False Bay Seagrass Research

Summer 2016 Report

Table of Contents

Plant demographics and environmental influence on seagrass wasting disease in *Z. marina* *2*

Fish diversity and predation within and near *Zostera marina* beds *15*

Invertebrate and algae biodiversity in *Zostera marina* beds *21*

False Bay Seagrass Report—Part I

Plant demographics and environment influence on

seagrass wasting disease in *Zostera marina*

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Summer 2016

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Keywords: Eelgrass, *Zostera marina*, seagrass wasting disease, *Labyrinthula zosterae*, marine diseases

Abstract

Eelgrass (*Zostera marina*) is a key marine foundation species that creates essential habitats for economically valuable fish and invertebrates worldwide. *Labyrinthula zosterae*, a marine slime mold and causative agent of seagrass wasting disease, is among the modern threats to eelgrass. To determine how disease patterns vary across environmental gradients, we collected eelgrass blades on replicate transects from three sites across and adjacent to the University of Washington False Bay Preserve. We measured characteristic *L. zosterae* lesions on each blade for disease prevalence and severity. Intertidal wasting disease prevalence near the kanaka Bay edge was higher compared to subtidal wasting disease. Of the three subtidal sites, wasting disease was highest at the pocket bay site farthest from Kanaka Bay. Pocket Bay had the highest disease prevalence with 37.7% of subtidal eelgrass infected, followed by Middle and Kanaka Bay with 26.6% and 14.4% prevalence. We also found statistically significant effects of eelgrass blade length and site on disease prevalence. Across all sites, subtidal prevalence ranged from approximately 10-53%. Seagrass wasting disease has important implications on the sustained health of eelgrass beds. However, the drivers of disease are no fully understood and merit further research. This study highlights the need for more marine epidemiological studies to determine which abiotic and biotic factors allow *L. zosterae* to persist in certain environments.

Introduction

Eelgrass (*Zostera marina*) is a marine angiosperm found in temperate coastal waters worldwide.[1] A valuable component of estuarine and marine ecosystems, eelgrass provides many important ecological and economic services, creating safe habitats for fish and invertebrates and serving as a critical food source for waterfowl.[2-5] Furthermore, eelgrass beds assist with sediment stabilization, nutrient filtration, and are key sources of primary production and carbon sequestration.[1]

The marine slime mold *Labyrinthula zosterae* is an opportunistic pathogen that infects eelgrass and is the causative agent of seagrass wasting disease.[6-8] Seagrass wasting disease outbreaks in the 1930s and ‘40s decimated eelgrass beds worldwide, leading to dramatic shifts in community structures and functions within these habitats.[5-6,8] Seagrass beds along the Atlantic coast of the United States and Europe received the brunt of the epidemic, although documented cases of wasting disease ranged from Nanaimo, British Columbia to San Diego, CA.[2,9-10] Subsequent smaller epidemics occurred during the 1980s primarily along the Atlantic Coast of

the U.S.[7] The eelgrass beds in the San Juan Islands, WA were not immune to wasting disease, and experienced small-scale epidemics, first in the 1980s and later throughout the 1990s and early 2000s.[7,11-12] Recent studies indicate that seagrass wasting disease persists throughout the archipelago,[12-14] although the cause of disease outbreaks remains unclear. Because eelgrass is critical marine habitat, eelgrass research and conservation is a top federal and state priority.[15-16]

While most wasting disease research focuses on monitoring intertidal eelgrass beds—those that are completely exposed at low tide—subtidal eelgrass beds that remain constantly submerged merit further research. Subtidal eelgrass beds are challenging to sample because they require scuba divers or underwater videography for surveys and collections.[17] While these methods can be used to estimate subtidal eelgrass area, to the best of our knowledge, they have not previously been used to examine subtidal wasting disease.

To determine if seagrass wasting disease varied across environmental gradients, we conducted field surveys of intertidal and subtidal eelgrass beds from four sites in the San Juan Islands, WA (Figure 1). We then measured and compared disease prevalence—the proportion of *Z. marina* with lesions—and the severity—the proportion of *Z. marina* covered with necrotic tissue. Because intertidal eelgrass beds are under considerably more environmental stress (eg, large and rapid fluctuations in temperature, desiccation) than subtidal eelgrass populations that are constantly submerged, we predicted that subtidal eelgrass beds would be more resistant to infection and would have lower levels of wasting disease. Furthermore, since warmer temperatures favor the growth of the slime mold *L. zosterae*, we expected eelgrass in warmer, shallower waters to have higher incidences of wasting disease.

Methods and Materials

Eelgrass Field Collections

We collected subtidal eelgrass from Kanaka Bay, Middle False Bay, Pocket Bay (San Juan Island). We conducted paired intertidal and subtidal surveys at Kanaka Bay. We selected these sites from other long term monitoring sites that historically had documented eelgrass beds.[12,18-19] We conducted subtidal surveys from July 26-29, 2016 and intertidal surveys on July 31-August 1, 2016.

We gathered subtidal *Z. marina* blades from evenly-spaced quadrats along submerged transects that ran parallel to shore. At each site, we used one 40-m. transect consisting of three 10 m. sub-transects spaced 5 m apart. We recorded the depth of the transect every 5 m. and averaged them. Within each 10 m. transect, we randomly collected 30 *Z. marina* shoots, taking care to keep the stems and blades intact, and stored them in mesh bags for transport to the laboratory (n=360 subtidal).

To collect intertidal samples, we used three 60 m. transects at approximately -1, -1.5 and -2 ft depths relative to mean low low water (MLLW). Along each transect, we randomly collected 30 *Z. marina* blades (n=180 intertidal blades). Once in lab, we stored the blades in flow-through seawater tables exposed to ambient light. We measured all samples within 5 hours of collection time.

Laboratory Analyses

For disease measurements, we selected the second-oldest blade from each shoot, as is consistent with other studies that measured seagrass wasting disease.[12,19] Because the longest blades are often torn off and younger, smaller blades may not be infected with *L. zosterae*, the second-oldest blades serve as reliable indicators of disease. We identified the second-oldest blade from each shoot by selecting second highest blade from the sheath.

Since we collected entire shoots for subtidal samples, we measured canopy height as the length of the longest shoot from blade tip to the start of the rhizome. We measured canopy height for intertidal blades from ten randomly selected eelgrass shoots every 10 meters and averaged their length. We measured the density of eelgrass blades within a 1 m^2 quadrat every 5 meters for subtidal transects and every 10 m for intertidal transects. For each blade, we measured the length and width of each blade and the length and width of all lesions.

We visually identified *L. zosterae* lesions per established protocol.[12] We only measured spots with clear, dark outlines and lighter interiors, and did not measure lesions near torn or damaged tissue, except those with clear *L. zosterae* borders (Figure 2). Likewise, we did not include sun spots, bleached tissue, or spots less than 1x1 mm in our measurements. From these measurements, we calculated the disease prevalence and severity across all sites. We performed generalized linear mixed effects regressions (GLMER) and linear mixed effects regressions (LMER) in R to determine significant effects and interactions between the different factors (site, tidal regime, depth, average density, blade length, canopy height).

Results

Our data indicated significant statistical differences in disease prevalence between the three subtidal eelgrass beds in False Bay, as indicated by a one-way ANOVA ($F(2, 266)=6.55$,

p=0.00167). Pocket Bay had the highest disease prevalence with 37.7% of subtidal eelgrass infected, followed by Middle and Kanaka Bay with 26.6% and 14.4% prevalence, respectively (Figure 3). When comparing intertidal and subtidal samples from Kanaka Bay and Indian Cove on Shaw Island, there were statistically significant effects of blade length and site on disease prevalence (p=0.000761, $p=8.21*10^{-9}$). There was a slightly significant effect of tidal regime on disease prevalence as well (p=0.0539). Across all subtidal samples at the four sites, there was a statistically significant effect of blade length on disease prevalence ($p=4.115*10^{-5}$, Figure 4). There were no statistically significant effects of factors on disease severity for intertidal and subtidal blades from Kanaka Bay and Indian Cove.

Discussion

Of the three eelgrass beds surveyed in False Bay, Pocket Bay had the highest disease prevalence. Further work could explore environmental differences (for example, water temperature, turbidity, salinity) and potential drivers of elevated disease levels. When comparing disease prevalence between sites, there were significant statistical differences between the False Bay sites and Indian Cove. Interestingly, the sites that appear to be most insular and protected — Indian Cove and Pocket Bay—had the highest measured disease prevalence, whereas those that were more exposed to tidal flushing had lower levels of disease prevalence and severity (Figure 1, 3). This suggests that variable geomorphology of the eelgrass beds may create conditions favorable to *L. zosterae.* We found intertidal disease prevalence to be higher than subtidal prevalence at Kanaka Bay. The significant variation in disease prevalence between sites highlights some areas of the San Juan Islands that may need priority in eelgrass conservation.

The results also indicate that blade length influenced subtidal wasting disease prevalence, with longer blades having generally greater disease prevalence than shorter blades (Figure 4). This is consistent with previous research on population demographics of infected *Z. marina* in the San Juan Islands, which found longer blades had higher disease prevalence than shorter blades.[12,19]

There were no statistically significant differences between group means of severity among subtidal, False Bay sites as determined by one-way ANOVA ($(F\ 2, 267) = 2.80$, $p = 0.06$). However, there were higher levels of severity measured in intertidal *Z. marina* compared to subtidal samples, as anticipated (Figure 3). This could be attributed to more favorable conditions for *L. zosterae* in the intertidal or conditions that stress *Z. marina* and make it more susceptible to infection. Further studies examining the environmental conditions and disease prevalence and severity among intertidal and subtidal beds will help determine drivers of eelgrass wasting disease.

Understanding *Z. marina* population declines is important for predicting and mitigating seagrass wasting disease, since disease outbreaks can result in significant shifts in community structure and can significantly alter ecosystem services. Seagrass beds serve as "biological sentinels," and can provide key information about environmental conditions through changes in their abundance and health.[1,3] Continued research will help ascertain which environmental factors influence disease prevalence and severity between intertidal and subtidal *Z. marina*.

This study is an important contribution to seagrass wasting disease research because it serves as a pilot study in quantifying wasting disease prevalence and severity in subtidal eelgrass beds, and because it bridges intertidal and subtidal eelgrass ecology, which typically are examined as separate systems. More broadly, these data can help develop and direct seagrass conservation, restoration, and management efforts within the San Juan Islands, WA.

Supplemental Information

Biodiversity Surveys

Pema Kitaeff, Dive Safety Officer at Friday Harbor Labs, and her University of Washington Scientific Diving Students also performed biodiversity surveys of the False Bay—Pocket Bay subtidal eelgrass beds on August 22, 2016. From identifying and counting the organisms and eelgrass density along eleven 25-m transects, they found an eelgrass bed that supports a diverse marine community with arthropods, mollusks, cnidarians, and echinoderms (n=100, 93, 47, 13). While the eelgrass bed was patchy, the eelgrass density ranged from 0-38 blades/m^2 and averaged 6 blades/m^2. Combined with observations from diving at the other field sites, these surveys indicate that the False Bay eelgrass beds provide important habitat for many marine invertebrates. Please see the Biodiversity Report for further details on these surveys.

Acknowledgements

I would like to thank Dr. Drew Harvell and Morgan Eisenlord their intellectual and field support; Phoebe Dawkins, Miranda Winningham, and Clio Jensen for their field and laboratory assistance; Pema Kitaeff, Colette Feehan, Chris Wells, and the UW Scientific Diving Students for their dive help. I would also like to thank Evan Fiorenza and Erika Mudrak for statistical support and the FHL Adopt-A-Student Fund for financial assistance. Finally, I would like to extend warm thanks to Michael Prentiss and Tom Schultz for allowing access to their private beaches.

Figure 1. Subtidal and intertidal field sites in the San Juan Islands, WA (Image source: Google maps). Indian Cove and Kanaka Bay (yellow) had paired subtidal and intertidal surveys; all sites had subtidal surveys.

Figure 2. *Zostera marina* blades collected from False Bay and Indian Cove, San Juan Islands, WA in 2016. (A) Healthy and (B) diseases samples with *Labyrinthula zosterae* lesions.

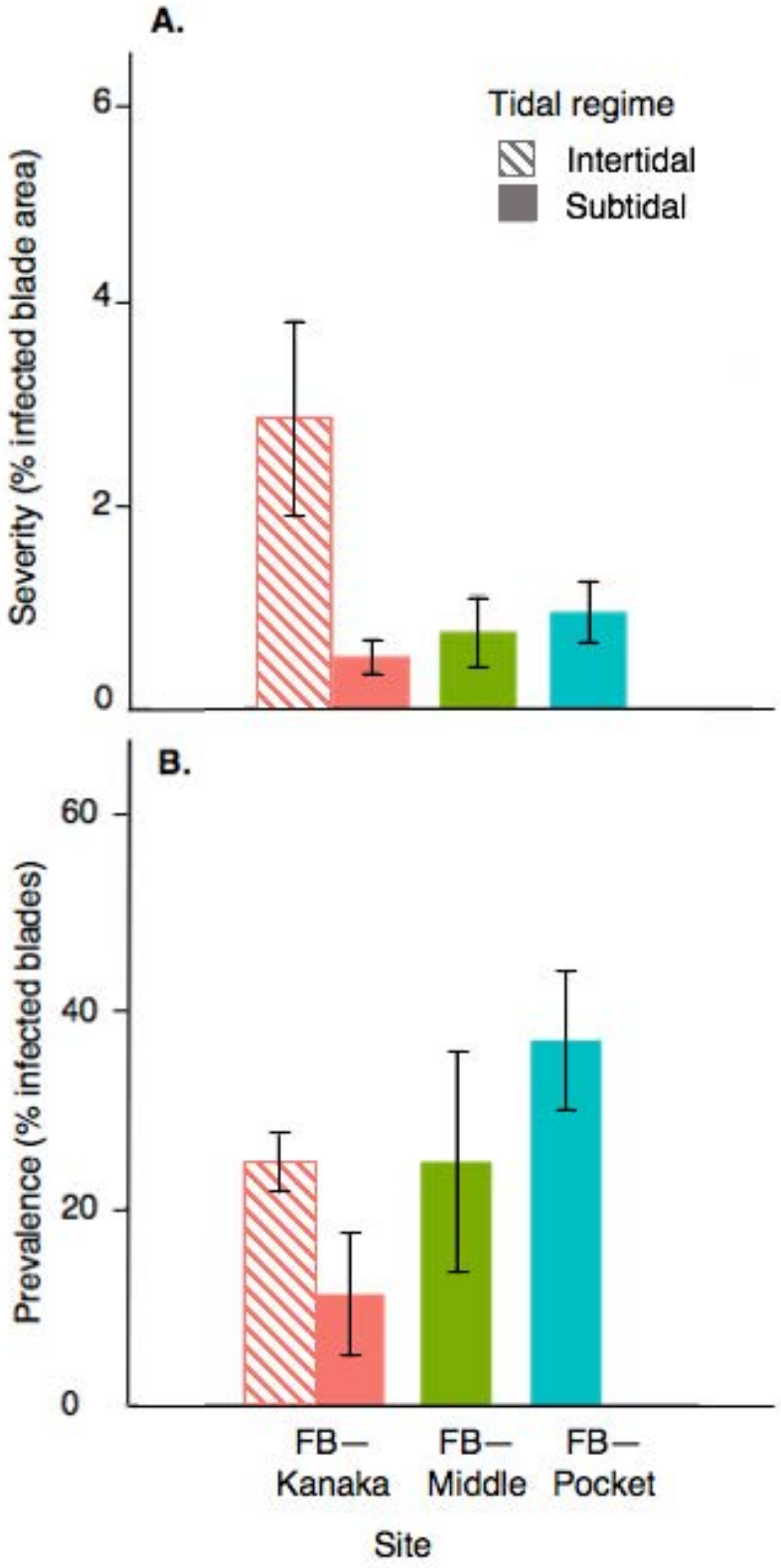

Figure 3. The severity (A) and prevalence (B) of *L. zosterae* in subtidal and intertidal eelgrass from July 2016.

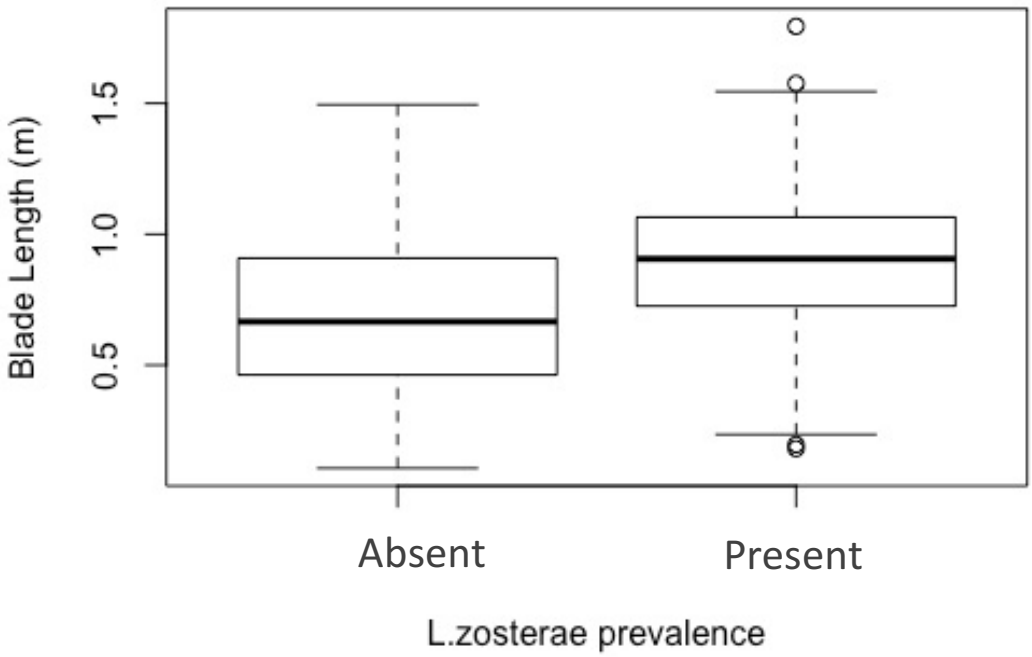

Figure 4. The prevalence of *L. zosterae* by blade length (m) for subtidal eelgrass.

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False Bay Seagrass Report—Part II

Fish diversity and predation within and near *Zostera marina* beds

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Summer 2016

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Keywords: Eelgrass, *Zostera marina*, seagrass wasting disease, *Labyrinthula zosterae*, marine diseases

Introduction

To identify fish communities within and outside of the eelgrass beds, we participated in the Smithsonian Institution's Marine Global Earth Observatory (MarineGEO) BiteMap Project, a collaborative research project involving 25 researchers in 9 countries and 5 continents. For our study site, we focused on the eelgrass bed in the University of Washington Reserve in False Bay, adjacent to Kanaka Bay. Given that eelgrass beds are remarkably productive and serve as key habitat for many species of fish,[1-3] we anticipated that we would find greater number of different fish species (species richness) and in higher numbers (abundance) inside eelgrass beds than outside.

Methods

To determine diversity of fish inside and outside of eelgrass beds, we conducted paired seines in the intertidal eelgrass beds (vegetated) and unvegetated regions of False Bay—Kanaka Bay (Figure 1). We completed a total of six seines (3 unvegetated, 3 vegetated) from July 21-23, 2016. For each, we waded into the water with a 10 m. seine net to a depth of 1 m. at low tide. With the net taught, we pulled the seine net to shore, where we identified (with fish expert Dr. Jeffrey Jensen) and counted all fish; we estimated fish counts greater than 100 and released all fish after each seine. We also measured the length of the first 25 individuals per species in each seine.

Results & Discussion

From these estimates, we found nine different fish species in the eelgrass bed and eight in the unvegetated region without eelgrass (Table 1). Six of these were found in both regions, with

three species found only in the eelgrass and two species found only in the unvegetated area. Fish caught in the eelgrass bed included perch, pipefish, gunnels, and sculpin with several sole and a smelt caught in the nearby sandy region (Figure 2). As predicted, there was remarkably greater fish abundance in the eelgrass (n=2415, 745 total fish respectively).

Differences in fish abundance and richness could be attributed to the fact that eelgrass beds provide robust habitat that is safe and has ample food compared to sparse, sandy regions of the bay nearby. Indeed, the value of eelgrass beds as safe spawning and rearing grounds for juvenile and small fish is widely acknowledged.[2,3] The long blades provide protection and cover for young fish that otherwise be easily predated upon in exposed regions. Furthermore, as critical habitat for many marine invertebrates and algae, eelgrass beds also serve as key feeding grounds for these fish. While English sole were only caught in the unvegetated region, they are commonly found in eelgrass as well. Altogether, these data indicate that False Bay eelgrass beds support a diverse community of fish, many of which are critical forage fish for key marine organisms within the San Juan Islands.

Acknowledgements

I would like to thank Dr. Drew Harvell, Dr. Emmett Duffy, and Ross Whippo for the invitation to participate in this project; Clio and Jeffrey Jensen for assistance with fish identification; Phoebe Dawkins, Miranda Winningham, Drew, Clio, and Jeff for their help with beach seines; and the FHL Adopt-A-Student Fund for financial assistance. Finally, I would like to thank Drew and Dr. Billie Swalla for their valuable feedback on drafts.

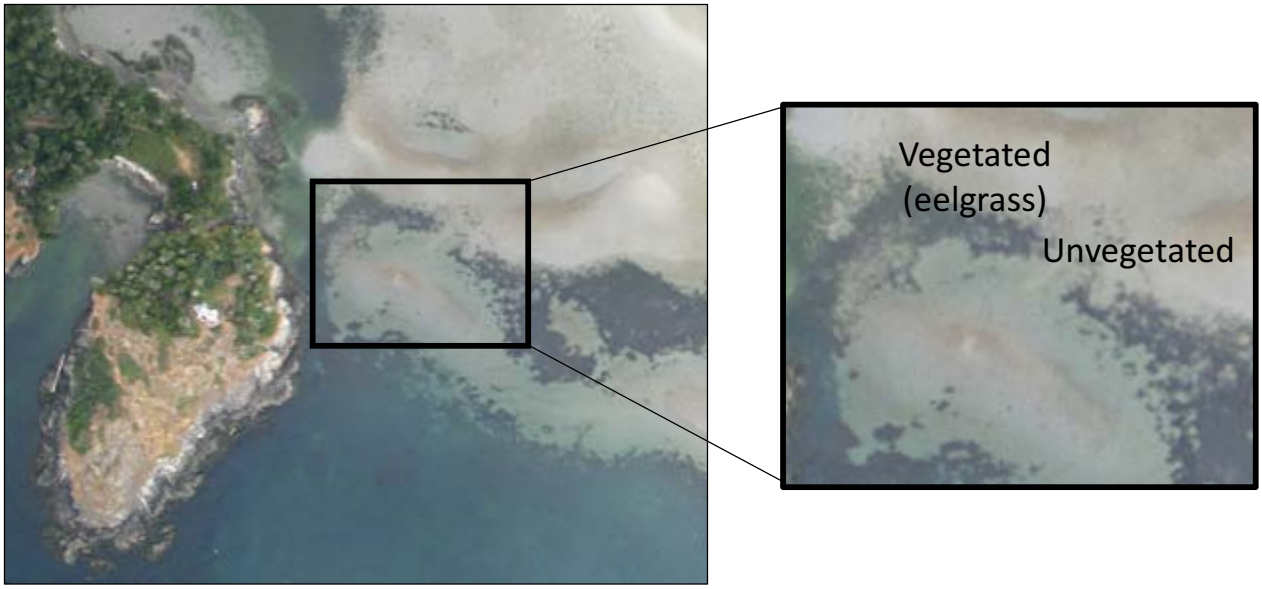

Figure 1. Aerial map of False Bay—Kanaka Bay. Seines were conducted in the vegetated (eelgrass) and unvegetated portions of the bay to survey fish communities. (Image source: Gregg Ridder.)

Table 1. Number of fish collected in unvegetated and vegetated areas of False Bay.

Fish species	**Unvegetated**	**Vegetated**
Cymatogaster aggregate (shiner perch)	668	2213
Embiotoca lateralis (striped surfperch)	15	74
Syngnathus griseolineatus (bay pipefish)	2	39
Apodichthys flavidus (penpoint gunnel)	1	20
Pholis ornata (saddleback gunnel)	1	16
Leptocottus armatus (staghorn sculpin)	35	7
Pholis laeta (crescent gunnel)	-	16
Brachyistius frenatus (kelp perch)	-	7
Nautichthys oculofasciatus (sailfin sculpin)	-	1
Parophrys vetulus (English sole)	22	-
Hypomesus pretiosus (surf smelt)	1	-
Total	**745**	**2415**

Figure 2. Diverse fish species caught in the False Bay—Kanaka Bay eelgrass bed (top to bottom, left to right): perch, gunnels, sculpin, and pipefish. (Image sources: perch—Phillip Colla; gunnels—Andy Murch; staghorn sculpin—Matt Gieselman; sailfin sculpin—dic.academic.ru; pipefish—John McCall.)

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False Bay Seagrass Report—Part III

Invertebrate and algae biodiversity in *Zostera marina* beds

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Keywords: Eelgrass, *Zostera marina*, biodiversity, biodiversity surveys, invertebrates, algae

Abstract

One of the most productive ecosystems in the world, eelgrass (*Zostera marina*) forms dense coastal meadows that serve as valuable habitats for many marine organisms, including arthropods, mollusks, cnidarians, echinoderms, fish, and algae. The San Juan Islands, WA have robust eelgrass beds that are part of federal and state ecological monitoring projects. While False Bay eelgrass is a site for long-term seagrass disease research, little is known about the invertebrate and algae biodiversity within these beds. To establish baseline estimates for invertebrate and algae in the pocket bay of False Bay, University of Washington Scientific Diver students estimated abundance and species richness of invertebrates and algae in the bay. From the 11 transects, divers determined that the eelgrass was spatially patchy and supported abundant arthropods and mollusks, moderate cnidarians, and few echinoderms. Of the kelp and algae identified, green algae were abundant in most quadrats, while brown kelp, other brown algae, and red algae comprised <10% cover in each quadrat. Altogether, these data provide valuable insight into the invertebrate and algae communities in False Bay. In the future, more intensive studies could produce more detailed species list of the biota present.

Introduction

A central theory in ecology is that loss of a few species can impact the functioning of entire ecosystems. Currently, global biodiversity is declining at an unprecedented rate, with extinctions occurring at 100–1000 times historical rates, and future rates predicted to be up to 100 times current rates[1]. It is important to protect species richness, since the number of species is a strong indicator of ecosystem health and confers critical functions: increased productivity, stability in times of disturbance, community structure[2,3], and disease resilience[4].

Eelgrass beds (*Zostera marina*) are diverse, productive ecosystems that are classified as essential marine habitat. The most abundant plant in the northern hemisphere[5], eelgrass forms dense coastal meadows that serve as valuable habitats for many marine organisms, including arthropods, mollusks, cnidarians, echinoderms, fish, and algae. Furthermore, eelgrass is one of the most productive ecosystems worldwide. Compared to corn and sugar cane, eelgrass generates comparable amounts of biomass annually[6]. Combined with its ability to sequester carbon, filter water, and protect coastlines, eelgrass is not only one of the most biologically diverse ecosystems in the world, but also one of the most important[7-9].

Despite its valuable ecosystem services, eelgrass beds worldwide are under threat from anthropogenic and environmental stressors. Nutrient and sediment runoff, habitat destruction, disease, and climate change cause an estimated 110 km^2 annual loss in global eelgrass[10]. Consequently, continued research is needed to identify the most vulnerable eelgrass beds, and inform effective conservation and management strategies in the face of a continually changing planet.

In response, federal and state agencies have made eelgrass monitoring and protection a top priority[11,12]. The Washington Department of Natural Resources (WA-DNR) conducts annual eelgrass monitoring studies to changes in Puget Sound eelgrass populations over time[13]. Likewise, NOAA is working to study the influence of urbanization on eelgrass disease levels[14]. Further north, the San Juan Islands are home to many long-term eelgrass monitoring efforts, focusing on habitat monitoring, eelgrass genetic diversity, and disease dynamics[15-18].

For nearly two decades, certain sites within the San Juan Islands have experienced declining eelgrass density and distribution[13,15,19]. One such well-studied eelgrass bed with a history of decline is in False Bay[15]. While researchers from the University of Washington have studied eelgrass genetic diversity[15,16] and disease in False Bay[17,18], little to no work has been done to examine the invertebrate biodiversity within these eelgrass beds, to the best of my knowledge.

To determine the abundance and species richness of invertebrates and algae, University of Washington Scientific Diver students conducted submerged transects in False Bay (Pocket Bay) in August 2016. This was a pilot study to develop baseline estimates for invertebrate and algae biodiversity.

Methods and Materials

On August 22, 2016, students conducted biodiversity and abundance surveys along eleven 25-m transects at False Bay (Pocket Bay), WA (Figure 1). Transects were oriented perpendicular to shore. Divers estimated eelgrass density and invertebrate species within 1 m^2 quadrats every 5 m along the submerged transects. Invertebrate species were identified by phyla (arthropod, mollusk, cnidarian, echinoderm). For most surveys, epiphytes on eelgrass and substrates within the quadrats were included in estimates. Future, more intensive surveys could enumerate species within these groups. Depth and temperature were recorded using divers' individual dive computers. GPS headings were recorded, when possible, using a Garmin GPS hand-held device. As these surveys were strictly observational surveys, no organisms were collected.

Results

Eelgrass

There was not a clear relationship between mean eelgrass density and depth (Figure 2). However, eelgrass measured at shallower depths usually were more sparse than deeper eelgrass. Eelgrass density ranged from 0-38 blades/m^2 and averaged 7.38 blades/m^2 across the transects (Table 1).

Invertebrates

Arthropods and mollusks were the most abundant invertebrate phyla identified (n=100, 93), including kelp crabs, shrimp, red rock crabs, amphipods, chitons, barnacles, limpets, and snails. Fewer cnidarians were identified (n=47) and included stalk jellyfish and moon jellyfish,

among others. Echinoderms were the least abundant (n=13), and included brittle and other sea stars (Figures 3-6).

Algae

Mean brown kelp cover was 0.48% and ranged from 0-5% across all quadrats. For other brown algae, mean percent cover was 3.89%. Bladed red algae had an 8.30% mean cover, and mean branched red algae cover was 4.76%. Overall mean green algae cover was the highest at 70.13%.

Discussion

Eelgrass density

Across all transects, the eelgrass density was spatially variable around 7.38 blades/m^2, which is comparable to other eelgrass densities measured in False Bay from previous eelgrass fieldwork in July 2016 (Table 1). The mean eelgrass densities by depth (Figure 2) suggest that the eelgrass bed is patchy, with both dense and sparse areas.

Invertebrates

Arthropod abundance was widely variable across the sampled depths. Of the arthropods that were identified, barnacles and crabs were the most dominant, with fewer numbers of shrimp observed. There were usually less than 10 arthropods/m^2, the exceptions being two quadrats at 4 ft that contained 12 hermit crabs and 20 barnacles, respectively (Figure 3).

Mollusks were found from 4-10 ft depths, but were most abundant at 6 ft. Among the mollusks that were identified, snails were easily the most abundant, with only a few clams, chitons and limpets noted. Most counts were less than 10/m^2, although in one instance, there was

an outlier of 31 mollusks/m^2 dominated by snails. This could have resulted if there was a large rock or other hard substrate to which many mollusks could have attached (Figure 4).

Cnidarians were found at all depths except for 12 ft. Abundance appeared to increase with depth. Jellyfish (moon, stalk, unidentified) were the most abundant of the identified cnidarians, followed by several anemones. The number of individuals counted within a single quadrat ranged from 1-6 cnidarians/m^2 (Figure 5), including epiphytes attached to eelgrass.

Echinoderms were the least abundant of all invertebrate phyla identified. The only echinoderms divers encountered were sea stars; no sea urchins or sea cucumbers were observed. While there was not a clear relationship between depth and abundance, the three sea stars counted in a single quadrat were at one of the greatest depths, 10 ft (Figure 6). Overall, divers encountered echinoderms in only seven of the 57 total quadrats. Such low abundance could likely be a remnant of the sea star wasting disease outbreak that decimated over 20 species of echinoderms in 2013-2014 (Eisenlord et al 2016).

Algae

Brown kelp comprised the smallest amount of algae cover in the sampled quadrats. Other brown algae, bladed red algae and mean branched red algae had comparable mean percent cover. Of all the surveyed algae, green algae had the greatest mean percent cover. Because green algae were easily the most dominant, it is possible that environmental conditions in this area are most favorable to green algae growth. Alternatively, the other types of algae could be smaller than green algae and would comprise a smaller percent cover, even if they were abundant.

Conclusion

These biodiversity surveys provide valuable baseline data for invertebrate and algae living in Pocket Bay. Finding these organisms throughout the eelgrass beds across variable

depths highlights the rich marine life within the False Bay eelgrass beds, and underscores the productivity and diversity of this key area. Future more intensive studies could produce more detailed species lists of the biota present. While SCUBA surveys are commonly used to monitor the abundance and richness of tropical marine species, they are not regularly used to survey eelgrass beds in the San Juan Islands, to the best of my knowledge. Therefore, they serve as a useful tool to assess fine-scale biodiversity in False Bay eelgrass beds.

Altogether, the surveys indicate that False Bay eelgrass beds supports many marine invertebrates and algae, which contribute to the productivity and health of this important costal environment. Furthermore, the surveys show that the eelgrass bed is extensive in size with both dense and patchy regions. Repeated surveys could enumerate specific species and indicate changes in the health of the eelgrass beds over time. These findings are important in protecting and sustaining Pocket Bay as a critical marine habitat for local marine species.

Acknowledgements

I would like to give tremendous thanks Pema Kitaeff, the Friday Harbor Labs Dive Safety Officer, for her remarkable organization and execution of the dive surveys. This project would not have been possible without her dedication. I would also like to thank her University of Washington Scientific Diving students and the additional support divers who were the "boots on the ground" collecting data. I would like to thank Mike Prentiss for kindly allowing the divers access to his property to reach the dive site. I would also like to extend warm thanks to Michael Prentiss and Tom Schultz for allowing access to their private beaches. Finally, I would like to thank Dr. Drew Harvell for her continuous intellectual support and inspiration.

Figures and Tables

Figure 1. Approximate locations of biodiversity transects at False Bay (Pocket Bay), San Juan Island, WA. (Image source: Google maps.)

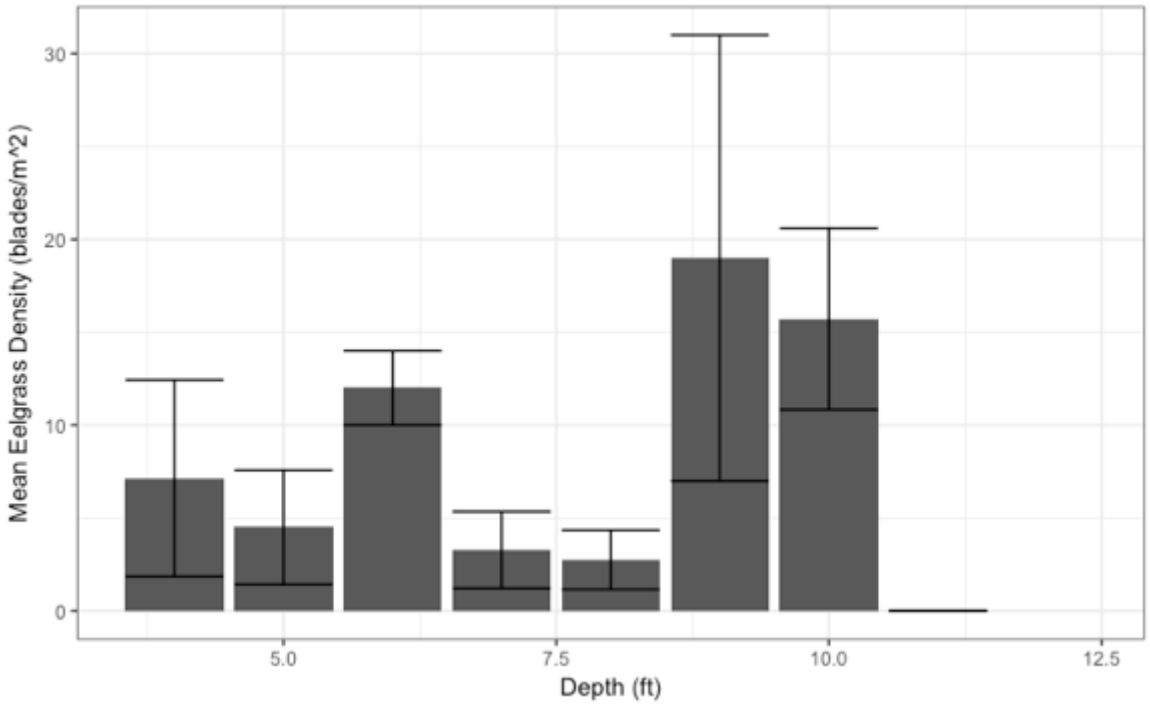

Figure 2. Mean eelgrass density (shoots/$m^{2)}$ (+/- SE) across a depth gradient (ft) in Pocket Bay.

Table 1. Average eelgrass density (blades/m^2) for each subtidal and intertidal site sampled in July and August 2016. *Indicates density measurement is from 8/22 survey. All other densities were measured during July 2016 subtidal and intertidal surveys for annual eelgrass wasting disease surveys.

Site	Tidal Regime	Average eelgrass density (blades/m^2)
FB - Pocket	Subtidal	19
FB - Pocket	Subtidal	7.38*
FB - Middle	Subtidal	10.6
FB - Kanaka	Subtidal	17.3
FB - Kanaka	Intertidal	13.5
Indian Cove	Subtidal	3.2
Indian Cove	Intertidal	16.88

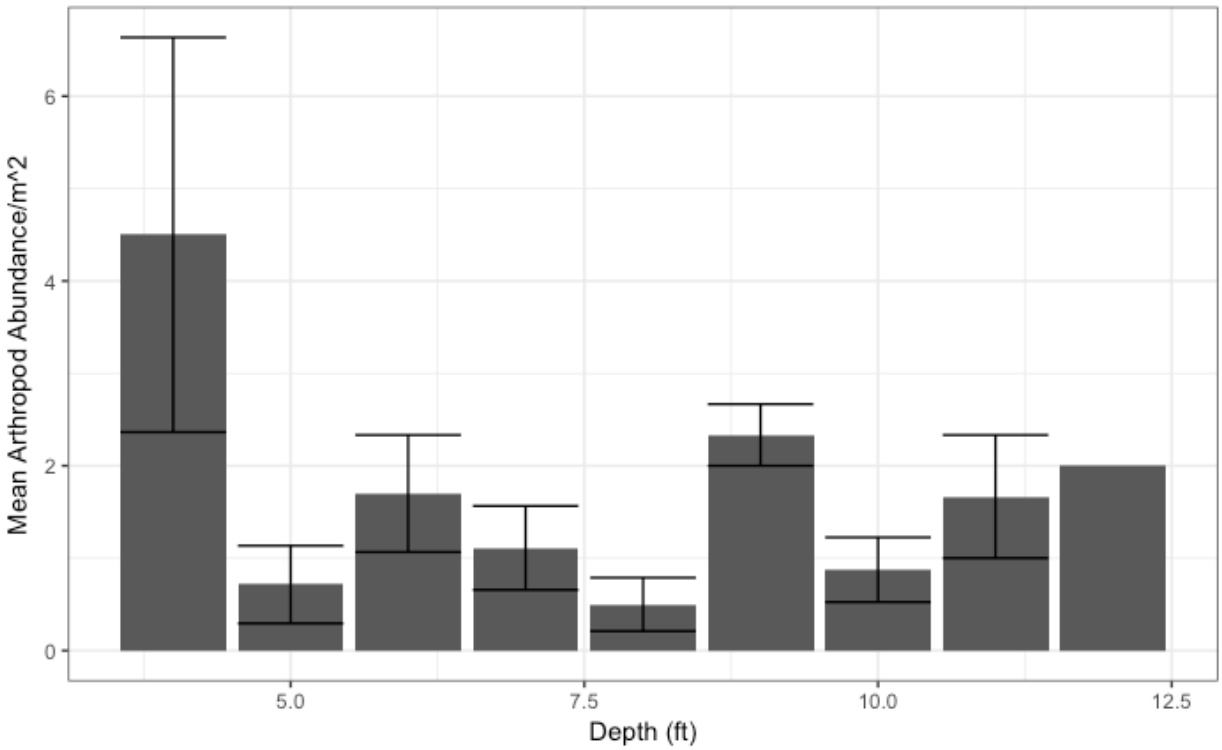

Figure 3. Mean arthropod abundance/m^2 (+/- SE) across a depth gradient (ft) in Pocket Bay.

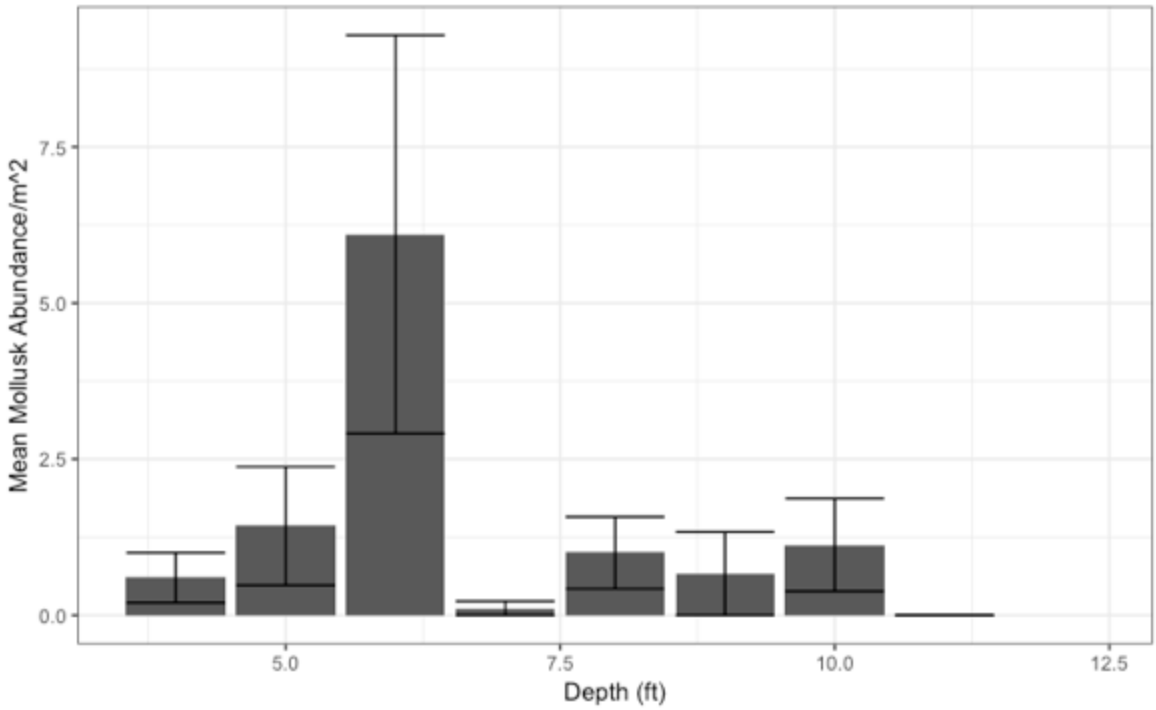

Figure 4. Mean mollusk abundance/m^2 (+/- SE) across a depth gradient (ft) in Pocket Bay.

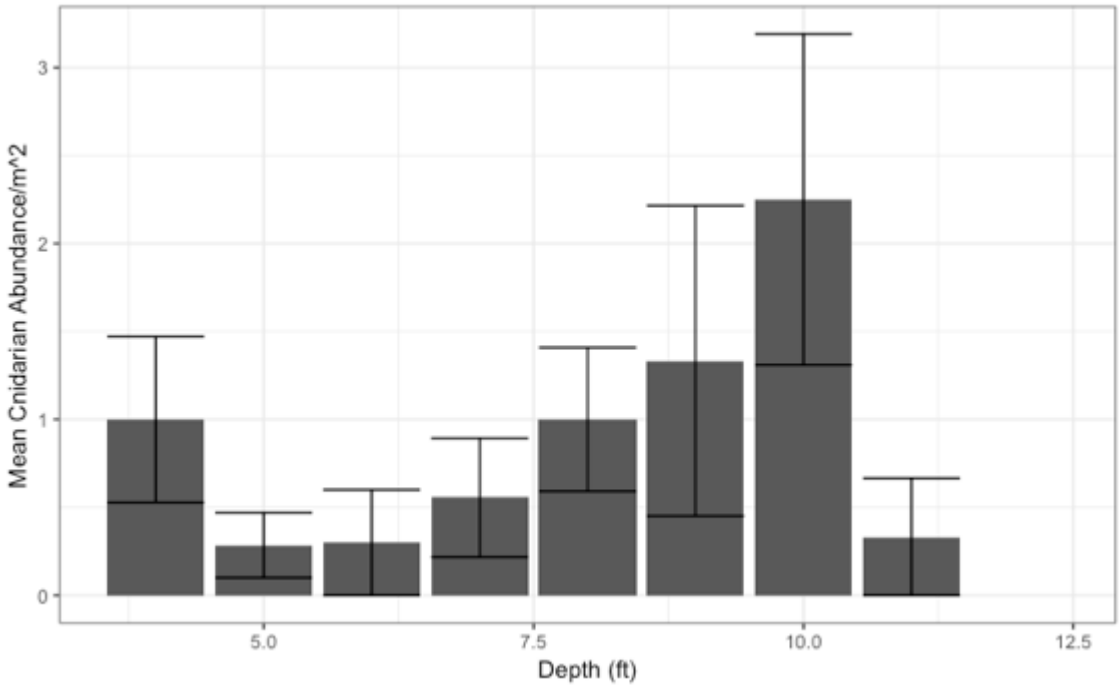

Figure 5. Mean cnidarian abundance/m^2 (+/- SE) across a depth gradient (ft) in Pocket Bay.

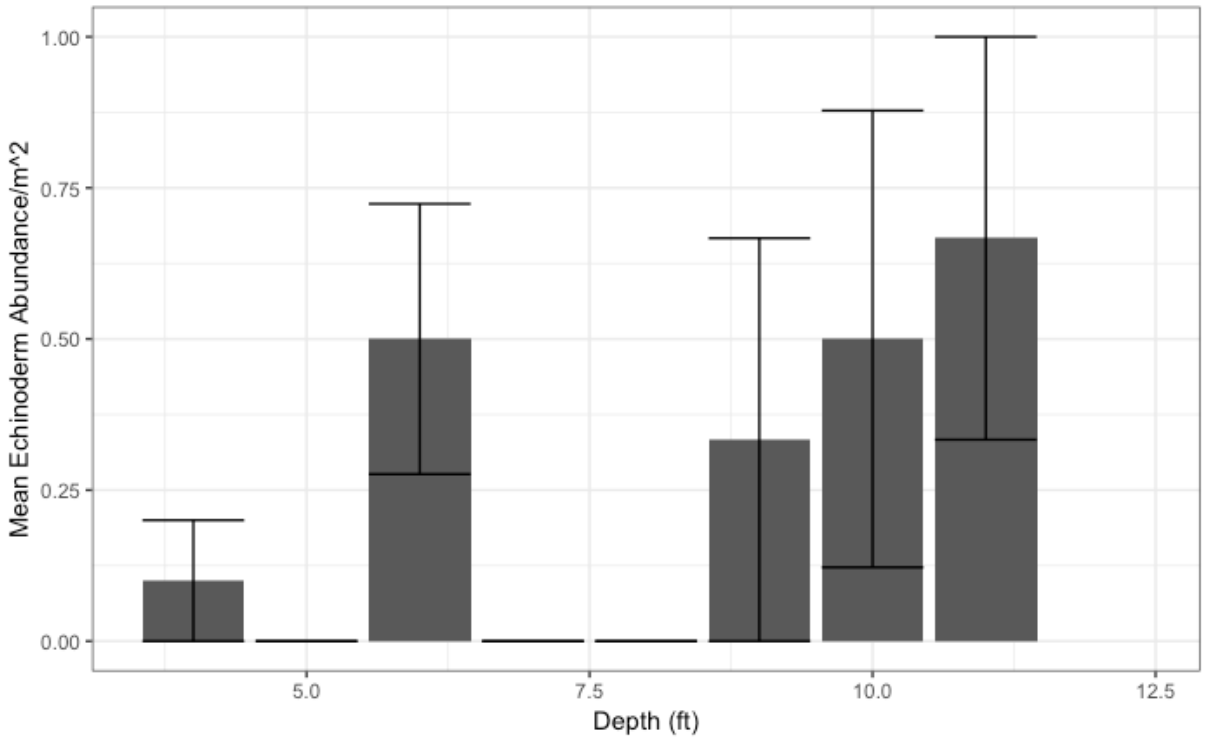

Figure 6. Mean echinoderm abundance/m^2 (+/- SE) across a depth gradient (ft) in Pocket Bay.

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