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GRAND LAKE STREAM

STRATEGIC PLAN FOR FISHERIES MANAGEMENT

WEST GRAND LAKE

Prepared for:

The Cabinet Committee on
Hydropower Policy,
Land and Water Resources Council

Elevation
298'

To U.S. Rt. 1

Dam
Dam pool

Fish hatchery

Hatchery
Pool

Picnic
area

Greenlaw
Gould Landing
Landing

Big
Falls

Little
Falls

GRAND LAKE
STREAM

BIG LAKE

Elevation
203'

SH
222
.M2
J6
1985

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6 1987

FOREWORD

This management plan has been developed by the Department of Inland Fisheries and Wildlife in response to Governor Brennan's Executive Order on Maine Rivers Policy, July 6, 1982; the "Maine Rivers Act" of June 17, 1983; directives by the Cabinet Committee on Hydropower Policy; and the Department's need to formalize and document specific objectives and procedures for managing important fisheries under its jurisdiction.

The Maine Rivers Study, completed in May of 1982 by the Department of Conservation, identified Grand Lake Stream as a "B" river; rating its landlocked salmon fishery as among the state's most significant resources. This plan will serve to document the extent and quality of this fishery, to show how the Department intends to manage the fishery, and to serve as a guide and source of reference for the protection and enhancement of this valuable resource in the future.

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TABLE OF CONTENTS

| | Page |
|---------------------------------------|------|
| INTRODUCTION..... | 1 |
| PHYSICAL DESCRIPTION..... | 3 |
| Location..... | 3 |
| Topography and Geology..... | 3 |
| Climate..... | 4 |
| Hydrology..... | 5 |
| HISTORY OF USE..... | 7 |
| Land and Water Development..... | 7 |
| Fisheries..... | 7 |
| Water Quality and Pollution..... | 9 |
| Obstructions and Fishways..... | 9 |
| Access..... | 10 |
| SPECIES OCCURRENCE AND ABUNDANCE..... | 12 |
| Resident Species..... | 12 |
| Anadromous Species..... | 15 |
| HABITAT QUANTITY AND QUALITY..... | 17 |
| Migration..... | 17 |
| Spawning..... | 17 |
| Nursery..... | 18 |
| Adult Holding..... | 21 |
| RECREATIONAL FISHERIES..... | 23 |
| MANAGEMENT GOAL..... | 25 |
| MANAGEMENT OBJECTIVES..... | 25 |
| Fisheries..... | 25 |
| Environmental Protection..... | 25 |
| Public Access..... | 25 |
| MANAGEMENT PROBLEMS..... | 26 |
| Resource Abundance and Quality..... | 26 |
| Habitat..... | 26 |
| Angler Use..... | 26 |
| Public Access..... | 26 |

| | Page |
|-------------------------------------|------|
| MANAGEMENT STRATEGIES..... | 27 |
| Resource Abundance and Quality..... | 27 |
| Habitat..... | 27 |
| Angler Use..... | 27 |
| Public Access..... | 28 |
| LITERATURE CITED..... | 29 |

INTRODUCTION

This document sets forth the management plan for landlocked Atlantic salmon in Grand Lake Stream because it is the species of primary concern to the sporting public, and because the habitat is best suited for the management of this species. Other species are considered to be incidental and of much lesser importance, although their occurrence and relative abundance will be described. The potential occurrence of sea-run Atlantic salmon in Grand Lake Stream at some time in the future, as the result of planned restoration in the St. Croix River, will be mentioned but not treated in any detail at this time.

The plan is based on the existing habitat potential of the stream to support a landlocked salmon fishery, and its current level of use by the sporting public. No attempt is made to predict the future use of this resource, although some increase in fishing pressure is expected and will have to be dealt with when it occurs. Rather than to attempt to accommodate ever-increasing use of the resource, it is Department policy to manage Grand Lake Stream within the physical and biological limits of the habitat, and its capacity to sustain a fishery and provide reasonable fishing opportunities, even if this should mean severe restrictions on use in the future.

The first section of the plan describes the general physical characteristics of Grand Lake Stream. Next we describe the historical use of the river, current species occurrence and abundance, habitat suitability for salmon, and the current nature of the fisheries. Next we have attempted to state in concise terms what we believe are the best management goals and objectives for the stream, identified some existing or potential problems that might prevent or make difficult the attainment of our management goal if not corrected, and finally, presented some management strategies or work tasks that seem the most appropriate at this time in order to achieve our management goal and objectives.

This plan is not intended to be so rigid as to preclude changes as necessary to better manage the resource. Many hours of interviews with anglers, public discussions at meetings, and correspondence with anglers and other users of Grand Lake Stream have had considerable influence on the direction of Department policy, management, and development of this plan, as they will in the future. As conditions or public needs change, as new information or more precise data becomes available, or as new management options develop, this plan will be updated or changed as appropriate.

GRAND LAKE STREAM
PHYSICAL DESCRIPTION

Location

Grand Lake Stream, the outlet of West Grand Lake, is located in eastern Maine, about 15 miles from the Maine-New Brunswick border. Lying within the St. Croix River drainage, Grand Lake Stream forms the upper part of the West Branch of the St. Croix. The lower section of the west branch is represented by several inter-connected lakes which meet the St. Croix's east branch at the Grand Falls Flowage. Although only two miles long, Grand Lake Stream drains a watershed of 227 square miles in part of three counties, including West Grand Lake (14,340 acres), Pocumcus Lake (2,201 acres), Sysladobsis Lake (5,376 acres), Junior Lake (3,866 acres), Scraggley Lake (2,758 acres), and Pleasant Lake (1,574 acres).

Topography and Geology

The average stream gradient is 1% (95 feet in 2 miles) with the Big Falls section exhibiting the steepest slope profile. With an average width of approximately 100 feet, Grand Lake Stream can be more accurately described as a river.

Soils of the Grand Lake area are of the Ridgebury-Peru-Histosols group. Ridgebury soils are wetland soils, consisting of deep, level, poorly drained soils formed in very firm, stony glacial till. Peru soils are seasonally wet, deep, moderately drained soils formed in very firm glacial till. The Histosols are poorly drained peat and muck wetland soils associated with bogs and swamps. They usually consist of a layer of organic material over inorganic sandy, clayey, or loamy soils, or bedrock. Both the Ridgebury and the Histosols group have a water table at or near the ground surface for at least seven months of the year.

These soils often occur in natural drainage ways, acting as natural sponges to collect excess run-off and prevent flooding. They provide valuable fish and wildlife habitat and are best left undeveloped. Peru soils are better drained, but still represent wetland soils with a water table within 1 1/2-2 1/2 feet of ground level during parts of the year. Development of Peru soils should be avoided where possible; their high seasonal water table can result in flooded cellars, submerged septic systems, and possible groundwater contamination.

The bedrock of Grand Lake Stream and its watershed is of two major types, with the change occurring in the vicinity of the outlet dam at West Grand Lake. The portion of the drainage above the West Grand Lake dam is composed of igneous rocks of the biotite and biotite-muscovite granite and quartzmonzonite compositions. Bedrock of this type exhibits little acid buffering capacity. The portion of the drainage between the West Grand Lake dam and the Kellyland area, including all of Big Lake, is composed of a mixture of metamorphosed gray and green siltstone, sandstone, shale, graywacke conglomerate and sedimentary iron-manganese deposits, unnamed metamorphosed limestone, shale, and tuff (the Kellyland formation of Washington County, notably calcareous siltstone and slate). This bedrock formation exerts some degree of buffering capability on acid waters.

Climate

The climate of Grand Lake Stream is one of moderate summer temperatures, only occasionally exceeding 90°F, and long cold winters, occasionally colder than -20°F. Annual temperature regimes are quite typical of the southern interior section of Maine. From 1979-84 annual precipitation ranged from 40-60 inches, with a 6-year mean of 50 inches.

Winter ice thicknesses on the lakes range from 2-3 1/2 feet. Winter snow depths usually range from 6-36 inches on the ground, and total annual snowfalls range from 20-100 inches.

Hydrology

The hydrology of Grand Lake Stream is totally regulated by the Georgia-Pacific Corporation through the dam at West Grand Lake. This dam has a combined useable storage capacity of 8.25 billion cubic feet. Flow releases are used downstream in the lower St. Croix River for hydro-electric power generation and for dilution of papermill effluent. The International Joint Commission has set a minimum flow requirement of 775 cfs below the Woodland dam, primarily for maintenance of water quality standards through adequate dilution of effluent from a forest products mill complex in Woodland. Lakes on the east branch of the St. Croix are similarly regulated for hydropower generation with provision for minimum flows.

Patterns of flow releases at the West Grand Lake dam are influenced by lake level, precipitation, time of year, and need for water at Woodland. Since this dam controls 14,340 acres of West Grand, which in turn receives inflow from an additional 16,000 acres of lakes in its watershed, a large range of outflows is expected. U.S. Geological Survey flow records document historical extreme flows during the past 40 years from a minimum of 5 cfs (1945) to a maximum of 2,840 cfs (1952). Flow discharge at the West Grand dam usually range from a minimum of 130 cfs to a maximum of 1500 cfs. The 54-year average discharge for Grand Lake Stream is 400 cfs.

Stream discharge influences fishability at discharges greater than 500-600 cfs; water depth and velocity increase to a level that makes wading dangerous. During these periods fishermen can fish only from shore or from canoes anchored in pools, but fast water velocities make proper fly presentation difficult.

Presently, Georgia-Pacific (G-P) utilizes a drainage-wide (St. Croix drainage) water management program with computer monitoring of flow fluctuations and a computer program for deriving the best patterns of flow release from all water storage facilities. Local workers in Grand Lake Stream manually adjust gate

openings at the West Grand dam, according to orders from the hydro superintendent. Georgia-Pacific's Federal Energy Regulation Commission (FERC) license of September, 1980 stipulates a minimum flow of 100 cfs to be released from the West Grand dam at all times. In addition, there is a non-binding agreement that West Grand Lake will be drawn down to its minimum autumn-spring level by October 15 to ensure successful lake trout reproduction in the lake. However, lake drawdowns occasionally continue into November or later during low rainfall periods, with no penalty provisions. Although the effect of these occasional late drawdowns on lake trout reproduction have not been directly observed, it is reasonable to suspect that they may have an adverse impact on egg deposition and survival.

HISTORY OF USE

Land and Water Development

The village of Grand Lake Stream (population of 198 in 1980 census), represents the only population center within the watershed bearing its name. A few year-round homes and a limited number of seasonal cottages border the wooded steep banks of Grand Lake Stream, mostly on its upper section. In addition, a limited number of seasonal camps is found on the lakes in the watershed, primarily concentrated on the lower southwest shore of West Grand Lake.

The watershed is notable and important for its remoteness and undeveloped character, except for wood harvesting operations and haul roads. Wood harvesting represents the primary land use. Other land use activities are recreational and include hunting, trapping, and snowmobiling.

On a watershed basis present water uses are water storage, sporting camps, fishing, boating, trapping, and some waterfowl hunting. There are no hydro-power generation facilities in the Grand Lake Stream watershed.

Historically, log drives and pulpwood drives were common on Grand Lake Stream. This annual spring activity continued until prohibited by state law in the early 1970's.

Fisheries

West Grand Lake and its outlet are noted as one of the original homes of landlocked salmon in Maine. Historically, they have been noted for their outstanding landlocked salmon fishery for over a hundred years. In 1875, Charles Atkins, a fisheries commissioner in Maine, wrote that Grand Lake Stream represented "the finest breeding ground" of landlocked salmon and "the favorite water for angling them".

From November 6-26, 1874, Mr. Atkins was engaged in obtaining salmon at Grand Lake Stream for egg-taking purposes. Their "fish pounds" captured salmon that were leaving West Grand to spawn in the stream. During a 20-day period,

they captured 2,626 mature landlocked salmon.

Atkins' report indicates that in 1874 the West Grand landlocked salmon were of a size similar to those presently found in the lake. Meticulous in detailing his observations, Atkins reported that: "I had nearly every fish measured, and a large number weighed...The most frequently recorded length was 17 inches, and the average would probably exceed that a little. Fish of more than 20 inches in length were rare, and not one of this species reached two feet."

The Maine Department of Inland Fisheries and Wildlife owns and operates a landlocked salmon hatchery on the banks of Grand Lake Stream, approximately 1/4 mile below the West Grand Lake dam. As noted by Atkins' account, fish culture has been practiced in the Grand Lake Stream area for over 100 years, previously at a spring site west of the lake, then at the outlet cove at West Grand before the current site was built. Each fall hatchery personnel trap and spawn approximately 700 mature adult fish for Maine's landlocked salmon program. The Grand Lake Stream Hatchery rears from 40,000-60,000 spring yearling salmon (7-8 inches) each year for stocking into coldwater lakes throughout eastern and northern Maine.

Although Grand Lake Stream has supported a stream fishery for more than 100 years, fishing pressure has markedly increased during the past 10 years (1975-1985), due to a general increase in the angler population, and to a dramatic increase in the popularity of fly fishing and improvements in tackle. In addition, today's serious angler is highly mobile and commonly utilizes leisure time in pursuit of enjoyable fishing opportunities.

The village of Grand Lake Stream offers anglers the rare opportunity to troll at one of Maine's most productive and most noted salmon lakes, and fly cast for salmon in the crystal-clear waters of the outlet - Grand Lake Stream - experiencing some of the best angling available in Maine for landlocks in a river setting.

Water Quality and Pollution

Grand Lake Stream currently is classed "A" for water quality purposes by the Maine Department of Environmental Protection (DEP). Residents use the stream for drinking water. Swimming and "tubing" are common in the summer. Although there are no point sources of domestic pollution along the stream, the fish hatchery discharges into the stream.

Since the early 1980's, increased growth of algae and macrophytes has been noted on the stream bottom, beginning at the Dam Pool (uppermost pool on the stream). Water quality tests performed in May, 1984, by DEP staff indicated that total phosphorus levels were significantly higher than expected. Attempts will be made to locate the source of this water quality degradation and remedy it.

Obstructions and Fishways

The West Grand Lake Dam, originally built around 1900, represents the only obstruction on Grand Lake Stream. The current dam, owned by Georgia-Pacific Corporation, is a wooden-crib dam with 5 gates and a 9-foot head. A wooden vertical-slot (Hell's Gate) fishway was constructed on the west end of the dam in 1972. This structure has proven itself to be highly efficient in passing fish of all species. Direct observation from within the fishway pools using SCUBA gear has shown that salmon parr move readily from pool to pool. Young-of-the-year salmon as small as 2-3 inches in length have been observed maintaining positions on the floor of the fishway with a minimum of effort. During peak migration periods (late June to mid-July) divers observed a virtual "parade" of juvenile and adult salmon moving upstream from pool to pool. Results of a fishway trapping operation will be discussed later in this plan.

During the 1970's the Maine Department of Inland Fisheries & Wildlife had requested that flow releases at the dam be made from the gate closest to the fishway entrance. However, this created a very strong back-eddy which appeared

to interfere with attraction to the fishway entrance. SCUBA observation confirmed that very few fish held positions adjacent to the fishway entrance. The eddy was swift and very turbulent. Most of the fish occupied positions within 10-30 feet to the east of the gate where flow was being released. Fish (1) appeared to be naturally drawn to the area farthest from the fishway, and (2) appeared to be repelled from the fishway entrance area by currents flowing upstream, rather than downstream.

In the early 1980's, the Department changed its recommendation for flow releases. We now recommend that they be accomplished from the gates on the east side of the dam. Georgia-Pacific has been very cooperative in complying with this request. Direct observations of the fishway, as well as SCUBA observations in the Dam Pool, have shown that flow releases from gates on the east side of the dam are preferred because they do not "mask" the flow from the fishway. Therefore, the fishway flow would become a discrete flow, representing the only flow release on the west side of the stream, except for slight leakage from nearby gates.

Access

Public access to Grand Lake Stream is very good. The east bank of the river from the dam to the fish hatchery is owned by the State of Maine. Parking is available at both sides of the dam, along the east shore of the Dam Pool and at the fish hatchery. The remainder of the river frontage is privately owned, but landowners have allowed relatively unrestricted access to anglers. The Big Falls area has parking for a few vehicles and a foot trail along the steep east bank. At Little Falls the Grand Lake Stream Conservation Association operates a small park and picnic area with ample streamside parking. Since Grand Lake Stream is only two miles long, the above access points permit anglers to utilize almost all of the fishing area on the stream.

Most fishing is done by wading. Fishing from canoes is limited due to high-water seasonal flow releases, sections of Class II-III whitewater, and a difficult portage at Big Falls.

Finally, it should be noted that overnight camping is prohibited by town ordinance in Grand Lake Stream. However, several fine lodges and sporting camps offer comfortable accommodations to the sporting public vacationing in the area.

SPECIES OCCURRENCE AND ABUNDANCE

A total of 26 fish species are known to occur in Grand Lake Stream or the lake system. These are listed below with an asterisk marking those that have been observed in the stream proper:

| <u>Common Name</u> | <u>Scientific Name</u> |
|-----------------------------|--------------------------------|
| *Landlocked Atlantic salmon | <i>Salmo salar</i> |
| *Sea-run Atlantic salmon | <i>Salmo salar</i> |
| *Brook trout | <i>Salvelinus fontinalis</i> |
| *Lake trout | <i>Salvelinus namaycush</i> |
| *Rainbow smelt | <i>Osmerus mordax</i> |
| *Lake whitefish | <i>Coregonus clupeaformis</i> |
| Round whitefish | <i>Prosopium cylindraceum</i> |
| Burbot (cusk) | <i>Lota lota</i> |
| *Smallmouth bass | <i>Micropterus dolomieu</i> |
| *White perch | <i>Morone americana</i> |
| Yellow perch | <i>Perca flavescens</i> |
| *Chain pickerel | <i>Esox niger</i> |
| Brown bullhead (Hornpout) | <i>Ictalurus nebulosus</i> |
| Redbreast sunfish | <i>Lepomis auritus</i> |
| Pumpkinseed sunfish | <i>Lepomis gibbosus</i> |
| *American eel | <i>Anguilla rostrata</i> |
| *Alewife (sea-run) | <i>Alosa pseudoharengus</i> |
| *White sucker | <i>Catostomus commersoni</i> |
| *Fallfish | <i>Semotilus corporalis</i> |
| Creek chub | <i>Semotilus atromaculatus</i> |
| Golden shiner | <i>Notemigonus crysoleucas</i> |
| Bridled shiner | <i>Notropis bifrenatus</i> |
| Common shiner | <i>Notropis cornutus</i> |
| Blacknose dace | <i>Rhinichthys atratulus</i> |
| *Three-spine stickleback | <i>Gasterosus aculeatus</i> |
| Nine-spine stickleback | <i>Pungitius pungitius</i> |
| Banded killifish | <i>Fundulus diaphanus</i> |

Resident Species

Grand Lake Stream supports only two resident species of sportfish that spend all or part of their life cycle in the stream - brook trout and juvenile landlocked

salmon. Although brook trout are indigenous to the watershed, their relative abundance is low. Summer water temperatures in the stream exceed 72°F, thus limiting trout production. A few small spring areas account for most of the production. Annual stocking of a few hundred (usually 500) brook trout augments the stream's trout fishery.

Although adult landlocked salmon, lake trout, whitefish, bass, and pickerel (occasionally) all occur in the stream on a seasonal basis, none of them completes its entire life cycle in Grand Lake Stream. Rather, they grow to adulthood in either West Grand Lake or Big Lake, then migrate into Grand Lake Stream.

The documented occurrence of a few lake trout and whitefish in Grand Lake Stream is limited to the upper section of the stream at the Dam Pool. On one occasion in the fall, lake trout eggs were found by Department divers in the Dam Pool in October. Lake trout and whitefish are probably swept out of the lake occasionally during periods of heavy flow releases at the dam. Those which escape capture by anglers probably utilize the fishway to re-enter the lake during early summer in response to increasing water temperatures. According to our records, a 12-pound togue and a 3 3/4-pound whitefish represent the largest catches of these species on Grand Lake Stream.

During the period from June to early September, smallmouth bass are taken by anglers. Probably they represent both fish which have migrated downstream from West Grand Lake and others which have moved upstream from Big Lake (noted for its excellent bass fishery). We do not know if Big Lake bass can negotiate either Little Falls or Big Falls. Even during peak periods, bass are not especially abundant in the stream and inhabit the deeper pools. Our SCUBA observations have shown them to be most abundant in the Dam Pool, which may have 20-30 legal bass in it, ranging from 19-20 inches and averaging about 12 inches in length.

Grand Lake Stream is primarily noted for its landlocked salmon resource. It ranks near the top of the list of Maine's best landlocked salmon rivers. The

quality of the salmon fishery in Grand Lake Stream is directly related to the quality of the fishery in West Grand Lake, and to a much lesser degree, the salmon fishery in Big Lake. Although West Grand's salmon fishery is composed of both wild and hatchery-reared salmon, the wild component represents less than 5% of the population. Thus, regular annual stockings of spring yearlings are necessary to maintain a fishable salmon population. Salmon production in the lake's tributaries is practically nil, contributing little to the fisheries in this 14,340-acre lake. Annual salmon stocking rates are determined by the size of fish available and by current growth conditions in the lake. Since growth conditions are variable and unstable, stocking rates will fluctuate to some degree and are designed to produce the best possible population of healthy, fast-growing salmon without directly causing a lasting decline in the lake's forage base of smelts.

Although Big Lake, into which Grand Lake Stream flows, has only received stocked salmon twice during the past two decades, a limited salmon fishery occurs there each year. The Big Lake fishery probably results from two sources of salmon - fish which leave West Grand Lake, and native salmon (produced in Grand Lake Stream) which move downstream into Big Lake as age 1+ or 2+ "smolts". We have no data or estimate of how many stream-produced native salmon may enter Big Lake. It has been noted elsewhere in Maine (Moosehead, Rangeley) that the contribution of outlet spawning salmon populations to production of future generations in a headwater lake (such as West Grand) is much lower than would be expected. If reproduction is successful through to production of one and two-year-old salmon parr, and if these fish tend to contribute little to the headwater lake, then, apparently, they may be expected to contribute to salmon production in lakes further downstream in the drainage. If this is occurring at Grand Lake Stream, it is possible that Big Lake may received more of the stream's production of native salmon than does West Grand. West Grand Lake's

salmon habitat is much superior to Big Lake's salmon habitat. While it is desirable that most of the stream's native salmon parr should move into West Grand rather than Big Lake, no control of the direction of their movement is possible. However, Big Lake salmon may move into Grand Lake Stream as adults, either for spawning or feeding purposes. They would contribute to the stream fishery to a limited extent, although West Grand would contribute the most.

Anadromous Species

Fish passage for anadromous species in the St. Croix drainage was markedly improved with the completion of a new pool and overflow type fishway at the Milltown Dam in October, 1980. This fishway is expected to facilitate a higher level of alewife spawning escapement to the entire St. Croix drainage, resulting in modest increases in alewife runs in future years. Dams at Woodland and Grand Falls are both equipped with very long Denil fishways.

Alewives will be denied access into West Grand and other lakes above it on the Grand Lake Stream drainage. The Department of Inland Fisheries and Wildlife took this action (1) to reduce the possibility of introducing any alewife-carried fish diseases into the hatchery at Grand Lake Stream, and (2) to ensure that West Grand Lake's smelt population (the most valuable forage species for salmon) is not diminished by competition for food from millions of juvenile alewives. For these reasons, the Grand Lake fishway is blocked with a screen during the alewife migration period.

During the early 1980's, a cooperative Atlantic salmon restoration program between U.S. and Canadian fishery agencies was initiated. Atlantic salmon have been stocked at all stages of their life cycle from fry to adults in efforts to restore salmon to their historic habitat on the St. Croix. Although both landlocked and sea-run Atlantic salmon co-existed historically in Grand Lake Stream, no Atlantics will be stocked directly into the stream during the restoration effort.

Conditions today for producing a supply of landlocked salmon which is adequate to satisfy the demands of sport fishermen of the 1980's require that we manage Grand Lake Stream for maximum production of landlocked salmon. However, with time it is likely that sea-run Atlantic salmon will find and utilize the habitat of Grand Lake Stream for reproduction. Competition for food and space will occur between landlocked and sea-run Atlantic salmon. Only time will tell whether the presence of sea-run salmon will constitute a detriment to the landlocked salmon fishery or an enhancement to general fishing opportunities at Grand Lake Stream. The Department of Inland Fisheries and Wildlife and the Atlantic Sea-Run Salmon Commission have agreed to let nature take its course, and resolve any management problems, should they arise, when and if sea-run salmon make their appearance. In fact, this potential mixing of stocks of the same species could provide a natural experiment for study that might yield valuable information about their genetics, life histories, and management compatibility.

HABITAT QUANTITY AND QUALITY

Migration

The spawning migration of landlocked salmon into Grand Lake Stream usually begins in early to mid-September. Two factors which influence migration are cooling water temperatures and the magnitude of flow releases at the West Grand dam. Cool water temperatures and flows of greater than 300 cfs appear to favor successful September fishing. However, even during minimum flow (100 cfs) periods, the spawning instinct of mature salmon will put them on the stream's spawning areas by late October-early November. Salmon leave West Grand either by passing downstream through the fishway or by moving through the open gate(s) with the discharge water. Big Lake salmon migrate upstream into Grand Lake Stream for spawning. Once in the two-mile-long stream, all salmon have unimpeded access to all spawning areas. Neither Little Falls nor Big Falls is an obstacle to salmon movement.

Screening of the fishway at the West Grand dam to block alewife movement during May and June poses a temporary obstacle to migration of adult and juvenile salmon. It would be desirable to design and install a modification to the fishway (to facilitate a short vertical jump) that would allow salmon to continue through the fishway during this period while still blocking alewives (non-jumpers) from entering the lake. The Mactaquac Dam on the Saint John River in New Brunswick successfully separates salmon and alewives in this manner.

Spawning

Grand Lake Stream contains an abundance of high-quality salmon spawning habitat. An intensive stream survey conducted in 1985 by Fish and Wildlife Department personnel indicated that 9,475 square yards of stream bottom (6% of total stream habitat) are suitable for landlocked salmon spawning at minimum flow conditions. This habitat is characterized by clean rubble from 1-3 inches in diameter, water depths usually 1-2 feet, and water current velocities

from 1-2 feet/second. Most of the spawning area is concentrated in three locations: the lower end of the Dam Pool, the lower end of the Hatchery Pool, and the area of Little Falls. Some spawning also occurs to a lesser extent in other areas. The location of spawning areas throughout most of the stream's length ensures that all nursery habitat will be "seeded" by spawning salmon. Spawning usually occurs between October 25 and November 10.

Eggs incubate in the gravel during the winter and hatch early in May. By late May and early June, the tiny 1 1/4-inch salmon fry emerge from the redds and begin their life in the stream.

From 1974-78, biologists counted salmon redds after spawning was complete. During the period between 50 and 100 redds were observed on the three main spawning areas. No effort was made to count all redds in the entire stream; swift flows, deep-water sections, and the treacherous section at Big Falls combine to render complete redd counts an almost impossible task. In 1982, more than 200 salmon spawned at the lower end of the Dam Pool.

It should be noted that several hundred salmon are captured above the dam by hatchery personnel for egg-taking purposes, thus reducing the number of fish available to spawn in the stream. However, after being stripped of eggs, many of these fish drop into the stream and over-winter in the deeper pools. Efforts to truck salmon far up the lake away from the outlet after stripping, in hopes of keeping them in the lake for faster post-spawning "rejuvenation", have been unsuccessful. Within a day or two, most of them are recaptured in the nets at the dam. The outlet-seeking behavior of mature salmon apparently remains active after eggs and milt have been artificially stripped. This phenomenon has also been observed in outlets of other Maine lakes.

Nursery

The salmon nursery habitat of Grand Lake stream represents some of the best available in the state of Maine. A detailed, systematic survey of fish habitat

during minimum flow conditions was conducted in 1985 by the staff of the Department of Inland Fisheries and Wildlife. From West Grand Lake to Big Lake, Grand Lake Stream measures 2.75 miles long, has a mean width of 98 feet, and contains 153,141 square yards of fish habitat. Although fish habitat increases with higher stream flows, a knowledge of the amount of habitat available during minimum flows is important because it is a limiting factor in fish production. Riffles represent 61% of the habitat, runs represent 19%, and pools and deadwaters represent 20%. Boulder and rubble are the predominant substrate types in slightly more than 50% of the stream bottom. Stream gradient (slope) measured 0.5% or greater in 64% of the transects. The steepest gradient occurred in the Big Falls area, ranging from 1.5-2.5% slope at the upper section. Fish habitat in Grand Lake Stream is summarized in Table 1.

Table 1. Amount of fish habitat types in Grand Lake Stream during minimum flow conditions.

| HABITAT TYPE | AREA (sq. yds.) | NUMBER OF UNITS | PERCENT OF TOTAL STREAM HABITAT |
|-----------------|-----------------|-----------------|---------------------------------|
| Riffle | 90,330 | 903 | 61 |
| Cascade | 3,244 | 32 | |
| Run | 29,421 | 294 | 19 |
| Pool and pocket | 13,441 | 134 | 9 |
| Deadwater | 16,705 | 167 | 11 |
| TOTAL | 153,141 | 1,530 | 100 |

Juvenile salmon thrive in boulder riffle, moderate water velocities, excellent water quality, and abundant production of caddisflies, mayflies, and stoneflies.

In 1980, results of electrofishing showed that production of young-of-the (y-o-y) salmon ranged from 6-46 per 100 square yards (100 sq. yds = 1 unit) of nursery habitat. Specifically, the section below Little Falls produced 10

y-o-y/unit while the section immediately below the Hatchery Pool produced 46 y-o-y/unit. In 1981, this latter section produced 20 y-o-y/unit.

Salmon production at Grand Lake Stream compares favorably with production reported in available literature. Havey and Warner (1970) reported a mean of 27 y-o-y/unit for a large number of Maine streams. AuClair (1982) estimated production of 28 y-o-y/unit for a tributary to Moosehead Lake. For Atlantic salmon, Meister (1962) reported a mean y-o-y production of 26.5/unit at a coastal tributary to the Penobscot River. Beland et al. (1982) reported a 4-year mean of 17 y-o-y/unit for Atlantic salmon nursery areas on the Dennys River.

Older salmon parr were not frequently captured during electrofishing in August. We assume (1) that most of them had already entered the lakes, and (2) those which were still in the stream either escaped from our equipment or were not in riffle habitat.

Observations made by SCUBA diving and snorkelling at Grand Lake Stream in August, 1980 and 1981 showed that yearling (and older) salmon parr tended to be seen in groups, inhabiting pools from 4-8 feet deep with some current rather than being found in more traditional boulder riffles and rapids. As a matter of fact, a group of 300 parr (6-10 inches long) was seen at the immediate base of the dam on August 7, 1980.

Observations in June, 1982, confirmed the presence of 20-30 parr in the Dam Pool. In July, 1983, about 100 parr were counted (6-9 inches, almost all natives, without clipped or deformed fins) in the Dam Pool.

The above observations correlate closely with the pattern of fish movement documented in 1974 during trapping operations in the West Grand fishway. A total of 1,384 sublegal salmon were trapped while moving upstream into West Grand. Of these, 356 were wild fish and 1,018 were of hatchery origin. While a few sublegal salmon were taken in May and June, the catch increased dramatically

during the first week of July, reached a peak of 186 in a 3-day trapping period ending on July 19, then declined. Most of the sublegals had moved into West Grand by the end of July.

To summarize, Grand Lake Stream contains 935 units and 93,574 square yards of excellent salmon nursery habitat. While stream flows and depths make intensive electrofishing nearly impossible, limited electrofishing has shown that excellent levels of young-of-the-year salmon production occur. Diving observations have shown that yearling (and older) parr are numerous in nursery habitat during mid-June and that groups ranging from several dozen to a few hundred parr can be seen in the deeper pools during July and August. Wild salmon currently comprise less than 3% of West Grand's salmon population.

Several unanswered questions remain. What is the average annual landlocked salmon smolt production in the stream? Based on known production of landlocked and sea-run salmon elsewhere in Maine, it seems reasonable to expect that Grand Lake Stream could produce 2,100-8,400 smolts (1.0-4.0 smolts/unit) annually. What portion of the smolt population moves into West Grand Lake? Do Big Lake salmon utilize Grand Lake Stream for spawning on a large-scale basis?

Adult Holding

Grand Lake Stream has a demonstrated capacity for holding adult fish during much of the year. Adult holding areas vary with the season. Although adult salmon may be found in relatively small "pockets" near boulders in June and September, deeper pools represent the most common adult holding areas. At Grand Lake Stream, these pools occur at the Dam Pool, the area from the Hatchery Pool down to the head of Big Falls, the area around Little Falls, and at the meadows below Little Falls. After the completion of spawning, most salmon appear to overwinter in these pools prior to re-entering the lake the next summer. The poor conditions for post-spawning salmon caused by the crowding of salmon into a few, relatively small pools, and a limited food supply yields a

slender kelt in the spring.

During May and June, salmon will utilize small "pockets" as well as "runs" of moderate depth when water temperatures are optimum for growth and when insect hatches are occurring regularly. Also, smelts occasionally wash into the stream from West Grand, providing additional forage for adults.

RECREATIONAL FISHERIES

Our stream census activities at Grand Lake Stream do not permit a statistical estimate of total angler-days of effort with confidence limits. However, based on our observations of the relative numbers of anglers during creel checks throughout the season for several years, our subjective estimate is between 1,200-1,500 angler-days of effort annually, perhaps exceeded in "good" years.

We have 5 years of very complete fishing records at Grand Lake Stream from anglers who voluntarily record data on their trips. The trip records are a composite of the good fishing period and the slow fishing periods (July, August). During the 5-year period, these anglers were successful in landing legal salmon on 39% of their trips, which averaged only 2.3 hours/trip. Mean angler-trips/year was 111 and the five-year mean number of legal salmon caught was 110. This computes to a catch of 1.00 salmon/angler-trip - very good, by all standards. On the average, it took these anglers 2.3 hours to land a legal salmon. During the period, 94% of the legal salmon were released.

In 1984, we conducted a partial clerk survey of Grand Lake Stream throughout the season, but primarily in July and September. A long cool, wet spring allowed good fishing to continue until mid-July. We interviewed 105 anglers who had caught 138 legal fish and 45% of the anglers caught at least one legal fish. Salmon were frequently released, totalling 88% of all legal salmon caught. Anglers required 2.5 hours to catch a legal fish, and they averaged 1.3 legal salmon/angler. Sublegal salmon represented 14% of the total catch. During peak periods, some daily catches of 8-20 legal salmon/day were observed.

Results of the partial census complemented what was learned from voluntary records: that anglers at Grand Lake Stream experience a high success rate and release a high proportion of the legal fish that they catch.

If we apply the average catch rates of 1.0 (voluntary records) and 1.3 (clerk surveys) to our subjective estimate of 1,200-1,500 angler-days of use, we obtain

an estimate of the total catch that is between 1,200 and 1,950 legal salmon per year. Census data indicated, however, that anglers released 88% of the legal fish, and harvested (killed) only 12% of the legal fish caught. Thus, we can estimate that between 144 and 234 salmon were actually harvested (or killed) by anglers in 1984. Clearly, the fishery at Grand Lake Stream is one which starts with a few hundred salmon available each season and continues for a long period at a fairly high catch level because many fish are released and re-caught several times. The high rate of release for legal salmon is due to the predominance of fly fishing as the method of taking fish, and to the presence of a special regulation bag limit of 1 salmon per day. Much of the fishing at Grand Lake Stream can be classified as "catch-and-release" fishing; a non-consumptive use of a renewable resource.

Salmon caught in April and May are "kelts" which spawned the previous fall. On the average, 85% of the salmon caught in the stream in May and June are ages 4 and 5. The remainder is made up of age 3 and 6 salmon. Mean lengths for these fish are: age 3- 15.5"; age 4- 17.4"; age 5- 17.8"; age 6- 18.8".

The number of anglers who fish Grand Lake Stream early in the season during cold weather is evidence of the strong demand from anglers for a fishery of this nature and quality. Anglers travel from all over the State of Maine to fish at Grand Lake Stream, and dozens of anglers from all sections of the United States report that they come here each year. Many non-residents have come annually for 20-30 years. This influx of anglers contributes significant economic benefit to the State of Maine and to the local economy of Grand Lake Stream.

Commercial Fisheries

Currently there are no commercial fisheries in Grand Lake Stream.

MANAGEMENT GOAL

To maintain the present level of fishing quality

MANAGEMENT OBJECTIVES

Fisheries

1. Maintain an average angler success rate of approximately 1.00 legal salmon per angler-day (kept plus released).
2. Maintain the average size of age 3+ salmon at approximately 17.4 inches and 1.75 pounds.
3. Allow an annual harvest of between 150 and 250 salmon.
4. Continue to provide angling diversity by means of limited brook trout stocking.

Environmental Protection

5. Maintain and protect the existing 2,150 units (215,000 square yards) of nursery habitat for salmon.
6. Maintain present water quality.

Public Access

7. Maintain current public access and improve legal guarantee of access.

MANAGEMENT PROBLEMS

Resource Abundance and Quality

1. Populations of smelt, the major forage fish in West Grand Lake, at times fluctuate drastically in abundance, making it difficult to maintain optimum salmon growth.
2. Increased fishing pressure and over-exploitation of salmon in West Grand Lake, Big Lake, and/or West Grand Stream may reduce salmon abundance and fishing quality if not controlled.

Habitat

3. Reductions in stream flow resulting from manipulation of gates at the West Grand dam can result in dewatering of aquatic habitat, resulting in stranding and mortality of fish and aquatic insects, unless sufficient time is allowed for their movement.
4. Existing salmon habitat and/or water quality may deteriorate with shoreline development, modification of spawning or nursery areas, and/or pollution and pesticides, unless environmental laws are strictly enforced and special protection given to shorelands.

Angler Use

5. There is a lack of season-long data on angler-use of Grand Lake Stream.

Public Access

6. Although at present public access is good, there is no long-term guarantee for public access over portions of the shorelands under private ownership.

MANAGEMENT STRATEGIES

Resource Abundance and Quality

1. Continue monitoring the status of the fall spawning population during egg taking operations.
2. Continue to monitor the status of juvenile salmon in Grand Lake Stream by means of periodic SCUBA diving.
3. Continue to monitor the status of spawning activity by periodic redd counts.
4. Adjust stocking rates at West Grand Lake in relation to smelt abundance, salmon growth, and rate of salmon exploitation.

Habitat

5. Implement a stream flow reduction schedule in cooperation with the Georgia-Pacific Corporation to prevent or lessen the possibility of stranding or killing salmon, and destruction of aquatic insects.
6. Continue an active involvement with other state and federal agencies to protect aquatic and shoreland habitat from degradation as the result of unwise land use practices, pollution, and application of pesticides.
7. Continue support and involvement in the strict enforcement of environmental laws.
8. Determine the feasibility of design modification to the fishway to facilitate passage of salmon while blocking passage of alewives to West Grand Lake.

Angler Use

9. Continue to monitor angler-use and harvest at Grand Lake Stream by means of partial surveys and voluntary angler reports.
10. When man-power becomes available, implement a complete angler survey at Grand Lake Stream.

11. Implement appropriate fishing regulations as needed to sustain high quality fishing in relation to supply of salmon.

Public Access

12. Support the recommendations of the "Maine Rivers Access and Easement Plan" (Dept. of Conservation) which are:

to provide for special protection by acquisition or easement of both banks of the river at Big Falls, and the west bank of the river at Little Falls, opposite the Conservation Association Park; and

to rezone the river from Big Falls to the mouth (Big Lake) as a Land Use Regulation Commission PRR zone; and

to maintain state property (Dept. of Inland Fish and Wildlife) below West Grand Lake in its present undeveloped status for purposes of fishing access.

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