Regional Operational Plan SF.2A.2013.08

Post Recompression Survival of Rockfish of the Prince William Sound

by

Mike Thalhauser

May 2013

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

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.

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 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)

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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POST RECOMPRESSION SURVIVAL OF ROCKFISH OF THE PRINCE WILLIAM SOUND

by

Mike Thalhauser

Alaska Department of Fish and Game, Division, Anchorage

Alaska Department of Fish and Game
Division

May 2013

Mike Thalhauser
Alaska Department of Fish and Game, Division of Sport Fish,
333 Raspberry Road Anchorage, AK 99518

This document should be cited as:
Thalhauser, M. 2013. Post recompression survival of rockfish of the Prince William Sound. Alaska Department of Fish and Game, Division of Sport Fish, Regional Operational Plan ROP.SF.2A.2013.08, Anchorage.

SIGNATURE PAGE

Project Title:	**Post Recompression Survival of Rockfish of the Prince William Sound**
Project leader(s):	***Mike Thalhauser (Fishery Biologist II)*** ***Daniel Bosch (Fishery Biologist III)*** ***Dan Reed (Biometrician III)***
Division, Region, and Area	***Sport Fish, Region II, Prince William Sound***
Project Nomenclature:	
Period Covered:	**May 2013 – December 2013**
Field Dates:	**May - July of 2013**
Plan Type:	**Category II**

Approval

Title	Name	Signature	Date
Project leader	Mike Thalhauser	[signature]	5/23/13
Biometrician	Dan Reed	[signature]	5/23/2013
Research Coordinator	Jack Erickson	[signature]	5/24/2013

TABLE OF CONTENTS

Page

LIST OF FIGURES II

PURPOSE 1

BACKGROUND 1

OBJECTIVES 2

METHODS 2

Sample Size 3

DATA ANALYSIS 4

Survival Estimate 4

SCHEDULE AND DELIVERABLES 4

RESPONSIBILITIES 4

REFERENCES CITED 5

LIST OF FIGURES

Page

Figure 1.–Boyle’s Law describes the inverse relationship between the volume of an ideal gas (temperature is constant) and pressure (shown as depth). 3

PURPOSE

The purpose of this study is to expand previous knowledge on the effects of rapid decompression caused barotrauma, associated with hook and line fishing, on dark, dusky, and silvergray rockfish in the Prince William Sound. Each of these species are physoclistic fish, making them more susceptible to physical injury and mortality that can occur with discarded hook and line caught fish. Specialized cages will be used to re-submerge fish for 2 days, in order to recreate the effects of using a deepwater release mechanism and to estimate survivability under these conditions. Total length, signs of external barotrauma, and water temperature at depth of capture and at the surface will be collected to determine any relationships between these parameters and survival probability.

BACKGROUND

Pacific rockfish *Sebastes* spp. are a diverse group of marine fishes found throughout the Northeast Pacific Ocean (Love et al. 2002). Rockfish, like many other physoclistic fish, frequently experience physical injury and positive buoyancy (collectively called barotrauma) due to rapid decompression associated with hook-and-line capture (Rummer and Bennett 2005; Parker et al. 2006). The frequency of external signs of barotrauma (Pribyl et al. 2009), the probability of submergence after release at the surface (Hannah et al. 2008; Hochhalter 2012), and the probability of post-recompression survival (Jarvis and Lowe 2008) is highly species-specific. Despite species-specific responses to barotrauma and post-release performance, three general patterns have emerged from recent research: i) for most species, external signs of barotrauma and submergence probability are correlated with capture depth (Hannah et al. 2008; Hochhalter 2012); ii) demersal species, relative to pelagic species, show the highest potential for post-recompression survival (Hannah et al. 2012); and, iii) for all species studied to date, the probability of post-recompression survival is greater than the probability of successful submergence after release at the surface (Hochhalter and Reed 2011; Hannah et al. 2012).

Evidence of high survival for rockfish released at depth (e.g., 98.8% for yelloweye; Hochhalter and Reed 2011) has resulted in ADF&G actively encouraging deepwater release for all discarded rockfish (http://www.adfg.alaska.gov/index.cfm?adfg=fishingSportFishingInfo.rockfishconservation), and the Alaska Board of Fisheries to adopt a regulation that mandates deepwater release for all non-pelagic rockfish released in the guided recreational fisheries in Southeast AK. On average 45% of all rockfish captured in the recreational fisheries of Southcentral AK are released (ADF&G unpublished creel survey data). Accounting for total fishery removals (harvest + discard mortality) requires accurate estimation of harvest and discard mortality. With this in mind, estimates of discard survival for of rockfish that support the majority of recreational harvest are needed.

Three experimental approaches have been used to generate estimates of discard survival: mark-recapture studies, controlled field experiments, and laboratory studies. Each of these approaches has advantages and disadvantages that must be considered when designing a discard survival study. The mark-recapture approach provides the most realistic and applicable estimates of survival, but is the most logistically demanding of the three options, and is unworkable for species that exhibit extensive movements. For mark-recapture studies, variables cannot be controlled (i.e., variables are random, rather than fixed) which can restrict statistical inference. The primary advantage of controlled field experiments such as cage studies are that they are logistically practical and provide more applicable estimates of short-term survival than those derived in a laboratory setting. With that said, cage studies can lead to biased estimates of survival because individuals are not exposed to predation (i.e., overestimate survival) and cages can impart additional stress (i.e., underestimate survival). Hannah et al. (2012) have developed a novel cage system to estimate that minimizes the negative bias in survival estimates that is attributed to cage-effects. While Hannah et al. (2012) found the cage design to be effective at minimizing negative bias in survival estimates for seven species of rockfish, the reported estimates of survival are limited by small sample sizes, particularly for capture depths greater than 50 m.

In 2012, this project targeted yelloweye and quillback (demersal) rockfish species in order to estimate the 2-day post recompression survival of each species. While the target sample size for each species was 40 fish, 22 and 23 fish were successfully sampled for yelloweye and quillback rockfish, respectively. Formal results from 2012 will be published in the final report for this project. Preliminarily, all captured demersal rockfish, including a non-targeted silvergray rockfish and one northern rockfish survived the 2-day recompression test successfully. Experimental failures were encountered with two yelloweye rockfish during the recompression test (one escaped or was removed and the trap was lost for the other). These two fish are not reflected in the numbers above. A total of 5 pelagic rockfish were captured and sampled using the same methods (2 dark and 3 dusky rockfish.) One of these dusky rockfish represented the only fish that did not survive recompression in our 2012 sampling efforts.

2013 Sampling efforts will focus on the survivability of dark, dusky, and silvergray rockfish. Each of these species are frequently caught and released in the Prince William Sound and so are more susceptible to associated barotraumas. Based on experience gained in 2012, the target sample sizes in 2013 have been reduced to 25 fish per species with a corresponding adjustment to the precision criteria in Objective 1. Once the target sample sizes have been achieved, additional effort will be expended to increase samples sized to increase precision of survival estimates within the constraints of the 2013 project budget.

OBJECTIVES

1. Estimate the 2-day post-recompression survival (proportion (p_s)) of dark, dusky, and silvergray rockfish (by species) captured at a range of depths, so that the estimated proportions are within 12 percentage points of the true values 95% of the time.

METHODS

Dark, dusky, and silvergray rockfish will be captured with hook-and-line gear in western Prince William Sound at depths ranging from 20-100 meters . Captured rockfish will be measured for total length (mm) and assessed for five external signs of barotrauma: exophthalmia, distended abdomen, corneal emphysema, and everted esophageal tissue. Additionally, depth of capture, surface water temperature, water temperature at depth, and ambient air temperature will be recorded for each captured rockfish. Water temperature at depth was not previously recorded as part of this project; however surface/bottom temperature differential has been shown to be negatively associated with survivability of pelagic rockfish in similar studies (Hannah et al. 2012). Sampling and handling times will be recorded for each individual. Captured individuals will be placed inside a specialized cage that is designed to minimize the negative bias in survival estimates generated from short duration cage experiments (Hannah et al. 2012; http://www.tandfonline.com/toc/umcf20/current). Once the fish is in the cage and the cage lid has been secured, the fish and cage will be lowered to a depth of at least 35 m. A target return depth of ≥ 35 m is expected to be sufficient to reverse most barotrauma signs because Boyle's Law indicates that the majority of gas expansion occurs within the first 30 m of the water column (Figure 1).

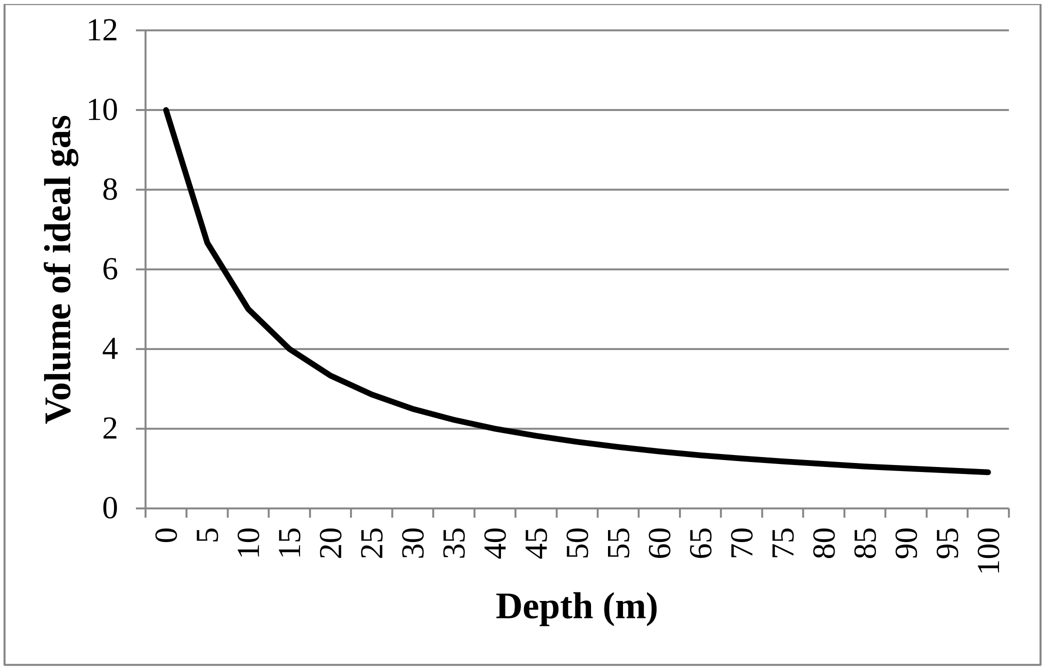

Figure 1.–Boyle's Law describes the inverse relationship between the volume of an ideal gas (temperature is constant) and pressure (shown as depth).

A numbered buoy will be attached to the cage with floating line so that cages can be located and retrieved at the end of the holding period. After approximately 48-hours, the cage and fish will be retrieved and individual fate determined. A total of 20 cages will be available for each 7-day sample event. It is anticipated that at least 40 individuals can be sampled during each event. The 2013 budget will likely allow 3 sample events which will allow us to sample a grand total of 120 individuals (40 of each species) during the 2013 field season. We will attempt to distribute the samples evenly across each species' depth range.

SAMPLE SIZE

1. Assuming survival is 0.9, a sample size of 24 rockfish per species will be necessary to achieve the precision criteria stated for Objective 1 (Cochran 1977). Therefore, the expected sample size of 25 individuals per species will be adequate to achieve the stated precision. If survival is actually 0.8, a sample size of 24 will allow us to estimate survival rate within 16 percentage points of the true values 95% of the time. If survival is 0.5, a sample size of 38 will allow us to estimate survival rate within 20 percentage points of the true values 95% of the time.

DATA ANALYSIS

SURVIVAL ESTIMATE

For each species, the fraction p_s of the fish that survive the 2-day holding period will be estimated (Cochran 1977):

$$\hat{p}_s = \frac{n_s}{n} \quad (1)$$

$$v\hat{a}r[\hat{p}_s] = \frac{\hat{p}_s(1 - \hat{p}_s)}{n - 1} \quad (2)$$

where n is the number of rockfish of a given species in the experiment and n_s is the subset of n that survive the 2-day holding period.

If survival ranges between 0.20–0.80, sufficient data may be available to use logistic regression (Hosmer and Lemeshow, 2000) to estimate the relationship between depth at capture and survival for each species similar to the modeling described by Hannah et al. (2012). Similarly, logistic regression models will be estimated to examine the relationship between surface/bottom temperature differential and survival if sufficient data are available.

SCHEDULE AND DELIVERABLES

Field sampling activities are scheduled as follows:

1. Equipment drop off at cabin	May
2. Field sampling	May - July

Data editing and entry into spreadsheets will occur as the season progresses and should be completed by July 30. The project leader will complete a draft Fisheries Data Series report of the results by December 31, 2013 to fulfill the reporting obligation for this Federal Aid Project.

RESPONSIBILITIES

Mike Thalhauser, Fishery Biologist II, PI and Lead Biologist. Writes operational plan, supervises overall project; edit, analyze, and report data.

Daniel Reed, Biometrician III. Provide input to sampling design and operational plan. Provides support during data analysis, and final report.

Jack Erickson, Regional Research Coordinator. This position reviews the operational plan and the FDS report and assists in obtaining funding for the project.

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