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

Graduate Student Research Awards
AY 2014-2015 Application Form

Application Deadline: Monday, October 26, 2015, 5:00 p.m. PDT
Save this file as *LastName_FirstName.docx* and email it as an attachment to:
graduate@share.calstate.edu.

Student Applicant Information

First Name:	Caitlin	Department or Degree Program:	Biology
Last Name:	McGarigal	GPA in Major Courses:	4
Student ID#:		Matriculation date (mm/yy):	08/2014
CSU Campus:	Long Beach	Anticipated graduation date (mm/yy):	05/17
Email:	Caitlin.Mcgarigal@gmail.com	Degree Sought (e.g., MS, PhD):	M.S
Phone		Thesis-based? (Y/N):	Y

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

Faculty Advisor Information

First Name:	Chris	Position/Title:	Faculty
Last Name:	Lowe	Email:	Chris.lowe@csulb.edu
CSU Campus:	Long Beach	Phone:	562-985-4111
Department:	Biology		

Research Project Title:	Physiological and behavioral effects of angling stress on two important gamefish in southern California, kelp bass (Paralabrax clathratus) and barred sand bass (P. nebulifer)

Project Keywords (5-7 keywords related to your project):	Kelp bass, calico bass, barred sand bass, catch and release, angling stress

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

Award amount directly to awardee:	1500
Award amount to Department:	1500

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

Project Description (60 points)-1750 word maximum

Introduction:

Kelp bass and barred sand bass have historically supported two of the largest recreational fisheries in southern California for over 60 years, providing valuable economic, social, and ecological functions in coastal communities. However, gamefish have been facing increasing fishing pressures as a result of more anglers engaging in marine recreational activities (Calif. Dept. Fish & Game 2009). Fisheries managers, as well as many anglers, are concerned about the sustainability of these fisheries given the rapid population declines already observed for many popular species, such as kelp bass and barred sand bass (Erisman et al 2011; Jarvis et al 2014). Stakeholders invested in the future viability of these fisheries are keen to improve our understanding of how harvest control measures are impacting local stocks and to identify improvements to be made in the management of these populations, whether that be through changes in regulation or angler behavior.

Significant declines in kelp bass and barred sand bass abundances over the last two decades provide a compelling need for improving our understanding of the processes driving these declines. Kelp bass and barred sand bass have consistently ranked among the top four most landed gamefish in southern California since the mid-1950's (Leet et al 2001) with over 80% of annual catches occurring between June and August when these species form large spawning aggregations (Love et al 1996; Dotson and Charter 2003; Erisman et al 2011). Targeting these aggregations has supported consistently high catch per unit effort, a measure of population stability which has masked stock declines until recently as populations became critically low (Erisman et al 2011). Jarvis et al. (2014) found that annual kelp bass landings have declined 70% from 1980's levels, and annual barred sand bass landings have reduced 85% since 2001 alone. Fisheries managers have responded to these declines by increasing the minimum size limits and reducing the daily bag limits (CA Dept. Fish & Wildlife 2013), which has resulted in more fish being caught and released.

Although catch and release is a commonly used management strategy in marine fisheries there is a substantial lack of direct scientific evidence supporting the efficacy of these regulations for many targeted species. Managers assume that released fish survive, grow, and reproduce, however, no research has been conducted on kelp bass or barred sand bass to validate these assumptions. Physiological and behavioral responses to the angling and handling stresses experienced during catch and release has been shown to negatively affect fish health, growth, reproduction, and, ultimately, influence stock dynamics in other species studied (Wydowski et al 1977; Cooke & Schramm 2007; Donaldson et al 2008). Therefore, it is valuable for managers to account for the impacts of angling stress on individuals when considering the potential long-term outcomes of certain harvest control measures.

The objectives of this study are to 1) Assess the physiological and behavioral responses of kelp bass and barred sand bass to angling and handling stress, 2) Determine the rate of recovery for individuals post-release, and 3) Identify specific angling and handling practices that minimize stress on fish during catch and release. By accomplishing these goals this study will provide the much needed data on the potential impacts of fishing activity on these populations and assist managers in modifying harvest control measures to ensure sustainable fishing practices for these valuable fisheries.

Methods:

Fish in this study will be collected from Wheeler North Artificial Reef (WNAR) in San Onofre, CA (a popular fished artificial reef) and Big Fisherman's Cove (a no-take marine reserve) on Santa Catalina Island, CA. The protection from fishing afforded by the reserve provides some assurance that fish residing in these

areas have not been recently caught and stressed. Blood samples will be collected to evaluate physiological condition and acoustic telemetry will be employed to measure behavioral responses to angling and handling stresses.

Physiology (Baseline): Baseline concentrations of cortisol, glucose and lactate will be quantified using blood samples collected from 20 individuals per species between June and August 2015 in the Catalina Island Marine Life Reserve (CIMLR). Fish will be caught using typical recreational fishing practices and a 0.2 – 0.8 mL whole blood sample will be collected in < 3-5 min of fish being hooked. Samples will be spun (5 min at 10,000 rpm) and decanted plasma will be frozen in liquid nitrogen for transport to a CSULB - 80°C freezer. Fish will be measured (SL cm), weighed (g), and externally tagged with a spaghetti tag (8 cm long x 1.5 mm diameter; unique serial number) through the dorsal musculature (Lowe et al 2003; Topping et al 2005, 2006) before fish are released. Because there is a delay between the initiation of stress and the complete circulation of stress hormones and metabolites associates with the stress response a blood sample collected in <3 min of the fish being hooked reflects the pre-angling, baseline concentration of the biomarkers measured (Mommsen et al 1999; Grutter & Pankhurst 2000; Lowe & Kelley 2004). In a previous catch & release study, California sheephead (*Semicossyphus pulcher*) did not experience an appreciable rise in cortisol, glucose, or lactate until at least 10 min after fish were hooked (Galima 2004; Lowe & Kelley 2004). Therefore, rapid blood sampling should provide accurate baseline levels of these important stress-related biomarkers.

Physiology (Stress Response): To quantify the endocrine stress response kelp bass and barred sand bass will be caught at WNAR and CIMLR between Sept 2015 and 2016. To obtain realistic measures of angling related stress, we will collaborate with commercial sportfishing vessels to quantify angling, handling, and holding effects. Detailed notes on the fight time, air exposure, handling, and terminal tackle for each fish will be recorded to determine the importance of these variables on individual stress responses. Once landed, fish will be held in an onboard tank with circulating seawater for 10, 15, or 20 min before a blood sample is collected; this standardized holding period allows time for cortisol elevation and circulation to stimulate glucose production (Mommsen et al 1999; Lowe & Kelley 2004) and will allow us to identify when a significant stress response occurs. Fish will also be measured, weighed, externally tagged, and capture location will be recorded before fish are released.

All fish recaptured throughout the study at WNAR or CIMLR will be rapidly blood sampled to evaluate the recovery of individuals after varying time at liberty. Rapid sampling of recaptured fish ensures the physiological state is assessed before the stress response to the current capture event occurs. For all samples whole blood glucose and lactate will be measured in the field using a hand-held OneTouch UltraMini glucose meter and Lactate Plus meter (Wells & Pankhurst 1999; Beecham et al 2006). Plasma cortisol will be quantified by enzyme immunoassays.

Statistical Analysis (Physiology): To determine if a significant biomarker response occurs following capture stress baseline samples will be compared with fish caught and held for 10, 15, and 20 min using ANOVA. Effects of angling, handling, and holding times on the stress response will be evaluated for each biomarker using a General Linear Model (GLM). Rate of recovery will be determined by comparing biomarker levels from fish recaptured after varying days at liberty with the biomarker levels of control fish using ANOVA.

Behavior (Baseline): Unstressed behavior will be determined by monitoring the movements of 10 fish per species in the CIMLR between June 2015 and August 2016. Acceleration/Pressure transmitters, (Vemco Ltd, USA; V9AP) will be hand-fed to fish hidden inside squid bait by SCUBA divers to avoid causing capture-related stresses (Winger et al 2002; Lowe and Kelley 2004). Fish activity will be monitored for 24 hrs or until the transmitter is regurgitated, at which point the transmitters will be recovered and used to track additional fish. Three VRAP surface buoys (Vemco Ltd, USA) will be deployed throughout the study

site to listen for transmitter signals, trilaterate fish location, and transmit data to a base-station where fish activity can be viewed in real-time. Acoustic tags transmit at 2 second intervals at 68 kHz, contain a unique ID number, an acceleration vector, a depth value and have an expected battery life of 21 days.

Behavior (Stress Response): Effects of angling and handling stress on behavior will be assessed for 10 individuals of each species captured in the CIMLR using typical recreational angling methods. Fish will be anesthetized in MS-222 (75 mg/l; Schreck & Moyle 1990) before a wax-coated transmitter (paraffin-beeswax to reduce immune rejection) is inserted into the body cavity and the wound is closed with 2 sutures of Chromic gut (Lowe et al. 2003; Mason 2008). Fish will be measured, weighed, and externally tagged with a spaghetti tag, and released, as described previously. Fish activity will be monitored for the duration of the transmitter battery life to determine post-release survival and rate of recovery. Previous tagging and surgical experience with these species indicates very high survival rates (>90%, Lowe et al. 2003; Mason & Lowe 2010; McKinzie et al. 2014; Teesdale et al., in press).

Statistical Analysis (Behavior): Daily activity space will be measured using 95% and 50% Kernel Utilization Distributions (KUDs) and biased random bridges determined from the active tracking data. KUD's are the probability of finding a fish within a determined area while biased random bridges provide measurements of space use around complex habitats. Both metrics reflect total daily area and home-ranges of individuals as well as provide insight into habitat selectivity if tracks are georeferenced with benthic habitat maps. To detect if stress results in significant behavioral differences the first 24 hrs post-release will be divided into 4 hr bins and mean space use and rate of movement (ROM) for each period will be compared between stressed and control fish using ANOVA. GLMs will be used to evaluate the effects of angling, handling, and holding duration on the first (binned) 24 hrs of activity (e.g. space use, ROM). Recovery rates will be analyzed using repeated-measure ANOVAs comparing space use and motion values from binned data of the first 24 hrs at liberty with corresponding periods on days 3 and 7 post-release.

References (10 points)-no limit

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McKinzie, M. K., Jarvis, E. T., Lowe, C. G. 2014. Fine-scale horizontal and vertical movement of barred sand bass, Paralabrax nebulifer, during spawning and non-spawning s easons. Fisheries Research 150. pp 66-75.

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Schreck, C. B., Moyle, P. B. 1990. Methods for fish biology. American Fisheries Society Bethesda, Maryland.

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Relation to COAST (15 points)-250 word maximum

The proposed study aligns well with COAST goals for enhancement of knowledge, solutions to coastal resource issues, and promoting public education and stewardship. This project will enhance our knowledge of gamefish physiology and behavior, as well as fill a critical gap in our understanding of how recreational fishing activity impacts economically and ecologically valuable fisheries. Catch and release is a commonly used harvest control strategy for marine species; however, few studies have investigated the, often significant, effects of these practices on targeted gamefish species. This study will aid resource managers in more efficiently managing complex fisheries by providing evidence and insight into the effects of the harvest control measures themselves on fish populations, as well as suggesting regulatory changes that promote the sustainability of exploited species. This study is also consistent with COAST goals of promoting ocean literacy and stewardship through the identification of best fishing practices and education of recreational fishermen on angling and handling methods that minimize their negative impacts on popular fisheries. Through collaboration with local anglers and commercial sportfishing vessels we will be enhancing angler buy-in of scientific research and by giving anglers the tools to reduce their impact we will be empowering generations of anglers as capable stewards of the resources important to them. Public education will also be accomplished through discussion of fisheries issues and research conclusions with local fishing and yacht clubs, student groups, and through other venues reaching both the fishing and non-fishing communities.

wBudget and Justification (15 points)

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
Cortisol EIA kits, 96 well-plate (Cayman Chem.)	$270.00	3		$810.00
V9AP acoustic Transmitter (Vemco Ltd, USA)	$650.00	1		$650.00
Assorted tackle (hooks, lures, bait etc)				$40.00
Living Expenses (2 months)			$1,000.00	
Tuition & Fees			$500.00	
		Subtotals:	*$1,500*	*$1,500*
		Grand Total	**$3,000**	

Justification (250 word maximum):
Each 96 well-plate in a commercially available cortisol EIA kit can run up to 45 individual samples (in duplicate) with standards. Therefore, the kits purchased here will process 135 different plasma samples and provide a solid preliminary assessment of whether kelp bass and barred sand bass exhibit a significant cortisol stress response. The purchase of 1 acoustic transmitter can be recovered and reused on multiple fish for the duration of the battery to determine the normal, unstressed behavioral of these species. A single transmitter may be sufficient to accomplish all the control behavioral assessments for kelp bass in the CIMLR. A variety of hooks, baits, lures, and fishing lines are required to catch all the individuals necessary for this study. The requested living expenses will cover the costs of a room at Wrigley Marine Institute on Catalina Island where the student will live over the summer months for proximity to the study site. Funds are requested to help allay the costs of tuition and fees at CSULB for the 2016 academic year.

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