A Site Characterization of the Piedras Blancas State Marine Conservation Area Using a Towed Camera Sled

A Capstone Project

Presented to the Faculty of Science and Environmental Policy

in the

College of Science, Media Arts, and Technology

at

California State University, Monterey Bay

in Partial Fulfillment of the Requirements for the Degree of

Bachelor of Science

by

AJ Cecchettini

April 30, 2008

Abstract

With the advancements of software and technology, videographic data has shown to be a valuable spatial management tool for marine protected areas (MPAs). There are numerous ways of acquiring videographic data on benthic communities, including remotely operated vehicles, autonomous underwater vehicles, human occupied submersibles, and towed camera sleds. This paper focuses on the use of a towed camera sled in August of 2007 to acquire videographic habitat (mud, sand, rock) and relief (high, med, low) data in the newly designated Piedras Blancas State Marine Conservation Area (PBSMCA). A spatial distribution of the communities and the scale at which they occur found that primary habitats recorded by the towed camera sled showed no significant difference between soft and hard substrate. Hard substrate was recorded 10% more than soft substrate for the secondary classification. The average patch size of hard substrate was 19.79 (10-second viewing frames) while the soft substrate was 13.77. Comparing the two sampling rates of every ten seconds to one minute intervals yielded a significant Mann-Whitney U statistic suggesting that one minute sampling intervals are too large and contribute to a loss of data. The results of this paper are exclusive and are the only version of such data and analyses in the PBSMCA to date.

Introduction:

Marine protected areas (MPAs) are areas where natural and/or cultural resources are protected more rigorously than the surrounding waters (MPA 2007). Examples of MPAs encompass a wide variety of habitats including the open ocean, coastal areas, intertidal zones, estuaries, and the Great Lakes. An MPA's objective is dependent upon the level of protection, legal authorities, management approaches, agencies, and restrictions of human uses (MPA 2007). In the United States, the official federal definition of an MPA is: "any area of the marine environment that has been reserved by federal, state, tribal, territorial, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein," (Clinton 2000, MPA 2007).

MPAs and their subset of marine reserves have been shown to increase fish numbers, increase biodiversity, and protect their ecosystems from habitat destruction that is associated with fishing (Suman et al. 1999, Friedlander 2001). Different types of habitats are a refuge for certain fishes for avoiding predators or for spawning (Friedlander

2001). MPAs have been used increasingly as a viable fisheries management tool and have been shown to protect marine biodiversity (Suman et al. 1999).

There are numerous types of MPAs that fall under different levels of the United States government. Federal MPAs are managed by the Dept. of Commerce/National Oceanic and Atmospheric Administration and the Dept. of the Interior (MPA 2007). The Dept of commerce/NOAA manages national marine sanctuaries, fishery management zones, and with the cooperation of states, national estuarine research reserves. The Department of the Interior manages MPAs through national parks and national wildlife refuges. States and Territories have over 100 different bureaus, departments, and divisions that regulate the environment, manage fisheries, manage lands, and regulate commerce. State Marine Conservation Areas (SMCAs) fall under this category. Tribes who have sovereign land rights can designate areas and co-manage areas with the 100+ state departments as well.

With the increasing impacts on natural resources of marine ecosystems and the lack of sound fisheries management, MPAs have been implemented globally in an effort to sustain biodiversity. One method to deal with these impacts is that of the “no-take” MPA where all extractive activities such as collecting or fishing is illegal (Begg 2005). It has been suggested that ecosystems that can sustain exploited fish populations can be sustained by use of no-take MPAs (Lindholm et al. 2004). However, not all MPAs are no-take. In reality, less than one percent of United States waters are no-take MPAs and the majority of MPAs are multiple use conservation areas that permit both consumptive and non-consumptive activities, such as fishing, diving, boating and swimming (NMPAC 2008)..

Management of MPAs involves two primary objectives. The first is the goal of sustainable use of resources and maintenance of natural values for the long term, including the preservation of the genetic diversity; and the second being preservation of the integrity of the ecosystem, both its structure and functions (Dayton 1995). These objectives can be somewhat difficult to achieve if the data, technology, or personnel are not readily available.

Knowledge of what organisms occupy the seafloor and what the substrate consists of cannot only provide a foundation for optimal marine management practices and MPA designation, but also provide data for previously unexplored areas. MPAs are being used as a spatial management tool and representation of habitat types is a major factor in MPA design (Stevens T 2005). This poses technical and logistical challenges in providing robust and quantitative information at scales relevant to MPA design and management (Stevens T 2005).

Underwater videography has proven to be an important tool for research and monitoring. For instance, underwater videography has been used to groundtruth sidescan sonar maps (Rooper and Zimmermann 2005, Barker et al. 1999) and also to assess the distribution of microhabitat use of various fishes and benthic invertebrates (Auster et al. 2003; Lindholm et al. 2004). It can provide exceptional close-up observation of small areas, at the scale of square meters and centimeters (Stevens B 2005). Most recently, rapid development of high resolution digital video and low light sensitivity provides higher quality of data (Somerton and Glendhill 2005) and has led to legislation such as the California Marine Life Protection Act Initiative (CDFG1 2007). If the data is of higher quality, then a more in depth analysis can be made and acted upon. Newer technologies make it easier to access data in areas that were previously unattainable (CDFG1 2007) and new video analysis software has made underwater video photography an important tool for providing quantitative data on the seafloor (Somerton and Glendhill 2005). These new technologies and software make monitoring of MPAs easier and more manageable.

Towed camera sleds are a frequently-used platform for collecting underwater video data (Barker et al. 1999, Auster et al. 2003; Lindholm et al. 2004; Anderson and Yoklavich 2007). Although there are other platforms available, including remotely operated vehicles, autonomous underwater vehicles, and human occupied submersibles (Barker et al. 1999), towed camera sleds have many advantages over other video sampling methods including inexpensive operation, ease of use and maintenance, relatively long dive duration (compared to manned submersibles), and a direct video connection with the topside platform (Anglin 2007). Sleds capture georeferenced video images of the seafloor (such as hard and soft substrate, high and low relief, and the scales at which they occur) in real time, allowing scientists aboard the support vessel to quantify benthic taxa and seafloor substrate characteristics in real-time as well (Anglin 2007). Sub-sampling methodologies can be used for many different types of applications in an effort to decrease the post processing time interval. Using sub-sampling techniques is also a way to bypass the limitations of post-processing software (Stone and Brown 2005).

The first major implementation of the Marine Life Protection Act went into effect on September 21st, 2007 with the designation of 29 State Marine Conservation Areas (SMCAs) from Pigeon Point, CA to Point Conception, CA. The 29 MPAs cover approximately 204 square miles, or eighteen percent of state waters. The MPAs are intended to provide long term protection for the rockfishes, abalone, and kelp which are vital parts of the coastal ecosystem (CDFG2 2007). The purpose of this capstone was to collect baseline data on the occurrence and spatial scale of seafloor habitat attributes within the newly designated Piedras Blancas State Marine Conservation Area (PBSMCA).

The distribution of fishes and inverts is known to vary significantly with landscape attributes of the seafloor. Hard and soft habitats are two broad categories which are used to classify the substrates physical characteristics (Lindholm et al. 1999). The primary research questions underlying this project were the following: What is the distribution of habitat attributes on the seafloor within the PBSMCA? What are the spatial scales at which particular habitat attributes occur? A related secondary question was: How does the collection of videographic data on a frame-by-frame basis compare to the real-time collection of data at one-minute intervals? Statistical analyses of the data answered the research questions and provided a standard for future videographic research. The product of my capstone, the collection of baseline data on topographic relief on the seafloor, serves as a foundation on which future studies will be based to evaluate the utility of the Piedras Blancas State Marine Conservation Area (PBSMCA) and its management of marine resources. The results of my capstone also provide the first type of study for the new PBSMCA. It gives the first and only quantitative spatial description of the PBSMCA while also evaluating the sampling technique of a towed camera sled.

Methods

A research cruise was conducted to the PBSMCA in early August 2007 aboard the NOAA Vessel *Fulmar* during which a towed camera sled was deployed to collect data on seafloor communities. The towed camera sled (hereafter referred to as the sled) is owned and operated by the Monterey Bay National Marine Sanctuary (MBNMS). Data collection, analysis, and visualization using the sled are being conducted at the Institute for Applied Marine Ecology (IfAME) at CSUMB through a partnership with the MBNMS.

The sled has a weight of 56.7kg (125lbs) and its overall length, width and height is 190cm, 44cm, 100cm respectively. The tow wire, or sometimes referred to as the umbilical data-cable, has an overall length of 304 m (1000ft), but should be towed at 274 m based on a deck length of 30.4 m. It has a diameter of 1.27 cm and can sustain a load of 544 kg (1200lbs). It also has an altimeter, a compass (±1o), depth gauge (±1%), and leak detectors which will show an on screen alarm aboard the ship. It has two 500 mW lasers spaced so that 10cm laser dots are visible on the videographic data and two 250 W Tungsten/Halogeon Bulbs providing the light at depths where solar radiation is not present. The camera is in color and has a 10:1 optical zoom, high resolution, and can be tilted ± 90o via an external motor control. The entire sled runs on 100-120 volts of alternating current (Anglin 2007).

A total of six 1-hour transects and two 15-minute transects were conducted within the PBSMCA (Figure 1). Data were collected in real-time during each transect using a set of programmable X-Keys (PI Engineering, Williamston, MI, USA) by a team of three scientists. The “observer” watched the live video feed and identified all habitat attributes and organisms seen during 20-second sampling intervals conducted every minute. The X-key “technician” records each identification made by the observer using the X-keys. Each key logs the full name rather than having to type in the full name on a regular keyboard. The X-keys also have a certain section of keys so that the type of substrate (i.e. sand, mud, rock) can be logged and its associated relief (i.e. high, medium, low). All organisms and substrate characterizations are logged by way of the programs GNAV and MediaMapper. GNAV saves these 20 sec interval data on a geo-referenced map. MediaMapper is designed to read GPS information that is burned directly onto the camera sled video tapes for rapid playback, exporting video clips, and watching streaming video at the transect location of choice (Anglin 2007). The “note taker” logs the precise time each new organism was identified for each transect, as well as any additional information noted by the observer.

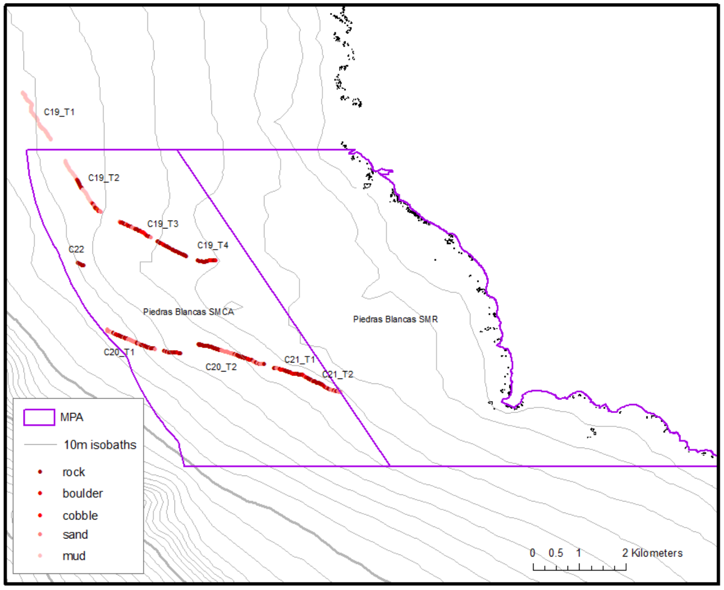


Figure 1: Map of the six 1-hour and three 15-minute transects conducted in August of 2007 aboard the NOAA Vessel *Fulma.r*

For my capstone, I analyzed all eight of the transects on a frame-by-frame basis in the lab, treating each “frame” as a non-overlapping 10-second video quadrat (as per Lindholm et al. 2004). Within each frame I used the Greene et al. (1999) approach to characterize the dominant or primary habitat attribute (>50% of the frame) and the secondary habitat attribute (>20% of the remaining portion of the frame). Over the ten-second sampling interval, I would estimate which habitat made up greater than 50% of what was seen and that would be recorded as the primary habitat. Of the remaining area covered in that ten-second interval, if a habitat covered greater than 20% it would be considered the secondary habitat. In some instances, there would be the same primary and secondary habitat classification because there was not a large enough amount of secondary habitat that was different from the primary habitat. This would make the secondary habitat be the same as the primary habitat.

In addition to habitat, I characterized the relief - bio-turbaded, rippled, wavy, flat, low, moderate, or high - of both the dominant and secondary habitats in each frame using the same type of classification scheme: >50% = primary relief, >20% = secondary relief.

To answer my first question (What is the distribution of habitat attributes on the seafloor within the PBSMCA?), I plotted the results of my data as detailed scatter plots. In this way, the precise distribution of habitats along the areas visited by the camera sled were clearly delineated. To answer my second question (What are the spatial scales at which particular habitat attributes occur?) I investigated any spatial patterns in the habitat data, including the number of frames per habitat feature and the number of times each habitat feature occurs. Percent cover and mean habitat patch size were noted to give a spatial description of the habitat. The study of spatial pattern is a key first step to understanding the abundance of organisms and their distribution. It also provides a basis for monitoring their long-term changes due to both natural and human disturbances (Garcia-Charton et al. 2004)

To answer my third question (How does the collection of videographic data on a frame-by-frame basis compare to the real-time collection of data at one-minute intervals?) I first plotted the data from 1-minute intervals and frame by frame to identify any spatial correspondence between habitat attributes. I then compared the relative abundance of each recorded habitat attribute for each transect between frame-by-frame and 1-minute sampling intervals. Any differences between sampling approaches were quantified by a Mann-

Whitney-U since the parametric assumptions of the student's t-test were not met. The statistical package SPSS© was used to run the Mann-Whitney-U.

Comparisons were made between hard and soft substrate. Pebble, cobble, gravel, boulder and rock classifications were considered hard substrate while mud and sand were considered soft substrate. The comparisons were between the hard substrate of the two sampling intervals and then the soft substrate between the two sampling intervals. If there was a significant difference between the two intervals then this would have suggested a loss of data.

Results:

What is the distribution of habitat attributes on the seafloor within the PBSMCA?

The distributions of all habitat types varied highly along the seafloor. Some transects had a constant or even amount of habitat types while others showed a somewhat scrambled placement (Figure 2). One trend that was common was that each transect showed that the primary and secondary habitats complemented each other. If there was a Mud primary

Table 1: Total Percent cover of substrate and relief across all eight transects.

			Total Percent cover			
			Primary	Secondary	Primary	Secondary
Substrate	**Soft**	Mud	26.0%	29.1%	45.4%	41.5%
		Sand	19.4%	12.4%		
	Hard	Pebble	0.0%	2.5%	47.2%	51.2%
		Cobble	2.3%	8.2%		
		Gravel	0.0%	0.0%		
		Boulder	8.0%	11.5%		
		Rock	36.9%	28.8%		
		Incomplete	3.3%	3.2%		
Relief		Bioturbaded	0.0%	26.4%		
		Flat	29.3%	15.7%		
		Ripple	3.2%	0.7%		
		Wavy	12.6%	0.8%		
		Low	27.3%	30.1%		
		Moderate	20.3%	18.5%		
		High	0.0%	0.6%		
		Incomplete	3.3%	3.3%		

classification, then there most likely was not a pebble or gravel secondary counterpart. If there was a mud primary classification then there was most likely a mud secondary classification. If there was a primary rock classification, then there was most likely a rock or boulder secondary classification.

Table 1 displays the primary and secondary percent cover for all different types of substrate and relief. Note that the primary and secondary percent covers are not habitat percentages that occurred concurrently. For example, when referring to table 1, the primary percent cover for “mud” was 26% but that percentages did not solely have a secondary percent cover of 29.1% of “mud”. The primary habitat classification is independent of the secondary. The same is applied for the secondary habitat percentages. The percent cover comes from the total amount of frames that the substrate or relief came from divided by the total amount of frames across all transects.

Rock was the most common primary substrate with almost 37% of the total percent cover across all transects and it was also the second highest secondary substrate. Mud was the second most common primary substrate with 26% of the total area covered and it was the most common secondary substrate. Sand was the third most observed for both primary and secondary while boulder was in a close fourth. Cobble was seen more as a secondary habitat with it totaling 8% as a secondary but only 2% as a primary habitat. Pebble was not recorded as a primary habitat and it only consisted of 2% of the entire percent cover. Gravel was not recorded as a primary or secondary substrate across all eight transects.

Hard substrate made up 47.2% of the primary substrate while soft made up 45.4%. For the secondary classification, hard substrate made up 51.2% while the soft substrate made up 41.5%. Incomplete frames made up about 3% of both primary and secondary habitats.

What are the spatial scales at which particular habitat attributes occur?

The differences in the substrate data varied widely between the eight transects. Some transects contained a primary and secondary substrate feature of mud-mud for the entire 1-hour transect while other transects jumped from one substrate to another in no set pattern. In most cases, when the primary or secondary substrate changed, a change in the opposite substrate would change as well. For example, if the substrate changed its primary-secondary from rock-rock to sand-rock respectively, you would expect it to eventually change to either sand-sand or back to rock-rock. Figure 2 below shows the varied plots of all eight transects (graphs A-H). The blue (darker) data points are the primary habitat and the pink (lighter) data points are the secondary habitat types. The Y-axis labels are the letter codes for the habitat, which is expressed in table 3.

Table 2: Average Patch size of substrate types across all transects sampled at one minute intervals and ten second intervals.

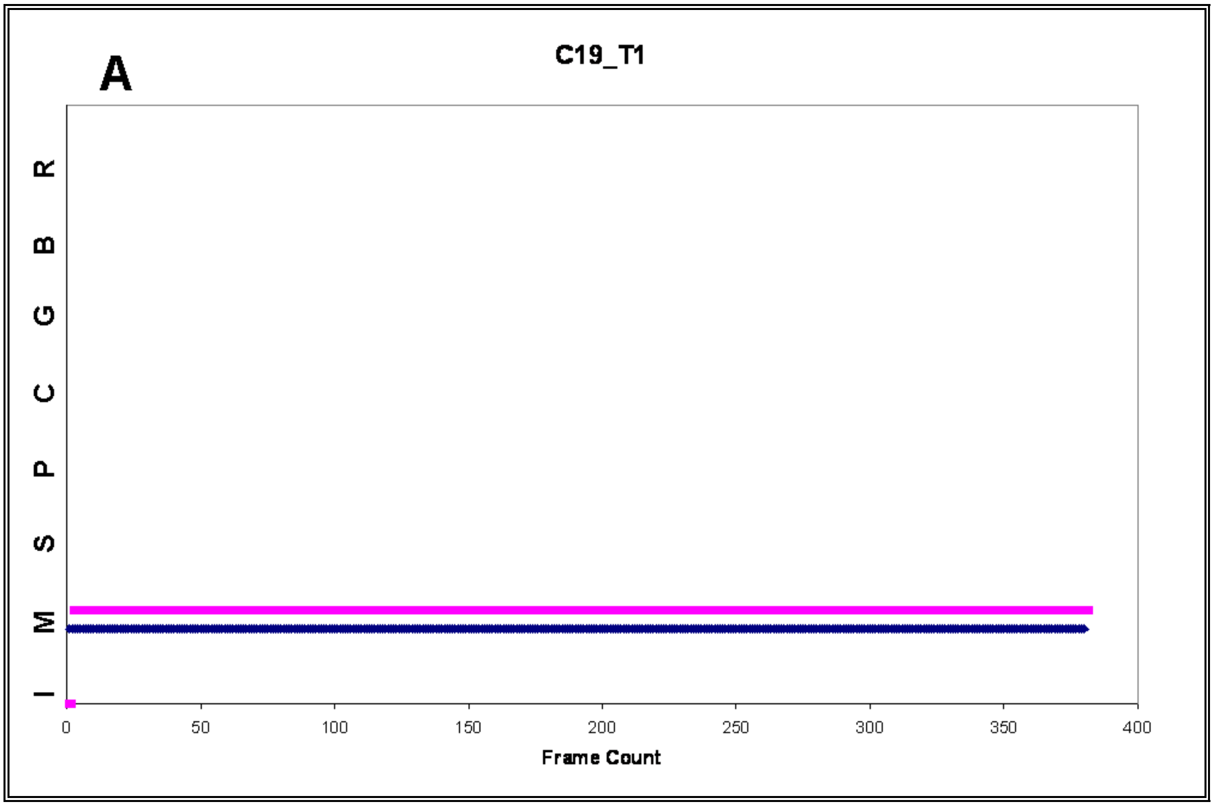
1-min intervals	Soft	Hard
Total Counts	188	209
Total Patches	37	37
Total Mean	5.08	5.65

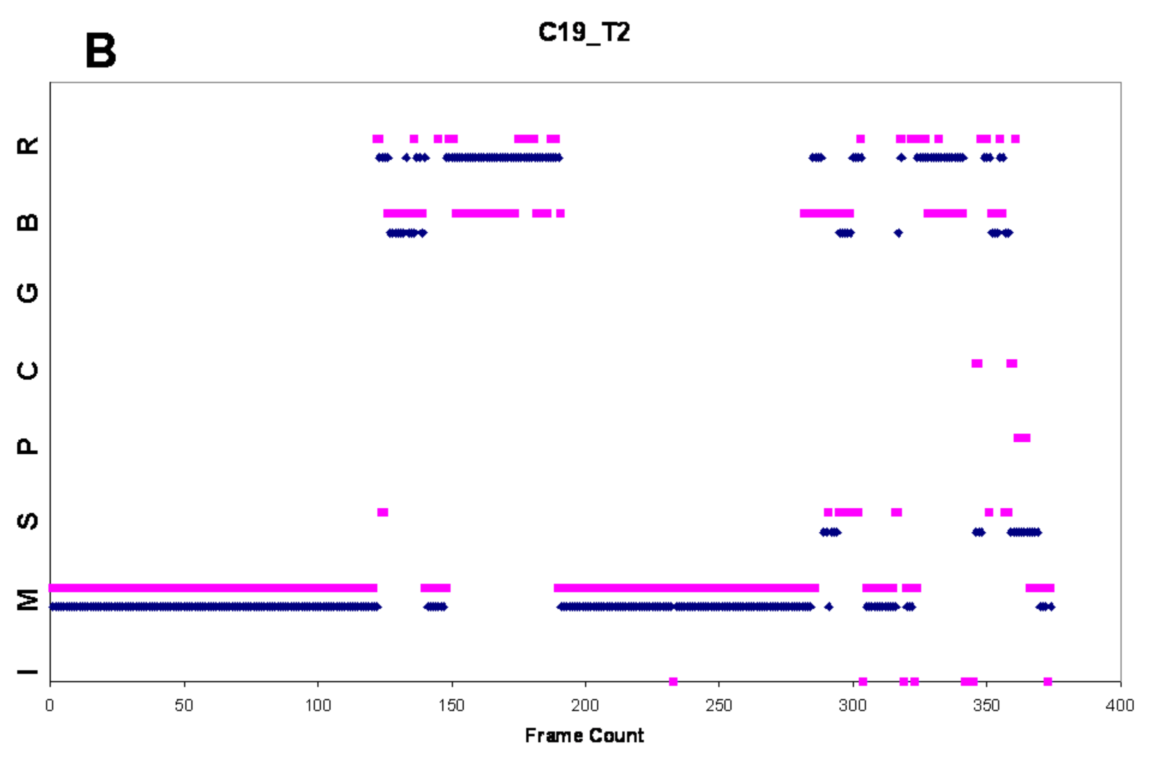
10 Sec Intervals	Soft	Hard
Total Counts	1425	964
Total Patches	72	70
Total Mean	19.79	13.77

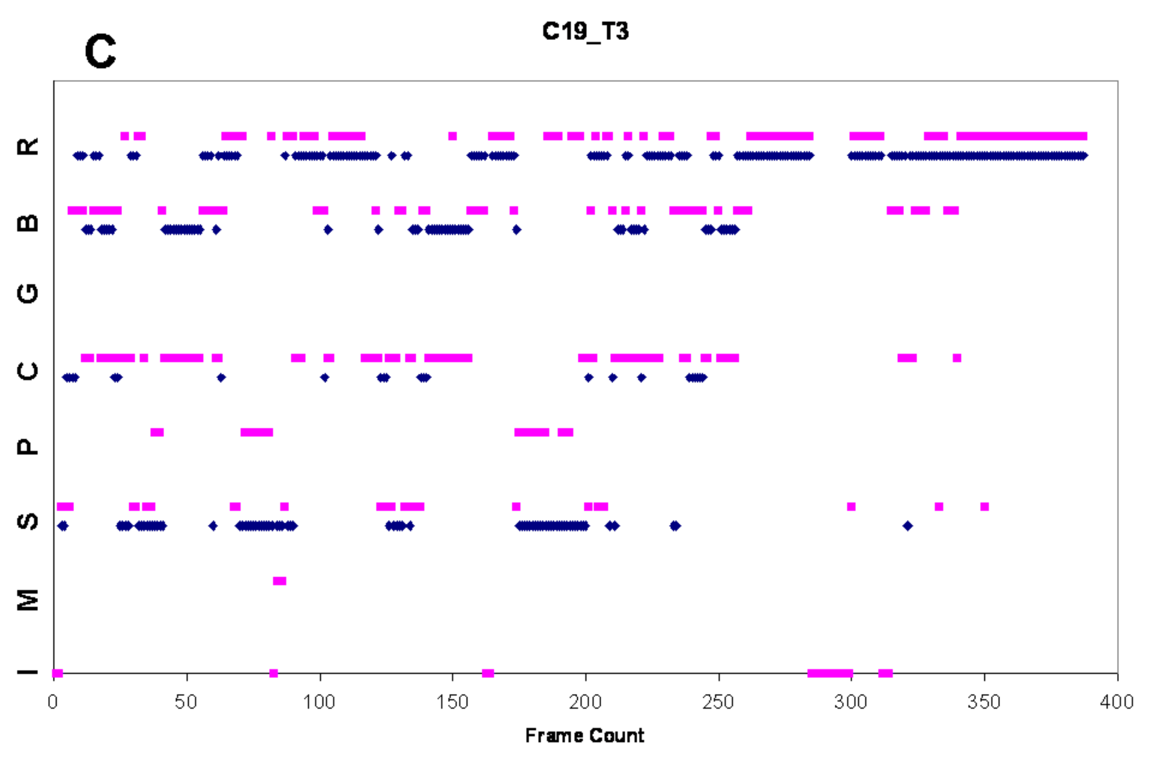
Table 3: Letter code classification scheme used for substrate.

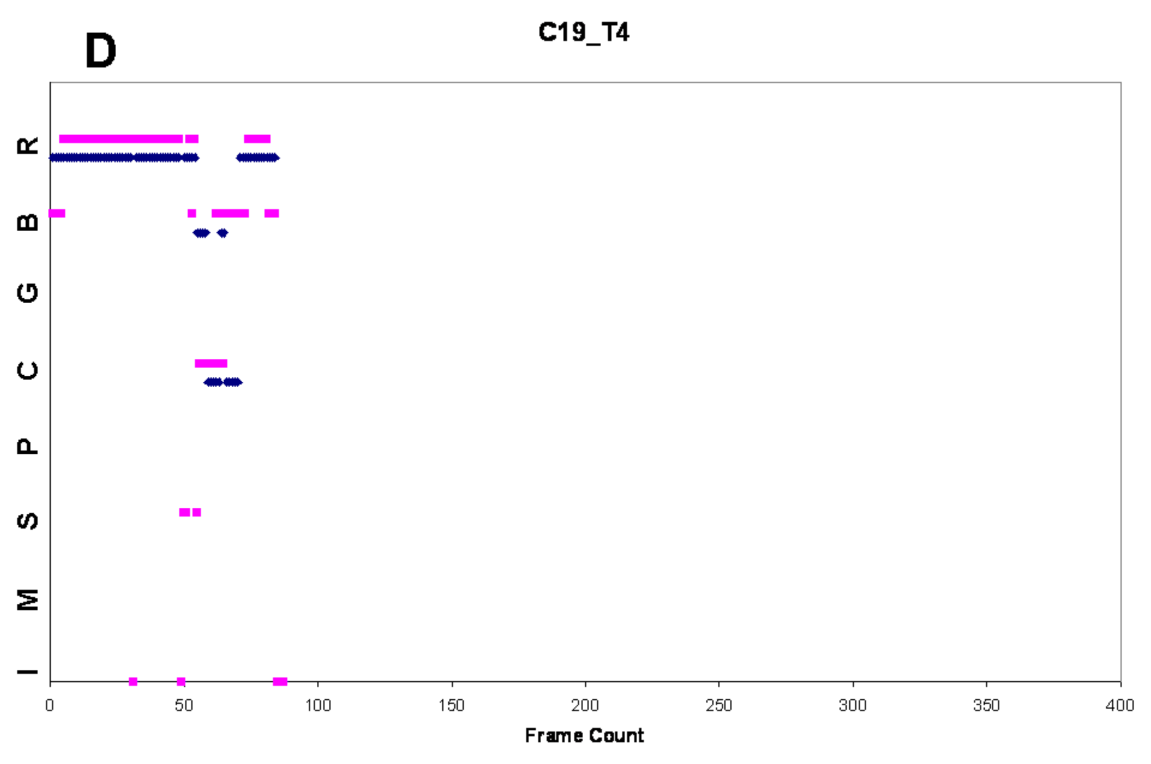
Letter Code	Habitat Type
R	Rock
B	Boulder
G	Gravel
C	Cobble
P	Pebble
S	Sand
M	Mud
I	Incomplete

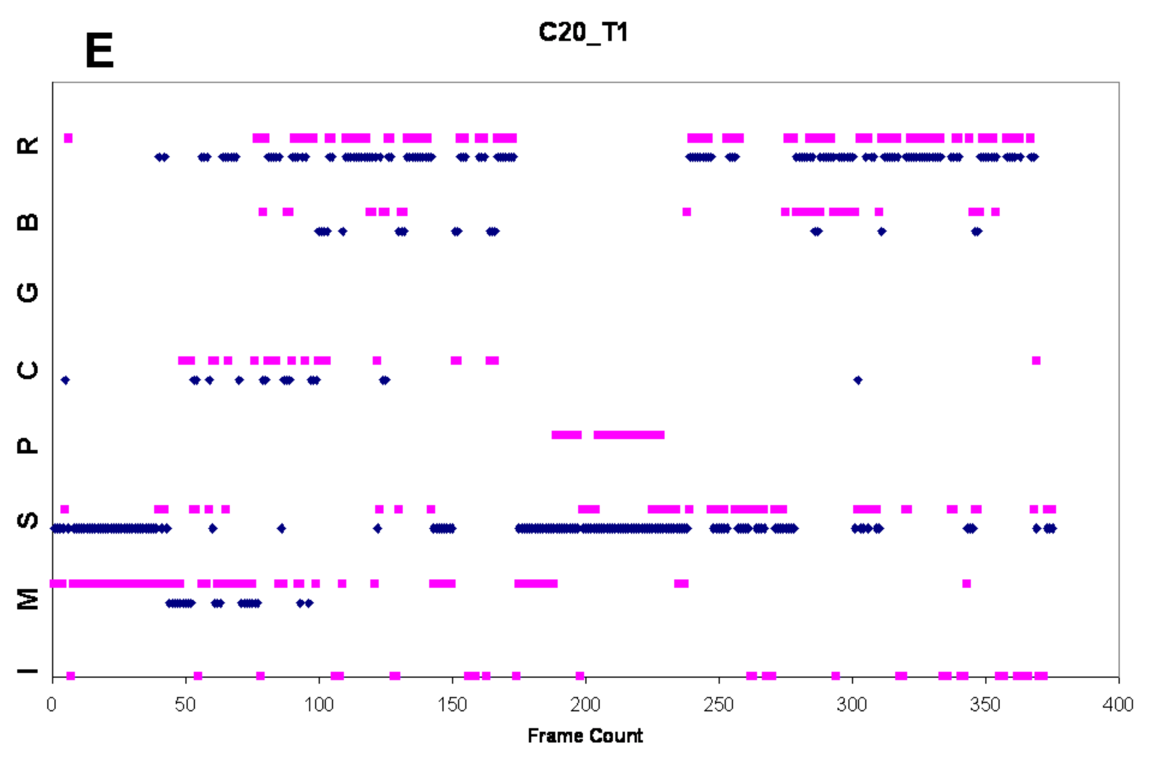
Different habitat patch sizes varied widely as well across all transects. The mean patch size (frame count) was 19.79 for the soft substrates and 13.77 for the hard substrates. From the graphs in figure 2, you can see that the patch size and amount of patches is different between all transects. The mean patch size at 1-minute intervals was lower and somewhat even between soft and hard substrates with means of 5.08 and 5.65 respectfully.

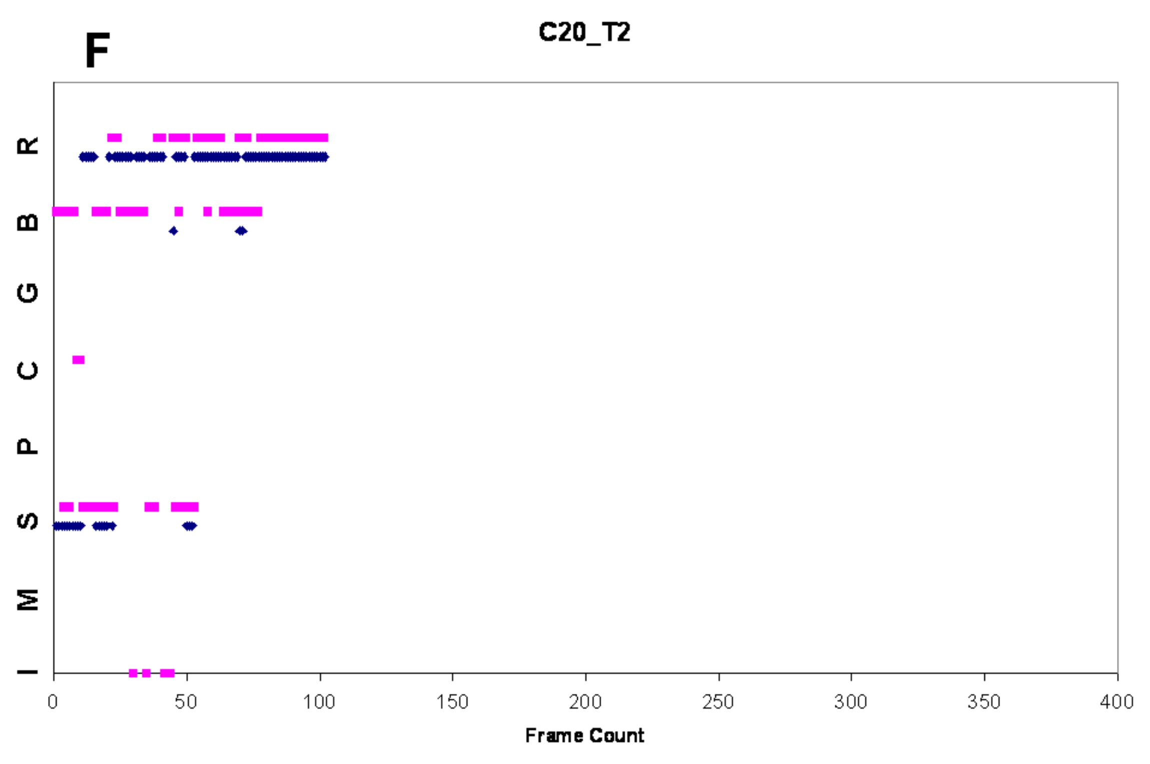


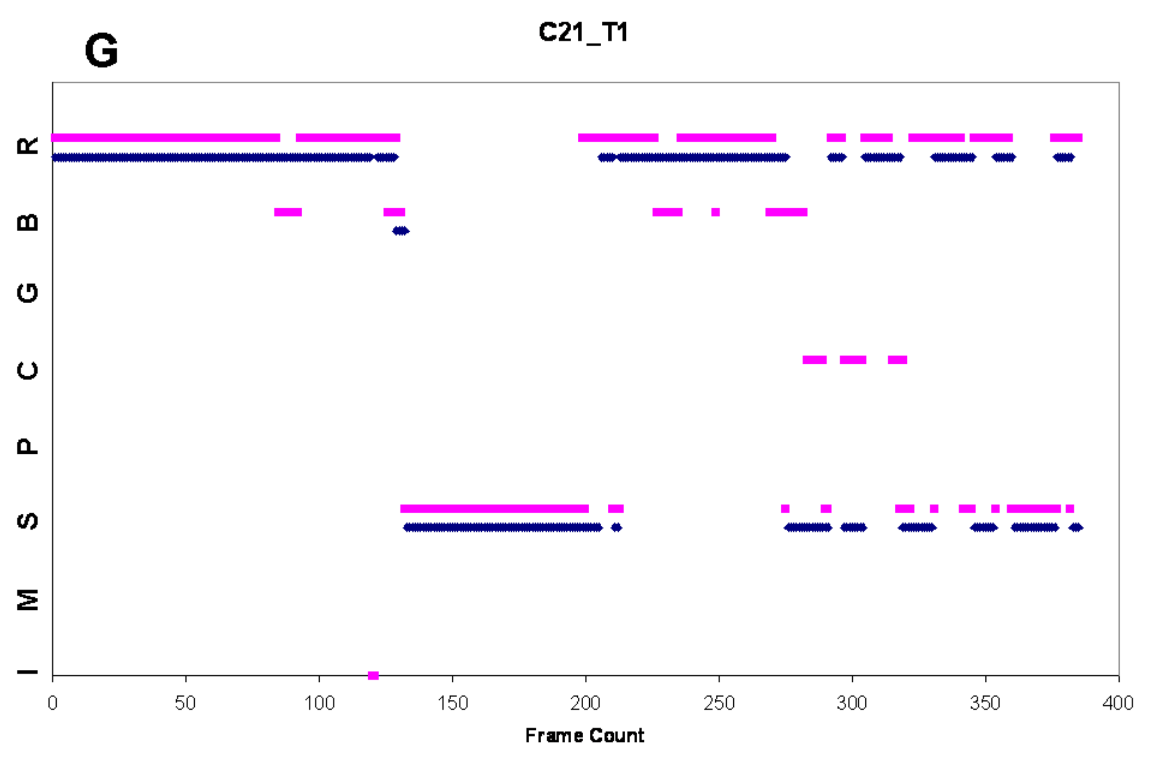

B
C19_T2
R
B
G
C
P
S
M
I
0
50
100
150
200
250
300
350
400
Frame Count


C
C19_T3
R
B
G
C
P
S
M
I
0
50
100
150
200
250
300
350
400
Frame Count


D
C19_T4
R
B
G
C
P
S
M
I
0
50
100
150
200
250
300
350
400
Frame Count


E
C20_T1
R
B
G
C
P
S
M
I
0
50
100
150
200
250
300
350
400
Frame Count


F
C20_T2
R
B
G
C
P
S
M
I
0
50
100
150
200
250
300
350
400
Frame Count


G
C21_T1
R
B
G
C
P
S
M
I
0
50
100
150
200
250
300
350
400
Frame Count

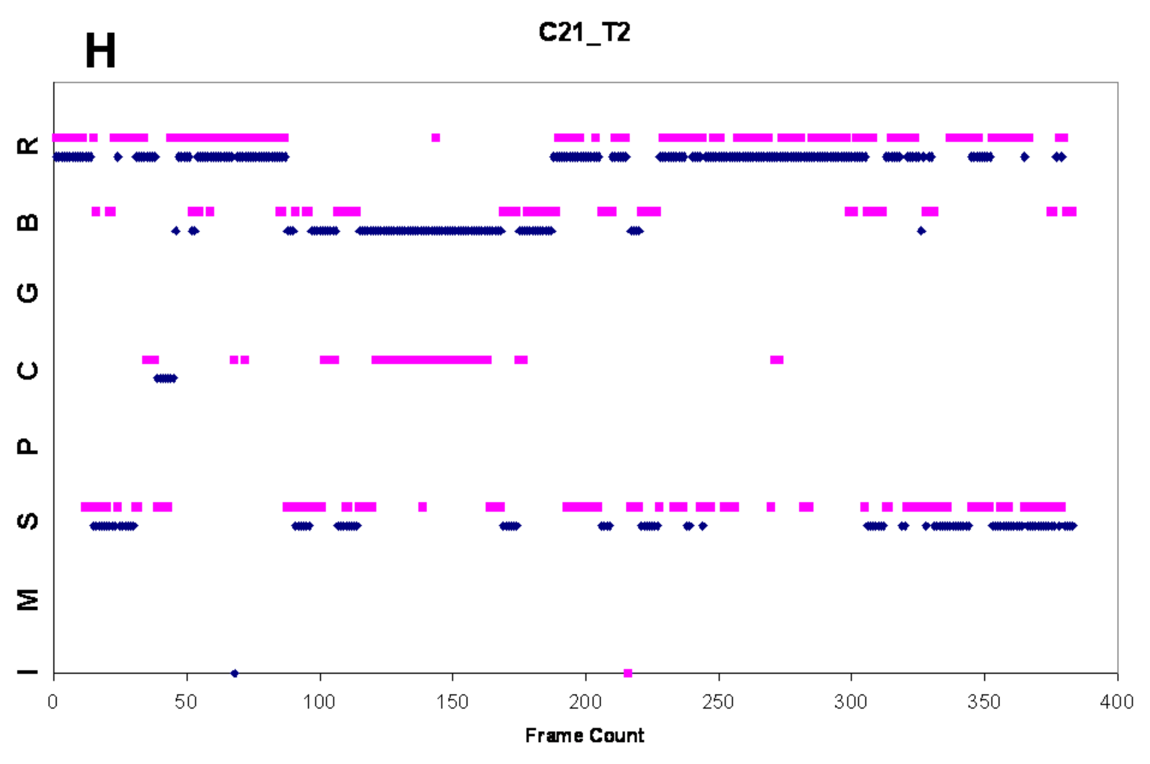


Figure 2: Graphs A-H are scatter plots of primary and secondary habitat types. The blue (darker) data points are the primary habitat and the pink (lighter) data points are the secondary habitat types. The Y-axis labels are the letter codes for the habitat; R=Rock, B=Boulder, G=Gravel, C=Cobble, P=Pebble, S=Sand, M=Mud, I=Incomplete frame. The X-axis represents the number of 10-second frames the feature was recorded.

How does the collection of videographic data on a frame-by-frame basis compare to the real-time collection of data at one-minute intervals?

The patch size comparison data for the hard substrates between the ten second and one minute intervals was not normal (Kolmogorov-Smirnov = 0.255, dF = 109, $p<0.001$; Shapiro-Wilk = 0.630, dF = 109, $p<0.001$). This violates the assumptions of the student's t-test so a non-parametric Mann-Whitney-U test was run. The results of the test suggest that patch size of hard substrate between the two sampling intervals was significantly different ($z = -3.059$, $p = 0.002$).

Table 4: The Percent cover difference between ten second sampling intervals and one minute sampling intervals			**10 Second Intervals**		**1 Minute Intervals**		**Percentage Difference Total**		**Absolute Percentage Change Between soft and hard**	
			Total Percent cover		Total Percent cover					
			Primary	Secondary	Primary	Secondary	Primary	Secondary	Primary	Secondary
Substrate	Soft	Mud	26.0%	29.1%	25.48%	29.33%	-0.50	0.28	1.30	1.05
		Sand	19.4%	12.4%	20.19%	13.22%	0.80	0.78		
	Hard	Pebble	0.0%	2.5%	0.00%	2.40%	0.00	-0.14	2.97	1.78
		Cobble	2.3%	8.2%	1.92%	8.65%	-0.34	0.41		
		Gravel	0.0%	0.0%	0.00%	0.00%	0.00	0.00		
		Boulder	8.0%	11.5%	8.17%	11.78%	0.13	0.26		
		Rock	36.9%	28.8%	39.42%	29.81%	2.49	0.96		
		Incomplete	3.3%	3.3%	4.81%	4.81%	1.53	1.53		
Relief		Bioturbaded	0.0%	26.4%	0.00%	26.44%	-0.04	0.06		
		Flat	29.3%	15.7%	29.33%	16.59%	0.03	0.91		
		Ripple	3.2%	0.7%	3.13%	1.20%	-0.07	0.52		
		Wavy	12.6%	0.8%	12.74%	0.96%	0.09	0.15		
		Low	27.3%	30.1%	28.61%	31.25%	1.33	1.15		
		Moderate	20.3%	18.5%	21.39%	17.55%	1.11	-1.00		
		High	0.0%	0.6%	0.00%	1.20%	-0.04	0.56		
		Incomplete	3.3%	3.3%	4.81%	4.81%	1.53	1.53		

The patch size comparison for the soft substrates violated the same assumptions of normality (Kolmogorov-Smirnov = 0.381, dF = 111, p<0.001; Shapiro-Wilk = 0.262, dF = 111, p<0.001). A Mann-Whitney-U was ran again and the results suggest that the patch size of soft substrate between the two sampling intervals was also significantly different (z = -3.121, p = 0.002).

Table 2 shows the mean patch sizes for the two sampling intervals and there is about a 75% loss in patch size for the soft substrate and a 59% loss in patch size for the hard substrate. This also suggests that there is a loss in data due to the decreasing patch size mean. Table 4 shows the differences in percent cover of each habitat type and its coinciding relief. Every relief experienced some percentage change ranging from a decrease in 1% to an increase by 1.3%. The only substrate types that had no changes were that of the ones that weren’t recorded. There were no primary pebble or gravel and no secondary gravel meeting the requirements to be considered primary/secondary so there could not be a change in percent cover. The range of substrate percent covers varied from a decrease in 1.00% or and increase in 2.49%.

The percentage changes, when coupled between hard and soft substrate were noticeable as well. The absolute percentage change in primary and secondary soft habitat was 1.30% and 1.05% respectfully. Hard substrate had a larger absolute percentage change with a 2.97% change in the primary classification and a 1.78% change in the secondary classification.

Discussion:

Spatial pattern studies are a crucial first step to understanding the abundance and distribution of organisms, as well as to provide a basis for monitoring their long-term changes due to both natural and human disturbances (Garcia-Charton et al. 2004). The results of my capstone provide the only version of such a study for the new PBSMCA. It gave the first and only quantitative spatial description of the PBSMCA. This study quantified distribution of seafloor attributes, the scale and which the attributes occur, and evaluated the sampling technique. This provides a standard for future towed camera sled studies to build upon.

The differences between the primary percent covers for the hard and soft substrate habitat were fairly even which is somewhat surprising giving the apparent randomness of the Graphs C, E, G, and H. When observing the graphs, particularly A, B, it would seem that there would be an extreme skew towards the soft substrate but the soft substrate was actually about 2% less than that of the hard.

The main differences between the soft and hard substrate was that of the secondary habitat. There was a difference of 9.7% between hard and soft substrate with rock and boulder making up most of the percent cover. A pattern that was observed was that in most cases, areas that have a primary classification of sand (soft substrate), usually had some type of rock, cobble, pebble, or boulder in the upcoming frames where it could be classified as secondary habitat. This was usually not the case with Soft substrate. When the camera was moving over a boulder field, or slaty rock uplifted shelves, there was usually not any sand in the upcoming frames and the habitat was somewhat homogenous with respect to hard substrate.

Another notable pattern was that when there was a primary classification of hard substrate, then there usually was a secondary classification of hard substrate as well. This is also evident in figure 2. When the graphs are separated between soft and hard substrate you rarely see a primary classification of hard substrate with a secondary classification of soft. Since hard substrate was seen more, then we should expect to see a greater amount of secondary hard substrate which is exactly what was observed.

The spatial patterns observed in marine landscapes influence ecological processes and are a result of complex interactions between biological, physical, and social forces (Turner 1989). Understanding these spatial patterns and the scales at which they occur is a vital tool for classifying the areas that are most essential for sustainable, productive, and diverse marine ecosystems. Being able to recognize the differences in species habitat interactions and how they vary between different habitats is important with respect to spatial management and it can be used in MPA designation and implementation.

The patch size comparisons showed a big difference when they were evaluated at 10-second intervals as opposed to 1-minute intervals. There was a loss of data by the patch sizes becoming smaller, and the differences between soft and hard substrate were not as noticeable by having a difference of averages of 0.57 frame counts. It almost makes the averages seem the same which was not the case for the 10-second sampling intervals. This suggests that sampling technique (10-second vs. 1-minute intervals) can alter the results of a study greatly.

Sleds have been used effectively in both shallow and deep seafloor surveys but they have somewhat of an inability to negotiate hard or rough bottom features without a high risk of damage or loss of the system (Barker et al. 1999). Spencer et al. (2005) noted that their camera sled performed better in low-relief areas. This is affirmed in my study by reviewing the graphs of A, F, G, and H where the habitat patch sizes were visually larger and there were less sporadic changes per unit time than that of the other graphs. In the transects (graphs) B, C, E, and F, there was an abundance of incomplete frames where the habitat changed randomly numerous times at small time intervals. These quick changes resulted in small habitat patch sizes where the changes don't follow a certain pattern. This is probably the reason for the abundance of incomplete frames because as mentioned earlier, the towed camera sled is tethered to the topside platform and its altitude above the seafloor bottom is controlled manually by a winch operator on the topside platform.

Sampling technique selection is among the most important decisions to be made prior to the sampling in aquatic habitats (Muzaffar and Colbo 2002). When comparing aquatic communities, sampling techniques that best capture samples that are representative of the community will yield the highest quality of results.

The Mann-Whitney-U statistical analysis showed that there was a significant loss of substrate when the different sampling techniques were analyzed. With the combination of differences between the average patch size of habitat and the results of the Mann-Whitney-U test, my results confirm that a frame-by-frame analysis of the videographic data is superior to the real-time sampling of 1 minute intervals.

This comes as no surprise because fifty seconds of data was deleted for every ten seconds of data that was kept. Although the percent changes shown in table three are showing an increase in the abundance of substrate or relief, this is most likely due to the fact that other different habitat types and relief were lost in that fifty second time interval that was omitted. Since percentages are a proportion, the amount of rock habitat appears to go up, but it only goes up proportionally to the rest of the data set. So what may be seen as an increase is actually a considerable loss of data. Table 2 shows that the number of patches and the total number of habitat type (soft or hard) that was recorded and it shows that both the hard and soft substrate habitat patch sizes declined with the larger intervals.

With the advancement of newer technologies and software such as towed camera sleds, providing data for sound MPA management has become easier and more cost effective (Barker et al. 1999). Site characterizations of previously unexplored areas are an essential step for using MPAs as a spatial management tool (Garcia-Charton et al. 2004). The baseline data collection is critical for monitoring overtime because comparisons to the baseline data can be made in the future. In order to have optimal baseline data, a sampling technique that yields the most accurate data must be used in order to get an accurate spatial description of the seafloor communities (Muzaffar and Colbo 2002). It is recommended that future studies adopt this study's sampling techniques and acquire more videographic data so that optimal marine management practices can be achieved.

Acknowledgements

I'd like to first and foremost thank Dr. James Lindholm for agreeing to be my capstone advisor for the past year and giving me the opportunity to participate in this great ongoing project. I'd like to thank the lead organization, the Institute for Applied Marine Ecology (IAME) at California State University Monterey Bay (CSUMB), all the project partners Dr. Andrew DeVogelaere (MBNMS), Jean de Marignac (MBNMS), the collaborators Dr. Rick Starr (Moss Landing Marine Labs) and Mary Yoklavich (National Marine Fisheries Service), the crew of the NOAA Vessel *Fulmar*, and my CSUMB peers Ashley Knight, Donna Kline, Jake Hinkle, and Jessica Watson.

Literature Cited

Anderson TJ, Yoklavich MM. 2007. Multiscale habitat associations of deepwater demersal fishes off central California. Fishery Bulletin 105: 168-179.

Anglin, L. 2007. Use of a towed camera sled for benthic continental shelf characterization and monitoring in the sanctuary. Monterey Bay National Marine Sanctuary Draft. Pages 3-46.

Auster PJ Lindholm J, Schaub S, Funnell G, Kaufman LS, Valentine PC. 2003. Use of sand wave habitats by silver hake. Journal of Fish Biology 62(1): 143-152.

Barker BA, Helmond I, Bax NJ, Williams A, Davenport S, Wadley VA. 1999. A vessel-towed camera platform for surveying seafloor habitats of the continental shelf. Continental Shelf Research 19: 1161-1170

Begg GA, Mapstone BD, Williams AJ, Adams S, Davies CR, Lou DC 2005. Multivariate life-history indices of exploited coral reef fish populations used to measure the performance of no-take zones in a marine protected area. Canadian Journal of Fisheries and Aquatic Sciences 62(3): 679-692.

[CDFG1] California Department of Fish and Game [date unknown]. Why the California marine life protection act initiative? [Internet]. [cited 2007 October 15]. Available from: http://www.dfg.ca.gov/mlpa/highlights.asp

[CDFG2] California Department of Fish and Game [Aug 2007] Landmark "central coast" marine protected areas will be in effect sept. 21. california's marine life protection act launched as first region opens. [Internet]. [cited 2007 November 4, 2007]. Available from: http://www.dfg.ca.gov/news/news07/07065.html

Clinton B. 2000 May 26. Principles Marine protected areas. Executive Order 13158. <http://www.nepa.gov/nepa/regs/eos/eo13158.html>. Accessed 2007 Dec 21.

Dayton PK, Thrush SF, Agardy MT, Hofman RJ. 1995. Environmental effects of marine fishing. Aquatic Conservation: Marine and Freshwater Ecosystems 5: 205-232.

Friedlander AM. 2001. Essential fish habitat and the effective design of marine reserves: application for marine ornamental fishes. Aquarium Sciences and Conservation 3:135-150

Garcia-Charton JA, Perez-Ruzafa A, Sachez-Jerez P, Bayle-Sempere JT, Renones O, Moreno D. 2004. Multi-scale spatial heterogeneity, habitat structure, and the effect of marine reserves on Western Mediterranean rocky reef fish assemblages. Marine Biology 144: 161-182.

Lindholm J, Auster P, Valentine P. 2004. Role of large marine protected area for conserving landscape attributes of sand habitats on Georges Bank (NW Atlantic). Marine Ecology Progress Series 269: 61-68.

[MPA] All about marine protected areas [2007]. [Internet]. [cited 2008 April 14]. Available from: http://www.mpa.gov/all_about_mpa/basics.html

Muzaffar SB, Colbo MH. 2002. The effects of sampling technique on the ecological characterization of shallow, benthic macroinvertebrate communities in two Newfoundland ponds. Hydrobiologia 477: 31–39.

[NMPAC] National Marine Protected Areas Center. 2008. Clarifying Misconceptions About Marine Protected Areas. [Internet]. Available at: <http://mpa.gov/pdf/helpful-resources/factsheets/mpamisconceptions2.pdf>

Rooper C., Zimmermann M. 2005. Using video to map distribution of habitat and fish in Alaska. Pages: 2-3 In: Somerton, D. A. and C. T. Glendhill (editors). 2005. Report of the National Marine Fisheries Service Workshop on Underwater Video Analysis.

Somerton, D. A. and C. T. Glendhill (editors). 2005. Report of the National Marine Fisheries Service Workshop on Underwater Video Analysis. U.S. Dep. Commerce, NOAA Tech. Memo. NMFS-F/SPO-68,69 p.

Spencer ML, Stoner AW, Ryer CH, Munk JE. 2005. A towed camera sled for estimating abundance of juvenile flatfishes and habitat characteristics: Comparison with beam trawls and divers. Estuarine, Coastal and Shelf Science 64: 497-503

Stevens BG. 2005. Use of video and sector scanning sonar for studying tanner crab aggregations. Pages 6-7 In: Somerton, D. A. and C. T. Glendhill (editors). 2005. Report of the National Marine Fisheries Service Workshop on Underwater Video Analysis.

Stevens T. 2005. Scales of similarity in soft sediment epibenthic assemblages: implications for marine protected area design. Marine Biology 146(2): 345-354.

Stone R, Brown E. 2005. Use of underwater video at the auke bay laboratory. Pages 14-15 In: Somerton, D. A. and C. T. Glendhill (editors). 2005. Report of the National Marine Fisheries Service Workshop on Underwater Video Analysis.

Suman D, Shivlani M, Milon JW. 1999. Perceptions and attitudes regarding marine reserves: a comparison of stakeholder groups in the Florida Keys National Marine Sanctuary. Ocean and Coastal Management 42: 1019-1040.

Turner MG. 1989. Landscape ecology: the effect of pattern on process. Annual Review of Ecology and Systematics 20: 171-197.