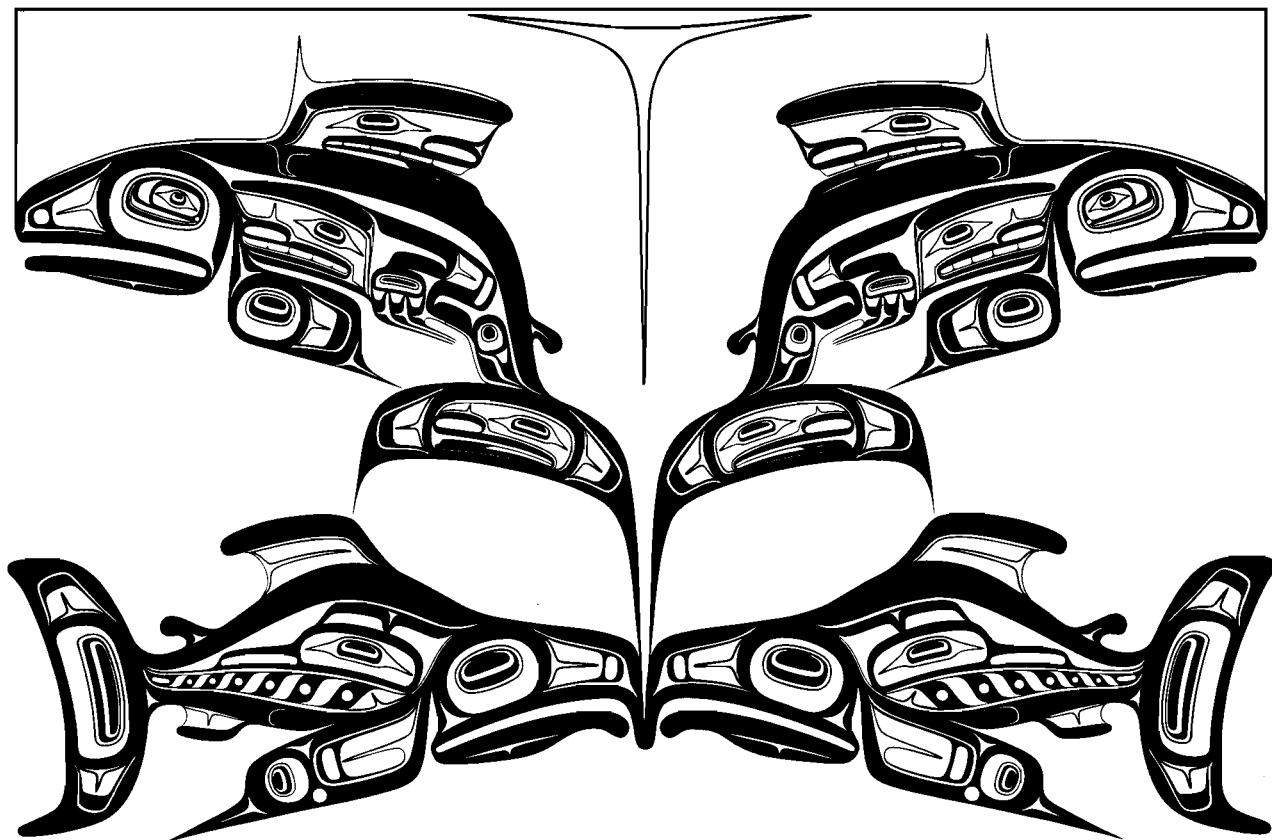


**Species Profiles: Life Histories and  
Environmental Requirements of Coastal Fishes  
and Invertebrates (Pacific Northwest)**

# **SOCKEYE SALMON**

**NATIONAL WETLANDS  
RESEARCH CENTER LIBRARY**  
700 Cajundome Blvd.  
Lafayette, LA. 70506-3152



Biological Report 82 (11.116)  
TR EL-82-4  
December 1989

**Species Profiles: Life Histories and Environmental Requirements of Coastal  
Fishes and Invertebrates (Pacific Northwest)**

**SOCKEYE SALMON**

by

**Gilbert B. Pauley, Ron Risher, and Gary L. Thomas**  
Washington Cooperative Fishery Research Unit  
School of Fisheries  
University of Washington  
Seattle, WA 98195

**Project Officer**  
David Moran  
U.S. Fish and Wildlife Service  
National Wetlands Research Center  
1010 Gause Boulevard  
Slidell, LA 70458

**Performed for**  
Coastal Ecology Group  
Waterways Experiment Station  
U.S. Army Corps of Engineers  
Vicksburg, MS 39180

**U.S. Department of the Interior**  
Fish and Wildlife Service  
Research and Development  
National Wetlands Research Center  
Washington, DC 20240

This series may be referenced as follows:

U.S. Fish and Wildlife Service. 1983-19\_\_\_. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates. U.S. Fish Wildl. Serv. Biol. Rep. 82(11). U.S. Army Corps of Engineers, TR EL-82-4.

This profile may be cited as follows:

Pauley, G.B., R. Risher, and G.L. Thomas. 1989. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest)--sockeye salmon. U.S. Fish Wildl. Serv. Biol. Rep. 82(11.116). U.S. Army Corps of Engineers, TR EL-82-4. 22 pp.

**NATIONAL WETLANDS  
RESEARCH CENTER LIBRARY**  
700 Cajundome Blvd.  
Lafayette, LA. 70506-3152

**PREFACE**

This species profile is one of a series on coastal aquatic organisms, principally fish, of sport, commercial, or ecological importance. The profiles are designed to provide coastal managers, engineers, and biologists with a brief comprehensive sketch of the biological characteristics and environmental requirements of the species and to describe how populations of the species may be expected to react to environmental changes caused by coastal development. Each profile has sections on taxonomy, life history, ecological role, environmental requirements, and economic importance, if applicable. A three-ring binder is used for this series so that new profiles can be added as they are prepared. This project is jointly planned and financed by the U.S. Army Corps of Engineers and the U.S. Fish and Wildlife Service.

Suggestions or questions regarding this report should be directed to one of the following addresses.

Information Transfer Specialist  
U.S. Fish and Wildlife Service  
National Wetlands Research Center  
NASA-Slidell Computer Complex  
1010 Gause Boulevard  
Slidell, LA 70458

or

U.S. Army Engineer Waterways Experiment Station  
Attention: WESER-C  
Post Office Box 631  
Vicksburg, MS 39180

## CONVERSION TABLE

### Metric to U.S. Customary

<i>Multiply</i>	<i>By</i>	<i>To Obtain</i>
millimeters (mm)	0.03937	inches
centimeters (cm)	0.3937	inches
meters (m)	3.281	feet
meters	0.5468	fathoms
kilometers (km)	0.6214	statute miles
kilometers	0.5396	nautical miles
square meters (m <sup>2</sup> )	10.76	square feet
square kilometers (km <sup>2</sup> )	0.3861	square miles
hectares (ha)	2.471	acres
liters (L)	0.2642	gallons
cubic meters (m <sup>3</sup> )	35.31	cubic feet
cubic meters	0.0008110	acre-feet
milligrams (mg)	0.00003527	ounces
grams (g)	0.03527	ounces
kilograms (kg)	2.205	pounds
metric tons (t)	2205.0	pounds
metric tons	1.102	short tons
kilocalories (kcal)	3.968	British thermal units
Celsius degrees (° C)	1.8 (° C) + 32	Fahrenheit degrees

### U.S. Customary to Metric

inches	25.40	millimeters
inches	2.54	centimeters
feet (ft)	0.3048	meters
fathoms	1.829	meters
statute miles (mi)	1.609	kilometers
nautical miles (nmi)	1.852	kilometers
square feet (ft <sup>2</sup> )	0.0929	square meters
square miles (mi <sup>2</sup> )	2.590	square kilometers
acres	0.4047	hectares
gallons (gal)	3.785	liters
cubic feet (ft <sup>3</sup> )	0.02831	cubic meters
acre-feet	1233.0	cubic meters
ounces (oz)	28350.0	milligrams
ounces	28.35	grams
pounds (lb)	0.4536	kilograms
pounds	0.00045	metric tons
short tons (ton)	0.9072	metric tons
British thermal units (Btu)	0.2520	kilocalories
Fahrenheit degrees (° F)	0.5556 (° F - 32)	Celsius degrees

## CONTENTS

	<u>Page</u>
PREFACE .....	iii
CONVERSION TABLE .....	iv
FIGURES .....	vi
ACKNOWLEDGMENTS .....	vii
NOMENCLATURE/TAXONOMY/RANGE .....	1
MORPHOLOGY/IDENTIFICATION AIDS .....	1
REASON FOR INCLUSION IN SERIES .....	4
LIFE HISTORY .....	4
Spawning .....	4
Eggs and Fecundity .....	4
Alevins and Fry .....	5
Lake Residence .....	6
Saltwater Life .....	6
GROWTH CHARACTERISTICS .....	7
THE FISHERY .....	8
Forecasting Models .....	8
Puget Sound Stocks .....	8
Columbia River Stocks .....	12
North Coastal Stocks .....	13
ECOLOGICAL ROLE .....	13
ENVIRONMENTAL REQUIREMENTS .....	14
Temperature .....	14
Salinity .....	15
Dissolved Oxygen .....	15
Substrate .....	15
Water Depth .....	15
Water Movement .....	15
Turbidity .....	16
Oil Spills .....	16
REFERENCES .....	17

## FIGURES

<u>Number</u>		<u>Page</u>
1	Sockeye salmon .....	1
2	Major rivers and lakes supporting sockeye salmon in the Pacific Northwest .....	2
3	Major sockeye salmon rearing lakes in the Fraser River, Rivers Inlet, and Smith Inlet systems of British Columbia .....	3
4	Estimated commercial catch of sockeye salmon in Asia, North America, and the Japanese mothership fishery .....	9
5	Average annual commercial catch of sockeye salmon in important coastal and high seas fishing areas .....	9
6	Commercial catches of blueback salmon in the Columbia River .....	12

## **ACKNOWLEDGMENTS**

I am grateful to Richard Thorne and Donald Rogers, University of Washington, for their reviews of the manuscript.

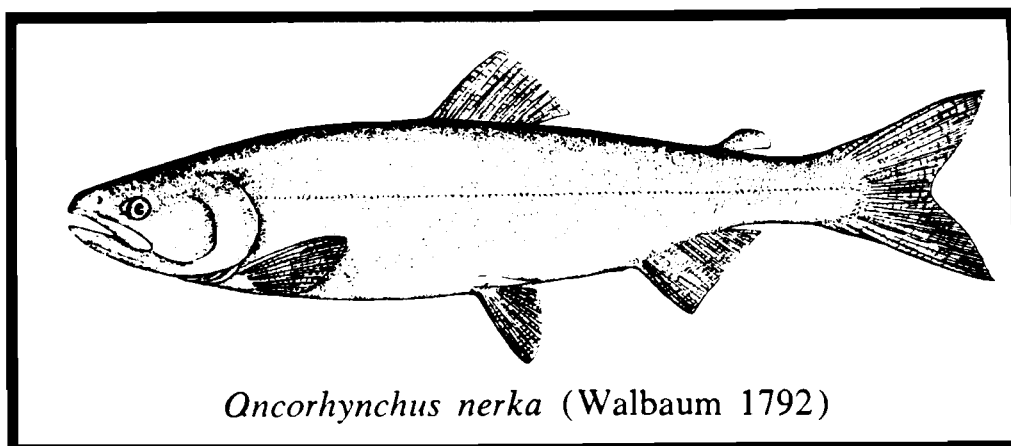


Figure 1. Sockeye salmon (after Hart 1973).

## SOCKEYE SALMON

### NOMENCLATURE/TAXONOMY/RANGE

Scientific name.....*Oncorhynchus nerka* (Walbaum)  
 Preferred common name.....Sockeye salmon  
 (Figure 1)  
 Other common names.....Blueback, red salmon,  
 kokanee (Lacustrine stocks only)  
 Class.....Osteichthyes  
 Order.....Salmoniformes  
 Family.....Salmonidae

Geographic range: Found from the Klamath River, California, to the Yukon River, Alaska, but commercially important only from the Columbia River to Bristol Bay. The major Alaskan spawning grounds are in tributaries and lakes of the Kenai, Chignik, Naknek, Kuichak, Wood, and Kodiak Island river systems. In the Pacific Northwest, the major spawning river for sockeye is the Fraser River system in British Columbia, while less important runs exist in the United States in the Baker, Columbia, Cedar, Quinault, and Ozette Rivers in Washington State (Figure 2). The Fraser River (Figure 3) includes a number of important nursery lakes and many tributaries that support the major portion of the sockeye salmon population in the Pacific Northwest. The principle sockeye rearing lakes on the Fraser River are Cultus, Adams, Harrison, Horsefly, Shuswap, and Quesnel Lakes. In eastern

Washington, the major nursery lakes for the Columbia River are Lake Wenatchee on the Wenatchee River and Osoyoos Lake on the Okanogan River. There are eight separate geographic stocks of Columbia River sockeye that home to specific rearing lakes (Mullan 1986). In western Washington the major nursery lakes are Quinault Lake on the Quinault River, Ozette Lake on the Ozette River, Baker Lake on the Baker River, and Lake Washington into which the Cedar River flows (Poe and Mathisen 1981). Landlocked populations of sockeye salmon, called kokanee, have been successfully introduced into many western states (Wydoski and Whitney 1979; Wydoski and Bennett 1981).

### MORPHOLOGY/IDENTIFICATION AIDS

Dorsal fin (11-16 rays), adipose small, slender and fleshy, anal fin (13-18), pelvic fins (9-11) abdominal in position with a free-tipped fleshy appendage above its insertion, pectoral fins (11-21). Cycloid scales. Gill rakers (29-43) long, rough, slender, and closely set on first gill arch. Body elongate with moderate lateral compression.

Greenish-blue coloration with fine black speckling on the back. No large dark spots. Breeding male with pale

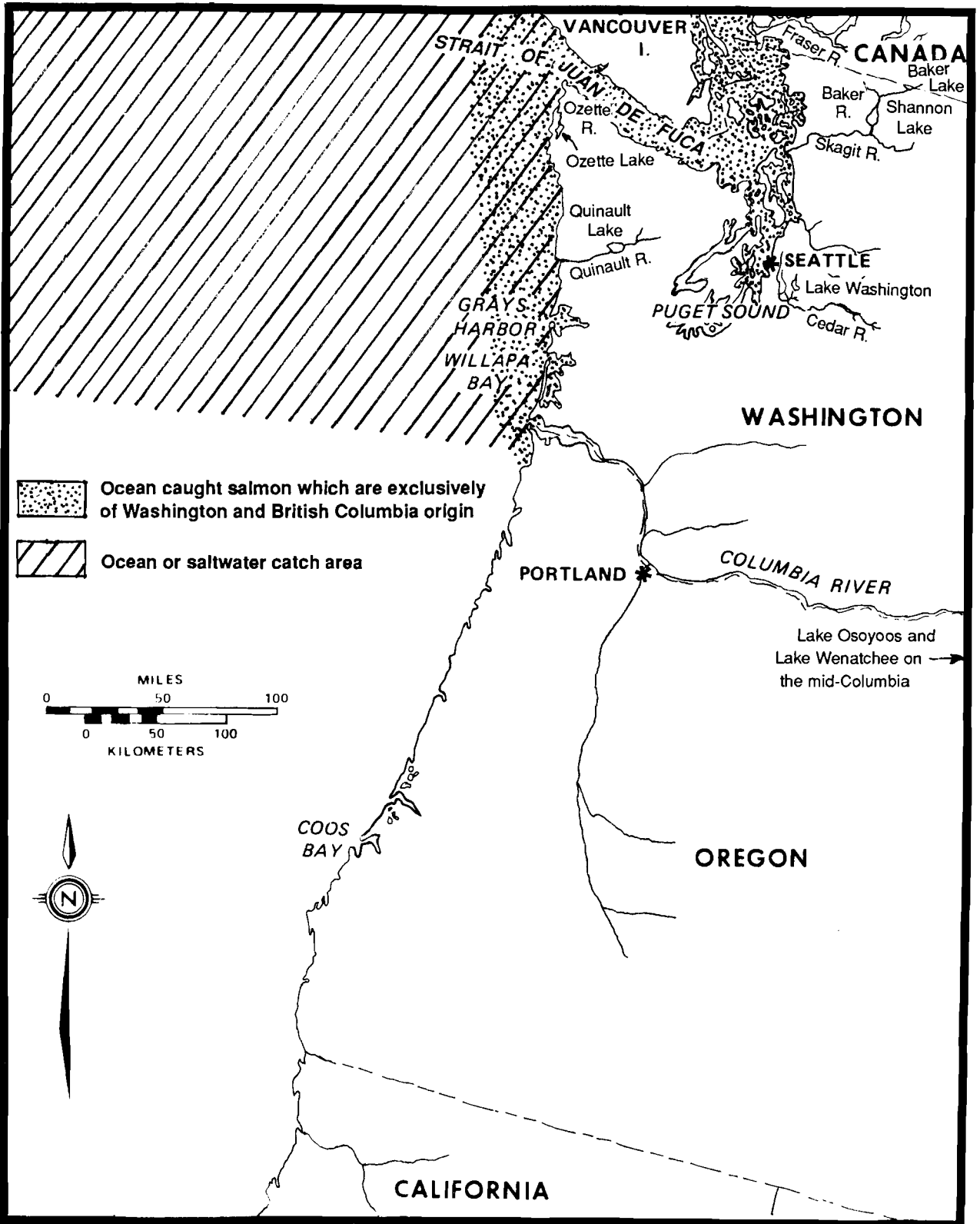


Figure 2. Major rivers and lakes supporting sockeye salmon in the Pacific Northwest.

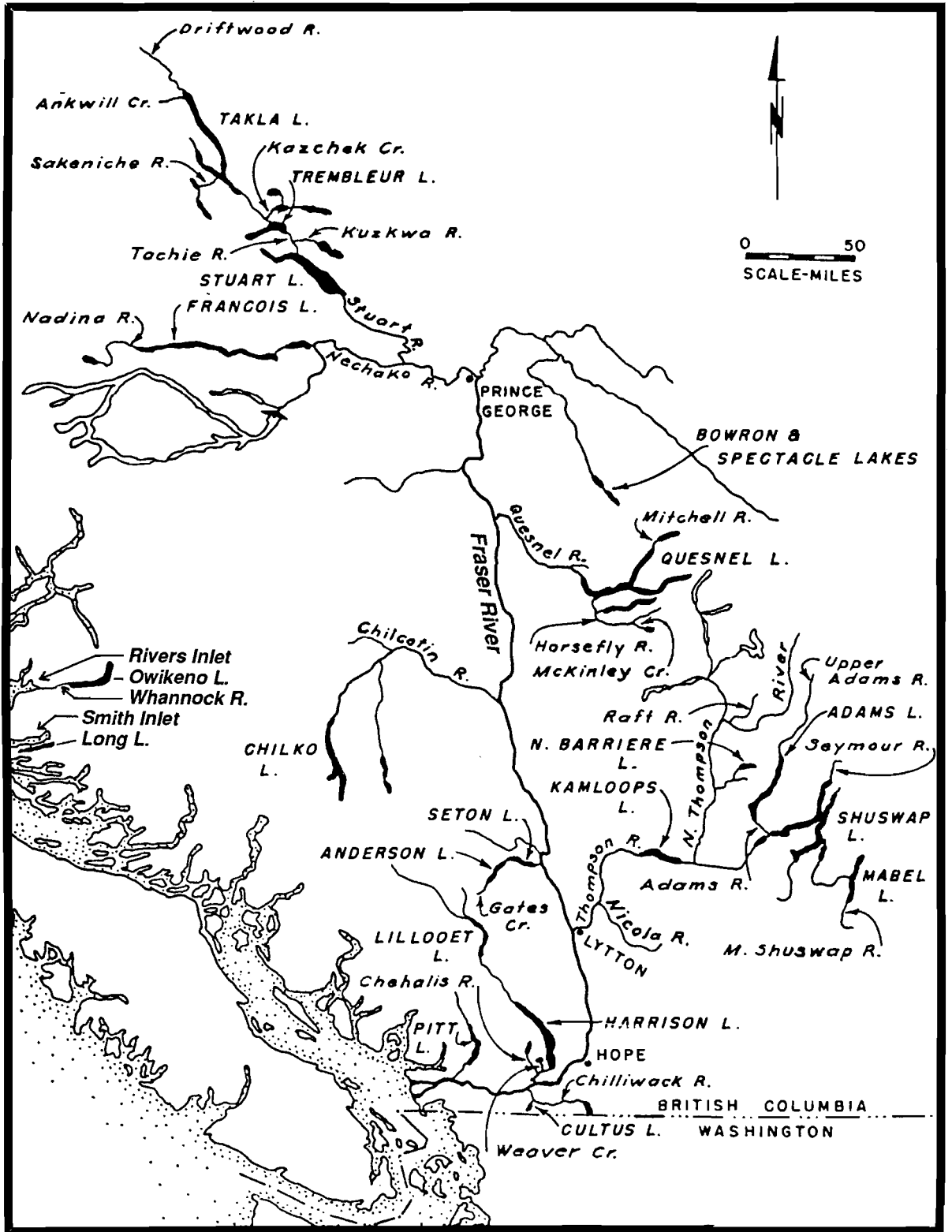


Figure 3. Major sockeye salmon rearing lakes in the Fraser River, Rivers Inlet, and Smith Inlet systems of British Columbia (after Poe and Mathisen 1981).

green head, bright red body, and red fins. Breeding female generally the same with characteristic bright scarlet body. In juveniles the parr marks are shorter than the diameter of eye, oval and usually above lateral line. Hart (1973) and Scott and Crossman (1973) are the source of morphology and identification aids.

## REASON FOR INCLUSION IN SERIES

Sockeye salmon are found in commercial quantities along the North American coast from the Columbia River, between Oregon and Washington, to Bristol Bay, Alaska, and are the most valuable commercial fishery in both Alaska and British Columbia. They are extremely important as subsistence and ceremonial fish to the Indians of Alaska, British Columbia, and Washington. The brilliant red flesh of these fish is highly desired by both commercial and sport fishermen.

## LIFE HISTORY

### *Spawning*

Sockeye salmon are anadromous, spending 1-4 years in the ocean, usually 2, and 2 years in freshwater. This gives a complex number of life cycle years. With the onset of maturity, sockeye travel from their oceanic feeding areas to their natal streams which are usually associated with lakes. After ascending a river, they spend 1-8 months in the lake before moving to their natal spawning areas. There appears to be a diel migration pattern that operates during migration, and this probably differs between stocks (Manzer et al. 1984). Spawning areas selected by the adults may be (1) in streams flowing into the lake; (2) in the upper sections of the lake's outlet river; or (3) along the shores of the lake where seepage outflows, springs, or wind-induced waves occur (Foerster 1968).

Redds are selected in areas of gravel bottom where there is sufficient waterflow through the gravel to provide the developing eggs and embryos with oxygen and to remove the waste products of metabolism (Foerster 1968). A redd consists of 3-10 nesting pockets,

each with an average of 750 eggs (Hart 1973). In general, medium- to small-sized gravel (1.3-10.2 cm according to Reiser and Bjornn 1979) is utilized for redd production. Olsen (1968) has indicated that either sand or gravel may be used by sockeye salmon, depending upon which is available. If small amounts of silt, detritus, or fine sand are mixed with the coarser gravel, they are removed by the fish in the process of excavating the redd (Foerster 1968). The male takes little part in redd building, although he remains near the redd for courtship purposes. The female excavates the redd by vigorous upward and downward motions of her body, causing both the tail and water pressure to move the sand and gravel. When spawning occurs, the female places herself over the pocket, followed by the male a second or two later. Both fish lower their tails to bring their vents close together near the center of the pocket. Eggs and milt are then released while the two fish remain over the pocket for 4-19 seconds. Immediately after spawning, the eggs are buried by the female (Mathisen 1955). Mathisen (1955) observed 198 redds with Bristol Bay sockeye spawning in them at Pick Creek and found egg concentrations 6-9 inches below the gravel surface. Spawning occurs between August and January, depending upon the sockeye stock. Adults die after spawning. Adult spawning escapement can be assessed by several methods including aerial surveys, test fisheries, or hydroacoustics (Thorne 1979; Cousens et al. 1982).

### *Eggs and Fecundity*

The number of eggs per female varies directly with the size of the fish, but there is good evidence that this relationship may vary appreciably between stocks of sockeye (Foerster 1968; Manzer and Miki 1986). Coastal stocks are 18% more fecund than interior stocks in British Columbia. The number of eggs is high compared to other species (averaging about 3,500 per female; Manzer and Miki 1986). However, the size of the eggs (5.29-6.60 mm in diameter) is the smallest among the Pacific salmon (Foerster 1968). High fecundity in sockeye is thought to be related to the long period that they spend in freshwater (Foerster 1968). The fecundity of Pacific Northwest sockeye is reported to vary among females depending upon body size (Table 1; Manzer and Miki 1986) and not age. There is not any relationship of age to fecundity once size is accounted for.







































