Regional Operational Plan SF.2A.2015.06

Operational Plan: Postrecompression Survival of Rockfish of Prince William Sound

by

Mike Thalhauser

May 2015

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 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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by

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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)* *Jiaqi Huang (Biometrician III)*
Division, Region, and Area	*Sport Fish, Region II, Prince William Sound*
Project Nomenclature:	
Period Covered:	May 2015 – June 2017
Field Dates:	May-September 2015, 2016, & 2017
Plan Type:	Category II

Approval

Title	Name	Signature	Date
Project leader	Mike Thalhauser	[signature]	5-7-2015
Biometrician	Jiaqi Huang	[signature]	5-7-2015
Research Coordinator	Tim McKinley	[signature]	5/21/15

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ABSTRACT

Identification of variables that can be used to predict discard mortality is an important step towards improving estimates of total fishery removals. This study will document capture depth, temperature differentials between capture depth and surface, and 6 external signs of barotrauma that make up the impairment associated with rapid decompression of hook-and-line captured demersal rockfish species in Prince William Sound. Deepwater release methods have proven successful in increasing the probability of survival of fish exhibiting symptoms of barotrauma, and a novel cage system will be used to estimate the effectiveness of these release methods for an expanded number of species of commonly caught demersal rockfish species in Prince William Sound.

Key words: assessment, management, sport fishing, demersal rockfish species, physoclist, deep water release, recompression, survival, Alaska Department of Fish and Game, Prince William Sound.

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 rockfish in Prince William Sound. Pacific rockfish are physoclistic fish, lacking a duct between the air bladder and alimentary canal, making them more susceptible to barotrauma injury and mortality that can occur with discarded hook-and-line caught fish. Specialized cages will be used to resubmerge 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 temperatures taken at depth of capture and at the surface will be collected to look for 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 postrecompression survival (Jarvis and Lowe 2008) is highly species-specific. Despite species-specific responses to barotrauma and postrelease performance, 3 general patterns have emerged from recent research: 1) for most species, external signs of barotrauma and submergence probability are correlated with capture depth (Hannah et al. 2008; Hochhalter 2012); 2) demersal species, relative to pelagic species, show the highest potential for postrecompression survival (Hannah et al. 2012); and 3) for all species studied to date, the probability of postrecompression 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 rockfish [*Sebastes ruberrimus*]; Hochhalter and Reed 2011) has resulted in the Alaska Department of Fish and Game (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 (BOF) to adopt a regulation that mandates deepwater release for all nonpelagic 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 plus discard mortality) requires accurate estimation of harvest and discard mortality. With this in mind, estimates of discard survival 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 3 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., survival is overestimated) and cages can impart additional stress (i.e., survival is underestimated). Hannah et al. (2012) have developed a novel cage system 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 7 species of rockfish, the reported estimates of survival are limited by small sample sizes, particularly for capture depths greater than 50 m.

Sampling efforts in years 2015–2017 will focus on the survivability of dark (*Sebastes ciliatus*), dusky (*Sebastes variabilis*), and silvergray (*Sebastes brevispinis*) rockfish. Each of these species are frequently caught and released in Prince William Sound and so are more susceptible to associated barotraumas. The target sample sizes in 2015 will be 25 fish per species. Additionally, nontargeted demersal rockfish will also be sampled with the goal of being more efficient in our sampling efforts and able to make survivability estimates for a greater number of species. Sampling of additional individuals will cease for a particular species once a target sample size of 25 fish is reached. For dark, dusky, and silvergray rockfish, additional effort may be expended to increase sample size to increase precision of survival estimates of these target species.

OBJECTIVE

This project will estimate the 2-day postrecompression 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

Demersal 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 6 external signs of barotrauma: exophthalmia, distended abdomen, corneal emphysema, and everted esophageal tissue. Additionally, depth of capture temperature will be recorded for each captured rockfish and water temperature at depth and at the surface will be recorded for each sampling site. Water temperature at depth was not previously recorded as part of this project; however, the surface to 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 greater than or equal to 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).

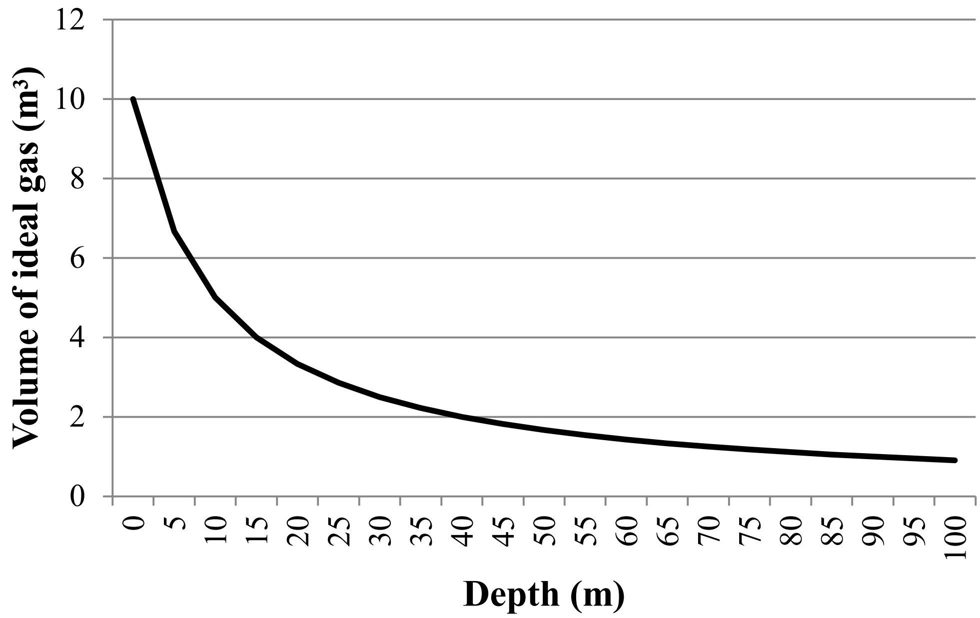

Figure 1.–Boyle's Law describes the inverse relationship between the volume of an ideal gas (when temperature is constant) and pressure (shown as depth from sea surface).

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 16 cages will be available for each 5-day sampling event. It is anticipated that at least 32 individuals can be sampled during each event. The anticipated 2014–2017 budgets will likely allow 4 sample events, which will allow us to sample a grand total of 128 individuals for each of the 3 years covered by this operation plan. We will attempt to distribute the samples evenly across each species' depth range.

SAMPLE SIZE

Assuming the probability of 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 value 95% of the time. If survival is 0.5, a sample size of 24 will allow us to estimate survival rate within 20 percentage points of the true value 95% of the time.

DATA ANALYSIS

The estimated probablility of survival will be calculated as follows. For each species, the fraction p_S of the fish that survive the 2-day holding period will be (Cochran 1977)

$$\hat{p}_s = \frac{n_s}{n} \tag{1}$$

with

$$\text{var}\left[\hat{p}_s\right] = \frac{\hat{p}_s(1-\hat{p}_s)}{n-1} \tag{2}$$

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 the probability of survival ranges between 0.20 to 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; this is similar to the modeling described by Hannah et al. (2012). Similarly, logistic regression models will be estimated to examine the relationship between the surface to bottom temperature differential and survival if sufficient data are available.

SCHEDULE AND DELIVERABLES

Field sampling activities for the 2015–2017 seasons are scheduled as follows:

1) April–May: equipment shuttle
2) May–September: 4 or greater sampling trips, depending on trip length (3–7 days)[1]
3) Data editing and entry into spreadsheets will occur as the season progresses and should be completed by 30 September of each year.
4) A Fisheries Data Series report will be completed following the 2017 field season.

RESPONSIBILITIES

Mike Thalhauser, Fishery Biologist II, PI and Lead Biologist. Writes operational plan, supervises overall project; edits, analyzes, and reports data.

Jiaqi Huang, Biometrician III. Provides input to sampling design and operational plan. Provides support during data analysis, and final report.

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

[1] These dates are tentative and will change based mostly on weather in Prince William Sound.

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