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:	Alyssa	Department or Degree Program:	Biological Sciences
Last Name:	Clevenstine	GPA in Major Courses (If first semester as a graduate student, please enter, "n/a, first semester".):	
Student ID#:		Matriculation date (mm/yy):	08/16
CSU Campus:	Long Beach	Anticipated graduation date (mm/yy):	12/18
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:	

Thesis Advisor Information

First Name:	Chris	Position/Title:	Faculty
Last Name:	Lowe	Email:	chris.lowe@csulb.edu
CSU Campus:	Long Beach	Phone:	(562) 985-4918
Department:	Biological Sciences		

Research Project Title: Movement patterns and site fidelity of giant sea bass (Stereolepis gigas) on Santa Catalina Island, California

Project Keywords (5-7 keywords related to your project): Giant sea bass, telemetry, movement, site fidelity

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

Award amount directly to awardee: 1050

Award amount to Department: 1950

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

Background & Significance

Understanding fish movement allows insight into the ecological functions of fish in marine ecosystems. Numerous factors affect movement, such as the search for increased food resources, more suitable habitat conditions, and the search for breeding grounds to improve fertilization success (Molloy et al., 2012). For example, environmental cues like lunar phase, tidal phase, and season signify spawning periods for many species of grouper in the eastern and southern Pacific (Colin, 2012; Salinas-de-Leon et al., 2015). These factors signal many species of fish, particularly large carnivorous fish, to move purposefully and form aggregations (Bolden, 2000; Sala et al., 2003; Whaylen et al., 2004; Semmens et al., 2010; Erisman et al., 2012; Salinas-de-Leon et al., 2015). Of the multiple factors leading some fish to aggregate, breeding and spawning aggregations represent one of the most critical and vulnerable processes to the success of a population and species. These reproductive opportunities may be limited in space and time and provide a platform for data collection on important life history traits. Aggregating fishes tend to be heavily fished because they are more desirable as food and are easy to target in mass (Sala et al., 2003; Hamilton, 2005). Giant sea bass (*Stereolepis gigas*) are a prime example of a species that was assumed to aggregate for spawning purposes and targeted by anglers throughout California and Mexico in the early 20th century. Historically, landings of *S. gigas* occurred during the summer months (May through September) and included multiple individuals, indicating the possibility spawning aggregations. Due to the consistency of these suspected aggregation events, the population in Southern California was locally fished to extinction during the mid-1900s (Allen and Andrews, 2012). Allen and Andrews (2012) estimated the minimum lifespan of giant sea bass (GSB) to be over 50 years and the age at maturation 11-13 yrs, making the species particularly susceptible to overfishing. With a maximum length over 2 m and weight exceeding 200 kg, paired with a curious nature and little fear of humans, it is easy to see why such GSB were historically exploited by anglers. This is evidenced by a decline in commercial landings in California from 115 mt in 1932 to only 5 mt in 1980, while over the same time period in Mexico tonnage dropped from 363 mt to just 12 mt (Domeier, 2001). However, anecdotal evidence from the dive and fishing communities report an increase in sightings and catch of GSB in recent years, suggesting the species may be recovering south of Point Conception.

To better answer the question of whether or not GSB are returning, innovative technologies should be utilized to understand how species of ecological and economic importance use the marine and coastal resources of California. One such technology is acoustic telemetry, a tool used to quantify temporal (i.e. diel, lunar, tidal) and spatial rhythmicity of species to provide high quality, three dimensional spatial resolution of fish movement (Payne et al., 2010). By examining the frequency of detections of tagged organisms, passive monitoring can be used to determine movement patterns in relation to space use, home range size, and site fidelity (Lowe and Bray, 2006). Since the drastic reduction in the population of GSB, scientists and managers have little information on where the species moves and when they aggregate in coastal waters, a question that can be addressed using acoustic telemetry over an annual scale. By tagging individual GSB and semi-permanently mooring receivers in areas where GSB have been seen in mass, the question of if, where, and when aggregations occur can be answered.

My research will use acoustic telemetry to determine whether purported aggregation sites are being utilized by GSB and, if so, the temporal and spatial scale of use. To do so, I will tag individuals to quantify aggregation sites of GSB around Santa Catalina Island and quantify movement patterns among GSB relative to aggregation sites and season.

Specific Aims

1. Quantify aggregation sites of giant sea bass around Santa Catalina Island.
    - H_1: Giant sea bass will aggregate at specific study sites.
    - $H_{1.1}$: Giant sea bass will aggregate seasonally at study sites.
2. Quantify movement patterns among giant sea bass relative to aggregation sites and season.
    - H_1: Giant sea bass will show site fidelity to aggregation sites.
    - $H_{1.1}$: Giant sea bass will show seasonal site fidelity to aggregation sites.

Methods

For large, mobile species like GSB, passive monitoring is the best choice for telemetry due to their perceived diel movement patterns and large depth range (Cornish, 2004). Although this type of acoustic monitoring can only provide presence-absence data, establishing a receiver pattern with overlapping detection ranges can provide information on space use and long-term movement patterns (Heupel et al., 2006). Based on evidence of potential spawning aggregations around Santa Catalina (Catalina) and La Jolla, California (Erisman, pers. comm.), I will consider a group of 5 or more GSB within a 50 m transect to be an aggregation. Once data are collected, I will be able to provide dive survey evidence that supports or disproves this metric. Based on these data, I chose three sites around Catalina that meet the criteria of aggregation sites and seven adjacent "corridor" sites that do not. GSB aggregation sites have been identified at the V's, Little Farnsworth, and Goat Harbor (House et al., 2016). Corridor sites were chosen based on diver observation of small numbers (less than 5) of GSB at Church Rock, Seal Rocks, Casino Point, Long Point, Italian Gardens, Empire Landing, and Isthmus Reef. Omnidirectional acoustic receivers (VR2W, Vemco Ltd.) will be deployed at all sites to passively monitor fish movement. Three receivers will be deployed at each aggregation site to more accurately estimate individual fish location within the receiver array while a single receiver will be deployed at each adjacent areas thought not be aggregation sites. These single receivers will also provide insight into movement of GSB on a diel, temporal, and seasonal scale. This will enable us to determine if and for how long individuals remain at each site and whether individuals move between aggregation sites. Aggregation site receivers will be positioned about 400 m apart in a triangle such that their detection ranges overlap and all receivers will be suspended approximately 2-3 m off the seafloor. Dive surveys will be conducted every three months along the coast of Catalina at every site to observe the number of individuals per site temporally and download receiver data.

Acoustic transmitters can be internally, surgically implanted into animals or may be attached externally (Holland et al., 1996; Holland et al., 1999; Meyer et al., 2000). To choose the best option, fish size, catchability, handling stress, and transmitter attachment success must be taken into account

Since GSB are curious and show little fear of divers, the animals will be approached on scuba and darted in the dorsal musculature using a modified handheld pull spear. A single externally darted acoustic transmitter will be applied to 40 individuals to assess long-term movements. This tagging method is needed to assess: degree of site attachment to suspected aggregation sites, potential for moving between aggregation sites, and periodicity of movements among sites. GSB will be tagged with Vemco V13 coded acoustic transmitters operating at 69kHz with a lifespan of approximately three years. Transmitters will be treated with antifouling coating to prevent growth of biofouling organisms that can attenuate the output of the transmitter and increase drag. Transmitters are 48 mm long and 13 mm in diameter and will be attached to a short 14 cm long tether with a stainless-steel anchor dart. Video will be taken of each fish tagged and a size will be estimated by holding the pole spear (of known size) in frame.

Transmission delay, detection period, detection rate, and group detection rate must be known to accurately quantify how many fish are utilizing a space at a given time. Using Vemco's coded pinger detection simulator, these factors were calculated and averaged to determine the detection probability based on number of tagged individuals (transmitters) within the detection range of a single receiver. Movement and degree of site attachment of tagged fishes will be measured by calculating evenness of detections among receivers for each tagged individual and compared using a diversity index of space use adapted from Pielou's evenness index to determine site attachment. The same comparison will be used to determine attachment across seasons, which will be measured by quantifying the number of tagged fish that return relative to season during a year-long study. Site fidelity, the return of animals to the same location for some biological purpose, will be measured as the proportion of days tagged individuals are present at a site (at least two detections within a 24 hr period) and compared using mean squared displacement, calculated as the mean displacement from each position of a fish's movement path to its center of activity (determined by geometric mean) and linearity index, calculated as the linear distance between movement endpoints divided by the total distance traveled.

References-no limit

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Timeline (10 points)-250 word maximum

February 1-14, 2017 – Eight trips to Catalina Island to deploy 13 receivers and tag 10 giant sea bass.
May 1, 2017 – Day trip to download receivers and tag 10 GSB.
August 1, 2017 – Day trip to download receivers and tag 20 GSB during height of suspected spawning season.
November 1, 2017 – Day trip to download and clean receivers.
February 1, 2018 - Day trip to download and clean receivers.
May 1, 2018 - Day trip to download and clean receivers.

Relation to COAST (15 points)-300 word maximum

This project will directly benefit COAST goals and missions by supporting research related to the California coast, advancing our knowledge of coastal and marine resources, using innovative technology to answer ecological challenges, and promoting environmental literacy and sustainable use of California's coast. GSB are the largest teleost and mega-carnivore in kelp forest and rocky reef communities, maintaining the balance of the food web and health of the coast. Despite a moratorium on fishing for GSB, incidental take and sale of two individuals on commercial vessels is still legal in California and provides an economic gain to those who land them. Beyond the market value of a dead fish, GSB are charismatic megafauna and a prized sight by divers, underwater photographers, and recreational anglers alike. GSB have been negatively impacted by humans over the last 80 years which may have caused their behaviors, particularly aggregating and spawning, to change. If GSB do, in fact, form aggregations it may mean additional protection is required to help maintain the kelp forest community and promote sustainable fisheries in California. If numbers are increasing, more people are likely to encounter this species, requiring research and education to reduce potential negative interactions. Results of this study can lead to the alteration of management strategies to protect GSB from fishing in specific areas. With the support of COAST I will use applied research techniques and innovative technology to fill in the gaps in life history to advance our knowledge of this valuable resource as it recovers from human influence.

Budget and Justification (15 points)

Item/Description	Unit Price	Quantity	Amount to Awardee (via Financial Aid)	Amount to Department
Fuel for small vessel trips to Catalina	$150.00/trip	13	-	$1950.00
Tuition	-	-	$1050.00	
		Subtotals:	*$1050.00*	*$1950.00*
		Grand Total	**$3,000.00**	

Justification (250 word maximum):

AltaSea has generously provided the telemetry tools necessary for my project, which I will be conducting around Santa Catalina Island. In order to make the initial 8 trips to deploy receivers and tag giant sea bass, along with 5 subsequent trips to Catalina to download receiver data, I will need fuel to make each trip from February 2017 through February 2018. As a graduate student, I spend the majority of my time at school as a student, teaching associate, and graduate assistant. Although this provides me with enough income to pay for most of my living expenses, the cost of tuition every year puts a huge stress on finances prior to each semester. As such, the requested tuition funds will relieve some of the financial burden by covering half the cost of one semester of tuition as a graduate student at CSULB during the 2017 school year.

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