs and Schultz (cited in Hankinson, 1929). These collections were made primarily at Jamestown and LaMoure, North Dakota. Russell (1975) collected fishes at 24 stations on the James River in North Dakota. Additional records of James River fishes were provided by the North Dakota Game and Fish Department's annual statewide investigations of lakes, streams, and impoundments (NDGF, 1968; 1969; 1970; 1973; 1975). These mimeographed records also list species stocked in portions of the drainage. The North Dakota Game and Fish Department recently sampled fishes in Jamestown Reservoir, Pipestem Reservoir, Arrowwood National Wildlife Refuge impoundments, and in the headwaters of the James River (personal communication, James Ragan, 1974). The U. S. Fish and Wildlife Service also netted impoundments of the Arrowwood National Wildlife Refuge (personal communication, Ron Ulrich, 1974).

Owen and Russell (1975a) studied the possibility of interbasin transfer of fishes from the Missouri and James River basins to the Wild Rice-Hudson Bay drainage through the Oakes irrigation area. They reviewed the literature and tabulated species present in each of the basins, and also described and recommended barriers to interbasin transfer.

Evermann and Cox (1896) collected fishes in the James River in South Dakota. Churchill and Over (1933) described the fish fauna in South Dakota, but did not delimit all species by drainage basins. Fishes of the James River drainage in South Dakota were included in a study of the James River basin by the U.S. Public Health Service (1952). Bailey and Allum (1962) listed species from the James River drainage in South Dakota. Their collections are the best source of information on fish distribution in the James River in South Dakota. There is no available comprehensive study of the ranges of the fishes throughout the James River.

Tol (1976) studied the fish populations of a 120 mile section of the James River between Tacoma Park and Redfield, South Dakota. He discussed the importance of the James River in his study area as a spawning ground for adult fishes and as a nursery for young fishes, and described duration of adequate flow volume as appearing to be an important limiting factor to the fishes in relation to growth, reproduction, and movement. Lockard (1976) studied a winter fish kill in the James River near Tacoma Park, South Dakota in March, 1976.

I relied largely upon Scott and Crossman (1973) for my compilation of fish species in the Hudson Bay basin in Canada. The fishes of the Red River of the North were listed in Eddy and Underhill (1974), Eddy, et al. (1972), and Underhill (1957). Fishes of the tributaries of the Red River of the North in North Dakota were reported by Copes (1965), Copes and Tubb (1966), and Feldman (1963). Owen and Russell (1975a) and Russell (1975) reported on fishes collected in the Wild Rice River and Sheyenne River and reviewed earlier collections of fish species in the Red River of the North tributaries in North Dakota.

The natural distribution of fishes in the above basins and the possibility of interbasin transfer through incomplete or temporary barriers in the Red River basin have been considered by investigators. Bailey and Allum (1962) and Underhill (1957) pointed out that there is a temporary connection between Lake Traverse (Red River drainage) and Big Stone Lake (Mississippi River drainage). This connection results from spring flooding on the divide separating the two lakes, although the dispersal of fishes through this connective seems a rare occurrence. Stewart and Lindsey (1970) have recently reported the presence of the stonecat, <u>Noturus flavus</u>, in the Red River of the North. This species had not been previously reported in the Hudson Bay drainage, and they believed it may have crossed over the divide between Big Stone Lake and Lake Traverse in modern times.

Eddy, et al. (1972) discussed postglacial dispersal routes of Minnesota fish species through connectives of glacial Lake Agassiz and reported present distribution of fishes in the Red River of the North drainage.

Wilson (1950) collected fishes in the Sheyenne River, North Dakota, before impoundment of Lake Ashtabula. He believed water depth limited the numbers of fish species and found the greatest number of species at the Baldhill Creek area, about midway along the length of the river.

Tubb, et al. (1966) studied the fishes of the Sheyenne River, North Dakota. They found few fish species in the headwater regions because of high turbidities, elevated summer temperatures, and winterkill. Fish fauna downstream was more diversified.

Feldman (1963) described a preference of Forest River, North Dakota, fishes for general environments resulting from Pleistocene history. On the old glacial Lake Agassiz beaches, more rapid water, sand and gravel bottoms, and aquatic vegetation prevailed; while slower, turbid water and silted bottoms occurred on the old Lake Agassiz bottom.

Copes and Tubb (1966) reported on fishes in Red River tributaries in North Dakota, and found that species increased downstream from the headwaters. They considered the principal physical factors affecting the fishes as high turbidity, water temperature, erratic streamflow, heavy silt loads, and lack of suitable spawning habitat.

Russell (1975) studied fish distribution in the James River, Wild Rice River, Souris River, Sheyenne River, and Devils Lake in North Dakota. He listed intermittent flow as probably limiting fish distribution to varying degrees in each drainage.

Bailey and Allum (1962) discussed distribution for each species in South Dakota. They discussed the origin and composition of South Dakota fishes including the glacial relict species, the species invading during the post-glacial invasion, and those derived by hydrographic interchange.

Underhill (1959) studied the fish of the Vermillion River, South Dakota, a largely intermittent stream altered by agricultural practices, channel straightening, and dredging. He discussed species rare or restricted in relict habitats where the old channel is present and described species left in pools of the drying stream bed.

Hansen (1971) studied some physical factors, bottom fauna, and fish populations in channelized and unchannelized portions of the Little Sioux River, Iowa. He found numbers of fish species greater in the unchannelized sections of the river, and determined that major changes in species composition of fishes compared to early surveys resulted from a control structure near the mouth, which blocked upstream movement of certain species from the Missouri River.

Miller (1972) reported on the status of endangered, rare, or depleted freshwater fish species in North Dakota, South Dakota, and other states.

Distribution Literature

The distribution of fishes in rivers has been studied by many researchers who have used stream fauna to investigate such ecological factors as species diversity and longitudinal succession. Stream fish populations provide excellent subjects for study because the stream is a linear system and sampling problems are reduced (Sheldon, 1968). Small streams especially demonstrate faunal changes as the fish species change quickly within relatively short distances (Shelford, 1911).

Studies concerned with the distribution and abundance of stream fishes usually recognize a complexity of interacting factors governing the fish community. Thompson and Hunt (1930) stated that one factor or just a few factors could not explain fish distribution and abundance in Illinois streams; rather a combination of abiotic and biotic factors had to be evaluated. Abiotic factors included volume and depth of the stream, seasonal permanency and rate of streamflow, bottom type and soil fertility, and temperature fluctuations. Biological factors included seasonal migrations and behavior, morphological and physiological adaptations, feeding habits, and intraspecific or interspecific interactions such as predation and competition.

In many river systems, researchers have found a general pattern of increased species and increased diversity downstream. This increase has usually been regarded as a reflection of the increased physical heterogeneity and depth of the stream and a probable variety of physical niches (Tramer and Rogers, 1973). This increased number of downstream fish species has been related to an increased watershed area (Thompson and Hunt, 1930; Larimore and Smith, 1963).

Often the changes in species composition in stream fish are additions to headwater species. If the succession is chiefly additive, the factors determining the upstream limits of individual species also determine species diversity (Sheldon, 1968). Many factors have been used to explain this succession, and most factors have been some measure of stream size or stream morphometry.

Shelford (1911) was one of the first ecologists to study fish distribution patterns in streams. He discussed an ecological succession where similar fish communities occupy similar physiographic stages in the base leveling of a stream. Trautman (1942) stated that although the presence of a species is the result of a combination of many favorable factors, stream gradient appeared to be of greater and more universal importance than other factors. He believed gradient explained distribution patterns of fish, the presence of relict colonies of rare species, and served as a tool for evaluating stocking, selecting headwater reservoirs, and finding species previously unrecorded. Burton and Odum (1945) found stream size, gradient, and temperature to be important factors in the distribution of stream fish in Virginia. They reported changes in fish species are more pronounced the greater the altitudinal gradient, but distinct longitudinal differences occur with very slight changes in altitude. Starrett (1950) considered the inability of some Iowa stream fishes to withstand low oxygen and crowded conditions in late summer pools to be an important factor in limiting the number of species in small streams subject to partial drying. He found that some fish species tend to have a limited distribution because of ecological preference. Starrett (1951) discussed floods and silt as appearing to be important factors affecting abundance of the fish population. Spawning success was considered dependent on population size and space. Sheldon (1968) emphasized stream depth as important in predicting the number of fish species in a New York stream. Vincent and Miller (1969) discussed trout distribution related to water temperature. Whiteside and McNatt (1972) analyzed fish distribution in relation to physico-chemical conditions and stream order of a Texas drainage basin. With the smallest unbranched tributary designated as a first-order stream, the confluence of two first-order streams a second-order stream, etc., numbers of fish species generally increased as stream order increased. Harrel and Dorris (1968) used a similar stream order analysis of community structure of benthic macroinvertebrates in an intermittent stream. They attributed the increase in species as stream order increased to decreased environmental fluctuations and increased available habitat. Hubbs (1957) considered the basic factors controlling the fish distribution in Texas to be climatological and geological factors which determine water properties. He also stated that recent faunal modifications complicated the evaluation of natural distribution of fishes.

The basic pattern of species addition as downstream stream size increases can be modified by factors in the stream environment. Sheldon (1968) found structural cover such as roots and logs produced an increase in species diversity; and water velocities seemed to reduce the effective depth, apparently because fish could not occupy the entire water column in faster water. Hanson and Campbell (1963) found the linear distribution of fishes in a warm-water Missouri stream related to stream gradient and watershed area, but superimposed on this pattern, several beaver ponds improved the carrying capacity of the stream. The presence of beaver pools in the headwater section affected fish by increasing volume of water, providing pools in times of intermittent stream flow, and increasing the variety of fish habitat.

Not all fish species follow the simple pattern of addition to the headwater assemblage as the stream size increases. Some species do not range the length of the river between the point where they are added to the assemblage and the mouth, but are found only in localized habitat. Forbes (1907) reported that darters have strong preferences for substrates and occur in special habitats along the stream. Sheldon (1968) found some species confined in restricted habitats behind beaver dams or in aquatic vegetation areas. Starrett (1950) found some stream fish have a limited distribution because of ecological preference. He reported blacknose dace, Rhinichthys atratulus, confined to small tributaries with steep gradients. Underhill (1959) found some species limited to small portions of the river. While habitat preferences appeared to restrict these species, inter-specific competition may be equally important in the restriction of one species. Some Salmonidae (trouts), which have definite temperature distribution, do not always range the length of the river, but are distributed in sections of the river with suitable temperature (Vincent and Miller, 1969; Burton and Odom, 1945).

Some streams do not have the additive pattern to fish distribution, but demonstrate a replacement pattern. Tramer and Rogers (1973) found changes in species composition occurred as replacements rather than as additions in a stream undergoing pollution stress. They believed the environmental perturbation cancels out the diversity-enhancing effects of increasing physical heterogeneity. Deacon and Bradley (1972) found the spring pools at the headwaters of a Nevada river are physically and chemically stable habitats, and their fish populations differed from the fish in the fluctuating downstream reaches.

Some investigators have found little movement in stream fishes. Gerking (1953) found distribution relatively stable in smallmouth bass streams. He considered each pool more or less an isolated unit with little or no movement from one pool to the next. Larimore et al. (1959) found some Centrarchidae (sunfishes) relatively slow in repopulating segments of a stream. Gard and Flittner (1974) found that while the timing and severity of floods can cause numbers to fluctuate up to 10 fold, the distribution was remarkably stable in trout streams. Minnows, sculpins, and suckers (Tahoe and mountain suckers) were the most sedentary.

Many fishery investigators have found considerable movement in warm-water stream fish. Funk (1955) found that some stream fish in Missouri are sedentary, but others range quite freely upstream and downstream. He proposed that warm-water stream fish species consist of a sedentary and a mobile group. Larimore et al. (1959) found fish populations re-establishing themselves following a severe drought by an upstream ingression when streamflow resumed. Deacon (1961) found a similar readjustment by fish following intermittent conditions of a drought. Larimore et al. (1959) discussed a "colonization cycle" in which stream fish migrate upstream, reproduce, and withdraw downstream. Gunning and Berra (1968) found that in some situations, repopulation of upstream segments may be accomplished by spring and/or summer movements of immature fish. Paloumpis (1958) studied minnows responding to the fluctuations of an intermittent stream in Iowa. During flood periods, small tributary streams appeared to serve as havens; while during drought, isolated pools in the channel, flood plain pools, and large rivers were important havens. Hanson and Campbell (1963) found an influx of large fishes from the Missouri River into their study stream during spring. Hansen (1971) found that a low head dam at the mouth of the Little Sioux River in Iowa was an effective barrier, and that flathead catfish, sauger, shortnose gar, smallmouth buffalo, white bass, bigmouth buffalo, and gizzard shad all depended primarily upon upstream migration from the Missouri River. These species became absent in the Little Sioux River after construction of the dam. Van Eeckhout (1974) studied channel catfish reproduction and movement in a North Dakota River. He described streamflow as imperative for both spring ascent and autumnal descent. Tramer and Rogers (1973) stated seasonal migrations are the rule in most temperate zone creeks.

Methods

Fishes were collected from June 10 to October 19, 1975, at 69 stations in the James River and tributaries. Tentative station locations were selected from Highway Department county maps in an attempt to sample all sections of the river within the time available. Final station locations were determined by access to the river and flow conditions which permitted the setting of nets (Figure 3).

Fish were captured by ¼-inch mesh seines, ¼-inch mesh frame or trap nets, various-sized mesh experimental gill nets, and hook-and-line. Provisional identifications were made in the field, aided by the taxonomic key of Eddy (1969). Verifications were made in the laboratory utilizing taxonomic keys by Eddy (1969), Bailey and Allum (1962), Scott and Crossman (1973), and Cross (1967). Dr. James C. Underhill, University of Minnesota, identified 3 species. Some specimens are preserved in the collection of the Fisheries Research Unit, Biology Department, University of North Dakota. Scientific and common names are those listed by the American Fisheries Society (1970), except for the central stoneroller, *Campostoma anomalum*, and the grass carp, *Ctenopharyngodon idella*, which follow Pflieger (1975).

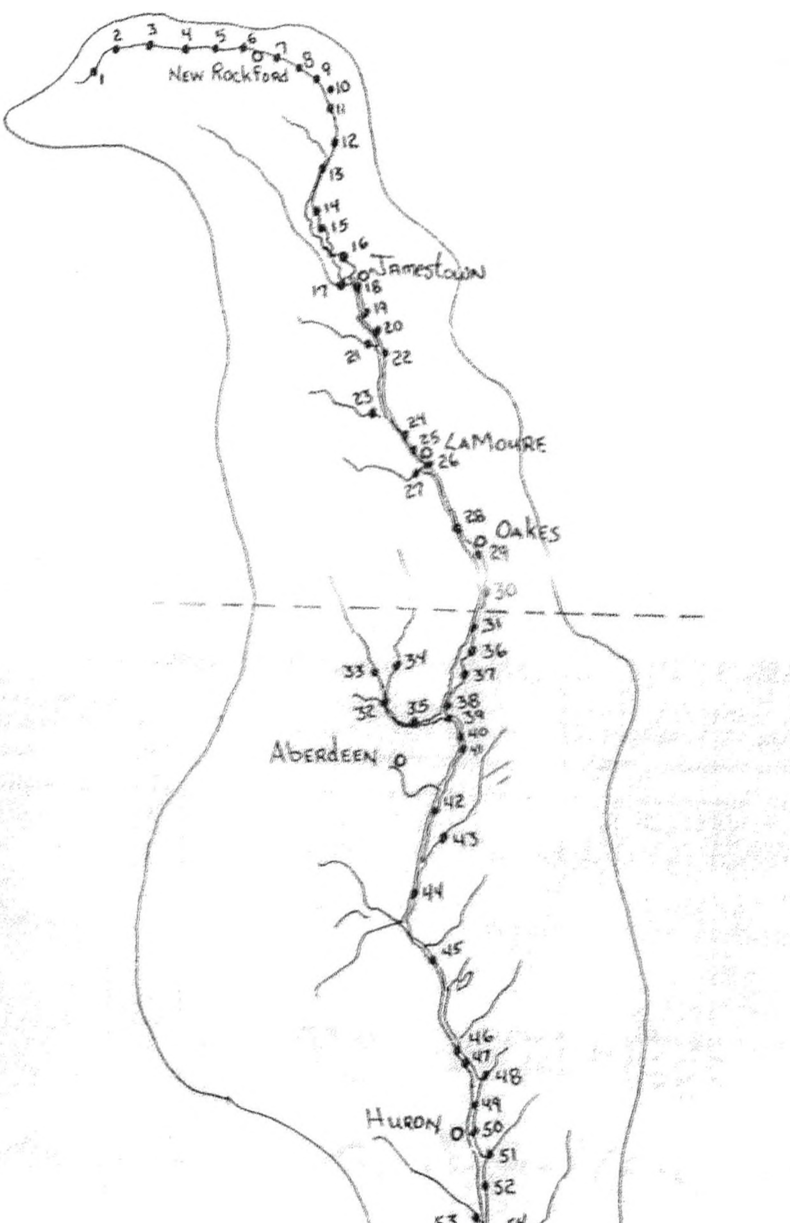


Figure 3. Collection stations

Results

Annotated List of Fishes

Fifty-nine species of fish have been reported for the James River drainage. The following list includes 41 species collected at stations in 1975 plus an additional 18 species reported by other investigators.

Polyodontidae--paddlefishes

1. Polyodon spathula (Walbaum), the paddlefish, are sometimes present in the lower end (3-5 miles at least) of the river (personal communication, Ronald P. Catlin, 1977). Bailey and Allum (1962) stated that they have "heard rumors of an occasional capture well upstream in the James River". Station records: not collected during this survey.

Lepisosteidae--gars

2. Lepisosteus platostomus Rafinesque, the shortnose gar, adults were found in the James River from near Huron to the mouth. This species has been collected as far north as Tacoma Park in Brown County, South Dakota (personal communication, Douglas Hansen, 1977).
Station records: 56, 59, 63, 64, 65, 66, 67, 68, 69.

Clupeidae--herrings

3. Dorosoma cepedianum (Lesueur), the gizzard shad, young-of-the-year (YOY) were abundant in the quiet shallows of the James River from Huron to the mouth and in Lake Mitchell. Adults were found at the mouth and in Lake Mitchell.

Station records: 50, 51, 52, 55, 56, 57, 58, 60, 62, 63, 64, 65, 66, 67, 68, 69.

Hiodontidae--mooneyes

4. Hiodon alosoides (Rafinesque), the goldeye, adults were found in the lower reaches of the river; no young-of-the-year were found.
Station records: 63, 64, 65, 66, 67, 68, 69.

Salmonidae--trouts

5. Salmo gairdneri Richardson, the rainbow trout, was introduced into Lake LaMoure, a reservoir on Cottonwood Creek, North Dakota (NDGF, 1975). A few dead trout on the creek banks at station 27 testified to the death for any trout escaping through the dam. Bailey and Allum (1962) listed the rainbow trout as an introduction in the James River basin in South Dakota.
Station records: not collected during this survey.

Esocidae--pikes

6. Esox lucius Linnaeus, the northern pike, adults were common in most of the river. Young-of-the-year were found in the James River just below Jamestown Dam; in North Dakota tributaries (Beaver, Bonehill, and Cottonwood Creeks); and in the Elm River and Mud Creek, South Dakota.
Station records: 5, 10, 11, 12, 14, 16, 17, 19, 20, 22, 23, 24, 25, 26, 27, 29, 30, 31, 32, 33, 35, 36, 37, 39, 40, 41, 42, 44.

7. Esox masquinongy Mitchill, the muskellunge, and E. masquinongy X E. lucius, hybrid between muskellunge and northern pike, were introduced into Jamestown and Pipestem Reservoirs in North Dakota in 1976 and 1977 (personal communication, Gene Van Eeckhout, 1977).
Station records: not collected during this survey.

8. Campostoma anomalum (Rafinesque), the central stoneroller, was collected in Enemy Creek, Hanson Co., South Dakota. Woolman (1896) found large numbers at Jamestown, North Dakota. Bailey and Allum (1962) found stonerollers in the James River in South Dakota.

Station records: 61.

9. Cyprinus carpio Linneaus, the carp, adults and young-of-the-year were abundant along the James River and in tributaries.

Station records: 4, 5, 6, 11, 12, 13, 14, 15, 25, 28, 30, 31, 32, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 55, 56, 57, 59, 60, 61, 62, 64, 65, 66, 67, 68.

10. Ctenopharyngodon idella (Valenciennes), the grass carp, was recently reported from near the mouth of the James River in South Dakota (personal communicationm Dale Henegar, 1977).

Station records: not collected during this survey.

11. Hybognathus hankinsoni Hubbs, the brassy minnow, was reported by Bailey and Allum (1962) in seven collections in the river in South Dakota.

Station records: not collected during this survey.

12. Hybognathus nuchalis Agassiz, the silvery minnow, was reported at Jamestown, North Dakota (Woolman, 1896; Hankinson, 1929). Recent collectors have failed to find this species in the James River.

Station records: not collected during this survey.

13. Nocomis biguttatus (Kirtland), the hornyhead chub, was listed by Woolman (1896) as common in the James River in North Dakota. Hankinson (1929) found this species in the North Dakota portion of the river. Recent collectors have failed to find the horneyhead chub in the James River.

Station records: not collected during this survey.

14. Notemigonus chrysoleucas (Mitchill), the golden shiner, was found by Bailey and Allum (1962) in three ponds in the James River drainage in South Dakota. Hubbs and Schultz cited in Hankinson (1929) found this species in the James River in North Dakota. North Dakota Game and Fish records show the golden shiner in Jamestown and Pipestem Reservoirs, North Dakota (NDGF, 1969; NDGF, 1975).

Station records: not collected during this survey.

15. Notropis atherinoides Rafinesque, the emerald shiner, was common near the mouth of the James River.

Station records: 65, 66, 67, 68, 69.

16. Notropis blennius (Girard), the river shiner, was listed in North Dakota State Game and Fish Collections (1968) in the James River in North Dakota.

Station records: not collected during this survey.

17. Notropis cornutus (Mitchill), the common shiner, adults and young-of-the-year were occasionally collected, most commonly in tributaries. Their range is from below Jamestown Reservoir to the mouth.

Station records: 17, 18, 19, 20, 21, 23, 27, 33, 61.

18. Notropis dorsalis (Agassiz), the bigmouth shiner, was collected in Enemy Creek, Hanson Co., South Dakota. Bailey and Allum (1962) reported this species from Lake Mitchell and in Dry Creek in South Dakota.

Station records: 61.

19. Notropis heterolepis Eigenmann and Eigenmann, the blacknose shiner[1], was found by Woolman (1896) at Jamestown, North Dakota, and by

---

[1]Endangered in the state of South Dakota (Miller, 1972).

Hankinson (1929) in the James River in North Dakota. Evermann and Cox (1896) collected this species in the James River in South Dakota. Bailey and Allum (1962) did not collect this species, and stated that it has become rare in South Dakota. Recent collectors have failed to find the blacknose shiner in the James River.

Station records: not collected during this survey.

20. Notropis hudsonius (Clinton), the spottail shiner, was common in Lake Mitchell, South Dakota. Hankinson (1929) collected this species in the James River in North Dakota. Evermann and Cox (1896) and Bailey and Allum (1962) reported spottail shiners from the James River in South Dakota.

Station records: 57, 58.

21. Notropis lutrensis (Baird and Girard), the red shiner, was common in the James River and in tributaries in South Dakota from Spink County to the mouth.

Station records: 43, 44, 47, 48, 52, 53, 57, 62, 63, 64, 65, 66, 67, 68, 69.

22. Notropis stramineus (Cope), the sand shiner, was common from below Jamestown Reservoir to the mouth of the James River.

Station records: 20, 21, 23, 24, 27, 29, 32, 33, 34, 35, 40, 41, 43, 44, 46, 47, 48, 50, 52, 53, 55, 56, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69.

23. Notropis topeka Gilbert, the topeka shiner[2], was found in two tributaries of the James River in South Dakota. Bailey and Allum (1962) recorded this species in the lower James River in South Dakota.

Station records: 32, 33, 57.

24. Pimephales notatus (Rafinesque), the bluntnose minnow, was reported by Woolman (1896) at LaMoure and Jamestown, North Dakota. Hankinson (1929)

---

[2] Rare in the state of South Dakota (Miller, 1972).

also found this species in the James River in North Dakota. Recent collectors have failed to find the bluntnose minnow in the James River.
Station records: not collected during this survey.

25. Pimephales promelas Rafinesque, the fathead minnow, was the most common fish in the James River in North Dakota. Although still very common, this species became less abundant in downstream stations.
Station records: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 23, 25, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 59, 60, 61, 62, 63, 64, 65, 66, 67, 68, 69.

26. Rhinichthys atratulus (Hermann), the blacknose dace[3], was found in North Dakota in Bonehill, Cottonwood, and Beaver Creeks and in the James River at Montpelier. This species preferred rocky-bottomed riffles in high gradient tributaries. Bailey and Allum (1962) identified blacknose dace in an early collection from Enemy Creek, Davison County, South Dakota.
Station records: 20, 21, 23, 27.

27. Semotilus atromaculatus (Mitchill), the creek chub, adults and YOY were found in most of the tributaries below Jamestown Reservoir. Scattered adults were collected in the James River.
Station records: 17, 23, 27, 32, 33, 34, 40, 48, 53, 61.

Catostomidae--suckers

28. Carpiodes carpio (Rafinesque), the river carpsucker, adults were

---

[3]Rare in the state of South Dakota (Miller, 1972).

occasionally found in the James River as far north as the North Dakota border. Young-of-the-year were found in the lower reaches of the river.
Station records: 25, 39, 50, 63, 64, 66, 69.

29. Catostomus commersoni (Lacepede), the white sucker, adults and YOY were common in tributaries and in the James River over most of the length of the river.
Station records: 4, 5, 6, 14, 16, 18, 22, 27, 30, 31, 32, 35, 37, 38, 41, 47, 48, 57, 58, 61, 63.

30. Cycleptus elongatus (Lesueur), the blue sucker[4], was reported by Beal (1963) as entering the James River from the Missouri River for an early spring spawning run.
Station records: not collected during this survey.

31. Ictiobus bubalus (Rafinesque), the smallmouth buffalo, adults and YOY were found in quiet pools in the lower reaches of the river. North Dakota State Game and Fish Department (1969) listed a population of smallmouth buffalo in Jamestown Reservoir.
Station records: 60, 61, 63, 64, 65, 66, 68, 69.

32. Ictiobus cyprinellus (Valenciennes), the bigmouth buffalo, adults and YOY were collected in the James River from near the North Dakota border to the mouth.
Station records: 30, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 50, 51, 52, 55, 56, 57, 59, 60, 62, 63, 64, 65, 67, 68, 69.

33. Ictiobus niger (Rafinesque), the black buffalo, was reported in Lake Mitchell, South Dakota by Moen (1970).

---

[4] Depleted in the state of South Dakota (Miller, 1972).

Station records: not collected during this survey.

34. Moxostoma macrolepidotum (Lesueur), the shorthead redhorse, adults were collected near LaMoure, North Dakota, and in South Dakota portions of the river. Young-of-the-year were found at the mouth of the river over gravel bottoms.

Station records: 25, 46, 47, 58, 64, 65, 66, 67, 68, 69.

Ictaluridae--freshwater catfishes

35. Ictalurus furcatus (Lesueur), the blue catfish[5], is known from the mouth of the James River, and a one-time world record of 94.5 lbs. was caught in 1949 and mounted in the Yankton office of the South Dakota Game, Fish and Parks Department (personal communication, Ronald P. Catlin, 1977).

Station records: not collected during this survey.

36. Ictalurus melas (Rafinesque), the black bullhead, was abundant over the entire length of the river. Adults and YOY were present at all stations except at the mouth.

Station records: 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22, 24, 25, 26, 28, 29, 30, 31, 32, 33, 34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 54, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65.

37. Ictalurus natalis (Lesueur), the yellow bullhead[6], was found at one station in Spink County, South Dakota. Woolman (1896) collected the yellow bullhead at LaMoure, North Dakota.

Station record: 44.

---

[5]Rare in the state of South Dakota (Miller, 1972).

[6]Rare in the state of South Dakota (Miller, 1972).

38. Ictalurus nebulosus (Lesueur), the brown bullhead, was reported by Woolman (1896) in the James River in North Dakota. Recent collectors have failed to find this species in the James River.

Station records: not collected during this survey.

39. Ictalurus punctatus (Rafinesque), the channel catfish, was found in most of the South Dakota portion of the James River. Adults ranged from Elm River, Brown County, to the mouth. Young-of-the-year were common from Huron, South Dakota to the mouth.

Station records: 35, 41, 42, 46, 47, 49, 50, 52, 55, 56, 59, 62, 63, 64, 65, 66, 67, 68, 69.

40. Noturus gyrinus (Mitchill), the tadpole madtom, was found in the James River and in tributaries from LaMoure, North Dakota to the mouth.

Station records: 24, 25, 26, 40, 43, 46, 49, 53, 55, 61.

41. Pylodictis olivaris (Rafinesque), the flathead catfish, YOY were present at the mouth of the James River.

Station records: 68, 69.

Cyprinodontidae--killifishes

42. Fundulus sciadicus Cope, the plains topminnow[7], was found in Sand Creek, South Dakota. Evermann and Cox (1896) collected this species at Prairie and Rock Creeks in South Dakota.

Station record: 53.

Gasterostidae--sticklebacks

43. Culaea inconstans (Kirtland), the brook stickleback, was common in the headwater portion of the James River. This species became

---

[7]Rare in the state of South Dakota (Miller, 1972).

less abundant below Jamestown Reservoir, and the only South Dakota specimens were taken in Brown County.

Station records: 1, 2, 3, 4, 5, 8, 9, 10, 12, 14, 15, 17, 36, 37, 38, 39.

Percicthyidae--temperate basses

44. Morone chrysops (Rafinesque), the white bass, YOY were found near the mouth of the James River. Local sportsmen reported a spawning run in May during years when sufficient flow allowed migration from the Missouri River. This species is also in Jamestown Reservoir (NDGF, 1969).

Station records: 67, 68, 69.

Centrarchidae--sunfishes

45. Lepomis cyanellus Rafinesque, the green sunfish, adults and YOY were common from the Elm River, Brown County, South Dakota to the mouth of the James River.

Station records: 32, 33, 34, 35, 38, 40, 41, 42, 43, 44, 46, 47, 48, 50, 51, 52, 53, 54, 55, 56, 57, 60, 61, 62, 63, 64, 65, 66.

46. Lepomis gibbosus (Linnaeus), the pumpkinseed, was reported by Bailey and Allum (1962) as present in the James River drainage through introductions in South Dakota ponds.

Station records: not collected during this survey.

47. Lepomis humilis (Girard), the orangespotted sunfish, adults and YOY were common from below Jamestown Reservoir to the mouth.

Station records: 18, 20, 21, 27, 28, 29, 32, 33, 34, 40, 41, 42, 43, 44, 45, 46, 48, 49, 50, 51, 52, 56, 57, 60, 62, 63, 64, 65, 66, 67, 68, 69.

48. Lepomis macrochirus Rafinesque, the bluegill, adults and YOY were collected in Jamestown Reservoir and in scattered stations in the James River in both states. Bailey and Allum (1962) listed the bluegill

through introductions in two ponds in the South Dakota drainage.

Station records: 16, 20, 50, 57, 59, 69.

49. Micropterus dolomieui Lacepede, the smallmouth bass, adults and YOY were found in Firesteel Creek, South Dakota. This species was also introduced into Jamestown Reservoir in North Dakota (personal communition, James Ragan, 1975).

Station record: 57.

50. Micropterus salmoides (Lacepede), the largemouth bass, adults and YOY were collected in the James River near Columbia, South Dakota, and in Firesteel Creek near Lake Mitchell. Bailey and Allum (1962) listed this species from introductions into lakes and ponds in South Dakota.

Station records: 38, 39, 57.

51. Pomoxis annularis Rafinesque, the white crappie, adults and YOY were common in the James River from Columbia, South Dakota to the mouth.

Station records: 35, 39, 40, 41, 42, 43, 44, 45, 46, 47, 48, 49, 50, 51, 52, 53, 55, 56, 57, 58, 59, 60, 61, 62, 63, 64, 65, 66, 68, 69.

52. Pomoxis nigromaculatus (Lesueur), the black crappie, adults and YOY were common in the James River from LaMoure, North Dakota to the mouth.

Station records: 25, 28, 32, 34, 35, 36, 37, 38, 40, 41, 42, 43, 44, 45, 46, 47, 48, 50, 51, 52, 55, 56, 57, 58, 59, 60, 62, 65, 66, 67, 69.

Percidae--perches

53. Etheostoma exile (Girard), the Iowa darter, was present in fast-flowing riffles over gravel bottoms in the upper portions of the James River in North Dakota. Bailey and Allum (1962) listed this species for the James River in South Dakota.

Station records: 9, 11, 21, 27.

54. Etheostoma nigrum Rafinesque, the johny darter, was collected from Arrowwood National Wildlife Refuge, North Dakota to the mouth. Station records: 14, 21, 27, 32, 33, 39, 43, 44, 46, 48, 50, 51, 52, 55, 60, 61, 65.

55. Perca flavescens (Mitchill), the yellow perch, was common in most of the North Dakota portion of the James River and in the northern portion of the South Dakota river. Bailey and Allum (1962) collected yellow perch throughout most of the South Dakota portion of the river. Station records: 6, 7, 12, 13, 14, 15, 16, 18, 25, 26, 28, 30, 32, 33, 34, 36, 37, 38, 39, 41.

56. Percina maculata (Girard), the blackside darter, was reported by Woolman (1896) from the James River near Jamestown. Recent collectors have failed to find this species in the James River.
Station records: not collected during this survey.

57. Stizostedion canadense (Smithe), the sauger, is found in the lower reaches of the James River (personal communication, Ronald P. Catlin, 1977). Station records: not collected during this survey.

58. Stizostedion vitreum vitreum (Mitchill), the walleye, was occasionally found in the James River from Jamestown Reservoir to the mouth. No young-of-the-year were found. Evermann and Cox (1896), Hankinson (1929), and Russell (1975) collected walleye in the James River.
Station records: 16, 33, 37, 40, 42, 45, 46, 47, 50, 58, 64.

Sciaenidae--drums or sheepheads

59. Aplodinotus grunniens Rafinesque, the freshwater drum, adults were found from Huron, South Dakota to the mouth. This species has been collected as far north as Spink County, South Dakota (personal communica-

tion, Dennis Tol, 1976). Young-of-the-year freshwater drum were common in the lower reaches of the James River.

Station records: 50, 55, 58, 59, 60, 62, 63, 64, 65, 66, 67, 68, 69.

Description of Collection Stations

Sixty-nine collection stations were utilized in the James River and tributaries. Locations of the stations are shown in Figure 3. A brief description of each station follows. Fish species collected at each station are indicated by annotated list numbers.

North Dakota

Station 1: James River headwaters, 9.5 mi. W. Fessenden; T. 148N, R. 72W, sec. 10; Wells Co.; June 10, 1975; water temperature 15 C; intermittent pools, sluggish flow; width to 15 feet, depth 1 to 5 feet; slight turbidity; bottom silt, some large stones; moderate shoreline and emergent vegetation. Species: 25, 36, 43.

Station 2: James River at Manfred city impoundment; T. 149N, R. 71W, sec. 28; Wells Co.; June 10, 1975; water temperature 15 C; small impoundment, slight flow; width to 80 feet, depth to 5 feet; moderate turbidity; bottom silt and large stones; moderate emergent vegetation. Species: 25, 36, 43.

Station 3: James River, 4 mi. N. Fessenden; T. 149N, R. 70W, sec. 27; Wells Co.; June 11, 1975; water temperature 16.5 C; slow flow stream; width to 30 feet; depth to 5 feet; moderate turbidity; bottom silt, gravel, and stones; dense emergent vegetation. Species: 25, 36, 43.

Station 4: James River, below dam 11 mi. NE Fessenden; T. 149N, R. 69W, sec. 36; Wells Co.; June 12, 1975; water temperature 18 C; fast flow stream; width 15 feet, depth to 4 feet; slight turbidity; bottom silt and large stones; dense emergent vegetation along shore. Species: 9, 25, 29, 36, 43.

Station 5: James River, 13 mi. ENE Fessenden; T. 149N, R. 69W, sec. 25; Wells Co.; June 12, 1975; water temperature 18.5 C; pools and riffles;

moderate flow; width to 60 feet, depth to 5 feet; moderate turbidity; bottom silt and large stones; moderate emergent vegetation, attached algae on rocks. Species: 6, 9, 25, 29, 36, 43.

Station 6: James River, 3 mi. NW New Rockford; T. 149N, R. 67W, sec. 26; Eddy Co.; June 12, 1975; water temperature 19.5 C; pools and riffles, moderate flow; width to 15 feet, depth to 4 feet; moderate turbidity; bottom silt and large stones; moderate emergent and submerged vegetation, some attached algae. Species: 9, 25, 29, 36, 55.

Station 7: James River, 4 mi. SE New Rockford; T. 148N, R. 66W, sec. 10; Eddy Co.; June 13, 1975; water temperature 19.5 C; riffle area, moderate flow; width 20 feet, depth to 5 feet; water turbid; bottom silt and large stones; moderate emergent vegetation. Species: 25, 36, 55.

Station 8: James River, 2 mi. W Brantford; T. 148N, R. 65W, sec. 33; Eddy Co.; June 13, 1975; water temperature 19.5; sluggish stream and marsh, very slight flow; width 60 feet, depth to 5 feet. Water turbid; bottom silt; dense emergent vegetation. Species: 25, 36, 43.

Station 9: James River, 2 mi. S Brantford; T. 147N. R. 65W, sec. 9; Foster Co.; June 14, 1975; water temperature 19.5 C; riffle and pool, moderate flow; width to 24 feet, depth to 3 feet; moderate turbidity; bottom silt, gravel, and large stones; sparse emergent vegetation, attached algae on stones. Species: 25, 36, 43, 53.

Station 10: Juanita Lake; T. 147N, R. 63W, secs. 18, 19; Foster Co.; June 17, 1975; water temperature 20 C; shallow lake, very slight outlet flow to James River; width ½ mile, depth to 6 feet; heavy turbidity; bottom silted, some large stones; dense emergent vegetation in places, moderate submerged vegetation, algal bloom. Species: 6, 25, 36, 43.

Station 11: James River, 5 mi. S Grace City; T. 146N, R. 64W, sec.

10; Foster Co.; June 17, 1975; water temperature 20 C; pool and riffle, moderate flow; width to 27 feet, depth to 6 feet; heavy turbidity; bottom silt, sand, gravel, and large stones; moderate emergent vegetation along shore, attached algae on stones. Species: 6, 9, 25, 36, 53.

Station 12: James River, 10 mi. NW Kensal; T. 145N, R. 64W, sec. 11; Foster Co.; June 18, 1975; water temperature 20 C; pool, moderate flow; width 60 feet, depth to 5 feet; heavy turbidity; bottom silt; moderate emergent vegetation, some attached algae. Species: 6, 9, 25, 36, 43, 55.

Station 13: James River, 5 mi. NW Kensal; T. 145N, R. 64W, sec. 22; Foster Co.; June 18, 1975; water temperature 20 C; pool, moderate flow; width 60 feet, depth to 4.5 feet; heavy turbidity, bottom silt; moderate emergent vegetation along shoreline. Species: 9, 25, 36, 55.

Station 14: Arrowwood Lake; T. 144N, R. 64W, sec. 19; Stutsman Co.; June 25, 1975; water temperature 23 C; width 3500 feet, depth to 7 feet; moderately turbid, bottom mud, silt and gravel; dense submerged vegetation. Species: 6, 9, 25, 29, 36, 43, 54, 55.

Station 15: Jim Lake; T. 143N, R. 64W, sec. 33; Stutsman Co.; June 25, 1975; water temperature 23 C; width 3000 feet, depth to 7 feet; moderate turbidity; bottom silted; moderate emergent vegetation along shore and sparse submerged vegetation. Species: 9, 25, 36, 43, 55.

Station 16: Jamestown Reservoir; T 141N, R. 64W, sec. 24; Stutsman Co.; June 26, 1975; water temperature 21 C at surface; width 2500 feet, depth to 30 feet; moderate turbidity; bottom silt, gravel, and sand; sparse emergent vegetation. Species: 6, 25, 29, 36, 48, 55, 58.

Station 17: Pipestem Creek, 4.5 mi. W Buchanan; T. 142N, R. 65W, sec. 33; Stutsman Co.; June 27, 1975; water temperature 20 C; riffle and pool; width 50 feet, depth to 4 feet; moderate turbidity; bottom silt, gravel, and large stones; sparse emergent vegetation, attached algae on stones. Species: 6, 17, 25, 27, 36, 43.

Station 18: James River below Jamestown Reservoir; T. 140N, R. 64W, sec. 26; Stutsman Co., June 30, 1975; water temperature 20 C; pool below spillway; width 50 feet, depth to 6 feet; moderate turbidity; bottom silt, gravel, and large stones; moderate emergent and submerged vegetation. Species: 17, 25, 29, 36, 47, 55.

Station 19: James River at Ypsilanti; T. 138N, R. 63W, sec. 13; Stutsman Co.; June 27, 1975; water temperature 19.5 C; murky pool, sluggish flow; width 50 feet, depth to 5 feet; heavy turbidity; bottom silt and large stones; moderate emergent vegetation. Species: 6, 17, 36.

Station 20: James River, at Montpelier; T. 137N, R. 63W, sec. 11; Stutsman Co.; June 27, 1975; water temperature 21 C; pool, moderate flow; width 50 feet, depth to 6 feet; moderate turbidity; bottom silt, gravel, and large stones; moderate emergent vegetation. Species: 6, 17, 22, 25, 26, 36, 47, 48.

Station 21: Beaver Creek; T. 137N, R 63W, sec. 3; Stutsman Co.; June 30, 1975; water temperature 18 C; riffle and pool, fast flow; width 8 feet, depth to 4 feet; moderate turbidity; bottom silt and large stones; moderate emergent vegetation. Species: 17, 22, 25, 26, 36, 47, 53, 54.

Station 22: James River, 1 mi. S Adrian; T. 136N, R. 63W, sec. 13; Stutsman Co.; July 8, 1975; water temperature 21.5 C; winding stream, fast flow; width 30 feet, depth to 5 feet; heavy turbidity; bottom silt; moderate emergent vegetation. Species: 6, 25, 29, 36.

Station 23: Bonehill Creek; T. 135N, R. 62W, sec. 14; Stutsman Co.; July 8, 1975; water temperature 20 C; riffle and pool, fast flow; width 9 feet, depth to 3 feet; moderate turbidity; bottom silt, gravel, and large stones; moderate emergent vegetation and attached algae on stones. Species: 6, 17, 22, 25, 26, 27.

Station 24: James River, 1 mi. S Grand Rapids; T. 134N, R. 61W, sec. 9; Stutsman Co.; July 9, 1975; water temperature 22.5 C; uniform main channel, fast flow; width 90 feet, depth to 6 feet; heavy turbidity; bottom silt; sparse emergent vegetation. Species: 6, 22, 36, 40.

Station 25: James River, 3 mi. N LaMoure; T. 134N, R. 61W, sec. 26; LaMoure Co.; July 9, 1975; water temperature 23 C; winding main channel, fast flow; width 50 feet, depth to 6 feet; heavy turbidity; bottom silt; sparse emergent vegetation. Species: 6, 9, 25, 28, 34, 36, 40, 52, 55.

Station 26: James River, 1 mi. S LaMoure; T. 133N, R. 60W, sec. 18; LaMoure Co.; July 9, 1975; water temperature 23.5 C; main channel, fast flow; width 90 feet, depth to 5 feet; heavy turbidity; bottom silt; sparse emergent vegetation. Species: 6, 25, 36, 40, 55.

Station 27: Cottonwood Creek, 4 mi. S LaMoure; T. 133N, R. 60W, sec. 32; LaMoure Co.; July 10, 1975; water temperature 21 C; riffle and pool, moderate flow; width 8 feet, depth to 5 feet; slight turbidity; bottom silt, gravel, and large stones; sparse emergent vegetation. Species: 6, 17, 22, 25, 26, 27, 29, 47, 53, 54.

Station 28: James River, 10 mi. N Oakes; T. 132N, R. 60W, sec. 34; Dickey Co.; July 11, 1975; water temperature 22 C; uniform main channel, moderate flow; width 100 feet, depth to 6 feet; heavy turbidity; bottom silt; moderate emergent vegetation, algae bloom in water. Species: 9, 25, 36, 47, 52, 55.

Station 29: James River, 1 mi. W Oakes; T. 131N, R. 59W, sec. 19; Dickey Co.; July 11, 1975; water temperature 22 C; main channel, moderate flow; width 350 feet, depth to 8 feet; heavy turbidity; bottom silt; moderate shoreline and emergent vegetation, algae bloom in water. Species: 6, 22, 25, 36, 47.

Station 30: James River, 1 mi. W Ludden; T. 129N, R. 60W, sec. 11; Dickey Co.; July 12, 1975; water temperature 21.5 C; wide pool, moderate flow; width 500 feet, depth to 8 feet; heavy turbidity; bottom silt; moderate emergent vegetation along shore, algae bloom in water. Species: 6, 9, 25, 29, 32, 36, 55.

South Dakota

Station 31: James River, at Hecla bridge; T. 128N, R. 61W, sec. 29; Brown Co.; July 15, 1975; water temperature 22 C; main channel and flooded lowlands adjacent to river, fast flow; width 90 feet, depth to 8 feet; heavy turbidity; bottom silt; dense emergent vegetation along shore, algae bloom in water. Species: 6, 9, 25, 29, 36.

Station 32: Elm River, 6 mi. SW Frederick; T. 127N, R. 64W, sec. 30; Brown Co.; July 15, 1975; water temperature 22 C; riffle and pool, moderate flow; width to 15 feet, depth to 4 feet; heavy turbidity; bottom silt with a few large stones; sparse emergent vegetation. Species: 6, 9, 22, 23, 25, 27, 29, 36, 45, 47, 52, 54, 55.

Station 33: Elm River, 4 mi. S Frederick; T. 127N, R. 64W, sec. 28; Brown Co.; July 15, 1975; water temperature 22 C; pools, moderate flow; width 13 feet, depth to 5 feet; moderate turbidity; bottom silt; no vegetation in stream. Species: 6, 17, 22, 23, 25, 27, 36, 45, 47, 54, 55, 58.

Station 34: Maple River at Frederick; T. 127N, R. 64W, sec. 11; Brown Co.; July 15, 1975; water temperature 21.5 C; riffle and pool, moderate flow; width 30 feet, depth to 5 feet; moderate turbidity; bottom silt and large stones; sparse shoreline vegetation. Species: 9, 22, 25, 27, 36, 45, 47, 52, 55.

Station 35: Elm River, 8 mi. W Columbia; T 125N, R. 63W, sec. 30; Brown Co.; July 16, 1975; water temperature 22 C; winding stream and pool, moderate flow; width to 65 feet, depth to 4 feet; moderate turbidity; bottom silt with large stones and rubble; sparse shoreline vegetation. Species: 6, 9, 22, 25, 29, 36, 39, 45, 51, 52.

Station 36: Mud Lake; T. 127N, R. 62W, sec. 24; Brown Co.; July 19, 1975; water temperature 24.5 C; width approximately 5200 feet, depth 6 feet; moderate turbidity; bottom silt; moderate shoreline, emergent, and floating vegetation. Species: 6, 9, 25, 32, 36, 43, 52, 55.

Station 37: Columbia Road Reservoir; T. 126N, R. 62W, sec. 21; Brown Co.; July 16, 1975; water temperature 24 C; width approximately 7500 feet, depth to 8 feet; moderate turbidity; bottom silt and gravel, dense emergent and floating vegetation. Species: 6, 9, 25, 29, 32, 36, 43, 52, 55, 58.

Station 38: James River at Columbia Park; T. 125N, R. 62W, sec. 28; Brown Co.; July 16, 1975; water temperature 22 C; main channel and adjacent flooded park area, fast flow; width 80 feet, depth to 6 feet; heavy turbidity; bottom silt; moderate shoreline and emergent vegetation. Species: 9, 25, 29, 32, 36, 43, 45, 50, 52, 55.

Station 39: James River at Elm River mouth; T. 125N, R. 62W, sec. 32; Brown Co.; July 18, 1975; water temperature 22 C; main channel and adjacent flooded fields, sluggish flow; width 120 feet, depth to 8 feet; heavy turbidity; bottom silt; moderate shoreline vegetation. Species: 6, 9, 25, 28, 32, 36, 43, 50, 51, 54, 55.

Station 40: James River, 1 mi. S Tacoma Park; T. 124N, R. 62W, sec. 24; Brown Co.; October 18, 1975; water temperature 10 C; main channel, moderate flow; width 60 feet, depth to 5 feet; heavy turbidity; bottom silt;

no aquatic vegetation. Species: 6, 9, 22, 25, 27, 32, 36, 40, 45, 47, 51, 52, 58.

Station 41: James River, 2 mi. S Tacoma Park; T. 124N, R. 62W, sec. 25; Brown Co.; October 19, 1975; water temperature 10 C; main channel, moderate flow; width 70 feet, depth to 5 feet; moderate turbidity; bottom silt; sparse shoreline vegetation, some dead trees in water. Species: 6, 9, 22, 25, 29, 32, 36, 39, 45, 47, 51, 52, 55.

Station 42: James River, 5 mi. NW Brentford; T. 120N, R. 63W, sec. 26; Spink Co.; July 21, 1975; water temperature 22 C; meandering river at mouth of Mud Creek, moderate flow; width 65 feet, depth to 7 feet; heavy turbidity; bottom silt; dense shoreline vegetation. Species: 6, 9, 25, 32, 36, 39, 45, 47, 51, 52, 58.

Station 43: Timber Creek, 4 mi. E Frankfort; T. 116N, R. 62W, sec. 12; Spink Co.; July 23, 1975; water temperature 22.5 C; standing water; width 27 feet, depth to 4 feet; heavy turbidity; bottom silt; moderate shoreline and emergent vegetation. Species: 9, 21, 22, 25, 32, 36, 40, 45, 47, 51, 52, 54.

Station 44: James River, 7 mi. S Frankfort; T. 115N, R. 62W, secs. 16, 17; Spink Co.; July 24, 1975; water temperature 22.5 C; meandering main channel, moderate flow; width 100 feet, depth to 8 feet; heavy turbidity; bottom silt; moderate shoreline and emergent vegetation. Species: 6, 9, 21, 22, 25, 32, 36, 37, 45, 47, 51, 52, 54.

Station 45: James River, 6 mi. NE Hitchcock; T. 114N, R. 62W, sec. 16; Spink Co.; July 30, 1975; water temperature 22 C; main channel above Spink Co. Dam, moderate flow; width 110 feet, depth to 9 feet; heavy burbidity; bottom silt; dense emergent vegetation along shore. Species: 9, 25, 32, 36, 47, 51, 52, 58.

Station 46: James River, 19 mi. N Huron; T. 113N, R. 62W, sec. 14; Beadle Co.; July 30, 1975; water temperature 22.5 C; main channel above James River Diversion Dam, moderate flow; width 130 feet, depth to 9 feet; heavy turbidity; bottom silt with some gravel; moderate shoreline vegetation, some dead trees in water. Species: 9, 22, 25, 32, 34, 36, 39, 40, 45, 47, 51, 52, 54, 58.

Station 47: James River, 18 mi. N Huron; T. 113N, R 62W, sec. 13; Beadle Co.; July 31, 1975; water temperature 22.5 C; width 130 feet, depth to 8 feet; heavy turbidity; bottom silt; moderate shoreline and emergent vegetation. Species: 9, 21, 22, 25, 29, 32, 34, 36, 39, 45, 51, 52, 58.

Station 48: Shue Creek, 5 mi. NW Yale; T. 112N, R. 60W, sec. 33; Beadle Co.; July 30, 1975; water temperature 24 C; shallow, murky pool, no flow; width 15 feet, depth to 4 feet; heavy turbidity; bottom silt; moderate emergent and submerged vegetation. Species: 9, 21, 22, 25, 27, 29, 36, 45, 47, 51, 52, 54.

Station 49: James River, 9 mi. NE Huron; T. 111N, R. 61W, sec. 2; Beadle Co.; August 1, 1975; water temperature 22 C; main channel, moderate flow; width 120 feet, depth to 8 feet; heavy turbidity; bottom silt; moderate shoreline and emergent vegetation. Species: 9, 25, 36, 39, 40, 47, 51.

Station 50: James River, at Huron; T. 110N, R. 61W, sec. 6; Beadle Co.; August 2, 1975; water temperature 22.5 C; main channel, moderate flow; width 130 feet, depth to 8 feet; heavy turbidity; bottom silt; moderate shoreline vegetation. Species: 3, 9, 22, 25, 28, 32, 36, 39, 45, 47, 48, 51, 52, 54, 58, 59.

Station 51: Pearl Creek, 9 mi. S Huron; T. 109N, R. 61W, sec. 14; Beadle Co.; August 1, 1975; water temperature 23.5 C; standing water; width

Station 46: James River, 19 mi. N Huron; T. 113N, R. 62W, sec. 14; Beadle Co.; July 30, 1975; water temperature 22.5 C; main channel above James River Diversion Dam, moderate flow; width 130 feet, depth to 9 feet; heavy turbidity; bottom silt with some gravel; moderate shoreline vegetation, some dead trees in water. Species: 9, 22, 25, 32, 34, 36, 39, 40, 45, 47, 51, 52, 54, 58.

Station 47: James River, 18 mi. N Huron; T. 113N, R 62W, sec. 13; Beadle Co.; July 31, 1975; water temperature 22.5 C; width 130 feet, depth to 8 feet; heavy turbidity; bottom silt; moderate shoreline and emergent vegetation. Species: 9, 21, 22, 25, 29, 32, 34, 36, 39, 45, 51, 52, 58.

Station 48: Shue Creek, 5 mi. NW Yale; T. 112N, R. 60W, sec. 33; Beadle Co.; July 30, 1975; water temperature 24 C; shallow, murky pool, no flow; width 15 feet, depth to 4 feet; heavy turbidity; bottom silt; moderate emergent and submerged vegetation. Species: 9, 21, 22, [illegible], 27, 29, 36, 45, 47, 51, 52, 54.

Station 49: James River, 9 mi. NE Huron; T. 111N, R. 61W, sec. 2; Beadle Co.; August 1, 1975; water temperature 22 C; main channel, moderate flow; width 120 feet, depth to 8 feet; heavy turbidity; bottom silt; moderate shoreline and emergent vegetation. Species: 9, 25, 36, 39, 40, 47, 51.

Station 50: James River, at Huron; T. 110N, R. 61W, sec. 6; Beadle Co.; August 2, 1975; water temperature 22.5 C; main channel, moderate flow; width 130 feet, depth to 8 feet; heavy turbidity; bottom silt; moderate shoreline vegetation. Species: 3, 9, 22, 25, 28, 32, 36, 39, 45, 47, 48, 51, 52, 54, 58, 59.

Station 51: Pearl Creek, 9 mi. S Huron; T. 109N, R. 61W, sec. 14; Beadle Co.; August 1, 1975; water temperature 23.5 C; standing water; width

36 feet, depth to 4 feet; moderate shoreline and emergent vegetation. Species: 3, 9, 25, 32, 36, 45, 47, 51, 52, 54.

Station 52: James River, 16 mi. S Huron; T. 108N, R. 61W, sec. 26; Sanborne Co.; August 3, 1975; water temperature 22.5 C; heavy turbidity; bottom silt; moderate emergent vegetation. Species: 3, 9, 21, 22, 25, 32, 36, 39, 45, 47, 51, 52, 54.

Station 53: Sand Creek, 1 mi. NW Forestburg; T. 107N, R. 61W, sec. 36; Sanborne Co.; August 2, 1975; water temperature 26 C; creek behind beaver dam, slight flow; bottom silt; sparse emergent vegetation. Species: 9, 21, 22, 25, 27, 36, 40, 42, 45, 51.

Station 54: Redstone Creek, 2 mi. NE Forestburg; T. 107N, R. 60W, sec. 20; Sanborne Co.; August 2, 1975; water temperature 23 C; murky creek, slight flow; width 5 feet, depth 3 feet; heavy turbidity; bottom silt and stones; moderate emergent vegetation. Species: 25, 36, 45.

Station 55: James River, 16 mi. N Mitchell; T. 106N, R. 60W, sec. 34; Sanborne Co.; August 5, 1975; water temperature 22.5 C; main channel, moderate flow; width 130 feet, depth to 8 feet; heavy turbidity; bottom silt; moderate emergent vegetation. Species: 3, 9, 22, 25, 32, 36, 39, 40, 45, 51, 52, 54, 59.

Station 56: James River, 8 mi. N Mitchell; T. 104N, R. 60W, sec. 11; Davison Co.; August 4, 1975; water temperature 23 C; main channel, moderate flow; width 120 feet, depth to 8 feet; heavy turbidity; bottom silt; dense emergent vegetation. Species: 2, 3, 9, 22, 25, 32, 36, 39, 45, 47, 51, 52.

Station 57: Firesteel Creek, 3 mi. NW Mitchell; T. 104N, R. 61W, sec. 36; Davison Co.; August 5, 1975; water temperature 22.5 C; small creek entering Lake Mitchell, no flow; width to 50 feet, depth to 6 feet; moderate turbidity; sand and silt bottom; sparse emergent vegetation. Species: 3, 9, 20, 21, 23, 25, 29, 32, 36, 45, 47, 48, 49, 50, 51, 52.

Station 58: Lake Mitchell; T. 104N, R. 60W, sec. 32; Davison Co.; August 6, 1975; water temperature 23 C at surface; presently no outflow to the James River; width approximately 3000 feet, depth to 25 feet; slight turbidity; sand and silt bottom. Species: 3, 20, 29, 34, 36, 51, 52, 58, 59.

Station 59: James River, 2 mi. E Mitchell; T. 103N, R. 60W, sec. 25; Davison Co.; August 7, 1975; water temperature 22.5 C; main channel, fast flow; width 85 feet, depth to 6 feet; heavy turbidity; sand and silt bottom; sparse emergent vegetation along shore. Species: 2, 9, 25, 32, 36, 39, 48, 51, 52, 59.

Station 60: James River, 5 mi. W Alexandria; T. 102N, R. 59W, sec. 15; Hanson Co.; August 6, 1975; water temperature 23 C; flooded ditch along river; depth to 4 feet; heavy turbidity; silt bottom; sparse shoreline vegetation. Species: 3, 9, 22, 25, 31, 32, 36, 45, 47, 51, 52, 54, 59.

Station 61: Enemy Creek, 8 mi. W Alexandria; T. 102N, R. 59W, sec. 15; Hanson Co.; August 6, 1975; water temperature 23 C; clear, shallow tributary, slight flow; width 8 feet, depth to 2.5 feet; sand and silt bottom; some floating vegetation. Species: 8, 9, 17, 18, 22, 25. 27, 29, 31, 36, 40, 45, 51, 54.

Station 62: James River, 9 mi. E Ethan; T. 101N, R. 58W, sec. 20; Hanson Co.; August 7, 1975; water temperature 23 C; main channel, moderate flow; width 140 feet, depth to 6 feet; heavy turbidity; silt bottom; no vegetation. Species: 3, 9, 21, 22, 25, 32, 36, 39, 45, 47, 51, 52, 59.

Station 63: James River, 10 mi. S Miltown; T. 99N, R. 58W, sec. 16; Hutchinson Co.; August 8, 1975; water temperature 23 C; main channel, moderate flow; heavy turbidity; silt bottom; no vegetation. Species: 2, 3, 4, 21, 22, 25, 28, 29, 31, 32, 36, 39, 45, 47, 51, 59.

Station 64: James River at Wolf Creek mouth; T. 99N, R. 57W, sec. 31; Hutchinson Co.; August 8, 1975; water temperature 23 C; main channel, moderate flow; heavy turbidity; silt bottom; no vegetation. Species: 2, 3, 4, 9, 21, 22, 25, 28, 31, 32, 34, 36, 39, 45, 47, 51, 5[illegible] [illegible].

Station 65: James River, at Olivet; T. 97N, R. 58W, sec. 11; Hutchinson Co.; August 12, 1975; water temperature 23 C; main channel below dam, moderate flow; width 120 feet, depth to 9 feet; heavy turbidity; silt bottom; moderate emergent vegetation along shore. Species: 2, 3, 4, 9, 15, 21, 22, 25, 31, 32, 34, 36, 39, 45, 47, 51, 52, 54, 59.

Station 66: James River, 6 mi. S Menno; T. 96N, R. 57W, sec. 10; Yankton Co.; August 12, 1975; water temperature 23 C; main channel, moderate emergent vegetation along shore. Species: 2, 3, 4, 9, 15, 21, 22, 25, 28, 31, 34, 39, 45, 47, 51, 52, 59.

Station 67: James River, 14 mi. N Yankton; T. 95N, R. 56W, sec. 13; Yankton Co.; August 13, 1975; water temperature 23 C; main channel, moderate flow; width 140 feet; depth to 10 feet; heavy turbidity; silt bottom; sparse emergent vegetation along shore. Species: 2, 3, 4, 9, 15, 21, 22, 25, 32, 34, 39, 44, 47, 52, 59.

Station 68: James River, 6 mi. NE Yankton; T. 94N, R. 55W, sec. 21, Yankton Co.; August 13, 1975; water temperature 23 C; main channel, moderate flow; width 135 feet, depth to 10 feet; heavy turbidity; silt bottom; sparse emergent vegetation along shore. Species: 2, 3, 4, 9, 15, 21, 22, 25, 31, 32, 34, 39, 41, 44, 47, 51, 59.

Station 69: James River, 5 mi. E Yankton; T. 93N, R. 55W, sec. 13; Yankton Co.; August 15, 1975; water temperature 23 C; main channel, moderate flow; width 150 feet, depth to 10 feet; silt bottom; sparse emergent vegetation along shore. Species: 2, 3, 4, 15, 21, 22, 25, 28, 31, 32, 34, 39, 41, 44, 47, 48, 51, 52, 59.

Discussion

Early fishery investigations of the James River in North Dakota, especially those by Woolman (1896) and Hankinson (1929) indicated that the river was ecologically different from the present silty and intermittent stream. Woolman (1896) sampled the James River on a gravel bed near LaMoure, and at Jamestown where the river was "quite clear and cool" with an August water temperature of 60 F indicating considerable spring water supplying the river. At Jamestown, he described the James River as "swarmed with small fishes; Rhinichthys (blacknose dace) was taken by hundreds", along with brown bullhead, bluntnose minnow, black bullhead, white sucker, shorthead redhorse, stoneroller, silvery minnow, common shiner, sand shiner, blacknose shiner, hornyhead chub, creek chub, northern pike, johnny darter, blackside darter, Iowa darter, and yellow perch.

Since the area has undergone settlement, the James River has gradually changed and the fish fauna has undergone an accompanying transformation. One of the ecological alterations of the James River in North Dakota has been a drop in the water table and a resulting loss of flow from springs into the river. Willard (1909) described several springs on the slopes along the river valley. The State Planning Board and Works Progress Administration (1939) discussed the lowering of the ground water levels in some areas along the James River and the diminished yield from springs. Declining ground water levels along portions of the James River were also discussed by the U. S. Public Health Service (1952). The springs, which once provided the river with some flow in months without precipitation, are now few. This has created a dependence upon snowmelt and rainfall for streamflow in the James River.

Another influence on the fishes of the James River in North Dakota has been the increase of siltation on the river's bed. This has harmed fish species which require a gravel bottom for reproduction or food. Willard (1909) stated that much of the James River in Stutsman County, North Dakota (Jamestown area) had a gravel and sand bottom. Today, gravel bottoms are found in some parts of the river, but much of the river bed has undergone heavy siltation. Perhaps as good a testimony to the lack of suitable gravel bottom in the river was given by the many minnows that were found in high densities at the flooded gravel road at the James River Diversion Dam north of Huron, South Dakota (station 47).

A third factor which has altered the river is the nutrient load added by feedlots, industries, and municipalities along the river. The U. S. Public Health Service (1952) surveyed the James River and sewage treatment needs for communities of the basin.

Another change in the river's characteristics has been the construction of low-head dams on the river (Figure 4). A list of dam locations is in Appendix 1. These dams form long pools which constitute much of the river during low flow periods. Although providing increased depth and volume to stretches of the river which would dry up or become shallow in dry months, these pools also appear to be nutrient traps accumulating autumn leaves and other organic material in the river. The impounded nature of the river encourages waste localization (U. S. Public Health Service, 1952). The depth of these pools is insufficient to pro-

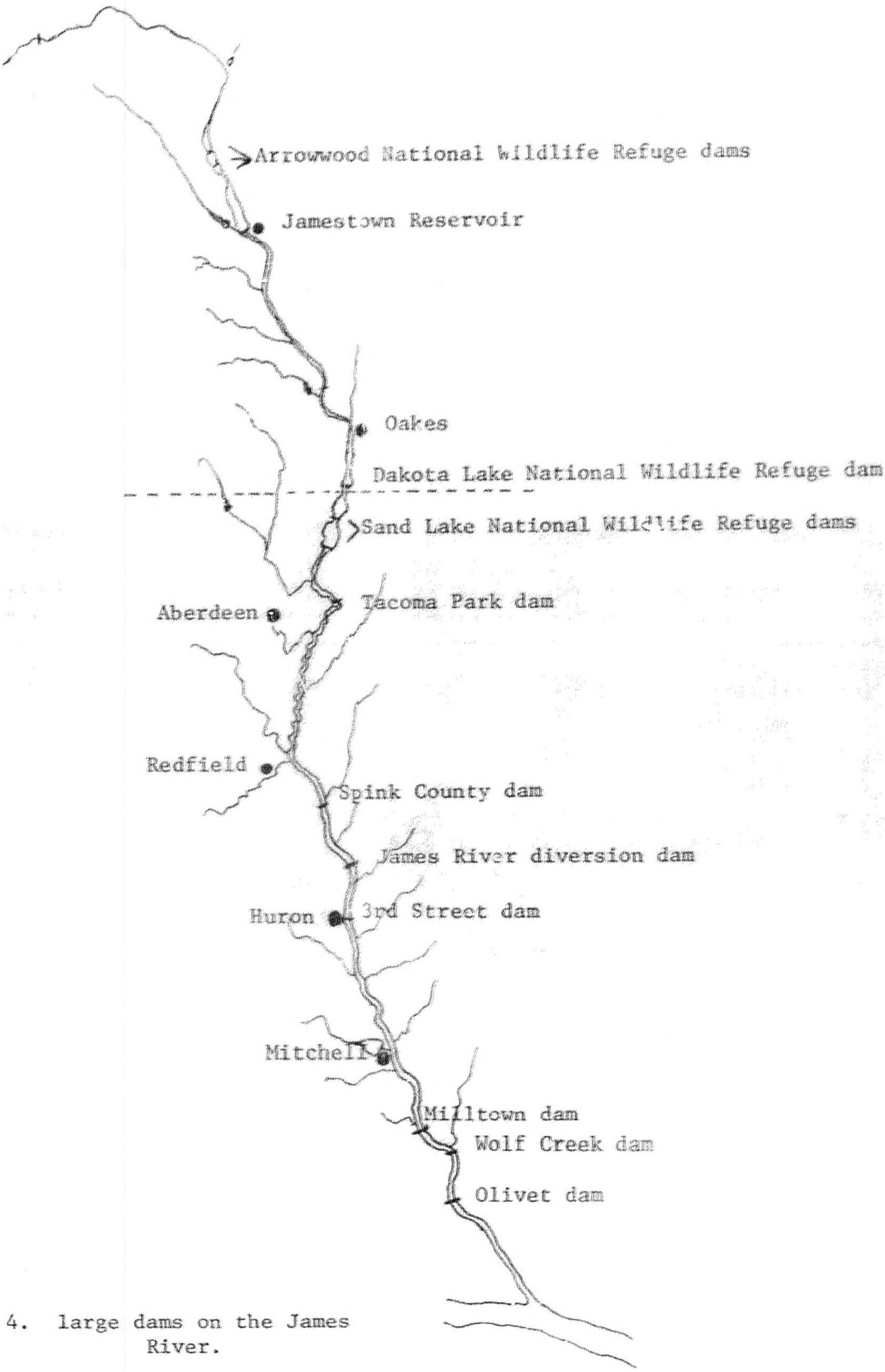


Figure 4. large dams on the James River.

tect against winter deoxygenation and it is possible that fish survive the winter only by crowding into upper ends of the pools where aeration by flow over dams keep oxygen levels above the lethal mark (U. S. Public Health Service, 1952). Migration of many fish species is prohibited or inhibited by some dams during all conditions except during periods of high flow.

In 1953, the upper section of the James River in North Dakota was chemically treated with Fish Tox in an unsuccessful effort to eliminate carp from Jamestown Reservoir (personal communication, Dale Henegar, 1977).

The fish community has responded to these changes in the James River. Several species which formerly inhabited the cooler, gravel-bottomed river near Jamestown, North Dakota when Woolman (1896) sampled the river's fish have now been eliminated from the river. These probably include the blacknose shiner, silvery minnow, bluntnose minnow, hornyhead chub, brown bullhead, and the blackside darter. Other species formerly found in much of the James River in North Dakota appear to have been restricted to a few areas of suitable habitat. The stoneroller, formerly abundant at Jamestown (Woolman, 1896), is now absent from the North Dakota portion of the river and appears restricted to gravel-bottomed tributary areas in South Dakota. The blacknose dace, formerly present "by hundreds" near Jamestown (Woolman, 1896), is now restricted to a few high-gradient tributaries in North Dakota. The Iowa darter appears to have had its habitat compressed to a few gravel-bottomed riffle areas in the James River.

Two South Dakota species, the topeka shiner and the bigmouth shiner, appear restricted to a few portions of tributaries where the old channel is relatively undisturbed. Underhill (1959) discussed the restriction of the common shiner, Iowa darter, blacknose dace, bigmouth shiner, and brook stickleback to relict habitats of old channel or vegetated areas in the Vermillion River, South Dakota.

The major changes in the fish fauna have been in the North Dakota portion of the river. Eight of the 20 fish species collected by Woolman (1896) in the James River in North Dakota are now eliminated in the North Dakota portion of the river. With the exception of the blacknose shiner, all of the 20 fish species collected in the South Dakota portion of the James River by Evermann and Cox (1896) are still present in the James River in South Dakota.

Figure 5 shows the number of fish species present in recent collections in four areas of the James River. Section one is Jamestown Reservoir and the upstream river to the headwaters. Section two extends from below Jamestown Dam to the North Dakota-South Dakota border. Section three is from the border to Frankfort, South Dakota and includes most of glacial Lake Dakota. Section four is from Frankfort to the mouth. Species are relatively numerous in the lower part of the river and progressively diminish towards the headwaters. Some of the southern fish species near the mouth are apparently Missouri River species which periodically enter the lower reaches of the James River. Compared to the number of species in the lower river, the fish species in northern South Dakota and in North Dakota are few. The extreme headwater area near Fessenden, North Dakota dramatically shows the decrease in upstream species, as only three species, the black bullhead, the brook stickleback, and the fathead minnow, can be found.

This small number of species found in the upper portion of the river probably results from the unstable habitats in upstream areas. Harrel and Dorris (1968) attributed the decrease in species diversity in up-

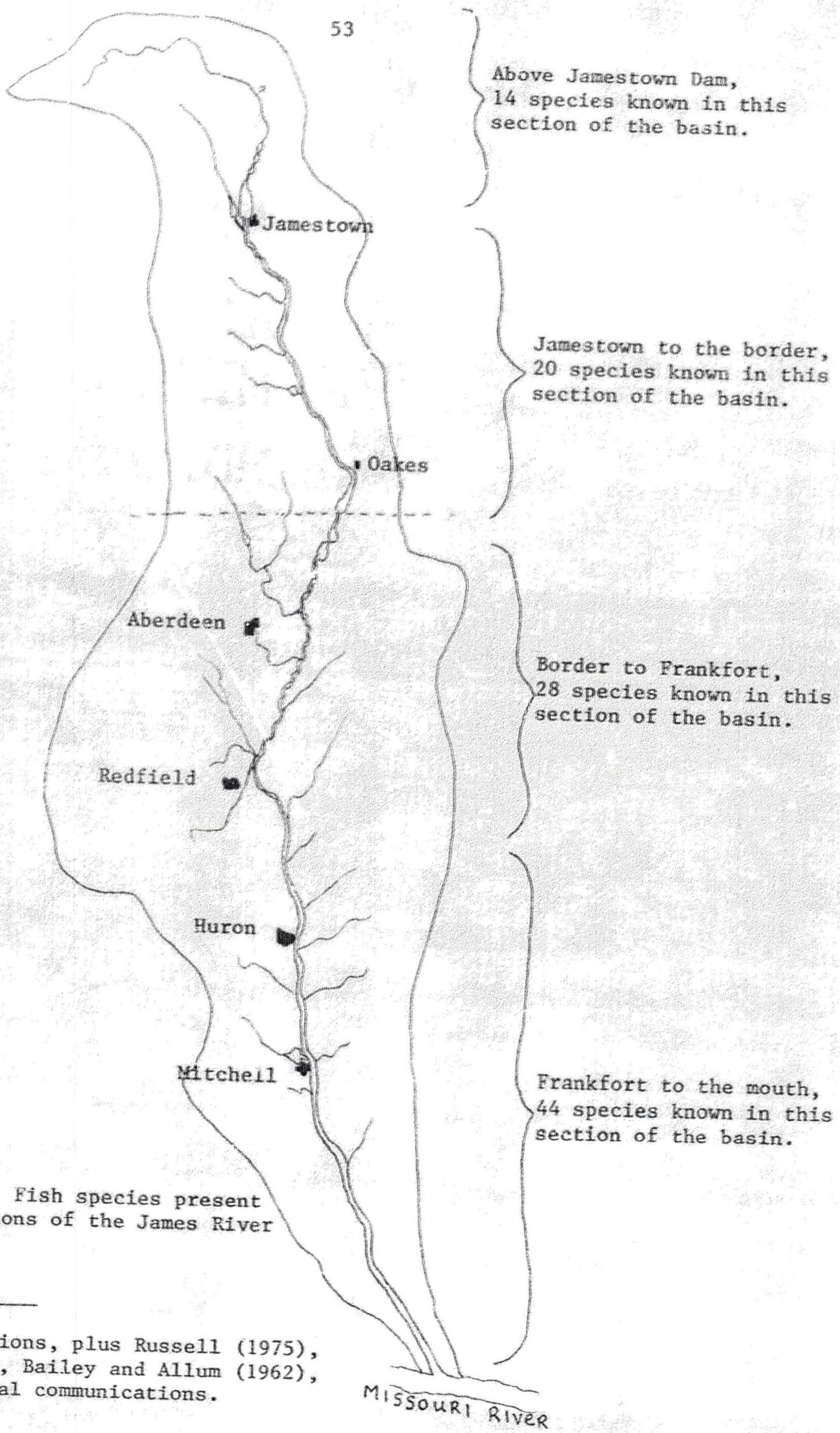


Figure 5. Fish species present in 4 sections of the James River basin[1].

---

[1] My collections, plus Russell (1975), Tol (1976), Bailey and Allum (1962), and personal communications.

stream areas of their river to decreased habitat and increased environmental fluctuations.

Stream habitats of the prairies present a fluctuating, unstable environment with respect to flow, turbidity, dissolved oxygen, and temperature. Pflieger (1971) stated survival in the unstable prairie environments in Missouri placed a premium on adaptability and generalized requirements, whereas stable environments of streams with permanent flow, gravel or sand bottom, and low turbidity place less of a premium on adaptability and permit greater specialization. Specialization leads to more ecological "niches" and more faunal diversity.

Present ecological conditions in the James River in the upper portion offer a harsh environment to fish species in the river. One of the strongest limiting factors regulating distribution of fishes in the upper James River is winterkill. During the harsh Dakota winters, flows are minimal or zero, reoxygenation is restricted by a thick ice cover, photosynthesis is limited by the ice and snow cover, and a high biological oxygen demand (BOD) built up in the river uses up the oxygen in the water. The U. S. Public Health Service (1952) found winter dissolved oxygen as low as 0.5 ppm in the James River near Ludden, North Dakota. The North Dakota Game and Fish Department (1975) found winter dissolved oxygen at 0.0 at New Rockford, North Dakota and 0.4 at Jim Lake, Arrowwood National Wildlife Refuge, North Dakota.

Bailey and Allum (1962) took advantage of the winterkill conditions in the James River as three of their collection stations were "a dipnet collection from an open spring hole during a winterkill". Lockard (1976) investigated a winterkill in the James River in Spink County, South Dakota. He reported carp, black bullhead, northern pike, crappie, and largemouth bass were dead at several locations. Unreported winterkills are probably frequent in many portions of the upper James River, especially in the old Lake Dakota lake bed where winter flows often are zero. Stream flows are in Appendix 2.

Winterkill effects are probably variable. All fish species may be killed in some small stretches of the river or only the less tolerant species or older individuals of a species may be selectively killed. Schoenecker (1970) found winterkill in Nebraska sandhill lakes is seldom complete. Winterkill conditions usually permitted some survival of the species tolerant of low dissolved oxygen while less tolerant species were killed or allowed smaller individuals of a species to survive while causing some adult mortality.

Winter flows in the James River appear to be critical for winter survival. Lockard (1976) found water turbulence at the Tacoma Park dam apparently improved oxygen levels and allowed survival of fishes in the immediate vicinity downstream from the dam, while mortality was high upstream from the dam.

The fish community in the upper James River largely reflects the winterkill conditions. Those species which are tolerant of the low dissolved oxygen conditions in winter compose the fish fauna in the James River in North Dakota. Best examples of these are the black bullhead and the fathead minnow which dominate the fish community in the James River in North Dakota. The black bullhead, fathead minnow, and brook stickleback seem the three hardiest species in surviving winter conditions and occupying the headwater region of the James River. Less tolerant species are limited to the lower James River where there are volume and flow conditions to permit survival of some individuals.

Migrations are important in considering the upstream limits of some fish species in the James River. Distribution of some species in the fluctuating environment of the James River is a dynamic process with movement in and out of reservoirs, migrations from and back to downstream sections, and adjustment to flow conditions. Species which can not survive the winter low flow and low dissolved oxygen in the upper James River can still utilize the upper river by moving upstream in the spring flows and later withdrawing downstream. Migrations for some James River fishes such as the gizzard shad, white bass, white suckers, bigmouth buffalo, and smallmouth buffalo are evident from the finding of young-of-the-year much further upstream than the adults. Channel catfish, freshwater drum, and river carpsucker adults were found in tributaries or in upstream areas some distance from young-of-the-year, and these species are also probably quite migratory. Carp and bigmouth buffalo were often seen attempting to move upstream over low-head dams. Green sunfish were once seen leaping over a three-foot drop of a low-head dam. The minnows had no clear examples of different distribution of the young and adults, but some migration is indicated by the appearance of minnows in small tributaries which regularly dry up or freeze solid.

Present distribution of most of the fish species in the James River appears to be a result of two important factors-winter survival and migrations. The winter low flow and low dissolved oxygen conditions permit few species in the upper James River. From the three species-black bullhead, fathead minnow, and brook stickleback-found in the headwaters, species are generally added as winter volume and flow conditions increase downstream. Superimposed on the winter tolerance pattern are the migrations of some fish species.

Distribution probably varies each year according to flow conditions.

1975 was a high water year and the high flows enabled some movement upstream. My collections and reports from South Dakota workers probably represent the best available estimate of the northern limits of the various species under present flow conditions in the James River.

Some species show a distribution limited to areas of restricted habitat. The brook stickleback is found in the upper portion of the river and is probably associated with aquatic vegetation. The blacknose dace appears dependent on a few steeper gradient tributaries in North Dakota. The topeka shiner and bigmouth shiner appear to be confined to regions of relatively undisturbed tributaries in South Dakota. The stoneroller is restricted to gravel-bottomed tributary regions in South Dakota. The plains topminnow appears restricted to warm, vegetated, spring-fed tributary regions in southern South Dakota.

Most species were found along the length of the James River from the point where they were first collected to the mouth of the river. These appeared to have mose generalized habitat tolerances, and their distribution is probably largely influenced by winter survival and migrations allowed by flow conditions in the James River.

Flows from the Garrison and Oahe projects may generally improve conditions for winter survival of some fishes in the upper James River. Flows are predicted to be more sustained than present flows (Figures 6 and 7). Although peak flows would be about the same as historical peaks, low water periods are predicted to be lessened. Because the critical period for survival of many James River fishes is in winter, higher flows between September and March will be of special importance.

Migrations upstream should be enhanced by the additional periods of high flow over the low-head dams when the irrigation projects are

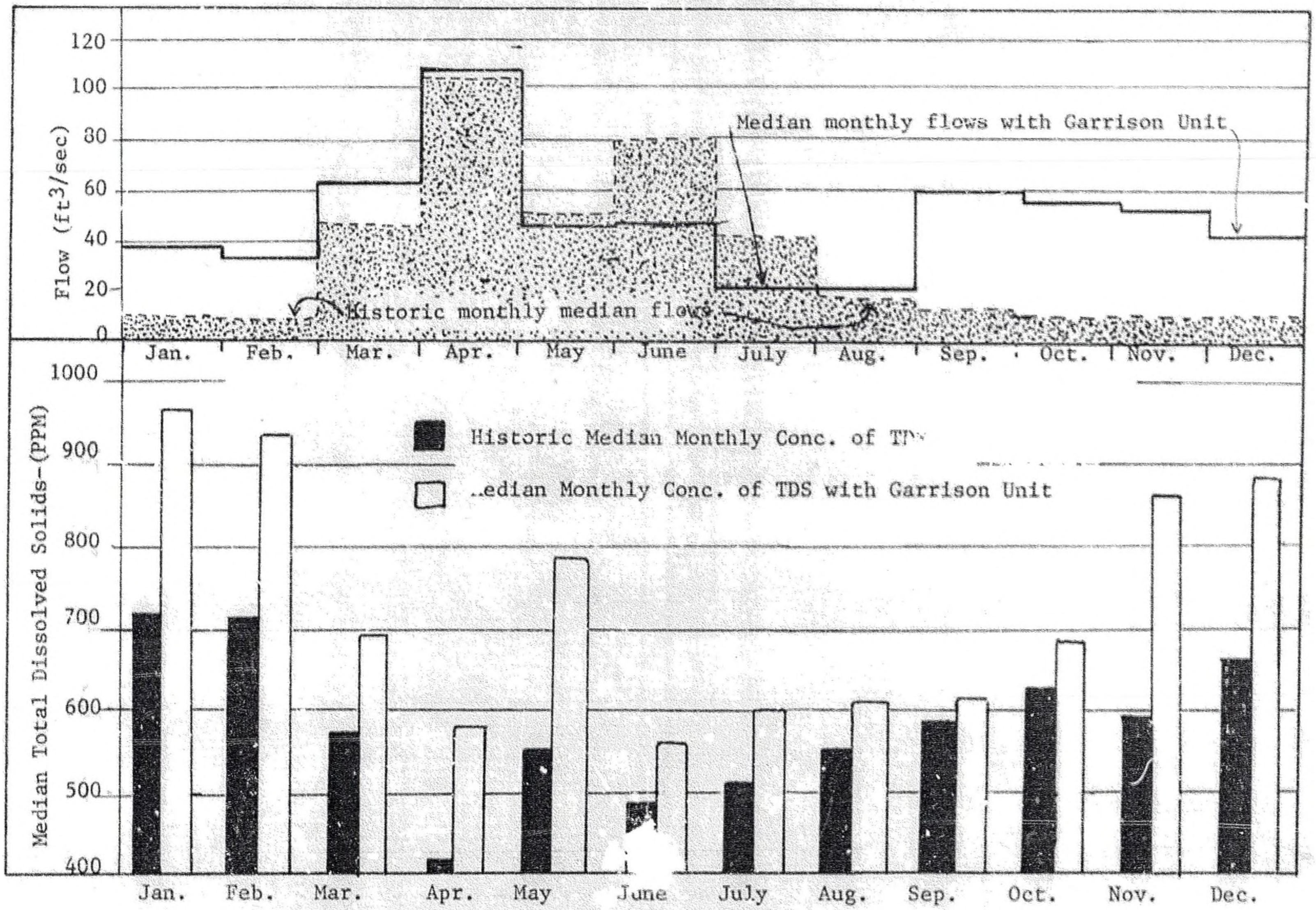


Figure 6. Median flows and total dissolved solids by months, James River at North Dakota-South Dakota border[1].

---

[1]U. S. Bureau of Reclamation (1976).

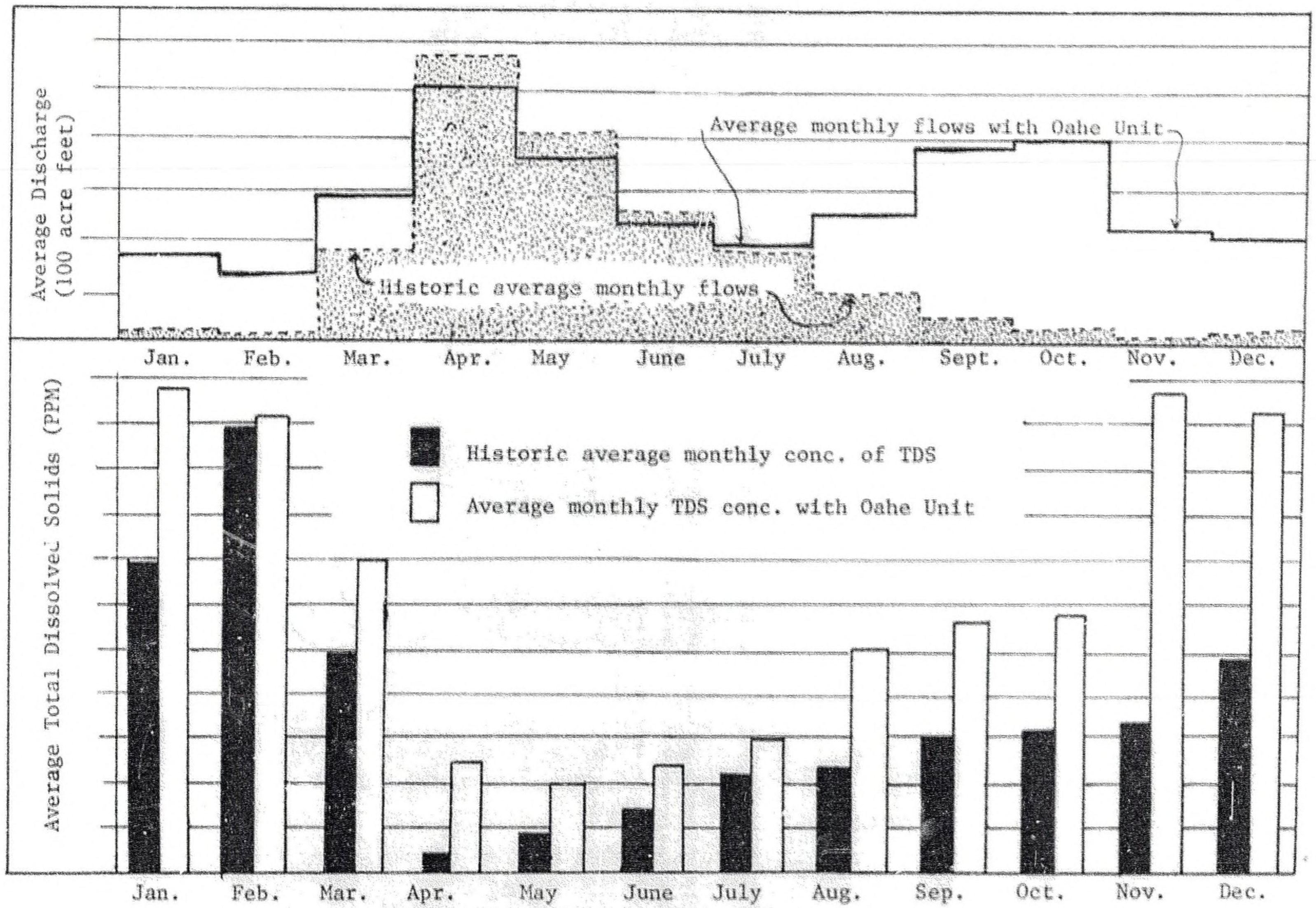


Figure 7. Mean Flows and TDS at Huron, South Dakota[2].

---

[2]U. S. Bureau of Reclamation, (1975).

operational. Seasonally migratory species could appear further upstream than they do with present flows.

The water quality for fishes and other aquatic organisms will be altered by higher levels of total dissolved solids (TDS) and constituent ions which will increase in the James River if the irrigation projects are completed. All substances in solution in the water collectively exert osmotic pressure on fish and other aquatic organisms (McKee and Wolf, 1963). Salinity, often in combination with other factors such as oxygen and temperature, may have marked effects on egg development, hatching, and larval growth (Holliday, 1969). Oxygen depletion in the river may occur due to increased algal growth caused by added nutrients such as nitrogen or phosphorous. Dissolved solids, temperature, and nutrients are important factors in the environment of James River fishes, and more study or analysis of the water quality of irrigation return flows is needed before total impact on fishes in the James River can be assessed.

The factor of species interaction may be important in the distribution of fish species in the James River. The large population of northern pike (Esox lucius) in the old Lake Dakota region may especially important. These predators undoubtedly exert some pressures on many of the other fish species. Not all species or sizes of species may be preyed upon, but some minnows and young-of-the-year fish probably are. In the normal lower flow periods of autuman and winter, there is a crowding of species in pools, and the northern pike may have a marked influence during these periods. This may result in a filtering influence against invasion by downstream species which have moved northward during the higher flows. Thompson and Hunt (1930) and Burton and Odum (1945) discussed the effect Esox species can have on other fishes in streams. This biological barrier created by the northern pike is probably less than the barriers of the low flow and winterkill conditions operating to restrict some species to the lower river. Biological interactions of the fish species and between fish and other fauna or flora are often subtle and difficult to assess.

A balance of conditions permits the existence of the fish species in the James River. A change in the environment may bring about changes in species composition, abundance, and distribution. When the flow regime and water quality in the James River are altered by the irrigation flows of the two proposed projects, the fish species will adjust their locations up or down the river to correspond with the ecological conditions produced. Because upstream migrations and winter survival should be enhanced by added flows, a general upstream expansion of fish species should occur. These would be both permanent residents and seasonal migrants. Not all species will increase their ranges upstream as far as the North Dakota portion of the river. Winter conditions, although lessened, should probably still be severe in the upper river. Depth of the river and distance from the Missouri River should operate to control the upstream distribution of some species. However, because the North Dakota portion of the river is currently species-poor, some species will probably be added to the upper portion of the river.

Fish species which could occur near Oakes, North Dakota would be of special importance because they will be potential interbasin transfers to the Wild Rice River and the Hudson Bay drainage. Atton (1959) discussed the invasion of Canada by carp, once that species gained access to the Red River of the North. I have selected the 15 species of James River fish not presently inhabiting the Red River of the North, and I will briefly discuss each.

Polyodon spathula, the paddlefish, is a large river (Missouri River) species which apparently occasionally enters the mouth of the James River.

Lepisosteus platostomus, the shortnose gar, migrate upstream when streamflow allows them to pass over the low-head dams. Three local residents commented that the gar appear upstream when the summer rains brought high water. No young-of-the-year were found in 1975, but gar may be able to spawn in the James River as gravid females have been found (personal communication, Dennis Tol, 1976). Shortnose gar currently penetrate the river as far north as Tacoma Park, about 40 miles below the North Dakota border (personal communication, Douglas Hansen, 1977).

Dorosoma cepedianum, the gizzard shad, occurs in the Missouri River and in the lower reaches of the James River. Early summer spawning runs evidently bring the gizzard shad at least as far north as the Huron area, and young-of-the-year use the quiet shallows as a nursery area. At least two different sizes of young-of-the-year were clearly evident in 1975, indicating more than one "peak" of reproductive activity. Winter survival may be critical in determining the gizzard shad's northern limit in the James River. Thompson and Hunt (1930) listed the gizzard shad as especially susceptible to winterkill in streams.

Ctenopharyngodon idella, the grass carp, is an exotic species presently expanding its range northward in the Missouri River system. The distance it will move in the James River is unknown, as this species' ecological preferences and spawning ability in the wild are not well known. The grass carp has a voracious appetite and should receive some attention and be monitored. It can have serious impact on aquatic vegetation and may also outcompete some of the native fish species for food and space.

Hybognathus nuchalis, the silvery minnow, was last collected in the

James River by Hankinson (1929). It appears to be absent in the river now, but it is in the Missouri River (Bailey and Allum, 1962) and may enter the James River from this source.

Notropis lutrensis, the red shiner, is a common inhabitant throughout most of the James River in South Dakota. This species currently is found as far north as below Sand Lake National Wildlife Refuge, or about 30 miles below the North Dakota border.

Notropis topeka, the topeka shiner, appears confined to relatively undisturbed tributaries in South Dakota. Very little is known of its ecological requirements. Pflieger (1975) found this species in small, clear creeks with sand, gravel, or rubble bottoms and permanent pools maintained by the percolation of water through the stream bed. Its presence in the Elm River in South Dakota puts it about 40 miles below the North Dakota border.

Carpiodes carpio, the river carpsucker, appeared very mobile in the James River and adults ranged into North Dakota in 1975.

Cycleptus elongatus, the blue sucker, is a large river (Missouri River) fish and apparently enters the lower James River for spawning in the spring (Beal, 1963).

Ictiobus bubalus, the smallmouth buffalo, is a resident in the James River both in Jamestown Reservoir and in the lower portion of the South Dakota river. Its presence in Jamestown Reservoir provides this species with an opportunity of moving downstream through the dam as well as moving upstream from the lower James River.

Ictiobus niger, the black buffalo, is known only from Lake Mitchell, South Dakota (Moen, 1970). This species can be easily confused with I. bubalus, the smallmouth buffalo, and perhaps may be in the lower James River.

Ictalurus furcatus, the blue catfish, is a rare inhabitant of the Missouri River in South Dakota. It is known to enter the lower reaches of the James River.

Ictalurus natalis, the yellow bullhead, is an inhabitant of the James River in South Dakota. The last collection of this species in North Dakota was by Woolman (1896). Thorn and Starostka (1969) found that the yellow bullhead had been transplanted into small ponds in northeastern South Dakota. The 1975 collection of the yellow bullhead was from about 60 miles below the North Dakota border.

Pylodictus olivaris, the flathead catfish, is a large river (Missouri River) fish that enters the lower reaches of the James River. My collections were young-of-the-year. Adults are occasionally caught by anglers in the lower James River (personal communication, Ronald P. Catlin, 1977).

Fundulus sciadicus, the plains topminnow, appears limited to areas of the James River in southern South Dakota where warm spring-fed tributaries occur. In the Sand Creek tributary of the James River, plains topminnows were found in a small, spring-fed pool with a sandy bottom, abundant aquatic vegetation, and a water temperature of 80 F.

Other James River species such as the green sunfish Lepomis cyanellus and the bigmouth buffalo Ictiobus cyprinellus are present in the Red River of the North drainage but only in a few tributaries or in tributary lakes. The connection at the irrigation canals at Oakes may allow these species to appear in the fish community of the Red River of the North. Although these would not be new introductions into the Hudson Bay drainage, they may have a noticeable effect on the aquatic ecosystem when the Oakes connection presents them with an additional opportunity to come into the Red River of the North.

This list of species does not imply that other fish species are not present in the James River. Additional species may be found if more intensive collections are made. More Missouri River species probably can be found at the mouth of the river during some periods of the year. Underhill (1959) collected or reported *Ichthyomyzon unicuspis*, the silver lamprey; *Scaphirhynchus platorhynchus*, the shovelnose sturgeon; *Lepisosteus osseus*, the longnose gar; *Hybopsis gracilis*, the flathead chub; *Notropis shumardi*, the silverband shiner; *Notropis blennius*, the river shiner; *Noturus flavus*, the stonecat; *Anguilla rostata*, the american eel; and *Lota lota*, the burbot, from the mouth of the Vermillion River. These and other Missouri River species may occur in the lower reaches of the James River during some periods of the year.

Appendix 1

Known dams in the James River in North Dakota and South Dakota (list of dams in South Dakota provided by the U. S. Bureau of Reclamation).

North Dakota

	location	type	height	remarks
Wells Co.	T. 149N, R. 71W, sec. 28	rock		Manfred Dam
"	T. 149N, R. 70W, sec. 27			
"	T. 149N, R. 69W, sec. 35	concrete	8'	
Eddy Co.	T. 149N, R. 66W, sec. 30	rock		New Rockford Dam
"	T. 149N, R. 66W, sec. 33			
Stutsman Co.	T. 143N, R. 65W, sec. 25			Arrowwood Lake
"	T. 143N, R. 64W, sec. 33			Jim Lake
"	T. 142N, R. 64W, sec. 3			DePuy marsh
"	T. 140N, R. 64W, sec. 24	concrete	40'	Jamestown Dam
"	T. 138N, R. 63W, sec. 12			Ypsilanti Dam
LaMoure Co.	T. 135N, R. 61W, sec. 33			Grand Rapids Park
"	T. 133N, R. 61W, sec. 11			LaMoure Dam
Dickey Co.	T. 129N, R. 60W, sec. 34			Dakota Lake NWR

South Dakota

	location	type	height	remarks
Brown Co.	T. 127N, R. 62W, sec. 36	earth-fill		Houghton Dam
"	T. 125N, R. 62W, sec. 4	earth-fill		Columbia Road Dam
"	T. 125N, R. 62W, sec. 27			
"	T. 124N, R. 62W, sec. 24	wood-plank	6'	Tacoma Park
"	T. 124N, R. 62W, sec. 25	rock	3'	
"	T. 123N, R. 62W, sec. 3	rock	3'-6'	
"	T. 123N, R. 62W, sec. 22			
"	T. 122N, R. 62W, sec. 9	rock	3'-6'	
"	T. 122N, R. 62W, sec. 16			
"	T. 122N, R. 62W, sec. 32			
Spink Co.	T. 120N, R. 63W, sec. 22			

	location	type	height	remarks
Spink Co.	T. 119N, R.63W, sec. 9	rock	6'	
"	T. 118N, R. 64W, sec. 25			
"	T. 117N, R. 63W, sec. 30			
"	T. 116N, R. 62W, sec. 17	rock	3'-6'	
	T. 114N, R. 62W, sec. 16	masonry	9'	Spink Co. Dam
"	T. 113N, R. 62W, sec. 13	earth	15'	James Diversion
"	T. 113N, R. 62W, sec. 24	rock	2'-4'	
Beadle Co.	T. 112N, R. 61W, sec. 26	rock	3'-6'	
"	T. 111N, R. 61W, sec. 11	rock	3'-6'	
"	T. 110N, R. 61W, sec. 6	rock-masonry	9'	3rd Street Dam Huron
"	T. 110N, R. 61W, sec. 7	rock	2'	
"	T. 110N, R. 61W, sec. 17	rock	3'	
"	T. 110N, R. 61W, sec. 33	rock	2'-4'	
"	T. 109N, R. 61W, sec. 9	rock	1'-3'	
"	T. 109N, R. 61W, sec. 35			
"	T. 109N, R. 61W, sec. 26	rock	1'-3'	
Sanborne Co.	T. 108N, R. 61W, sec. 23	rock	1'-3'	
"	T. 108N, R. 61W, sec. 23	rock	1'-3'	
"	T. 107N, R. 60W, sec. 19			
"	T. 106N, R. 60W, sec. 34	rock	2'-4'	
Hanson Co.	T. 103N, R. 59W, sec. 18	rock	6'	
"	T. 103N, R. 60W, sec. 25	rock	3'-6'	
"	T. 101N, R. 58W, sec. 6	rock	3'-6'	
Hutchinson Co.	T. 100N, R. 59W, sec. 35	rock	6'	Milltown
"	T. 99N, R. 57W, sec. 31	rock	6'	Wolf Creek
"	T. 97N, R. 58W, sec. 11	rock	6'	Olivet

Appendix 2

Water discharge data for water years 1974, 1975, and 1976 at gaging stations at LaMoure, North Dakota, Columbia, South Dakota, Ashton, South Dakota, and Huron, South Dakota (supplied by the U. S. Department of the Interior, Geological Survey).

Discharge, in cubic feet per second, Columbia, South Dakota, water year 1974.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	0	7.3	1.0			.50	45	70	107	118	93	69
2	0	7.6	1.0			3.0	47	71	106	119	92	68
3	0	7.8	.80			15	52	73	104	124	91	68
4	0	7.6	.70			14	57	77	102	127	90	68
5	0	8.3	.60			13	61	81	101	127	88	68
6	0	8.3	.50			12	59	84	98	125	85	64
7	0	8.7	.30			11	58	87	95	125	82	56
8	0	8.0	.20			11	56	89	94	123	80	43
9	0	7.8	.10			11	31	90	94	123	79	30
10	0	8.0	0			12	8.7	92	97	122	79	17
11	.01	8.3	0			13	4.6	96	102	121	81	7.6
12	0	8.5	0			14	9.2	93	104	123	81	2.3
13	.38	8.3	0			13	25	94	105	123	80	.14
14	1.4	7.3	0			11	45	96	106	123	78	0
15	2.1	7.3	0			10	47	96	107	123	76	0
16	3.2	7.3	0			9.5	48	96	107	121	75	0
17	4.5	7.1	0			9.0	48	95	109	120	75	0
18	5.0	6.9	0			8.5	48	93	112	120	74	0
19	5.8	6.3	0			8.5	48	92	114	118	73	0
20	6.1	5.2	0			8.0	49	97	114	117	73	0
21	6.5	5.0	0			[illegible].0	54	104	114	116	74	0
22	6.5	4.5	0			8.0	54	102	115	114	74	0
23	6.7	4.0	0			8.5	53	100	118	112	74	0
24	6.7	3.5	0			8.5	53	99	120	109	73	0
25	6.5	3.0	0			9.0	54	97	120	107	72	0
26	6.5	3.0	0			10	58	96	119	105	71	0
27	6.3	2.5	0			22	64	99	118	104	71	0
28	6.7	2.0	0			30	68	104	118	101	71	0
29	6.9	2.0	0		---	49	70	105	117	98	71	0
30	6.9	1.5	0		---	58	71	106	117	97	71	0
31	6.9	---	0		---	53	---	107	---	94	70	---
Total	101.6	182.9	5.2	0	0	471.0	1445.5	2881	3254	3599	2417	561.04
Min	0	1.5	0	0	0	.50	4.6	70	94	94	70	0
Ac-Ft	202	363	10	0	0	934	2870	5710	6450	7140	4790	1110

Discharge, in cubic feet per second, at Ashton, South Dakota, water year 1974.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1					0	15	62	64	112	85	82	53
2					0	15	60	65	113	86	81	49
3					0	14	56	66	114	87	81	46
4					0	12	54	66	117	88	79	44
5					0	11	52	70	119	89	77	42
6					0	10	51	75	122	90	76	40
7					0	10	50	80	124	88	75	38
8					0	11	48	85	126	89	74	36
9					0	12	49	90	129	89	73	34
10					0	13	55	95	130	88	74	33
11					0	13	59	100	129	88	76	31
12					0	12	62	100	128	87	78	29
13					.50	12	64	100	125	87	79	28
14					.50	12	65	105	122	89	78	26
15					1.0	11	66	105	116	88	79	25
16					2.0	10	67	100	112	87	79	24
17					3.5	10	67	100	110	87	79	22
18					4.0	10	66	100	108	88	78	21
19					4.0	15	65	100	105	89	77	20
20					3.6	39	64	110	104	90	76	19
21					3.5	55	60	110	104	90	75	16
22					3.2	62	58	105	101	92	75	15
23					3.0	67	56	105	100	94	74	13
24					3.0	69	54	105	96	94	74	12
25					3.5	69	55	100	94	94	73	9.6
26					5.0	67	55	100	92	92	73	8.0
27					6.0	67	57	105	90	90	71	6.1
28					8.0	67	59	106	89	89	67	4.3
29					---	66	60	108	87	87	64	2.4
30					---	65	61	110	86	86	60	.90
31					---	64	---	110	---	84	56	---
Total	0	0	0	0	54.30	986	1757	2940	3304	2751	2313	747.30
Min	0	0	0	0	0	10	48	64	86	84	56	.90
Ac-Ft	0	0	0	0	108	1960	3490	5830	6550	5460	4590	1480

Discharge, in cubic feet per second, at Huron, South Dakota, water year 1974.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1		0	.10		0	37	58	27	87	58	38	35
2		0	.15		0	43	74	66	90	62	43	39
3		0	.15		0	53	93	74	83	64	39	32
4		0	.15		0	55	66	62	83	60	34	24
5		0	.10		0	55	62	87	83	46	32	11
6		0	0		0	57	62	58	90	37	24	16
7		2.4	0		0	53	58	66	89	42	24	27
8		.30	0		0	52	47	66	90	44	27	32
9		.20	.01		0	50	51	66	124	52	32	30
10		.15	0		0	48	35	66	110	52	47	22
11		.15	0		0	49	51	80	107	39	47	32
12		.15	0		0	46	62	93	97	44	51	35
13		.10	0		0	43	74	70	96	39	47	27
14		.30	0		0	18	74	66	96	46	24	27
15		.40	0		0	0	74	62	101	44	35	30
16		.11	.10		0	0	58	62	96	26	39	19
17		.02	.02		0	0	66	66	86	44	47	27
18		.25	0		.4	3.6	62	62	82	50	43	22
19		.30	0		40	11	35	54	82	48	27	27
20		14	0		49	11	51	51	76	40	27	27
21		0	0		62	11	70	70	91	49	39	27
22		.10	0		49	13	87	87	86	48	39	16
23		0	0		46	13	74	112	79	39	30	16
24		.10	0		36	16	39	106	72	44	27	22
25		.10	0		30	19	74	99	66	44	32	11
26		.10	0		27	24	62	93	55	46	43	8.0
27		.15	0		29	27	66	87	50	42	35	27
28		.15	0		35	35	80	93	54	46	32	3.0
29		.15	0		---	47	80	93	63	43	39	11
30		.15	0		---	51	87	93	61	40	35	4.0
31		---	0		---	54	---	93	---	35	35	---
Total	0	19.88	.78	0	403.40	994.6	1932	2330	2530	1413	1113	686.0
Min	0	0	0	0	0	0	35	27	50	26	24	3.0
Ac-Ft	0	39	1.5	0	800	1970	3830	4620	5020	2800	2210	1360

Discharge, in cubic feet per second, at Columbia, South Dakota, water year 1975.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	0	2.5	7.8	5.0	4.5	3.0	0	180	670	758	913	459
2	0	2.6	7.8	5.0	5.0	3.0	1.0	240	657	761	893	450
3	0	3.0	7.6	4.5	5.5	2.0	5.0	310	646	816	874	442
4	0	3.2	7.1	4.5	5.5	2.0	7.0	380	640	895	852	436
5	0	3.4	6.9	4.0	5.0	2.0	8.0	440	636	962	835	437
6	0	3.6	6.9	4.5	4.5	2.0	10	510	627	1010	811	430
7	0	3.7	6.7	5.0	4.5	1.0	25	565	619	1080	780	427
8	0	3.9	6.3	5.0	4.0	1.0	40	619	610	1130	761	421
9	0	3.9	6.5	5.0	4.0	1.0	60	654	615	1200	742	415
10	0	3.7	6.5	3.0	4.5	1.0	100	678	615	1300	728	410
11	0	3.9	6.1	3.0	5.0	0	120	702	612	1410	712	406
12	0	4.1	5.6	4.0	5.0	0	125	720	609	1490	700	405
13	0	4.5	5.6	6.0	5.0	0	115	728	601	1530	680	396
14	0	4.6	5.6	6.5	5.0	0	108	742	600	1530	667	384
15	0	5.2	5.6	6.5	5.0	0	85	750	609	1500	651	373
16	0	5.6	5.4	7.0	5.0	0	69	734	604	1480	639	364
17	0	3.9	5.4	7.0	5.0	0	67	729	601	1390	631	357
18	0	3.7	5.0	7.0	4.0	0	64	732	589	1390	621	361
19	0	8.0	4.5	7.5	4.0	0	63	750	633	1350	610	354
20	0	11	4.5	8.0	4.0	0	63	765	648	1320	603	347
21	0	9.7	4.5	8.0	4.0	0	64	773	550	1260	594	351
22	0	9.7	5.0	8.0	4.0	0	64	778	-40	1230	582	351
23	.04	9.7	5.0	8.0	4.0	0	65	780	-750	1210	570	348
24	.14	9.7	5.0	9.0	4.0	0	20	768	-450	1170	555	346
25	.38	9.7	5.0	8.0	4.0	0	-10	758	-90	1130	535	343
26	.60	9.4	5.5	7.0	3.0	0	-15	747	100	1090	514	336
27	.77	9.4	6.0	6.0	3.0	0	-8.0	724	240	1070	500	331
28	1.1	8.5	6.0	6.0	3.0	0	4.0	716	360	1030	493	328
29	1.4	7.8	6.0	5.0	---	0	45	704	480	989	483	326
30	1.6	7.8	5.5	4.0	---	0	110	692	610	949	475	323
31	2.1	---	5.5	4.0	---	0	---	681	---	924	467	---
Total	8.13	179.4	182.4	181.0	123.0	18.0	1474.0	20049	13451	36354	20471	11457
Min	0	2.5	4.5	3.0	3.0	0	-15	180	-750	758	467	323
Ac-Ft	16	356	362	359	244	36	2920	39770	26680	72110	40600	22720

Discharge, in cubic feet per second, at Ashton, South Dakota, water year 1975.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	.04					0	0	199	658	637	1050	790
2	0					0	0	220	659	649	1060	766
3	0					0	0	240	661	668	1070	744
4	0					0	0	257	668	686	1090	719
5	0					0	.50	279	670	710	1100	705
6	0					0	1.0	298	670	735	1110	687
7	.04					0	1.5	324	668	754	1120	668
8	.08					0	2.0	338	671	769	1120	649
9	.04					0	3.0	352	681	788	1130	632
10	.04					0	4.0	371	684	800	1130	628
11	.08					0	7.0	385	689	809	1120	626
12	.12					0	10	406	690	818	1120	611
13	.16					0	30	428	690	832	1110	590
14	.20					0	65	451	690	850	1090	571
15	.24					0	74	482	690	860	1080	550
16	.28					.50	70	510	689	869	1060	531
17	.32					1.0	81	523	684	875	1050	514
18	.40					1.0	87	548	679	877	1040	498
19	.36					1.5	102	560	671	879	1030	489
20	.32					1.0	110	566	674	890	1010	478
21	.28					1.0	119	583	674	902	1000	468
22	.16					.50	133	605	671	915	986	460
23	.08					0	154	629	664	926	972	453
24	.04					0	160	644	656	940	956	442
25	.04					0	166	652	652	952	930	439
26	.04					0	168	656	646	968	909	437
27	.04					0	167	653	637	986	886	432
28	.04					0	167	649	634	1010	886	424
29	.04				---	0	176	652	631	1020	865	418
30	0				---	0	187	652	631	1030	838	411
31	.04	---			---	0	---	653	---	1040	814	---
Total	3.52	0	0	0	0	6.5	2245.0	14765	20032	26444	31732	16830
Min	0	0	0	0	0	0	0	199	631	637	814	411
Ac-Ft	7.0	0	0	0	0	13	4450	29290	39730	52450	62940	33380

Discharge, in cubic feet per second, at Huron, South Dakota, water year 1975.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	4.9	0	.13			0	24	215	564	537	956	892
2	.21	0	.11			0	24	214	564	551	939	818
3	0	0	.10			0	21	202	531	576	936	817
4	0	0	.04			0	18	202	586	567	958	785
5	0	0	0			0	21	190	597	584	957	780
6	1.1	0	0			0	24	175	586	576	951	740
7	0	0	0			0	32	213	575	584	1130	734
8	0	0	0			0	49	221	586	609	1140	692
9	0	0	0			0	52	268	630	629	979	680
10	0	0	0			0	65	303	652	638	986	688
11	.04	0	0			0	65	347	641	665	1010	689
12	.17	0	0			0	78	331	630	666	1050	605
13	0	0	0			0	108	309	641	685	1040	315
14	0	0	0			0	100	352	641	685	1030	301
15	0	0	0			0	95	337	641	704	1020	432
16	0	0	0			0	91	300	663	695	1020	493
17	0	0	0			.03	117	367	685	709	1010	496
18	0	0	0			.25	127	422	641	797	1000	580
19	0	0	0			4.1	145	438	556	792	960	551
20	0	0	0			14	162	503	607	783	994	519
21	0	9.7	0			24	139	446	633	777	1030	474
22	0	22	0			27	133	413	623	794	983	455
23	0	20	0			36	145	450	602	827	971	459
24	0	.86	0			43	133	480	574	819	952	430
25	0	1.6	0			30	162	531	561	801	938	410
26	0	.44	0			32	133	542	588	828	1030	390
27	0	.19	0			36	133	510	586	844	966	435
28	0	.16	0			30	139	542	542	821	977	438
29	0	.16	0			30	187	575	557	826	928	424
30	0	.16	0			30	215	564	549	841	907	431
31	0	---	0			27	---	553	---	894	855	---
Total	6.42	55.27	.38	0	0	363.38	2937	11515	18032	22104	30603	16953
Min	0	0	0	0	0	0	18	175	531	537	855	301
Ac-Ft	13	110	.8	0	0	721	5830	22840	35770	43840	60700	33630

Discharge, in cubic feet per second, at Columbia, South Dakota, water year 1976.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	318	315	210	45	11	35	161	276	180	9.2	25	
2	315	314	190	40	11	35	137	281	174	8.0	23	
3	312	314	170	35	11	33	127	283	166	8.5	7.8	
4	309	313	158	30	11	33	122	285	158	7.3	2.0	
5	306	312	150	27	12	32	117	293	152	8.2	2.0	
6	302	307	150	25	12	35	115	298	149	7.8	2.6	
7	295	304	140	25	13	37	116	310	143	9.2	.11	
8	285	303	130	24	15	40	117	316	139	3.9	.70	
9	279	305	120	23	17	45	117	321	136	4.5	.45	
10	277	306	110	22	20	50	134	325	134	5.6	.31	
11	292	310	100	21	25	60	155	324	129	5.8	0	
12	300	313	90	20	30	65	169	327	126	6.5	0	
13	304	329	85	20	35	70	178	328	120	28	0	
14	309	329	85	19	37	75	187	328	119	34	0	
15	301	327	80	18	40	80	188	333	128	26	0	
16	297	321	75	17	43	85	183	332	127	22	0	
17	297	316	70	17	43	90	188	334	123	21	0	
18	295	315	70	16	43	100	191	331	117	21	0	
19	294	321	65	15	42	120	187	334	113	21	0	
20	292	300	60	15	42	130	193	329	108	22	0	
21	293	280	60	14	40	140	193	318	104	21	0	
22	297	250	60	13	38	150	191	289	101	20	0	
23	303	210	55	12	37	200	192	259	73	26	0	
24	324	200	55	11	37	250	220	238	30	28	0	
25	331	210	55	10	37	300	243	219	20	27	0	
26	325	210	50	10	37	320	253	210	17	26	0	
27	321	220	50	11	36	320	259	204	15	27	0	
28	317	230	50	11	36	312	264	199	14	26	0	
29	318	230	47	11	35	272	268	194	12	26	0	
30	317	230	47	12	--	233	274	189	11	25	0	
31	315	---	47	12	--	196	---	185	--	26	0	---
Total	9440	8544	2884	601	846	3944	5439	8792	3138	557.5	63.97	0
Min	277	200	47	10	11	32	115	185	11	3.9	0	0
Ac-Ft	18720	16950	5720	1190	1680	7820	10790	17440	6220	1110	127	0

Discharge, in cubic feet per second, at Ashton, South Dakota, water year 1976.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	405	316	240	80	25	40	335	242	230	85	0	.36
2	394	318	230	75	25	38	355	246	214	72	0	.36
3	388	320	230	65	24	38	370	250	200	59	0	.20
4	384	320	220	60	23	37	380	258	187	45	0	.12
5	378	319	210	55	22	35	388	263	176	34	0	.08
6	371	319	200	50	22	35	390	269	166	27	0	.04
7	365	319	190	48	22	36	392	274	159	19	8.8	0
8	361	318	180	46	23	38	383	280	155	12	14	.04
9	355	314	170	44	24	40	373	282	149	7.1	16	.04
10	348	312	160	43	25	45	359	285	151	6.4	16	.04
11	343	312	150	42	27	50	340	286	163	2.5	16	0
12	338	313	140	40	30	55	318	288	153	.16	16	0
13	333	312	130	40	30	60	298	287	140	0	15	0
14	328	312	130	38	33	65	280	259	131	.12	12	0
15	312	310	120	38	36	70	266	288	122	0	9.9	0
16	312	308	120	36	40	75	253	288	117	.12	8.3	0
17	307	307	120	35	43	80	245	286	115	.16	6.7	0
18	306	306	110	35	45	85	241	292	114	.18	4.8	0
19	300	306	110	33	46	95	238	296	113	.20	3.3	0
20	294	305	100	32	46	110	239	295	111	.20	2.4	0
21	292	305	100	31	45	120	240	295	110	.16	2.2	0
22	289	290	100	30	43	140	243	196	109	.20	2.0	0
23	288	250	95	28	42	150	244	294	108	.12	1.8	0
24	301	220	95	27	42	160	247	292	112	.08	1.5	0
25	306	220	90	25	42	180	248	290	112	.08	1.3	0
26	309	220	90	25	42	200	249	287	111	.08	1.2	0
27	312	230	90	23	40	226	246	284	109	.04	.82	0
28	316	240	87	23	40	252	245	277	107	.04	.54	0
29	316	250	85	23	40	275	243	269	103	0	.43	0
30	316	250	87	24	--	293	243	258	96	0	.32	0
31	316	---	85	24	--	313	---	244	--	0	.36	0
Total	10283	8741	4264	1218	987	3436	8891	8630	4143	370.94	161.67	1.28
Min	288	220	85	23	22	35	238	242	96	0	0	0
Ac-Ft	20400	17340	8460	2420	1960	6820	17640	17120	8220	736	321	2.5

Discharge, in cubic feet per second, at Huron, South Dakota, water year 1976.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	398	292	293	114	63	101	196	227	206	35		
2	366	299	277	111	65	93	223	240	177	30		
3	380	277	259	108	63	91	286	209	163	25		
4	340	234	238	103	64	92	256	188	154	19		
5	386	254	225	98	65	90	284	234	152	20		
6	329	248	220	93	65	90	294	215	146	30		
7	288	297	215	88	66	89	298	215	135	24		
8	287	305	211	85	58	89	305	212	130	12		
9	382	315	204	83	57	90	246	209	120	4.0		
10	352	303	202	80	59	92	331	243	123	7.0		
11	310	303	194	82	61	98	323	205	104	1.1		
12	322	389	193	85	65	107	275	235	110	.08		
13	321	280	186	91	68	111	257	259	122	0		
14	317	264	192	87	72	113	302	230	112	0		
15	315	278	180	90	77	112	273	277	124	0		
16	296	287	170	88	83	113	188	259	112	0		
17	292	291	160	81	90	114	261	236	121	0		
18	269	300	150	78	97	119	277	206	101	0		
19	286	300	155	75	103	120	250	224	95	0		
20	292	270	160	78	107	133	246	250	85	0		
21	290	240	162	72	110	125	225	246	31	0		
22	282	225	160	70	110	123	213	257	0	0		
23	308	231	156	67	106	132	192	242	.01	0		
24	311	227	156	67	104	137	223	239	33	0		
25	289	232	156	66	100	136	219	222	52	0		
26	271	243	155	65	99	152	206	235	54	0		
27	294	255	145	65	99	151	209	257	49	0		
28	289	263	123	63	99	150	204	255	54	0		
29	283	268	119	62	96	192	212	234	51	0		
30	271	285	116	61	--	206	227	226	43	0		
31	302	---	115	62	--	206	---	223	--	0		
Total	9718	8255	5647	2518	2371	3767	7501	7209	2959.01	207.18	0	0
Min	269	225	115	61	57	89	188	188	0	0	0	0
Ac-Ft	19280	16370	11200	4990	4700	7470	14880	14300	5870	411	0	0

Discharge, in cubic feet per second, at LaMoure, North Dakota, water year 1976.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	300	366	50	30	25	60	250	393	40	40	18	6.5
2	300	377	42	28	24	55	250	360	35	37	17	8.5
3	311	377	40	26	23	50	230	333	30	35	12	18
4	311	377	40	24	22	45	230	333	28	30	22	6.5
5	306	371	42	24	22	42	230	322	30	28	17	6.5
6	306	316	42	22	22	40	220	311	26	37	14	8.5
7	322	235	40	20	22	38	220	267	24	26	11	15
8	333	190	40	20	22	36	210	230	24	26	15	15
9	350	159	40	20	24	36	200	215	20	33	17	8.5
10	344	150	42	22	26	34	220	200	24	30	17	8.5
11	360	200	42	22	26	32	205	159	15	26	17	14
12	366	168	40	22	28	30	245	172	28	22	15	15
13	360	154	40	22	28	30	267	134	37	37	15	18
14	366	138	40	22	30	30	283	114	52	28	14	9.6
15	360	142	35	22	33	30	272	138	69	30	12	11
16	366	146	35	22	37	37	294	110	60	24	14	12
17	366	118	30	22	44	44	383	81	78	24	18	12
18	360	110	30	24	47	66	383	60	63	22	14	15
19	371	114	30	24	50	138	377	81	55	26	15	20
20	366	92	30	24	47	245	388	63	47	24	17	12
21	338	52	30	25	44	311	371	60	47	17	17	9.6
22	355	74	30	25	44	459	371	58	33	22	9.6	15
23	366	69	30	25	44	476	371	55	30	20	7.5	12
24	388	60	33	25	50	432	388	52	52	15	9.6	14
25	377	60	33	25	60	410	421	47	40	22	14	12
26	377	55	33	25	74	393	443	60	44	18	12	20
27	377	52	33	25	85	333	432	50	44	15	14	11
28	371	50	33	25	80	338	426	47	55	20	6.5	12
29	371	50	33	26	70	349	415	42	52	18	6.5	18
30	371	50	32	26	---	305	410	47	40	20	11	20
31	371	---	32	26	---	272	---	42	---	15	12	---
Total	10886	4872	1122	740	1153	5196	9405	4636	1222	787	430.7	383.7
Min	300	50	30	20	22	30	200	42	15	15	6.5	6.5
Ac-Ft	21590	9660	2230	1470	2290	10310	18650	9200	2420	1560	854	761

Discharge, in cubic feet per second, at LaMoure, North Dakota, water year 1976.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	300	366	50	30	25	60	250	393	40	40	18	6.5
2	300	377	42	28	24	55	250	360	35	37	17	8.5
3	311	377	40	26	23	50	230	333	30	35	12	18
4	311	377	40	24	22	45	230	333	28	30	22	6.5
5	306	371	42	24	22	42	230	322	30	28	17	6.5
6	306	316	42	22	22	40	220	311	26	37	14	8.5
7	322	235	40	20	22	38	220	267	24	26	11	15
8	333	190	40	20	22	36	210	230	24	26	15	15
9	350	159	40	20	24	36	200	215	20	33	17	8.5
10	344	150	42	22	26	34	220	200	24	30	17	8.5
11	360	200	42	22	26	32	205	159	15	26	17	14
12	366	168	40	22	28	30	245	172	28	22	15	15
13	360	154	40	22	28	30	267	134	37	37	15	18
14	366	138	40	22	30	30	283	114	52	28	14	9.6
15	360	142	35	22	33	30	272	138	69	30	12	11
16	366	146	35	22	37	37	294	110	60	24	14	12
17	366	118	30	22	44	44	383	81	78	24	18	12
18	360	110	30	24	47	66	383	60	63	22	14	15
19	371	114	30	24	50	138	377	81	55	26	15	20
20	366	92	30	24	47	245	388	63	47	24	17	12
21	338	52	30	25	44	311	371	60	47	17	17	9.6
22	355	74	30	25	44	459	371	58	33	22	9.6	15
23	366	69	30	25	44	476	371	55	30	20	7.5	12
24	388	60	33	25	50	432	388	52	52	15	9.6	14
25	377	60	33	25	60	410	421	47	40	22	14	12
26	377	55	33	25	74	393	443	60	44	18	12	20
27	377	52	33	25	85	333	432	50	44	15	14	11
28	371	50	33	25	80	338	426	47	55	20	6.5	12
29	371	50	33	26	70	349	415	42	52	18	6.5	18
30	371	50	32	26	---	305	410	47	40	20	11	20
31	371	---	32	26	---	272	---	42	---	15	12	---
Total	10886	4872	1122	740	1153	5196	9405	4636	1222	787	430.7	383.7
Min	300	50	30	20	22	30	200	42	15	15	6.5	6.5
Ac-Ft	21590	9660	2230	1470	2290	10310	18650	9200	2420	1560	854	761

Discharge, in cubic feet per second, at LaMoure, North Dakota, water year 1975.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	40	24	11	10	8.7	10	11	984	502	2310	195	313
2	31	22	11	10	8.8	9.9	11	1040	503	1570	224	300
3	50	24	11	11	9.2	9.9	11	903	494	1240	287	293
4	57	25	11	11	11	9.7	11	778	504	745	298	286
5	45	21	11	11	11	10	11	689	507	546	289	293
6	62	22	11	11	10	9.8	11	623	511	451	283	289
7	52	23	12	11	10	10	12	619	503	359	280	293
8	62	18	11	11	10	9.9	15	605	523	279	299	285
9	54	23	11	12	9.9	9.9	12	586	527	227	292	292
10	54	18	11	13	9.9	9.8	11	581	527	188	294	293
11	67	28	12	15	9.2	10	12	587	528	162	295	269
12	45	12	13	8.9	9.5	10	15	571	522	151	295	280
13	58	21	13	7.8	9.8	9.8	16	558	515	185	286	287
14	56	8.9	13	8.1	9.9	9.9	18	560	516	181	287	287
15	50	12	14	9.0	9.9	11	21	547	521	178	282	298
16	56	14	12	9.0	9.5	13	25	531	522	169	288	292
17	56	14	11	9.3	9.9	17	60	550	515	158	291	293
18	56	14	12	9.5	10	22	202	520	506	157	288	303
19	55	14	11	9.6	9.8	44	790	533	549	173	297	292
20	41	13	11	8.4	9.6	64	1760	537	629	224	307	288
21	39	14	10	9.3	9.9	77	2520	592	547	229	302	295
22	32	14	11	8.0	10	72	2900	564	415	219	300	296
23	20	14	11	8.1	9.5	61	2680	546	302	236	309	291
24	24	13	11	9.8	9.8	32	1990	549	336	245	304	287
25	19	14	11	9.9	11	11	1530	578	293	227	303	284
26	17	15	11	8.9	9.8	10	980	559	245	213	298	285
27	18	14	11	9.2	9.6	11	678	537	219	200	288	290
28	19	12	12	9.3	9.9	11	692	533	226	199	296	289
29	19	11	12	10	---	11	708	528	1030	190	303	292
30	17	11	11	9.2	---	11	743	509	2520	190	309	287
31	25	---	11	8.9	---	11	---	504	---	194	306	---
Total	1296	501.9	355	306.2	275.1	627.2	18456	18901	16557	11995	8975	8722
Min	17	8.9	10	7.8	8.7	9.7	11	504	219	151	195	269
Ac-Ft	2570	996	704	607	546	1240	36610	37490	32840	23790	17800	17300

Discharge, in cubic feet per second, at LaMoure, North Dakota, water year 1974.

Day	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
1	53	11	9.9	7.1	7.9	9.9	41	68	335	158	27	50
2	38	12	11	6.2	7.9	12	41	85	405	158	29	50
3	37	12	11	6.2	7.9	17	38	62	465	158	22	50
4	18	9.9	9.9	6.2	8.7	15	38	57	477	144	20	45
5	12	11	8.7	6.2	7.9	18	43	55	483	102	20	41
6	16	11	7.9	6.2	7.9	55	48	43	514	79	17	60
7	12	12	7.1	6.2	7.9	144	50	43	514	85	17	50
8	13	11	8.7	6.2	8.7	158	52	43	508	88	22	45
9	16	9.9	8.7	5.4	7.9	217	57	43	496	82	29	48
10	9.3	9.9	7.1	6.2	7.9	247	62	50	483	74	31	55
11	12	9.9	7.9	6.2	7.9	230	85	62	471	74	29	55
12	10	11	7.9	6.2	8.7	230	116	38	459	82	52	45
13	39	12	7.1	6.2	8.7	213	147	43	447	85	43	48
14	45	12	7.1	7.1	8.7	221	140	60	441	98	31	52
15	58	11	7.1	7.1	7.9	234	191	48	423	98	43	43
16	58	11	7.1	7.1	8.7	208	288	65	417	95	29	45
17	54	12	7.1	7.9	8.7	195	252	74	417	105	20	48
18	40	12	7.9	7.9	8.7	200	174	116	411	88	26	48
19	41	11	7.9	7.9	9.9	204	126	144	399	88	31	48
20	27	11	7.9	7.9	9.9	195	119	158	399	91	43	45
21	31	14	7.9	7.9	9.9	147	119	187	386	95	29	43
22	29	9.9	7.9	8.7	9.9	80	204	217	380	88	24	38
23	20	9.9	7.9	8.7	9.9	50	411	187	368	88	26	45
24	33	9.9	7.9	7.9	8.7	20	314	217	329	95	36	50
25	13	9.9	8.7	7.9	8.7	25	226	268	293	85	38	36
26	18	11	8.7	8.7	9.9	30	151	278	273	88	41	48
27	16	9.9	8.7	8.7	9.9	32	137	268	278	77	52	48
28	13	9.9	8.7	7.9	11	34	109	257	238	57	52	36
29	12	9.9	8.7	7.9	----	34	102	273	191	31	52	62
30	15	9.9	7.9	8.7	----	36	91	309	165	22	57	27
31	20	----	7.9	7.9	----	38	----	324	----	24	48	----
Total	828.3	326.8	255.9	224.5	246.3	3548.9	3972	4142	11865	2782	1036	1404
Min	9.3	9.9	7.1	5.4	7.9	9.9	38	38	165	22	17	27
Ac-Ft	1640	648	508	445	489	7040	7880	8220	23530	5520	2050	2780

Literature Cited

A erican Fisheries Society. 1970. A list of common and scientific names of fishes from the United States and Canada (3rd. ed.). Special Publication No. 6, American Fisheries Society. 149 p.

At on, F. M. 1959. The invasion of Manitoba and Saskatchewan by carp. Trans. Amer. Fish. Soc. 88(3):203-205.

Bai ey, R. M., and M. O. Allum. 1962. The fishes of South Dakota. Misc. Publ. Mus. Zool., University of Michigan, No. 119. 134 p.

Bea , C. D. 1963. Life history information on the blue suck r, Cycleptus elongatus (LeSueur), in the Missouri River. M.A. Thesis, University of South Dakota. 36 p.

Burt n, G. W., and E. P. Odum. 1945. The distribution of stream fish in the vicinity of Mountain Lake, Virginia. Ecology 26:182-194.

Chur hill, E. P., and W. H. Over. 1933. Fishes of South Dakota. South Dakota Department of Game and Fish, Pierre. 87 p.

Cope , F. A. 1965. Fishes of the Red River tributaries of North Dakota. M.S. Thesis, University of North Dakota. 46 p.

Cope , F. A., and R. A. Tubb. 1966. Fishes of the Red River tributaries in North Dakota. University of North Dakota, Inst. Ecol. Studies Contrib. 1:1-26.

Cro s, F. B. 1967. Handbook of fishes of Kansas. University of Kansas, Mus. Nat. Hist. Misc. Publ. 45:1-357.

De con, J. E. 1961. Fish populations following a drought, in the Neosho and Marias des Cygnes Rivers of Kansas. University of Kansas, Mus. Nat. Hist. Publ. 13(9): 359-427.

D acon, J. E., and W. G. Bradley. 1972. Ecological distribution of fishes of the Moapa River in Clark Co., Nevada. Trans. Amer. Fish. Soc. 101(3):408-419.

ddy, S. 1969. How to know the freshwater fishes. Wm. C. Brown Co., Dubuque, Iowa. 286 p.

Eddy, S., R. C. Tasker, and J. C. Underhill. 1972. Fishes of the Red River, Rainy River, and Lake of the Woods, Minnesota, with comments on the distribution of species in the Nelson River drainage. Bell Mus. Nat. Hist., University of Minnesota, Occ. Pap. 11. 24 p.

Eddy, S., and J. C. Underhill. 1974. Northern fishes. University of Minnesota Press, Minneapolis. 414 p.

Evermann, B. W., and U. O. Cox. 1896. A report upon the fishes of the Missouri River basin. Rept. U. S. Comm. Fish. and Fish. (1894) 20: 325-429.

Feldman, R. M. 1963. Distribution of fish in the Forest River of North Dakota. Proc. North Dakota Acad. Sci. 17:11-19.

Forbes, S. A. 1907. On the local distribution of certain Illinois fishes. An essay in statistical ecology. Bull. Ill. St. Lab. Natur. Hist. 7:273-303.

Funk, J. L. 1955. Movements of stream fishes in Missouri. Trans. Amer. Fish. Soc. 85:39-57.

Gard, R., and G. A. Flittner. 1974. Distribution and abundance of fishes in Sagehen Creek, California. J. Wildl. Manage. 38(2):347-358.

Gerking, S. D. 1953. Evidence for the concepts of home range and territory in stream fishes. Ecology 60:347-365.

Gunning, G. E., and T. M. Berra. 1968. Repopulation of a decimated stream segment by the sharpfin chubsucker. Prog. Fish-Cult. 30(2): 92-95.

Hankinson, T. L. 1929. Fishes of North Dakota. Pap. Mich. Acad. Sci. Arts Lett., (1928) 10:439-460.

Hansen, D. R. 1971. Stream channelization effects on fishes and bottom fauna in the Little Sioux River, Iowa, p. 29-51 in E. Schneberger and J. L. Funk, eds. Stream channelization symposium. North Central Division, American Fisheries Society, Spec. Publ. 2. 83 p.

Hanson, W. D., and R. S. Campbell. 1963. The effects of pool size and beaver activity on distribution and abundance of warm-water fishes in a north Missouri stream. Amer. Midl. Natur. 69(1):136-149.

Harrel, R. C., and T. C. Dorris. 1968. Stream order, morphometry, physicochemical conditions, and community structure of benthic macroinvertebrates in an intermittent stream system. Amer. Midl. Natur. 80:220-251.

Holliday, F. G. T. 1969. The effects of salinity on the eggs and larvae of teleosts, p. 293-309 in Hoar, W. S., and D. J. Randall, eds. Fish physiology. Vol 1. Acad. Press, New York. 465 p.

Hubbs, C. 1957. Distributional patterns of Texas freshwater fishes. Southwest. Natur. 2(2):89-104.

Larimore, R. W., W. F. Childers, and C. Heckrotte. 1959. Destruction and re-establishment of stream fish and invertebrates affected by drought. Trans. Amer. Fish. Soc. 88(4):261-285.

Larimore, R. W., and P. W. Smith. 1963. The fishes of Champaign County, Illinois, as affected by 60 years of stream changes. Ill. Nat. Hist. Surv. Bull. 28(2):299-382.

Lockard, L. L. 1976. James River fish kill-1976. South Dakota Acad. Sci. (submitted for publication).

McKee, J., and H. Wolf. 1963. Water quality criteria (2nd. ed.). California State Water Resources Control Board, Sacramento. Publ. 3-A, 547 p.

Miller, R. R. 1972. Threatened freshwater fishes of the United States. Trans. Amer. Fish. Soc. 101(2):239-252.

Moen, T. 1970. The occurrence of black buffalo, Ictiobus niger Rafinesque in Lake Mitchill, South Dakota. Proc. South Dakota Acad. Sci. 49: 42-45.

North Dakota State Game and Fish Department. 1968. Surveys of reservoirs, natural lakes and streams for fishery management (statewide). Dingell-Johnson Division, Project F-2-R-15, Job No. 4, Report No. A-1005.

____________________. 1969. Surveys of reservoirs, natural lakes, and streams for fishery management (statewide). Dingell-Johnson Division, Project F-2-R-16, Job No. 4, Report No. A-1000.

____________________. 1970. Surveys of reservoirs, natural lakes, and streams for fishery management (statewide). Dingell-Johnson Division, Project F-2-R-17, Job No. 4, Report No. A-1014.

____________________. 1973. Ecological investigations of lakes, streams, and impoundments in North Dakota (statewide). Dingell-Johnson Division. Project F-2-R-20. Study II. Jobs IIA and IIB. Report No. A-1028.

____________________. 1975. Ecological investigations of lakes, streams, and impoundments in North Dakota (statewide). Dingell-Johnson Division. Project F-2-R-22. Study II, Jobs IIA and IIB. Report No. A-1041.

Omodt, H. W., G. A. Johnsgard, D. D. Patterson, and O. P. Olsen. 1968. The major soils of North Dakota. Agr. Exp. Sta., North Dakota State Univ. 60 p.

Owen, J. B., and G. Russell. 1975a. Distribution of fishes in North Dakota affected by the southern section of the Garrison Diversion Unit. Mimeo. report to the U. S. Bureau of Reclamation. 43 p.

Owen, J. B., and G. Russell. 1975b. Distribution of fishes in North Dakota affected by the central section of the Garrison Diversion Unit. Mimeo. report to the U. S. Bureau of Reclamation. 54 p.

Owen, J. B., and G. Russell. 1975c. Distribution of fishes in North Dakota affected by the northern section of the Garrison Diversion Unit. Mimeo. report to the U. S. Bureau of Reclamation. 56 p.

Paloumpis, A. A. 1958. Responses of some minnows to flood and drought conditions in an intermittent stream. Iowa State J. of Sci. 32(4): 547-561.

Pflieger, W. L. 1971. A distributional study of Missouri fishes. Univ. of Kansas Publ., Mus. Nat. Hist. 20(3):225-570.

Pflieger, W. L. 1975. The fishes of Missouri. Missouri Dept. of Cons., Jefferson City, 343 p.

Rothrock, E. P. 1943. A geology of South Dakota. Part 1, the surface. South Dakota Geological Survey, Bull. 13, 88 p.

Russell, G. 1975. Distribution of fishes in North Dakota drainages affected by the Garrison Diversion Project. M.S. Thesis, University of North Dakota. 100 p.

Schoenecker, W. 1970. Management of winterkill lakes in the sandhill region of Nebraska. pp. 53-56. In A symposium on the management of midwestern winterkill lakes. E. Schneberger (editor), Special Publ., American Fisheries Society, North Central Division. 75 p.

Scott, W. B., and E. J. Crossman. 1973. Freshwater fishes of Canada. Fish. Res. Bd. Can., Bull. 184. 966 p.

Sheldon, A. L. 1968. Species diversity and longitudinal succession in stream fishes. Ecology 49(2):193-198.

Shelford, V. E. 1911. Ecological succession: 1. Stream fishes and the method of physiographic analysis. Biol. Bull. 21(1):9-35.

Starrett, W. C. 1950. Distribution of the fishes of Boone County, Iowa with special reference to the minnows and darters. Amer. Midl. Natur. 43(1):112-127.

Starrett, W. C. 1951. Some factors affecting the abundance of minnows, in the Des Moines River, Iowa. Ecology 32:13-27.

State Planning Board and Works Progress Administration. 1939. James River drainage basin North Dakota. O. P. No. 665-73-3-67. 105 p.

Stewart, K. W., and C. C. Lindsey. 1970. First specimens of the stonecat Noturus flavus from the Hudson Bay drainage. J. Fish. Res. Bd. Canada 27(1):170-172.

Thompson, D. H., and F. D. Hunt. 1930. The fishes of Champaign County. A study of the distribution and abundance of fishes in small streams. Ill. Nat. Hist. Surv., Bull. 19:1-101.

Thorn, W. C., and V. J. Starostka. 1969. The yellow bullhead in two small impoundments in northeastern South Dakota. Proc. South Dakota Acad. Sci. 48:148-150.

Tol, D. 1976. An evaluation of the fishery resource in a portion of the

James River, South Dakota scheduled for channel modification. M.S. Thesis, South Dakota State University, 69 p.

Tramer, E. J., and P. M. Rogers. 1973. Diversity and longitudinal zonation in fish populations of two streams entering a metropolitan area. Amer. Midl. Natur. 90(2):367-374.

Trautman, M. B. 1942. Fish distribution and abundance correlated with stream gradients as a consideration in stocking programs. Trans. 7th North Amer. Wildl. Conf., Washington, p. 211-223.

Tubb, R. A., F. A. Copes, and C. Johnston. 1966. Fishes of the Sheyenne River of North Dakota. North Dakota Acad. Sci. 29:120-128.

Underhill, J. C. 1957. The distribution of Minnesota minnows and darters in relation to Pleistocene glaciation. Occas. Paps. Minnesota Mus. Natur. Hist., University of Minnesota, No. 7, p. 1-45.

Underhill, J. C. 1959. Fishes of the Vermillion River, South Dakota. Proc. South Dakota Acad. Sci. 38:96-102.

U. S. Bureau of Reclamation. 1975. Summary report, water quality and return flow study, initial stage-Oahe Unit, September 1975.

U. S. Bureau of Reclamation. 1976. Report on water quality, Garrison Diversion Unit, June 1976.

U. S. Public Health Service. 1952. James River drainage basin. Public Health Service, Publ. No. 187. 133 p.

Van Eeckhout, G. 1974. Movement and reproduction of channel catfish in the Little Missouri River. M.S. Thesis, University of North Dakota. 71 p.

Vincent, R. E., and W. H. Miller. 1969. Altitudinal distribution of brown trout and other fishes in a headwater tributary of the South Platte River, Colorado. Ecology 50(3):464-466.

Westin, F. C., L. F. Buhr, and G. J. Buntley. 1967. Soils of South Dakota. Exp. Sta., South Dakota State University, Soil Surv. 3, 32 p.

Whiteside, B. G., and R. M. McNatt. 1972. Fish species diversity in relation to stream order and physiochemical conditions in the Plum Creek drainage basin. Amer. Midl. Natur. 88:90-101.

Willard, D. E. 1909. Jamestown-Tower folio No. 168: Geol. Atlas of the U. S. Geological Survey, 9 p.

Wilson, H. W. 1950. A study of the fishes of the upper Sheyenne River. M.S. Thesis, University of Minnesota. 45 p.

Woolman, A. J. 1896. Report upon the ichthyological investigations in western Minnesota and eastern North Dakota. Report U. S. Comm., Fish. and Fish (1893):343-373.