Fishery Data Series No. 08-61

Cutthroat Trout Maturity Study at Baranof Lake, Southeast Alaska, 2004

by

Peter D. Bangs

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Alaska Department of Fish and Game   Divisions of Sport Fish and Commercial Fisheries

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Department of Fish and Game	ADF&G
Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat. or long.
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Measures (fisheries)

fork length	FL
mideye to fork	MEF
mideye to tail fork	METF
standard length	SL
total length	TL

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	log_2, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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ABSTRACT

The purpose of this study was to evaluate the relationship between length and sexual maturity for male and female cutthroat trout in Baranof Lake. The timing of sampling differed from previous studies conducted at other lakes in Southeast Alaska in that sampling was conducted in early May (presumably before the initiation of spawning activities) whereas prior studies were conducted in late fall. Another key difference was that this study relied upon external, morphological characteristics to determine sex and maturity status whereas in previous studies all fish were killed to determine their reproductive status. During this study, we found evidence that spawning activity in some fish was already underway and therefore we concluded that spawning and non-spawning fish likely had unequal probabilities of capture (particularly if spawning fish had immigrated into the lake tributaries). Furthermore, we discovered in the latter part of the sampling trip that our technicians' ability to classify fish based upon external, morphological characteristics was unreliable. Therefore, the data we collected were deemed unsuitable for developing length at sexual maturity models. Due to the difficulty in predicting the often protracted spawning period for cutthroat trout, we recommend that researchers avoid the spring months for conducting maturity studies. We also suggest that researchers avoid relying upon external, morphological characteristics for determining the sex and reproductive status of cutthroat trout.

Key words: Baranof Lake, cutthroat trout, *Oncorhynchus clarki*, sexual maturity.

INTRODUCTON

The sport fishing regulations for cutthroat trout *Oncorhynchus clarki* populations in Southeast Alaska are based largely upon the relationship between length and sexual maturity in females (see Harding and Jones 2004). Previous maturity studies (e.g., Foster 2003, Harding and Jones 2004) at other Southeast Alaska lakes were conducted in the fall months (i.e., September through October) and relied upon lethal sampling techniques to determine the sex and reproductive status of fish. Baranof Lake is one of the most extensively studied cutthroat populations in Southeast Alaska (e.g., Der Hovanisian and Marshall 1995 and Harding et al. *In prep*) although no maturity studies have been conducted to date. The motivation for this study was largely opportunistic in that charter flights were already planned to Baranof Lake to clean up a dilapidated field camp and thus a maturity study could be conducted at a minimal cost. The study objective in 2004 was to estimate the proportion of sexually mature cutthroat trout (by sex) in 20 mm length increments.

METHODS

STUDY AREA

Baranof Lake (Figure 1) is located 25 km east of Sitka at the head of Warm Springs Bay on Baranof Island. The lake is about 4.8 km long and 0.6 km wide, and has a surface area of 324 ha, a maximum depth of 87 m, and mean depth of 38 m (Schmidt 1982). A barrier falls on the lake outlet prevents upstream fish migrations. Baranof Lake is relatively unique among large lakes in Southeast Alaska in that it supports only one species of fish (cutthroat trout). The abundance of cutthroat trout ≥180 mm FL in Baranof Lake in 2003 was estimated at 8,739 fish (SE = 2,028, Harding et al. *In prep*) using a Petersen closed population model.

SAMPLING DESIGN AND FISH CAPTURE

This study was designed to estimate the maturity schedule of cutthroat trout in Baranof Lake. The primary assumption of the experiment was that all fish, including spawning and non-spawning fish, had an equal probability of capture. Sampling was conducted between May 8th and 15th, 2004. Cutthroat trout were captured by setting baited traps (see Figure 2 in Rosenkranz et al. 1999) uniformly across the lake in all areas that were ≤50 m in depth. Bait for the traps consisted of whole/crushed salmon eggs that had been disinfected in a povidone-iodine solution. Traps were set on the lake bottom and depths were measured with a fathometer or metered buoy line. Sampling was not conducted in the lake tributaries where spawning would occur. We assumed that spawning activity had not yet commenced, and the presence of spawned-out fish in the lake would indicate that this assumption was incorrect.

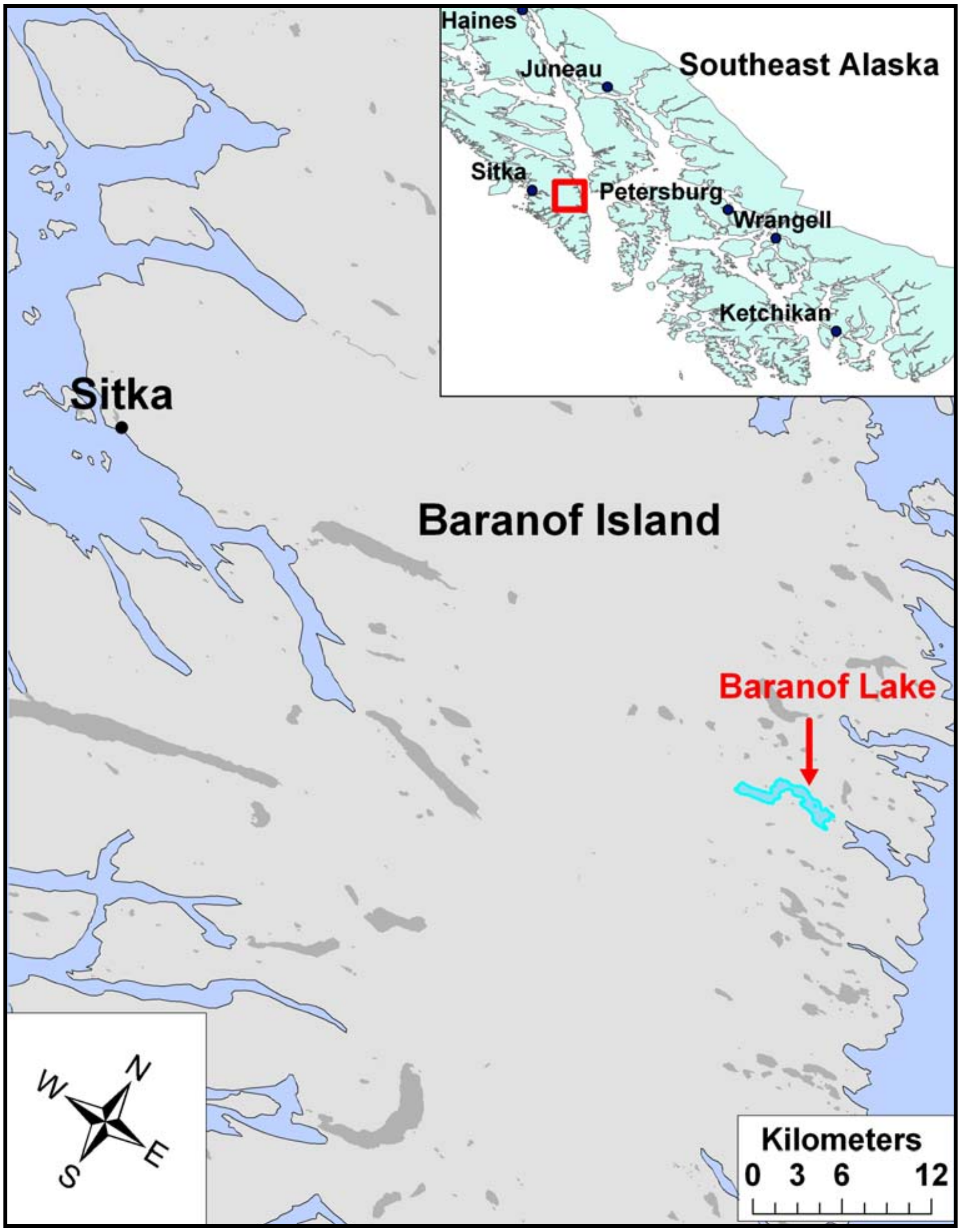

Figure 1.–Location of Baranof Lake, near Sitka.

All cutthroat trout captured were measured to the nearest mm FL and evaluated for sex and maturity status. If the technicians were able to classify a fish as a mature female or mature male based upon external, morphological characteristics (e.g., ovipositor protruding from vent in mature females, distended abdomen on mature females, release of eggs or milt upon gentle pressure to the abdomen for very ripe fish), the fish was given a shallow upper caudal clip (to prevent duplicate sampling) and released. If the sex or maturity status of a fish was unknown, the fish was sacrificed to determine its maturity status following the methods of Foster (2003).

RESULTS

During the course of the sampling trip, we found that the project technicians were not able to accurately determine the sex and maturity status of mature fish in a non-lethal manner. For example, some fish that were determined to be male cutthroat trout (based upon external, morphological characteristics) turned out to be females, or vice versa. Another complication was that some fish were correctly sexed based upon non-lethal techniques, but their maturity status was misclassified. For example, some females were classified as mature, but the ovaries were actually not developed for that spawning season. Factors contributing to the confusion were that some fish (males and females) appeared to have already spawned that season, and that some females appeared to be "skip spawners," which means that they had spawned in previous years but did not have developed ovaries in 2004. The previous spawning activity was indicated by the presence of large residual oocytes in the ovaries. Because our sampling occurred after the onset of spawning activity, we concluded that mature and immature fish likely had unequal probabilities of capture, particularly for spawning females that had immigrated into the lake tributaries for spawning and were therefore not available for capture. Because of this factor, along with our inability to accurately determine the sex and maturity status of fish, our data was deemed unsuitable for compiling summary statistics or developing length at maturity models.

DISCUSSION

This project failed to meet the stated objective of developing length at maturity models (by sex) for cutthroat trout in Baranof Lake. The project failed because sampling occurred after the onset of spawning activities and we concluded that spawning and non-spawning fish likely had unequal probabilities of capture, and also because the project technicians were not able to accurately determine the sex and maturity status of cutthroat trout based upon external, morphological characteristics. The technicians' inability to correctly identify mature female and mature male fish was surprising because they had recently been successful at doing so in practice trials at Florence Lake. We suspect that differences in coloration, morphological characteristics, and maturity schedules among populations of cutthroat trout may lead to inconsistent results when identifying mature cutthroat trout based upon external characteristics.

This study was initiated as a last minute "add-on" to a camp cleanup trip, with the project going from conception to field operations in under a week. In retrospect, we believe that more thorough planning may have led to a more robust plan for evaluating the study techniques and assumptions. As discussed by Harding et al. (*In prep*), avoiding spawning activities in the spring months can be difficult due to the protracted spawning period of cutthroat trout and the inter-annual variation in stream temperatures in the spring months. Harding and Jones (1993) found that spawning cutthroat trout entered lake tributaries (presumably for spawning) at Florence Lake between April 22 and June 6, 1992. Developing a more robust maturity study during the spring months may be difficult without a significant increase in project cost by conducting additional sampling trips or installing and operating weirs in the spawning tributaries. In the absence of a more elaborate study design, we recommend that researchers avoid the spring months for conducting maturity studies. We also suggest that researchers avoid relying upon external, morphological characteristics for determining the sex and reproductive status of cutthroat trout.

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APPENDIX A

Appendix A1.–Computer file containing raw data from the 2004 Baranof Lake maturity study.

File Name	Description
BARANOF_2004_DATA	EXCEL spreadsheet with Baranof Lake 2004 raw data.