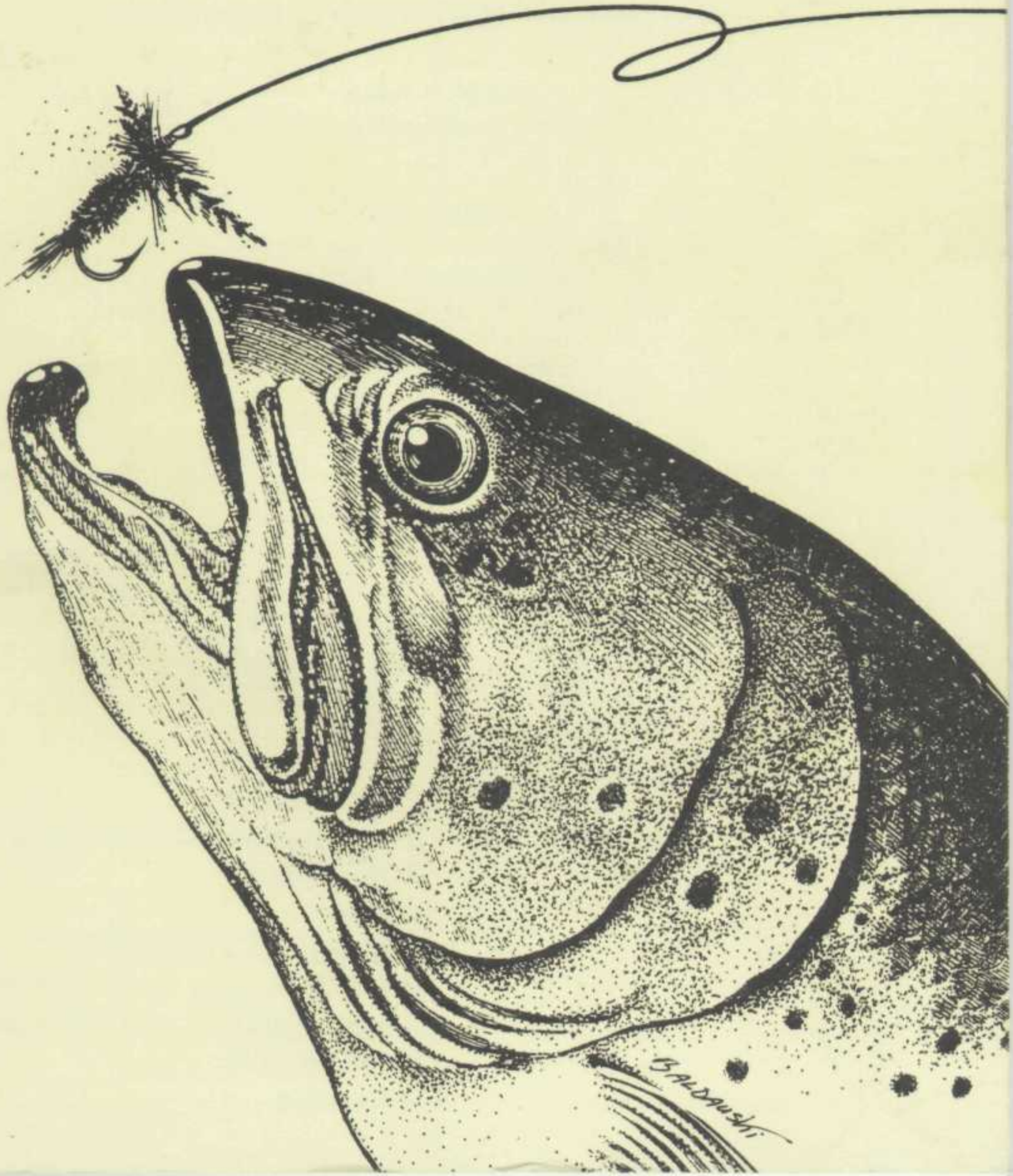
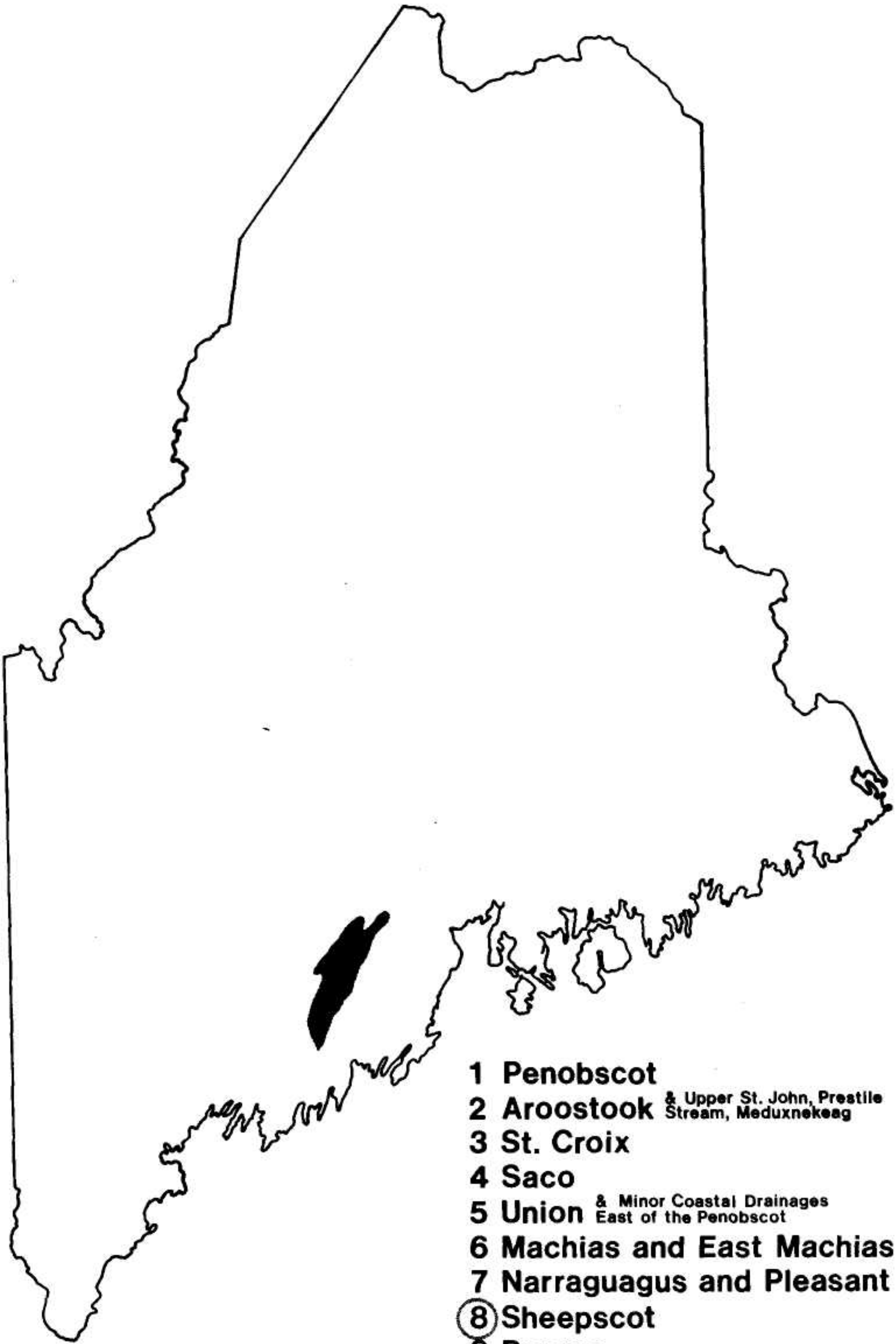
A RIVER MANAGEMENT REPORT BY THE ATLANTIC SEA-RUN SALMON COMMISSION

Sheepscot



ATLANTIC SALMON RIVERS OF MAINE



THE SHEEPSCOT RIVER

An Atlantic Salmon River Management Report

by
Alfred L. Meister
Atlantic Sea Run Salmon Commission

State of Maine
Atlantic Sea Run Salmon Commission
Glenn H. Manuel, Chairman

Bangor, Maine
1982

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INTRODUCTION

One of the earliest sites of colonization in the present State of Maine is located in the Sheepscot River valley. First settled in 1630, this area called "Pashipakokee River" by James Davis the scribe of the Popham Colony, and referred to as "Aponey" or "Aponeag" by other early historians was noted for its abundant natural resources, not the least of which were the fisheries. In the intervening years the runs of salmon, shad, and alewives were lost or depleted, and by 1880 Charles G. Atkins stated in his field notes that the catch of salmon was reduced to "...one to three salmon are taken **almost** every year...". This condition persisted until the late 1940's, a period of reawakening of interest in outdoor activities and our natural resources, when studies were initiated on the anadromous fish resources of the State of Maine.

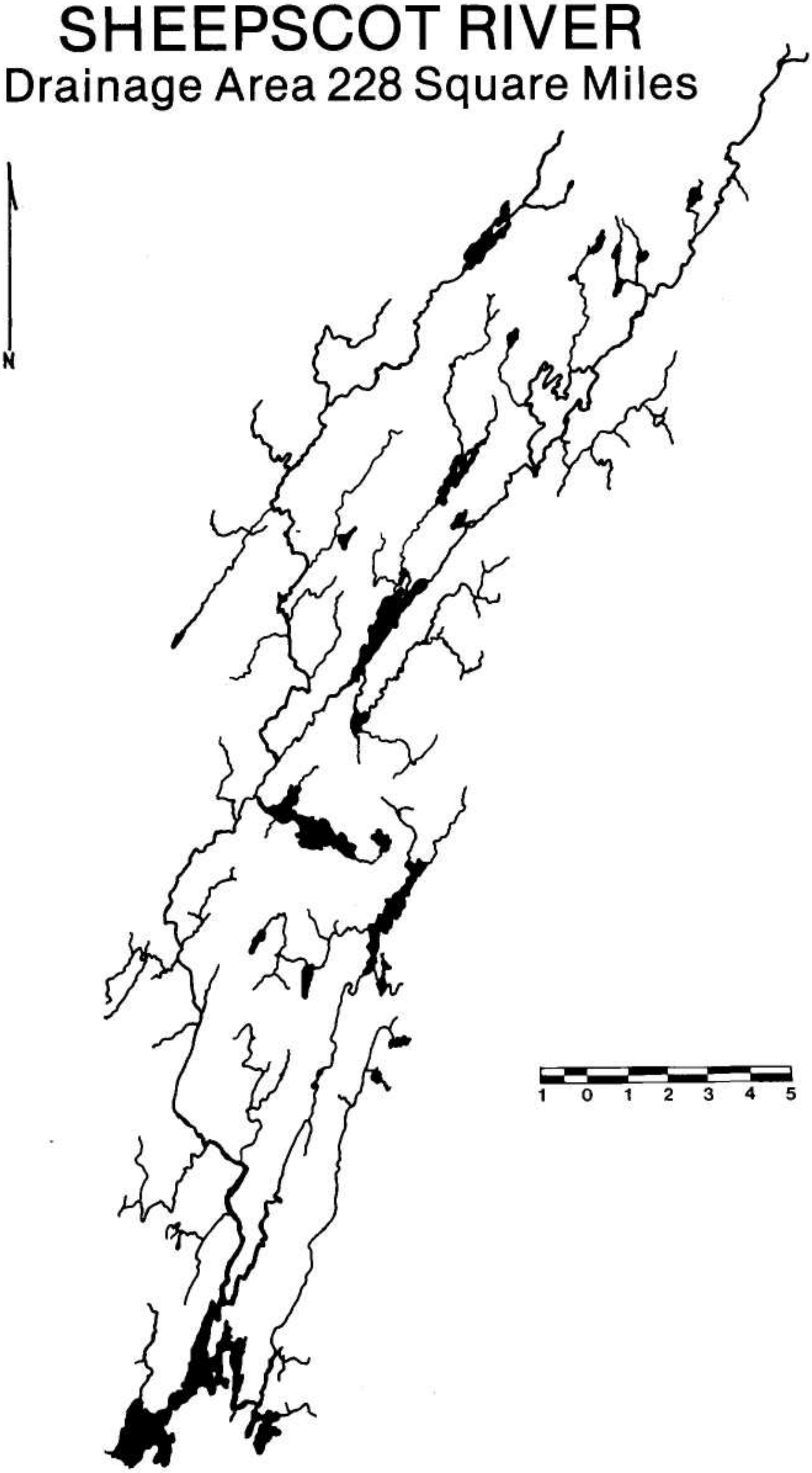
Preliminary studies indicated that the Sheepscot River was a suitable candidate for anadromous fish restoration (Rounsefell and Bond, 1948). With the opening of a dam at the mouth of the river in the same year, a decision was made to stock Atlantic salmon. The United States Fish and Wildlife Service and the Atlantic Sea Run Salmon Commission conducted an intensive survey of the river in 1950 and the results of that study were presented by Bryant (1956). In the decade that followed nearly all the lakes and ponds of the drainage were surveyed by the Department of Inland Fisheries and Wildlife. The limited distribution of the 1956 report prompted the preparation of an updated river management report that addressed the sport fisheries potential of the Sheepscot watershed (Meister and Foye, 1963).

This report contains much of the original material presented in the previous studies with updates and revisions where necessary. The focus of attention will be on studies of Atlantic salmon conducted since the 1963 report.

DESCRIPTION OF THE DRAINAGE

The Sheepscot River arises as a series of hillside springs in West Montville, Waldo County, Maine. The river flows in a general south-westerly direction to Whitefield, Lincoln County, where the West Branch, originating in Kennebec County, joins the mainstem Sheepscot. From Whitefield the river runs almost due south until it enters the long tidal estuary at Alna, Lincoln County (Figure 1). The Sheepscot water-shed encompasses approximately 228 square miles and includes over 24

Figure 1. *Map of the Sheepscot River.*



lakes and ponds. Atwood (1946) states that the Sheepscot River has a length of 34 miles with an average gradient of 11.6 feet per mile. The reader is referred to Figure 2 for information on stream gradients and a profile of the Sheepscot River.

The tidal estuary below Wiscasset, Lincoln County, superficially resembles a fjord. However, the lower estuary is river-cut rather than glacier-cut and is a typical drowned river valley. Above the Wiscasset-Edgecomb bridge the upper estuary extends for approximately five miles to Head Tide, Alna. This section of the estuary is characterized by extensive mud flats and salt marshes. Two tributary streams enter the upper estuary on the east shore. These streams are primarily tidal, but one, the Dyer River, will be discussed in more detail.

The Dyer River, the major tributary to the Sheepscot estuary, arises in Jefferson township at an elevation of 290 feet. It flows in a general southwesterly direction, has a stream length of over 17 miles, and drains a watershed of approximately 30 square miles. In the area below Dyer Long Pond there is a section of rubble riffle on both sides of the Route 215 bridge. Approximately one-third of the mainstem, in the area above tidal influence, consists of a series of long shallow deadwaters.

Midway along the upper estuary a rock ledge formation creates a constriction known as Sheepscot Falls. Here the ebbing tide creates a waterfall that in former times was the site of a large mill dam. This site is not considered an obstruction to fish passage. Tidal range in this area is considered to be 8 feet.

Studies on estuarial flushing rates, water currents and velocities, temperature and salinity profiles, and others including water chemistry, have been conducted and reported by Maine Yankee Atomic Power Company, Wiscasset, Maine in a series of environmental study reports published during the period 1970-1977.

From the Head Tide Dam, Alna upstream to Coopers Mills (a distance of 15 miles), the Sheepscot consists of riffle areas 20 to 60 feet wide with water depths of 2 to 12 inches during summer flows. The intermittent deadwaters and long pools range from 30 to 80 feet in width and 2 to 5 feet in depth. Occasional deeper pools of 6 to 10 feet are also encountered.

Above Coopers Mills, from Long Pond to the outlet of Sheepscot Pond, pools with mud, sand, and small rubble bottoms are prevalent. Riffles are found in the two-mile stretch below Sheepscot Pond. Above Sheepscot Pond the stream is of small size and of limited value to anadromous fishes. Consequently, the rest of this report will be concerned with the mainstem of the Sheepscot below the pond and with the lower reaches of the West Branch.

From Branch Pond in its headwaters, the West Branch flows approximately 15 miles to its confluence with the mainstem Sheepscot. Riffle areas are found throughout a large part of the lower 11 miles of the West

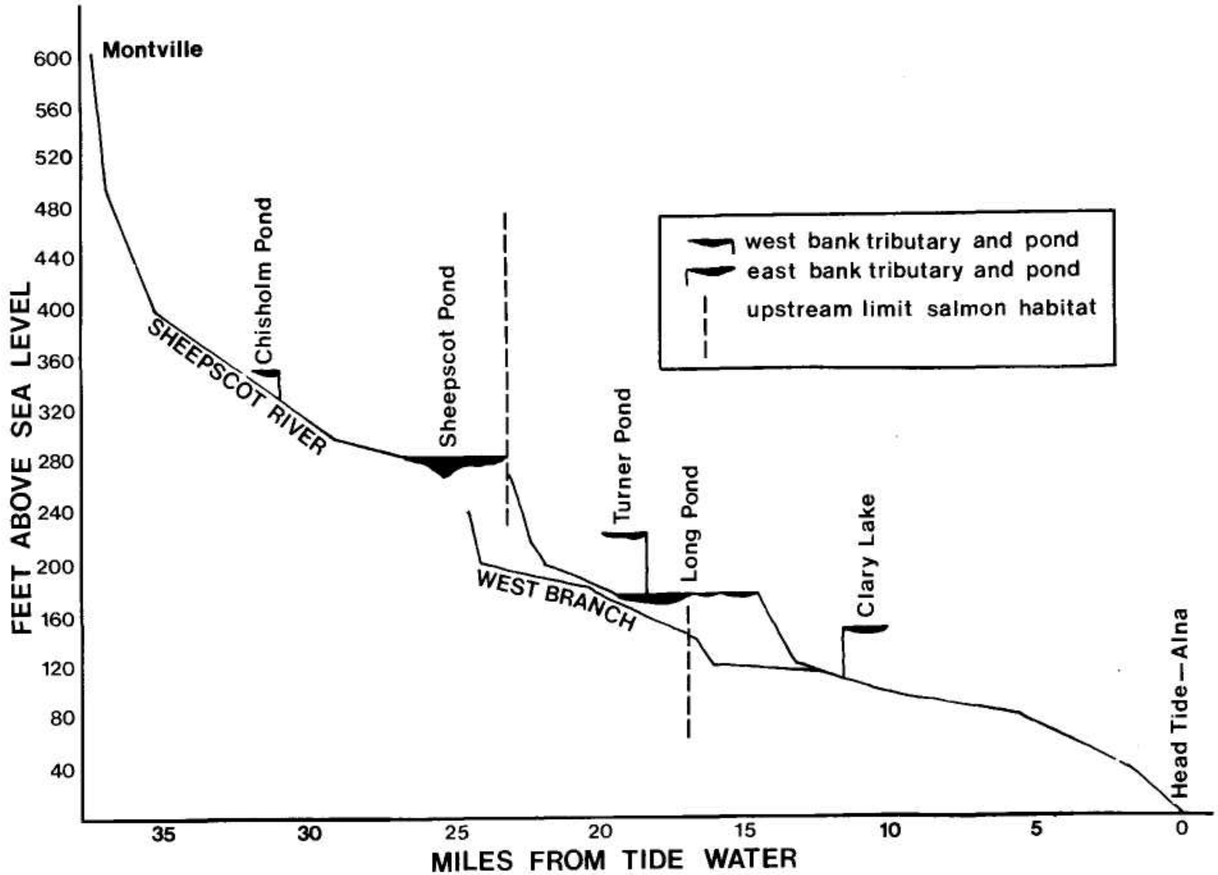


Figure 2. *Profile of the Sheepscot River.*

Branch, but the small size of the tributaries to the West Branch and chronic low flows preclude their use by most anadromous fishes.

The Sheepscot watershed once intensively farmed, is now 80 percent forested and extensive areas are reverting to brush and woodland. The area is sparsely populated, with the town of Wiscasset being the largest population center. The 1970 population of Wiscasset was listed as 2,250 permanent residents with an additional 1,500 residents in adjacent smaller towns. The towns are Palermo, Coopers Mills, Whitefield, and Jefferson have smaller numbers of residents whose populations seasonally increase in those areas with lakes or coastal frontages.

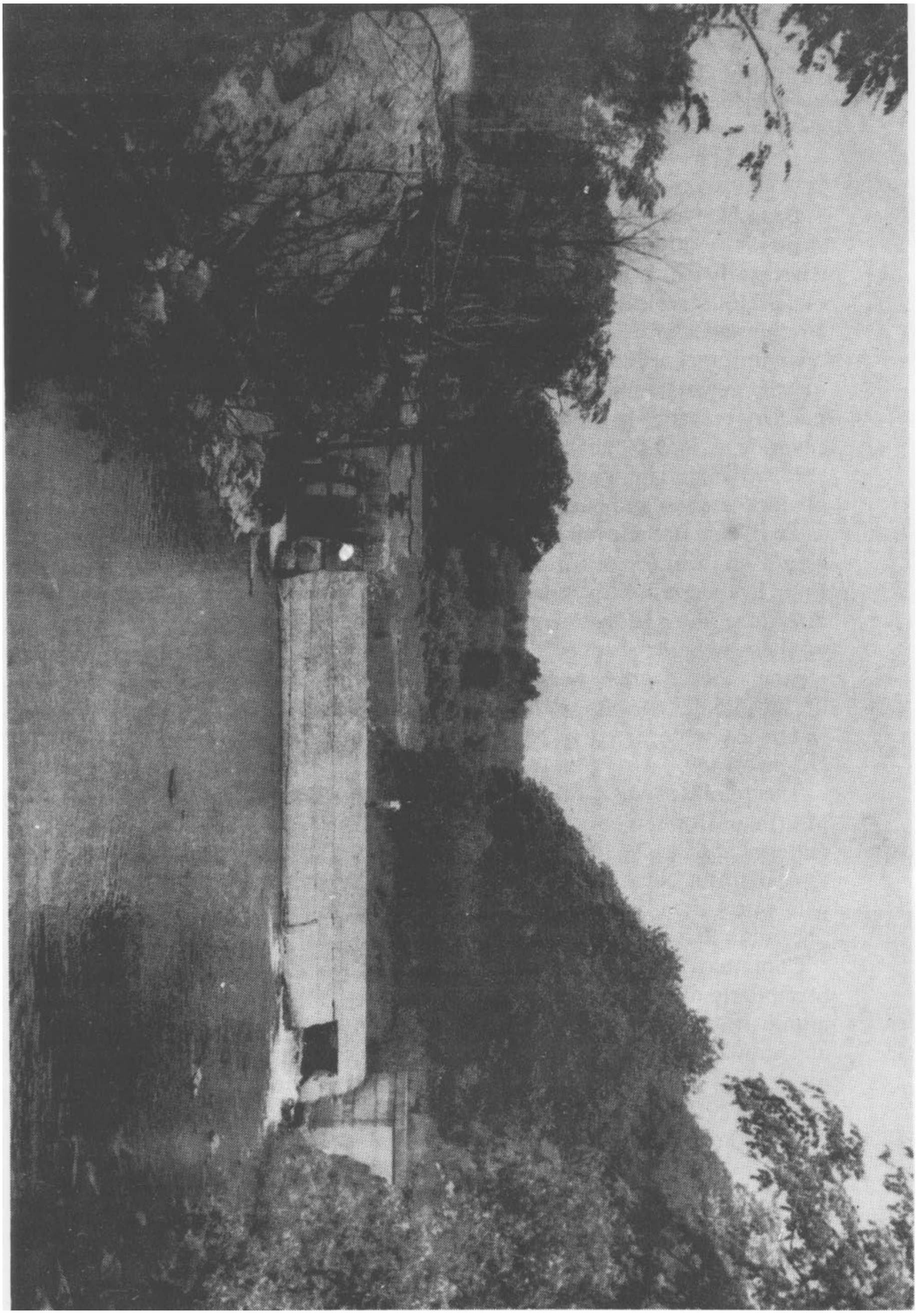
Bedrocks of the Sheepscot watershed are Siluro-Devonian in age. Along the east side of Sheepscot Bay to Edgecomb, and then northeast in a narrow band to Dyer Long Pond in Jefferson, the bedrock is composed of felsic metavolcanics and tuffaceous metasandstone with subordinate amphibolite, limesilicate gneiss and biotite-sillimanite gneiss. These metamorphics are overlain with biotite and biotite-muscovite granite and quartz monzonite on the west and north sides of Dyer Long Pond. The main river valley and the estuary, west of the above intrusions, and covering an area from Small Point northeast to the headwaters in Montville, are underlain with bedrock that is composed of thinly interbedded phyllite or schist and quartzite and biotite-muscovite gneiss.

The West Branch waters from Windsor to North Whitefield and an area of the main stem from Coopers Mills to the northend of Sheepscot Pond is underlain with bedrock that is oriented in a northeast-southwest direction. These bedrocks are biotite-muscovite gneiss. On the west edge of the watershed there is a sill facing an area of calcareous metasedimentary rocks from Weeks Mills south to Windsor. The sill is composed of sulfidic gneiss and schist of Devonian age. On the southwest the watershed is bordered by the Lincoln sill — a metasyenite deposit of Devonian age.

The dominant soils of the drainage are brown podzolics of the Scantic-Merrimac-Hollis types. These soils were derived from a glacial parent material and can be readily observed along the stream banks. There the typical forest soils overlie the sands and gravels. The glacial material where deposited is the source of boulders and rubble in the riffles of the Sheepscot River.

Climatological conditions on the Sheepscot watershed are such that precipitation averages 4 inches per month in the winter and 3 inches per month in the summer. Annual precipitation ranges from 42-44 inches and snowfall in the coastal zone has been as little as 29 inches and as much as 119 inches. Temperatures are such that the mouth of the river averages 20 days of subzero temperature yearly. The average January temperature is 22 °F. and the average annual temperature is a pleasant 45°. However, temperatures in excess of 90 °F are reported for the coastal area.

Head-Tide Dam, Sheepscot River, Alna, Maine, in the early days of salmon restoration.



OBSTRUCTIONS AND POLLUTION

The initial survey in 1950 revealed 24 past and present obstructions to fish passage on the Sheepscot River drainage. Of these 24 only 17 were man-made, the rest being natural obstructions at some or all water levels. Since 1950, many of the man-made obstructions have deteriorated. By 1963, only 12 of these could be considered total or partial obstructions to fish movement and only 3 of these were to be found on the mainstem. The Head Tide Dam, Alna, was opened in 1952 to allow passage of salmon and alewives. Il still presented an obstacle to fish at high flows, a conditions that was finally corrected in 1968 when the dam was effectively breached.

The Coopers Mills Dam, the only serious obstacle on the mainstem, was provided with a new Denil fishway in 1960. Periodic inspections indicate that the structure is functioning properly and fish have free passage to Long Pond and Sheepscot Pond. The Maine Department of Inland Fisheries and Wildlife maintains a low-head dam at the outlet of Sheepscot Pond. Operated in conjunction with the Palermo Fish Cultural Station the dam has a stabilizing effect on both the pond level and stream flow. The other remaining obstructions on the Sheepscot drainage are of little importance to Atlantic salmon. They are located at the outlets of tributary ponds and above the sections of streams available and suitable for anadromous salmonids. Recommendations for these obstructions may be found in Table 1.

Water contaminants, more properly called pollutants, are restricted to domestic sewage and the debris from old wood products industries (sawmills). Debris and some leaching may occur from sawdust piles or small mill sites at Clary Stream, Coopers Mills, Branch Mills, Turner Pond, and Colby Stream.

During the original survey small garbage dumps and the usual amount of stream littering was encountered at several points. Current state statutes now prohibit this form of disposal on or in streams and it is no longer considered a problem.

The total pollution load of the Sheepscot is relatively small. The major population center is located on the tidal estuary where flushing rates are adequate to prevent a major problem. The statutory water classification for this watershed indicates the minor loading problems of its waters. The river above tidewater is classed Bl unless otherwise classified. The main stem to the confluence of the West Branch is classified as B2. The West Branch from Branch Pond to the confluence is also Class B2. The Dyer River tributary is classified as Bl and the tidal waters of Alna and Wiscasset are Class SB 1.

The present pollution load of the Sheepscot drainage has little effect on the fisheries. However, non-point pollutants such as aerial spraying of insecticides or herbicides, should be rigidly controlled, especially during periods of low river flow.

Table 1. Sheepscot River, major obstructions to fish passage with recommendations for anadromous fish.

Obstruction	Description	Fish Passage	Recommendations
No. 1.	Coopers Mills Dam, a 10-foot concrete and stone dam with fishway.	Dam is an obstruction.	Maintain fishway.
No. 2	Hatchery dam at outlet of Sheepscot Pond. A 4*Vi*-foot concrete dam with fishway.	Dam is an obstruction. There is a fishway present.	Seasonal closure of fishway recommended.
No. 3	Branch Mill at China — 8 to 10 ft. stone dam at outlet of Branch	Obstruction at all water levels.	Install fishway for alewives.
No. 4	A 6-foot sawmill dam at Clary (Pleasant) Pond Stream. Located below road.	Obstruction at all water levels.	None
No. 5	An 8-foot storage dam above road on Clary Pond Stream.	Obstruction at all water levels.	None

The Department of Marine Resources maintains laboratory facilities at Boothbay Harbor, Maine where shellfish are monitored for endotoxins as well as bacterial and viral contaminants. Clams and mussels are monitored from the Edgecomb-Wiscasset area and these flats have been closed when they posed a hazard to public health.

At present, there is no active 208 program on this watershed but both the Southern Kennebec Valley and the Southern Mid-Coast Regional Planning Commissions have member towns from the Sheepscot River drainage.

HYDROLOGY

Stream Discharge

The U.S. Geological Survey Branch, Department of the Interior, maintains a water stage recorder on the Sheepscot River at North Whitefield. Daily discharge records are available from 1938 to the present. The drainage area at the gauging station is 148 square miles and it is located 101 feet above mean sea level. The maximum discharge of record was 6,420 cfs on December 8, 1973. The minimum flow of record was 5.0 cfs on October 24, 1941.

Peak flows are of little value in fisheries investigations for they are usually associated with severe storms and are of short duration. Of far more interest are the minimum and mean daily flows. These flows govern the production of aquatic life and determine the fisheries potential of any watershed.

On the Sheepscot River minimum flows are invariably associated with the late summer and early fall months. Flows of less than 10 cfs have been recorded in 7 of the past 37 years and flows of 20 cfs or less have occurred in 27 of the years. The lowest mean daily flows in cubic feet per second for the years 1940 through 1976 are presented in graphic form in Figure 3.

Water control, highly desirable from the standpoint of fisheries management, could, through stored waters, raise the present low daily flows of the Sheepscot River. However, the only site with sufficient storage for flow augmentation would be Sheepscot Pond. Problems encountered in raising the lake level to store additional water make the project unfeasible at this time. A measure of water control is achieved at Sheepscot Pond by the metered discharge from the hatchery and the fishway at the pond outlet.

Water Chemistry

Water chemistry data are available from the Department of Inland Fisheries and Wildlife for the lakes and ponds of the drainage. Additional data in the form of stream conductivity, oxygen levels, and temperature recordings are available from the U.S.G.S. files. Detailed water analysis for anion and cation composition was undertaken by Taylor (1973) and the results of his studies on the Sheepscot are presented in Table 2.

A great deal of information on salinity and temperature profiles for the estuary is available from the environmental studies associated with construction and operation of the Maine Yankee Atomic Power Plant in Wiscasset.

Figure 3. *Lowest mean daily flow in the Sheepscot River at North White-field, 1940-1976.*

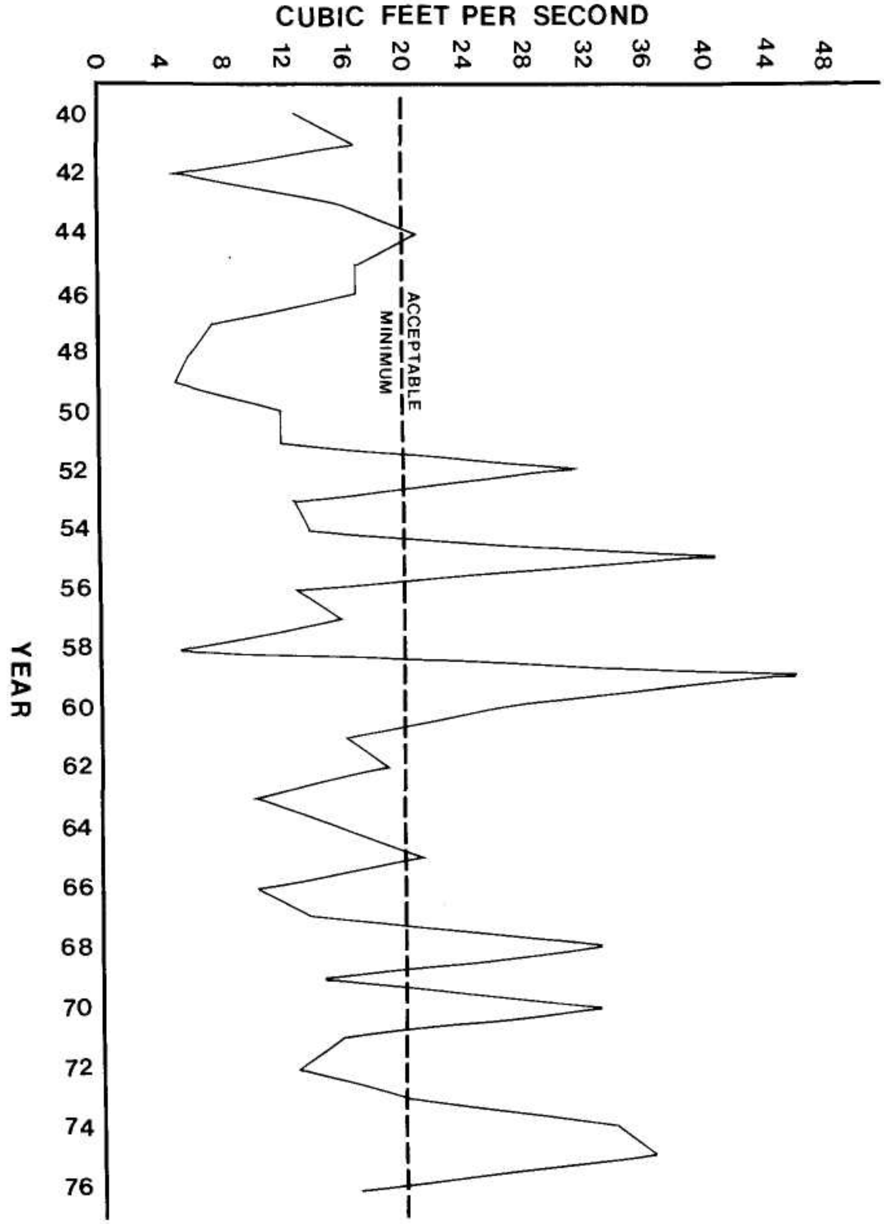


Table 2. Water Quality and Characteristics of the Sheepscot River, adapted from Taylor (1973). Data presented as mean levels for both nursery areas and Head of Tide at Alna.

	Nursery areas	**Head of Tide**
Total Solids (ppm)	38.10	44.92
Specific conductance (Micromhos)	30.07	35.83
pH (November)*	5.5	
alkalinity (HCO^3)	5.71	6.91
Camg/1	2.74	2.93
Mg mg/1	0.66	0.72
phosphorus (total)	0.148	0.138
Nitrate (NO^3) mg/1	0.126	0.159
Na mg/1	3.03	3.47
Kmg/1	0.588	0.554
Clmg/1	2.38	2.88
SO^4= (sulfate)mg/l	3.90	5.94
Fe (ppb)	1.08	16.7*
Al (ppb)	51.3	54.2
Mn (ppb)	3.6	11.7*
Cu (ppb)	4.6	4.3
Zn (ppb)	23.7	6.2

* Significant Difference

Major cations in order of abundances in Sheepscot River were Ca, Na, Mg and K, while the order of abundance of anions was SO^4 =, HCO^3, Cl, and NO^3.

Rather wide seasonal variability was found among trace elements P, Al, Fe, Mn, Zn, Co, and B.

FISHES OF THE SHEEPSCOT RIVER SYSTEM

The rivers of the State of Maine provide countless hours of recreation to outdoor enthusiasts. Among these rivers the Sheepscot is widely known within angling circles and the more familiar sport fishes of Maine are found within the lakes and streams of this drainage. Of equal biological importance, but less well known to the angler, are a host of other species of fish. In the listing that follows, the common and scientific names of the fishes are those adopted by the American Fisheries Society. The list follows a phyletic sequence. The families are not given herein but species are listed alphabetically following the format and occurrence designation of **A List of Common and Scientific names of fishes from the United States and Canada,** 3rd ed., Reeve M. Bailey, Editor, Special Publication No. 6. 1970. 150 pp. American Fisheries Society, Washington, D.C.

Anadromous and catadromous species present within this river system are important sport and commercial fishes. The term anadromous refers to fish that spawn in fresh water but spend most of their lives in the ocean — while the term catadromous, represented by the eel, refers to fishes that spawn in salt water but live most of their lives in fresh water.

Common estuarial species are listed where information on their distribution is available from personal investigations or studies conducted by colleagues in the Department of Marine Resources. For information on the life histories of the sport fishes, the reader is referred to W. Harry Everhart, **Fishes of Maine,** 2nd. ed. Rev. 1966., Me. Dept. Inland Fish & Wildlife, Augusta, Maine.

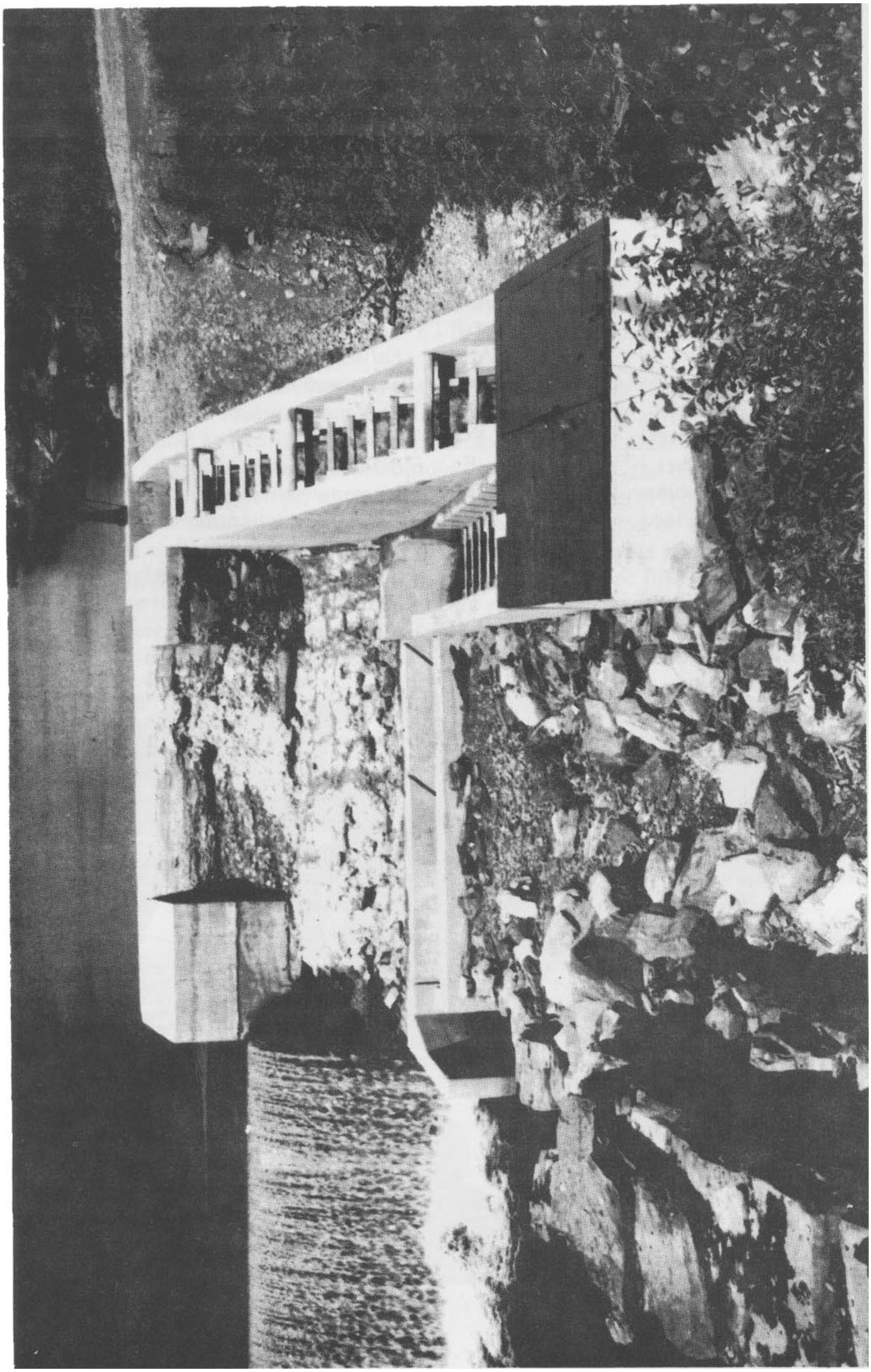
A Sheepscot beauty! The lucky angler is Paul Wagstaff of Damariscotta, Me.

FISH SPECIES — Sheepscot River

Common Name	Occurrence	Scientific Name
Sea lamprey	A*-F	*Petromyzon marinus*
Shortnose sturgeon	A*	*Acipenser brevirostrum*
Atlantic sturgeon	A*	*Acipenser oxyrhynchus*
American eel	A*	*Anguilla rostrata*
Blueback herring	A*	*Alosa aestivalis*
Hickory shad	A	*Alosa mediocris*
Alewife	A*-F	*Alosa pseudoharengus*
American shad	A*	*Alosa sapidissima*
Atlantic salmon	A*-F	*Salmo salar*
Brown trout	A*-F-I	*Salmo trutta*
Brook trout	A*-F	*Salvelinus fontinalis*
Lake trout	F	*Salvelinus namaycush*
Rainbow smelt	A*-F	*Osmerus mordax*
Chain pickerel	F-I	*Esox niger*
Golden shiner	F	*Notemigonus crysoleucas*
Common shiner	F	*Notropis cornutus*
Blacknose dace	F	*Rhinichthys atratulus*
Fallfish	F	*Semotilus corporalis*
White sucker	F	*Catastomus commersoni*
Brown bullhead	F	*Ictalurus nebulosus*
Atlantic tomcod	A*	*Microgadus tomcod*
Banded killifish	F	*Fundulus diaphanus*
Mummichog	A*	*Fundulus heteroclitus*
Brook stickleback	F	*Culaea inconstans*
Threespine stickleback	F	*Gasterosteus oculeatus*
Ninespine stickleback	A-A*-F	*Pungitius pungitius*
White perch	A*-F	*Morone americana*
Striped bass	A*	*Morone saxatilis*
Pumpkinseed	F	*Lepomis gibbosus*
Smallmouth bass	F-I	*Micropterus dolomieui*
Largemouth bass	F-I	*Micropterus salmoides*
Yellow perch	F	*Perca flavescens*

F — Freshwater
A* — anadromous and catadromous
A — Marine
I — Introduced

Coopers Mills Fishway.



HISTORY AND STATUS OF THE FISHERIES

In the Sheepscot area, the settlers relied heavily on fishing as a means of livelihood. "Codfish" was a magic word and great quantities were salted and dried for export to Europe and later to the West Indies, but little, if any, recognition was given to most other species, their incidental capture being for domestic use.

An indication of the magnitude of the resources that greeted the settlers of the area is contained in a quote from Cushman (1882).

"Sheepscot, in her marshes, both salt and fresh, her unrivalled soil, magnificent forests, and spring "run" of salmon, shad and alewives, was a gem of untold worth to the agriculturist and planter...". Although salmon are never mentioned as being extremely abundant, the following notation from Chase (1941) gives some insight into the extent of the runs of anadromous fishes in the early days.

"In the Sheepscot River before the mills polluted the stream, were great schools of fish. Salmon, shad and alewives were at the falls at Head Tide; striped bass at Sheepscot Falls; smelts were so abundant in this and the neighboring rivers that they were used as fertilizer." By the late 1800's, dams at Sheepscot Falls and Head Tide had blocked the river and destroyed all but the remnants of the anadromous fisheries that the early settlers had depended upon for sustenance.

The salmon runs were depleted at an early date, for Charles G. Atkins in his unpublished field notes states that in 1872 and 1873 the nets and traps on the Sheepscot River caught 12 or 15 salmon — **"a much larger number than usual."** In 1880 and again in 1881, he further stated that one to three salmon were taken almost every year by the shad nets and on occasion a few were speared at Puddledock Bridge. Atkins attributed the continuation of the small run to the limited spawning and nursery area that was available below the Head Tide Dam in Alna.

Atkins wrote in 1887:

> "...Impassable dams at Alna, at the head of tide, have for many years shut the migratory fishes out from nearly its entire course. The main river was exempted from the operation of the fish law by the act of legislature of 1800..." "At present, the fisheries of the Sheepscot River are of little importance, the total value of the product being but $2,540, which is about the ninth part of the Damariscotta. About 1,000 shad were taken in traps arranged for them in the river near Alna. One or two salmon are commonly taken in these shad nets, but none in 1880. No alewives of consequence were caught, there being no fishing specially for them..."

The above conditions describe the decline of Maine's river fisheries, not only on the Sheepscot but all along the coast. The decline continued and by the late 1940's the shad catch on the Sheepscot was listed as one or two fish a year (Taylor, 1951), and salmon were nonexistent. Other species of anadromous fish, of lesser commercial value, were also depleted.

The Sheepscot River once supported a good run of alewives. Atkins (1887) and Rounsefell and Stringer (1943) blamed dams, constructed on the river during the past century, for destroying the fishery. Later, Baird (1953), in discussing the status of the alewife fisheries in Maine, stated that the Sheepscot River appeared to have the greatest potential of eleven prospective areas in the state.

The alewife fishery is largely commercial. Adults ascend coastal streams in May and June to spawn in inland lakes and ponds. They are harvested during the spawning migration. Many coastal towns own the exclusive rights to fish alewives within their town limits, and alewives often constitute a valuable source of income for a community.

The town of Alna holds the exclusive rights to the taking of alewives within the town limits in the Sheepscot River pending adherence to the rules and regulations of the Maine Department of Marine Resources.

Alewives have been harvested by use of a weir located in Alna, and in 1978 approximately 95,000 pounds were landed. Other landing sites utilized in the past are located at the outlet of Sheepscot Lake and at the dam at Coopers Mills in Whitefield.

Alterations on the Head Tide Dam make it possible for alewives to negotiate this former obstruction, and fishways at Coopers Mills and Sheepscot Pond allow alewives access to the headwaters of the Sheepscot.

Introductions of alewives were made in Long Pond by the Department of Marine Resources to re-establish the run in this section of the drainage. Natural runs of adult alewives now enter Long Pond and Sheepscot Pond. Alewives are known carriers of PEN (Piscine Erythrocytic Necrosis) and because the present distribution of this viral disease in inland waters is unknown, all introductions of anadromous alewives into new waters should be undertaken with caution. The potential for introduction of fish diseases, to the water supply of fish cultural stations should be of concern to fishery managers.

Alewife runs appear to be on the increase and scientists are optimistic over the future of the alewife in the Sheepscot River. Potentially, several other areas of the drainage could provide alewife spawning area, but dams on the outlets of the ponds prevent their utilization.

The installation of fishways at the outlet of Pleasant (Clary) Pond, a tributary of the main river, and at Branch Pond on the West Branch would increase the available spawning area for alewives by nearly a thousand acres.

A new Denil-type fishway has been constructed at the outlet of Dyer Long Pond and alewives are now harvested under the direction of the Department of Marine Resources by the town of Jefferson.

There is a modest run of bluebacks (river herring) in the Sheepscot River. They arrive during the latter part of the alewife runs and are exploited commercially in the same weirs. Total landings are unknown as no effort is made to differentiate between the two species landed during the alewife industry.

The American shad, a close relative of the alewife, is important to both sport and commercial fishermen along the eastern seaboard. Our Maine rivers once contained large numbers of shad, but they are no longer productive; obstructions and pollution have decimated the populations.

Shad enter the rivers in late spring, and spawning occurs in late May and early June over sand and gravel riffle areas. Spawning activities reach a peak in the evenings and the semi-buoyant eggs are broadcast to roll about on the bottom. Hatching occurs in 8 to 12 days depending upon water temperature.

The shad is noted for its reluctance or inability to use fish passage facilities. However, shad will pass a vertical slot, or a Denil-type, fishway. An obstruction-free approach to spawning grounds is a necessary prerequisite to the maintenance of a shad run.

Available information indicates that at one time the Sheepscot River had an abundant shad run. Logging dams and other obstructions reduced the run, and erection of the Head Tide Dam at Alan effectively blocked shad from their spawning grounds. Taylor (1951), in his publication on former shad streams in Maine, reports that the Sheepscot has maintained a small run of shad and 12-15 fish were taken during the spring of 1950 in gill nets. No shad have been seen in recent years, although studies conducted for the Maine Yankee plant have recorded juvenile shad from the estuary.

In the past, a commercial fishery existed for striped bass in the Sheepscot estuary, but the extent or value of this fishery is obscure. Atkins' unpublished field notes for 1881 state "In the winter of 1879 and 1880 Shortwell and many boys of Newcastle got $300 worth of bass in nets set through the ice. $300 or $400 at $.10 per lb. bass taken in Wiscasset by hook."

Striped bass fishermen in the Sheepscot River are now restricted to the use of hand lines or rod and reel and management of the tidal water fishery is the responsibility of the Maine Department of Marine Resources.

In conjunction with the alewife harvest at Alna, a fishery exists for the sea lampreys returning to the Sheepscot to spawn. Annual catches of 8,000 have been taken in recent years and sold as specimens to various biological supply houses. Although these fish are edible, little or no attempt has been made to harvest them for human consumption.

A few lampreys reach Sheepscot Pond tributaries to spawn. Newly transformed lampreys have been found to parasitize salmonids in Sheepscot Pond but they are not expected to pose a major threat to the management of the fisheries of the area.

The catadromous eel is common throughout the freshwaters of the Sheepscot drainage. A commercial fishery is possible, but utilized very little at present. Occasional minor catches for bait or for culinary purposes are largely unreported. A small pot fishery could be sustained in the estuary, and the potential for development of a modest elver fishery exists at the tidal falls and at the head of tide in Alna.

The Atlantic salmon, a major sport species, will be discussed in detail in later sections of this report.

Over two dozen lakes and ponds, and numerous small brooks and streams, lie within the boundaries of the Sheepscot drainage. Many of these waters contribute heavily to the rod catches of Central Maine anglers.

The major species of freshwater gamefish of Maine thrive in the waters of the Sheepscot drainage. The Maine Department of Inland Fisheries and Wildlife has completed inventory studies on all major waters and they now have the necessary information to manage the inland fisheries. More than twenty-three lake and pond inventory reports for waters of the Sheepscot drainage north of U.S. Route 1 at Wiscasset are available.

The Sheepscot drainage contains a preponderance of warmwater lakes and ponds. Of the twenty-three lakes and ponds for which information is available, eighteen are classified as suitable for warmwater fishes, while only five are classified as suitable for coldwater fish species. On an acreage basis, warmwater fish habitat is more than double that of the coldwater habitat. In addition, four of the five coldwater ponds contain one or more species of warmwater gamefish. These warmwater species compete with the more desirable coldwater ones and prevent maximum yields of the coldwater fish.

In the section of this report that follows, the inland fisheries of the Sheepscot drainage will be briefly discussed. Additional information on these fisheries may be obtained from the Department of Inland Fisheries and Wildlife.

Of the several coldwater fish species in the drainage, the brook trout is by far the most widely distributed. Brook trout occur in many of the spring-fed tributaries of the main river and West Branch and are resident in sections of both waters. They are generally more abundant, however, near the headwaters.

Four small ponds, Bowler and Crotch on the main river, Prescott on the West Branch, and Deer Meadow (whose outlet enters the estuary at South Newcastle), provide brook trout habitat and have been stocked in the past to bolster natural stocks. Prescott Pond and Deer Meadow Pond were removed from the trout stocking list for lack of a public access site and continued access at other ponds is now in question.

The inability of trout to tolerate competition from both the more numerous rough fishes and other salmonid species, combined with the summer water temperatures of the drainage, has prevented the establishment of a native resident brook trout population in many sections of the Sheepscot drainage.

Brown trout, an introduced species, occur in both branches of the Sheepscot River and in Sheepscot Pond. On the main river, natural populations now thrive in the stream above and below Sheepscot Pond.

Their presence throughout a large segment of the river above Coopers Mills seriously limits salmon production in this section of the river.

Although brown trout are more difficult to catch than brook trout or landlocked salmon, their fighting ability is beyond repute. While their presence in some parts of the drainage may hinder the successful establishment of other species, they, nevertheless, are a challenge to anglers who possess the patience and skill to catch these wary fish.

The eventual spread of brown trout throughout the lower reaches of the drainage could result in the development of a modest fishery for anadromous or sea-run brown trout.

The landlocked salmon, native to the State of Maine, has been stocked in Sheepscot Pond. A fishery exists for this species but natural production is limited. Hatchery-reared stocks are released in sufficient numbers to maintain the fishery, however.

Lake trout (togue) introductions have been made in Sheepscot Pond where the cold, deep, well-oxygenated water provides suitable habitat. Catches indicate that lake trout survive and grow there, but the fishery to date has been unable to maintain itself by natural reproduction. Current management plans call for maintenance stockings of lake trout in this pond.

Most of the warmwater gamefish species found throughout the Sheepscot watershed are not native to the area. The dates of introduction of many of these fish are not known. Some, like the largemouth bass in Sherman Pond, were made by fishery scientists to provide an additional fishery and to utilize available habitat. Other introductions were made via the bait pail or by unauthorized individuals and/or organizations. Regardless of the method of introduction, these species, now widely distributed in the drainage, provide an angling harvest of value to the state. A brief description of the fisheries for pickerel, bass, and white perch follows.

Eastern chain pickerel are widely distributed in the drainage. They occur in 18 of the 23 waters inventoried and are known to inhabit others. Most shallow ponds provide desirable habitat, and the pickerel is extremely popular with both open water and ice fishermen.

Chain pickerel also thrive in several of the coldwater ponds of the Sheepscot drainage and in the deadwater areas of the streams. In these waters they may compete with the more desirable coldwater species. Studies by Barr (1962), Warner (1972), and others, have shown beyond a doubt that predation by pickerel is a serious factor in the management of our landlocked and Atlantic salmon resources. In many areas game fishes are the preferred prey. Pickerel depredation of migrating salmon smolts is also well documented.

An unauthorized introduction of smallmouth bass into Bowler Pond during the late "forties" has resulted in the establishment of bass in numerous waters of the system. Bass appeared in Sheepscot Pond in the early "fifties" and shortly thereafter entered Long Pond. Both waters now provide an attractive bass fishery.

The appearance of bass in Sheepscot Pond (a pond well known in-central Maine for its coldwater fisheries) alarmed many sportsmen. Some anglers were concerned over the prospects of a decline in the salmon and trout fishery. While it seemed likely that the bass introduction would effect some change in the coldwater fish populations in Sheepscot Pond, there is little evidence the expected changes were all detrimental.

Summer anglers have benefited from the introduction of smallmouth bass at Sheepscot Pond, for coldwater species seldom provided dependable summer fishing. Summer anglers now have the opportunity to enjoy an additional fishery because bass are now one of our important warmwater sport fishes.

With fishable populations of bass already established in Sheepscot and Long Ponds, a successful future is predicted for bass in the Sheepscot drainage. No known method will prevent the gradual spread of bass to other ponds of the drainage. Several waters will provide suitable habitat and should become excellent bass ponds.

Dams on the outlets of some ponds will prevent the natural introduction of bass. Introductions of smallmouth bass under the supervision of Fisheries and Wildlife Department personnel may have management possibilities in these waters.

Smallmouth bass adapt readily to cool rocky-bottomed streams, and many sections of the Sheepscot River provide bass habitat. While smallmouths are presently limited to the waters of the main river, they will eventually become established in the waters of the West Branch. What effect bass will have on the production of Atlantic salmon in the Sheepscot is a subject for speculation. It seems likely that some reduction in the production of salmon can be expected as bass become more widespread. Bass are proven predators as young salmon hatch and disperse in the streams of Washington County (Jordan 1978).

Smallmouth bass have been long-time residents of several ponds near the headwaters of the Dyer River which has been a focal point for the introduction of this species into the Sheepscot for many years. Nevertheless, bass have never been associated with the lower reaches of the Sheepscot River. It is possible that the salinity of the estuary may have acted as a barrier to the natural migration of bass from the Dyer River. The estuary is considered an adequate barrier to prevent the largemouth bass, now present in Sherman Pond, from spreading to adjacent waters.

White perch are present in the estuary of the Sheepscot and in 14 ponds of the drainage, and are a popular game fish with many anglers. In several of the ponds, growth is rapid and weights of a pound or more are common. In other ponds, white perch are over-populated and few fish in these stunted populations ever attain a desirable size.

Protective regulations are unnecessary in the management of white perch or other such prolific species, and anglers are encouraged to increase their utilization of the white perch resource.

ATLANTIC SALMON IN MAINE

The Atlantic Salmon, *Salmo salar L.*, occupies a unique niche in the management of the natural resources of the State of Maine. It is a fish steeped in history and lore that has intrigued mankind from the dawn of recorded history. It recognizes no man-made boundaries. It spends much of its life at sea but returns to freshwater to reproduce its kind. It is subject to exploitation throughout its natural range and the management of the salmon as a valued resource poses problems that are both local and international in scope.

From the caveman of the Pyrenees, to the Roman Legionnaires, to the early colonies in North America the salmon was a fish of wonder and speculation. This long and intimate association has given rise to terminology that describes the life stages of the salmon, and the terminology is not confined to the halls of academia or musty scientific journals. The terms are used by statesman and sportsman alike and are in common usage on both sides of the North Atlantic.

Annotated Terminology List for Atlantic Salmon *(Salmo salar)*

The terms as listed in the following are extracted from Jarvi and Menzies (1936) as revised by Allan and Ritter (1975) and altered and defined on the basis of known environmental and biological factors that influence the life history of the salmon in Maine.

Term	Definition	Comments or Synonyms
1. Alevin	Young salmon from hatch through absorption of yolk sac to independent feeding.	Sac fry
2. Fry	Brief transitional stage from emergence to dispersal from the area of the redd.	Duration of this stage normally measured in days.
3. Parr	Stage initiated by dispersal from the redd. Parr markings (vertical bars, 9-11 each side) are discernable. Parr stage lasts until fish commences migration to the sea. Parr stage is subdivided by age as follows:	
	0 + parr are less than one year old	Young-of-the-year
	1 + parr in second summer less than two years old	Yearlings or small parr.
	2 + parr in third summer or less than three years old	Large parr.

	3 + parr in fourth summer.	
3a. Precocious parr	Sexually mature male parr.	
3b. Silvery parr	Parr that have commenced smoltification, i.e. undergoing physiological changes prior to migration to the sea.	Term is synonymous with pre-smolt.
4. Smolt	An actively migrating young salmon that has undergone the physiological changes to survive the transition from freshwater to salt.	Smoltification is size dependent and migration occurs in spring.
5. Post-smolt	Stage during first year at sea from the time of departure from river to end of first winter at sea.	
6. Salmon	All adult fish regardless of age or state of sexual maturity. This stage begins after post-smolt period and ages are described according to the number of sea winters of life. Feeding salmon are categorized by the system of l+, 2+, 3 + , or 4 + sea-winters.	
6a. Grilse	A one sea-winter salmon that returns to its natal river to spawn. To the angler it is a small size-dependent salmon usually weighing less than 5 pounds. Fish of this size taken in the ocean and feeding are not grilse.	
6b. Bright salmon	A term in common usage to describe a salmon taken in freshwater. This term refers to all fresh run fish that enter their natal stream. The term is	

	synonymous with virgin or maiden salmon. Further descriptions are encountered but they are based on information regarding age and degree of sexual maturity.	
7. Kelt	A spent or spawned-out salmon found in the freshwater portion of a river system.	Term is synonymous with black salmon, racer, slink, snake, etc.
8. Post-Kelt	A spent or spawned-out salmon that has returned to the marine environment. This stage ends when fish regains the weight it lost during spawning.	
9. Repeat Spawners	Usually large salmon that are returning to their natal streams on another spawning journey. These fish can be further defined on the basis of number of spawning migrations, length of time at sea, and on the basis of time at sea between spawnings. These fish represent a small portion of the ascending runs but may represent a large portion of the trophy fish sought by the angler.	

The late Ai Ballou with a nice catch from the Tidal Falls, Sheepscot River, Me.

ATLANTIC SALMON RESOURCE

Creation of the Atlantic Sea Run Salmon Commission by the legislature in 1947 was the culmination of increased public awareness and concern for the drastic declines in anadromous fish runs in Maine. Management and restoration plans were formulated and the Sheepscot River, listed as the best of the salmon producing areas between the Kennebec and Penobscot Rivers, was included in the program.

A few salmon may have been produced in the area below Head Tide Dam at Alna, but production was inadequate to stock the drainage and a release program began in 1948 utilizing Canadian stocks. This was followed by a detailed stream survey of the Sheepscot River during 1950 and 1951, summarized by Bryant (1956).

Information collected during the survey of the main river and the major tributaries of the Sheepscot drainage enabled us to determine the extent of the various types of bottom and to compare the pool and dead-water areas with the riffle areas of the drainage. The potential of any river to produce Atlantic salmon is limited by the habitat available during the riverine stages of their life cycle. A salmon river must have adequate spawning habitat, ready access to these areas, suitable nursery areas for juvenile salmon, and holding pools for the adults.

Atlantic salmon spawning areas usually have a bottom composed of loose rubble 0.5-4.0 inches (2-10 cm.) diameter. Sand and fine gravel may be present in varying quantities, but the bottom substrate must be permeable enough to allow interstitial water flows for exchange of dissolved gasses and the removal of metabolic wastes from the redd. The water covering the spawning rubble may vary in depth from 10-30 inches (25-76 cm.) with a mean of approximately 14 inches (36 cm.). In Maine, most salmon redd construction occurs in water less than 20 inches (50 cm.) deep. Water velocities over spawning substrate vary from 0.9-2.6 ft/sec. (27-80 cm/sec.) with a mean of 1.6 ft/sec. (50 cm/sec.) and higher values observed during freshets (Jordan 1978).

High water flows from freshets frequently change stream bottoms by transporting rocks and rubble. Ice flows change stream bottoms by their scouring scraping action in shallow areas. Rubble composition in riffles may change markedly as sand and small rubble are carried downstream by high-water flows. Pools may fill as sand and rubble are deposited where stream velocities drop. These natural changes in stream topography help reduce compaction in spawning habitat and keep rubble accessible to salmon. Areas which experience little movement of the bottom rubble become compacted and silt-laden, making redd construction difficult.

The suitability of a stream as a salmon nursery area depends upon water velocity, water depth, bottom substrate and available cover. Symons and Heland (1978) observed that juvenile Atlantic salmon in the Miramichi River inhabited areas with water velocities from 0.7-2.5

ft/sec. (20-75 cm/sec), however, the highest salmon concentrations were found in areas with velocities between 1.6-2.1 ft/sec. (50-65 cm/sec.). Underyearling salmon were commonly found in water from 4-6 inches deep (10-15 cm.) and cover was provided by rubble between 0.5-2.5 inches (1.6-6.4 cm.) in diameter. Salmon parr longer than about 3.0 inches (8 cm.) were more commonly found in riffle areas with water deeper than 12 inches (30 cm.), and rubble greater than 2.5 inches (6.4 cm.) in size. Cover was provided by rocks over 10 inches (25 cm.) in diameter. Larger parr were not found in water less than 8.0 inches (20 cm.) deep, unless adequate cover was provided by rocks over 10 inches (25 cm.) in diameter.

Observations by the staff of the Maine Atlantic Sea Run Salmon Commission indicate that juvenile salmon are frequently found in shallow water, with or without boulders, if adequate cover is provided by aquatic vegetation, overhanging streambanks, overhanging branches, and/or smaller rocks. In addition to providing cover for salmon parr, rubble provides a substrate for many aquatic insects and other food organisms.

The distribution of juvenile Atlantic salmon during the winter can differ markedly from that observed during the summer. Juvenile salmon tend to move from the riffle areas or feeding stations they occupied in the summer to deeper resting pools in winter (Meister 1962), possibly as a physiological response to the changing physical environment of the stream or river. Saunders and Gee (1964) also reported that fry appeared to move into deep riffles and pools in the autumn.

Stream survey data compiled by Bryant (1956) pinpointed the major spawning and nursery areas of the Sheepscot drainage and catalogued the approximately 202,700 square yards of suitable salmonid habitat.

The main river below Coopers Mills Dam contains 201,500 square yards of riffle area or approximately 38 percent of the total bottom area of the main river at a flow of 48 cfs (cubic feet per second). Of this total (201,500 sq. yds.), 23,000 square yards, or 11 percent of the riffle area, is unsuitable for the production of salmon. The remaining 89 percent of the riffle area provides fair to excellent spawning and nursery area.

The lower five miles of the West Branch contains 139,000 square yards of bottom area of which 21 percent, or 29,000 square yards, are in riffle areas at a flow of approximately 16 cfs. Approximately 24,000 square yards of the above riffle area are suitable for salmonids. The upper West Branch to Weeks Mills adds a small amount of spawning and nursery area currently utilized by salmonids. This section contains approximately 10,000 sq. yds. of nursery area during periods of above average water flow. The addition of this spawning and nursery area does not appreciably increase the total productivity of the Sheepscot drainage.

Combining the figures for the main river and the West Branch reveals that 30 percent of the bottom area of the Sheepscot River is composed of riffles, of which 202,742 square yards can be considered adequate habitat for salmon production. This figure may be minimal, for sustained high water flows would increase the available area and some of the pool area would provide marginal nursery area. However, considering the low water flows that prevail during part of each year, the 202,742 square yard figure represents a good approximation of the total salmon-producing area of the Sheepscot drainage.

Elson (1957) reported salmon production in streams based upon a unit area concept of 100 sq. yds. of stream bottom and this approach was applied to Maine streams by Meister (1962). In these studies it was noted that salmon production was dependent upon the quantity, quality, availability and distribution of spawning and nursery areas. The Sheepscot River drainage contains 202,700 square yards of useable salmon rearing habitat, the equivalent of 2,027 production units.

Juvenile Production

In the period 1957 through 1970 the abundance of young salmon in this watershed was estimated as funds, time, and weather permitted personnel and equipment to be released from other obligations. During this period the same selected sites were sampled to provide an index of salmon abundance.

Sample Sites. Sample sites were selected as representative of the salmonid nursery and spawning areas in the Sheepscot drainage. Physical characteristics and location of the selected areas follow:

No. 1 — Located below the Head Tide Dam, Alna, Lincoln County, Maine. The approximate width of stream is 60 feet and the length of the study area is 300 feet. Water temperature averaged 71 °F during study periods. Flows normally ranged from 20-50 cfs, although flows in excess of 70 cfs have prevented sampling in this area. Gradient of the study section is low and bottom is composed of mixed rubble with some gravel and sand deposition at the lower end of the section. Resitivity of the water is approximately 20,000 ohm centimeters. Stream banks are covered with sedges, mixed hardwoods, and alders that provide little shading of the study area.

No. 2 — Located below the outlet of Long Pond, Coopers Mills, Lincoln County. This section has an average width of 4o feet and a length of 300 feet. Water temperatures averaged 60°F during the study period and flows ranged from 15-20 cubic feet per second. The gradient is relatively steep and the bottom is composed of mixed small to large rubble. Resitivity ranged from 20,000 to 29,000 ohm centimeters during the study period. This section is partially shaded in the upper reaches, and bank cover is predominately hardwoods.

No. 3 — Located upstream of the bridge in Weeks Mills, China, Kennebec County. The approximate length of the section is 600 feet and the average width is 12 feet. Water temperatures were in the mid-sixties and stream flows ranged from 7-20 cubic feet per second throughout the study period. This section has a moderate to good gradient with medium to large rubble riffles and pools. Some sand and gravel is found throughout the study section in isolated deposition pockets. The banks are covered with sedges, grasses and patches of alders with little or no direct shading of the stream. Resitivity was 17,000 ohm centimeters.

No. 4 — Located above the bridge at Maxeys Mills, Windsor, Kennebec County. This section of the West Branch, Sheepscot River has a low to moderate gradient. The bottom is composed of sand, gravel, and small rubble riffles. Flow in this 250-foot section, with an average width of 12 feet, ranged from 3-12 cubic feet per second during the study period. Resitivity ranged from 14,000 to 16,500 ohm centimeters and temperatures were normally in the high sixties in late summer. Stream banks are stable and moderate shading of pools and riffles is provided by low deciduous shrubs.

The salmon populations of the Sheepscot River were sampled annually for the period 1954 through 1962 and this assessment study was reinstated in 1968. Fish were captured using a 500-volt direct current gasoline-operated generator during the early study period. Sampling of the study areas by electrofishing enabled personnel to gauge the success of spawning and determine potential parr production.

Beginning in 1968, a population estimate by study section was obtained using a Petersen mark and recapture method. In 1969, excessive river flows and inclement weather prevented adequate assessment of the two larger sections. Studies during 1970 were hampered by equipment malfunctions.

Population assessments for two of the study sections are presented below:

Population estimates by age class & year

		1968	**1969**	**1970**
	Young-of-year	542	30*	232
Section 3	Parr	135	191	229
	Young-of-year	263	52*	149
Section 4	Parr	42	34	40

* Inadequate estimates due to high water levels.

The high water levels during 1969 prevented a reliable estimate of young-of-the-year salmon. This is apparent when the estimated 1970 parr populations (derived from the 1969 young-of-year) are compared from the two study areas.

In 1968, the young-of-year salmon ranged from 2.0-3.0 inches total length with a mean of 2.55 inches. In 1969 the fish ranged from 2.1-2.7 inches total length with a mean length of 2.32 inches. The parr population consisted primarily of 1-plus year old fish that would migrate from the river as smolts the following spring. Mean length of parr in 1968 was determined to be 5.83 inches total length with a range of 4.8 to 6.9 inches. In 1969, the parr salmon averaged. 5.83 inches total length with a range of 4.5 to 6.2 inches. These figures compare favorably with length distribution figures compiled for other populations of wild Atlantic salmon in Maine.

The size distribution of young salmon populations reinforces the material presented by Meister and Foye (1963) that the vast majority of salmon in the Sheepscot River migrate to the ocean as two-year-old fish. Current studies indicate that little or no change in the fluvial life span of Sheepscot River salmon has occurred during the past three decades. Additional, information was obtained during the 1971 studies when standing crop figures were developed, (Table 3). Figures 4 and 5 show the length frequency distribution and length-weight relationship of young salmon in the Sheepscot River.

Table 3. Standing crop figures by number of fish and weight expressed in grams, Sheepscot River, 1971. (Meister 1972)

Area sampled	**Number of fish weighed**		**Average weight of fish weighed**		**Estimated population**		**Estimated Weight of population**	
	YOY*	**Parr**	**YOY**	**Parr**	**YOY**	**Parr**	**YOY**	**Parr**
Section I	18	17	2		40			
Section II	7	40	2		46		98	4276
Section III	18	92	3	28	30	114	116	3188
Section IV	23	16	2	26	56	30	113	1166
Combined	66							
Areas		165	2	35	106	201	212	6633

* **Young-of-year (0 * parr.)**

Salmon Potential

The stream production of Atlantic salmon from egg deposition to the migratory stage (smolt) has been investigated in Eastern Canada and Maine by Elson (1957) and Meister (1962), respectively. Production calculated on a unit area basis (100 square yard area) and expressed as number of fish per unit area, indicates that a production of three smolts per year per unit may be optimum for Maine waters.

Figure 4. *Length-frequency histogram for juvenile Atlantic salmon, Sheepscott River, 1971.*

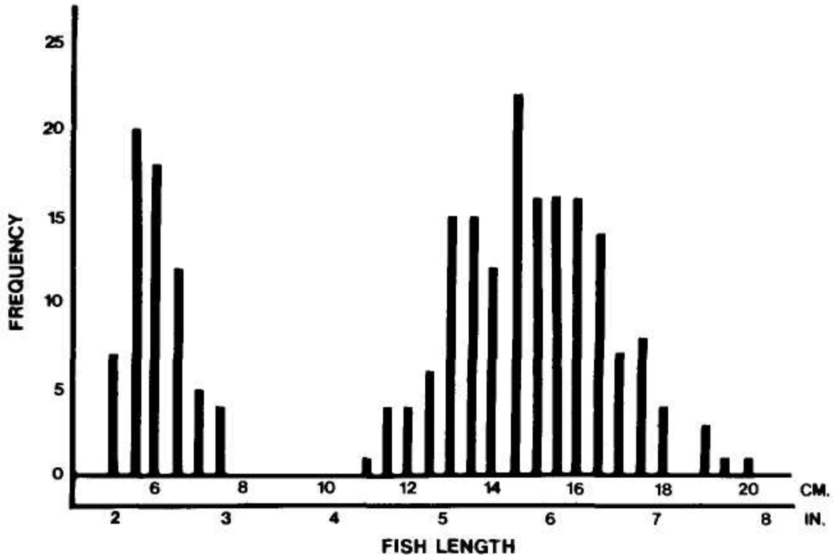
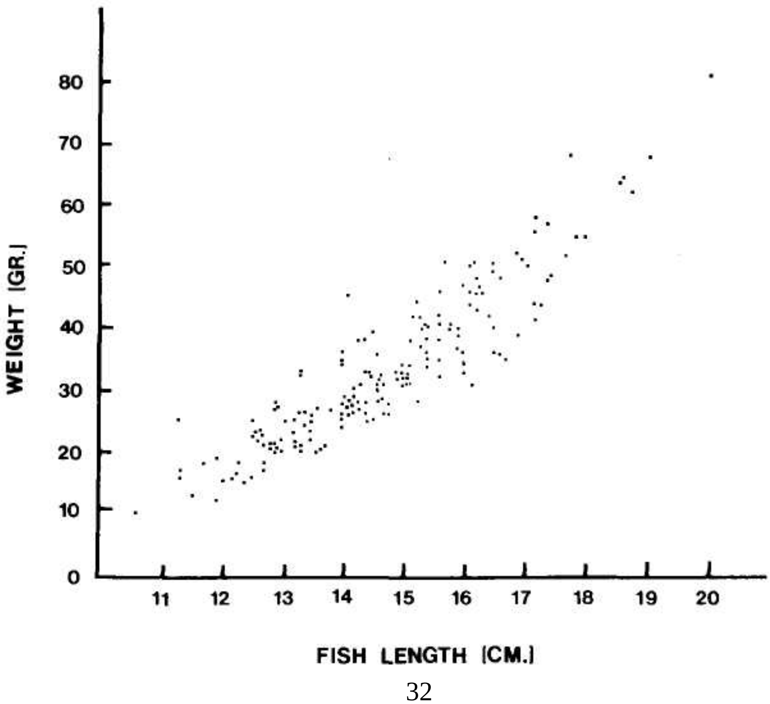


Figure 5. *Length-weight relationship for juvenile Atlantic salmon,*



On a unit basis, 47.2 units were electrofished in 1968 and 13.8 units in 1969 and 1970. In 1968, the salmon production was estimated to be 21 young-of-the-year and 7 parr per unit. Young-of-the-year production was estimated at 16 per unit in 1969 and 19 in 1970. The extremely high parr production in 1970 further indicates the difficulty experienced in 1969 in obtaining an adequate estimate of young-of-the-year in 1969.

Smolt production can be calculated on the basis of an approximate 50 percent overwinter survival of parr. [Elson (1957), Meister (1962), and Symons (1979)]. On this basis, the smolt production from the Sheepscot River for the period 1968-70 ranged from 3 to 9 smolts per unit area for the study sites. Data on file in the Machias office of the Atlantic Sea Run Salmon Commission for the period 1957-62 indicated a smolt production ranging from 0.5 to 9.5 per unit area for the Sheepscot River.

The Sheepscot River contains 2,027 production units at a base flow of 48 cubic feet per second. However, characteristic low summer flows reduce the potential production of this drainage to less than one smolt per unit per year for many areas.

With the above figures as a guide, the production potential of the Sheepscot drainage may be estimated. The 202,742 square yards of suitable habitat in the drainage represent 2,027 production units. Assuming that the optimum production of three smolt per unit is realized, then we could expect 6,081 two-year-old smolts from this river each year. Two-year-olds are the predominant age group in the smolt migrations from the Sheepscot. This smolt figure is in all probability the maximum production figure, because severe predation combined with competition from other species and the characteristic low water conditions that plague the Sheepscot each fall can result in a production of less than one smolt per unit per year. On this one/unit basis we could expect 2,027 smolts annually.

The annual production of 2,027 to 6,081 smolts when compared with known percentage returns from smolt to spawning adults, provides an estimate of the number of adult salmon we can expect to return to the Sheepscot.

Returns as spawning adults seldom exceed 5 percent and the range of 1 to 3 percent is closer to the average figure reported for salmon streams in other areas. Figures over 5 percent are almost always associated with returns to a commercial fishery and not to the river as spawning stock. High return figures are frequently associated with smaller 1-sea winter salmon (grilse) and seldom occur where multi-sea winter stocks are dominant.

From these data we can define the limits of the expected survival from smolt to returning adult. A 5 percent return of the optimum 3 smolt per unit area would result in 305 adult salmon. A one percent return would be 61 fish. Based on a minimum production of one smolt per unit, we would expect 103 adults for a 5 percent return or a low of 20 fish with a one percent return.

Fluctuations in the annual rate of survival to the smolt stage and in the survival of salmon in the marine environment will affect adult returns to the river. **Depending upon the severity of these fluctuations we would expect the adult salmon run of the Sheepscot to range from 20 to 300 fish per year.**

The production units used in the above calculations were based on stream measurements at a flow of 48 cfs. In years that water flows drop below 20 cfs for extended periods, the total production units of the watershed may be decreased by 50 percent.

It is interesting to note that for the two years, 1957 and 1959, (Stickney 1960) for which we have smolt counts, these fish were subjected to the low water years of 1955 and 1957 when flows dropped below 20 cfs for considerable periods. Known smolt migrants of 1,012 in 1957 and 1,076 in 1959 yield a smolt production figure of ' *Vi*' smolt per unit area. In the period 1947 through 1960 only one year class of salmon, those hatched in the spring of 1958, have escaped the rigors of survival in water flows of less than 20 cfs.

Stickney (1960) operated a counting fence on the Sheepscot River for the period 1956-1959. Adult escapement through this fence is presented in Table 4. The adult returns, including rod catches, range from 65 to 128 fish and these returns are well within the calculated range of 20 to 300 adult fish per year.

Table 4. Adult salmon escapement by age groups through the Sheepscot River counting fence (1956-1959). From Stickney (1960).

Age Group	**1956**	**1957**	**1958**	**1959**	**Totals**
Grilse (1-sea winter)	1	4	6	23	34
Salmon (multi-sea winter)	3	47	5	73	129
Repeat Spawners	4	5	0	1	10
Not aged	1	9	1	29	40
Totals	9*	65	13*	128	215

* Incomplete counts.

During the period of operation of the counting fence it was noted that approximately 40 percent of the adults had ascended the stream by mid-August. A definite fall run was encountered in 1957, a year of severe low flows, when 48 of the 65 salmon counted entered during October and November. It should also be noted that a fairly substantial segment of the escapement consisted of grilse (1-sea winter) returns. This was not unexpected, as fish from Canadian eggs were reared and released in the Sheepscot from 1948 through 1960.

The stocking history of Atlantic salmon in the Sheepscot for the period 1948 through 1976 is presented in Table 5.

Table 5. Atlantic salmon stocked in the Sheepscot River, 1948 -1976.

Date of stocking	Number stocked	Number of fish per pound	Mark	Year of majority return
Oct. 1948	12,000	168.2	none	1952
May 1949	8,241	53.1	D&L	1952
May 1950	20,200	72.5	D&N	1953
Oct. 1950	19,800	230.6	A&L	1954
Nov. 1950	10,010	67.3	none	1955
Oct. 1952	20,000	271.4	none	1956
Oct. 1954	29,400	140.7	D&R	1958
Oct. 1955	19,892	118.7	D&N	1959
Oct. 1956	19,319	105.7	L&R	1960
Oct. 1957	10,000	68.9	L	1961
	10,000	68.9	N	1961
Oct. 1958	17,286	73.7	D	1962
	1,806	73.7	A	1962
	1,087	73.7	D&A	1962
May 1960	36,961	44.2	none	1963
Oct. 1960	27,048	69.0	D&L	1964
Nov. 1961	24,219	18.0	none	1965
Oct. 1962	32,845	9.8	L&R	1965
Nov. 1962	15,495	15.0	none	1966
Apr. 1964	6,176	16.0	NR	1966
Apr. 1965	14,208	11.2	DR	1967
Apr. 1966	25,038	12.3	none	1968
Apr. 1967	10,516	9.0	none	1969
Apr. 1968	15,982	9.6	none	1970
May 1971	1,023	12.6	Ad	1973
May 1975	2,520	8.6	none	1977
May 1976	3,000	11.4	none	1978

In recent years all hatchery-reared salmon stocked in the Sheepscot River have been released in the spring as smolts and have migrated directly to the ocean. Returns from these releases have not been adequate to permit a detailed analysis. However, limited returns are received as rod-caught data from cooperating anglers, and this information can be used as an index of adult returns.

During the past decade the recorded catch from the Sheepscot has averaged 19 fish per year. Despite this rather low yield the Sheepscot has provided countless hours of enjoyment to many anglers. Not the least of these was the late great angler and fly-tyer Ai Ballou of Winthrop, Maine, shown in Figure 6 with an 18 ¼ pound salmon he angled from the Sheepscot in August, 1966. Figure 7 shows the Sheepscot Falls salmon pool where Paul Wagstaff of Damariscotta caught a 20 pound 37 inch salmon in June, 1977. This fish is the largest salmon to be reported angled from the Sheepscot River and is so listed in the records of this Commission.

Fletcher and Meister (1966) and others have reported that anglers frequently catch from 15-20 percent of the ascending run. On the Penobscot River angler utilization has ranged from 11-26 percent of the known adult returns. It was further reported that anglers on other rivers in Maine report from 60-80 percent of the salmon angled. Known rod catches from the Sheepscot River as reported to the Commission for the period 1953-1981 are presented in Table 6.

Table 6. Known Atlantic salmon sport catches for the Sheepscot River, Maine, 1953-1981.

Year	Rod Catch	Year	Rod Catch
1953	0	1968	10
1954	6	1969	5
1955	32*	1970	6
1956	2	1971	30
1957	2	1972	(Less than)20
1958	16	1973	(Less than)20
1959	22	1974	(Less than)20
1960	est?10	1975	11
1961	13	1976	10
1962	14	1977	24
1963	10	1978	35
1964	20	1979	8**
1965	20	1980	30
1966	40	1981	15
1967	30		

* Includes rod caught kelts captured in the spring fishery.

** Angling season closed 2 months early.

If the reported catches represent 60 to 80 percent of the actual catch and we assume a 20 percent exploitation rate, the ascending run and the upriver escapement of salmon can be calculated. For example, in a year when 20 fish are reported as caught by anglers we would calculate the ascending run to range from 125 and 170 adult salmon and the escapement would represent 100-145 adults. In years with the catch affected by low water flows or a delayed entrance of adults these estimates could be minimal.

Meister and Cutting (1967) reporting on the spawning runs of Atlantic salmon in the smaller rivers of Eastern Maine found a sex ratio that was close to 1:1. On this basis, an escapement of 140 salmon to the Sheepscot River would represent approximately 70 females. Baum and Meister (1971) recorded an average production of 8,300 eggs per female salmon for Maine populations. Elson (1957), and Meister (1962) reported that approximately 200 eggs per production unit were required to maintain an optimal production of fry, parr and smolt. These figures were later refined by Symons (1979) who reported that 180 eggs per unit were adequate to maintain the production of 2-year smolts.

On the basis of the studies conducted in Maine, and comparing these with the results others have reported in the literature, we find that an ascending run of 70 female salmon with an average individual weight of 9.4 pounds would produce in excess of 500,000 eggs. This would provide more than enough eggs to satisfy the requirement of 200 eggs per unit needed for optimal production of 2-year smolts from the 2,027 production units located in the Sheepscot drainage.

A physical description of spawning habitat and an evaluation of spawning success in Maine rivers has been reported on by Jordan (1978). Based on the parameters recorded in his study, the spawning habitat within the Sheepscot drainage is considered to be sufficient for current and projected adult salmon stocks. Available information indicates that juvenile Atlantic salmon populations appear to be adequate to maintain current levels of production.

The judicious use of hatchery stocks can enhance depleted salmonid populations. An increase in the number of adults returning to our smaller rivers such as the Sheepscot may be possible by supplemental releases of suitable stocks. The salmon populations of the Sheepscot drainage, over a number of generations, have been selected for environmentally, and these fish have adapted to the physical and chemical characteristics of this watershed.

In other salmon producing areas like Sweden, where salmon stock augmentation has been ordered for mitigation purposes, the program is considered to be economical only on the basis of supporting a commercial fishery. Time alone will determine the practicality of a routine release program to augment the sport fishery in our Maine streams. Until this information becomes available it does not appear to be desirable from a biological viewpoint to contaminate self-sustaining genetically-isolated populations of salmon on a routine basis.

Resource Management

The Sheepscot watershed, rich in natural resources, has a history of exploitation that goes back to the early days of the Pemaquid colony (Foye 1967). The area has been exploited for its timber, its fisheries, and in the past it has been harnessed for water power. The river itself has been a candidate for inclusion in the federal listing of Wild and Scenic Rivers, and the lands of the watershed are currently under scrutiny by the abutting regional planning commissions. The Sheepscot Valley Conservation Association, supported by many of the towns within the drainage, is at present coordinating resources to develop long range protection and/or development plans for the area.

Hydrological data, including projected storage capabilities of the existing reservoirs in the Sheepscot watershed has been addressed by King (1970). However, the capability to augment stream flows cannot be increased without a considerable expenditure of funds. The problems inherent in the control of water levels for the maintenance of the aquatic biota has been discussed by Fletcher (1971), and little additional benefits to the anadromous fisheries of the Sheepscot can be expected. The low flow conditions (less than 8.0 cfs) encountered in the past are a part of history. A minimum sustained flow is now provided in the upper reaches of the Sheepscot by the discharge of the Palermo fish hatchery from the stored waters of Sheepscot Pond. River flows of less than 15 cupic feet per second are not expected at Whitefield under average rainfall and discharge conditions. Flows of lesser magnitude, although common in the past, have been recorded only twice in the last 15 years of operations of the Palermo hatchery.

A modest increase in lower main stem flows could result from a metered fishway discharge at Clary Pond and from Branch Mill Pond on the West Branch. Fishways are lacking at both of these sites. The use of this pond habitat for alewives would offset some of the reduced production from Long Pond and Sheepscot Pond where alewives have been denied access to protect the hatchery water supply.

The fisheries of the Sheepscot drainage are currently regulated by state agencies. The Department of Inland Fisheries and Wildlife regulates the taking of our freshwater fish species while anadromous and catadromous stocks are under concurrent jurisdiction with the Department of Marine Resources. Atlantic salmon in both the inland and tidal waters of the state are regulated by the Atlantic Sea-Run Salmon Commission.

Liberalized regulations on the warmwater fisheries of the Sheepscot are to be encouraged. Fish such as pickerel and bass are known predators of salmonids and are a major problem in the dead water areas of streams managed for Atlantic salmon (Barr 1962, and Warner 1972). Avian predation by mergansers on juvenile Atlantic salmon has been documented by Elson (1975) and predation by the double-crested cormorant on migratory smolts has been studied by Meister and

Gramlich (1967). This attrition can significantly reduce salmon populations unless control and/or harassment measures are implemented.

On occasion sea lampreys have been harvested from the upper reaches of the Sheepscot estuary. This fishery should be encouraged. The town-operated alewife fisheries on the Dyer River and the mainstem traps at Alna or Puddledock should be continued. However, adequate escapement to maintain the runs must be assured and the protection of other migrating fish species provided for.

Present water quality of the Sheepscot drainage is considered adequate for water-based recreation and for maintenance of the aquatic biota. However, any additional point source discharges or large scale pesticide programs could alter the current status and should be closely monitored.

Many of the hardwood stands within the Sheepscot drainage are infested with insects and the defoliation of oak, willow, poplar and maple trees is immediately noted by the visitor. These infestations tend to be cyclic and major control programs involving aerial spraying should be discouraged. Pesticide applications, should they coincide with other chemical uses by agricultural interests or the public utilities, could cause substantial damage to the aquatic environment upon reaching the water. A discussion of the problems associated with chemical applications reaching the waters of Atlantic salmon rivers has been presented by Elson, et al. (1973).

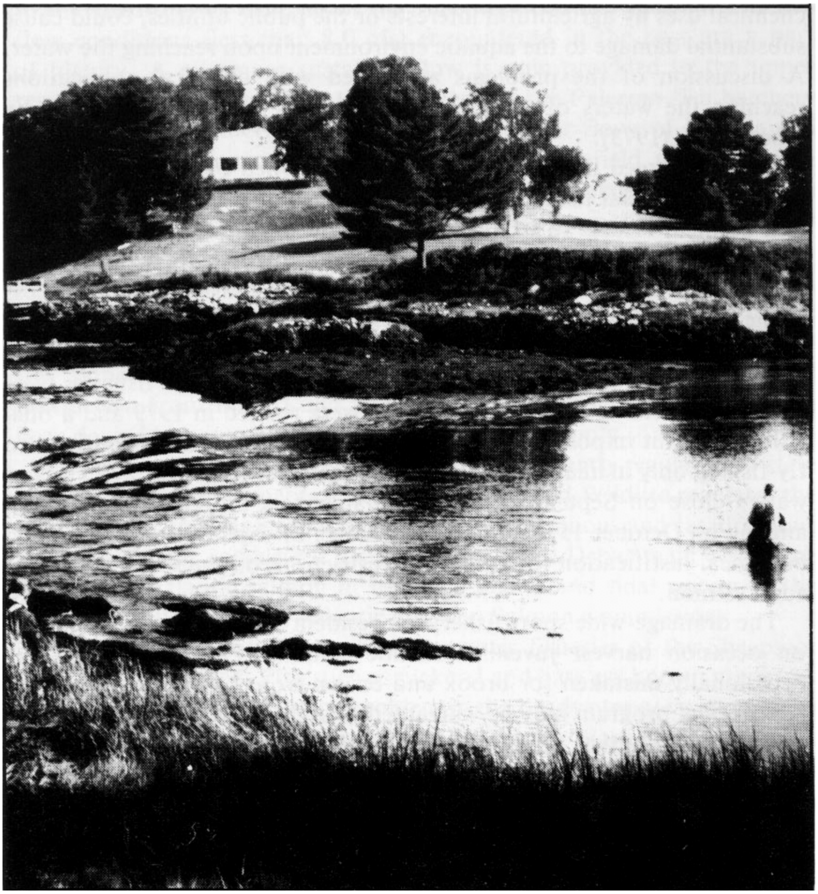
The submerged lands of great ponds are owned by the State but the ownership of tidal lands and the stream areas of the Sheepscot are less well defined. Access to streams and the tide waters of the estuary is at present limited, and in the hands of private ownership. Conservation easements or the purchase of right of ways would guarantee public access to the waters of the Sheepscot for recreational purposes.

The development of the Atlantic Sea Run Salmon Commission and the evolution of our present regulations governing the salmon fisheries were covered by Meister (1969). Regulations were revised in 1979 and a one-fish daily limit imposed upon the angler. The sportsman is confined to fly-fishing only in inland waters and the season now opens May 1. Inland waters close on September 15 and tidal waters are closed to salmon angling on October 15. At the present levels of exploitation, there is no biological justification for additional restrictions on the sport harvest of adult salmon.

The drainage-wide sport fishery for resident species of salmonids may on occasion harvest juvenile Atlantic salmon. Parr and smolts are occasionally mistaken for brook and brown trout by the angler and an educational program may be warranted in areas of the state where these populations co-exist. Studies on the juvenile salmon populations in the Sheepscot drainage (Meister 1971 and 1973) show that the majority of salmon parr are now protected by existing minimum length regulations.

The populations of Atlantic salmon endemic to Maine's rivers are unique biological entities: they recognize no man-made boundaries and roam international waters for half their life span; they are exploited by distant fisheries as well as those in home waters; they migrate td feeding areas north of the Arctic circle yet they return to their natal streams to reproduce their kind. They exhibit a plasticity that is unique among anadromous fishes and given the opportunity, small populations like those returning to the Sheepscot River are capable of circumventing both natural and man-made catastrophies. They surmount the marine and freshwater fluctuations in survival that determines the number of salmon returning each year. They remain as a renewable resource of importance to the State of Maine, for the benefits derived are woven throughout the fabric of our economy as citizens and visitors alike pursue *Salmo salar* for food and sport.

Tidal Falls, Sheepscot River, Maine.



RECOMMENDATIONS

The following recommendations, derived from material included in this report, are presented for the guidance of those involved in the maintenance and management of the anadromous fish resources of the Sheepscot River and its tributary waters.

1. A continuing data bank on development and changing land use pat terns is considered necessary to protect the aquatic resources of the Sheepscot watershed.
2. The abstraction or diversion of the surface waters of the drainage would be detrimental to the water-based resources of the area and should be opposed.
3. Studies should be undertaken to determine the feasibility of con structing fishways at: Clary Pond and Branch Mill Pond Dam.
4. The existing water control structures at Coopers Mills and Sheepscot Pond should be maintained and operated to ensure a minimum metered flow to the mainstem of the river.
5. Fishway at Sheepscot Pond should be screened or closed to protect the indigenous fisheries and hatchery water supplies.
6. The state and/or a responsible local institution should obtain right-of-ways or conservation easements to selected portions of the fresh and tidal waters of the drainage. Stream access areas and permanent access to the Tidal Falls angling site is of paramount importance to the management and maintenance of Atlantic salmon sport fishing in the Sheepscot area.
7. The construction or renovation of in-stream or tidal water dams should be opposed as they are detrimental to the maintenance and management of the anadromous fish resources of the area. Miti gation objectives and procedures should be established as a federal and state pre-requisite for developments in or on existing Atlantic salmon rivers.
8. A means of obtaining accurate catch records should be funded and implemented. An annual electrofishing inventory of the juvenile salmon populations should be reinstated.
9. Stock augmentation of individual year classes of Atlantic salmon should be based on inventory studies and catch records. If discrete riverine populations of Atlantic salmon are to be maintained and managed, a judicious use of the present hatchery product is recommended.
10. Anadromous species available for commercial harvest in the Sheep scot should be managed on a sustained yield basis with controlled escapement.

ACKNOWLEDGEMENTS

The material contained in this report represents a cooperative effort to manage the fishery resources of the State of Maine. Over the years, personnel from the Department of Inland Fisheries and Wildlife and the Department of Marine Resources have willingly assisted the staff of the Salmon Commission with various field studies. The individuals, sportsmen, students and professionals alike, deserve a special thanks for a job well done.

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NOTES

The following corrections should be noted:

Page 32: Figure 5 - length-weight relationship phrase - "Sheepscot River" should be omitted.

Page 44: Under Literature Cited; Meister and Gramlich, 1967. 2nd line should read Cormorant-salmon.