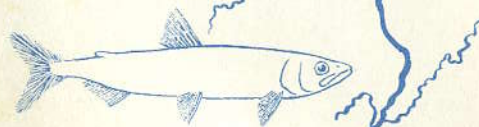
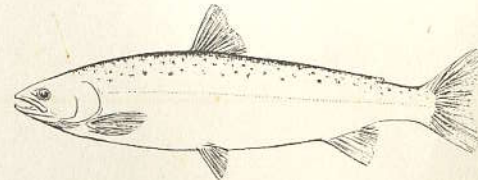
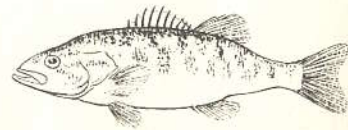
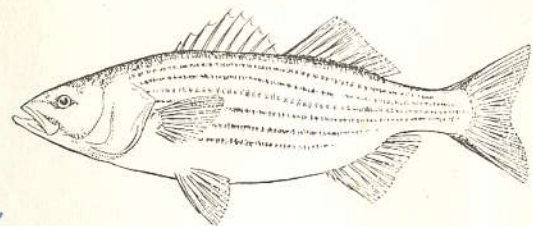
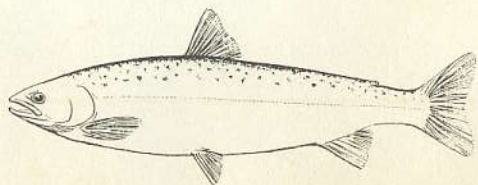
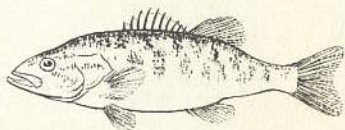
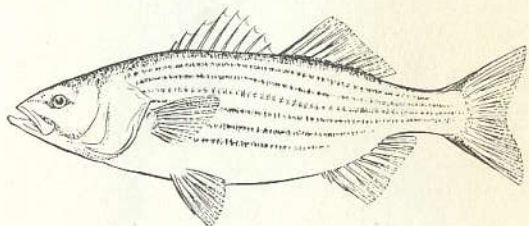


fish management in the  
**kennebec**  
**river**



MAINE DEPARTMENT OF INLAND FISHERIES AND GAME  
FISHERIES RESEARCH BULLETIN No. 8

FISH MANAGEMENT  
in the  
KENNEBEC RIVER

by

Robert E. Foye, Charles F. Ritzi, and Roger P. AuClair  
Fishery Biologists



Maine Department of Inland Fisheries and Game  
Ronald T. Speers, Commissioner

1969

Published under Appropriation 7750

## TABLE OF CONTENTS

Item	Page
Foreword .....	3
Introduction .....	5
Description of the Drainage .....	8
Freshwater and Anadromous Fishes of the Kennebec River Drainage .....	10
Anadromous Fisheries of the Kennebec River .....	11
History of Anadromous Fisheries .....	11
Present Anadromous Fisheries and their Potential .....	16
Freshwater Sport Fisheries .....	24
Obstructions .....	27
Profile of the Kennebec River .....	28
Pollution in the Kennebec .....	37
Special Problems .....	40
Discussion and Conclusions .....	49
Summary .....	51
Recommendations .....	54
Acknowledgements .....	57
Literature Cited .....	58
Appendix .....	61

## FOREWORD

A state-wide biological study of lakes, rivers, and streams is in progress to obtain facts to help your Inland Fish and Game Department, Atlantic Sea-Run Salmon Commission and Department of Sea and Shore Fisheries maintain and restore the sport and commercial fisheries of our waters. As these studies are completed, they are presented to the citizens of Maine.

This report summarizes the findings of the biological survey of the Kennebec River and its major tributaries from Moosehead Lake, Maine to the Atlantic Ocean.

Major problems relating to the management of freshwater and anadromous fisheries in the river are described and management recommendations are discussed.

LYNDON H. BOND, Chief  
Fishery Research and  
Management Division

Maine Department of Inland Fisheries and Game  
January, 1969



"Fast Water" in East Outlet of Moosehead Lake

## INTRODUCTION

Kennebec is an Indian name meaning "long quiet water." Fannie Hardy Eckstorm (1941), an authority on Maine Indian names, lists several spellings including Kinibeki, Kinibegui, Cineaque, Quinebequy, Kennebecke, Kennebeke, and Kenebeck. The river takes its name from the long stretch without falls below Augusta. Today, the name might well apply to many other sections of the river, for the Kennebec of our time is quite unlike the Kennebec of the Abnakis. There is little left of the river in its natural state to remind us of the days when Arnold and his troops in 1775 dared to venture up its challenging course in bateaux to battle the British at Quebec. The home of Reuben Colburn in Pittston near Agry's Point where Arnold's 200 bateaux were hastily built, and old Fort Western at Augusta which Arnold visited at the onset of his long, arduous journey are now historical landmarks. Still intact are some of the remains of Fort Halifax which was built during the French and Indian Wars near the junction of the Kennebec and Sebecook. But the Kennebec itself has suffered the same destructive changes as the Androscoggin, the Saco, the Penobscot, and the St. Croix, all because of man's greed and misuse.

"Kennebec salmon" still appear on exclusive menus to remind us of the time when salmon in countless numbers ascended the Kennebec to reach their spawning grounds. Now the great runs of salmon are gone; so are the shad, and only token runs of alewives enter the Kennebec each spring to spawn.

Historical references tell us of the Indians who lived along the shores of the river and of the exploits of hardy men and women who built homes on its banks a few hundred years ago. Vast wealths of natural resources were everywhere in those days, and our ancestors began early to exploit these riches. In doing so, they did many things that adversely affected our fish and wildlife.

The Abnakis who lived on the shores of the Kennebec fed upon the fish that thrived in its waters. Fish were plentiful and in no danger from the Indians. To blame them for the deplorable conditions that exist in the Kennebec today would be a grave injustice.

With the passing of the Indians in the relatively short period of time since the coming of our forefathers, we have also witnessed the passing of the river's valuable anadromous fishery resources. In the early days, the white man built dams which destroyed many of the river's natural characteristics. Shallow areas of quick water and natural falls along the main river were changed into long, deep impoundments stretching from the head of tide at Augusta nearly to Moosehead Lake. The shallow riffle areas which were destroyed were the spawning and nursery areas so vital to the continued existence of salmon and shad. Many of the major tributaries of the Kennebec suffered the same fate.

For many years, the waters of this vast drainage have been used as dumping grounds for a great variety of pollutants. Many of the pollutants are complex and it is difficult to determine their exact identity or how they adversely affect fish and other aquatic life. The present deplorable conditions of the waters of the Kennebec are nothing new, for the Fish and Game Commissioners wrote in 1889: "*The Kennebec salmon of world-wide fame were nearly exterminated by the Sprague Dam at Augusta preventing the access of the fish to their spawning ground for some eight years. Of course within that period all the parent fish were destroyed, while the small contribution of fry to the upper waters of the river from our scanty means has been neutralized by sawdust and edgings, and the refuse of villages and factories on their shores. Let anyone explore the river from Waterville to Augusta in summer. It more resembles the water of a neglected wood-yard than a river.*"

At the same time that our early Commissioners began complaining about pollution and noticeable declines of fish in the Kennebec, another grave mistake was made. Some of our ancestors, remembering how their families had raised carp in private ponds in the "old country", encouraged the federal government to bring carp to this country. Maine folk got their fair share and carp were stocked at one time or another in 15 of Maine's 16 counties. Most carp introductions were unsuccessful, but some of the fish became established in the tidal waters of the Kennebec. Many years later, biologists and sportsmen recognized the serious error that had been made. Fortunately, the Augusta dam prevents these most undesirable fish from entering the waters of the Kennebec drainage above tidewater.

Today, fish management in the Kennebec River is a difficult and complex problem. By necessity, it becomes a part of the multiple-use concept of river management. Nevertheless, one fact stands out above all others: *little has ever been done to improve conditions in the Kennebec to make it suitable for fishing and other recreational uses.*

Mere recognition of the problems in the Kennebec will not solve them. Man has been talking about most of the same problems for over a hundred years now. The cost of pollution abatement in the Kennebec will be extremely high, because the citizens of Maine lacked the foresight and willingness to do anything about these problems years ago except to talk about them. Today, we are still willing to do little more than talk about the same problems.

This report depicts conditions that presently exist in waters of the Kennebec drainage and how they affect the management and potential of this river for fish.

## DESCRIPTION OF THE DRAINAGE<sup>1</sup>

The Kennebec River arises in Moosehead Lake in Piscataquis and Somerset counties, in west-central Maine. The east and west branches from Moosehead Lake converge at Indian Pond a few miles southerly, and from Indian Pond the river continues a southerly course some 138 miles to the head of Merrymeeting Bay at Abagadasset Point, several miles above the city of Bath. Here, after joining the waters of the Androscoggin River and several small coastal streams, it continues for 20 more miles to its confluence with the Atlantic Ocean south of Hunniwell Point in Sagadahoc County. Head of tide is at Augusta, the site of the first obstruction on the river.

The Kennebec River basin, which is more than 75 miles wide at its widest point, drains approximately 6,000 square miles, one-fifth the total area of the state. Many streams and lakes occupy depressions between mountains rising 1,500 to 3,000 feet above them.

Central areas are characterized by lowlands and rolling hills with the lower third of the basin less than 100 feet above sea level. Much of the basin is forested. Croplands, located in the lower half of the basin, account for 8.5 percent of the land in the drainage. Lakes and ponds cover about 5 percent of the surface of the basin.

The Kennebec River from Moosehead Lake to Augusta falls a little over 1,000 feet over a distance of 120 miles, an average gradient of 8.5 feet per mile.

Major tributaries of the Kennebec River Basin below Moosehead Lake include the Dead River, Austin Stream, Carrabassett River, Sandy River, Sebasticook River, Messalonskee Stream, and Cobbosseecontee Stream. Numerous smaller tributaries enter the Kennebec along its course.

A brief description of major tributaries follows.

### *Dead River*

The main stem of the Dead River originates at Flagstaff Lake in Franklin and Somerset counties at the confluence of the north

and south branches of the Dead River. It flows in a northerly direction for eight miles to the confluence with Spencer Stream and then easterly 15 miles to join the Kennebec River at The Forks. It drains an area of nearly 900 square miles and has a total fall of 570 feet.

### *Austin Stream*

Austin Stream arises in Austin Pond and flows southwesterly 15 miles to its confluence with the Kennebec River at Bingham. It has a drainage area of 92 square miles and a fall of 840 feet.

### *Carrabassett River*

The Carrabassett River, formed by the junction of Huston Brook and the south branch of the Carrabassett River in Franklin County, follows a southeasterly course for nine miles to its junction with the west branch Carrabassett in Kingfield. Here it continues southeasterly for 6 miles and then easterly 16 miles to join the Kennebec River at North Anson. The Carrabassett River has a drainage area of 400 square miles and a total fall of 2,483 feet. More than 1,800 feet of the fall in the Carrabassett occurs in an 11-mile stretch of the south branch.

### *Sandy River*

The Sandy River arises at Sandy River Ponds, Franklin County, and flows southeasterly for 44 miles to Farmington Falls, and then northeasterly about 25 miles to its confluence with the Kennebec River at Starks, 2.5 miles below the villages of Madison and Anson. The Sandy has a total drainage area of 593 square miles and a total fall of about 1,544 feet.

### *Sebasticook River*

The West Branch Sebasticook River arises in Great Moose Lake (Maine Stream Pond), Somerset County and flows in a southeasterly direction for about 19 miles to its confluence with the East Branch at Detroit.

The East Branch arises in Lake Wassookeag, Penobscot County, and follows a general southerly course for 12 miles to Sebasticook Lake. From Sebasticook Lake, it continues in a southerly direction for 12 more miles to its confluence with the West Branch. From the confluence of the East and West Branches,

<sup>1</sup> Extracted, in part, from the 1954 report of the New England - New York Inter-Agency Committee entitled "The Resources of the New England - New York Region." Part Two, Chapter VI, Kennebec River Basin, Maine.

the river flows southwesterly nearly 30 miles to its confluence with the Kennebec River in Winslow.

Total fall in the West Branch is approximately 140 feet; the East Branch has a total fall of 253 feet. A fall of approximately 130 feet occurs between the confluence of both branches at Detroit and the Kennebec River. The Sebasticook River and its tributaries has a drainage area of 950 square miles and is the largest sub-drainage.

#### *Messalonskee Stream*

Messalonskee Stream arises in Messalonskee Lake, Kennebec County. It flows northeasterly for nearly 4 miles and then southeasterly 5.5 miles to its mouth on the west side of the Kennebec River in Waterville. Total fall below Messalonskee Lake is approximately 200 feet. Several large lakes and ponds and their tributaries, known as the Belgrade Chain of Lakes, are located in this watershed. Messalonskee Stream has a drainage area of 210 square miles.

#### *Cobbosseecontee Stream*

Cobbosseecontee Stream arises in Cobbosseecontee Lake, 5 miles west of Augusta. Numerous lakes and ponds occur in this drainage. This stream flows from Cobbosseecontee Lake south and east for 9 miles to Pleasant Pond and then northeast for 8 miles to its mouth at the Kennebec River at Gardiner, 6 miles below Augusta. Total fall from Cobbosseecontee Lake to mean tide level at Gardiner is approximately 163 feet. Cobbosseecontee Stream has a drainage area of 240 square miles.

#### FRESHWATER AND ANADROMOUS FISHES IN THE KENNEBEC RIVER DRAINAGE

Common Name	Scientific Name
Sea Lamprey	<i>Petromyzon marinus</i>
Atlantic Sturgeon	<i>Acipenser oxyrinchus</i>
Blueback Herring	<i>Alosa aestivalis</i>
Alewife	<i>Alosa pseudoharengus</i>
American Shad	<i>Alosa sapidissima</i>
Lake Whitefish	<i>Coregonus clupeaformis</i>
Round Whitefish	<i>Prosopium cylindraceus</i>
Rainbow Trout	<i>Salmo gairdneri</i>
Atlantic Salmon	<i>Salmo salar</i>
Landlocked Salmon	<i>Salmo salar</i>
Brown Trout	<i>Salmo trutta</i>
Brook Trout	<i>Salvelinus fontinalis</i>
Lake Trout	<i>Salvelinus namaycush</i>

American Smelt  
Chain Pickerel  
Northern Redbelly Dace  
Finescale Dace  
European Carp  
Lake Chub  
Golden Shiner  
Common Shiner  
Blacknose Shiner  
Fathead Minnow  
Blacknose Dace  
Longnose Dace  
Creek Chub  
Fallfish  
Pearl Dace  
Longnose Sucker  
White Sucker  
Brown Bullhead  
American Eel  
Banded Killifish  
Mummichog  
Burbot  
Brook Stickleback  
Threespine Stickleback  
Ninespine Stickleback  
White Perch  
Striped Bass  
Redbreast Sunfish  
Pumpkinseed Sunfish  
Smallmouth Bass  
Largemouth Bass  
Yellow Perch  
Slimy Sculpin

*Osmerus mordax*  
*Esox niger*  
*Chrosomus eos*  
*Chrosomus neogaeus*  
*Cyprinus carpio*  
*Hybopsis plumbea*  
*Notemigonus crysoleucas*  
*Notropis cornutus*  
*Notropis heterolepis*  
*Pimephales promelas*  
*Rhinichthys atratulus*  
*Rhinichthys cataractae*  
*Semotilus atromaculatus*  
*Semotilus corporalis*  
*Semotilus margarita*  
*Catostomus catostomus*  
*Catostomus commersoni*  
*Ictalurus nebulosus*  
*Anguilla rostrata*  
*Fundulus diaphanus*  
*Fundulus heteroclitus*  
*Lota lota*  
*Eucalia inconstans*  
*Gasterosteus aculeatus*  
*Pungitius pungitius*  
*Roccus americanus*  
*Roccus saxatilis*  
*Lepomis auritus*  
*Lepomis gibbosus*  
*Micropterus dolomieu*  
*Micropterus salmoides*  
*Perca flavescens*  
*Cottus cognatus*

#### ANADROMOUS FISHERIES OF THE KENNEBEC RIVER

##### History of Anadromous Fisheries

The Kennebec once supported very large runs of anadromous fish. Atlantic salmon, shad, and alewives once ascended the Kennebec and some of its tributaries nearly to their headwaters.

Foster and Atkins, Maine's first Fish and Game Commissioners, realizing the fisheries potential of the Kennebec drainage, wrote in 1867: "*The Sebasticook is a tributary of the first rank. It is the outlet of many lakes and ponds of which the principal are China Lake, Unity Lake, Moose Lake, and Newport Lake, having an area of 4,000 acres each. This characteristic rendered it principally an alewife river, and of those fish it produced immense numbers. It also yielded a great many shad, and some salmon. The most fish were taken in the town of Clinton, now Benton, and the town was vested with the right to take the fish by their agents, a fish committee, subject to*

certain conditions. Great quantities were sold to strangers, the ordinary price being twenty-five cents a hundred."

Foster and Atkins wrote in 1868: "The dam at the upper falls at Clinton was built before the war of 1775, but a gap for fish was left in it. About 1809 a dam was built at the lower falls twelve feet high, with no fishway. It stood five or six years, and in that time had so impoverished the fisheries that the selectmen cut it away, and allowed the fish to ascend to their breeding grounds. The town in 1814 obtained the act authorizing them to control the fisheries, and the first year after cutting away this dam the fishery was leased for two or three years."

Foster and Atkins also wrote: "The Kennebec is formed by many tributaries of diverse character. Some are the outlet of extensive systems of lakes; some are sluggish lowland streams; and some come down from the mountains. Among the former are the Cobbossee Contee, the Messalonskee, and the Sebasticook; among the latter are the Sandy River and Carrabassett. It [Kennebec] has itself a broad, gentle current for many miles before reaching the tide, broken, in its natural state, by a few rapids; and its fresh waters rise and fall with the tide for thirty miles before they mingle with those from the sea. It is, therefore, well fitted, in some of its parts, to produce all kinds of fish that dwell in this latitude. It has breeding grounds for salmon in its own bed, and in most of its tributaries above Richmond, particularly in the Sandy, Carrabassett and Dead Rivers, and in a multitude of small streams entering its upper portion; for shad in all the tidal portions, and the main river as far as they choose to go, in the tidal tributaries like Cathance River, and the Sebasticook and lower Sandy; for alewives in all those parts allotted to the shad, and in all the lakes and ponds to which they might be introduced . . . . At the present time, however, the salmon is suffering from neglect and persecution. So peculiarly is it exposed to the attacks of man, so greedy and relentless has been the pursuit and so regardless of their necessities has been the management of the waters, that in many rivers, both in Europe and America, it has become utterly extinct, and in very few of the remainder does it yield anything like the number it was wont."

By the late 1700's several dams already obstructed fish migration on the Kennebec and its tributaries. Fishways or other

provisions for fish passage were provided in some of these dams, but many of the earlier dams were swept away by spring freshets and, when rebuilt, were made larger and stronger. However, fishways were not reconstructed in most of the newer dams.

Kendall wrote in 1935: "In its original condition the Kennebec was scarcely surpassed by any salmon river in the country. Atkins stated that it was the second in the State of Maine in the number of salmon yielded by its fisheries, and in the facilities afforded for their reproduction. No serious natural impediments existed to their ascent of the main river as far as Caratunk Falls, in the town of Solon. At this point there is a precipitous fall, 16½ feet high, which was a serious hindrance to them but not impassable. In the days of their abundance the main fisheries for salmon were within 20 miles of the mouth of the river, at Waterville 60 miles above the mouth, and at Caratunk Falls. It was easy for two men to load a boat with salmon here in a day. At Waterville, just below Ticonic Falls a large number of drift nets were plied every season. As many as 82 have been counted at work at one time; but the average was not over forty. They took several thousand salmon in a season. Other drift net fisheries existed at Augusta and various other points on the river. The fisheries near the mouth of the river were carried on with set nets and weirs, the former coming into use much earlier than the latter. No exact statistics of their catch have been obtained. The use of nets was not confined to the river. Several were set quite outside its mouth on Hunniwell's Beach. At Cape Small Point, six miles west of the river, there were several nets set and one trap or ground-net was still in use at Baldhead, for the taking of various species, among which salmon accounted as of considerable importance. The salmon fisheries of the Kennebec were in flourishing condition in 1873<sup>2</sup> when the dam in Augusta was completed. For a few years they continued plenty, and then rapidly declined until they almost disappeared. The drift net fishery at Augusta was for some years abandoned because of the scarcity of salmon. The decade from 1850 to 1860 is generally believed to have been the period of greatest scarcity. In 1866, 1867, and 1868 there was a marked increase, the last year being by far the best since 1850. After that there was another decline, 1870

<sup>2</sup> It is apparent that this date is incorrect; the Augusta dam was built in 1837.

and 1871 being poor years. In 1872 and 1873 there was another increase which far surpassed that of 1868. It was also remarked on the Kennebec as on the Penobscot that the salmon of 1873 averaged uncommonly large. The Maine Sportsman (Anonymous 1894, p. 17) mentioned that a 12-pound salmon, taken near the hospital wharf in Augusta by a drift net in August was the first salmon taken so far up the river in several years.

A letter dated January 14, 1918, from James Derocher, then superintendent of the Craig Brook salmon hatchery, to the United States Commissioner of Fisheries said in part: "I was informed by past Commissioner Austin that a very large school of Atlantic salmon was seen below the tidewater dam in the Kennebec River, at Augusta, Maine. This was during 1917, and the Commissioner's attention was called to the fact that people were spearing fish in the river. Several arrests were made and it was found that the fish in their possession weighed from 12 to 19 pounds. Mr. Austin informed me that this was the first time in 25 years that Atlantic salmon have been seen in the Kennebec River."

The Kennebec River once supported the principal shad fishery in Maine. Foster and Atkins in 1868 related that the natural limit of shad ascending the Kennebec River was Norridge-wock Falls. In 1867, they indicated that a part of the Kennebec shad run ascended the Sandy River as far as the town of Farmington. According to our early Commissioners, the Sandy River maintained an excellent shad fishery for some years after a dam was built at New Sharon in 1804 which limited the fish to the lower part of the river.

Atkins in 1889 mentioned that the lower part of the Sebasticook River had a profitable shad fishery, and the fish were reported to go up this river as far as the town of Newport.

North (1870) wrote: "The event having a major effect on the fisheries of the Kennebec was the construction of the dam at Augusta which closed the entire runs above tidewater. The Maine Legislature was petitioned in January, 1834, for incorporation to build a dam, and an act incorporating the Kennebec Dam Company was approved March 7, 1834. The bill provided

for a fishway but the provision for a fishway was ignored when the dam was built in 1837."

This dam was breached by freshets in 1839, 1855, and 1870, according to Atkins. In 1898, a fishway was built and located at the eastern end but did not appear to be used by shad, according to Stevenson (1898).

In 1868, Atkins estimated the shad catch from records of fish inspected in the Merrymeeting Bay area, for the years 1830-1836, at 1,000 barrels totalling 120,000 shad per year, and the estimated catch for the whole Kennebec at 225,000 fish. Stevenson (1898) wrote: "The greatest injury to shad in the Kennebec other than fishways has been the vast quantities of sawdust run into the river from numerous sawmills."

Foster and Atkins (1868) wrote of the alewives of the Kennebec drainage: "Cobbossee-Contee Stream is a second-rate tributary, draining 21 ponds with a water surface of 13,000 acres. It must have been an excellent breeding ground for alewives. We know that at a very early date salmon and shad ascended the stream, as well as alewives. But these waters were long ago closed by a dam at Gardiner. In the old records for the town of Monmouth, then called Wales, we find that in 1787, a 'fish committee' was chosen consisting of three men; and in 1788 they are styled Committee to see that the fishways are kept open according to law. They were appointed a committee to obtain the opening of a fishway through the dam at Gardiner. But they were unsuccessful, reporting on one occasion that Squire Gardiner refused to do anything about it. The stream is now obstructed by dams at Gardiner to such an extreme as to render the opening of the upper waters to fish a considerable undertaking.

The Seven Mile Brook is a very important stream although in size only third rate. It drains several ponds and these formerly produced great quantities of alewives. There are several dams on the stream which would require fishways should the alewives be restored."

Ernest E. Marriner wrote in 1954: "One of the most important events that ever occurred on our river was the building of the dam at Augusta; it was completed in 1837, . . . The dam had a double purpose: to provide power for sawmills and other

factories and to create a pond, holding back sufficient water to operate the locks of a short canal. It was the latter cause which pushed the project to completion.

Of unquestioned benefits to Augusta, the dam was soon viewed with mixed emotions by the inhabitants above Cushnoc rapids. It made possible ship passage to Waterville, without changing to the longboats; for a time, it dignified Waterville as the head of navigation. But people soon learned that many a gain is accompanied by compensating loss. The very dam and lock that brought the ships stopped the fish; no longer would the settlers at Getchell's Corner and Winslow and even up the Sebasticook to Benton Falls, put out their seines for the spring runs of salmon, herring, and shad. After 1837 only an occasional and very venturesome fish worked his way through the lock and up past Coons Rips. Now the boats too are gone, but not because of the dam. For more than half a century after William Boardman drew his plans for the dam at Augusta, boats continued to come up the river to Ticonic Falls, but the salmon and the shad came up no more."

## Present Anadromous Fisheries and Their Potential

### Atlantic Salmon

Atlantic salmon have all but vanished in the Kennebec. Occasionally, but not every year, a few sea-run salmon are still seen near the Augusta Dam, but only rarely today is a sea-run Atlantic taken by anglers in the Kennebec. Sometimes, land-locked salmon wander down the river from their haunts in upper parts of the drainage and are mistaken for sea-run fish.

Biological studies show that small numbers of young Atlantic salmon are still produced in Togus Stream, a tributary of the Kennebec River below Augusta. These young salmon are frequently mistaken for small trout by uninformed anglers. We have no knowledge of natural populations of Atlantic salmon existing today in other waters of the drainage.

Atlantic salmon spawn in October and November in fresh, flowing water, usually well upstream from the sea. The female salmon must find a bed of suitable gravel where she digs a nest or 'redd', as it is frequently called. The eggs are deposited in several depressions in the redd, and the eggs are covered with

gravel. Mud and sand bottoms are unsuitable for salmon spawning.

Salmon eggs hatch in the spring, and the young salmon work their way up through the gravel. At emergence, the tiny salmon scatter, feeding on small insects over the same bottom in which they hatch; soon the young fish move to areas of a different bottom type, mainly areas composed of larger rocks, boulders, and ledge outcroppings, typically referred to as salmon nursery area. Here they live for two and sometimes three years.

In May or June of their second and third year of life, young Atlantic salmon undergo a change called *smoltification* and migrate downstream to the ocean. In the ocean, they grow rapidly and after 1-3 years return to their home river to spawn. Salmon which stay at sea for only one year are known as grilse.

In Maine returning salmon may enter our rivers in early spring. Between spring and spawning time in the fall, salmon rivers must provide deep pools which serve as resting areas. Water temperature must also be within the tolerance levels of this species.

A more detailed description of the life history of the Atlantic salmon is found in the publication *Fishes of Maine* (Everhart, 1966) available from the Maine Department of Inland Fisheries and Game, Augusta, Maine.

Canadian and Maine biologists (Elson, 1957; Meister, 1962; and Cutting, 1967) have shown that for each 100 square yards of salmon nursery area, only one to two salmon smolts are produced. Smolt production varies, depending on kinds and numbers of competitive species present, predation by birds, fish, and mammals, water temperatures, and stream flow, the latter having a considerable influence on salmon production in our rivers and streams. The effect of stream flow on salmon production is discussed in more detail later in this report.

In estimating actual smolt production, calculations must take into account the loss of smolts over and through dams during downstream migrations to the sea. Sizable smolt losses may occur at dam sites, particularly hydro-electric installations. Such losses may range from 10 to 20 percent of the salmon smolts at each installation.

River returns of adult salmon from smolts seldom exceed 5 percent. Returns ranging from 1 to 2 percent are normal for the salmon streams of Maine and Canada.

With a knowledge of the amount of salmon nursery area in a drainage and an understanding of the factors affecting stream survival of juvenile salmon and the returns expected, we can estimate the salmon potential of our rivers.

Table 1 summarizes the potential salmon nursery area in the Kennebec drainage as it now exists. Potential smolt production for the entire Kennebec drainage, based upon a production of 1 to 2 smolts per 100 square yards of nursery area, would vary from 137,225 to 274,450 smolts annually. The expected number of salmon smolts reaching the sea will be significantly reduced by losses incurred at many of the dams during their downstream migrations. The number of salmon smolts that would reach the sea after downstream losses at each dam are deducted, is estimated to lie between 29,590 and 129,225 fish. Expected number of adults returning to the river based upon a 1 to 2 percent sea survival is estimated at between 296 to 2,584 fish annually.

Nursery area in the drainage above Solon provides a potential for adult fish of between 93 and 1,062 individuals, some 31 to 41 percent of the entire potential of the river.

Seven major obstructions without fish passage facilities are located on the main Kennebec below Solon. Dams at Solon and those impounding Wyman Lake and Indian Pond compound the problem of Atlantic salmon restoration in the Kennebec.

Angler harvests of Atlantic salmon in Maine rivers normally vary between 15 and 25 percent of the run. From the estimated adult returns to the Kennebec, we estimate a potential rod catch of from 44 to 646 fish annually, if the full present potential of the river could be realized.

Table 1. Summary of Atlantic Salmon Nursery Area Potential in the Kennebec Drainage.

	Square Yards
Kennebec River—Harris dam to The Forks	305,000
Kennebec River—The Forks to Wyman Lake	2,200,000
Dead River	2,963,700
Austin Stream	82,138

Kennebec River—Wyman Lake to Solon	1,173,300
Kennebec River—Solon to Madison	1,760,000
Carrabassett River	1,985,980
Sandy River	1,730,400
Kennebec River—Madison to Skowhegan	117,000
Kennebec River—Skowhegan to Shawmut	291,532
Wesserunnett Stream	457,626
Carrabassett Stream	43,266
Martin Stream	64,202
Bond Brook	17,600
Eastern River	2,932
Togus Stream	95,777
Seven Mile Brook	14,100
China Lake Outlet	30,800
Pattee Pond Stream	5,866
Twenty-Five Mile Stream	29,333
Sebasticook River to Old Power Dam in Burnham	263,999
Sebasticook River (East Branch)	52,799
Martin Stream (Sebasticook Drainage)	35,200
<b>Total</b>	<b>13,722,550</b>

### Alewife

Adult alewives move up our rivers from April through June and enter lakes and ponds to spawn. Some spawning takes place in deadwater stretches of the larger rivers and streams. Alewives spawn in small schools by broadcasting their eggs. There is no parental care. The eggs hatch in a few days, and the young alewives spend part of their first summer in the waters in which they hatch. The young migrate to sea between July and December of their first year. After 3 to 5 years, they mature and return to fresh-water to spawn. Studies in Maine have revealed that many alewives return to spawn a second or third time. One female alewife may produce up to 100,000 eggs in a single spawning season.

In recent years, the alewife has become an increasingly important anadromous fish in Maine. Town-controlled alewife fisheries in several of Maine's coastal drainages currently yield from \$1.00 to \$5.00 profit per acre of available spawning area. Speaking of the Kennebec, Baird<sup>3</sup> wrote in 1964:

“The alewife fishery within this area is by law, regulated by the towns in most cases. Such towns as Woolwich, Phippsburg, Arrowsic, and West Bath annually harvest

<sup>3</sup> Personal communication from F. T. Baird, Maine Dept. of Sea and Shore Fisheries, Augusta, Maine.

the fish and derive income therefrom. The income for Woolwich and the landings for Sagadahoc County are reported below:

Year	Woolwich	Sagadahoc County (pounds)
1962	\$1300	82,390
1961	\$1100	147,700
1960	\$1110	204,750
1959	\$1100	184,800
1958	\$ 860	499,730

Baird states:

"The landings listed above or the income from landings represents in no way the total production of alewives within this area. Some areas are leased or fished, but no figures are kept. Other areas are fished by persons seeking fish for food or bait, and, though the fishery is erratic, a considerable poundage is harvested. These would include such areas as Dresden Bog outlet, Nehumkeag Brook, Eastern River, Abagadasset River, and Cathance River. It is believed that this estuary under proper management is capable of supporting a considerable fishery for alewives and other species if only to be used as lobster bait and fish meal."

In addition to the commercial aspects, young alewives serve as a forage fish for game fish and may act as a buffer to predation on the young of more desirable game fishes.

Lakes and ponds in the Kennebec drainage provide an extremely large potential for alewives. Many of them were once the spawning grounds for this species, but dams built in early times destroyed most of the runs. The alewife fisheries that exist today are maintained by fish which spawn in a small number of lakes and ponds and deadwater areas of the river and several tributaries in the drainage below Augusta.

#### Smelt

Baird (*op. cit.*) described the current status of the smelt fishery in the lower Kennebec estuary as follows:

"The smelt resources of the Kennebec estuary, though not great, are considerably greater than the values attributed

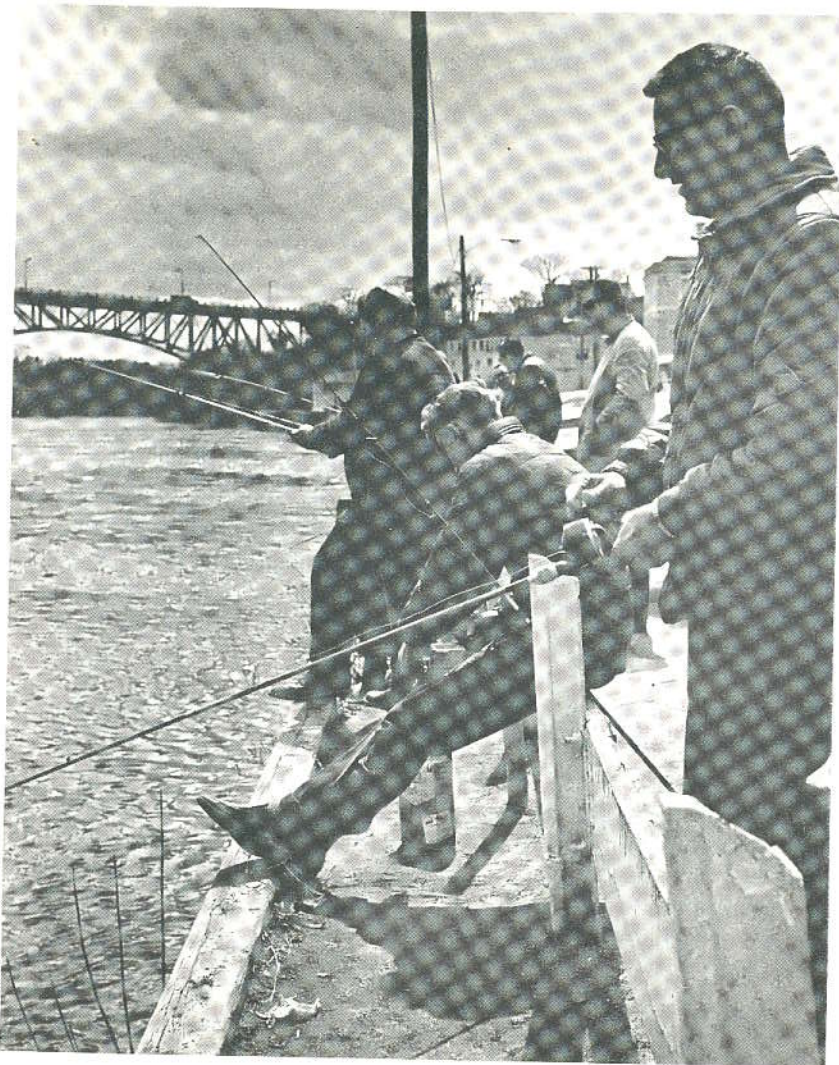
to them by the figures listed below and taken from annual commercial landings for Sagadahoc County.

Year	Sagadahoc County Pounds
1962	6,947
1961	1,447
1960	5,100
1959	4,275
1958	4,838

These landings reflect only those fish purchased by wholesale dealers for resale or those fish offered for interstate transportation and reported by the carrier. The fishery for smelts in this area is largely a hook and line, shanty fishery through the ice, or a dip net fishery in the spring. It is the experience of this author that probably less than half the total landings are even reported as such, as many of them are used for home consumption or offered as door to door sales which are never recorded.

So far, we have considered only the commercial aspect of this fishery, which reflects probably the smaller half of the total landings of smelt in this area. Though the smelt is available almost year round, the greater fishing activity is experienced during the winter and spring months when they are taken through the ice or dipped on the spawning grounds. While part of this winter take may appear in recorded landings, much is not, and neither are there any recorded or available income figures for shanty rental in such areas as the Sasanoa, Eastern River Breakwater, Bowdoinham, and Dresden. These colonies exist solely because of the smelt fishery and very probably derive a considerably greater value from rentals than they would on a price per pound of the smelts caught therein. It therefore appears safe to say that the recorded landings are small."

Each spring since the middle 1960's, anglers have experienced an early spring hook and line fishery for smelts along the west shore of the Kennebec opposite Fort Western in Augusta. Spawning runs of smelts have appeared close to shore and have attracted numbers of smelt anglers. This fishery, probably



Spring Smelt Fishing at Augusta

unique at this time, is reminiscent of times when the Kennebec also supported large runs of other anadromous species.

#### *Shad*

The Kennebec was once noted for its shad runs. This species is only rarely taken today in lower parts of the river below

Augusta. The life cycle of the shad is similar to that of the alewife, but the shad spawns in slow-moving waters of rivers and streams over sand and gravel riffle areas. Unlike the alewife, the American shad is noted for its reluctance or inability to use fish passage facilities, and access to and from spawning grounds is necessary to the maintenance of a good shad run.

Taylor (1951) concluded: "*The disappearance of shad from the rivers and streams of Maine was almost entirely a result of their exclusions from spawning areas by dam construction. The major exception to this was the lower Kennebec River where a shad fishery existed for many years following the closing of the river at Augusta in 1837. The eventual disappearance of shad below Augusta is believed to have been caused by industrial pollution, resulting first in wiping out the fishery just below Augusta and eventually extending to the Merrymeeting Bay area, the principal shad-producing district of the river. Industrial pollution from the Androscoggin coming from textile and paper mills, has an extensive influence in Merrymeeting Bay and possibly is carried up the Kennebec by tidal action as far as Richmond. This pollution appears to have destroyed the fishery in the lower Androscoggin below Brunswick as early as 1884. While probably an important factor in the decreases occurring in Merrymeeting Bay about 1906, no direct evidence supporting this conclusion is available.*"

Taylor (*op. cit.*) stated: "*Three rivers with former shad runs appear suitable for stocking when and if such a measure is contemplated. They are, in the order of their suitability, the Eastern, the Cathance, and the Abagadasset. The Abagadasset is considered the least suitable because of the small volume of fresh water entering its tidal portion, because it does not offer much sand bottom, and because it is subjected to possible tidal inflow of pollution coming from the Androscoggin. The Cathance River in its upper part is probably free from the influence of the Androscoggin and has a good proportion of sand and gravel bottom. The inflow of water from its drainage area is about equal to that of the Eastern River. The Eastern River not only has a greater area of sand and gravel bottom than the Cathance but is probably beyond the influence of water from the Androscoggin.*"

Information on the present shad potential of the Kennebec is presently unavailable. Further studies are necessary to provide this information.

### *Striped Bass*

Of striped bass, Bigelow and Schroeder wrote in 1953: "*Information as to the status of bass for the coastline and streams of northern and eastern Maine, past or present, is scant, and we have come to suspect that bass may never have been as plentiful there as was supposed. A few are caught here and there around Casco Bay in good years, product perhaps of the Kennebec. But the estimated catch in the Kennebec was only about 12,760 pounds as far back as 1880, and there have been far fewer bass there of late years. Our most recent information is that schools of large fish were seen in the lower Kennebec, off Popham and Reed beaches in early October, 1950, with some caught up to 26 pounds, and that a few were being taken daily in late June, 1951. Nearly as many were taken in the Sheepscot, formerly, as in the Kennebec; the present condition is not known.*"

A sport fishery for striped bass in tidal waters of the Kennebec River below the City of Augusta has grown in popularity during the past several years. Baird (*op. cit.*) states:

"Since 1960 the striped bass fishery in the Kennebec estuary has become increasingly publicized. Prior to this period a few fish were taken annually by those who were aware of their token existence. However, with the increase in coastal sport fishery activity, boating, etc., the interest in this species has increased to the point where such areas as Popham, the area between Bath and Merrymeeting Bay, the Eastern River, and the mouth of Cobbossee Stream are daily haunts of striped bass fishermen. No catch records are available but indications based on occasional creel checks and fishing intensity indicate a considerable landing for this species."

## FRESHWATER SPORT FISHERIES

A large variety of freshwater fish live in waters of the Kennebec drainage. Coldwater species predominate in the upper

parts of the drainage while natural populations of warmwater species prevail throughout its lower sections. The stocking of coldwater species is judiciously employed in many waters which lack facilities for natural reproduction.

### *The Main River*

The East Outlet dam at Moosehead Lake has been a popular fishing site for many years. Anglers gather here especially when the lake is rough or in the evening for a last try before dark. Large numbers of salmon, trout, and togue are caught from the dam during the open-water fishing season.

Early in the spring, a specialized fishery for salmon occurs from the dam to the highway bridge a short distance below. This flurry begins early in May and lasts approximately 10 days. The success of this fishery depends upon the discharge pattern of the water through the East Outlet dam at this time.

Another fishing site is at the foot of Low Falls near Indian Pond. Here there is a deep pool where some large trout and salmon are caught. The remainder of this stretch of the river is fished only occasionally. It is difficult for anglers to wade or hold a canoe when there is 2000 cubic-feet-per-second or more of water flowing down this rocky stretch of river. There are few pools where large fish can concentrate, and the very size and swiftness of the water is discouraging to most anglers.

Indian Pond, impounded by Harris dam, contains fishable populations of lake trout, salmon, and brook trout while fishable populations of salmon and brook trout occur along the main stem of the Kennebec River between Indian Pond and Wyman Lake.

Chain pickerel thrive in Wyman Lake, and most flowages below Wyman Lake. Pickerel are not found in the drainage above Harris dam.

Rainbow trout were introduced into the Kennebec River above Solon in 1933. The river and some of its tributaries between Solon and Caratunk now contain small fishable populations of naturally-spawned rainbows.

Largemouth bass do not occur in the Kennebec drainage above Madison, and smallmouth bass and white perch are not found in the drainage above Solon.

The fishery resources of the Kennebec below Madison are more diverse than those in upstream areas. Warmwater fish prevail in the impoundments throughout the middle and lower reaches of the river and the major tributaries above tidewater.

Landlocked salmon are occasionally harvested in small numbers in lower parts of the Kennebec River. A few are caught each year near Shawmut dam in Fairfield and Benton and occasionally further down river. These salmon represent downstream migrants from more heavily populated areas in upstream sections of the drainage.

#### *Tributary Streams*

The North and South branches of the Dead River, inlets of Flagstaff Lake, contain natural populations of brook trout although some hatchery-reared trout are stocked to supplement natural stocks. Chain pickerel and yellow perch thrive in Flagstaff Lake.

Natural populations of landlocked salmon and brook trout inhabit the Dead River below Flagstaff Lake. A few rainbow trout are occasionally angled from its lower reaches.

Brook trout are found in the upper reaches of the Carrabassett River although unstable water flows are a deterrent to maximum trout production above the village of Kingfield.

In recent years, a small fishery for landlocked salmon has developed below the Kingfield dam.

Lower sections of the Sandy River below Farmington contain populations of smallmouth bass and brown trout while middle sections of this river contain populations of brook trout and brown trout. The brown trout fishery is maintained in part by hatchery plantings. Uppermost areas of the Sandy contain only brook trout.

The Sebasticook River, especially its lower reaches, provide attractive fishing for smallmouth bass. Pickerel and white perch are found in many of the impoundments of both branches of the river. Natural populations of brown trout are established in some sections of the Sebasticook River and a few of its tributaries.

#### *Lakes and Ponds*

The Maine Fish and Game Department has made extensive studies of the lakes and ponds in the Kennebec drainage and lake inventory reports for 286 waters have been published. An index listing them is available.

Brook trout are found in 165 of the inventoried waters; salmon in 31; lake trout in 16; and brown trout in 18. The above species occur singularly or in combinations.

Warmwater game and panfish are widely distributed in lakes and ponds in lower sections of the Kennebec. Smallmouth bass, largemouth bass, chain pickerel, and white perch are abundant and occur in many of the same waters that also support populations of coldwater game fish.

Panfishes including yellow perch, hornpout, and the pumpkinseed and redbreast sunfishes are becoming increasingly popular with some anglers. In recent years, yellow perch have become more widespread in the drainage through the careless and illegal use of perch for bait. This species is a serious competitor of brook trout in waters where it has been introduced.

#### **Obstructions**

From early times, fish passage facilities have been non-existent in nearly all of the major obstructions on the Kennebec River and its major tributaries. Lack of fish passage facilities was responsible for rapid declines in runs of anadromous fish in the drainage following construction of dams. The Augusta dam had devastating effects on the fisheries in the Kennebec, and although facilities for fish passage were for a time provided in this dam, they were far from adequate. The Augusta dam was destroyed by freshets on numerous occasions in the middle and late 1800's with little or no regard given for fish passage when it was repaired or rebuilt.

Eleven major dams now obstruct fish passage on the Kennebec River between Augusta and Moosehead Lake. One or more sizable obstructions prevent upstream fish passage at different locations on all of the major tributaries of the river. Many of the smaller tributaries are likewise obstructed by man-made dams. Most of the larger lakes and ponds and many of the



19	Purgatory Pond, Litchfield	8
20	Togus Stream, Chelsea	10
21	Bond Brook, Augusta	10
22	Seven Mile Stream, Vassalboro	3
23	Seven Mile Stream, Vassalboro	11
24	Webber Pond Outlet, Vassalboro	7
25	Messalonskee Stream, Waterville	45
26	Messalonskee Stream, Waterville	50
27	Messalonskee Stream, Oakland	32
28	Messalonskee Stream, Oakland	50
29	Messalonskee Stream, Oakland	16
30	Messalonskee Lake, Oakland	10
31	Sebasticook River, Winslow	30
32	China Lake Outlet, Vassalboro	9
33	China Lake Outlet, Vassalboro	16
34	China Lake Outlet, Vassalboro	15
35	China Lake Outlet, Vassalboro	4
36	China Lake Outlet, Vassalboro	13
37	China Lake Outlet, Vassalboro	2.5
38	Pattee Pond Brook, Winslow	15
39	Sebasticook River, Burnham	33
40	East Branch Sebasticook River, Newport	13
41	Sebasticook Lake, Newport	8
42	West Branch Sebasticook River, Pittsfield	10
43	West Branch Sebasticook River, Pittsfield	15
44	West Branch Sebasticook River, Hartland	16
45	Great Moost Pond, Hartland	17
46	Martin Stream, Plymouth	9
47	Twenty-Five Mile Stream, Unity	3
48	Carrabassett Stream, Canaan	4
49	Wesserunsett Stream, Skowhegan	15
50	Lower West Branch Wesserunsett Stream, Madison	5
51	Lower West Branch Wesserunsett Stream, Madison	8
52	Wesserunsett Lake, Madison	6
53	Sandy River, Starks, Norridgewock	17
54	Carrabassett River, East New Portland	10
55	Carrabassett River, Kingfield	8
56	Gilman Stream, No. New Portland	8
57	Gilman Stream, No. New Portland	7
58	Austin Stream, Moscow	15
59	Pleasant Pond, Caratunk	5
60	Pierce Pond, Bowtown	5
61	Dead River, T3 R4	35
62	Dead River, T3 R4	2
63	Flagstaff Lake, T3 R4	63
64	Moxie Stream, Moxie Gore Twp.	90
65	Moxie Lake, The Forks, and East Moxie Twps.	19

toration. Obstructions on the major tributaries of the Kennebec are described below. See map for locations.

#### *Cobbosseecontee Stream*

Three dams (No. 13, 14, and 15) with heights ranging from 14 to 36 feet impound the stream in the first mile above its confluence with the Kennebec. An 8-foot stone dam obstructs the stream at Collins Mills (No. 16) in West Gardiner, and a 10-foot stone and concrete dam at the outlet of Cobbosseecontee

Lake in Manchester (No. 17) impounds Cobbosseecontee Lake. Two dams 10 and 8 feet high (No. 18 and 19) are located on the outlet of Purgatory Pond in Litchfield. There are no fishways in this subdrainage.

#### *Togus Stream*

Togus Stream enters tidal waters of the Kennebec in Randolph. The only major obstruction on this small stream is a 10-foot wood and concrete dam (No. 20) which impounds Lower Togus Pond in Chelsea. Salmon spawning and nursery areas in this stream below Lower Togus Pond presently support the only known population of Atlantics in the Kennebec drainage today.

#### *Bond Brook*

Bond Brook flows into tidal waters of the Kennebec at Augusta. The remains of an old, 10-foot high, stone and concrete dam (No. 21) are located a short distance upstream from its mouth. Upstream fish passage is blocked at this point.

#### *Seven Mile Stream*

This stream is the outlet of Webber Pond in Vassalboro. It is of limited importance as a spawning and nursery area for salmon, but Webber Pond and Three Mile Pond are potential spawning sites for alewives.

Three dams obstruct this stream below Webber Pond. The first dam (No. 22) is located a short distance upstream from its mouth. It is of stone construction and 3 feet high and is passable to fish moving upstream at most water levels. The second obstruction (No. 23) consists of the remains of a stone and wood dam nearly 11 feet in height and impassable to fish moving upstream at all water levels. The third obstruction (No. 24) is a 7-foot high, concrete and wood dam which impounds Webber Pond. Upstream fish passage is also prevented by this obstruction.

#### *Messalonskee Stream*

Messalonskee Stream is the outlet of Messalonskee Lake, the lowermost lake in the Belgrade Chain. Five major dams (No. 25, 26, 27, 29, 30) and a 50-foot natural falls (No. 28) completely block upstream fish passage between the Kennebec River in Waterville and Messalonskee Lake. These dams are used in

conjunction with hydroelectric power generation. Anadromous fish have never had access to lakes in the drainage above the 50-foot natural falls in Oakland.

#### *Sebasticook River and Tributaries*

Waters of the Sebasticook were once the spawning grounds for countless numbers of salmon, shad, and alewives. This river, the largest tributary of the Kennebec, was dammed in early times. These dams prevented anadromous fish from utilizing spawning and nursery area in this subdrainage and had noticeable effects on runs of these fish in the Kennebec.

Today, the Sebasticook's East and West Branches and many of its smaller tributaries and its lakes and ponds are impounded by dams. Much of the original spawning and nursery area for salmon has been inundated. Now only 5 percent of the potential for Atlantic salmon of the entire Kennebec drainage is located in this subdrainage.

The first major obstruction on this river is located a short distance upstream from its confluence with the Kennebec in Winslow. This obstruction, a 30-foot high concrete dam (No. 31), is used for generation of hydroelectric power. All fish are prevented access to the Sebasticook by this dam. Another dam, 33 feet high (No. 39), in Burnham, has no fish passage facilities. A 13-foot concrete dam (No. 40) is located on the East Branch in Newport, and an 8-foot concrete dam (No. 41) a short distance further upstream impounds Sebasticook Lake. Numerous other dams without fish passage facilities are located on the East Branch between Sebasticook Lake and Wassookeag Lake in Dexter.

The West Branch of the Sebasticook, which joins the East Branch at Detroit and Pittsfield, is obstructed by several dams which include two structures in Pittsfield (No. 42 and 43) with heights of 10 feet and 15 feet and two other dams (No. 44 and 45) in Hartland with heights of 16 feet and 17 feet. The latter impounds Great Moose Pond. No fish passage facilities are incorporated in any of these structures.

#### *Martin Stream*

Martin Stream is a small tributary entering the East Branch of the Sebasticook at Newport. A 9-foot high, wood and con-

crete dam (No. 46) impounds Plymouth Pond approximately 5 miles above the confluence.

#### *China Lake Outlet Stream*

China Lake outlet stream is obstructed by 6 dams (No. 32, 33, 34, 35, 36, 37) which range in height from 2.5 feet to 16 feet. These obstructions are all impassable to fish moving upstream.

#### *Pattee Pond Brook*

Pattee Pond Brook is obstructed by a 15-foot concrete dam (No. 38) without fish passage facilities.

#### *Twenty-Five Mile Stream*

A 3-foot wood and earth dam (No. 47) impounds Unity Pond. Fish are able to pass through this structure when the gate is open. Several other dams without fish passage facilities are located on tributaries of this stream.

#### *Carrabassett Stream*

The Carrabassett enters the Kennebec on its east bank in the town of Clinton. A 4-foot wood and concrete dam (No. 48) without fish passage facilities is located in the town of Canaan approximately 8 miles upstream from the stream's mouth.

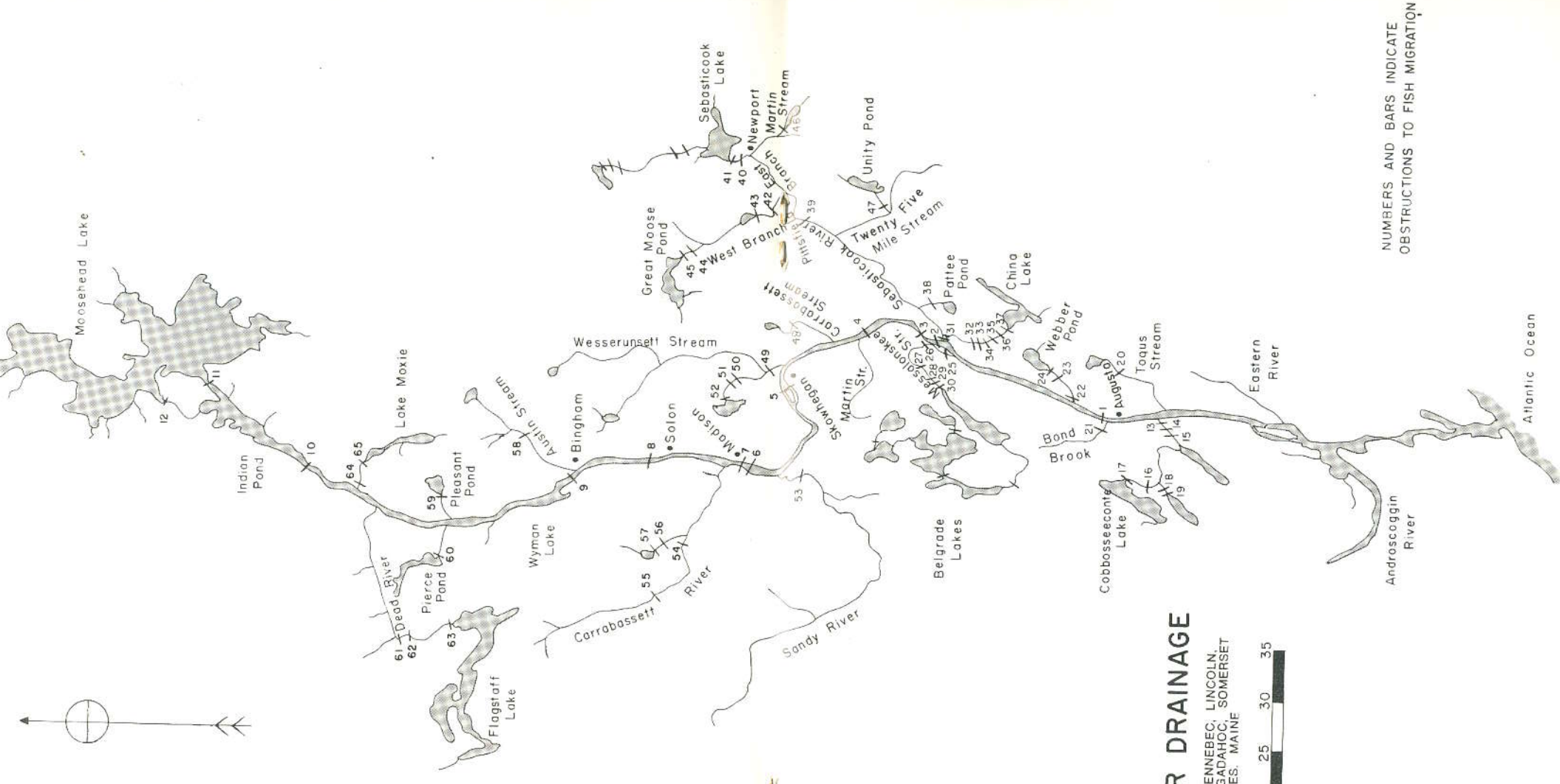
#### *Wesserunsett Stream*

Wesserunsett Stream enters the Kennebec on its east bank at Skowhegan. The remains of a 15-foot log-crib dam (No. 49), built on a ledge outcropping at Malbons Mills are still an obstruction to fish moving upstream at most water levels. The outlet of Wesserunsett Lake, which is part of the Lower West Branch above Malbons Mills, is obstructed by three dams. A five-foot wood dam (No. 50) is located a short distance below Lower Mill. At Lower Mill, there is an 8-foot concrete dam (No. 51) and further upstream a 6-foot concrete dam (No. 52) impounds Wesserunsett Lake. None of the above obstructions on the Lower West Branch of the Wesserunsett are passable to fish moving upstream.

The Upper West Branch of Wesserunsett Stream is obstructed by a dam at West Athens.

#### *Sandy River*

The Sandy River enters the Kennebec on its west bank in Starks and Norridgewock. A 17-foot-high concrete dam (No.



# KENNEBEC RIVER DRAINAGE

ANDROSCOGGIN, FRANKLIN, KENNEBEC, LINCOLN,  
 PENOBSCOT, PISCATAQUIS, SAGADAHOQ, SOMERSET  
 AND WALDO COUNTIES, MAINE



NUMBERS AND BARS INDICATE  
 OBSTRUCTIONS TO FISH MIGRATION

53) obstructs the Sandy approximately 4 miles upstream from its mouth. This dam is used for generation of hydroelectric power.

#### *Carrabassett River*

The Carrabassett is obstructed at East New Portland by a 10-foot-high timber and rock dam (No. 54) and another obstruction at Kingfield, an 8-foot timber and rock dam (No. 55). The East New Portland dam is breached at one end and passable to fish at some water levels. The dam at Kingfield has no fish passage facilities.

#### *Gilman Stream*

Gilman Stream enters the Carrabassett at East New Portland. It is obstructed by an 8-foot-high natural falls (No. 56) and a 7-foot concrete dam (No. 57) at North New Portland. Both obstructions are impassable to fish moving upstream.

#### *Austin Stream*

Austin Stream is a sizable tributary which enters the Kennebec at Bingham. A 15-foot-high natural cascading falls (No. 58) approximately 7 miles upstream from its mouth is a complete barrier to ascending fish.

#### *Pleasant Pond Stream*

This stream enters the Kennebec at Caratunk. Pleasant Pond is impounded by a 5-foot dam (No. 59) without fish passage facilities.

#### *Pierce Pond Stream*

Pierce Pond Stream has an impassable natural falls between Pierce Pond and the Kennebec; a 5-foot timber and rock dam (No. 60) impounds Pierce Pond.

#### *Dead River*

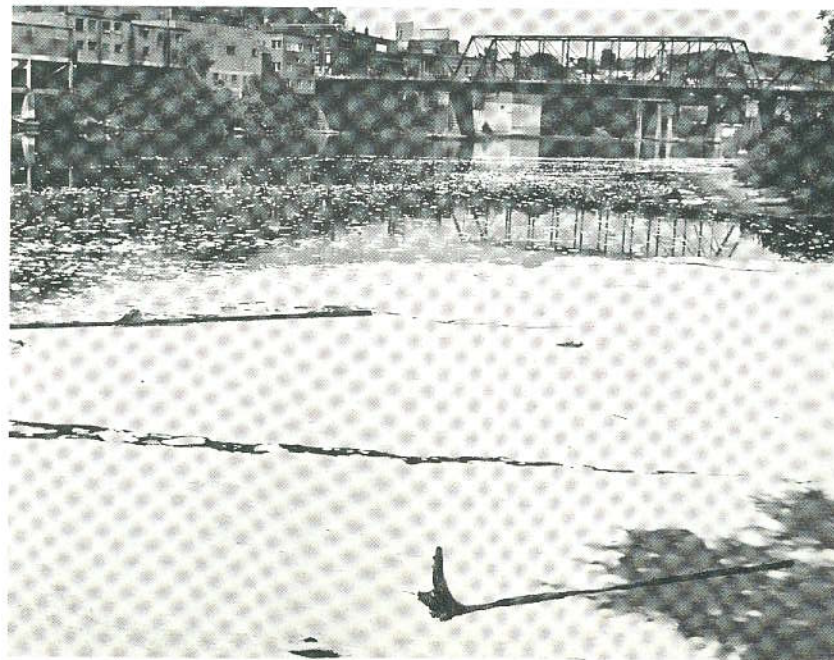
The Dead River is a sizable tributary entering the Kennebec at Bowtown and the West Forks. This river is obstructed at Grand Falls by a 35-foot natural falls (No. 61) some 16 miles upstream from its mouth and a 2-foot logging dam (No. 62) a short distance above Grand Falls. A 63-foot concrete dam (No. 63) impounds Flagstaff Lake.

#### *Moxie Stream*

A 90-foot natural falls (No. 64) obstructs this stream about one-half mile upstream from its confluence with the Kennebec. Moxie Lake is impounded by a 19-foot-high concrete dam (No. 65). Both obstructions are impassable to fish ascending the stream.

### POLLUTION IN THE KENNEBEC

Earlier in this report, mention was made of pollution problems that existed in the Kennebec some 80 years ago. Our early Commissioners referred to the Kennebec as resembling the water of a neglected wood-yard rather than a river. Pollution conditions in the river have steadily worsened since that time. The Maine Water and Air Environmental Improvement Commission wrote in 1966 with regard to conditions in the lower Kennebec: "*Although the Kennebec River has been highly polluted for a number of years, the present day pollution has never been paralleled in its severity. Fish kills and odors prior to 1963 were limited to the month of June and associated with low*



Industrial Pollution at Augusta

spring river run-off and rising temperatures. Vast fish kills have occurred in 1947, 1957, 1963, and 1965. Odors have been prevalent since 1963, during the summer months, reaching a peak in 1965 where extended drought conditions contributed to low run-off. Water quality deteriorates rapidly below Waterville presently, even with normal summer run-off, and from approximately 6 miles above Augusta to over 20 miles below the 'Capital City', most of the waters are characterized by oxygen depletion, scums, sludge blankets, and odors, being literally described as an 'open sewer.' "

In the Commission's original Kennebec River classification report dated August 1, 1960, they wrote: "It may be concluded that if present industry enlarges its production, populations increase, or if future industry moves into the Kennebec River valley, nuisance conditions will prevail much of the time during warm summer months . . ." These conditions have become a reality, according to the Commission's 1966 addendum to this report.



Fish Killed by Pollution in Merrymeeting Bay

In view of deteriorating water quality in the Kennebec, the Water and Air Environmental Improvement Commission recommended to the 103rd Maine Legislature the upgrading of segments of the main Kennebec and several of its tributaries.

Thus, the 103rd Maine Legislature (1967) upgraded several segments of the lower Kennebec and some of its tributaries to Abagadasset Point to Class C. Class C waters are those in the third highest classification and must be of such a quality as to be satisfactory for recreational boating and fishing, for a fish and wildlife habitat and for other uses *except* potable water supplies and swimming, unless such waters are adequately treated. *Nearly all of the reclassified waters presently do not meet class C standards.*

Lower sections of Merrymeeting Bay from Abagadasset and Chop Points to the southerly end of Popham Beach have classifications ranging from B-2 to SB-1. These classifications shall be suitable for all clean water usages including bathing and fishing.

Waters in the upper Kennebec River basin above Wyman Dam in Moscow, with a few exceptions, are classified B-2 or higher. Class B waters must be acceptable for recreational purposes *including* bathing, for industrial and potable water supplies after adequate treatment, and for a fish and wildlife habitat. With an ever increasing demand on water use in the Kennebec River basin, it becomes increasingly important that the present classifications be improved and that adequate enforcement be provided to assure the public that the water quality in each segment of the drainage meets the prescribed classification standards. The upgrading of waters to not less than Class B standards is highly desirable for waters used for recreation.

The main responsibilities for pollution abatement in the Kennebec lie with the industries and municipalities in the drainage. Although these reclassifications became effective on October 7, 1967, a time schedule established as part of the statute gives the responsible parties until October 1, 1976, to implement changes which will result in the waters meeting the prescribed standards.

Primary and secondary treatment of industrial and municipal wastes is necessary if the upgrading of water quality in the lower Kennebec is to become a reality. In 1966, the Water and

Air Environmental Improvement Commission estimated that in excess of \$45,000,000 would be needed to provide the facilities for primary and secondary treatment plants in this drainage.

As living costs continue to creep upwards, so do pollution abatement costs. Maine people must be willing now to face up squarely to the challenge of cleaning up our rivers and lakes if the multiple-use concept of water management is to continue for the benefit of mankind in this and future generations. Clean water is essential to the maintenance of the state's fish and wildlife resources. Maine has long been recognized for these resources, but because of Man's negligence and unwillingness to recognize and pay for his mistakes, these resources in many areas are now in peril.

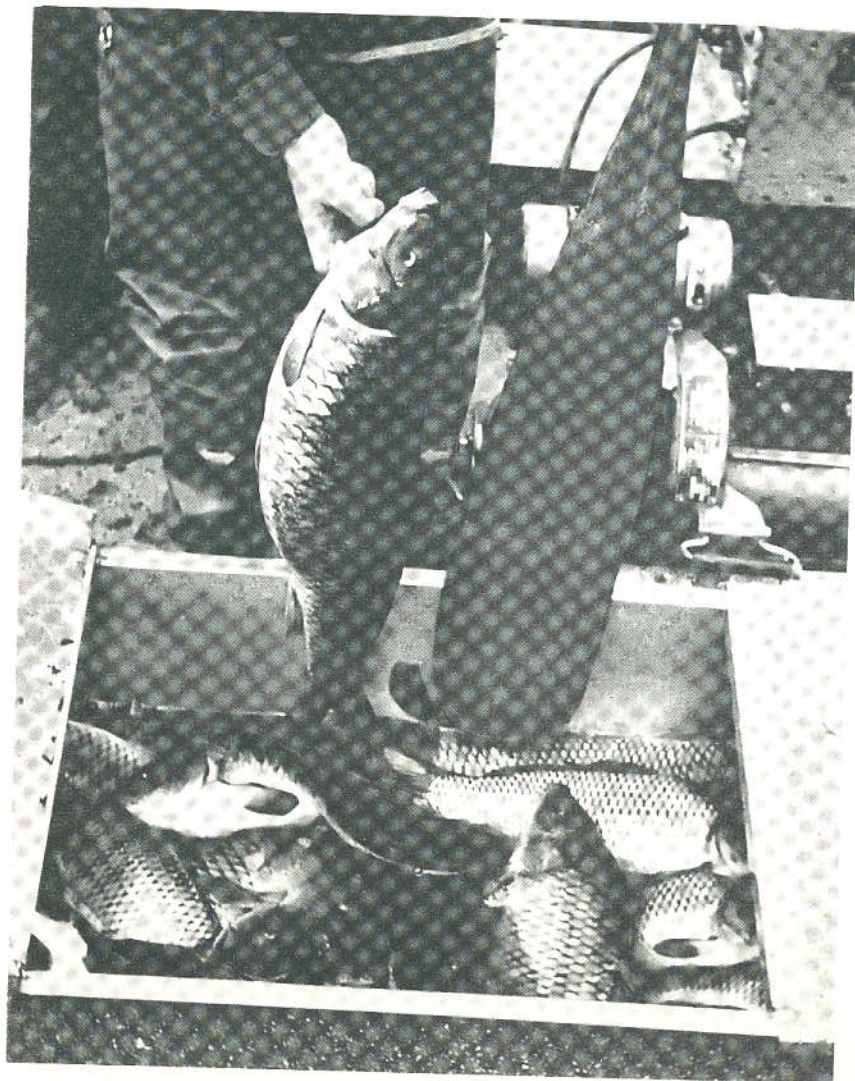
### SPECIAL PROBLEMS

#### The Carp Menace

A well established population of European carp exists in tidal areas of the Kennebec River below the Augusta dam and is a potential threat to game fish populations in all of the inland fresh waters of this drainage. Fish and wildlife managers are well aware of the problems arising in many parts of our country following the introduction of this species of fish.

Carp are typically associated with warmwater environments, thriving in the shallow weedy areas of ponds and streams. Carp sometimes enter swiftly flowing streams, especially when looking for suitable spawning areas or wandering about in search of food, but are rarely found in deep cool areas of stratified lakes. The feeding habits of carp play an important role in changing aquatic habitat utilized by fish, waterfowl, and other wildlife. Carp are bottom feeders utilizing a wide variety of food items, both plant and animal. They feed by sucking up the bottom mud, ejecting it, and then eating the food particles suspended in the water. Rooting in the bottom in search of food roils the water, causing it to remain very turbid much of the time. Water plants require sunlight which cannot penetrate roily water, and, consequently, valuable habitat utilized by both fish and waterfowl is destroyed. In addition, nests and eggs of game fish are sometimes torn up or covered by the feeding and spawning activities of carp. This inevitably results in fewer game fish.

Carp were, unfortunately, introduced into several dozen privately-owned ponds in Maine in the late 1800's. It was indeed fortunate that most of these introductions were unsuccessful. The allotment of small numbers to each water and the rough treatment which the fish received in makeshift transportation systems contributed to poor survival. The introduction of carp into tidal waters of the Kennebec River is reported to have



European Carp from Kennebec River at South Gardiner

come from fish stocked in a small pond in Augusta and later transported from this pond to an impoundment on Bond Brook in Augusta, whence they escaped into the Kennebec.

Carp are vigorous swimmers and have the ability to jump vertically five or six feet. They can pass through any fishway designed to pass trout, salmon, or alewives. A 25-year average annual count shows 15,000 carp using the Bonneville Dam fishways on the Columbia River.

Isolated populations in the Kennebec River below Augusta have been held in check by high dams and the apparent inability of carp to tolerate sea water.

Nevertheless, we are faced with a tremendous hazard: the possibility of carp spreading into other inland waters. Many states will sadly testify to the extent of this hazard, as millions of dollars have been spent in vain attempts to control carp and repair the damage to countless thousands of acres of game fish and waterfowl areas.

As testimonial to the above statements, the following paragraphs are quoted from a paper written in 1958 by William F. Sigler, entitled "The Ecology and Use of Carp in Utah":

*"But mere abundance is not the problem. It is generally conceded by fishery biologists that carp are often detrimental to game fish and their habitat. Their damage, through destruction of aquatic vegetation, is detrimental to young fish that are yet in shallow waters, to all fish which live perpetually in shallow water, and to spawning fish and their spawn."*

*"Carp populations which dominate areas apparently do so because of several factors. These include their ability to force other species out of a habitat, the ability to adapt themselves to a habitat that has become unsuitable for other fish, the tendency to degrade their habitat to the point where only they can remain in dominance and such additional factors as selective harvesting, lack of lethal diseases or of effective enemies, and a high biotic potential."*

*"The use of fishways to facilitate the movement of game fish has all too often served as a means of entry for carp. Many biologists advise against the continued use of fishways, believing the advantages are outweighed by the harmful consequences*

*unless operated with traps which have been incorporated in the fishways."*

### **Transportation of Long Logs and Pulpwood**

The transportation of long logs and pulpwood from staging areas in the headwaters of the river to downstream mills is one of the oldest water uses in the Kennebec. While long-log drives have decreased, records show that pulp drives have more than doubled in the Kennebec since the 1940's. The 1965-67 drives were two to three times those of the early 1960's and an even greater multiple of the drives of the 1950's.

Bark deposits and sunken pulpwood on the riffle areas and in the deeper pools have a detrimental effect on fish populations by rendering them unsuitable for spawning, for nursery areas for juvenile fish, and for cover for both juveniles and adults. These deposits also decrease insect populations and other fish food. The decomposition of sawdust and bark exerts a chemical demand on the oxygen supply and often depletes the oxygen content of the water to levels which are critical to fish and other aquatic life.

Sproul and Sharpe (1968) stated that significant water quality degradation results from materials leaching from woodbark stockpiles on land or in watercourses, and they point out that if appreciable quantities of bark were involved, the result might be catastrophic to the ecological balance in the stream. They also stated that the tannin-lignin fraction of the leached organic matter from bark deposits reaches values which suggest that they alone may render the water useless as a fish habitat.

Large log landings on the river banks have caused some problems. The pulp is pushed into the river by a bulldozer, and part of the banks go into the river with the pulp. This practice causes siltation and bank erosion. Many companies have willingly agreed not to cut the timber on the banks, but many log landings in other locations result in denudation of the bank cover.

Aside from its physical and chemical effects upon aquatic habitat, pulpwood in the Kennebec during many weeks of each year is a deterrent to the use of the river for recreation. Wyman Lake, Indian Pond, the flowage above Shawmut Dam in



Pulpwood Boomed in Wyman Lake

Fairfield, and other sections of the river are often jammed from shore to shore with pulpwood, preventing navigation by boat and the use of these areas for fishing, water skiing, waterfowl hunting, and other recreational uses.

#### Stream Flow

Stream flow is extremely important in the production of trout and salmon. Maine biologists (Havey, 1968) have recently demonstrated that stream flow is a major cause for variations in survival of young salmon at Barrows Stream in Washington County. Stream flow during the two years when any year-class involved was in the stream, was responsible for 88.18 percent of the variation in survival.

Flows in the Kennebec River are regulated by several dams on the main river and its larger tributaries. Major storage areas include First and Second Roach Ponds and Brassua Lake, which are tributaries of Moosehead Lake, Flagstaff Lake and

Spencer Lake in the Dead River system, Lake Moxie, and Indian Pond and Wyman Lake on the main river.

River flows are controlled and regulated by the Kennebec Water Power Company with offices in Waterville, Maine. The Kennebec Water Power Company is made up of five major water users on the river, namely, Central Maine Power Company, Kennebec River Pulp and Paper Company, Scott Paper Company, Milstar Manufacturing Company, and Bates Manufacturing Company. Although not a member of the Kennebec Water Power Company, the Kennebec Log Driving Company has certain water rights on the river.

Moosehead Lake has a storage capacity of 25 billion cubic feet; this storage is controlled at the East Outlet dam. The river between Moosehead Lake and Indian Pond is 2.6 miles long, and its width varies between 70 and 340 feet with an average of 180 feet. The banks of the river, once heavily forested, were cut recently except for narrow strips on either side. Gravel roads parallel both banks, providing easy access for anglers and hunters. Except for the regulated water flow, the river is still in a virtually natural condition.

The depth of the river between Moosehead Lake and Indian Pond varies from 1 to 10 feet, and the flow is maintained at approximately 2000 c.f.s. except for short periods when the minimum flow of at least 100 c.f.s. is used. During heavy runoff periods, flows as high as 15,000 c.f.s. have been recorded. At the 2000 c.f.s. flow, the surface velocity is approximately 5 feet/second where the gradient is moderate. In some sections, the velocity may be 2 or 3 feet/second greater.

Flows in the upper Kennebec River between Indian Pond and The Forks have undergone noticeable changes since 1940. Harris Dam, which impounds Indian Pond, was built in 1954. Before this date, this section of the river had high flows. The 1940-49 decade showed July lows of under 500 c.f.s. for only 2 years. The period from 1958-67 (no data for 1962) showed consistently lower flows and daily fluctuations. July flows of under 500 c.f.s. occurred on average of 27.4 days, less than 300 c.f.s. on 18 days, and less than 200 c.f.s. on 2.1 days. The duration of low flows has been about 4-5 hours, with some up to 26 hours. Water resources data for Maine for 1967, prepared by the U. S. De-

partment of the Interior in cooperation with the Maine Public Utilities Commission and other agencies, list a minimum flow of 328 c.f.s. on August 31, 1967, in the Kennebec River at The Forks.

The Dead River enters the Kennebec along its west bank below The Forks. Flows in lower sections of the Dead River are controlled at the dam at Flagstaff Lake and the dam on Spencer Lake.

Flagstaff dam was built in 1950. Since this dam was built, flows have been generally lower. Flagstaff dam is often shut down, and the section of the river below Flagstaff Lake to the first deadwater downstream becomes pretty much dewatered.

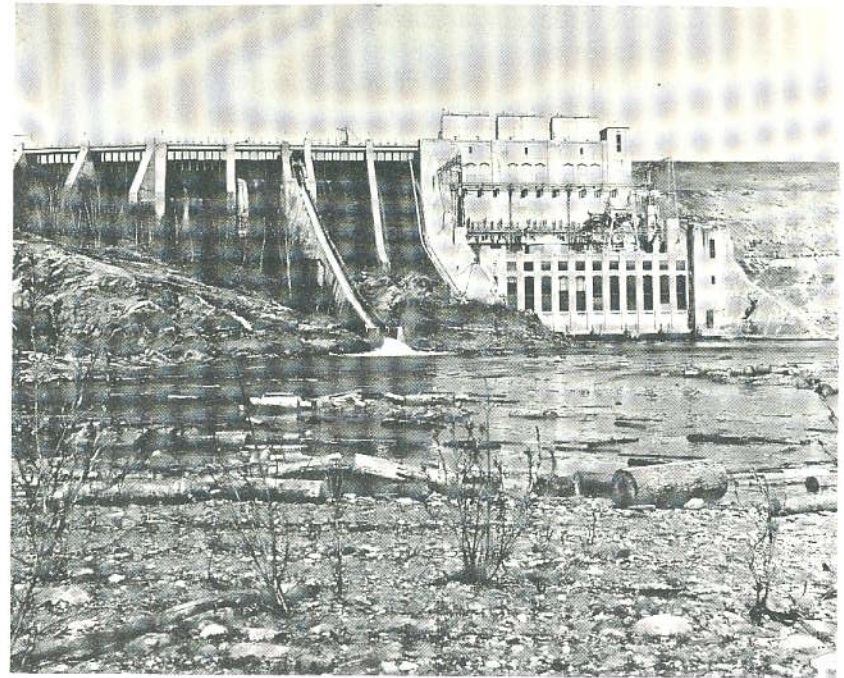
There is considerable daily fluctuation in the Dead River during the pulp drive in May-July (usually a 2-4 week period) and the rear of the drive period in August. Low flows then are usually 250-400 c.f.s. with an occasional one of less than 200 c.f.s.

Summer flows are not always the lowest. Fall, winter, and spring lows occur. Lows are often instantaneous, but some of less than 200 c.f.s. have lasted up to 90 hours (87 c.f.s.—August 3-8, 1965).

In 1967, a maximum flow of 8,310 c.f.s. occurred on June 27 while minimum flows of 1.0 c.f.s. occurred on many days during October through March at a point  $\frac{1}{2}$  mile downstream from Flagstaff Lake. In 1967 at The Forks, the Dead River had a maximum flow of 7,790 c.f.s. on June 25 and a minimum flow of 110 c.f.s. on March 16 and 17. Low flows were evidently rare between The Forks and Wyman Lake before the construction of the Flagstaff and Harris dams.

Noticeable changes in flow patterns have occurred since 1950 in the Kennebec River between Wyman dam and Solon. Flows in this section of the river before the Harris and Flagstaff dams were built would seldom have been below 1,000 c.f.s. in July. The lowest July flow during the decade 1940-1949 was 819 c.f.s.

Wyman dam was built in 1930. Flows below Wyman Lake from 1932 to 1934 in July showed very few days below 1,000 c.f.s. and a low of about 340 c.f.s. Low flows were of short duration.



Low River Flow below Wyman Dam

During the period 1958 to 1967, July flows showed a trend towards more frequent low flows down to  $215 \pm$  c.f.s. The years 1964-1967 have shown a rapid jump to almost daily lows of less than 300 c.f.s. (usually 215 c.f.s. or less) held for long periods (1-6 hours). This change in flow pattern is apparently due to a change in power generation. Originally, Wyman generated base load power, and large volumes were discharged all the time. Now the turbines operate at peak at certain hours only, and stream flow is cut back as the turbines drop to much lower generating rates.

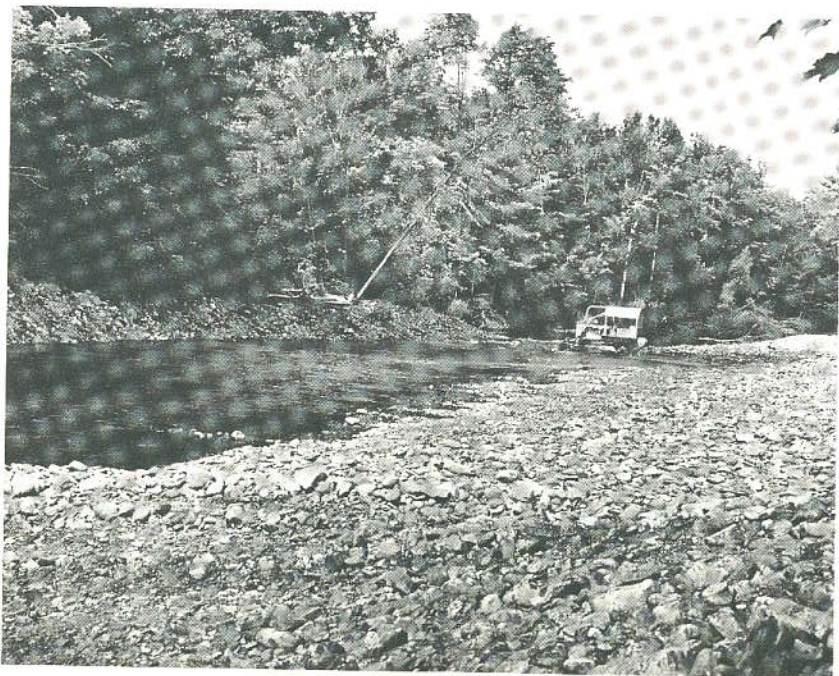
Operation of the gates of a dam has important effects on stream life. The gates on many of the older dams were once operated manually, but they have been replaced by fast, power-operated units which result in drastic changes in stream flow in a matter of minutes. This does not allow sufficient time for stream animals to adjust to changes in flow, as is the case under natural conditions.

In view of our studies on Barrows Stream in Washington County, where fluctuations in stream flow have been the principal cause for variations in survival of young salmon, it is quite probable that flows in the upper reaches of the Kennebec and many of its tributaries have been low enough and variable enough to have had a serious effect on fish populations. This is especially true of the years 1964-1967. Seasonal concentrations of pollutants in the lower river have also probably been more variable following change in flow pattern.

#### Austin Stream Bulldozing

Rainbow trout were introduced into waters of the upper Kennebec River in 1933. Bond (1955) reported that rainbows were maintaining themselves and were providing a valuable and attractive sport fishery at that time though the total number of fish taken was small.

The rainbow trout fishery appears to have declined since 1955. Trap netting of several of the major rainbow trout spawning



Austin Stream Bulldozing

streams in 1968 produced only small numbers of adult fish. No immature rainbows were encountered in sections of the main river by electrofishing in 1968.

Bond (*op. cit.*) reported rainbows reproducing and doing well throughout the entire lower portion of Austin Stream. Recent bulldozing of the stream bed in the lowermost two miles of this stream by the towns in this area to alleviate flood damage along this section of stream during spring run-off, has practically eliminated the deeper pools which served as resting areas for adult fish. Most of the large rocks and rubble which served as cover for immature rainbows have been bulldozed onto the banks. This section of Austin Stream is no longer considered good trout habitat.

#### DISCUSSION AND CONCLUSIONS

Man's use of the Kennebec River for industrial development for more than three centuries has resulted in the almost complete obliteration of many of the river's valuable fishery resources. Inundation by dams of a large portion of the original spawning and nursery areas once utilized by Atlantic salmon has greatly reduced the potential of the river for this species.

Some persons with a poor understanding of the living requirements of salmon frequently maintain that the "cure all" to salmon fishing in the Kennebec is fishways. We have indicated previously in this report that the estimated maximum potential today for Atlantic salmon in the Kennebec is between 296 and 2,584 adult fish annually. Between 31 and 46 percent of this potential lies in the drainage above Solon. Fishways in 10 dams on the main river and in numerous other dams on the major tributaries of the Kennebec would be necessary to realize this run.

Sportsmen generally consider "success" in terms of numbers of fish harvested rather than in terms of numbers of fish available. Rod harvests of sea-run Atlantic salmon in Maine rivers vary between 15 and 25 percent of the total run. Realistically then, we are talking in terms of an estimated maximum annual harvest of at most, 44 to 646 salmon in the Kennebec at its fullest potential.

Several other important biological considerations are related to the pros and cons of fishway construction in the Kennebec drainage. It is important to mention again some facts concerning the distribution in the drainage of several of our warm-water fishes which compete in one way or another with our valuable coldwater species. Largemouth bass do not occur in waters of the drainage above Madison. Smallmouth bass and white perch are not found in the drainage above Solon, and there are no pickerel above Harris dam at Indian Pond. Dams prevent these species from spreading upstream into the many coldwater lakes, ponds, and streams where they could measurably affect trout and salmon populations. Recent studies by fishery biologists of the Maine Fish and Game Department (Warner et al., 1968) have demonstrated heavy predation by pickerel on small salmon, and similar studies (unpublished) have also recently demonstrated predation by bass on young salmon.

Rainbow trout are established above and below Wyman dam. It is questionable if we want another salmonid in our salmon and trout waters above Harris dam. Rainbow trout would utilize the same habitat our native salmon and brook trout now use, and the production of these native species might be reduced.

American eels were once common in Moosehead Lake. They have not been found in the headwaters of the Kennebec drainage since the construction of Wyman and Harris dams. Eels must return to the sea to spawn. The tiny elvers journey sometimes hundreds of miles upstream to the headwaters of many river systems. They can swim or wiggle over or around most dams and falls, but these exceptionally high structures on the Kennebec are barriers to eel migrations.

The introduction of competitive species into trout and salmon waters cannot be taken lightly. The adverse effects of yellow perch introductions on trout and salmon fishing in several of Maine's important coldwater lakes is grim testimony of the seriousness of the problem and a warning to those who would "open the door" to other serious competitors. This brings us again to the problem of carp which thrive below Augusta. Surely no fishery biologist, administrator, or well-informed sportsman with a knowledge of the undesirable attributes of this species would want to jeopardize other valuable fish and game resources

above Augusta by advocating the construction of fishways in the Kennebec.

Coldwater game fish are now resident in many parts of the drainage classified in this report as potential nursery area for Atlantic salmon. These fisheries already constitute a valuable resource, and their replacement by juvenile Atlantic salmon could hardly be justified.

Management of the fishery resources in the drainage cannot be fruitful without the willingness of Maine citizens to support and cooperate in programs designed to improve habitat and living conditions for aquatic life. Cities, towns, and industry have monopolized the Kennebec for years, with little or no regard for its natural resources. Maine has a reputation for its bountiful supplies of fish and wildlife but as each day goes by, encroachments on these valuable resources continue. Facing the prospects of more dams associated with small watershed and pump-storage projects in the drainage, Maine citizens must take positive action to prevent further despoilment of the Kennebec's natural resources.

Water serves man's needs in many ways. As man finds more time to relax, it becomes increasingly important that he be able to find and enjoy the pleasures that are associated with clean, fresh water. Sacrifices are inevitable. Water must be shared, money must be spent to abate pollution, and constructive thinking must replace the negative thinking of those who are willing to be intimidated by the question, "*Would you rather have pickerel or payrolls?*"

## SUMMARY

Dams constructed on the Kennebec in colonial times without adequate fish passage facilities destroyed the large runs of anadromous fish in the river. Eleven major dams now obstruct the main river between Augusta and Moosehead Lake.

All of the major tributaries of the Kennebec, which once served as spawning and nursery areas for salmon and shad, have numerous dams without provisions for fish passage.

Most of the major lakes and ponds in the drainage, which once served as the spawning grounds for alewives, have been dammed with no provisions for fish passage.

The amount of nursery area available for young salmon governs to a large degree the potential of a river for this species. Dams have inundated large portions of the original salmon nursery area in the Kennebec drainage. The size of salmon runs is influenced by the very small numbers of young salmon which are produced in a given unit of nursery area, losses during downstream migration through hydroelectric installations, predation, and losses encountered during sea life. The Atlantic salmon potential of the Kennebec is estimated to lie between 296 and 2,584 adults annually.

Lakes and ponds in the drainage have a large potential for alewives. The fishery at present is limited to a small number of lakes and ponds below Augusta. In addition to their commercial value, alewives are utilized for food by several species of game fish.

Smelts are a source of income to commercial fishermen in the tidal waters below Augusta, and smelt fishing is a favored sport of many anglers during winter and early spring.

The Kennebec was once noted for its large runs of shad. This species is seldom encountered today. Much of the original shad spawning area of the drainage has been destroyed by inundation. An obstruction-free approach to spawning grounds is considered important to the maintenance of a good shad run.

Sport fishing for striped bass in the tidal portion of this river has increased in popularity in recent years and promises to become even more popular in the future.

A variety of freshwater fish live in the waters of the drainage. Coldwater game species, landlocked salmon, brook trout, and lake trout, predominate in the upper reaches of the drainage. A small, self-sustaining population of rainbow trout contributes to fishing in the Kennebec and a few tributaries between Solon and Caratunk. Smallmouth and largemouth bass, white perch, and chain pickerel are widely distributed in many waters of the lower Kennebec drainage. Their aesthetic and economic values to the State of Maine are immense.

Pollution in parts of the Kennebec has steadily worsened. The Maine Water and Air Environmental Improvement Commission reported in 1966 that pollution in the river has never been paralleled in its severity and described the lower section of the

Kennebec as an "open sewer." Following recommendations of the WAEIC, the 103rd Legislature passed legislation in 1967 upgrading segments of the lower river and its tributaries. A time schedule was also established giving the responsible parties until October 1, 1976, to implement changes which will improve these waters to meet prescribed classification standards.

European carp are well established in tidal waters of the Kennebec River below Augusta. Carp are detrimental to game fish populations and habitat, often reducing both to a point where the carp becomes dominant. This species now poses a real threat to game fish populations in the inland waters of the drainage. Carp have been prevented from entering the inland waters by impassable dams.

Log and pulp drives are one of the oldest uses of the Kennebec. Log drives have decreased, since early times, but pulp drives have increased noticeably since the 1940's. Pulpwood and bark accumulations on streams and lake bottoms are detrimental to fish and other aquatic life by rendering areas unsuitable for spawning, for use as nursery areas by juvenile fish, and for cover for both juveniles and adults. Recent findings indicate that significant degradation in water quality can result from the materials leached from wood bark stock piles on land or in watercourses. This may ultimately render extensive areas unsuitable for fish.

Salmon and trout production is influenced by stream flow. Flows in the Kennebec River are regulated by several dams on the main river and its larger tributaries. Flows in sections of the upper Kennebec and some of its tributaries have undergone noticeable changes since 1940. Flow pattern alteration is apparently due to changes in power generation demands at some sites which now operate at peak load at certain hours only, followed by drastic stream flow cut-backs as turbines drop to lower generating rates. Since implementation of changes in flow pattern in upper reaches of the drainage, it appears that flows have been sufficiently low and variable to have had a direct adverse effect on fish populations. Changes in flow pattern have also probably resulted in greater seasonal variation in the concentrations of pollutants in the lower river.

## RECOMMENDATIONS

Sound fish management is an important goal in the multiple-use planning of our rivers. The Kennebec River has an important potential for a vast variety of recreational activities including fishing, hunting, trapping, boating, water skiing, swimming, and camping.

Shore property along the Kennebec has a high potential for home and cottage development, but poor aesthetic surroundings in many sections today restrict this type of development.

Realization of the tremendous recreational potential of the Kennebec will result in great economic benefits to the people of Maine. However, before these economically beneficial uses can become a reality, several highly desirable changes and improvements in the present use of the river are essential.

The following recommendations are made to improve fishing in the Kennebec and will in turn, make the river more valuable for other recreational activities.

1. Pollution abatement in the Kennebec is of utmost importance. Strict compliance and adherence to the statutes passed by the Maine Legislature pertaining to water classification in the drainage are minimum essentials. The time schedule established by the State of Maine, containing dates for implementing pollution abatement measures in the Kennebec, must be maintained or accelerated.

2. The dissolved oxygen content of all the waters in the drainage should be kept at the highest possible levels, and the minimum level of dissolved oxygen should not be less than 5 parts-per-million for 100 percent of the time.

3. Water degradation results from woodbark deposited along river banks and on the stream bottom. These deposits adversely affect fish and other aquatic life. It is recommended that the companies engaged in the manufacture of paper and paper products from pulpwood transported by water to mills along the river, consider methods to prevent further pollution of the river by waste bark associated with pulpwood drives. Possible remedial measures include the transportation of pulpwood directly from the cutting site to the mill in lieu of river transpor-

tation. A second alternative would be the debarking of pulp at the cutting site to prevent bark accumulations at staging areas along the banks of streams and its subsequent disposition in the river.

4. As pulpwood drives in the Kennebec usually interfere with recreational uses of the river, especially in areas where log booms extend from shore to shore, it is recommended that companies engaged in pulpwood drives provide suitable room for boat passage at all impoundments where pulpwood is stored.

5. The following recommendations pertain to fishway operation and maintenance in the drainage:

- (a) The fishway in the dam at the East Outlet of Moosehead Lake must be maintained and properly operated. This fishway was opened in 1958; previously, salmon could pass through the dam only during short periods of very favorable flows. Now many small landlocked salmon and brook trout and small numbers of lake trout move upstream from nursery areas in the river into Moosehead Lake where they contribute to lake fishing.

- (b) A fishway in the dam at the West Outlet of Moosehead Lake is not recommended at this time. There is very little spawning or nursery area for salmon and trout between Moosehead Lake and Long Pond. The lower section of the West Outlet is available to salmon from Indian Pond and contributes a substantial number of young salmon to Indian Pond under proper flow conditions.

- (c) The maintenance and operation of the fishway in the dam on the Dead River at the outlet of Flagstaff Lake is not biologically justifiable. Flagstaff Lake is not suitable for cold-water fish management, and a fishway in this dam serves no useful purpose.

- (d) Fishways are not recommended at this time for any of the dams presently in existence along the main stem of the Kennebec from Indian Pond to head of tide at Augusta, for reasons already explained in this report, or in dams on the tributaries of the Kennebec below Augusta. Maintenance of the fishways which are already present is essential.

- (e) The operation and maintenance of fishways already present in existing dams on the tributaries of the Kennebec above

tidewater not specifically mentioned in this report, and the construction, operation, and maintenance of fishways in any new dams constructed in the future, should continue to be in accordance with state statutes.

6. Adequate stream flows are essential to the production of game fish. In view of problems associated with stream flow in the Kennebec, the following recommendations are made:

(a) A minimum flow of 200 c.f.s. in the East Outlet of Moosehead Lake is recommended to keep the river productive as a spawning and nursery area.

(b) The minimum flow of 25 c.f.s. presently provided in the West Outlet of Moosehead Lake should be maintained.

(c) A minimum discharge of 50 c.f.s. should be released from Flagstaff Lake in the Dead River system.

(d) A minimum discharge of 200 c.f.s. is recommended at Harris dam for the river between Indian Pond and The Forks.

(e) The combined minimum flow of the entire Dead River system, the Kennebec River above The Forks and several smaller tributaries should be sufficient to provide a minimum flow of approximately 400 c.f.s. in the Kennebec between The Forks and Wyman Lake.

(f) A minimum flow of 500 c.f.s. should be maintained in the Kennebec between Wyman Lake and Solon flowage at all times.

7. In view of the apparent decline in populations of rainbow trout in segments of the drainage between Solon and Bingham, it is recommended that the Maine Department of Inland Fisheries and Game undertake an experimental rainbow trout stocking program in the above areas. This program will be in conjunction with the implementation of revised minimum flows, pollution abatement, and other recommendations necessary to improve aquatic habitat in the drainage.

8. Fish management in the various segments of the Kennebec shall be in accordance with the habitat types and habitat requirements of species now present in the drainage and based upon studies and recommendations of personnel of the Maine Department of Inland Fisheries and Game.

9. It is recommended that the industries and communities along the Kennebec River provide suitable public access sites to allow for expanded use of all of the river's recreational opportunities.

#### ACKNOWLEDGEMENTS

The authors are grateful to fishery biologists Matthew Scott, Raymond DeSandre, and William Meyer for their help in collecting and analyzing field data in the study.

We wish to thank Dr. W. Harry Everhart, former Chief of Fisheries Research and Management, Maine Department of Inland Fisheries and Game, for assistance and helpful suggestions during the survey, and Mr. Lyndon H. Bond, Chief of Fisheries Research and Management, Maine Department of Inland Fisheries and Game, for his assistance during the survey and review of the manuscript.

Further appreciation is extended to Mr. Alfred L. Meister, Chief Biologist of the Maine Atlantic Sea-run Salmon Commission, and fishery biologist Donald F. Mairs, for reviewing the manuscript and helpful suggestions, and Mr. William C. Mincher, Chief, Information and Education Division, Maine Department of Inland Fisheries and Game, for editorial assistance.

We wish to thank Mrs. Jane I. Rupp for preparing the cover, Mr. Arthur Shaw for drafting the map, and Mr. Thomas Carbone for his assistance in obtaining photographs used in this report.

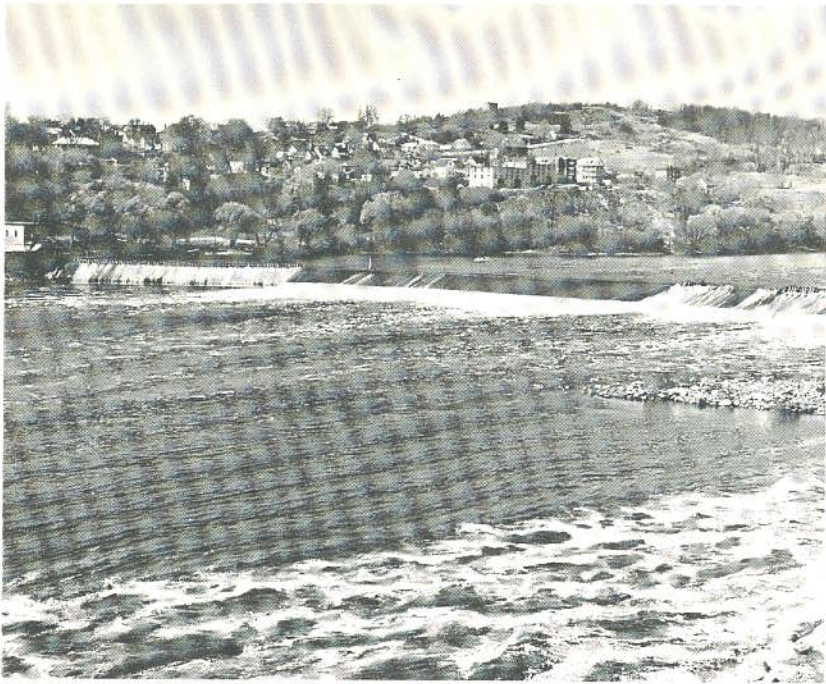
Appreciation is due Mr. Otis Bacon, hydraulic engineer with the Kennebec Water Power Company, for providing data on water flows described in this report, the Central Maine Power Company for allowing us to use their Profile of the Kennebec River, and Mr. B. M. Garland, Scott Paper Company, for providing information on pulp drives in the river.

This report was financed in part by the Dingell-Johnson Federal Aid to Fisheries Act under project F-8-R.

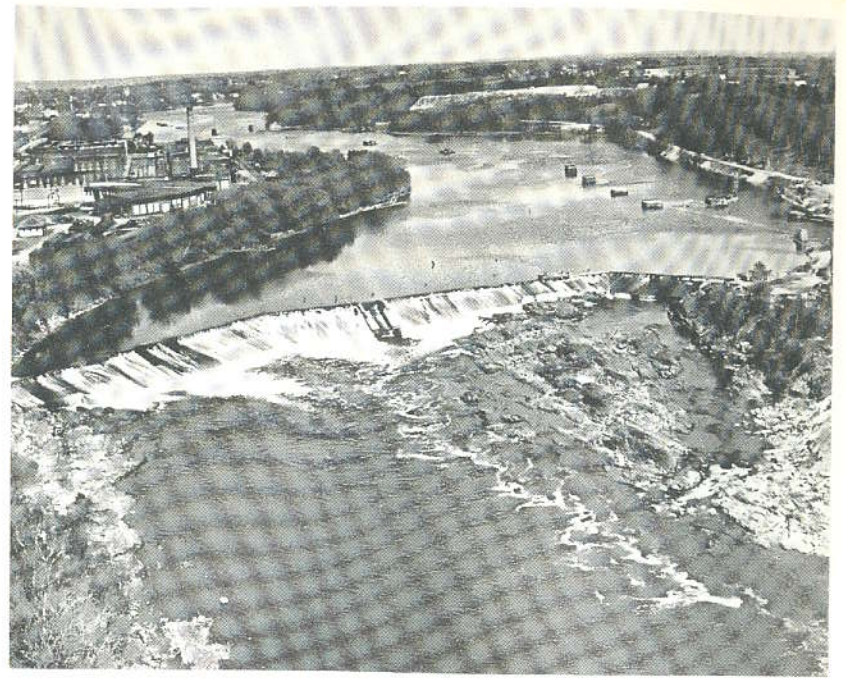
## LITERATURE CITED

- Bigelow, H. B. and W. C. Schroeder 1953. Fishes of the Gulf of Maine. Fish. Bull. U.S.F. W.S. No. 74, Vol. 53, 577 pp.
- Bond, L. H. 1955. Preliminary Study of Kennebec River Rainbow Trout. Mimeo. Rept. Maine Department of Inland Fisheries and Game, Augusta, Maine, 7 pp.
- Cutting, R. E. 1967. Estimation of Atlantic Salmon Smolt Production and Adult Salmon Runs. Mimeo. Rept. Maine Dept. of Inland Fisheries and Game, Augusta, Maine, 6 pp.
- Eckstorm, F. H. 1941. Indian Place-Names of the Penobscot Valley and the Maine Coast. University Press, Orono, Maine.
- Elson, P. F. 1957. Using Hatchery-reared Atlantic Salmon to Best Advantage. The Canadian Fish Culturist No. 21, pp. 7-17.
- Everhart, W. H. 1966. Fishes of Maine, 3rd Edition. Publ. Maine Dept. of Inland Fisheries and Game, Augusta, Maine, 96 pp.
- Havey, K. A. 1968. A Study of Standing Crops of Juvenile Salmon and their Competitors in a Salmon Spawning and Nursery Stream. Job Completion Report No. 1, Proj. F-14-R-9. Maine Dept. of Inland Fisheries and Game, Augusta, Maine.
- Kendall, W. C. 1935. The Fishes of New England. The Salmon Family. Part 2. The Salmon. Memoirs of the Boston Soc. of Nat. Hist. Vol. 9, No. 1.
- Marriner, E. C. 1954. Kennebec Yesterdays. Colby College Press, Waterville, Maine. 320 pp.
- Meister, A. L. 1962. Atlantic Salmon Production in Cove Brook, Maine. Trans. Am. Fish. Soc. 91(2) pp. 208-212.
- North, J. W. 1870. The History of Augusta from the Earliest Settlement to the Present Time, with Notices of the Plymouth Company, and Settlements on the Kennebec; together with Biographical Sketches and General Register. Augusta: Clapp and North.
- Sigler, W. F. 1958. The Ecology and Use of Carp in Utah. Utah State University Agricultural Experiment Station Bull. No. 405.
- Sproul, O. J. and C. A. Sharpe 1968. Water Quality Degradation by Wood Bark Pollutants. Water Resources Center, Univ. of Maine Publ. No. 5.
- State of Maine 1867-1868. Reports of the Commissioners of Fisheries of the State of Maine, Augusta, Maine.
1960. The Kennebec River Water Classification Report. Water and Air Environmental Improvement Commission, Augusta, Maine.
1966. Addendum to the Kennebec River Classification Report. Water and Air Environmental Improvement Commission, Augusta, Maine.
1967. Water and Air Environmental Improvement Commission Revised Statutes of 1964. Title 38 Chapter 3 (as amended).
- Stevenson, C. H. 1898. The Restricted Inland Range of Shad due to Artificial Obstructions and its Effect upon Natural Reproduction. Bull. U. S. Fish Comm.
- Taylor, C. E. 1951. A Survey of Former Shad Streams in Maine. U. S.F.W.S. Spec. Sci. Rept. Fisheries No. 66, 29 pp.
- U. S. Dept. of the Interior Geological Survey 1967. Water Resources Data for Maine. Publ. Water Resources Division, U.S.G.S., Augusta, Maine.
- Warner, K., R. P. AuClair, S. E. DeRoche, K. A. Havey and C. F. Ritzi. 1968. Fish Predation on Newly Stocked Landlocked Salmon. J. Wildl. Mgmt., 32 (4): 712-717.

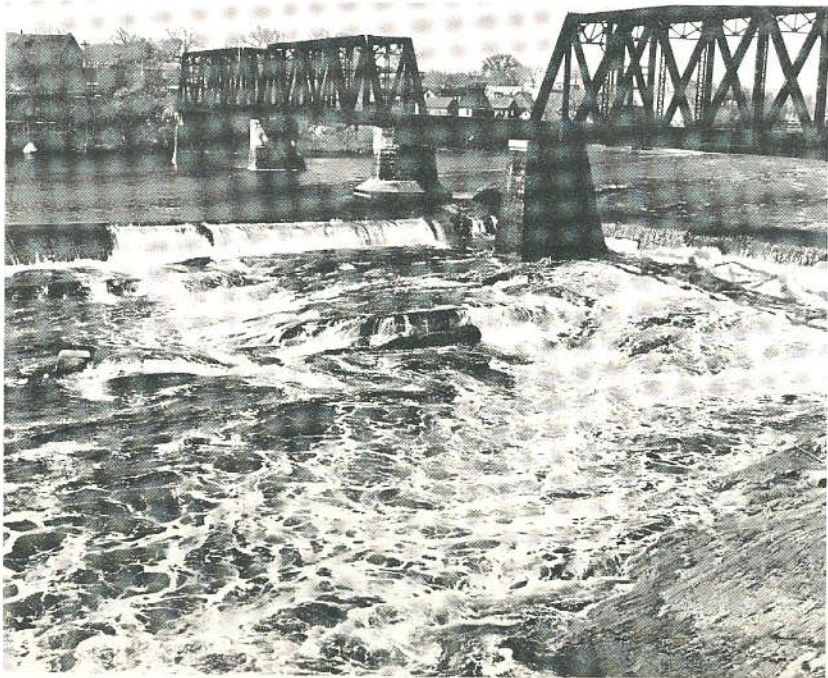
**APPENDIX**  
**Dams on the Main Kennebec River**



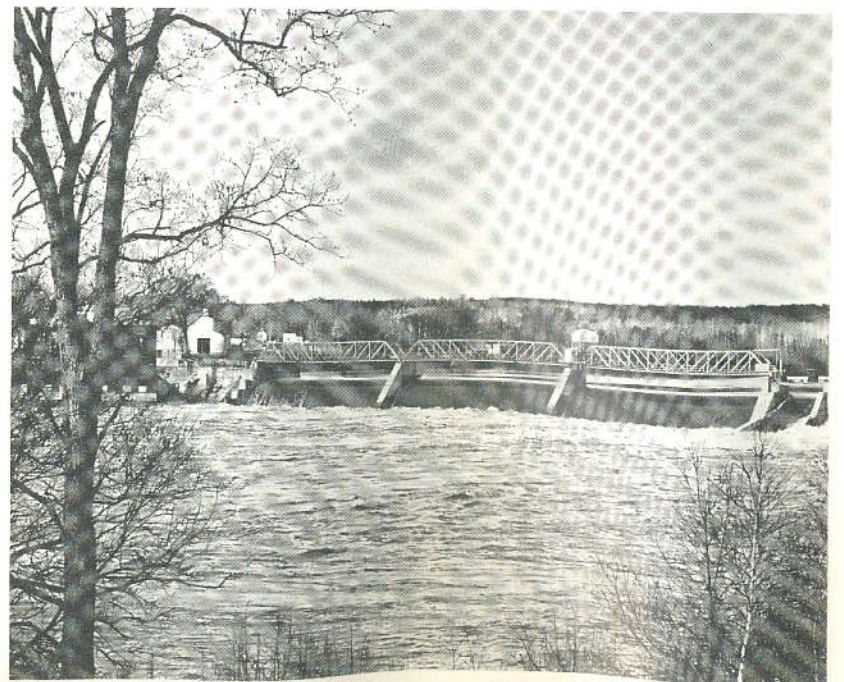
The Augusta Dam



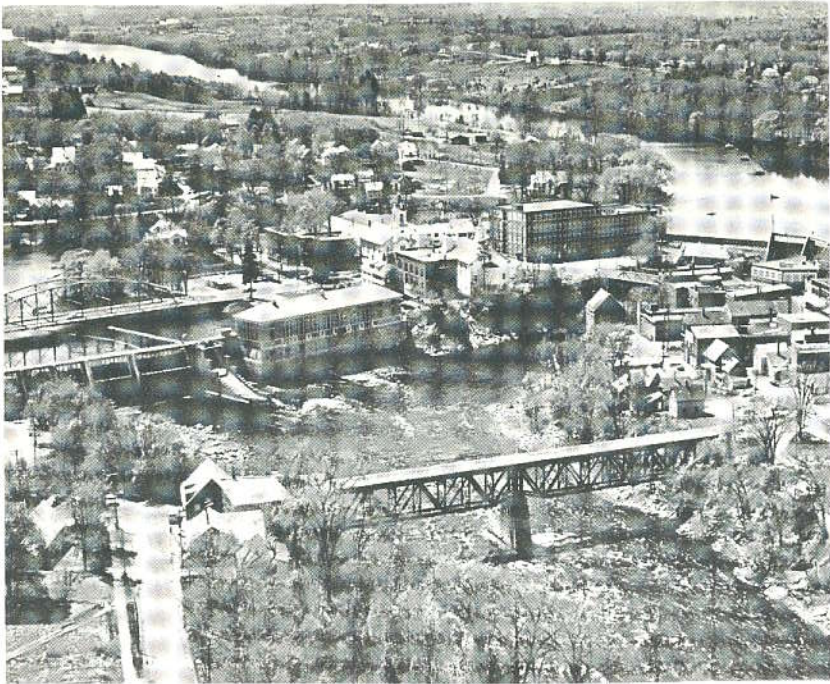
Upper Dam in Waterville - Winslow



Lower Dam in Waterville - Winslow



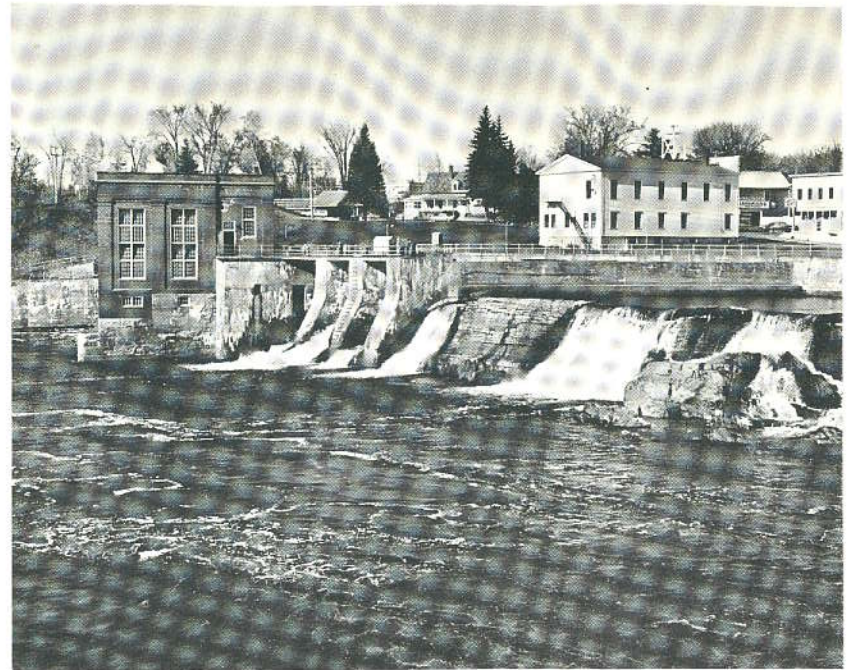
Shawmut Dam in Fairfield - Benton



Weston Dam in Skowhegan



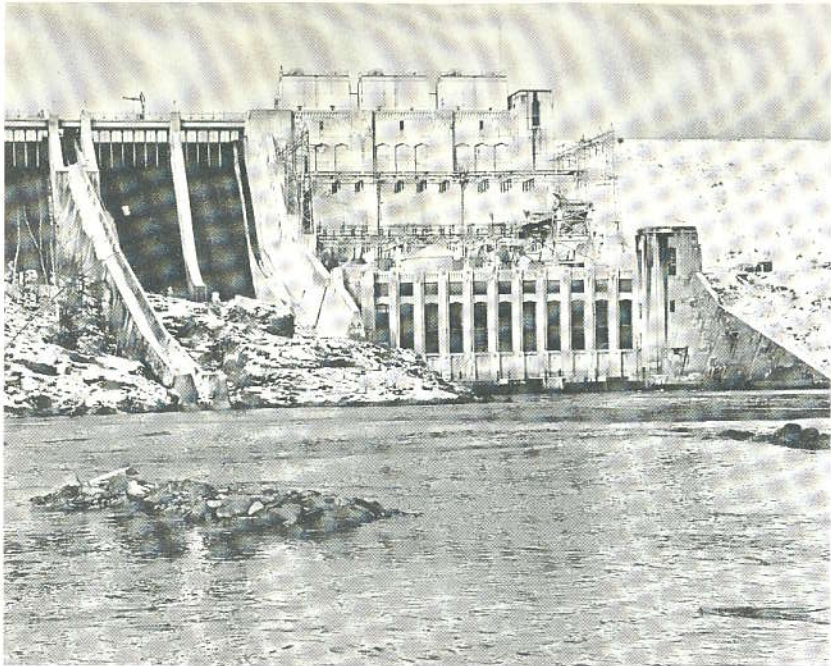
Lower Dam in Madison - Anson



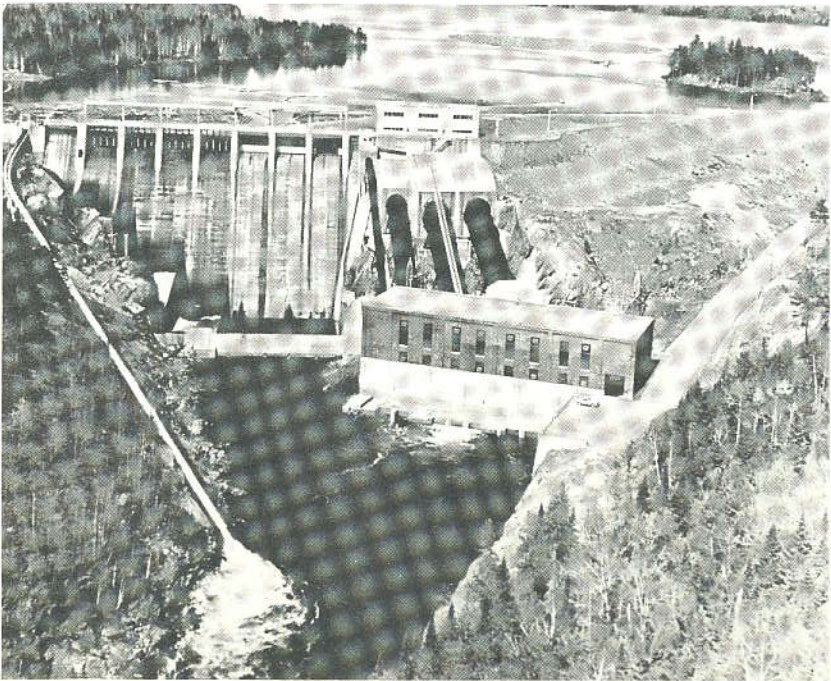
Upper Dam in Madison - Anson



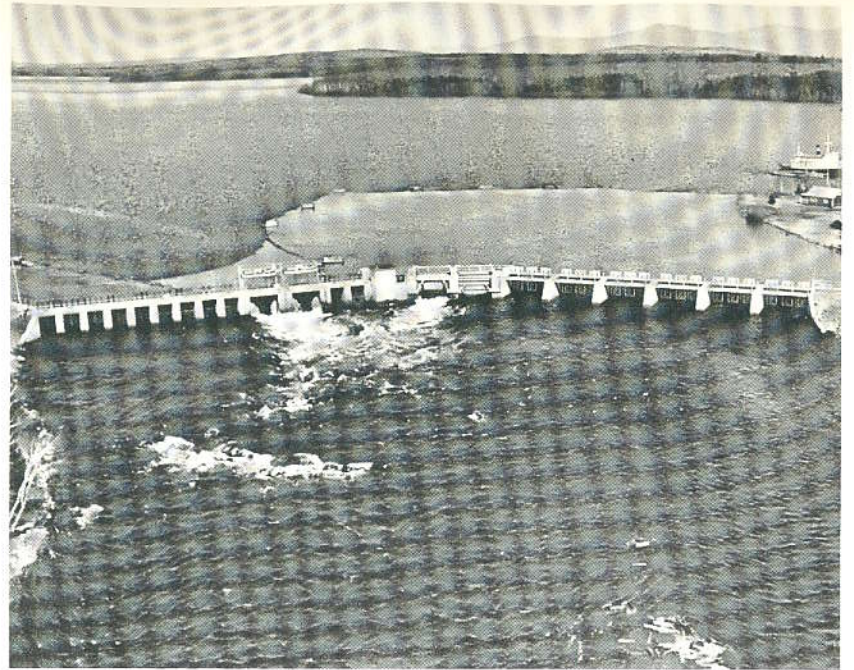
Williams Dam in Solon



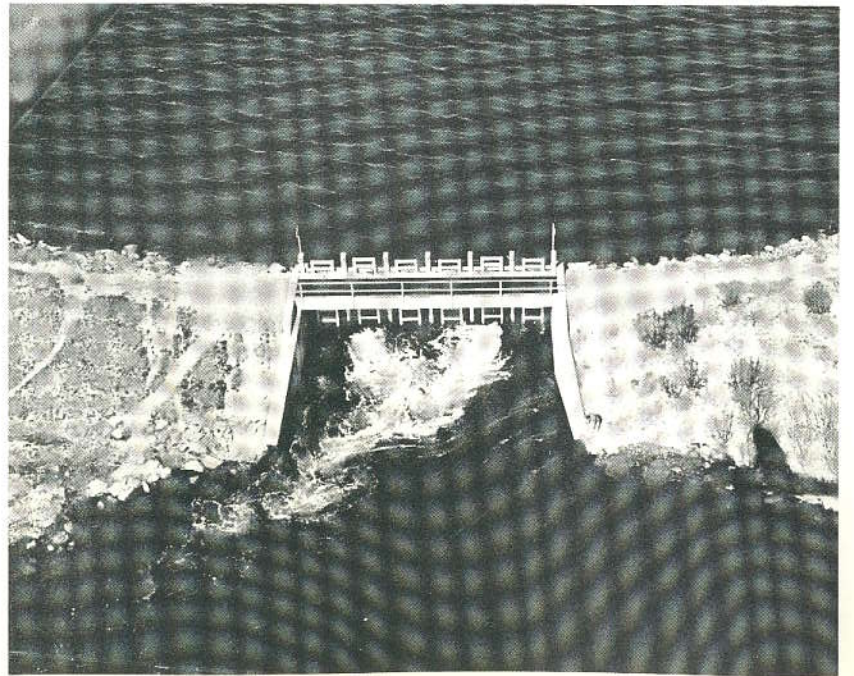
Wyman Dam in Moscow - Pleasant Ridge Plt.



Harris Dam at Indian Pond



East Outlet Dam at Moosehead Lake



West Outlet Dam at Moosehead Lake