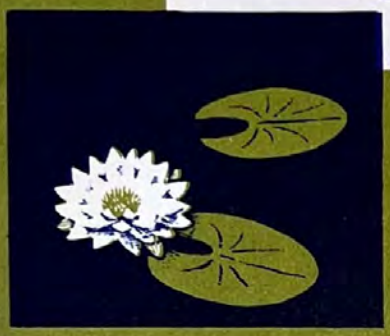
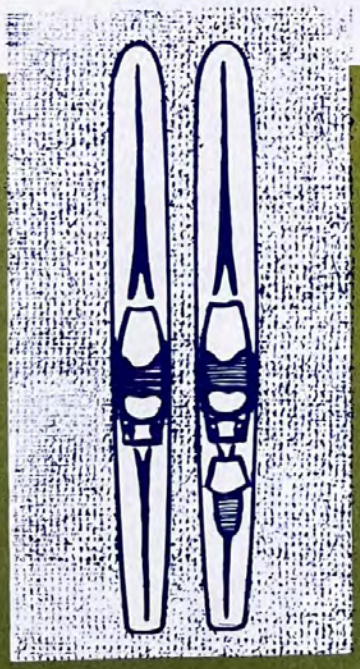


Fishery Management in the Androscoggin River



MAINE DEPARTMENT OF INLAND FISHERIES AND GAME

FISHERIES RESEARCH BULLETIN No. 7

FISHERY MANAGEMENT
in the
ANDROSCOGGIN RIVER

by

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Maine Department of Inland Fisheries and Game

Ronald T. Speers, Commissioner

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FOREWORD

A state-wide biological study of lakes, rivers, and streams is in progress to obtain facts to help your Fish and Game Department and Atlantic Salmon Commission maintain and restore the sport 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 Androscoggin River and its major tributaries from Umbagog Lake, New Hampshire to Merrymeeting Bay, Maine. Surveys already conducted by the Maine Water Improvement Commission, the Department of Health, Education and Welfare, and the Federal Power Commission provide information about the pollution problems and the industrial developments on the main Androscoggin River, but no river study is complete today unless it includes a consideration of fishery problems and potentials.

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Maine Department of Inland Fisheries and Game
November 1967

INTRODUCTION

The Abnaki Indians called it *Amascogin,* which means "fish coming in the spring." A section of Brunswick, Maine, was known as *Ammessukkautii,* "where there is an abundance of large fish." The seven Indian tribes that lived along the Androscoggin River had over 60 names and meanings for the Androscoggin River; all 60 of them referred either to the vast fast-water stretches of the river or the large numbers of anadromous fish that were present there. There is little doubt that anadromous fish played an important role in the lives of the Androscoggin River Valley Indian and of the early white settlers.

An early historian wrote, "The Androscoggin River has a troubled and difficult pathway"; yet, today, the only difficulty a canoeist might have in negotiating the river, with the exception of Rumford Falls and Lewiston Falls, would be in carrying his canoe around the 22 dams between Errol, New Hampshire, and Brunswick, Maine.

Not only have man-made obstructions blocked all migrations of anadromous fish and free movements of resident fish, but pollution from various industries and municipalities has destroyed the very habitat where fish live. Conditions are so deplorable on the main river from Berlin to Brunswick that all benefits normally contributing to the recreation industry are lost.

The Androscoggin River is the victim of Man's abuse.

The deplorable conditions on the Androscoggin are not new. As long ago as 1867, the Fisheries Commissioner recommended fishways in dams at Brunswick, Lisbon, and Lewiston. The Commissioner wrote, "The Androscoggin River is a noble river and, so far as I have examined, promises an easy task and great results to the cultivation of salmon. It should be thoroughly examined hereafter." As early as 1869, urgent petitions were received from citizens of Brunswick that fishways be built in dams. By 1875, more people were realizing the great injustice of permitting dams and pollution to destroy the fisheries. They felt that the loss of anadromous fish such as the Atlantic salmon, shad, alewives, and sturgeon far surpassed the capital gains from mills on the river, and they asked for stronger legislation to halt pollution and to require owners to build fishways in their dams. A drastic decline in numbers of Atlantic salmon was apparent as early as 1817, and as long ago as 1875, people began to realize the value of anadromous fishes, but nothing beyond a meagre stocking program in the 1800's has ever been done to protect and restore anadromous fish runs in the Androscoggin River.

Although the Androscoggin River has been abused for over 200 years, this is no justification for continued destruction and for the loss of this

valuable natural resource to the recreational industry and to the diversified industries which could contribute enormously to the economy of Maine. Man is beginning to appreciate the importance of outdoor recreation and to realize how essential clean waters are for recreation and diversified industry. Today, there are solutions to some of the problems that have been created. Many of the industrial wastes that pollute waters can be recovered and used to produce saleable by-products. Advancements in waste-water treatment systems make it possible to reduce the harmful effects of industrial pollutants before they enter a watershed.

Treatment plants for domestic as well as industrial wastes are becoming more common in progressive communities throughout the country. Fishery managers have developed methods of restoring fish populations in waters cleaned of harmful industrial and domestic wastes.

More sophisticated fishway designs are proving satisfactory in passing greater numbers of fish over high dams where fish attraction problems are great. Elevators to lift fish over exceptionally high dams are built into fishways, and fish collection systems are producing satisfying results in many of the larger West Coast Rivers. On some Pacific salmon rivers, where salmon runs have been blocked by huge dams, fishery workers have built artificial spawning channels below the dams, where salmon can spawn and then move only a short distance to the ocean. This easy access to the sea eliminates the long, and sometimes hazardous, journey young salmon would have if they had to move downstream over high dams. Young Pacific salmon, unlike Atlantic salmon, remain in these spawning channels for only a few weeks after hatching before they migrate to the sea. Young Atlantic salmon remain in active nursery areas in the river for two years before migrating to the ocean; therefore, work of this nature in Maine would require the construction of long stretches of nursery areas in addition to spawning channels.

Where rivers are blocked by numerous high dams, and fish passage is difficult even when fishways are available, fish collection systems are used to trap spawning fish at the lowermost dam on the river. The fish are then trucked to suitable upstream areas where they can spawn and the young salmon can find suitable nursery areas. This technique might be utilized with Atlantic salmon. Guiding systems, to lead downstream migrating salmon smolts around high dams and turbine intakes, are being used in many West Coast salmon rivers with some success. Although much more research is needed in the field of fishery biology, biologists are making significant strides in preserving and restoring fish populations in this nation's neglected rivers.

All of this sophistication in guiding systems, fish collection systems, spawning channels, nursery channels, fishway designs, and fish-lifting elevators costs money, a lot of money. Often, perhaps, the number of dams on a river such as the Androscoggin is too great to justify the costs of fish passage and fish guiding devices. When this is the case, alternatives are available to the fishery biologist. For example, it may be possible to manage sections of a river drainage for anadromous fish runs, providing the main river and the tributaries in a given section are suitable and the number of dams is few. In addition, sectional management of the remainder of the river drainage can provide excellent sport fishing for a varied number of resident game fishes. In the Androscoggin River, the variations in types of habitat that exist from Umbagog Lake in Errol, New Hampshire, to the falls at Lewiston, Maine, are numerous, and the possibilities for sectional fishery management are many. Such management would insure many happy hours of sport fishing throughout this vast river system.

In summary, the know-how is available to restore much of the river. Clean waters support game fish populations and provide a playground for people who are constantly seeking *all* forms of outdoor recreation. This report describes the fisheries potential of the Androscoggin River drainage and makes recommendations for fishery management based on the soundest biological and technological principles that exist today.

DESCRIPTION OF THE DRAINAGE

The Androscoggin River begins its trip to the sea at Umbagog Lake in Errol, New Hampshire, traveling in a southwesterly direction and then swinging southeasterly until it reaches tidewater at Brunswick, Maine, and then into Merrymeeting Bay and to the open sea. It has a drainage area of 3,460 square miles (750 square miles in New Hampshire, and 2,750 square miles in Maine), and a fall of 1,245 feet in its 161 miles. Based on a 36-year average annual rainfall of 42 inches, an average discharge of 6,000 c. f. s. can be expected. The Androscoggin River is the fourth largest drainage in Maine.

Williamson's *History of Maine* states that, prior to dam building, the Androscoggin River had more falls, rapids, and cataracts than any river of its size in Maine. Rumford Falls, with a drop of 162 feet in one mile, and Lewiston Falls, dropping 70 feet in one-half mile, are the only formidable cataracts that exist today. The majority of the rapids and falls that once characterized this great river are inundated by the numerous dams. In an early report, *The Indians of the Androscoggin Valley,* C. M. Starbird described the Androscoggin River from Berlin to Brunswick. This description is compared with the findings of the 1964 biological survey:

River Section	1807	1964
Berlin to Canton	No dams, Rumford Falls	12 dams, Rumford Falls
Canton to Lewiston	No dams, many dangerous rapids	7 dams, no dangerous rapids, long stretches of deadwater
Lewiston to Durham	No dams, no falls or great rapids	1 dam, no rapids or falls
Durham to Pejepscot	No dams, many falls and rapids	1 dam, no falls or rapids
Pejepscot to Brunswick	2 dams, no falls or rapids	2 dams, no falls or rapids

There are 163 lakes and ponds in the drainage below Umbagog Lake, and their total area is more than 37,000 acres with some 30,000 acres in Maine alone. The lakes vary in size from more than 4,000 acres to as little as 5 acres. Some are deep, coldwater lakes managed for trout and salmon, and some are shallow, warmwater lakes managed for bass and pickerel.

Approximately 85 percent of the drainage is in forest land, 4 percent in lakes and ponds, 5 percent in cropland, and 6 percent in municipalities. The estimated human population of the Androscoggin River Basin in 1960 was about 165,000. About 87 percent of these people live in Maine, one-half along the lower 30 miles of river.

ANDROSCOGGIN RIVER FISHERIES

History of Past Fisheries

The Atlantic salmon runs in the Androscoggin River prior to the early 1800's were bountiful. Salmon ascended the river as far as Rumford Falls and were abundant both there and in the Swift River, which enters the main river just below the falls. The Rumford Falls, because of one plunge of 80 feet at an angle of 30 to 40 degrees over ragged ledge, prevented salmon from ever reaching New Hampshire waters. The falls at Lewiston were difficult, but they did not prevent salmon passage. However, because of the difficult salmon passage, the pools below Lewiston Falls were noted for great salmon fishing. Indian tribes migrated to the Lewiston area to get their winter supplies of fish when the salmon were running.

Salmon ran in all the major tributaries, but runs in the Little Androscoggin River were the heaviest. The spawning migrations were stopped in this river at Snow Falls, with a favorite spawning area located just downstream from and opposite Paris Hill.

Atlantic salmon runs soon dwindled following the construction of dams in Brunswick, Lisbon, and Lewiston in the early 1800's. By 1817, only an occasional salmon was seen or caught at Rumford Falls. The last known Atlantic salmon was caught at Lewiston in 1815.

In 1628, Thomas Purchase caught and packed Atlantic salmon at Pejepscot Falls. In 1844, the run of salmon at Pejepscot Falls was extinct. The Atlantic salmon was doomed in the Androscoggin River from the first day the white man began to settle the Androscoggin River Valley in the early 1700's.

Atlantic salmon for commercial purposes were usually taken by weir, and until 1868 as many as 45 weirs were in operation in the lower Merrymeeting Bay area. People then believed that these weirs had much to do with the decline of Atlantic salmon, and regulations were made governing the sizes and depths of weirs and length of the open season. Drift nets and seines were also commonly used in the estuary to catch ascending salmon.

In 1871, a program of salmon stocking was started in the Androscoggin River with the introduction of 21,750 eggs. The Commissioner of Inland Fisheries and Game stated: "The whole 21,750 will, to say the least, be none too many to restock the Androscoggin River." Meanwhile, little progress was made in fishway construction although a half-hearted attempt was made to build a stone fishway in the dam at Brunswick. By 1874, as many as 100,000 salmon were being stocked in the Androscoggin River each year.

At the same time, many hearings were held in an attempt to compel dam owners to build fishways. The Commissioner urged the Legislature to give him more authority for fishway construction.

In 1884, the Commissioner reported: "Our poverty of resources has prevented us from properly stocking the Androscoggin River. Dams multiply faster on the river than we (the Department) can cope with. Manufacturers not only obstruct the river with monstrous dams, but, by the criminal neglect of the Legislature in providing restrictive laws, the bed of the river is covered with waste matter that destroys both spawning beds as well as food for fish. Poisonous matter from Brunswick factories destroyed the spawning grounds of shad and alewives and drove them away. Although fishways are built in the dams at Brunswick they are inadequate — they are not built to plan or design of our engineers." *So far as is known, this was the end of the only attempt ever made to restore runs of anadromous fish to the Androscoggin River.*

The Present Fisheries

Dams and pollution have destroyed the runs of anadromous fish in the Androscoggin River and limited the production of resident game fishes. Atlantic salmon taken in the river since about 1870 have been rare, and they presumably were strays from other Maine salmon rivers.

The main river above Berlin, New Hampshire, is classified as an excellent trout stream, and natural populations of brook trout provide the bulk of the fishing there. A limited rainbow trout and brown trout fishery is maintained by a stocking program, and an occasional landlocked salmon is also caught.

Pollution in the 120 miles of river from Berlin to Brunswick has virtually destroyed the natural environment for all game species of fish. There is evidence that small populations of brook, brown, and rainbow trout are resident in this stretch of river, but they are restricted to the areas around the mouths of tributaries where cool water and high oxygen levels are found. Spawning runs of rainbow trout enter some of the tributaries in the spring and provide a limited fishery.

A limited warmwater fishery for bass and pickerel exists in some of the coves and backwater areas along the main river. Generally speaking, it can be said that no appreciable fishery of any kind exists in the Androscoggin River from Berlin, New Hamphire, to Brunswick, Maine. A fragmentary run of alewives is still present in the river below Brunswick, but the limited numbers of fish do not justify a commercial fishery.

Most of the streams entering the main river provide fishing for brook, brown, and rainbow trout. Brook trout provide the bulk of the fisheries and are maintained naturally, while brown trout and rainbow trout offer limited fishing as the result of an annual stocking program. A few of the slow-moving, deadwater streams provide good fishing for bass and pickerel.

More than half of the 37,000 acres of lakes and ponds in the drainage below Umbagog Lake provide coldwater fishing for brook trout, salmon, lake trout, brown trout, or combinations of these. One hundred and thirty-nine lakes in the drainage have been biologically surveyed and are being managed for game fishes as part of the Maine Fish and Game Department's program.

Late in the 1800's, Man unknowingly went a step further in complicating anadromous fish restoration in the Androscoggin River by introducing European carp into some of Maine's coastal waters. The carp, a highly prolific fish, (one female may lay as many as 1,000,000 eggs) can literally "take over" lakes and streams in a matter of a few years. Fortunately, carp have not become established in Maine's inland waters, but they are well established in a few of the tidal estuaries of southern and central Maine's major river systems, including the Kennebec and Androscoggin rivers. Carp do, therefore, pose a realistic and constant threat to Maine's inland waters. Confinement of this species to southern and central Maine's coastal estuaries has probably been maintained by impassable dams above or at head-of-tide on coastal rivers and by high salinity levels which prevent coastwise migrations of carp into other Maine rivers.

When an Atlantic salmon, shad, or alewife restoration program is considered for any of Maine's coastal rivers, *every precaution must be taken to prevent the spread of carp to inland waters.* Once carp have become established in a drainage, there is little that can be done to eliminate them. Maine must not make the mistake of allowing carp to be introduced into its inland waters and thus further endanger freshwater sport fisheries. The threat of carp introduction into the upper Androscoggin River drainage makes the trapping and trucking of anadromous fish into up-river areas extremely dangerous.

OBSTRUCTIONS

All upstream fish passage is blocked and many miles of salmon spawning and nursery area are inundated by 40 dams in the Androscoggin River drainage (see center spread). Actually, there are 23 dams on the main river, plus 18 more on the tributaries; but, since only that part of the drainage

lying below Umbagog Lake is considered in this report, the total number of dams in the drainage will in most cases be referred to as 40, and the number on the main river as 22.

The Main River. As long ago as 1867, the Commissioner of Inland Fisheries and Game attempted to have fishways built in the dams in Brunswick, Pejepscot, and Lewiston, and he asked the Legislature to make more stringent laws concerning the building of fishways by dam owners. This policy did not continue, unfortunately, because in a little less than 100 years, 23 dams without fishways were built on the main stem of the Androscoggin River. The river falls 1,090 feet from Berlin to Brunswick, and hydroelectric plants use 790 feet of this drop. Table 1 lists the dams on the main Androscoggin River from Brunswick, Maine, to Errol, New Hampshire, and sketches of these dams appear in Appendix I to familiarize the reader with some of the structures and to help him better understand some of the fish passage problems.

Hydroelectric plants and pulp and paper mills generally discharge large volumes of water at one or two points in the dam. During periods of low run-off, the only source of river flow may be these discharge points. In periods of high water, the river flow is usually distributed over the entire length of the dam. Fish passage devices must be designed to pass fish during all migration periods and must be located at areas of the dam where fish are most apt to congregate. Because this is the situation that exists at most of the dams on the Androscoggin River, fish passage over these dams would require more than one fishway, and, in some cases, rather sophisticated fish collection systems would be needed.

As migrating fish approach a hydro- or mill-operated dam, their direction of movement and upstream progress are influenced by the velocity of water flowing through and over the dam, water turbulence, and eddying currents that are created at draft tubes and tail races. The point or points below a dam where the greatest number of fish are attracted should be the location for fishway entrances and fish collection systems.

Figure 1 may help the reader to understand how, as migrating fish approach an obstruction, they are directed (or led) by the collection system (A) to the fishway entrance (B). A fish collection system (insert, Figure 1) is no more than a channel or gallery, constructed along the face of the powerhouse tailrace, into which fish are attracted and led to the fishway. An auxiliary water supply, controlled by a regulating gate or valve, provides attraction into the collection gallery. Fish attracted to the opposite side of the river during freshet periods are led into the fishway entrance (C) either

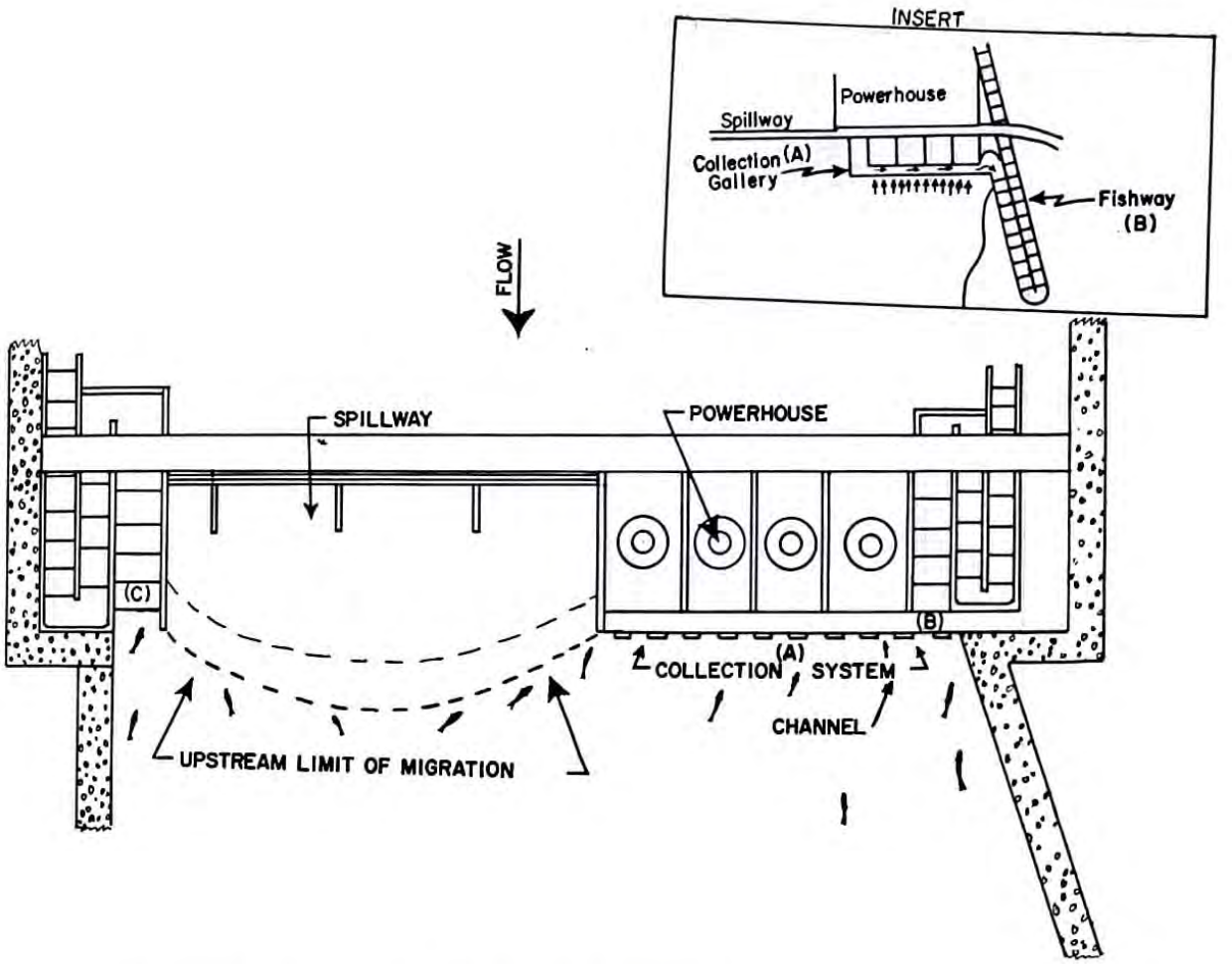

FIGURE I. DAM WITH POWERHOUSE, COLLECTION SYSTEM, AND TWO FISHWAYS

by eddying currents or behavioral swimming patterns of the fish as they reach the upstream limits of migration.

A full consideration and an understanding of fish behavior are exceptionally important in planning fishway locations and in designing a fish collection system. The most efficient fishway and the most costly fish collection system are no better than the planning that goes into locating the structures so the fish will find them easily and quickly.

In structures where the entire river flow is passed overland through giant penstocks (Appendix I, page 41), elaborate downstream fish collection and diversion systems are necessary. Provisions to transport the migrating fish to upstream locations by conveyors, elevators, or by trapping and trucking, are needed. Fish passage devices of this nature would be necessary in the Cascade, J. Brodie Smith, and Riverside Plants in Berlin, Appendix I, pages 48, 42, 43).

Table 1. Dams on the main Androscoggin River from Brunswick, Maine, to Errol, New Hampshire.

Dam number	Plant name	Owner	River mile	Town	Gross head (feet)	Pond area (acres)
1	Brunswick	Central Maine Power Co.	8	Brunswick	15	12
2	Topsham	Central Maine Power Co.	8	Topsham	22	300
3	Pejepscot	Pejepscot Paper Co.	13	Topsham	19	—
4	Lisbon Falls	J. P. Stevens Co.	16	Lisbon Falls	19	—
17	Lewiston Falls	Union Water & Power Co.	31	Lewiston	15	200
17	Lewiston	Pepperell Mfg. Co.	31	Lewiston	36	—
	Lewiston	W. S. Libby Co.	31	Lewiston	28	—
	Lewiston	P. Hall Enterprises	31	Lewiston	22	—
	Lewiston	Bates Mfg. Co.	31	Lewiston	27	—
	Hill Division	Bates Mfg. Co.	31	Lewiston	27	—
	Androscoggin	Bates Mfg. Co.	31	Lewiston	36	—
18	Lewiston	Lewiston Public Works	31	Lewiston	36	—
19	Deer Rips	Central Maine Power Co.	34	Lewiston	33	130
	Androscoggin No. 3	Central Maine Power Co.	34	Lewiston	36	130
20	Gulf Island	Central Maine Power Co.	35	Lewiston	59	2968
23	Livermore Mill	International Paper Co.	61	Livermore Falls	32	46
24	Otis	International Paper Co.	62	Chisholm	26	115
25	Jay	International Paper Co.	64	Jay	14	206
26	Riley	International Paper Co.	67	Riley	22	578
28	Rumford (Lower)	Rumford Falls Power Co.	87.2	Rumford	80	—
29	Rumford (Upper)	Rumford Falls Power Co.	87.4	Rumford	97	400
33	Shelburne	Brown Paper Co.	128	Shelburne, N. H.	16	300
34	Gorham	Public Service Co., N. H.	130	Gorham, N. H.	18	—
35	Gorham	Brown Paper Co.	133	Gorham, N. H.	28	6
36	Cascade	Brown Paper Co.	135.6	Gorham, N. H.	46	5
37	Cross Power	Brown Paper Co.	136	Berlin, N. H.	21	4
38	J. Brodie Smith	Public Service Co., N. H.	137	Berlin, N. H.	88	8
39	Riverside	Brown Paper Co.	137.8	Berlin, N. H.	65	3
40	Sawmill	Brown Paper Co.	138	Berlin, N. H.	17	—
41	Umbagog	Union Water Power Co.	172	Errol, N. H.	15	—

The development of the Androscoggin River's industrial potential still continues. Six sites for potential power and storage projects suggested by various government agencies have received some consideration. They are:

1.	Errol	55-foot head
2.	Millidgewock	45-foot head
3.	Pontook	80-foot head
4.	Pulsifer Rips	40-foot head
5.	Gilead	40-foot head
6.	Dixfield	25-foot head

These dams would provide another 314,000 acre-feet of storage in the main river.

Proposed flood control dams and reservoirs are being considered at two sites:

1.	Pontook Project	Dummer, N. H.
2.	Ellis River	Hanover, Maine

The multiple purpose project at Pontook would provide 254,000 acre-feet of storage. When filled to top of the flood pool, the Pontook reservoir would inundate an area of 7,470 acres with a drawdown of 23 feet. This project, if completed, will destroy 25 miles of excellent trout fishing in the main stem of the Androscoggin River from Errol to Berlin, New Hampshire. The Department of Health, Education and Welfare recently completed a survey of the Androscoggin River for the Department of the Army, and in their report they concluded that: "Since available controlled flows are ample on the Androscoggin River to meet anticipated needs, no benefits can be assigned to the Pontook Project for water storage, for water supply or water quality control purposes." Any of the above projects, if completed, will destroy many miles of coldwater fish habitat by inundation of spawning and nursery areas.

Tributary Obstructions. Most of the Androscoggin River tributaries that once supported runs of Atlantic salmon now have dams on them. Only the larger tributaries, where dams are creating problems in fishery management, are described in this section.

Little River

The Little River has one low, 4-foot dam that could prevent salmon from using the 1½ miles of spawning and nursery areas above this obstruction. This low-head dam presents no problem in fishway design. Migrating salmon would have to pass over 4 dams on the main stem of the Androscoggin River before reaching the mouth of the Little River.

Little Androscoggin River

As early as 1874, a dam on this river at Auburn blocked the runs of Atlantic salmon up this most-used spawning tributary. Today, besides the 4 dams on the main river, 11 obstructions from Auburn to West Paris block upstream migrations of fish. Snow Falls is the only natural barrier on the river, and early records report that salmon were stopped in their upstream migration by these falls.

A brief description of the fish passage conditions for the 11 dams on the Little Androscoggin River are as follows: the numbers in parenthesis are as those on center spread map.

1. Barkers Mill Dam (No. 6). This 30-foot dam is located a short distance upstream from the confluence with the Androscoggin River. Built in 1874, it marked the beginning of the end for all anadromous fish runs in the Little Androscoggin River.

2. Old Stone Dam (No. 7). This old, inoperable dam is located a short distance upstream from dam No. 6. It offers a 12- to 30-foot obstacle to upstream migrating fish. This dam should be removed to allow free fish migrations and movements.

3. & 4. Littlefield Corner Dams (No. 8 and No. 9). These dams are located at the Canadian National Railroad crossing above Auburn. The lower dam, which is of log crib construction, is in poor repair, and offers a 4-foot vertical jump to upstream migrating fish. About 500 yards upstream from this dam, there is a huge, inoperable power dam that has been made passable to migrating fish at most water levels by the washing away of a large portion of the spillway section. These dams should be removed so migrating fish can have free movement at all water levels.

5. Hackett Mills Dam (No. 10). This dam, located above Minot, presents an 8-foot vertical jump to upstream migrating fish. It is operable and provides water for mill use.

6. Mechanic Falls Dam (No. 11). This is a 10-foot high, spillway-type dam. During periods of low water, the entire stream flow is diverted through the gates and into a canal to the mill.

7. Welchville Dam (No. 12). This is a wooden, spillway-type dam that presents a 6-foot vertical jump to migrating fish. Except during periods of high water, the entire stream flow passes through the sluicegate section.

8. South Paris Dam (No. 13). This is a 15-foot high, spillway-type dam that supplies water to a tannery and a food processing plant. It is a complete barrier to upstream migrating fish.

9. Bisco Falls (No. 14). These are natural falls that have a concrete sluice-gate arrangement constructed on top of ledge. These falls may be passable to fish during periods of high water, but when water levels are low, they offer a 6-foot vertical jump to migrating fish. When Atlantic salmon ascended this river, these falls were not considered a barrier. The removal of the apparently unused sluice-gate section on top of these falls would make them completely passable to migrating fish at all water levels.

10. Snow Falls (No. 15). This natural barrier is located a short distance above Bisco Falls. A sheer drop of 20 feet over ledge prevents fish from ascending these falls.

11. West Paris Dam (No. 16). This is a log crib dam that is a complete barrier to upstream fish migration. The dam is not in use at the present time and should be removed.

There are a few low beaver dams in the Little Androscoggin River between West Paris and Greenwood, but they are of little consequence to fish passage.

Nezinscot River

Only two dams on this river are considered barriers to upstream fish migrations; however, 8 dams on the main Androscoggin River must be passed before upstream-migrating fish could reach the mouth of the Nezinscot River.

1. Turner Dam (No. 21). This is a typical, small mill dam with an 8-foot high spillway that spans the entire river. The dam is not in use at the present time, and its removal would insure free movement of fish up this river.

2. Buckfield Dam (No. 22). This dam is similar to the Turner Dam, and offers a 6-foot vertical jump to upstream migrating fish. This dam is not in operation, and its removal would insure free movement of fish in this section of the river.

Swift River

Large numbers of Atlantic salmon ascended this river in days past, and the mouth of the river below Rumford Falls used to be a favorite fishing spot. Today, upstream fish passage is blocked by 12 main Androscoggin River dams plus one dam and two natural barriers on the Swift River.

1. Sawmill Dam (No. 27). This dam is located about three miles upstream from the junction with the Androscoggin River and is probably a complete barrier to upstream migrating fish.

2. A natural falls is located about 6 miles upstream from the Sawmill Dam. This falls is probably passable at some water levels.

3. A natural falls and cascades are located in the town of Byron. These falls may be passable at some water levels.

East Branch, Swift River

The East Branch of the Swift River has the most salmon spawning and nursery potential of all the tributaries of this river. However, for migrating salmon to reach the 10 miles of suitable area, they must be assured passage over the three obstructions located on the main Swift River and the 12 dams on the main Androscoggin River.

West Branch, Swift River

Only the lower mile of this river is suitable for salmon. The upper reaches of the West Branch are very steep and have many impassable barriers. This tributary is located above the three barriers on the main Swift River.

Ellis River

There are two impassable barriers (No. 31 and No. 32) on the Ellis River. One is a dam at East Andover, and the other is a natural falls located two miles above this dam where the Ellis River crosses Route 120. Fourteen dams on the main Androscoggin River prevent fish from reaching the mouth of the Ellis River.

West Branch, Ellis River

This tributary has good spawning and nursery areas throughout its entire length. An old sawmill dam located in East Andover obstructs upstream fish migrations. The dam is not in use and is in poor repair; it should be removed.

New Hampshire Tributaries

So far as is known, there are no dams on any of the major New Hampshire tributary streams that enter the Androscoggin River; however, up to 22 dams on the main Androscoggin River below Errol, N. H., prevent upstream-migrating fish from reaching the mouths of these tributaries. Natural obstructions do occur in some streams, but these are generally in headwater areas and would be of no great consequence to Atlantic salmon restoration.

The U. S. Soil Conservation Service has plans for several flood prevention-recreation pond projects on several of the tributary streams that enter the Androscoggin River. Even though fishways may be recommended in

most of these proposed dams, the destruction of coldwater fish habitat by inundation will be considerable. Not only is a sizeable area of the trout stream destroyed by flooding, but the flowages created by these dams usually improve the habitat for warmwater fish, and their subsequent increase in numbers is detrimental to the successful management for trout and salmon. In this era of human population increase and increased demand for trout and salmon fishing in the Northeast, we can not afford to destroy our trout and salmon streams when there are alternative programs which will solve the problems of periodic flooding. It doesn't make very good sense to destroy God-given sources of recreation that Man has enjoyed since the beginning of time for an artificial lake which may not provide the quality of recreation desired by the recreation industry.

THE FISHERY AND RECREATION POTENTIAL

The ability of a watershed to produce and grow fish is measured by the amounts of spawning and nursery area present and the quality of the water to support fish life. When the factors that are necessary to produce and grow fish are present, fishery biologists may describe this in terms of the watershed's having a *potential* to produce a particular sport fishery. If the biological potential is great, and a sizeable sport fishery is possible, the full realization of this potential becomes the basis for the recreation industry which will follow.

A biological survey measures the physical and chemical characteristics of a watershed and provides data to predict the contribution a drainage may make to sport fishing and to the outdoor recreation industry. The magnitude of the over-all potential to provide fishing and outdoor recreation, which, by the way, is already a multi-million dollar industry in Maine, must be compared with the costs of fish passage devices and wastewater treatment plants.

Because Atlantic salmon played such an important role in the lives of the Indians and early settlers who lived along the Androscoggin River, and because this majestic fish is the envy of every salmon fisherman who ever wet a fly, one major purpose of this report is to show what Man has done in 200 years to destroy perhaps forever the Atlantic salmon runs in the Androscoggin River. The loss of Atlantic salmon runs in the Androscoggin River occurred over 150 years ago; therefore, the present generation, which has never known salmon fishing in the Androscoggin, should not consider it an earth-shaking discovery that the loss of the Atlantic salmon to this river is now perhaps permanent. Although the dams in the Androscoggin

River drainage make it impractical to restore and maintain anadromous fish runs, sectional management of the Androscoggin River for sport fishing is possible and practical. With pollution abatement in the main Androscoggin River and in the Little Androscoggin River, over 130 river miles will become available for fishery management. The restoration of sport fishing in these 130 miles of river will result in a tremendous economic improvement to the area. There is much to be saved by restoring the Androscoggin River to a quality where people can use it to full recreational potential.

The Main River

The Androscoggin River has a large potential to produce Atlantic salmon; however, restoration costs would be mountainous. As will be emphasized later in this report, it is quite probable that because of the dams on the main river and on the major tributaries, restoring an Atlantic salmon run in this watershed is impossible. Even though the main Androscoggin River has about 13 million square yards of spawning area and nearly 14 million square yards of nursery area (Table 2), the complications that the dams on the main river pose to upstream and downstream fish migrations make it very doubtful if enough fish could ever reach the suitable area, or return to the ocean, to make restoration costs feasible, or to approach anywhere near the full biological potential of the drainage.

Table 2. Square yards of spawning and nursery area on the main Androscoggin River.

Location	River miles	Spawning	Nursery	Resting pools
		Square yards (miles)		
Umbagog Lake to Berlin	17	2,807,640 (6.5)	2,807,640 (6.5)	good
Berlin to Maine border	34	None	None	deadwater
Maine border to Jay	57	10,146,667 (38)	10,146,667 (38)	good
Jay to Lewiston	30	30,000 (0.06)	470,000 (1.3)	fair
Lewiston to Brunswick	23	10,000 (0.03)	326,000 (1)	fair
Totals	161	12,994,307	13,750,307	

The 53 miles of the Androscoggin River below Jay have very little spawning and nursery area for salmon; however, from Jay to the New Hampshire border and from Berlin, New Hampshire, to Umbagog Lake, the main river is characterized by its near-ideal physical conditions for Atlantic salmon. Before salmon can get to the upper reaches of this river where most of the favorable conditions exist, however, they must pass over 22 main river dams, and the pollution load in 120 miles of river must be greatly reduced. Not only must adult salmon reach the upper reaches of the river to spawn and the young salmon find suitable nursery area to live in for a couple of years, but salmon smolts migrating to the sea *must be assured safe passage down over or through the main river dams.*

Tributary Streams

The total spawning and nursery area present in the tributary streams between Errol, New Hampshire, and Auburn, Maine, is summarized in Table 3. It can be generally stated that the 24 tributary streams listed in Table 3 have good to excellent conditions for Atlantic salmon production. Aside from the vast areas for breeding and rearing young salmon, these streams contain deep, active pools suitable for mature salmon to hide and rest in.

Remember that a certain number of dams on the main Androscoggin River must be passed in addition to those on the tributary stream itself before upstream migrating fish can reach the suitable spawning areas in the tributary system.

Maine Tributaries

Little River

This river has scattered spawning and nursery areas for salmon. Resident brook trout are not present in sufficient numbers to provide an adequate sport fishery. One dam (No. 5) in Lisbon Falls blocks all upstream fish migrations.

Little Androscoggin River

The Little Androscoggin River was noted for its large runs of Atlantic salmon, and a considerable potential remains for salmon. However, upstream-migrating fish are blocked by 11 dams. Pollution from a tannery and food processing plants in South Paris and a tissue paper mill in Mechanic Falls has rendered many miles of this river useless for fish production. An equal number of river miles have been destroyed aesthetically by stench and ugliness resulting from the deposit of residue from these industries.

Table 3. Summary of the spawning and nursery area for salmon in the drainage.

	Square Yards	
	Spawning	Nursery
Maine		
Androscoggin River (main stem)	12,994,307	13,750,307
Little Androscoggin River	1,255,200	660,000
Nezinscot River	619,520	502,400
Concord River	897,680	897,780
Pleasant River (West Branch)	580,000	580,000
Little River	105,600	52,800
Seven Mile Stream	56,613	56,613
Webb River	63,653	90,053
Swift River	440,000	611,307
East Branch	49,866	60,426
Berdeen Stream	22,000	53,680
West Branch	None	8,800
Ellis River	440,000	88,000
West Branch	70,104	36,080
Black Brook	None	8,800
Sunday River	137,860	54,267
Bull Branch	11,733	11,733
South Branch	None	25,000
Bear River	142,410	80,810
Great Brook	None	1,467
New Hampshire		
Wild River	96,800	96,800
Peabody River	140,360	140,360
Moose River	87,120	87,120
Chickwolnepy Stream	48,400	48,400
Clear Stream	96,800	96,800
Total	18,356,026	18,099,803

Nezinscot River

The upper reaches of the Nezinscot River are suitable for Atlantic salmon production, but long stretches of deadwater characterize the lower river.

The *West Branch* above West Sumner has a high potential for Atlantic salmon. Much of it consists of spawning gravel. An excellent brook trout fishery exists in this branch of the Nezinscot.

The *East Branch* has limited nursery area for salmon, and no appreciable coldwater fishery exists there.

Two inoperable dams at Turner and Buckfield obstruct all upstream movements of fish in the Nezinscot River.

Concord River

Much of the Concord River is suited for Atlantic salmon production. Competition from large populations of white suckers and minnows could greatly reduce this potential, however. Brook trout are present in most of the cold tributaries, and they are established throughout the main river. All upstream migrations of fish are blocked by the single concrete dam (No. 30) that is located a short distance above its confluence with the Androscoggin River. This dam is not in operation and is in poor repair.

Pleasant River

Only the West Branch of the Pleasant River has a potential for Atlantic salmon. Resident trout populations include brook, brown and rainbow. All three are maintained naturally, but annual stocking is necessary to provide satisfactory fishing. No barriers to fish migrations are found in this river.

Seven Mile Stream

The upper six miles of Seven Mile Stream have good spawning and nursery areas for salmon, but the lower three miles are limited as smolt-producing areas. Resting pools for adult salmon are most abundant in the lower three-mile section, but pools are few and of poor quality in the upper section. There are no obstructions on this river.

Webb River

The spawning and nursery areas of the Webb River are concentrated in the five miles below Webb Lake. Smolt production could be greatly reduced in this area by competing populations of pickerel, bass, and suckers. The remaining 10 miles of river would be valuable to salmon only as a resting-pool area.

Natural ledge cascades upstream from the bridge on Route 17 are probably passable to fish at most water levels, but they may require some alteration to pass fish efficiently.

Low flows in the tributaries to the Webb River limit the potential for salmon, although several maintain populations of brook trout and brown trout.

Swift River

The Swift River, renowned for its Atlantic salmon runs of yesteryear, has good spawning and nursery areas throughout its entire length. There are three barriers to fish migrations on this river.

The *East Branch* of the Swift River has the most salmon potential of all the tributaries. Before Atlantic salmon could enter the East Branch, however, they must pass over the three barriers on the main Swift River in addition to those on the main Androscoggin.

Stockbridge Brook and Bradeen Stream are tributaries to the East Branch that have additional salmon potential.

The *West Branch* has limited nursery area, and its few spawning areas are located in the lowermost mile of stream. Above this, the river becomes steep, and impassable falls block all upstream migrations.

Other tributaries of the Swift River are too small to offer more than limited potential for salmon.

Ellis River

The Ellis River is 24 miles long, but the best spawning and nursery areas are located in the five miles below Ellis Pond. Resting pools are numerous and of good quality throughout the main river. A long stretch of spawning area is located below Ellis Pond, but smolt production would be limited because there is no nursery area. Competing pickerel, bass, white perch, and yellow perch throughout the main Ellis River would further reduce smolt production.

Upstream-migrating fish must be provided passage over a dam and a natural falls if they are to reach the best spawning and nursery areas.

Pollution in the form of sawdust, woodchips, bark, slabs, and edgings occurs in this river between East Andover and the West Branch of the Ellis River.

The West Branch is the largest tributary of the Ellis River, and it has good spawning and nursery areas throughout most of its length. One dam at East Andover obstructs fish passage. Many of the tributaries of the West Branch have limited salmon potential.

Sunday River

The upper 3½ miles of the Sunday River have good spawning and nursery areas for salmon. The lower section has over 4 miles of spawning area. There are no obstructions to fish migrations in the main Sunday River.

Bull Branch of the Sunday River has about one mile of good spawning and nursery area that is located below a series of natural falls and a steep gradient that make this stream impassable to all upstream-migrating fish.

South Branch of the Sunday River has extensive nursery areas, but spawning areas are limited. Low summer flows would probably be the biggest limiting factor in producing salmon in this stream.

Bear River

The Bear River has considerable spawning and nursery areas for salmon. Several natural falls and cascades are considered barriers to upstream fish migration; six such barriers are located in the upper sections.

Great Brook is the only tributary that offers any salmon potential, and this is limited.

New Hampshire Tributaries

Wild River

The Wild River, located in both Maine and New Hampshire, has considerable potential for Atlantic salmon throughout its entire length. Smolt production would be reduced, however, by torrential spring flows and bottom scouring. There are no dams on this river.

Peabody River

This river has a potential for salmon, but due to channel straightening and bulldozing, this potential has been greatly reduced. The bottom is predominantly boulder rubble which creates almost ideal nursery conditions.

Moose River

Moose River has long stretches of spawning and nursery areas which should offer a good potential for Atlantic salmon. This stream, like many in this section of New Hampshire, is subject to heavy scouring during spring flows. It is quite infertile; therefore, smolt growth would be expected to be slower than normal.

Chickwolnepy Stream

The upper seven miles of the Chickwolnepy have good habitat for salmon. The lower four miles have a gravel bottom and the gradient is quite gradual, which does not lend itself to salmon production. A few deep pools in this section could be used for resting pools by adult salmon.

Clear Stream

Clear Stream is virtually all good for salmon spawning and nursery. The stream bed is predominantly rubble which offers long stretches of good nursery area.

Many of the tributary streams from Bethel, Maine, to Umbagog Lake, New Hampshire, are characterized as clearwater, infertile streams subject to heavy scouring during the spring run-off. Smolt production in many of these mountain streams would vary from year to year depending upon spring run-off, summer water temperatures, and river flow.

With the exception of the Little Androscoggin River, tributary streams mentioned in this report remain unspoiled by industrial pollution and relatively free of dams. Sport fishing for brook trout, brown trout, and rainbow trout is enjoyed in most of these streams, and in some, fishing for combinations of the three species occurs. After seeing any of these streams, one is saddened to realize that soon this sparkling-clear water must empty into "Man's catch-all," the Androscoggin River.

The numerous smaller trout streams that enter the main watercourse provide good to excellent trout fishing, and they certainly are a major contributor today, if not the only contributor, to the recreational sport fishing industry in the Androscoggin River basin. Many of them would provide spawning and nursery areas if the main river were sectionally managed for trout.

Electrofishing and netting operations in most of the Maine tributaries revealed that the brook trout is the predominant coldwater species present. Brown trout and rainbow trout occur, but only rarely is a well-established natural population found. Where a combination of all three trout species occur, brown trout and rainbow trout compete for supremacy.

The smaller trout streams are for the most part free from dams and pollution. Beaver dams are common on many of them, but during periods of high water when fish are on the move, beaver dams do not usually interfere with upstream passage.

A tremendous potential exists in the flowages and river sections along the Androscoggin River to develop recreational sport fishing. This potential cannot be realized until the Androscoggin River is cleaned of pollution and its waters contain higher dissolved oxygen levels and lower toxicity to game fish populations. Even the remnant trout populations that exist at the mouths of many tributary streams may someday increase to fishable populations when the main river is clean.

DISCUSSION

The natural resources of the Androscoggin River basin are not being fully developed for the recreation industry because of the single-purpose monopolies of industry. The human population explosion that is becoming

increasingly evident requires that more and more wide-open spaces be made available for outdoor-minded people to spend their leisure time. With increasing demands for outdoor recreation, there must be more cooperative relations between industry and the outdoor-living trend: both are large sources of revenue. For instance: in 1965, 33 million Americans spent 4 billion dollars on hunting and fishing in the United States. In Maine alone, it was estimated that hunters and fishermen spent 40 million dollars in 1952, and this figure does not include guiding fees or operation of sporting camps. Millions of additional dollars are spent each year in Maine for outdoor recreation other than hunting and fishing. This asset for outdoor recreation is lost to the Androscoggin River Valley from Berlin, New Hampshire, to Merrymeeting Bay in Maine.

The Androscoggin River has a drainage area of 3,460 square miles. The main river is 161 miles long and it has 273 miles of major tributaries. Nearly 42 percent of this river mileage is lost to recreational use because of pollution alone. Within the river system, there are about 18 million square yards of spawning area and another 18 million square yards of nursery area that would provide suitable habitat for Atlantic salmon. Maine fishery biologists have found that under conditions similar to those that exist on the Androscoggin River, about one to two salmon smolts can be reared on each 100 square yards of suitable nursery area. Although occasional higher returns are reported, the usual survival rate from smolts to returning adult spawners is about 1-2 percent.

In spite of the potential for Atlantic salmon production in the Androscoggin River drainage, Atlantic salmon runs are probably lost forever. Losses of seaward migrating smolts downstream over 40 dams, losses incurred during life at sea, and losses of returning adults from failure to find fishway entrances on their spawning migrations up river are responsible. From studies conducted in Maine and Canada, we can, with a comfortable degree of confidence, estimate somewhere near the number of Atlantic salmon smolts that will reach the sea after they migrate down over 40 dams and the number of smolts that will survive from life at sea and return to the river as spawning adults. Using this knowledge for the Androscoggin River survey data, the most favorable estimate we can make for returning adult salmon, based on a 10 percent loss of river-produced smolts down over each of the main-river power dams, a 5 percent average loss of tributary-produced smolts over each dam they descend on their way to the sea, and a two percent survival of smolts at sea, is 964 fish below the dam at Brunswick. A *more realistic* estimate, based on a 20 percent loss of river-produced smolts at each main-river power dam, a 5 percent average loss of tributary-produced smolts over dams, and a 2 percent survival of smolts at sea, is 278 - 557 fish

at Brunswick. Some of these returning adults will be caught by sport fishermen. Anglers may catch about 25 percent of the adult salmon running the river, and the money spent by sportsmen to catch these fish averages about $10 per pound. With these salmon averaging about eight pounds each, the Androscoggin River has the potential to provide an annual sport fishery for Atlantic salmon valued at $5,600 — $11,200. There is strong evidence that, with the restoration of salmon, the return of alewives and shad can be expected. These fisheries would contribute appreciably to the total economy of the drainage.

We can expect that from 5 to 10 pecent of the adults will be lost at each dam (after fishways have been constructed) due to failure to find fishway entrances. It becomes obvious now, even if it were possible to have the full potential of the Androscoggin River drainage filled to capacity with Atlantic salmon smolts, that it would not be many years before the "restored run" would dwindle away to nothing.

Losses of anadromous fish runs in the Androscoggin River drainage does not mean complete loss of this natural resource. On the contrary, sectional fisheries management and recreational benefits would become available once the Androscoggin River was cleaned up and would contribute enormously to the economy of the Androscoggin River Valley. It is difficult to estimate the benefits derived from the sport fishing, recreational swimming, boating, camping, and out-of-door living that would be possible in a clean Androscoggin River. The modern highway systems that now connect Maine with the heavily-populated cities along the East Coast and the midwest should provide a tantalizing challenge to develop every recreational facility Maine has to offer. The very fact that the Androscoggin River Basin lies within easy reach of this megalopolis should stimulate further the desire to develop this long-abused natural resource, a potential basis for our recreational industry.

POLLUTION

In 1960, the Mayor of Lewiston at a public hearing said this about the pollution in the Androscoggin River: "For a long time now, we have been annoyed by a filthy and foul river running between our cities of Lewiston and Auburn. The existence of such conditions as are found in this river has tragic consequences on the social and economic life of the entire area. Pollution, blight, and their byproducts are barriers to the growth of any community, and the notoriety of the Androscoggin River has damaged the reputation of our city. There is a lack of water for the use of industry in our community. This imperils the operations of our present industries and hampers the expansion we must plan if we are to meet demands of the future."

Pulp and paper mills, tanneries, and food processing plants in Maine and New Hampshire have contributed to the aesthetic and recreational destruction of this once-noble river. A report published in 1966 by the Maine Water Improvement Commission states that the organic load discharge to the Androscoggin River within Maine is equivalent to a human population of 870,000. Of this load, 90 percent (783,000) is from industry and 10 percent (87,000) is from domestic sewage. In addition, the United States Department of Health, Education and Welfare pollution control engineers estimate than an equivalent human population of 343,000 is discharged by New Hampshire, of which 95 percent is industrial. These figures are based on field data taken in 1964. It should be pointed out that wastewater discharge rates can change rapidly with changes in industrial procedures at the mill and as new plants locate on the river; therefore, the amount of polluted wastewater entering the Androscoggin River can and does change from year to year.

There are essentially no restrictions on the amount of pollution that can be discharged into the Androscoggin River. In 1948, there was a court decree requiring that dissolved oxygen could not go below 4 parts per million at the North Turner bridge. Samples taken in 1961 showed readings lower than 4 ppm 50 percent of the time, and in 1965, up to 85 percent of the time readings were less than 4 ppm. Maximum density of 5,000 coliform bacteria per 100 milliliters is accepted as satisfactory for potable water supplies. Tests from Berlin to Brunswick showed that coliform densities exceeded the acceptable limit by 3 to 50 times. The river is not suitable for domestic water, swimming, general recreation, and even many industrial water supplies.

Industry and municipalities use 125 million gallons of Androscoggin River water daily (1964 data). Of this amount, 122 million gallons are used by industry (pulp and paper 93 percent, textile 3 percent, food processing 1 percent, and other industries 3 percent). Municipalities use the remaining 3 million gallons per day for domestic uses. It is predicaed that by the year 2000, industry will be using 290 million gallons per day, and municipalities will be using 15 million gallons, for a total of 305 million gallons per day. By the year 2070, it is predicted, 426 million gallons per day of water will be used in the Androscoggin River by industry and municipalities.

There are no sewage treatment plants in New Hampshire or Maine along the main stem of this river. Brunswick is presently in the process of constructing a treatment plant.

The Maine Water Improvement Commission conducted a survey of the Androscoggin River in 1963-65. The survey was conducted within the Maine border, and the data were obtained from 19 stations along the main river from Gilead to Brunswick. This survey indicated that the Androscoggin River

was in a state of recovery from Gilead to Rumford, whereas below Rumford, the river was in a state of degradation, with nuisance conditions existing near Jay and throughout Gulf Island Pond. Water quality in this stretch prohibits any practical use other than transportation of sewage and industrial waste. From Lewiston to Brunswick, the river begins to recover from upstream pollution and generally benefits in quality. Serious problems of bacterial pollution do exist below each municipality, varying in severity with population. Tests of the water taken in the Merrymeeting Bay area at the mouth of the Androscoggin River showed virtually no dissolved oxygen present.

The Maine report further states that "the pollution load in New Hampshire points out the necessity of providing secondary treatment for wastewater in the Berlin area to maintain 'C' classification conditions in the New Hampshire section of the river to Gilead milepoint 119.2." Class "C" is defined as that classification that would require waste treatment offering 70 percent reduction of organic pollutants presently entering the river. This would allow the transportation of treated waste, the support of fish life, and limited recreation (swimming questionable). This water could be used as an industrial water supply without extensive pre-treatment, and as a municipal water supply with adequate treatment works. It would contain a pH range between 6.0 and 8.5 and dissolved oxygen would not drop below 5.0 mg/L (same as 5 ppm).

In 1961, the Department of Health, Education and Welfare published a report which stated that since New Hampshire discharges a high rate of untreated waste water into the Androscoggin River, it *is subject to abatement under the Federal Water Pollution Control Act,* because the health and welfare of persons in a state other than that in which the pollution originates are endangered.

The federal Department's report further states that: "The waste assimilation capacity of a stream is directly related to the reaeration rate of the stream. The existing dams on the Androscoggin River below Berlin reduce the reaeration rate of the stream, but no data are available to show how much this rate is decreased. However, with the possible exception of the Gulf Island project, *the effect of these impoundments is small and the river would be deficient in oxygen even if the dams were removed.* Furthermore, even though the 1550 cubic feet per second minimum flow agreement discharged at Berlin is sufficient to reduce the pollution problem, *this reduction is not sufficient to offset the effects of pollution to the point of providing water of satisfactory quality for recreational uses or anadromous fish restoration."*

The Department of Health, Education and Welfare concluded its 1961 survey by the following: "Pollution of the Androscoggin River was caused during the summer of 1961 by municipal and industrial wastes which:

1. Caused excessively high concentrations of oxygen-demanding organic matter.

2. Depleted the dissolved oxygen of the river to barely trace quantities below Rumford, in the Gulf Island Pool, and in the Lewiston-Auburn area. This level of oxygen was depleted below the desirable 5 parts per million from Station No. 3, Gilead, and below Lewiston-Auburn.

3. Caused excessively high densities of coliform bacteria.

4. Destroyed the aesthetic value of the river from Berlin to the mouth at Brunswick.

5. Prevented development of fishery resources.

6. Caused a pollutional block preventing the passage of anadromous fish.

7. Contributed to the polluted conditions of Merrymeeting Bay, resulting in the bay being closed to shellfish harvesting.

8. Caused the river to be of such low quality so as to prevent the potential development of municipal and industrial water supplies and recreational uses."

The Kennebec River, which joins the Androscoggin River as it enters Merrymeeting Bay, can also be placed in the "cesspool" category. Pollution from industries and municipalities create such deplorable conditions on the lower Kennebec that large fish kills are reported annually. The Kennebec River joins the Androscoggin River in destroying the shellfish industry in Merrymeeting Bay.

To this date, efforts to regulate pollution have been directed toward the prevention of a public nuisance; but very little, if anything, has been done to make the Androscoggin River suitable for recreational uses or for clean-water industrial use. For the most part, recommendations from the various pollution surveys made on the Androscoggin River since 1930 go unheeded.

Pollution is not a serious problem on any of the major tributaries of the Androscoggin River, with the exception of the Little Androscoggin River. Waste water from a tannery in South Paris is not only destructive to fish life for several miles below the discharge point, but the sludge and putrid waste that covers the bottom and shoreline of this once-beautiful stretch of river is deplorable. Wastes from food processing plants, a slaughterhouse, and untreated sewage further contribute to the pollution load in this section of the Little Androscoggin.

The Little Androscoggin River begins to recover quite well by the time it reaches Mechanic Falls; however, here it gets another charge of putrid waste from a tissue paper plant. Even though this plant, as well as the upstream plants, have pollution abatement facilities, they are considered inadequate to maintain the water classification of the Little Androscoggin River at a desirable level. As the settling ponds build up with sludge, they lose their efficiency, and the effluent from the plant flows unabated through the ponds and into the river. Even the sludge itself, floating in large "mats" in the settling ponds, is eventually deposited into the river where it creates a nuisance condition from odor and as an unsightly mess.

The Maine Water Improvement Commission's 1966 report recommended a Class "C" for the Little Androscoggin River from Range Brook, in Mechanic Falls, to the dam at Hackett Mills, and a Class "B-2" for the river from Hackett Mills to the confluence with the Androscoggin River in Auburn. Since the river between South Paris and the outlet of Thompson Lake is already classified as "D," the Commission made no recommendations to upgrade this section.

DISCUSSION AND CONCLUSIONS

This report was prepared from data collected during the Maine Department of Inland Fisheries and Game's biological survey conducted in 1963-64, from the Maine Water Improvement Commission's 1966 report, from past surveys conducted by the U. S. Department of Health, Education and Welfare pollution engineers and by Federal Power Commission personnel, and from historical accounts. No attempt has been made to estimate the costs of fish passage devices or pollution abatement systems. It is not within the scope of this report to furnish these costs, but merely to report the factors that have led to the total destruction of anadromous fish runs and resident game fish populations and to the loss of recreational and industrial benefits.

The economic benefits derived from the various industries on the Androscoggin River are unquestionably huge, but they have been based on a single-purpose policy which has destroyed the river system. The moral obligation of industry to restore the natural resource is obvious. The increasing value and importance of the recreational industry makes it more and more ridiculous for Maine to deprive her citizens and non-resident visitors for any single-purpose water use. Americans need recreation, and Maine needs the growing recreational industry.

The costs to build fishways, collection systems, and smolt guiding systems in all the dams on the Androscoggin River would be staggering. Loss of adult fish at each obstruction and the downstream mortality of smolts as

they return to the sea would reduce the sport fishery for Atlantic salmon below justification for restoration costs; however, much of the Androscoggin River can be restored by managing sections of the main river for sport fishing. Since Man cannot always restore the natural resource he has destroyed, in spite of his engineering ability and financial resourcefulness (some fish populations are not completely restorable), he can oftentimes create a situation that is highly satisfactory and one that will produce at least a desirable substitute for what has been taken away.

Before recommending a restoration program, we must stop and ask ourselves how much the restoration program is going to cost and if the predicted results will justify these costs. On page 30 in this report, it was stated that $5,600 - $11,200 *could be* expected from an Atlantic salmon fishery in the Androscoggin River drainage. This statement applies *only if all the spawning and nursery areas are fully utilized.* We know from fishery research that up to 10 percent of a run of adult salmon may be lost at each obstruction *even when adequate fish passage facilities are present.* This loss occurs because some fish may fail to find fishway entrances. There are 40 dams on the Androscoggin River drainage below Umbagog Lake, creating a total drop of more than 900 vertical feet, which migrating sea-run salmon would have to negotiate before the full salmon potential of the river could be realized. Aside from the upstream migration loss of adult salmon at each obstruction, up to 25 percent loss of downstream migrating smolts can be expected as they pass through each electrical generating plant. There are 22 dams on the main Androscoggin River that generate electricity. The cumulative loss in downstream-moving smolts would be great.

The preceding discussion makes it clear how impractical and perhaps impossible it may be at present to restore and maintain a run of Atlantic salmon sizeable enough to justify the costs of fishways and downstream fish guiding systems in the dams on the Androscoggin River drainage.

What will be the fate, then, of the main Androscoggin River drainage? Some sections of the main river lend themselves well to trout management while others provide habitat for bass and pickerel. Let us bear in mind that above the heavily polluted area in Berlin, New Hampshire, there exists some of the finest brook trout fishing in the Northeast. Many of the main river stretches from Berlin to Jay, Maine, can provide suitable habitat for trout management once pollution has been reduced. The main river from Jay to Lewiston should provide warmwater fishing because of the long deadwater stretches and warm water temperatures; also, there is little doubt that an occasional trout may be caught during the spring and fall months when water temperatures are lower.

The Maine Water Improvement Commission recommends a pH range between 6.0 and 8.5 under the "C" classification.

The above standards should be maintained, and constant bioassays should be made to ascertain that they are maintained.

2. The classification of the Little Androscoggin River as recommended by the Maine Water Improvement Commission and the upgrading of the Little Androscoggin River between South Paris and the Thompson Lake outlet to at least a "C." The upgrading of this section will allow for fishery management in about 15 additional miles of river.

3. Once pollution has been abated to satisfactory levels in the Androscoggin River drainage, sectional fishery management of the main river and its tributaries will include:

(1) The main river and all tributaries above Berlin, New Hampshire, will be managed for the coldwater species of trout that are already present there.

(2) The main river from Berlin to Rumford is limited in its ability to produce trout by high summer water temperatures and competition from other fish; however, the fact that small populations of trout now exist around stream mouths in this section is encouraging. If dissolved oxygen content in this area of the main river were raised above survival levels by pollution abatement, an appreciable trout fishery might develop over more extensive areas than just at stream mouths.

(3) The upper 10 miles or more of the main river between Rumford and Jay would be quite similar to the stretch described in (2) above. The lower section would be poorly suited for trout management, as it is all deep deadwater; this stretch should be managed for warmwater game fishes.

(4) The main river from Jay to Lewiston, with the exception of a very limited coldwater fishery, should be managed for warmwater game fishes. The long stretches of slow-moving water in this section should provide excellent habitat for smallmouth bass and pickerel.

(5) Gulf Island Pond, once the pollution is abated, should be surveyed by the Maine Department of Inland Fisheries and Game to determine its suitability to game fish populations.

(6) All tributary streams will be intensively managed for the game fish populations already established in them.

4. Minimum stream flow regulations to insure adequate river flows during low-water periods should be imposed. This agreement should be made in conjunction with the Maine Water Improvement Commission's pollution abatement program for the Androscoggin River.

5. As soon as permissible, tidal flats on the Lower Androscoggin River should be opened to the taking of shellfish. This opening will depend upon the surveys that will be necessary by the Maine Sea and Shore Fisheries Department.

ACKNOWLEDGMENTS

This report would not be possible without the services of Regional Fishery Biologists Charles Ritzi, Robert Foye, Richard Anderson, Raymond DeSandre, and Matthew Scott who took active parts in the field work in their respective regions. Further credit goes to Arthur Newell, Supervisor of Fishery Management and Research, New Hampshire Fish and Game Department, who furnished the biological survey data on the New Hampshire portion of the Androscoggin River. Mr. Robert Smith, Maine Water Improvement Commission is thanked for his cooperation and assistance with the water quality sections of this report.

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REFERENCES

Clay, C. H. 1961. Design of Fishways, Dept. of Fisheries, Canada, Ottowa, 297 p.

Cutting, Richard E. 1959. Penobscot River Salmon Restoration, Maine Atlantic Salmon Comm. Report, pp 24-25.

Everhart, W. H. et al. 1955. Maine Lakes. A Sportman's Inventory, Maine Dept. Inland Fish. and Game, Augusta, Maine.

Federal Power Comm. & Dept. of Health, Ed., & Welfare. 1963. Androscoggin River Basin, Maine, New Hampshire, 38 p. and Appendix 4.

Everything depends on an adequate pollution abatement program. As pollution is abated and the water in the Androscoggin River reaches the prescribed level of purity, more intensive studies by the Maine Department of Inland Fisheries and Game and the New Hampshire Fish and Game Department will be necessary to determine more precisely what each river section is capable of producing for game fish. Remember, it has taken Man over 200 years to destroy much of the recreational value and the sport fisheries in the Androscoggin River; restoration will take time, too.

SUMMARY

1. Atlantic salmon, shad, alewives, and sturgeon once ascended the Androscoggin River in large numbers. These runs were destroyed by the building of dams in Brunswick, beginning in 1809, and by pollution from factories in Lewiston and Brunswick. The last Atlantic salmon seen at Rumford Falls was in 1817.

2. Although the Androscoggin River drainage from Umbagog Lake to Brunswick has over 36 million square yards of Atlantic salmon spawning and nursery area, plus many acres of suitable habitat for spawning alewives and shad, 40 dams in the drainage make it economically impractical, if not physically impossible, to restore and maintain runs of anadromous fish in this drainage.

3. The 22 dams on the main Androscoggin River, below Errol, New Hampshire, plus 18 more on the major tributary streams, obstruct fish passage and create impoundments which inundate many miles of fish habitat, limiting the production of resident coldwater game fish.

4. The presence of carp in the estuary, below impassable dams in Brunswick, poses a serious and never-ending threat to Maine's inland waters.

5. Industrial pollution from Berlin, New Hampshire, to Brunswick, Maine, has rendered the Androscoggin River useless for fish management, recreation, water supply for industries requiring clean water, and for many municipal purposes.

6. Merrymeeting Bay is so polluted by the Kennebec River and the Androscoggin River that the shellfish industry has been completely destroyed and anadromous fishes have been reduced to token runs.

7. Pollution from a tannery, food processing plants, a slaughterhouse, and a tissue paper mill has destroyed fish life in several miles of the Little Androscoggin River and has further destroyed the recreational benefits of many additional miles in this once-beautiful stretch of river.

8. Industrial use of water in some areas along the river results in dry stream beds during the low-water periods.

But there is still hope that future developments and technological advances will someday make it possible to restore the Androscoggin River to its full fishery potential.

RECOMMENDATIONS

The Androscoggin River basin has a tremendous potential to improve the economy of Maine. Realization of this potential can provide the recreation industry with unlimited outdoor activities that, for a long time, have been denied to Maine people and her non-resident visitors because of the abuse of this waterway. Even industry itself has a stake in this potential because of the "clean water" industries that are now unable to settle along the Androscoggin River because of foul water. Populations of most of the game and food fish, that once played such important roles in the lives of the early settlers in the drainage, can be restored, and they will contribute tremendously to the regional economy. The real estate value of river-bank property will increase several-fold with a clean river. Not only will the financial value of river property increase, but the aesthetic value and general living conditions along the river will improve greatly. Summing it all up, it can be said that many more people can benefit socially as well as economically from a clean Androscoggin River.

The potential of the Androscoggin River cannot be fully realized unless the following recommendations are followed:

1. A pollution abatement program *must* be initiated in order to return most of these now-polluted waters to full fish production and to complete *recreational and industrial* use. Minimum permissible water quality standards for the Androscoggin River and tidal waters as recommended by the Maine Water Improvement Commission should be as follows:

"The main stem of the Androscoggin River located below the most downstream crossing of the Maine-New Hampshire boundary to a line across Merrymeeting Bay in a Northwest direction, be classified as "C", with a minimum of 5.0 mg/L of dissolved oxygen and with disinfection of all sewage or other wastes containing coliform bacteria. That the following conditions be maintained at the Route No. 2 bridge in Gilead (milepoint 119.2):

(1) That dissolved oxygen at this point shall not be less than 6 ppm.

(2) That the ultimate BOD at 20°C not exceed a maximum of 35,000 pounds per day, or, 2.0 mg/L as 5-day BOD at 20°C, outlined in current editions of 'Standard Methods' so-called."

Meister, Alfred L. 1962 — Atlantic Salmon Production in Cove Brook, Maine, Trans. Am. Fish. Soc. Vol. 91 No. 2, pp 208-212.

Newell, Arthur 1964 — Androscoggin River Fishery Survey Report (unpublished), N. H. Fish and Game Dept., Concord, N. H., 12 p.

Scotland, Dept. of Agri. & Fish. 1963 — Salmon and Freshwater Fisheries Research, Extracts from the Fisheries of Scotland, Report for 1963 (Cmnd. 2332), pp 11.

Ireland Dept. of Lands Fish. Div. 1965 — Inland Fisheries Bull. No. 1, Dublin, Ireland, 36 p.

Sidio, A. D. 1962 — Report on Androscoggin River. U. S. Dept. of Health, Education, and Welfare, Public Health Serv., 29 pp and Appendix A, B, & C.

Sprague, John F. 1819 — Journal of Maine History, Vol. 6, pp 159.

Starbird, C. M. 1938 — The Indians of the Androscoggin Valley. Lewiston Journal Printshop.

State of Maine 1967-1884 — Reports of Commissioner of Inland Fish & Game Dept., Augusta, Maine.

1891 — History of Androscoggin County, 32 pp.

1966 — Water Improvement Commission, Classification Report, Androscoggin River

1966 — Water Improvement Commission, Classification Report, Little Androscoggin River.

U. S. Dept. of Health, Education and Welfare 1965 — Water Supply and Water Quality Control Study, Andro. River Basin, New Hampshire — Maine. Public Health Serv., Region 1.

Warner, Kendall 1956 — Aroostook River Salmon Restoration and Fish. Mgt., Maine Dept. Inland Fish. and Game, Augusta, Maine 66 p.

Williamson 1832-1839 — History of Maine, Vols. 1 and 2.

APPENDIX

Sketches of dams on the main Androscoggin River

Published under Appropriation 7750

The Maine Water Improvement Commission recommends a pH range between 6.0 and 8.5 under the "C" classification.

The above standards should be maintained, and constant bioassays should be made to ascertain that they are maintained.

2. The classification of the Little Androscoggin River as recommended by the Maine Water Improvement Commission and the upgrading of the Little Androscoggin River between South Paris and the Thompson Lake outlet to at least a "C." The upgrading of this section will allow for fishery management in about 15 additional miles of river.

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(1) The main river and all tributaries above Berlin, New Hampshire, will be managed for the coldwater species of trout that are already present there.

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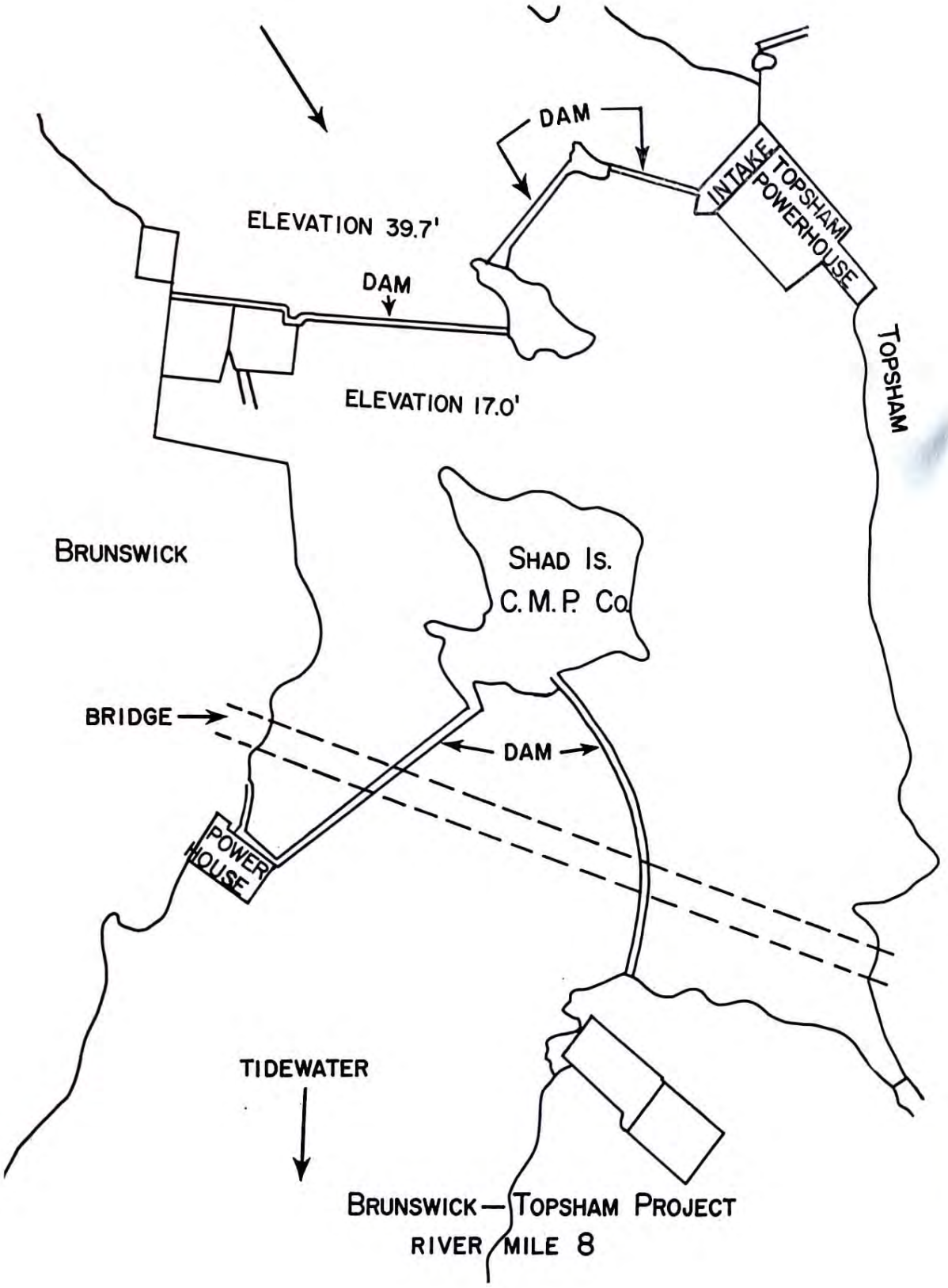
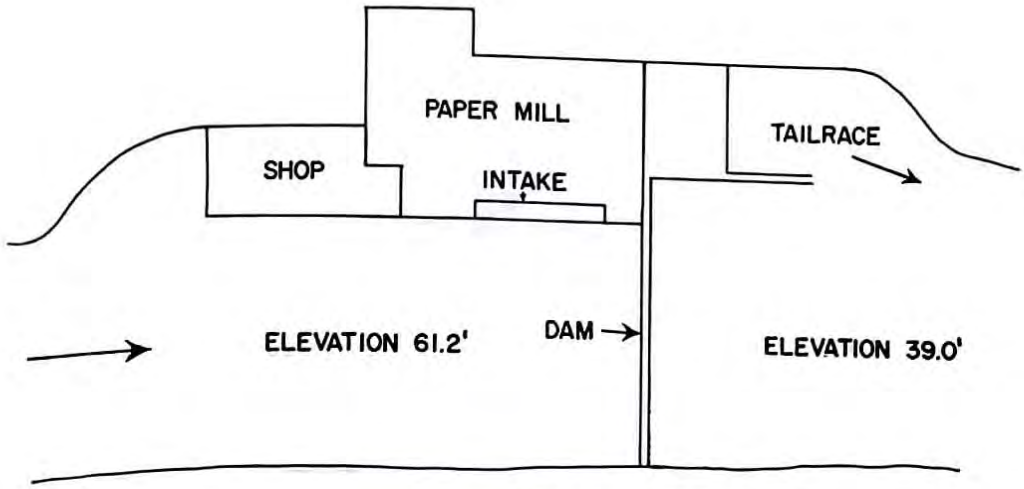
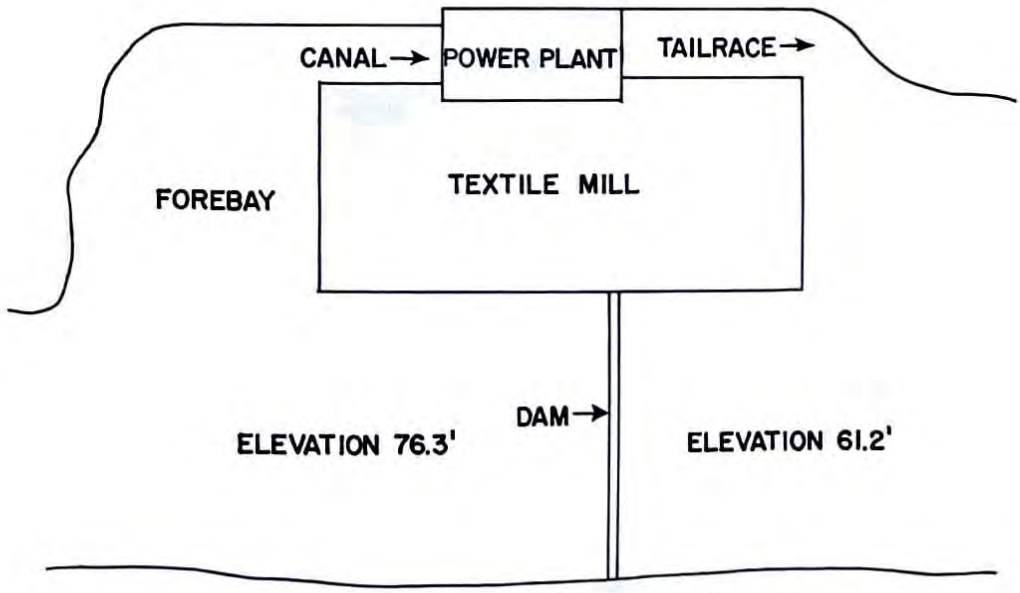
Federal Power Comm. & Dept. of Health, Ed., & Welfare. 1963 — Androscoggin River Basin, Maine, New Hampshire, 38 p. and Appendix 4.

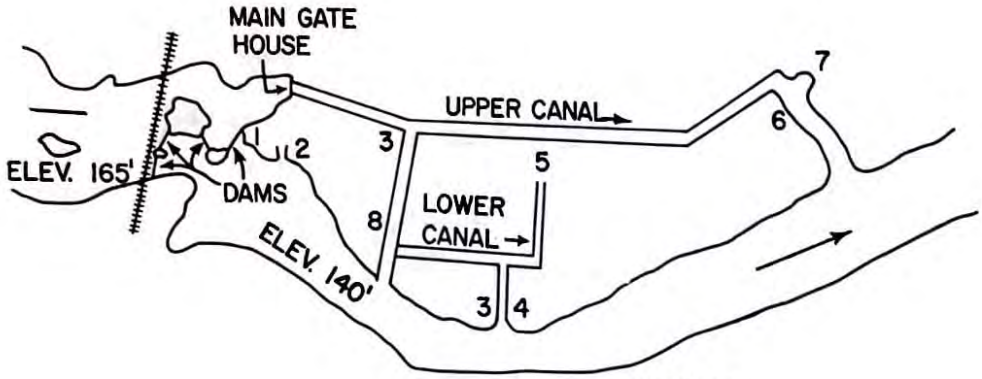

DAM
INTAKE
TOPSHAM POWERHOUSE
ELEVATION 39.7'
DAM
TOPSHAM
ELEVATION 17.0'
BRUNSWICK
SHAD IS.
C.M.P. Co.
BRIDGE
DAM
POWER HOUSE
TIDEWATER
BRUNSWICK — TOPSHAM PROJECT
RIVER MILE 8



PEJEPSCOT PAPER CO.
RIVER MILE 12.7



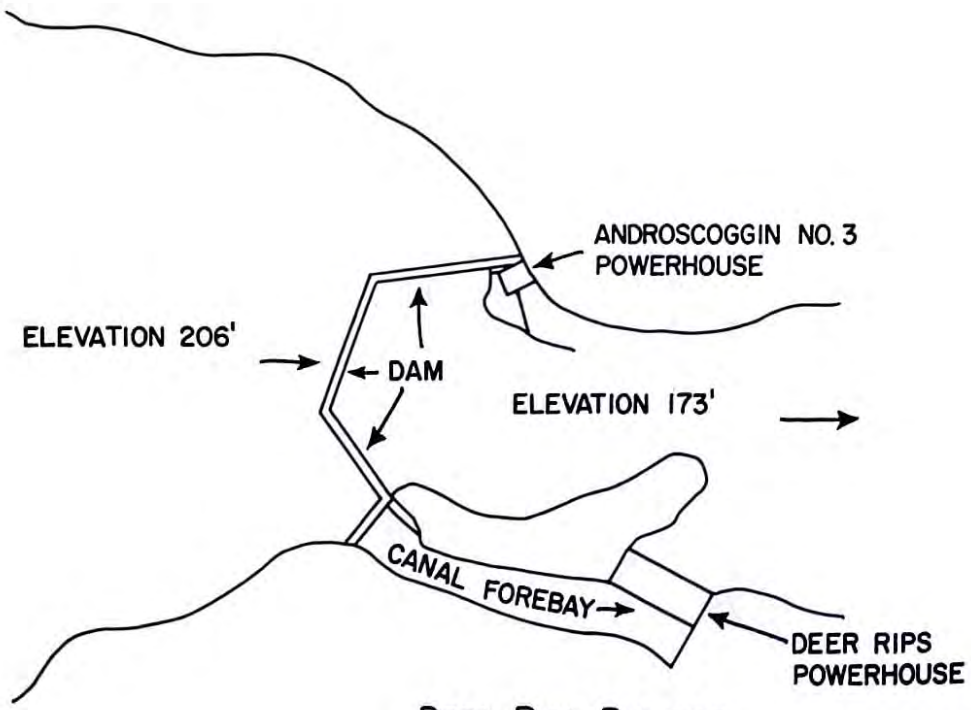
WORUMBO PLANT
RIVER MILE 16



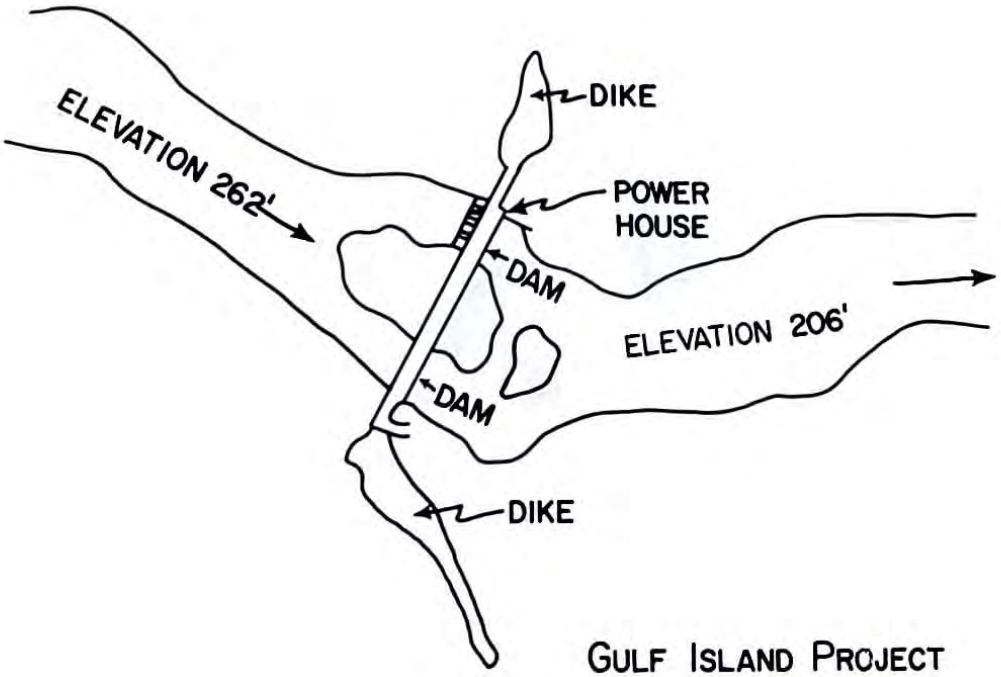
—PLANTS—

1. CITY OF LEWISTON
2. W. S. LIBBY CO.
3. LEWISTON DIVISION
4. CONTINENTAL MILLS
5. HILL DIVISION
6. ANDROSCOGGIN DIVISION
7. PEPPERELL MFG. CO.
8. LEWISTON FALLS

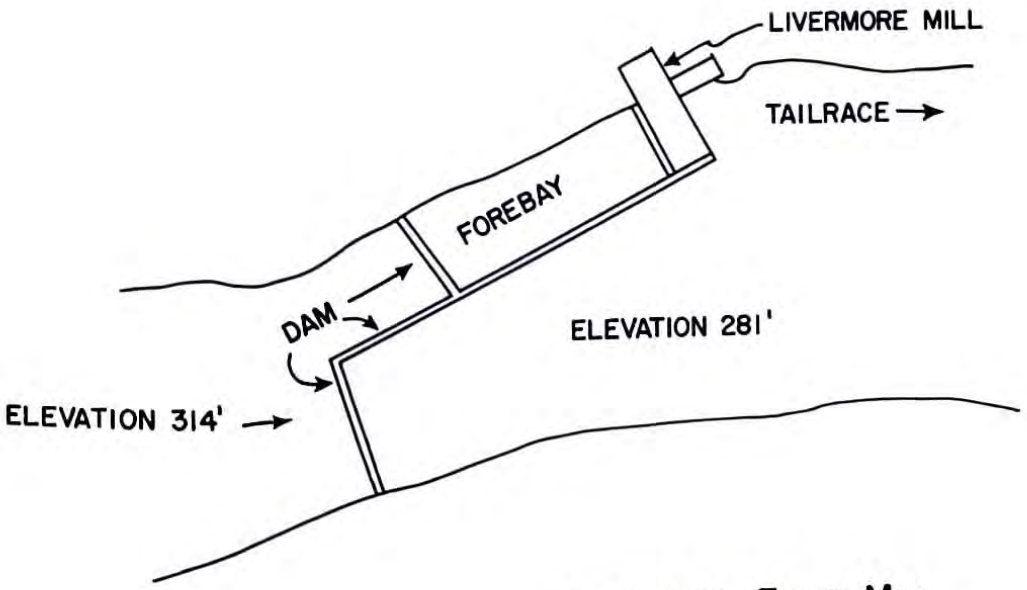
LEWISTON FALLS PROJECT
RIVER MILE 30.8



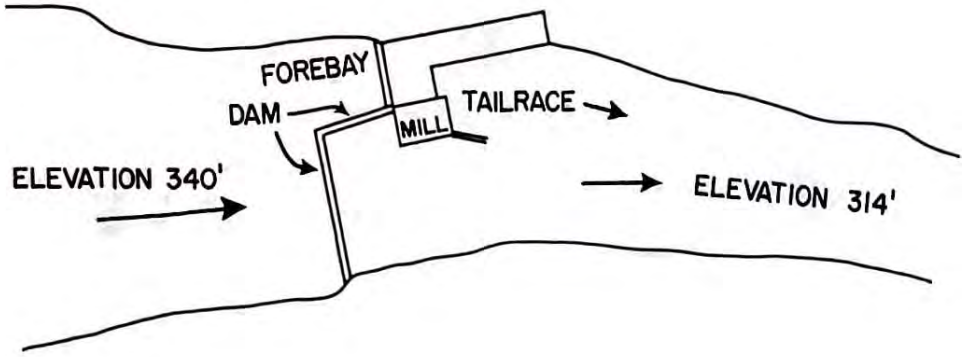
DEER RIPS PROJECT
RIVER MILE 34.8



GULF ISLAND PROJECT
RIVER MILE 34.8

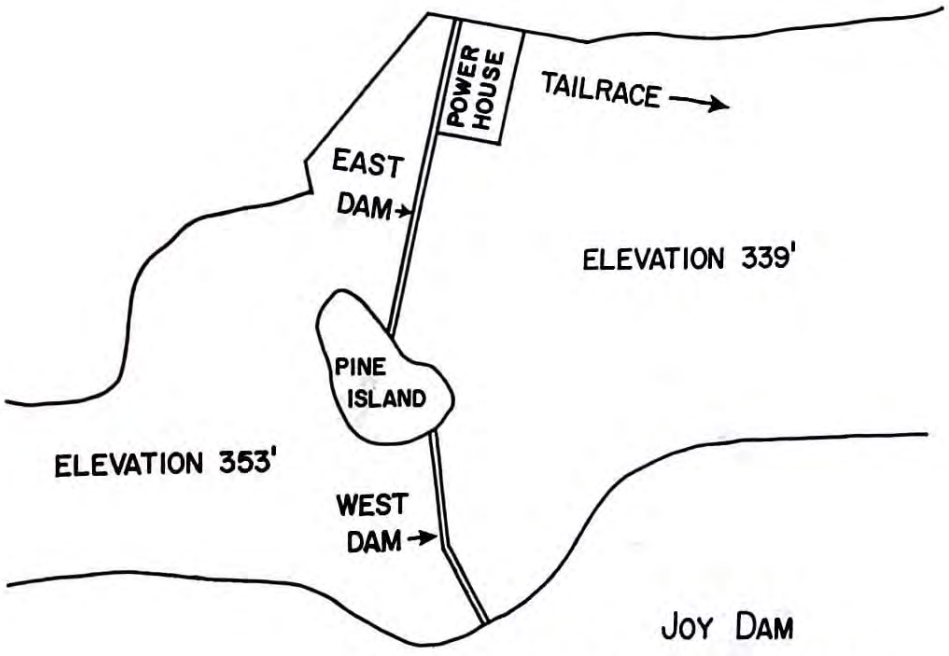


LIVERMORE FALLS MILL
RIVER MILE 60.8



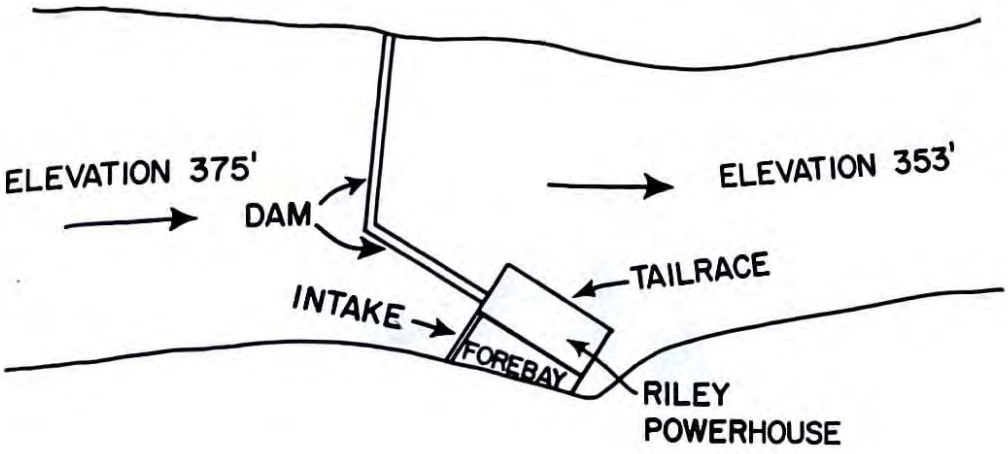
OTIS–LIVERMORE FALLS MILL

RIVER MILE 61.8

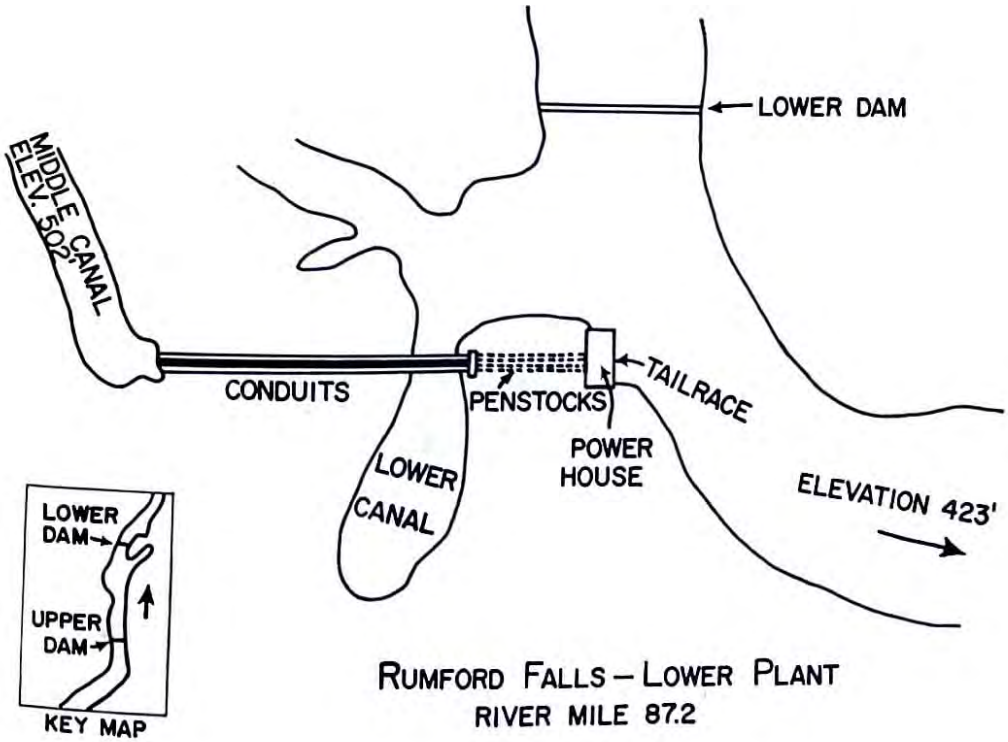


JOY DAM

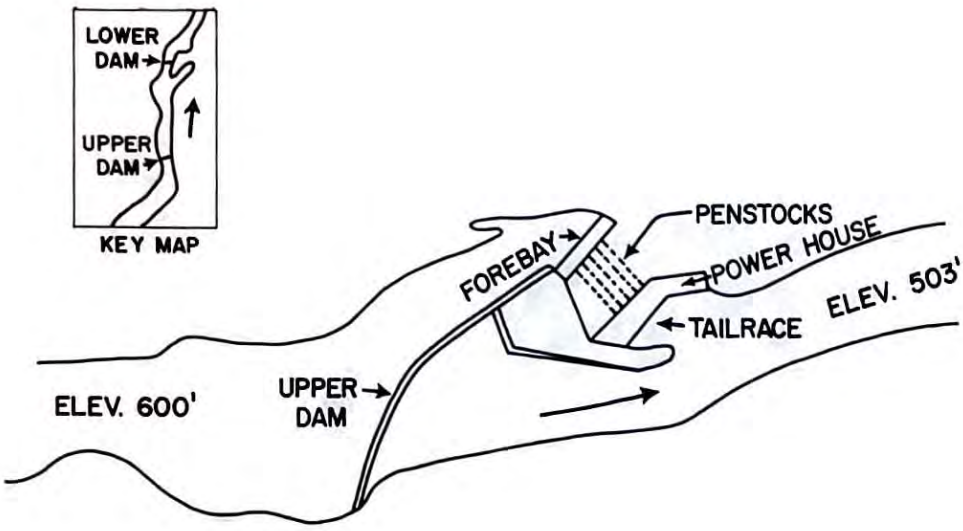
RIVER MILE 63.8



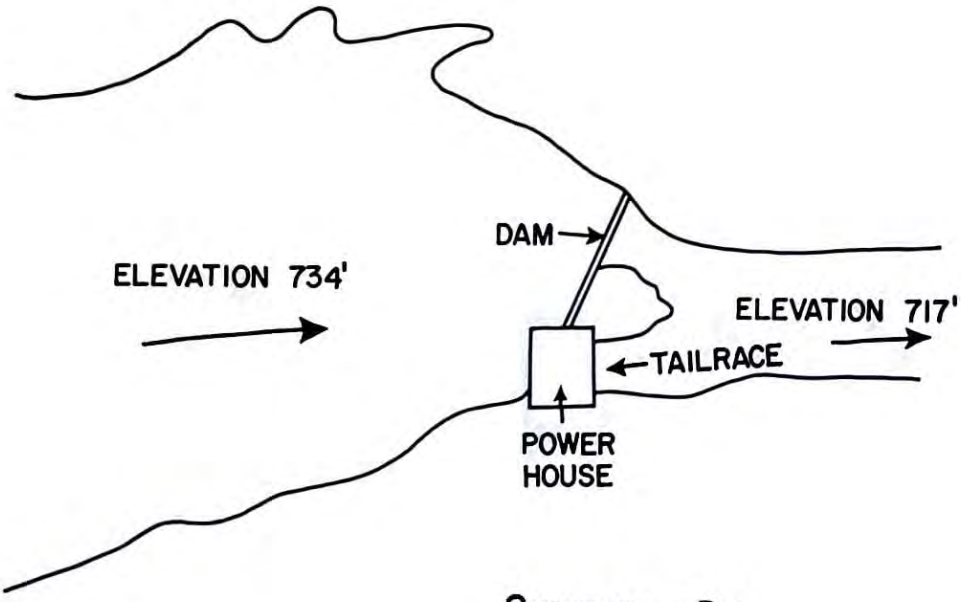
RILEY POWER PLANT
RIVER MILE 66.6



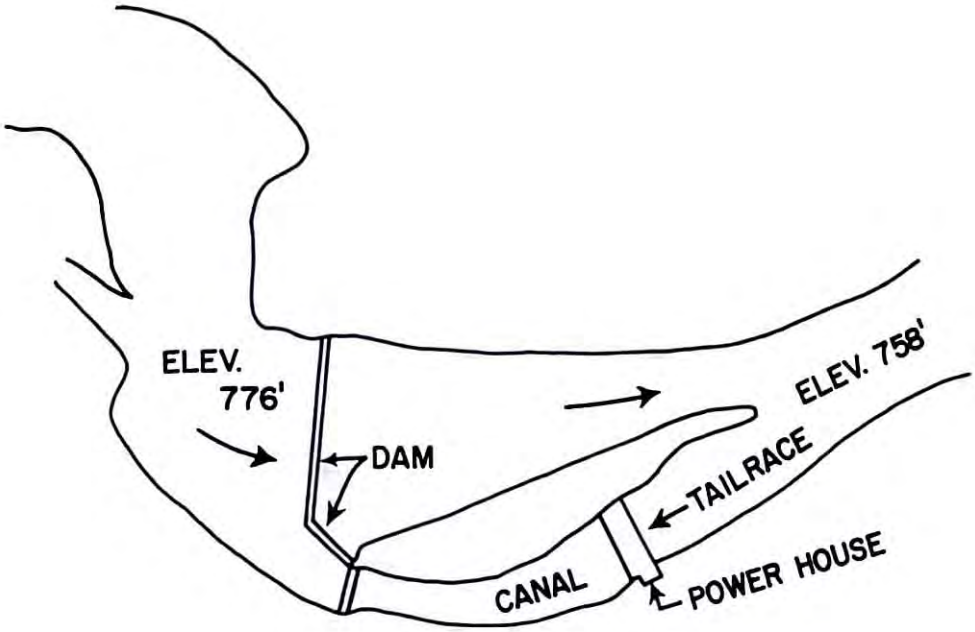
RUMFORD FALLS – LOWER PLANT
RIVER MILE 87.2



RUMFORD FALLS—UPPER DAM
RIVER MILE 87.4



SHELBURNE DAM
RIVER MILE 127.6



GORHAM POWER PLANT
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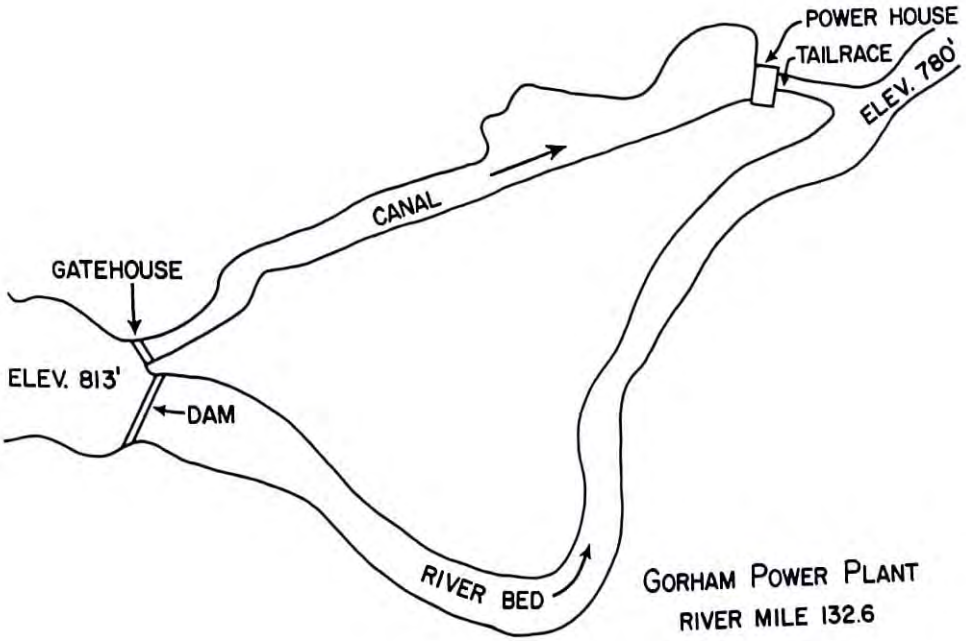
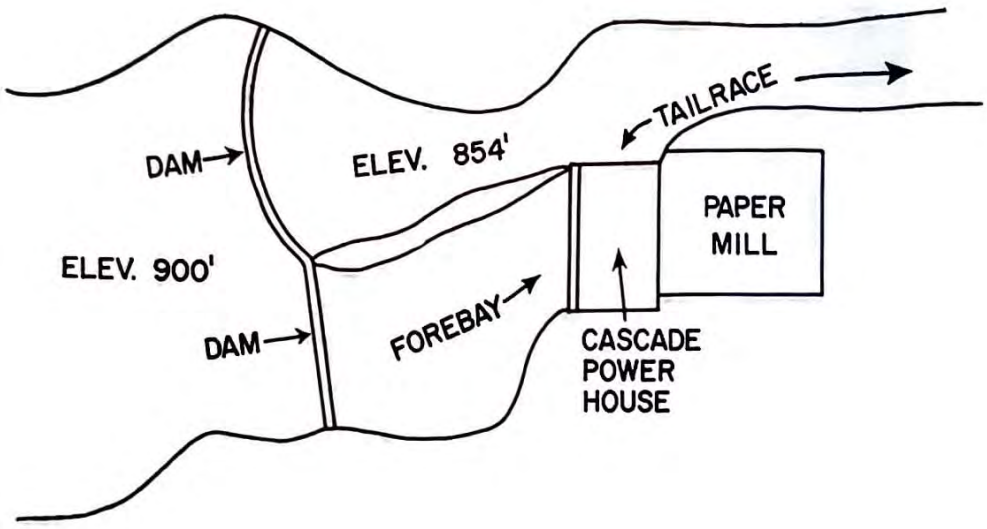
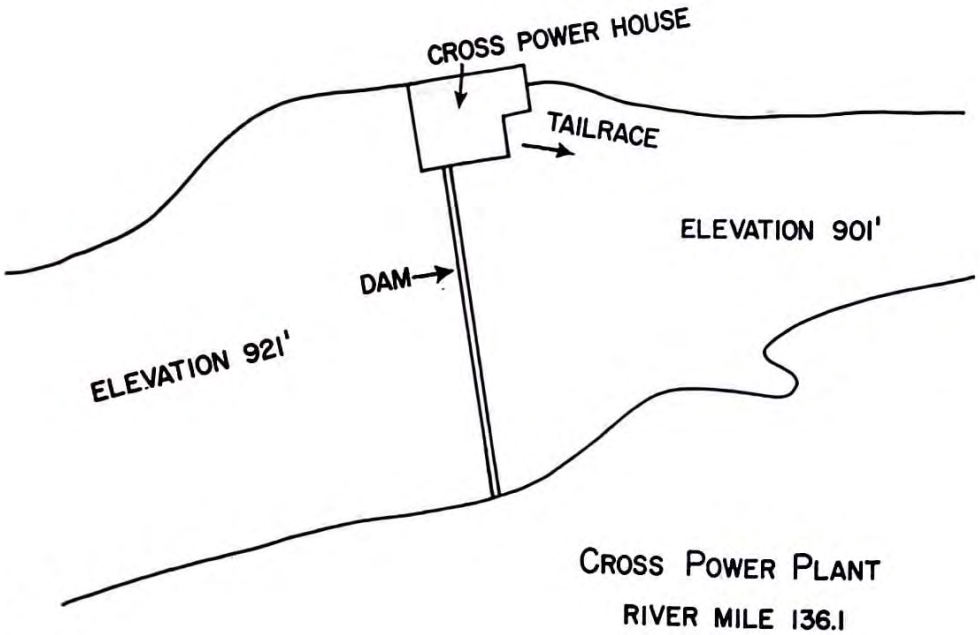


GORHAM POWER PLANT
RIVER MILE 132.6



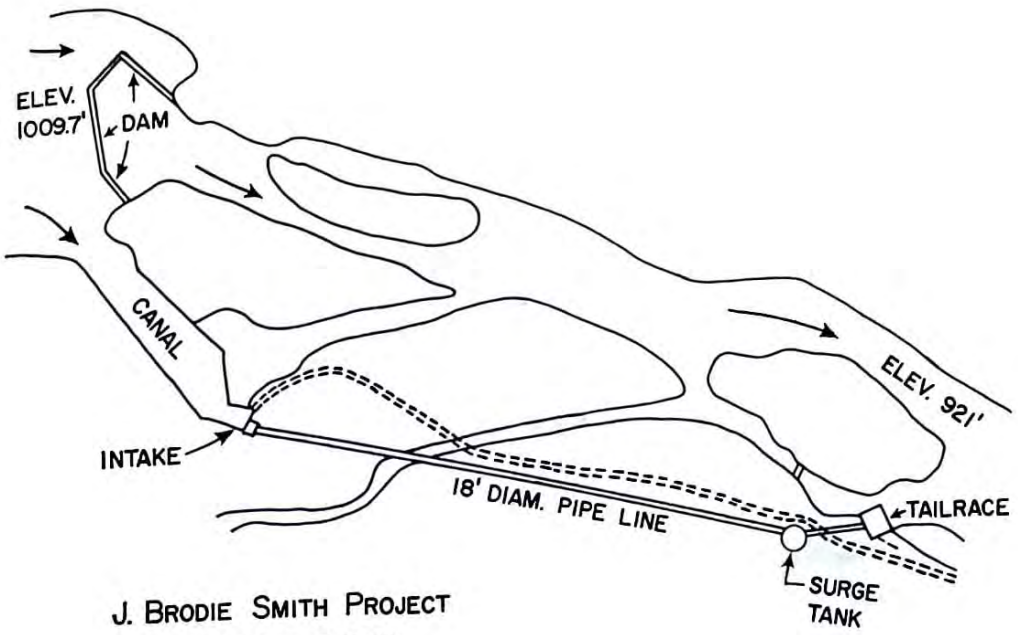
CASCADE POWER DAM

RIVER MILE 135.6

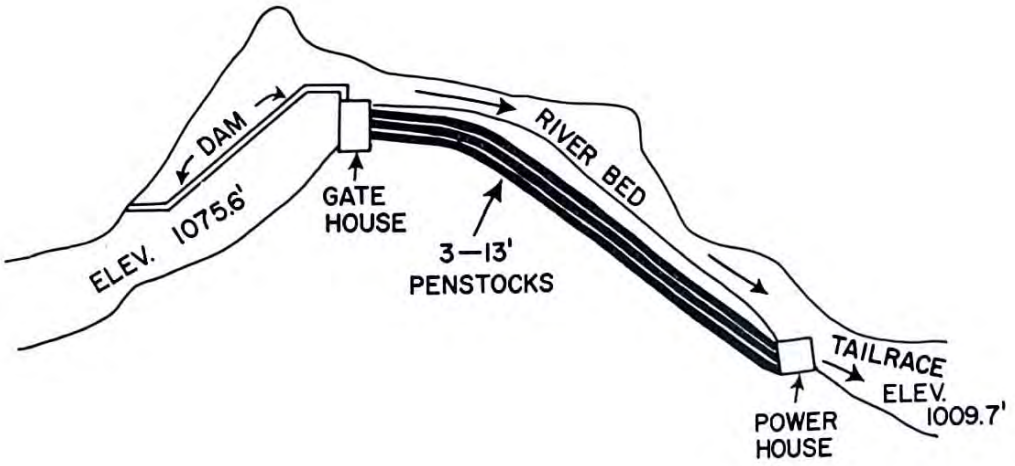


CROSS POWER PLANT

RIVER MILE 136.1



J. BRODIE SMITH PROJECT
RIVER MILE 136.7



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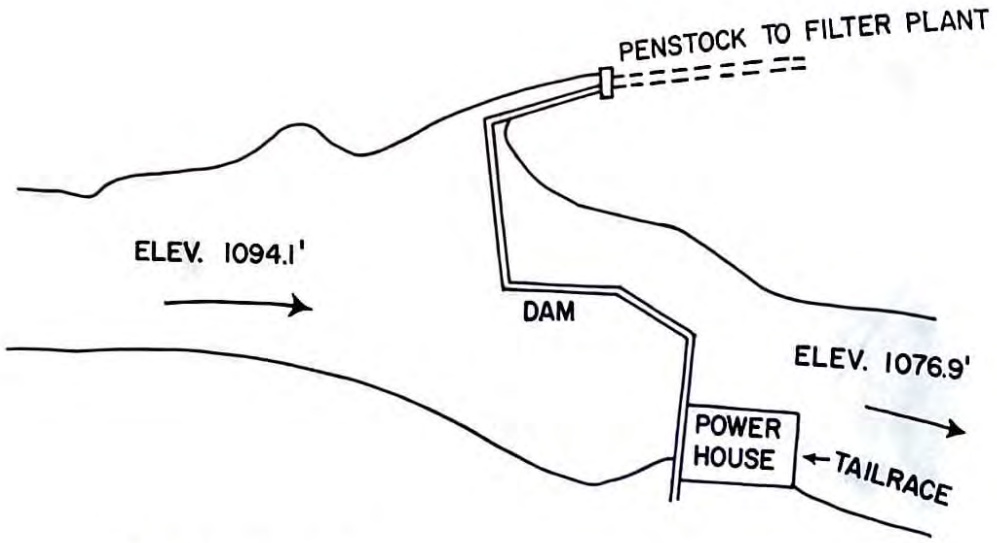
RIVER MILE 137.8



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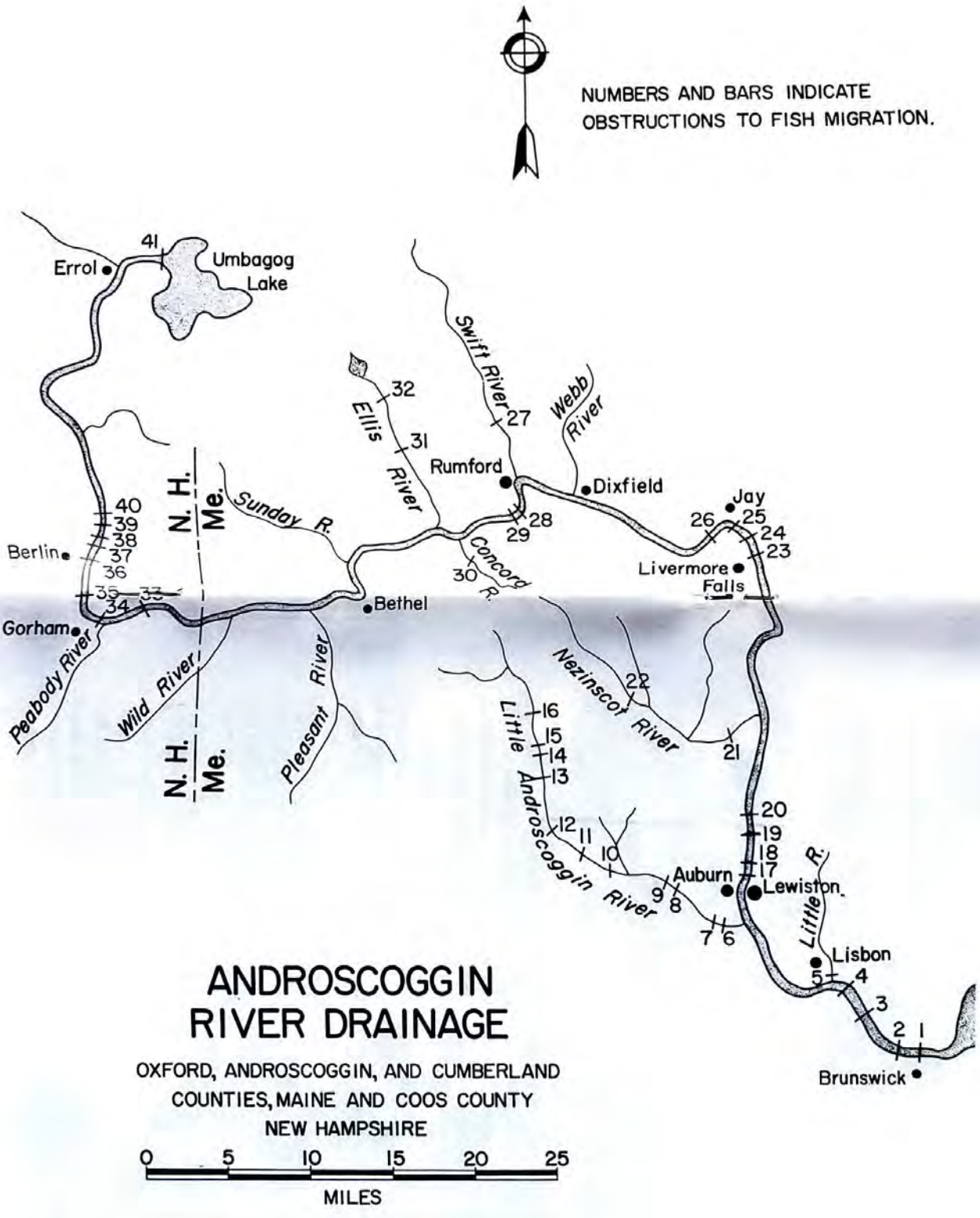
RIVER MILE 138.2



ANDROSCOGGIN RIVER DRAINAGE

OXFORD, ANDROSCOGGIN, AND CUMBERLAND
COUNTIES, MAINE AND COOS COUNTY
NEW HAMPSHIRE

0 5 10 15 20 25
MILES