Regional Operational Plan No. ROP.SF.2A.2023.06

Operational Plan: Post-recompression Survival of Black Rockfish in Prince William Sound, 2023–2025

by

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and

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June 2023

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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OPERATIONAL PLAN: POST-RECOMPRESSION SURVIVAL OF BLACK ROCKFISH IN PRINCE WILLIAM SOUND, 2023–2025

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SIGNATURE/TITLE PAGE

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Division, Region and Area	Sport Fish, Region II, Prince William Sound Management Area
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Period Covered	2023–2025
Field Dates:	May–September 2023 and 2024; May–June 2025
Plan Type:	Category II

Approval

Title	Name	Signature	Date
Project leader	Donald Arthur		
Project leader	Brittany Blain-Roth		
Biometrician	Logan Wendling		
Research Coordinator	Timothy McKinley		

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ABSTRACT

Identification of variables that can be used to predict discard mortality under different scenarios is an important step towards improving estimates of total fishery removals. This study will document the effects of barotrauma and deepwater release on black rockfish (*Sebastes melanops*) caught at a depth shallower than the depth at which they are released. The 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 pelagic rockfish species in Prince William Sound will be documented. 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 determine if there are detrimental effects associated with a release deeper than the original capture depth of pelagic rockfish. With regulations requiring the deepwater release of all rockfish in the salt waters of Alaska effective in 2020, it is necessary to determine if discard mortality increases when fish are released deeper than the depth at which they were caught.

Keywords: assessment, management, sport fishing, pelagic rockfish, black rockfish, *Sebastes melanops*, physoclist, deep water release, recompression, survival, Alaska Department of Fish and Game, Prince William Sound

INTRODUCTION

PURPOSE

The purpose of this study is to assess the potential effects of deepwater release on pelagic rockfish caught shallower than 20 m and released deeper than 35 m. Pacific rockfish are physoclistous fishes, 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 caught from 0 to 20 m to a depth deeper than 30 m for a minimum of 2 days. The effects of using a deepwater release mechanism to release shallow-caught black rockfish to a deeper depth is unknown. To inform future management actions, it is necessary to estimate the probability of survival under the caught shallow–release deep scenario that sport anglers might use. 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 long-lived marine fishes found throughout the Northeast Pacific Ocean (Love et al. 2002). These fish, like many other physoclistous 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). From 2004 to 2020, data from the Statewide Harvest Survey[1] shows that approximately 20,000 rockfish are released annually in Prince William Sound (PWS). Due to the high number of rockfish released in PWS, ADF&G has been conducting survival studies on released rockfish over the last 15 years. Studies have found that survival is high when nonpelagic and pelagic rockfish are released at depth (Hochhalter and Reed 2011; Blain-Roth et al. *In prep*), and that nonpelagic fish released at the surface have a low probability of resubmerging unassisted (Hochhalter 2012; Blain-Roth et al. *In prep*). Studies outside of Alaska have found that assemblage (pelagic vs. non-pelagic), depth of capture, and water temperature differentials between the surface and release depth can influence recompression survival, but in general deepwater release strongly

[1] Alaska Sport Fishing Survey database [Internet]. 1996–present. Anchorage, AK: Alaska Department of Fish and Game, Division of Sport Fish (cited April 2023). Available from: http://www.adfg.alaska.gov/sf/sportfishingsurvey/.

increases survival of Pacific rockfish (Hannah et al. 2012). Knowing this, the Alaska Department of Fish and Game (ADF&G) has been actively encouraging deepwater release for all discarded rockfish: http://www.adfg.alaska.gov/index.cfm?adfg=fishingSportFishingInfo.rockfishconservation. In addition, the Alaska Board of Fisheries (BOF) adopted a regulation that became effective in January 2020 that mandates deepwater release for all rockfish (nonpelagic and pelagic species) released in all salt waters of Alaska. However, anglers across Southcentral Alaska have expressed concern with the release of pelagic rockfish at deeper depths than they were captured while targeting salmon species (Brittany Blain-Roth, Michael Booz, Tyler Polum, ADF&G Sport Fish Region II Fisheries Biologists, personal communications). Pelagic rockfish do not typically occupy depths as deep as nonpelagic species; therefore, they may lack the physiological mechanisms associated with successful recompression seen in nonpelagic species (Hannah et al. 2012) and may need to be released more closely to depth of capture.

Accounting for total fishery removals (harvest plus discard mortality) requires accurate estimation of harvest and discard mortality. Estimates of discard survival of rockfish have been documented for several species under a standard scenario, catching them and releasing them close to the depth of capture. 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. However, controlled field experiments such as 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. Sampling efforts in the years 2023–2025 will focus on the post-recompression survivability of pelagic black rockfish (*Sebastes melanops*).

OBJECTIVES

PRIMARY OBJECTIVE

This project will estimate the 2-day post-recompression survival (proportion p_s) of black rockfish captured at a range of shallow depths and released at deeper depths, so that the estimated proportions are within 12 percentage points of the true values 95% of the time. This will address the question whether there are negative survival effects of releasing pelagic black rockfish deeper than depth of capture.

SECONDARY OBJECTIVES

1) Document temperature at capture depth, release depth, and surface for each fish sampled.
2) Collect biological data for yelloweye rockfish (*Sebastes ruberrimus*) that are <300 mm.
3) Collect genetic samples from a variety of rockfish species.

METHODS

STUDY DESIGN

Black rockfish will be captured with hook-and-line gear in Prince William Sound at depths ranging from 0–20 m. Using a "jaw hold," captured rockfish will be measured for total length (mm) and assessed for 6 external signs of barotrauma: exophthalmia, distended abdomen, corneal emphysema, prolapsed cloaca, branchial protrusions, and everted esophageal tissue. Depth of capture will be noted as well as the total time out of the water, and a photo will be taken of each fish. In addition, water temperature at depth of capture and at depth of release along with the water temperature at the surface will be recorded for each sampled fish. 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). Lastly, sampling and handling times will be recorded for each fish.

Captured individuals will be placed inside a specialized cage half filled with seawater 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). The fish's behavior will then be evaluated following the methods of Hannah et al. (2012). The fish will be scored with respect to orientation (upright, on its side, or belly-up), activity level (strong, weak, or none), and the presence or absence of movement in the operculum, body, tail, and pectoral fins. The cage lid will then be attached, and the cage and mooring will be deployed as soon as the vessel has navigated to deeper waters, if necessary. The time the fish is out of the water will be documented as "surface time." The fish and cage will be lowered to a depth of at least 30 m and the location marked on the chart plotter. A target return depth of greater than or equal to 30 m is expected to be sufficient to reverse most barotrauma signs because Boyle's Law indicates that 75% of gas expansion occurs within the first 30 m of the water column (Figure 1).

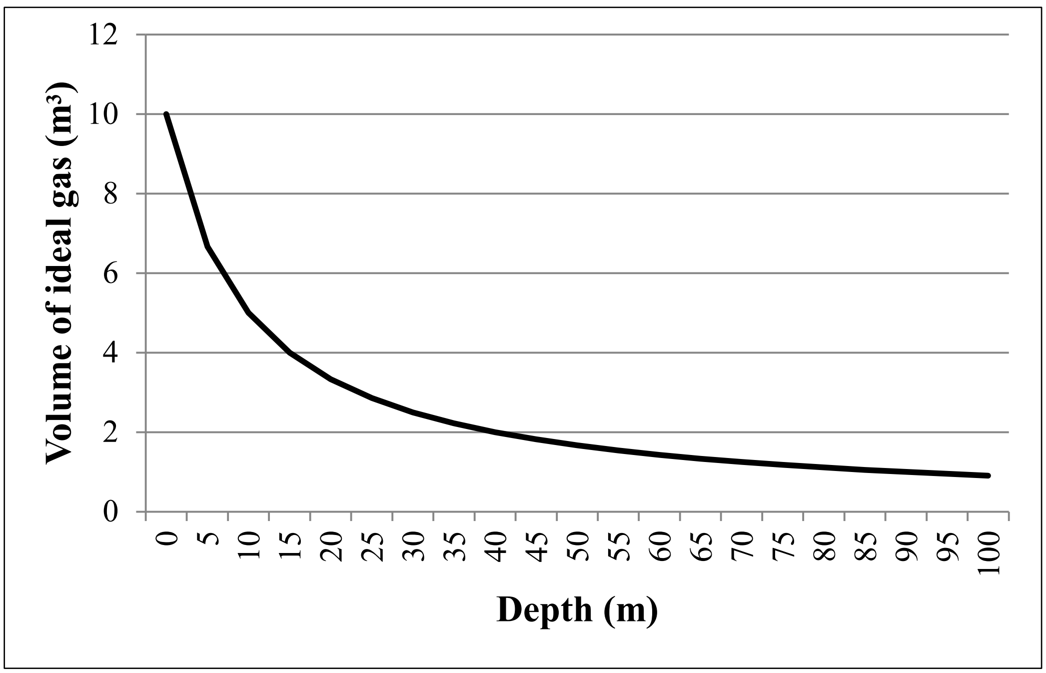

Figure 1.–Boyle's Law describes the inverse relationship between the volume of an ideal gas (when temperature is constant) and pressure (shown as depth from sea surface).

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 a target holding time of 48 hours, the cage and fish will be retrieved, and each fish's fate determined. In addition, fish will be re-evaluated while still in water in the cage for orientation, activity level, and movement. Once removed from the cage, barotrauma injuries will again be noted, and a photo taken. The fish will then be released into the ocean and its ability to descend unassisted will be documented. A total of 10 cages will be available for each 3–5 day sampling event. A maximum of 20 individuals can be sampled during each event if 2 fish are placed in each cage; however, 1 individual per cage is preferred. Any fish that do not survive the 2-day holding period will have a necropsy performed. In addition, a small sample of fish that do survive will be sacrificed to observe swim bladder and other internal damage, including gonad collection for other studies (Blain-Roth et al. 2019) and following the necropsy methods of Pribyl et al. (2009). The anticipated FY23–25 will allow for approximately 3 sample events per field season. We will attempt to distribute the samples evenly across a range of sizes and capture depth.

During capture events or holding time of black rockfish, project staff will opportunistically collect samples of juvenile yelloweye rockfish to assist stock assessment biologists with filling in life history information gaps. Additionally, staff will non-lethally collect archival genetic tissue (i.e., fin clip) from various rockfish species that are incidentally captured throughout all sampling activities.

SAMPLE SIZE

A sample size goal of 67 black rockfish will ensure that the precision criteria stated in the objective of this study is achieved for all possible probabilities of survival (Cochran 1977).

DATA ANALYSIS

The probability of survival for black rockfish, p_s, will be estimated using the fraction of fish that survive the 2-day holding period and will be calculated as follows (Cochran 1977):

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

with

$$SE[\hat{p}_s] = \sqrt{\frac{\hat{p}_s(1-\hat{p}_s)}{n-1}} \tag{2}$$

where n is the number of black rockfish 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 of black rockfish; this is similar to the modeling described by Hannah et al. (2012). Similarly, logistic regression models will be used to estimate the relationship between the surface to bottom temperature differential and survival if sufficient data are available.

SCHEDULE AND DELIVERABLES

Dates	Activity
May–September (2023–2025)	Eight or greater sampling trips, depending on trip length (3–5 days)[2]
September 30 (2023–2025)	Data editing and entry into spreadsheets completed.

A Fisheries Data Series report will be completed after field work is fully completed and sampling goals are met.

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

RESPONSIBILITIES

Donald Arthur, Fishery Biologist II, Co-Project Leader
Duties: Writes operational plan; supervises overall project; edits, analyzes, and reports data.

Brittany Blain-Roth, Fishery Biologist III, Co-Project Leader
Duties: Writes operational plan, supervises overall project, edits, analyzes, and reports data.

Taylor Cubbage, Fishery Biologist I, Crew Leader
Duties: Field work, data entry, assists with data visualization.

Robert Pype, Fish and Wildlife Technician III
Duties: Assist crew leader, collects data.

Logan Wendling, Biometrician
Duties: Provides input to sampling design and operational plan. Provides support during data analysis and final report.

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

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