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

by

Peter D. Bangs
### Symbols and Abbreviations

The following symbols and abbreviations, and others approved for the Système International d'Unités (SI), are used without definition in the following reports by the Divisions of Sport Fish and of Commercial Fisheries: Fishery Manuscripts, Fishery Data Series Reports, Fishery Management Reports, and Special Publications. All others, including deviations from definitions listed below, are noted in the text at first mention, as well as in the titles or footnotes of tables, and in figure or figure captions.

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<th>General</th>
<th>Measures (fisheries)</th>
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<tr>
<td>centimeter cm</td>
<td>Alaska Department of Fish and Game ADF&amp;G</td>
<td>fork length FL</td>
</tr>
<tr>
<td>deciliter dL</td>
<td>Alaska Administrative Code AAC</td>
<td>mideye to fork MEF</td>
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<tr>
<td>gram g</td>
<td>all commonly accepted abbreviations e.g., Mr., Mrs., Jr., Jr., etc.</td>
<td>mideye to tail fork METF</td>
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<tr>
<td>hectare ha</td>
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<td>standard length SL</td>
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<tr>
<td>kilogram kg</td>
<td></td>
<td>total length TL</td>
</tr>
<tr>
<td>kilometer km</td>
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<td></td>
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<tr>
<td>liter L</td>
<td></td>
<td></td>
</tr>
<tr>
<td>meter m</td>
<td></td>
<td></td>
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<tr>
<td>milliliter mL</td>
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<tr>
<td>millimeter mm</td>
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**Weights and measures (English)**
- cubic feet per second ft³/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
- percent %
- volts V
- watts W

### Symbols
- @ compass directions:
  - east E
  - north N
  - south S
  - west W
- @ copyright corporate suffixes:
  - Company Corp.
  - Corporation Corp.
  - Incorporated Inc.
  - Limited Ltd.
- District of Columbia et alii (and others)
- etc.
- (for example)
- Federal Information Code
- id est (that is)
- latitude or longitude symbols (U.S.)
- months (tables and figures): first three letters
- registered trademark trademark
- United States (adjective)
- United States of America (noun)
- U.S.C.
- U.S. state abbreviations (e.g., AK, WA)
- alternate hypothesis Hₐ
- base of natural logarithm e
- catch per unit effort CPUE
- coefficient of variation CV
- common test statistics (F, t, χ², 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) logₑ, etc.
- minute (angular) ′
- not significant NS
- null hypothesis H₀
- 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
CUTTHROAT TROUT MATURITY STUDY AT BARANOF LAKE, SOUTHEAST ALASKA, 2004

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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.

INTRODUCTION

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 $\geq 180$ 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 $\leq 50$ 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.
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 prolonged 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.

**ACKNOWLEDGEMENTS**

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**REFERENCES CITED**


REFERENCES CITED (Continued)


APPENDIX A
Appendix A1.—Computer file containing raw data from the 2004 Baranof Lake maturity study.

<table>
<thead>
<tr>
<th>File Name</th>
<th>Description</th>
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<tr>
<td>BARANOF_2004_DATA</td>
<td>EXCEL spreadsheet with Baranof Lake 2004 raw data.</td>
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