The California State University
COUNCIL ON OCEAN AFFAIRS, SCIENCE & TECHNOLOGY (COAST)

Graduate Student Research Award Program
AY 2018-2019 Application Form

Application Deadline: Thursday, January 31, 2019, 5:00 p.m. PST

Save as both a Word document and a PDF file named as follows:
***LastName_FirstName_App.docx* and *LastName_FirstName_App.pdf*.**
Submit both files as email attachments to graduate@share.calstate.edu.

Student Applicant Information

First Name:	Natalie	Department or Degree Program:	Fisheries Biology
Last Name:	Okun	GPA in Major Courses (If first semester as a graduate student, please enter, "n/a, first semester".):	
Student ID#:		Matriculation date (mm/yy):	
CSU Campus:	Humboldt State University	Anticipated graduation date (mm/yy):	
Email:		Degree Sought (e.g., MS, PhD):	MSc
Phone:		Thesis-based? (Y/N):	Y

Advisor Information

First Name:	Mark	Position/Title:	Adjunct Professor and Assistant Unit Leader
Last Name:	Henderson	Email:	Mark.henderson@humboldt.edu
CSU Campus:	Humboldt State University	Phone:	(707) 826-5644
Department:	Fisheries Biology		

Research Project Title:	Assessing Large Woody Debris Restoration Effectiveness for Increasing Salmonid Population Survival and Growth: a Before-After-Control-Impact (BACI) Experiment

Project Keywords (5-7 keywords related to your project):	habitat restoration, population ecology, salmon conservation, *Oncorhynchus kisutch,* large-woody debris, Before-After-Control-Impact

Budget Summary (must add up to $3,000)

Award amount directly to awardee:	$3000.00
Award amount to Department:	$0.00

The information on this page is for COAST use only and will not be shared with potential reviewers.

Have you previously received a COAST Graduate Student Research Award? (Y/N)	N
If yes, please provide year(s) of award(s):	

Suggested-Reviewers (Required)

Name:		
CSU Campus:		
Department:		
Email:		

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Please refer to the Award Announcement for detailed instructions on the information required for each of the following sections.

Project Description (60 points total)-1,500 word maximum; any text over this limit will be redacted

Project Description

Despite considerable habitat restoration efforts to reverse negative trends, many Pacific salmonid populations are in decline (Nehlsen et al. 1991, Spence et al. 1996, Ogston et al. 2014, NMFS 2016). Coho salmon (*Oncorhynchus kisutch*) populations in California have declined in excess of 95% over the past 50 years and only exist in about half of their historic streams within California (Cal Trout 2018, Brown et al. 1994). In an effort to improve federally listed salmonid populations, substantial resources have been invested in restoration of freshwater habitats necessary for spawning and juvenile rearing (Spence et al. 1996, Ricciardi and Rasmussen 1999, Naiman and Latterell 2005, Moyle et al. 2011). The number of habitat restoration projects throughout the Pacific Northwest has significantly increased in the past 30 years (Bernhardt et al. 2005). Of the instream habitat improvement efforts, the implementation of large woody debris (LWD) has become the most popular approach; however, studies have rarely provided evidence that the addition of LWD has created lasting effects on availability of rearing habitat or increases in fish abundances, growth, or survival (Roni et al 2014). I propose a study that will examine how large wood treatments affect the survival and growth of coho salmon and steelhead (*O. mykiss*) in Pudding Creek, California.

This graduate project will be part of a larger Before-After-Control-Impact (BACI) study that is currently being conducted on Pudding and Caspar creeks in Fort Bragg, CA (Figure 1). Pudding and Caspar creeks support independent populations of coho and steelhead. Both creeks have operated as Life Cycle Monitoring (LCM) stations within the Coastal Salmonid Monitoring Plan (CMP) since 2005. The goals within the CMP for these creeks are to estimate adult escapement, estimate summer juvenile abundance, estimate out-migrant production, and characterize salmonid life history patterns (Wright et al. 2012). Pre-treatment monitoring for the BACI study was initiated in 2012 and consisted of spawning ground surveys, downstream migrant trapping, running passive integrated transponder (PIT) tag arrays, conducting winter and summer habitat surveys, and summer and fall electrofishing. In 2015, LWD was strategically placed in 80% of mainstem Pudding Creek, with the remaining 20% serving as a within creek control. No LWD was actively placed in Caspar Creek. Both Pudding and Caspar creeks will be monitored through 2021 to ensure a sufficiently long duration to assess restoration effectiveness.

To estimate growth, I will use recaptures from existing summer and fall electrofishing data. After performing summer habitat surveys, in which the entire anadromous length of both creeks are delineated by habitat unit type (i.e. scour pool, riffle, non-turbulent fast water), we make a random stratified selection of a number of units to electrofish with a 3-pass depletion on both creeks. We PIT tag fish and collect morphometric data. We return to these same selected units in fall and repeat the methods, collecting the same data on each fish, putting out more tags, and recording recapture information. I will use recapture data to generate data on juvenile salmonid growth in each creek, before and after the large woody debris treatments, to see if large wood treatment led to increased salmonid growth.

I will use a robust design mark-recapture model to estimate survival rates of fish captured by night snorkeling and electrofishing during a three month period during the summer. The robust design model estimates survival from three primary events, each primary event having three secondary sampling sessions (Figure 3) (Pollock 1982).This design is useful in that it is robust to heterogeneity in capture probability, it can estimate temporary emigration, and can estimate abundance, survival, and recruitment if temporary emigration does not occur (Kendall and Pollock 1992, Kendall and Nichols 1995). The robust design has two levels of sampling, allowing for a more precise estimation of each parameter (Kendall and Pollock 1992). For this part of the study, we will use the nested control within Pudding Creek in that every fourth half-kilometer of the anadromous length of the creek was left untreated (Figure 2). I will sample scour pools within treated and untreated half kilometer sections in Pudding Creek and control scour pools from Caspar Creek. Sampling will be evenly spread throughout the creeks and performed three times in quick succession each month to collect the data necessary for the robust design mark-recapture model. The first two sampling sessions of each month will consist of night snorkeling to capture fish, followed by a third night during which we will perform 3-pass

depletion electrofishing. We will only electrofish scour pools during the third night of each monthly three-night sampling event to avoid trauma to fishes due to repeat electrofishing and to get capture efficiencies of the previous two nights' snorkel-netting. I will implant PIT tags in all unmarked fish, record the tag numbers of any recaptured fish, and collect morphometric data on all fish. This sampling process will take three visits to each selected pool and will happen over six days each month (Table 1.)

To estimate over-winter survival, I will use detections at PIT tag arrays and at juvenile downstream migrant traps. Each creek has PIT tag arrays running from October through July of each year, detecting tagged fish moving in and out of the watersheds. Caspar Creek has pass-through HDX arrays and Pudding Creek has pass-over FDX arrays (which can also detect HDX tags). In the spring, a fyke net operates on Caspar Creek and a rotary screw trap operates on Pudding Creek. At these traps, out-migrating coho salmon and steelhead have morphometric data collected and PIT tags surgically implanted. The PIT tag arrays read tags from fish that were tagged at these juvenile downstream migrant traps as well as tags implanted during summer and fall electrofishing. Out-migrant traps run daily in April and May of each year. To estimate year-specific over-winter survival, I will use a Cormack-Jolly-Seber model with the fall electrofishing (where fish are tagged and recaptured) as occasion 1, fish detected at the downstream migrant traps as occasion 2, and fish exiting the stream at the downstream arrays as occasion 3.

This graduate project will aim to provide quantitative evidence that LWD restoration can be an effective measure to increase salmonid populations as it continues to be implemented as a major method for restoring imperiled fish populations. This information will inform best management practices and funding decisions for future restoration aimed at bolstering coho salmon and steelhead populations. This study is the first of its kind in California and could provide the most intensive and comprehensive restoration effectiveness monitoring in the Pacific Northwest to date.

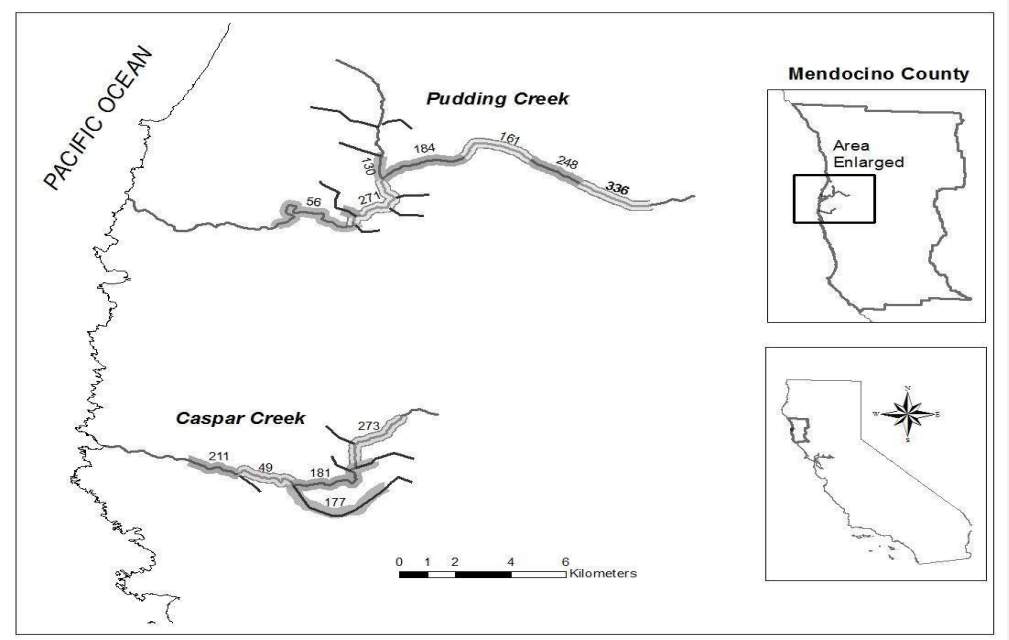

Figure 1. Caspar Creek and Pudding Creek are coastal streams located in Fort Bragg, CA. Caspar Creek is the reference watershed and Pudding Creek is the large-woody debris-treated watershed in the BACI experiment.

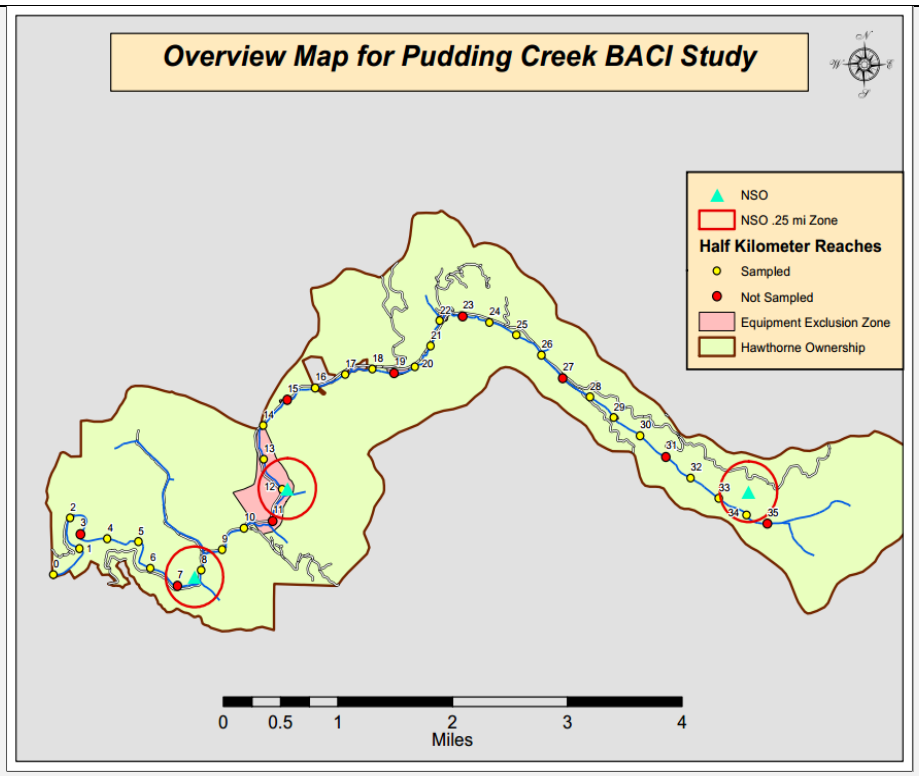

Figure 2. Pudding Creek is split into 35 half-kilometer sections, where every fourth section was left untreated, described as "not sampled" in the figure.

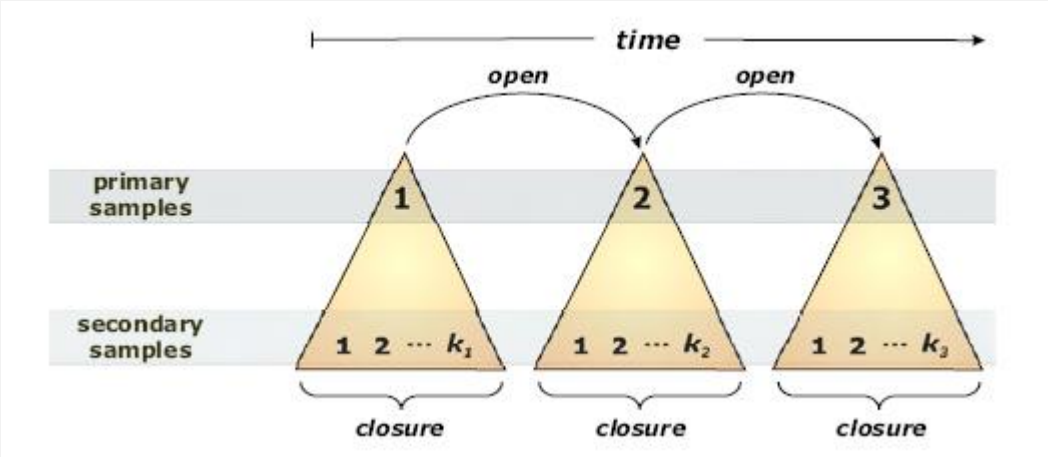

Figure 3. The schematic of a sampling design based on the robust design model. For the survival study, the primary samples (events) will be the months of June, July, and August. Within each primary event, the secondary samples (sessions) will be individual days of field sampling (figure from Murdoch University Cetacean Research Unit 2018).

Table 1. An example schedule for each 6-day period of sampling for survival on Caspar and Pudding creeks. The Pudding Creek scour pools will be half treated and half untreated with large woody debris. Habitat units will be randomly selected as Group A/B.

Sunday	Monday	Tuesday	Wednesday	Thursday	Friday
First round of night snorkel for Group A	First round of night snorkel for Group B	Second round of night snorkel for Group A	Second round of night snorkel for Group B	Electrofish Group A	Electrofish Group B

References (0 points)-no limit

References

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Timeline (10 points total)-250 word maximum

<u>Timeline</u>

Data collection started in 2012 on Caspar and Pudding creeks and will be completed at the end of May 2020. I started working on this project as year-round employee with Pacific States Marine Fisheries Commission in 2016 and then as a master's student at Humboldt State University in August 2018. This summer, I will return to field work on the BACI project and collect additional data from electrofishing and night snorkeling to assess over-summer survival.

During my first semester I organized and examined existing data to analyze over-summer growth throughout the study so far. I have met with several colleagues to create a plan for analyzing over-winter growth and I am currently working on a power analysis for the robust design model that I plan to use to assess over-summer survival. This semester, I will work on an analysis of over-winter survival and will add this year's data when data collection is finished. I will also perform a more extensive analysis of juvenile growth.

I will present my project proposal to a committee in the coming months and prepare for field work and data analysis. I plan to defend my thesis in Winter 2020.

Table 2. The tentative schedule of this project, aiming to submit a manuscript and defend in December 2020 with grant deliverables due in January 2021. X's denote completed actions.

Activities/Months	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
2018												
Meet with Mark Henderson weekly									X	X	X	X
Survival Portion of Proposal											X	X
Form committee												X
PSMFC Performance Review											X	
Start data organization (cont'd forward)									->			
2019												
Meet with Mark weekly	X											
Full Proposal Draft												
First Committee Meeting												
Field Work in Fort Bragg, CA												
Survival Study												
Start robust design model work												
Submit poster abstract to SRF Conference												
PSMFC Performance Review												
Data Analysis Prep	X											
Data Analysis												
2020												
Meet with Mark weekly												
BACI Project field data collection completed												
Data Analysis												
Second committee meeting												
Poster presentation at SRF Conference												
Thesis Writing												
First thesis draft completed												
PSMFC Performance Review												
Manuscript submittal												
Publication submittal												
Thesis Defense												
2021												
Grant Deliverables Due												

Relation to COAST Goals (15 points total)-300 word maximum

Relation to COAST Goals:

Coho salmon (*Oncorhynchus kisutch*) populations in California have declined in excess of 95% over the past 50 years and only exist in about half of their historic streams within California (Cal Trout 2018, Brown et al. 1994). Substantial resources have been invested in restoration of freshwater habitats necessary for spawning and juvenile rearing in an effort to improve federally listed salmonid populations (Spence et al. 1996, Ricciardi and Rasmussen 1999, Naiman and Latterell 2005, Moyle et al. 2011). Large woody debris (LWD) has become the most popular approach to instream restoration; however, studies have rarely provided evidence that the addition of LWD has created lasting effects on availability of rearing habitat or increases in fish abundances, growth, or survival (Roni et al 2014).

This graduate project will aim to provide quantitative evidence that LWD restoration can be an effective measure to increase salmonid populations as it continues to be implemented as a major method for restoring imperiled fish populations. This information will inform best management practices and funding decisions for future restoration aimed at bolstering coho salmon and steelhead populations. This study is the first of its kind in California and could provide the most intensive and comprehensive restoration effectiveness monitoring in the Pacific Northwest to date.

My project's objectives align well with those of the CSU Council on Ocean Affairs, Science and Technology (COAST). COAST works to support research that advances out knowledge of coastal and marine resources and process that affect them as well as to develop solutions to challenges that face our coastal zones. Coho salmon and their habitat are important and imperiled in California, and by studying how effective our restoration efforts are, we can better understand how to help them.

Budget and Justification (15 points total)

Example Budget (feel free to erase the content and use this format, adding additional rows as necessary, or create your own):

Item/Description	Unit Price	Quantity	Amount to Awardee (via Financial Aid)	Amount to Department
Living expenses	$100.00/month	12	$1,200.00	0
Tuition	-	-	$1,800.00	0
		Grand Total	**$3,000.00**	

Justification (250-word maximum):
Budget Justification:

The California Department of Fish and Wildlife's Fisheries Restoration Grant Program and Trout Unlimited fund the Caspar and Pudding Creeks BACI Project; because of this, the project-related equipment and my work while I am doing field work in Fort Bragg is funded. I am working part-time for Pacific States Marine Fisheries Commission right now while attending school, but I do not make nearly enough to cover tuition and pay living expenses (rent and food). I have limited hours as a part-time employee and I am almost always working many more hours than I can be paid for. I have already taken out substantial loans to attend school.

If I were to receive a COAST graduate award, it would be used as financial aid to pay for my living expenses and tuition. Without this award, it will be necessary to take out more student loans to fund the rest of my graduate education. I plan to continue to work in salmonid and restoration research in California with a state or federal agency once I have completed my master's program, and I will I be in a much better position if I can worry less about paying back school-related debt.

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