CSU 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:	Kaylee	Department or Degree Program:	Biology/Ecology
Last Name:	Griffith	GPA in Major Courses (If first semester as a graduate student, please enter, “n/a, first semester”.):	
Student ID#:		Matriculation date (mm/yy):	08/15
CSU Campus:	San Diego State University	Anticipated graduation date (mm/yy):	06/18
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:	N/A

Thesis Advisor Information

First Name:	Kevin	Position/Title:	Professor
Last Name:	Hovel	Email:	khovel@mail.sdsu.edu
CSU Campus:	San Diego State University	Phone:	
Department:	Biology		

Research Project Title:	Effects of habitat edge type on eelgrass community structure and relative survival

Project Keywords (5-7 keywords related to your project):	Seagrass, foundation species, seascape ecology, edge effects, ecosystem function, habitat heterogeneity, Crassostrea gigas

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

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

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

Patch edges, formed by the interface of adjacent habitats, are a common feature of landscapes and seascapes. Within a habitat type, proximity to edges influences a variety of ecological processes, including predator-prey interactions and recruitment within the seascape [1-3]. As a result, edges may contain high organismal densities due to enhanced resource availability, reduced competition, or access to resources within two habitat types [1-2]. However, predation risk is often elevated at edges because of high predator visitation or reduced refuge value of edge habitat structure [3]. Therefore, for some organisms, living in edge habitats is a tradeoff between increased resource availability and predation risk.

Habitat patches exist within seascapes, which are heterogeneous mosaics of patches in which processes occurring in one patch can influence those occurring in neighboring ones. Global decline of key foundation species, such as seagrasses, and increasing establishment of invasive habitat-forming species [4-5] highlights a need to better understand how adjacent habitats affect edge processes, such as biodiversity and predation risk. Seagrass and other foundation species provide critical ecosystem services, such as habitat provision that promotes biodiversity. Highly biodiverse systems tend to have greater functional diversity and enhanced overall ecosystem function [6], and predation can influence the impact of epiphytic algae on seagrass [7]. Though seagrass habitat typically is patchy, many questions remain about how proximity to seagrass edges affects ecological processes that dictate the value of this foundation species. In particular, studies that have examined edge effects in seagrass seascapes primarily address soft sediment edges (i.e., seagrass – unvegetated sediment edges) and few have considered the effect of adjacent biogenic or structured habitats [but see 8]. Broadly, without considering a mosaic of complex habitats, edge effects found thus far might only apply to vegetated-non-vegetated situations, and it is unclear how an edge with two structurally complex habitats would affect epifaunal and predator assemblages and resulting predation risks.

Eelgrass (*Zostera marina*) is the dominant subtidal foundation species in temperate soft-bottomed estuaries. While eelgrass is typically surrounded by unvegetated mud and sand, creating ‘simple’ edges, it can be bordered by more ‘complex’ edges such as salt marshes, rocky reefs, or in some locations, bivalve reefs. San Diego estuaries have a large amount of rip-rap and thus available substrate for settlement of non-native bivalves such as the Pacific oyster *Crassostrea gigas*, an invader that can rapidly expand hard substrates [9-10]. Both eelgrass beds and hard structure such as bivalves and rock are architecturally complex and thus provide refuge and foraging opportunities for epifauna and predators. Despite the prevalence of rocky substrate adjacent to eelgrass beds, the influence of adjacent hard structure on edge communities is relatively unexplored. The type of edge can alter eelgrass community structure and relative predation rates in edge communities, suggesting variability in community functions [6-7]. To determine if adjacent habitat type modifies edge processes, I will compare eelgrass community structure and predation rates at the interface with a complex habitat (rock and bivalves), the interior, and the interface with unvegetated mud and sand.

Research Questions and Hypotheses

Q1: Does adjacent complex habitat influence biodiversity and community assemblage in eelgrass

beds?
H1: Epifaunal biodiversity will be greater in rocky edges (hereafter complex edges) than unvegetated mud and sand edges (hereafter simple edges) because of increased structure, but diversity at interiors of eelgrass beds will not be affected by complex edges since effects of the adjacent habitat are manifested only at patch edges.

Q2: Does edge type affect predation risk for eelgrass epifauna?
H2: Survivorship of epifauna will be lower at complex edges than simple edges or eelgrass interior because only increased edge structure will increase predators foraging.

Experiments and Analyses

1. Edge types: Community Assemblages

To assess how rocky complex habitat influences eelgrass edge communities and predation risk, I will manipulate structure at four sites around San Diego Bay and Mission Bay. I will add broken cinderblock (and *C. gigas* shell if available) for 3x 0.25 m along the shallow edge (MLLW) of four eelgrass beds. The 3 m of eelgrass will be sampled before manipulation and a 3 m length of the same bed 10 m away will remain unmanipulated and serve as a control. These sites will be sampled every three months for both epifaunal community and environmental changes. I will quantify epifauna, predators, and habitat at the complex/shallow edge, interior, and simple/deep (3 m) edge of both experimental and control areas.

Epifaunal collections will be taken at high tide with a circular throw-trap and SCUBA diver-operated suction sampler, following methodology from Reed and Hovel 2006. Epifauna will be stored in ethanol until later sorting into lowest taxonomic resolution and feeding guild. To assess the predator community (fishes and decapods), I will use visual surveys, since a seine net is not easily dragged over rocky substrate.

In each zone, I will run a transect parallel to the edge of the bed and take five randomly placed eelgrass cores (20 cm diameter x 15 cm depth) to record substrate type; eelgrass shoot density, mean length, biomass, and epiphyte biomass (dry weight); and belowground biomass (dry weight) [12]. Epiphyte biomass will be estimated by gently scraping the shoot with a microscope slide, dried at 60^{o}C for 48 hours, and weighed dry.

Since both rocky and eelgrass habitats can attenuate currents and increase sediment deposition, abiotic attributes (temperature, salinity, and sediment characteristics) will also be recorded. Sediment characteristics (organic matter and silt:sand ratio) will be assessed from surface sediment cores (1.5 cm diameter, <5 cm deep). Sediment organic content is determined by ash free dry weight: samples are dried to a constant mass, weighed, ashed in a muffle furnace, and weighed again. Sieving of wet samples at 63 µm will generate a silt:sand ratio, which could indicate changes in sediment attenuation by both foundation species [13].

Anticipated Analyses

I will calculate abundance, species richness, and Shannon-Wiener diversity on the epifaunal and predator communties. R statistical software will be used to run general linear models with post-hoc comparisons. These models will determine if variation in faunal abundance, richness, or diversity is due to habitat type (complex or simple edge and interior), abiotic characteristics, site, or sampling period. Covariates such as shoot density will be considered.

Compositional differences will be compared using functions of PRIMER v6 software. A non-metric multi-dimentional scaling plot (nMDS) will be used to visualize community differences, a permutational multivariate analysis of variance (PERMANOVA) will test for community composition differences, and (SIMPER) will be used to identify taxa driving differences if they exist. [14].

2. Edge types: Predation Risk

I will tether prey to assess how distance from edges and edge type influence relative predation rates in eelgrass, and relate results to previous studies on ecosystem function. While tethering does not produce actual survival rates of prey, it does generate a reliable relative measure [3]. I will deploy tethers of two prey species 24 hours before each sampling period and retrieval. I will use a common eelgrass primary consumer (grass shrimp, *Hippolyte californiensis*) and a mesopredator (swimming crab, *Portunus xantusii*). Epiphytic algae on eelgrass is controlled by meiofaunal grazers, and by using these organisms we will be able to suggest if edge type influences top-down maintenance of eelgrass [7]. Prey will be glued to 10 cm lengths of monofilament fishing line and affixed to a clear acrylic rod. To capture localized edge effects, tethers will be placed in soft sediment on SCUBA at 0 m (edge itself), 0.25, 0.5, 1, and 2.5 m from the edge [3]. Prey will be scored as alive or eaten. The density of eelgrass 20 cm around the tether will be quantified using the 20 cm cores (described above) after tether collection to assess structure that may have served as refuge for the tethered prey. These data will be analyzed with logistic regression.

Novelty and Significance of Proposed Work

As a foundation species, eelgrass supports a diverse community and rich trophic structure that performs many ecosystem services and benefits both natural and human communities. Eelgrass is an essential habitat for many estuary species, including juveniles of California's recreational and commercial fisheries, so there is a pressing economic need to better understand ecological processes [15]. Since many estuaries are natural harbors, heavy human use has highly impacted these communities through habitat degradation and fragmentation, making them more vulnerable to species introductions [4]. Invasive foundation species such as bivalves can form novel habitats and impact native foundation species directly [5, 13], but may also influence processes in adjacent habitats by modifying edge community biomass and biodiversity, and indirectly affect ecosystem functions [10]. The influence of adjacent habitats and edge type are rarely studied in eelgrass systems or seascape ecology [but see 3, 8], so such situations should be capitalized on. In southern California, recent establishment of the Pacific oyster *Crassostrea gigas* has begun to create novel complex habitat on intertidal rip-rap. Although *C. gigas* has not yet formed expansive reefs [9], investigating the influence of adjacent complex habitat now may suggest how the projected spread of these habitat-forming bivalves might affect eelgrass communities.

References-no limit

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Timeline (10 points)-250 word maximum

March 2017: Complex edge deployment and baseline sampling and tethering
December 2017: Final sampling and tethering
January- August 2018: Analyze data, write thesis
August 2018: Defend and graduate

Relation to COAST (15 points)-300 word maximum

Eelgrass is a key foundation species throughout California, but it is also heavily impacted by anthropogenic activities, such as degradation, fragmentation, and colonization by invasive species [4-5]. Habitat engineers such as Pacific oysters have rapidly colonized San Diego estuaries, and as waters warm, these invaders may spread north, creating more hard edges in other eelgrass beds [9-10]. While this study does not consider the biotic effects of oysters, such as filtration and nutrient deposition, it does simulate novel, architecturally complex substrate in soft-bottomed estuaries. Better understanding of how adjacent hard habitats influence biodiversity and ecological processes in eelgrass edges will inform conservation and restoration efforts that are currently taking place throughout California.

As a member of San Diego State University's (SDSU) Marine Ecology and Biology Student Association (MEBSA), I participate in outreach in local schools, science-themed events, and with science educators to connect researchers to underserved communities in San Diego. For example, I have brought organisms into classrooms, led beach seines in local eelgrass beds, and helped with a long-term settlement tile project. Through these activities, I encourage students to utilize natural history and observation in their everyday lives and be responsible for our natural resources. I will incorporate my research questions into new activities, such as a game mocking transect sampling techniques. San Diego encompasses people from a large breadth of socioeconomic and ethnic backgrounds, and even a small educational effort has the potential to cascade into local communities and augment grassroots guardianship of the coast.

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**
Gas to/from field sites	$3.50/gallon	28.5	$100	-
Cinderblocks	$0.95	50	$50	-
Campus fees	$806/semester	2	$1612	-
Living expenses	-	-	$1238	-
		Grand Total	**$3,000.00**	

Justification (250 word maximum):

My primary expenses are gas to and from field sites, cinderblocks to build plots, and for living expenses and tuition. My lab already owns most of the materials needed for sampling and tethering, such as corers, suction sampler and mesh bags, sieves, scintillation jars, acrylic rods, and monofilament line. Complex habitat will be built with broken cinderblocks, which are inexpensive. If Pacific oyster shell is available, I will add pile some on top of the cinderblocks. Since I have not yet found a source for shell, I have not emphasized this in the proposal. Based on restoration reports in San Francisco, the estimated cost is $20/m2, and I would need at least 3 m2 (4 sites*0.75 m2 plots = 3 m2), totaling to $60.

I work as a teaching associate (TA) at SDSU, and have found it to be an exceptional opportunity to practice creating and giving lectures and mentor undergraduates, but I need supplemental income to cover living expenses, tuition, and fees. I hope to receive the Cal grant to cover tuition ($1953.00/semester). However, I spend 70% of my TA income on rent, so any financial assistance from grants is extremely helpful to cover other living expenses, such as utilities, groceries, and travel expenses.

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