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

Graduate Student Research Award Program
AY 2016-2017 Application Form
Application Deadline: Monday, October 24, 2016, 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:	Stephanie	Department or Degree Program:	Marine Science
Last Name:	Schneider	GPA in Major Courses (If first semester as a graduate student, please enter, "n/a, first semester".):	
Student ID#:		Matriculation date (mm/yy):	08/2014
CSU Campus:	Moss Landing Marine Laboratory (San Jose State University)	Anticipated graduation date (mm/yy):	12/2017
Email:		Degree Sought (e.g., MS, PhD):	MS
Phone		Thesis-based? (Y/N):	Y

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

Thesis Advisor Information

First Name:	Birgitte	Position/Title:	Assistant Professor
Last Name:	McDonald	Email:	gmcdonald@mlml.calstate.edu
CSU Campus:	Moss Landing Marine Laboratory (San Jose State University)	Phone:	(831) 771-4417
Department:	Marine Science		

Research Project Title:	Effects of behavioral flexibility on the reproductive performance of an apex predator, the Common Murre

Project Keywords (5-7 keywords related to your project):	Apex predator, behavioral flexibility, foraging ecology, Common Murre, reproduction, seabird, upwelling

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

Award amount directly to awardee:	3000
Award amount to Department:	0

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

Project Description (60 points)-1500 word maximum

Apex predators (organisms at the top of the food-web) must be able to cope with extreme variability of prey in upwelling ecosystems. I propose to assess the behavioral flexibility and magnitude of individual differences for an apex predator, the Common Murre (*Uria aalge*), across a spectrum of prey availability. Behavioral flexibility in chick-provisioning strategy will be linked to an individual's ability to feed and fledge young. This understanding is essential to assess the ability of apex predators to withstand natural and anthropogenic alterations of the marine environment (Schrimpf et al. 2012).

BACKGROUND: The most productive areas of the ocean are eastern boundary currents (e.g., California Current; US GLOBEC 1992). In these areas, biological activity is fueled by seasonal winds that cause deep, nutrient-rich water to upwell (Hickey 1998). Although upwelling areas are productive, variability in the strength and timing of seasonal winds cause order-of-magnitude differences in primary productivity (Hickey 1998). This variability permeates through the food web, resulting in dramatic fluctuations of prey available to apex predators (Ainley et al. 1996, Croll et al. 2005). Survival and reproduction requires that apex predators modify behavior to rapidly compensate (Harding et al. 2007, Boyd et al. 2006).

Traditionally, studies that identify behavioral mechanisms by which individuals compensate for a dynamic prey base rely on measures averaged across many individuals (Grémillet and Charmantier 2010). As such, these measures reflect population-level flexibility. While valid, natural selection occurs at the level of the individual, and populations that appear to be 'generalist' predators at the population level may in fact be a collection of individual-level trophic specialists that vary considerably in their prey base and foraging strategies (Kernaleguen et al. 2015). There is increasing evidence that dietary and behavioral specialization may be common, but the role of individual plasticity in diet and foraging strategy has not been investigated for a majority of apex predators (Grémillet and Charmantier 2010, Kernaleguen et al. 2015, Matich et al. 2011), including the Common Murre.

Common Murre are one of the most abundant non-migratory apex predators nesting in the northern hemisphere, with their breeding population conservatively estimated at 21 million individuals (Ainley et al. 2002). This species is ideal for assessing how individual-level plasticity mediates their ability to effectively respond to a dynamic prey base. Murres, like many seabirds, are conspicuous members of the marine community that predictably congregate at offshore islands to nest. As such, it is possible for colony-based studies to determine chick provisioning strategies, foraging effort, and reproductive success for many individuals in a population (Einoder 2009).

Murres are well-known for maintaining reproductive success even when prey are relatively scarce. At the population-level it is known that murres rely on behavioral flexibility to maintain reproductive success and chick-provisioning rates across a wide gradient in prey availability (Harding et al. 2007, Burger and Piatt 1990). Specifically, chick-rearing murres modify colony attendance to compensate for changes in prey availability; when prey are abundant murres spend a considerable amount of time at the colony and, as prey become

scarce, breeding individuals minimize time spent at the colony to increase time spent foraging. However, the degree of specialization of individuals, the maintenance of individual specialization across the breeding season, and the reproductive consequence of individual strategies remain unknown.

RESEARCH OBJECTIVES & QUESTIONS: I propose to investigate the behavioral flexibility of murres, in terms of individual variability in chick-provisioning strategies (foraging effort, chick diet, and chick energy ingestion), and its role in facilitating adequate provisioning of chicks across a spectrum of prey conditions (food-adequate vs. food-poor years). If individual variability exists, I plan to link individual strategies to the ability of murres to feed and fledge young. Under the direction of Dr. Richard T. Golightly (Humboldt State University) and Dr. Birgitte McDonald (Moss Landing Marine Laboratory) I have supervised colony-based monitoring of murres from 2010 to 2016 and have already archived videos necessary to conduct this research. I will investigate the following:
(1) Inter-individual flexibility: To what extent do different individuals specialize in chick-provisioning strategies?
(2) Intra-individual plasticity: Is individual specialization consistent across a breeding season or are individuals plastic in their daily response to prey conditions?
(3) Role of prey availability: How does the magnitude of inter- and intra-individual flexibility vary when prey are abundant relative to when they are scarce?
(4) Reproductive consequence of foraging strategy: Can distinct provisioning strategies be identified and, if so, what are the reproductive consequences of different strategies? Does the efficacy of a strategy vary as a function of prey availability?

METHODS At Castle Rock National Wildlife Refuge, one of the largest murre colonies in the California Current, a remotely-controlled video monitoring system was installed in 2006 (Golightly and Schneider 2016). I used these cameras to conduct surveys that will facilitate the assessment of chick-provisioning strategies, prey availability, and reproductive performance over a 6-year period (2010-2016). All videos needed to complete the proposed research have been digitally archived at Humboldt State University.

- **Inter- and intra-individual variation:** Time allocation surveys are essential to measure variability in chick-provisioning strategy. Between 3 and 30 time allocation surveys were conducted each year. For these surveys, the observer positioned the camera to maximize the number of chick-rearing murres visible in the field-of-view (13 to 26 pairs). Once positioned, the camera remained stationary from dawn to dusk to record all activities of chick-rearing pairs. Chick-provisioning strategies will be assessed by reviewing video and a mixed effect model will be used to identify individual effects.
- **Prey availability:** Direct measurement of prey available to seabirds is challenging and assumptions needed to define availability often lead to inaccurate assessments (Grémillet et al. 2004). For murres, the time that chick-rearing individuals spend at the colony is recognized to reliably indicate the availability of prey within flight distance of the colony (Smout et al. 2013, Harding et al. 2007, Burger and Piatt 1990). These colony-attendance patterns will be used to categorize prey conditions in each year as abundant, adequate, or insufficient. Inter- and intra-individual variation in chick-provisioning strategy will be compared for these different prey conditions using an ANOVA.
- **Reproductive consequence**: The reproductive success of chick-rearing pairs observed in time allocation surveys has already been determined by nest surveys where the contents of each nest (egg, chick, nothing) was observed every other day for the duration of the nesting season. This overlap enables individual provisioning strategies, if they exist, to be linked to differences in reproductive success using logistic regression.

SIGNIFICANCE: Behavioral flexibility in resource use at the level of the individual has ecological, evolutionary, and conservation implications. Ecologically, this study will enhance knowledge of the mechanisms by which apex predators maintain survival and reproduction even when prey become scarce. Evolutionarily, individual plasticity is relevant to assessing the capacity of organisms to adapt to a world increasingly altered by anthropogenic activity (Schrimpf et al. 2012, Harding et al. 2007). Because the marine system is so vast,

scientists and managers increasingly rely on population-level measures of apex predator reproduction and behavior to indicate changes in the broader marine system (Boyd et al. 2006, Piatt et al. 2007). Thus, awareness of individual flexibility (or lack thereof) would improve conservation and management decisions informed by apex predators (Schrimpf et al. 2012, Grémillet and Charmantier 2010, Piatt et al. 2007).

References-no limit

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Boyd, I.L., S. Waneless, and C.J. Camphuysen (Eds.). 2006. Top predators in marine ecosystems: their role in monitoring and ecosystem management. Cambridge University Press, New York, NY.

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Timeline (10 points)-250 word maximum

The proposed research is already underway. All surveys and video recordings required to complete the proposed research have been permanently archived at Humboldt State University. The remaining workload includes video review, data analysis, and communication of findings. These tasks should be accomplished by the end of the Fall 2017. During Fall 2016, I will finish video review and prepare the data for statistical analyses. During Winter 2016 and Spring 2017, data will be analyzed and interpreted. The initial findings will be presented at the 44th annual Pacific Seabird Group meeting in February 2017. Also during Spring 2017, I will begin writing my thesis and related publications. In Fall 2017, my thesis will be finalized and I will graduate. Concurrently, I will submit related publications to an appropriate journal for review.

Relation to COAST (15 points)-300 word maximum

In accordance with COASTS goals, the proposed research will advance knowledge of a large segment of California's nesting seabird population. Castle Rock is one of the largest seabird colonies in California, and is one of five islands that supports greater than 100,000 nesting seabirds south of Alaska (Manuwal et al. 2001). Importantly, this island is geographically isolated from other well-studied colonies. Thus, generalizing about the processes affecting seabird reproduction, foraging effort, and diet at these distant locations to Castle Rock may lead to an inaccurate assessment of the health California's seabird populations. Data obtained from the proposed study, although intended to answer specific questions about behavioral flexibility at the level of the individual, will add to a comprehensive baseline understanding of murre reproduction, behavior, and diet that accurately represents conditions experienced by seabirds nesting between the Farallon Islands (central California) and Yaquina Head (central Oregon).

COAST also strives to develop innovative solutions to the ecological challenges. One ecological challenge is that it is often impossible to make detailed observations of seabird reproduction and diet because many colonies, including Castle Rock, are (1) too distant from shore, (2) unsuitable for boat-based surveys due to typically rough seas, and (3) are threatened by human presence, which causes nest failure and habitat degradation. Research associated with this study is conducted using cameras that can be remotely-operated from the mainland and are capable of real-time panoramic scanning, tilting, zooming, and auto-focusing (Golightly and Schneider 2016). Without this innovative approach, seabird research at Castle Rock would not be possible.

Finally, the proposed research promotes environmental literacy and fosters stewardship of California's unique seabird community by encouraging everyone to watch live video of Castle Rock, broadcast online for the entire seabird breeding season (April-August) at http://www2.humboldt.edu/castlerockseabirds/ since 2006.

Budget 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**
Fees associated with enrollment at SJSU (2 semesters)	$974.50	2	$1949	$0
Living expenses	-	-	$1051	$0
Subtotals:			*$3000*	*$0*
		Grand Total	**$3,000**	

Justification (250 word maximum):
A graduate research award that recognizes the academic merit of my thesis and provides financial assistance would allow me to maximize the time and energy I can dedicate to my thesis and development as a marine scientist. I have no financial support for my graduate education other than my personal savings, and I must work multiple jobs to support myself while I attend graduate school. I currently work 4 different positions: (1) I am paid by a Marine Life Protection Act grant to aid in the censuses of seabirds at breeding colonies in northern California, (2) I assist the Humboldt Bay National Wildlife Refuge with seabird research at Castle Rock, (3) I am an on-call biologist for H.T. Harvey & Associates, and (4) I assist with the Marine Mammal Stranding Network as needed. My financial aid package includes a State University Grant, however this only covers tuition. Fees associated with enrollment are almost $1000 per semester and this award would ensure that I can pay these fees for Spring and Fall 2017. The remainder of the graduate research award from COAST would assist with living expenses. At my current pay-rate ($15/hour), a $1051 contribution is roughly equivalent 70 hours of work. Finally, these funds will make it possible for me to present the proposed research at the 2017 Pacific Seabird Group Conference by assisting with registration fees and travel to Tacoma, WA.

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