Comparison Gastrointestinal Parasite Species Richness in Peruvian Black Headed Night Monkeys

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Introduction

- Zoonotic transmission of parasites and other diseases between primates and humans has been fairly common. There is evidence that it has been responsible for the introduction of HIV and the Ebola outbreak.
- This is relevant in areas that have a high level of contact with primates through hunting bush-meat, a common practice in impoverished areas of the Amazon.
- Several studies have been done on parasites in other primate species correlating the effects of habitat disturbance and fragmentation with parasite abundance (Gillespie 2006; Gillespie and Chapman 2008; Young et al. 2013).
- *Aotus nigriceps,* the Black Headed Night monkey, has been used extensively for malaria study. It is naturally resistant to malaria but can also be infected with the human strain when directly exposed (Herrera et al. 2002).
- *Aotus nigriceps* has not been part of any extensive study of gastrointestinal parasites previously.

Methods

The studies were conducted on a section of the Peruvian Lowland Rainforest in the Kosnipata Valley of the Amazon Basin as part of the Amazon Conservation Association.

Initially 4 *A. nigriceps* groups were located and followed using GPS. During the course of the study those either groups changed location or did not yield usable fecal samples.

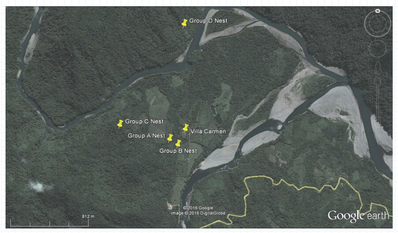
Samples were collected using large nets which were played under nesting sites at night while the monkeys were out feeding.

Methods

This was the first, preliminary study of parasites in *Aotus nigriceps.*

Fecal samples were collected and analyzed in the Pillcopata medical center using sedimentation techniques. Samples were shaken into a solution, strained, and run through a centrifuge. The remaining sediment was examined under a compound microscope.

All parasites seen were photographed and measured for identification through comparison to a textbook on parasitology.



Map 1. Nesting sites for collection

Monkey	Distance to human disturbance	Distance to Road
Group A	0.2 km	0.91 km
Group B	0.19 km	0.8 km
Group C	0.69 km	1.45 km
Group D	1.13 km	1.75 km

Fig 1. Table of Disturbance distances

Parasites	Group A	Group D
Strongyloides sp.	X	X
Trypanoxiuris sp.	X	
Enterobius sp.		X
Ucinaria sp.		X
Dicrocoelium sp.		X
Trematode #1		X
Trematode #2		X
Trematode #3		X
Hookworm #1		X

Fig 3. Parasites found in two groups

Table 1. Previously observed gastrointestinal parasites in the *Aotus* genus

Nematode	*Trypanoxiuris* sp.
	Strongyloides spp.
	Molineus torulosus
	Primasusbulura jacchi
	Schistosoma mansoni
	Trichuris trichiura
	Ascaris sp.
	Uncinaria sp.
Apicomplexa	*Isospora* sp.
Heterokonta	*Blastocystis sp.*
	Chilomastix mesnili
Flagellate	*Trypanosoma* sp.
	Trichomonas hominis
	Giardia spp.
Sarcodina	*Entamoeba* sp.
	Endolimax nana
	Toxoplasma sp.
Trematodes	*Athesmia heterolecithoides*
	Zonorchis goliath
	Phaneropsolus orbicularis
Cestode	*Hymenolepis diminuta*
	Taenia sp.

Results

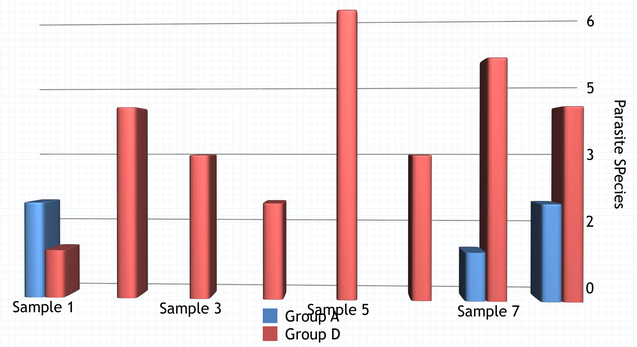


Fig 2. Chart of parasite abundance of the two groups at the disturbance distance extremes.

Fig 4. *Trypanoxiuris* sp.

Fig 5. *Strongyloides* sp.

Fig 6. *Dicrocoelium* sp.

Fig 7. *Enterobius* sp.

Discussion

The parasites *Enterobius* sp. and *Dicrocoelium* sp. were potentially positively identified in Group D, this is the first time these have been seen in the *Aotus* monkey. The importance of the presence of *Dicrocoelium* sp. appears when we know that it is primarily transmitted through infected ants and one of the primary eating sites observed for Group A was the *Cecropia* sp. tree, a host for ant colonies.

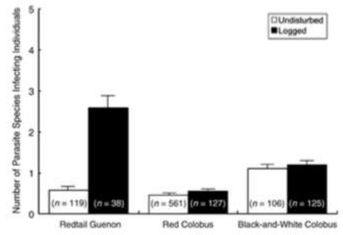


Fig 10. Findings from another primate study show a normal trend that would be directly opposite to my findings.

Further Study

The initial findings of this study provided an interesting basis for further study. Since the results of my study seem to be inverted from the others, a more thorough analysis of a larger sample size could demonstrate possible explanations to other factors like reduced competition or simply temporal fluctuations.

Additionally, I would like to examine the link to dietary composition, including the use of medicinal herbs to reduce parasite infection, which has been seen in other primate species.

An Interdisciplinary Analysis of Climate Change Education Programs and Applicability to the Climate Change Partners

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DUE-1239797

Introduction

The City of San Diego is taking great strides to prepare for the major problems that the City faces in regards to climate change (Fig. 1). The University of San Diego was one of six programs nationwide granted funding for climate change education research and strives to prepare our decision makers with the knowledge necessary from scientific, behavioral and communicative backgrounds to efficiently address climate change.

Due to the need and capacity for the Climate Education Partners to expand its resources into other educational programs, such research was warranted in order to identify replicable and viable programs for climate change education.

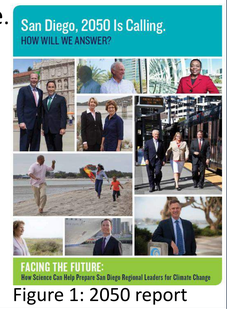

Figure 1: 2050 report

Methods

Quantitative Capture:

- Curriculum emphasis—# of courses offered with science or communication related material
  - 1=Low, 2-3=Moderate, 4=High
- Total hours dedicated to multi-day workshop/ conference/forum etc.
  - 1-4 hours=low, 4-8=moderate, 8-12=high

Communication Qualification:

- Time dedicated to presentations/ discussions
- Capacity of formal and informal peer networking
- Utilization of social media networks
- Was the majority of content grounded in communication efforts

Scientific Qualification:

- Analysis of online videos, webinars, pamphlets, speakers, and scientific article content
- Time spent discussing science in presentations/discussions
- Availability of all resources regarding science content vs. exclusive availability of content

Partnership Qualification:

- Adequate overall curriculum
- Emphasis identified in communication and science content
- Representative sampling of program diversity
- Related space for CEP to work with and into

*Term Definitions:
Educational Space—The format in which programs provided there education (i.e. online, formal meetings)
Organization Classification—The type of group heading educational programs (i.e. NGO, academic)
Sector Focus—The sectors in which a program may have given special attention (i.e. private, public, health)

Results

Geographical Reach + Primary Audience + Educational Space*

Organization Classification* + Curriculum Analysis

Sector Focus*

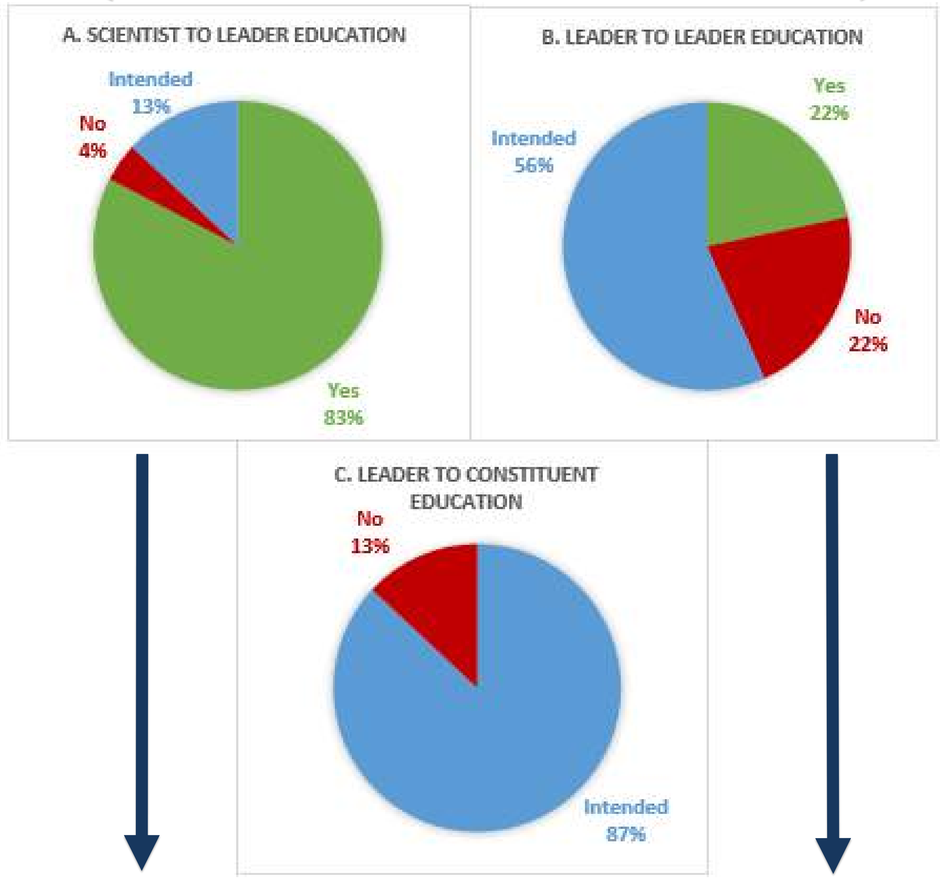

Figure 2: Breakdown of education source and permeability in decision makers.

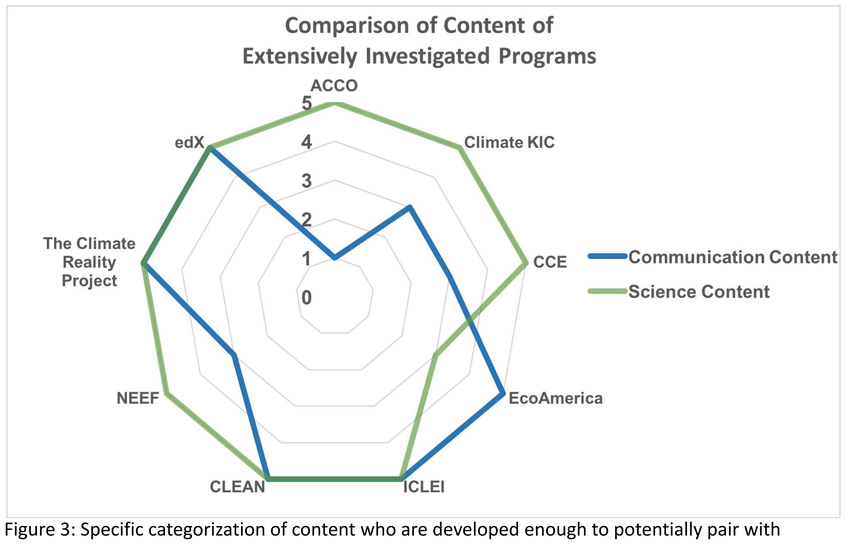

Figure 3: Specific categorization of content who are developed enough to potentially pair with the Climate Education Partners.

Discussion

General Overview:

- Multiple variables played significant roles in determining success and reach of each program
- Majority programs focus on scientist to leader education (Fig. 2A)
- Lack of explicit expression of Leader to Leader collaboration in large proportion of sample programs (Fig. 2B)
- Virtually no explicit emphasis on Leader to Constituent education, although implied (Fig. 2C)

Extensive Analysis:

- Sub-sample (n=9) programs indicated greatest viability
- Each exerted significant value on climate science content
- Each exerted focus in communication and behavioral sciences however, prose areas for expansion

Climate Education Partners
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Conclusion

The majority of programs exert a high emphasis of scientific content and harbor the capacity to expand communicative and behavioral approaches. In order to access real time effectiveness of education, further policy investigation as a direct result of partaking or becoming certified through these programs must take place.

ACCO, ClimateKIC, CCE, Climate Reality Project and EcoAmerica were suggested for potential partnership with CEP due to successful infrastructure and established networks.

Acknowledgments

Special thanks to Dr. Michel Boudrais for allowing me to partake in San Diego's climate initiative and to Christiana DeBenedict and CEP who supervised and mentored my research.

Calibrating an XRF for In-Field Metals Detection

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Background

- X-ray fluorescence (XRF) spectrometry has been widely used to determine the elemental compositions of rocks and dry soils
- Little preparation of samples required, XRF reduces the cost of sample transportation and storage (*Parsons et. al.. 2013*)
- XRF analysis is sensitive to interstitial moisture, soil texture (sand, silt, clay), and elemental interference. (*Weindorf et. al., 2012*) (*Zhu et. Al., 2011*) (*Parsons et. al.. 2013*)
- Studies have examined the use of a portable XRF to determine total metals concentrations by TCLP and AAS Analyses (*Stark et. al., 2008) (Radu and Diamond, 2009*)
- EPA Method 6010 comparison with XRF results is poorly represented in the literature
- **The goal of this study is to test the validity and accuracy of XRF analysis compared to EPA Method 6010**

Figure 1. Sampling the San Diego Formation

Methods

- 49 samples collected from the Scripps Formation, Torrey Sandstone, Penasquitos Formation, Friar's Formation, and San Diego Formation
- Samples analyzed by XRF for total metals concentrations
- Samples analyzed by a California Certified Analytical Laboratory by EPA Method 6010 (Partial Digestion)
- XRF and Lab results for each sample analyzed by linear regression
- Half of the Method Detection Limit value was used when non-detect values occurred

Figure 2. Innov-X Systems X-50 Mobile XRF used in study

Results

Table 1. r^2 values listed by formation: yellow highlighted values represent >50% r^2 value, red (blue) outline indicates the highest (lowest) r^2 value per formation

Formation	Classification	Metal	R^2
Friars	SM	As	0.8412
Friars	SM	Ba	0.0569
Friars	SM	Co	0.0065
Friars	SM	Cr	0.0002
Friars	SM	Cu	0.8537
Friars	SM	Pb	0.9148
Friars	SM	Zn	0.8176
San Diego	SM	As	0.8844
San Diego	SM	Ba	0.1585
San Diego	SM	Co	0.8468
San Diego	SM	Cr	0.1885
San Diego	SM	Cu	0.4487
San Diego	SM	Pb	0.9784
San Diego	SM	Zn	0.7359
Scripps	SM	As	0.6841
Scripps	SM	Ba	0.008
Scripps	SM	Co	0.5846
Scripps	SM	Cr	0.4154
Scripps	SM	Cu	0.923
Scripps	SM	Pb	0.8765
Scripps	SM	Zn	0.6965
Torrey_Sand	SP	As	0.6263
Torrey_Sand	SP	Ba	0.0164
Torrey_Sand	SP	Co	0.1011
Torrey_Sand	SP	Cr	0.0145
Torrey_Sand	SP	Cu	0.0371
Torrey_Sand	SP	Pb	0.0827
Torrey_Sand	SP	Zn	0.0028

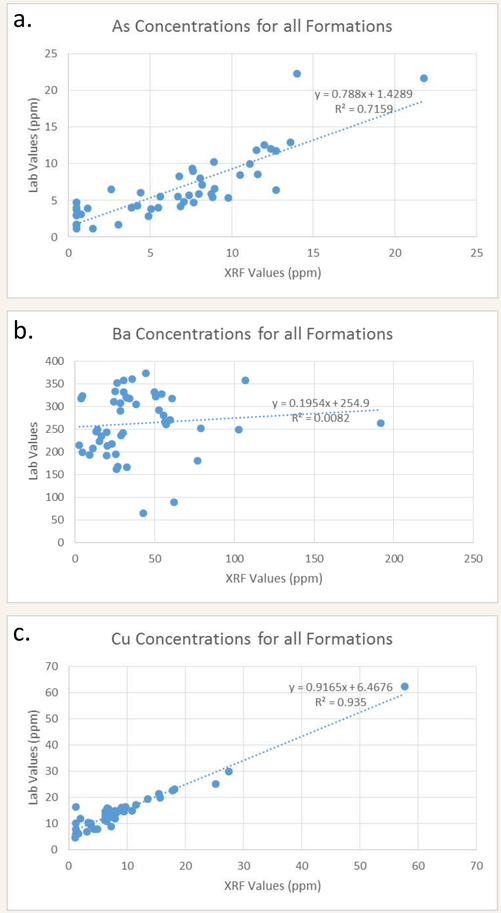

Figure 3. Scatter plot of XRF and Laboratory analytical results with a linear regression and r^2 value for a) Arsenic b) Barium c) Copper

Discussion

- As, Cu, Pb, and Zn had the best relationship between XRF and Lab values
  - The most soluble metals tend to have the highest r^2 values
  - The XRF values tend to be conservatively high for all metals
- Silty Sand (SM) had higher r^2 values
  - Torrey Sandstone had the lowest r^2 values and coarsest sediments
- XRF was ineffective for Ba and Cr
- XRF values are conservatively high
- Soil characterization requires an 80% UCL for the contaminant of concern

Conclusion

The XRF is suitable tool for in-field metals analyses for As, Cu, Pb, and Zn in silty sands and likely finer grained soils.

Future Directions

- Dry and sieve samples before analysis to test if moisture and particle size have an affect on accuracy
- Include additional samples representing clays, silts, and pure sands

Acknowledgements

I would like to thank Advantage Environmental Consultants, LLC and EnviroMatrix Analytical

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Effects of Hydrographic Conditions on Phytoplankton Communities in Mission Bay, San Diego

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Introduction

- **Phytoplankton** are unicellular organisms in upper layer of the oceans
- They **vertically migrate** in relation to nutrient, light availability, and hydrographic conditions
- High temperature waters tend to be lower in nutrients and phytoplankton abundance[2]
- Chlorophyll a can be used as a proxy for **phytoplankton abundance**
- Shape of a body of water affects the effectiveness of tidal flushing: to higher temperatures farther from mouth

Objective

To determine how phytoplankton abundance is affected by hydrographic conditions in Mission Bay over monthly time scales and how they vary spatially from the mouth to the back of the bay.

Mission Bay

- Modified from marsh-land; oddly shaped[1]
- Effects of tide exerted more strongly near mouth causes spatial gradient from front to middle to back bay
- Biogenous and terrigenous input near back of the bay[2]

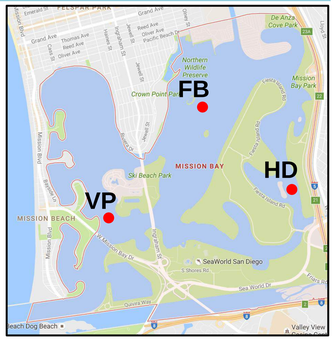

Fig. 1. Map of Mission Bay with sampling sites: VP is Ventura Point, FB is Fiesta Bay, and HD is Hilton Dock.

Methods

- Chlorophyll samples and hydrographic data taken in three locations every two hours over 24 hours from the surface and bottom of the water column
- In lab, chlorophyll samples filtered and frozen until chlorophyll abundance was measured using fluorometer

Fig. 2. Pumped water chlorophyll samples collection.

Results

Table 1. Temperature and salinity representative data averages for each site and each month of sampling. Sampling locations are Ventura Point (VP), Fiesta Bay (FB), and Hilton Dock (HD) in order from top to bottom. Averages in blue and red indicate greater variability in data set.

Increasing Salinity ↓ / Increasing Temperature ↓

Site		July	August	September
VP	Salinity	35 ± 0.5	34 ± 0.1	34 ± 0.1
	Temp (°C)	23 ± 1.0	20 ± 2.5	18 ± 2.0
FB	Salinity	35 ± 0.2	35 ± 0.4	35 ± 0.3
	Temp (°C)	25 ± 1.0	22 ± 1.0	23 ± 1.0
HD	Salinity	36 ± 0.1	36 ± 0.1	36 ± 0.1
	Temp (°C)	28 ± 0.3	26 ± 0.3	24 ± 0.3

Increasing Temperature →

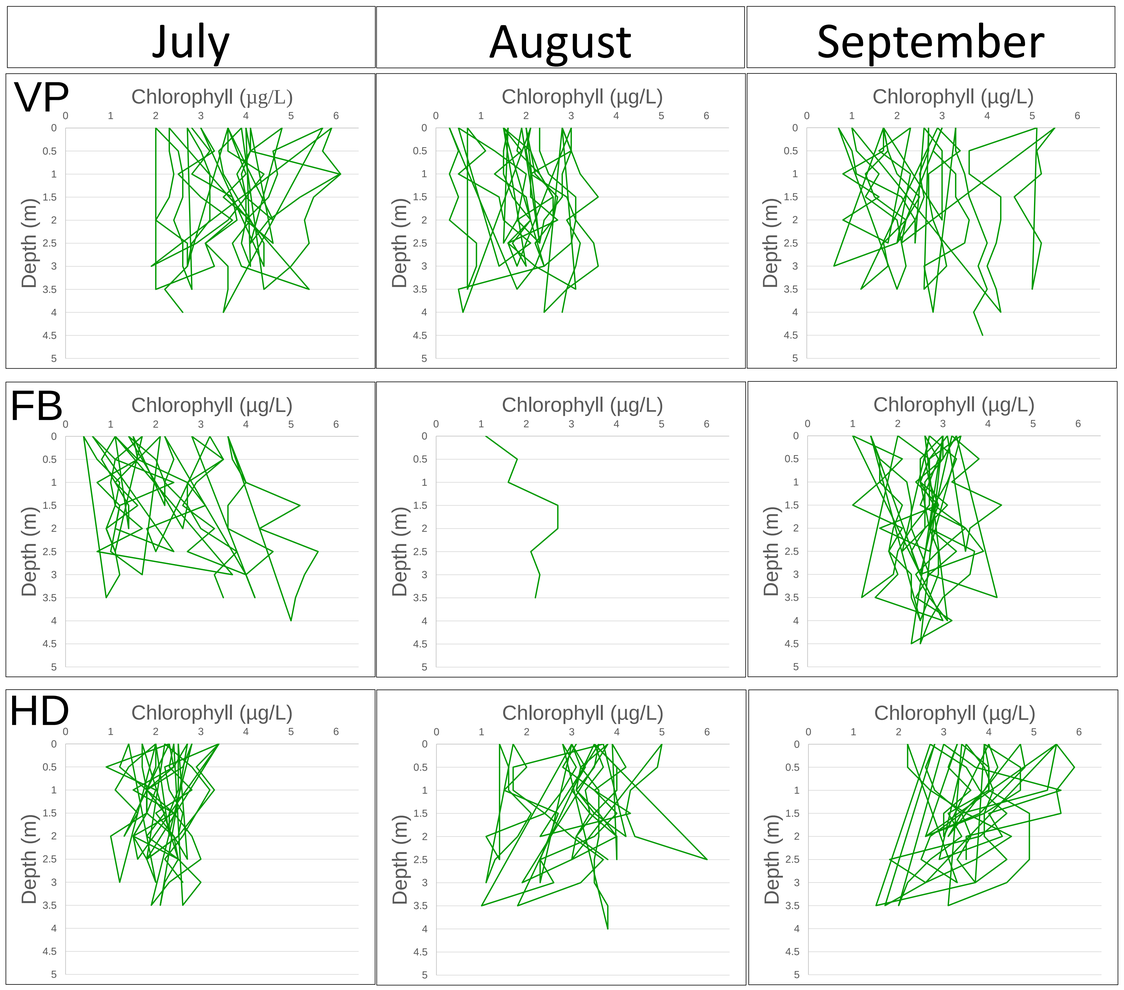

Fig. 3. Chlorophyll profiles taken via YSI multimeter. Each profile indicates reading taken every two hours. Sampling locations are Ventura Point, Fiesta Bay, and Hilton Dock in order from top to bottom. Regular readings for Fiesta Bay were not taken due to instrument failure.

Conclusions

- Odd shape of bay causes uneven influence of tidal flushing and resultant trends of increasing temperature and salinity with distance from the bay mouth
- Nutrients from the ocean via tides are unequally distributed in bay
- Phytoplankton communities are present throughout the bay horizontally
- Warmer back bay may not be as nutrient-depleted as previously hypothesized
- Vertical distribution of phytoplankton varies based on light availability
- Greater light availability tends to coincide with lower abundances at the surface

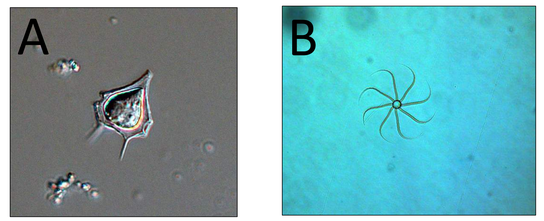

Fig. 4. Images of phytoplankton common in Mission Bay, San Diego. A) Protoperidinium oceanicum, and B) Bacteriastrum delicatulu

Discussion

- Phytoplankton welfare, abundance may change with global climate change and rising temperatures
- It is important to understand how phytoplankton are affected by changes to their habitat now to predict phytoplankton livelihood in the future
- Future studies could explore the relationship between the relative abundance and distribution of phytoplankton and zooplankton

Acknowledgements

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Combating the Race Gap in STEM Education for Students of Color

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Introduction

- Access to STEM education is far from equitable.
- Research shows higher test scores on average in STEM related subjects for K-8 education in white students than students of color.
- There are multiple programs to combat this inequality in STEM education, including out-of-school programs and field trips.
- I was able to implement these methods in communities of color during my internship with the Ocean Discovery Institute (ODI).

Figure 1. *ODI students assessing water quality*

Objective

To evaluate out of school programs that engage youth of color in STEM related careers and subjects.

Methods

Five papers were reviewed. Each paper focused on a different method used to engage youth of color in the sciences.

Paper 1

- The study used a K-8 school in Boston with the large majority of students being low-income students of color.
- An evaluation was administered.

Paper 2

- Used critical ethnography.
- Intensive notes were taken during an after-school STEM program on the teacher-student interactions, student engagement, the execution of the curriculum in the classroom.
- Students engaged in 30-40 minute interviews.

Methods cont.

Paper 3

- These scientists used a 2-week camp that utilized inquiry-based activities.
- 158 students were selected by three middle schools nearby based on ethnic diversity and previous knowledge of science subjects. A wide range of student ethnicities and student academic abilities were selected (average grade in science classes).
- Two quantitative surveys were administered to 79 participants of the science camp and 39 were given to those who applied but were not accepted (control group).

Paper 4

- The authors used a project-based science curriculum in 5 different schools in the Midwest that consisted of 86% or greater of underrepresented minority students.
- An evaluation of the courses was administered.

Paper 5

- The scientists used a community garden and had students practice science in the garden.
- Interviews and recorded conversations were used.

Results

Several themes can be observed across each program and non-traditional learning environment for youth of color in STEM related fields. These themes include:

- Increased neighborhood social connection, civic engagement, and interest in STEM related careers.
- Increased science interest when learning in environments that valued social connections.
- Increased positive attitude toward science and a greater interest in STEM.
- Increased academic success in STEM subjects
- Informal learning projects and environments promote science learning, even if science isn't the obvious objective.

Figure 2. *Instructor guiding ODI student*

Table 1. Evaluation of Programs

	Paper 1	Paper 2	Paper 3	Paper 4	Paper 5
Inquiry based learning increases STEM interest	✓	✓	N/A	✗	✓
Field trips increase STEM interest	✓	✓	✓	✓	✓
After school programs increase academic scores	✓	✓	✓	✓	✓

Discussion

- Inquiry based learning requires the student to think critically and creatively, fully engaging the student.
- Field trips are appealing to students because they break the regular classroom environment.
- Learning in the field helps students connect certain concepts learned within the classroom to the outside environment.
- Field trips can minimize the discomfort and fear of STEM subjects and show students that science is able to be learned and understood.
- After school programs offer a combination of inquiry based learning and field trips, in turn increasing academic performance.
- ODI programs involve movement and certain dance moves that aid students in remembering scientific terms.
- ODI youth were able to learn scientific terms simply by talking about them with each other or by hearing them repeatedly in the classroom.

Figure 3. *ODI students pipetting solution*

Acknowledgements

I would like to thank the Ocean Discovery Institute for having me as an intern this past Summer and giving me the opportunity to teach and interact with the youth in the San Diego community. I would also like to thank Eric Cathcart for helping me throughout my literature review.

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Efficacy of MPAs on the TCI Bank Determined by Queen Conch Densities

By MacKenzie Cordan

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Introduction:

- *Lobatus gigas* (Queen Conch) is a large, marine mollusk found Caribbean Archipelago (McCarthy 2008, Stoner et al. 2012).
- South Caicos is the largest exporter of conch in the islands and the economy relies on them heavily (Bene et al. 2003, Davis et al. 2005)
- Due to increased demand and overfishing, the stocks of *L. gigas* have been in heavy decline throughout the entire region (Stoner et al. 2012, Gell et al. 2003).
- DEMA monitors the local exploitation and sets restrictions (Tewfik et al. 2000).
- In addition to regulations, the conch is protected by marine protected areas (MPA).
- MPA's are designed to bolster the populations and replenish the stock through spillover and larval drift (Stoner et al. 2012, Gell et al. 2003, Bene et al. 2003).

Research Questions:

(1) Is the MPA on the South Caicos Bank effective in increasing conch populations?
(2) Is the density of conch greater inside or outside the MPA?
(3) Are siphonal lengths greater inside or outside the MPA?

Study Site:

- Conducted in South Caicos of the Turks and Caicos Islands, on the Caicos Bank to the south/southwest of the island.
- The sites studied were chosen by using randomly selected GPS data points.
- The sites were in an average of 5.46 meters of water but ranged from 2.1 to 7.8 meters on a variety of habitat types including: sea grass, sand plane, algal plane, coral rubble, patch reef, and gorgonian/seafan.

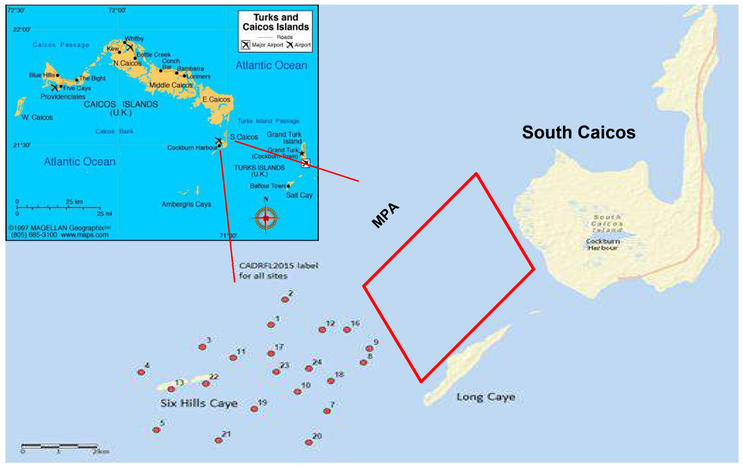

Figure 1: Map of all DR study sites done by researchers inside and outside East Harbour Lobster and Conch Reserve (EHLCR).

Methods:

- A two man SCUBA buddy team descended at random GPS point location.
- Laid three 50 meter belt transects. One to port, starboard, and stern of boat.
- One diver marked habitat every 10 meters.
- One diver collected and tagged conch within 1.5 meters on either side of the belt with identifying numbers.
- On the boat, siphonal length and lip thickness were measured in cm and mm, respectively.
- All conch above legal take size (178 cm) were kept. Others were thrown back.

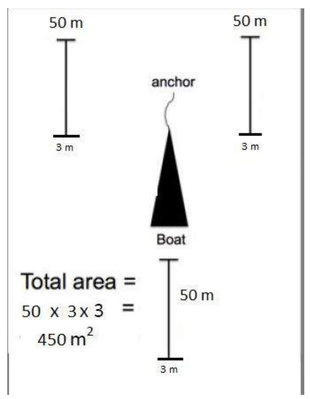

Figure 2: Diagram of transect layout conducted at each study site

Data Analysis:

- JMP Pro was used to analyze conch density, average siphonal length, and total conch per site.
- Data was plotted using Arc GIS to create visual maps.

Results:

- A total of 40 sites both inside and outside the EHLCR were analyzed.
- The median shell length for inside the MPA of 158 mm while outside the MPA a median shell length of 138 mm (Figure 3).
- Greater density was found inside the MPA with an inside median density of 0.022222 conch/meter (or 620,000 conch within the 28km^2 MPA) and an outside median density of 0.012222 conch per meter (or nearly 81 million on the entire 6,600km^2 Caicos Bank) (Figure 4).
- Small juvenile and medium juvenile conch were most significantly affected by the MPA (Figure 5).

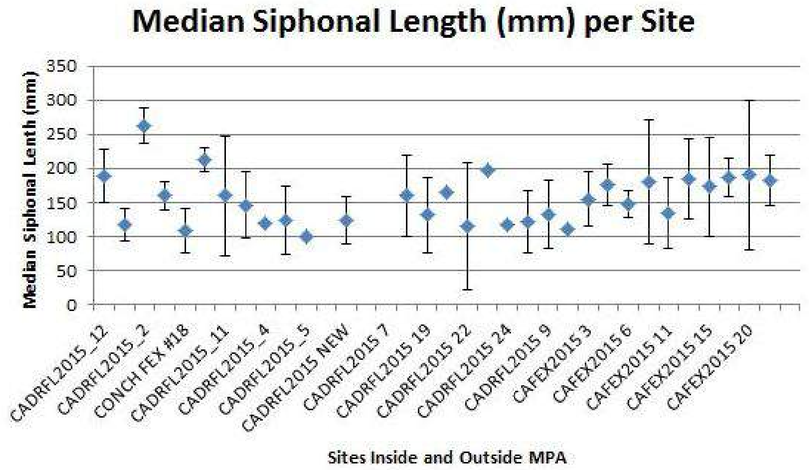

Figure 3: Table of median siphonal lengths of conch found at each random GPS point site inside and outside the MPA with IQR as error bars.

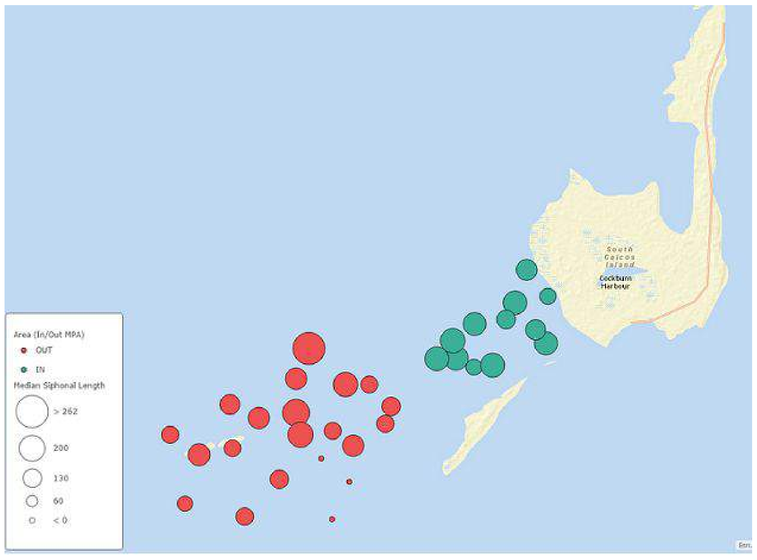

Figure 4: Median siphonal length (cm) per site inside and outside the MPA on the Caicos Bank

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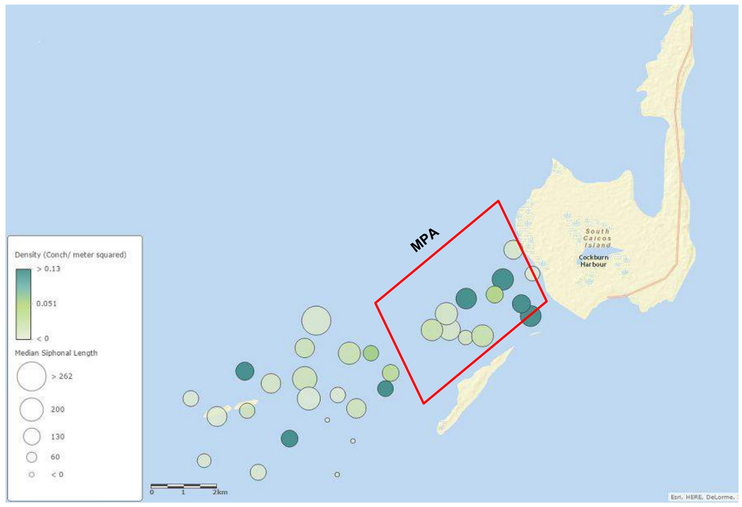

Figure 5: Density of conch per square meter versus median siphonal length (cm) inside and outside MPA

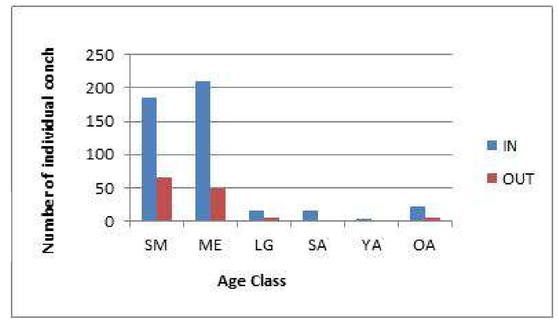

Figure 6: Number of individuals found inside versus outside the MPA separated by age class. [Small juvenile (SM), medium juvenile (ME), large juvenile (LG), small adult (SA), young adult (YA), old adult (OA)]

Discussion:

- The largest siphonal lengths were found outside of the MPA, but the median was lowered by the much larger group of small adults.
- Inside the MPA had the most small adults, which means the MPA is effective in increasing conch population, but may be affected by overcrowding.
- The density of conch inside the MPA is nearly double the density outside. This also further supports the efficacy of the MPA.
- The small and medium juveniles had the most significant increase in individuals found inside versus outside the MPA. This may speak to the retardation of spillover effect.

Conclusion:

- One benefit of an MPA is individuals tend to grow larger and live longer. Gell et al.'s data, as well as this study, found larger median siphonal lengths inside the MPA (Gell et al. 2003).
- There is the potential for stunting to occur within an MPA that negatively affects the reproductive health of the area (Twefik et al. 2003).
- The larger median siphonal length inside the MPA is likely due to protection from the targeted removal of large conch outside the MPA (Stoner et al. 2012).
- The greater internal density supports spillover and larval drift. According to their research, the more effective the spillover, the less pronounced the density gradient (Tewfik et al. 2003).

How Does Arsenic Enriched Soil Influence the Growth of Miners Lettuce?

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University of San Diego®

Background

- Arsenic (As) occurs naturally in the environment at low concentrations
- Anthropogenic activities, such as mining, account for the widespread dispersal and elevated concentrations of As.
- As can accumulate to toxic levels[1], therefore, it is not ideal for plant growth
- Some plant species are able to adapt and may even acquire a tolerance and respond positively to these stressful conditions[2].
- Claytonia Perfoliata, otherwise known as *Miners Lettuce*, was found growing naturally in an area known to be contaminated with high concentrations of As.
- **The goal of this study is to examine the extent to which the growth of Miners Lettuce is influenced by As contaminated soil.**

Methods

- Samples of Arsenic enriched soils were collected from locations along a 2x2 meter grid-like sampling site.

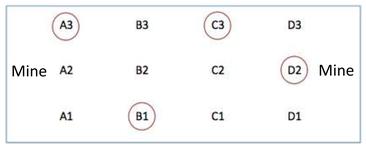

Figure 1: The subsamples that were used in this study were A3, B1, C3, and D2.

- As concentrations were determined using an Innov-X Systems X-50 Mobile XRF.
- Three Miners Lettuce seeds were planted into each soil subsample (200g)

Table 1: Average concentrations of As (ppm) in each of the soil samples

Sample ID	As (ppm)	Std. Dev. (%)	Sample ID	As (ppm)	Std. Dev. (%)
Control	14	0.67	C3	36	7.25
A3	297	25.4	D2	26	8.23
B1	339	44.2	Enriched	13,367	305

- On every Monday, Wednesday and Friday over a one month period (10/17/2016-11/14/2016), the number of plants, stem height (cm), leaf length (mm), and leaf width (mm) were measured; Each plant received 50mL H_20.

Results

Figure 2: Visual representations of the final growth stages for one subsample of each soil.

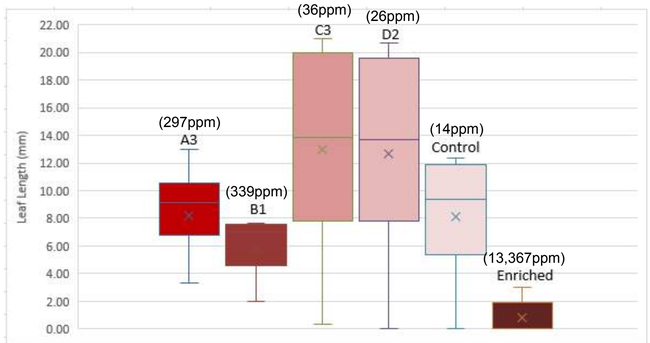

Figure 3: Box-and-Whisker graph representing the averaged leaf length growth (mm) for each soil subsample. The "X" represents the mean value.

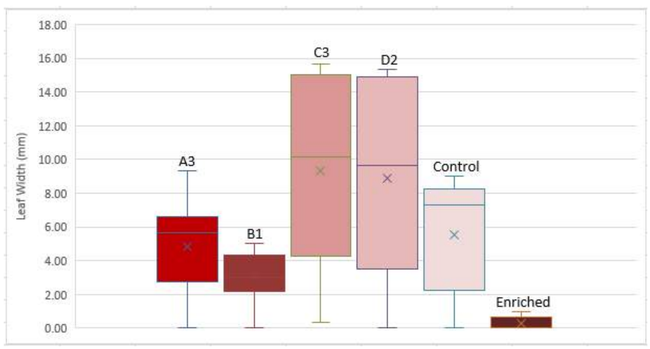

Figure 4: Box-and-Whisker graph representing the averaged leaf width growth (mm) for each soil subsample. The "X" represents the mean value.

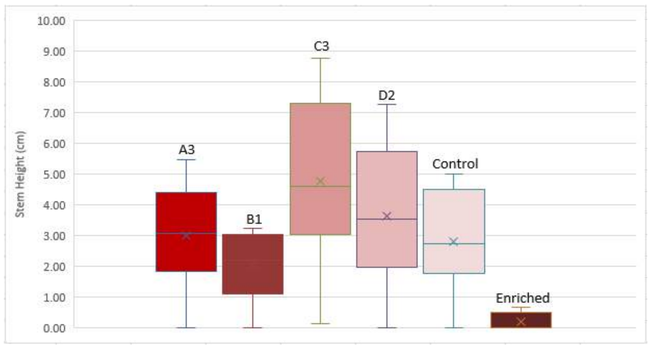

Figure 5: Box-and-Whisker graph representing the averaged stem height growth (cm) for each soil subsample. The "X" represents the mean value.

Results (cont.)

Table 2: Table indicating the maximum amount of plants that grew in each soil sample over a one-month time period

Sample ID	Max. # of Plants
A3	4
B1	9
C3	3
D2	4
Control	9
Enriched	2

Discussion

1. The Miners Lettuce in soil samples C3 and D2 showed better growth than the the plants growing in the control.
2. The Miners Lettuce in the enriched soil showed poor growth patterns.
3. Miners Lettuce growing in As enriched soil appears to develop a tolerance to the element up to a certain threshold [2].

Limitations

- Discrepancies in light distribution throughout the greenhouse may have influenced growth patterns.
- The pH and nutrient availability in each soil sample were not accounted for in this analysis.

Suggestions for Future Studies

- Assure the consistency of external factors such as light and water with light meters and hydroponics.
- Identify the soil pH and nutrient availability of each soil sample prior to planting.
- Ensure the precision of each measurements by using a caliber.
- Assess the influence of As on the growth of other plants in the region

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Regulatory and Health Analysis of Libby Amphiboles; Libby, Montana

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Background

- Asbestos is a naturally occurring mineral that has been used throughout the world (EPA)
- Used in construction and building material (EPA)
- Known to be: fire resistant, thermally resistant, chemically resistant, insulator, and strength
- Though asbestos has many useful properties, its small, durable fibers have resulted in negative health effects (CDC, 2011)
- Causes: Asbestosis, lung cancer, mesothelioma, and other respiratory diseases from fibers size and shape (Harper, 2015)
- Due to the increase in negative health effects, asbestiform minerals are regulated, starting in 1970 (EPA)
- Currently, asbestos has been phased out in US but is still used in other countries – regulated by EPA
- This study aims to analyze properties, effects and regulations of asbestos to compare with other hazardous minerals such as Libby Amphiboles – calls for regulation of new minerals

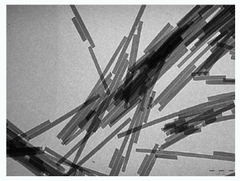

Figure 1 Chrysotile under PLM analysis.

Figure 2 Libby, MT clean-ups.

Introduction

- Libby, Montana is home to one of the largest Vermiculite mines, 1920-1990 (Harper, 2015)
- Like asbestos, Vermiculite is used for commercial applications – insulation, construction material, gardening (Price, 2008)
- Vermiculite contains Libby Amphibole (LA) minerals – combination of asbestiform structures and non-asbestiform structures (Price, 2008)
- Libby Amphiboles – associated with lung cancer, mesothelioma, asbestosis and other diseases [asbestos-related diseases] (Price, 2008)
- Libby, MT placed on National Superfund List and classified as "National Environmental Disaster" by the EPA (Harper, 2015)
- Libby Amphiboles are not classified as asbestos but have resulted in severe health effects (Dodson, 2013)
- No regulations currently exist for Libby Amphiboles – therefore they are used regularly around the world

Figure 3 Vermiculite with asbestos fibers

Table 1: Diseases Caused by Asbestiform Minerals

	Chrysotile	Amphiboles
Mesothelioma	✓	✓
Asbestosis	✓	✓
Pleural Plaques	✓	✓
Pleural Effusion	✓	✓
Lung Cancer	✓	✓

Methods

- Solid Asbestos samples are analyzed using Polarized Light Microscopy (PLM) to identify asbestiform structures
- Airborne asbestos fibers are analyzed using Phase Contrast Microscopy (PCM) to count the amount of fibers present in the sample
- Transmission Electrons Microscopy (TEM) is used to analyze solid, air and water samples. Unlike PCM, TEM can differentiate between asbestos fibers and non-asbestos fibers.
- To conduct this study, ArcGIS and ESRI Online were used to create a descriptive map of Libby, MT
- Extensive research on current asbestos regulations was conducted through EPA data and literature review of peer-reviewed articles
- Interviews with certified environmental consults were also used to conduct this study

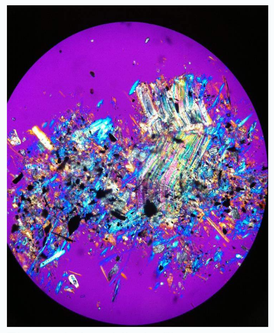

Figure 4. Amphibole fibers under PLM

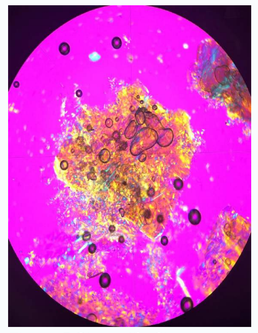

Figure 5 Chrysotile fibers under PLM

Results

Table 2: Estimated Cumulative Lifetime Exposure/Risk for Residents

Scenario 1 – Routine Activities	**1.2×10^{-03}**
Scenario 2 – Active Cleaning	**1.5×10^{-03}**
Scenario 3 – Limited contact with Vermiculite	**2.9×10^{-04}**
Scenario 4 – Home Gardening	**5.5×10^{-05}**

***Significant exposure beginning at 10^{-06}**

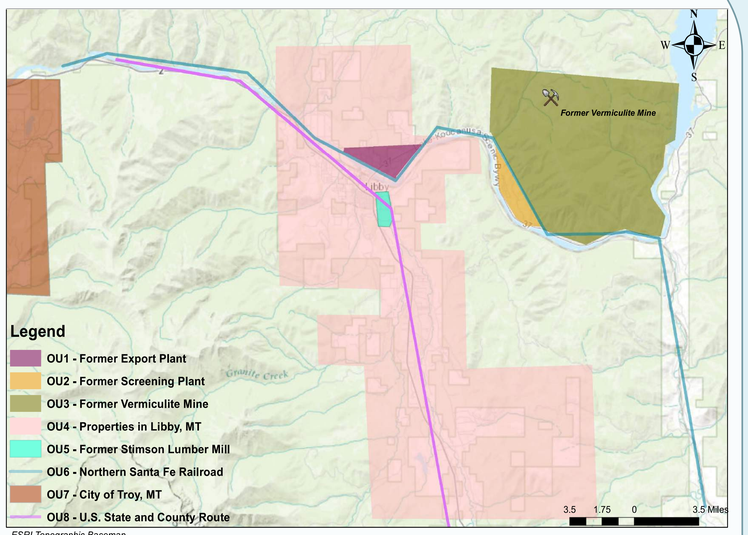

Figure 6 Operable Units in Libby, MT

Table 3: Current Asbestos Regulations (Federal and State)

Asbestos Hazard Emergency Response Act (AHERA)	• Requires inspection of school buildings for asbestos-containing material, prepare management plans/reduce asbestos hazards • Includes: chrysotile, crocidolite, amosite, anthophyllite, tremolite, actinolite
Occupational Safety and Health Administration (OSHA)	• Monitors working conditions for U.S. workers • Implements/manages occupational safety and health standards
Asbestos Information Act	• Provide information, identify companies producing asbestos-containing products
Clean Air Act (CAA)	• Monitor and improve national air quality through standards for hazardous air pollutants, such as asbestos
Safe Drinking Water Act (SDWA)	• Asbestos identified by EPA as a possible contaminate of drinking water.
California Occupational Safety and Health Regulations (Cal/OSHA)	• Occupational safety and health standards for places of employment in California - enforced by Division of Occupational Safety and Health

Discussion

- Libby health epidemic outbreak was directly caused by exposure to harmful amphibole structures
- Libby Amphiboles found to have similar structure, size and shape as asbestiform fiber
- Chemical make-up differs from asbestiform fibers
- Exposure to amphibole fibers - positively correlated to asbestos-related diseases
- Asbestos mortality 80 times greater than national average
- Products from Libby are shipped nationwide – possible exposure risks for other cities
- Vermiculite should be phased out, banning use completely
- Current knowledge about asbestos should be applied when looking at other hazardous minerals
- Similar lab analyses of asbestos can be used to identify amphibole structures
- Lack of regulations could result in future environmental and health disasters
- The need for regulations and monitoring systems is dire for public health safety
- Next steps: further research on effects of LA, identifying areas of concern, creation of regulations

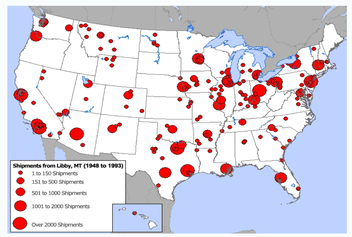

Figure 7. Shipments from Libby Vermiculite mine

Acknowledgements

I would like to thank Eric Cathcart and Dr. Boudrias for advising me on this project as well as throughout my college career. I would also like to thank H.M. Pitt Labs for providing data and research resources in order to make this project possible. Special thanks to Michelle Lavallee for sharing her knowledge about this subject.

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How does Blast Fishing Affect Fish Community Structures in Sabah, Malaysia?

PITCHAPORN JIARAVANON, Michel Boudrias*, Leo Chiu-Leung**, Adrian Chan** and Paul A. Hodgson****
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*The Reef Defenders, Hong Kong SAR** and Oceanway Corporation Limited, Hong Kong SAR****

Introduction

Blast (or dynamite) fishing a technique in which explosives are used to stun and kill fish. Currently, fish bombs are made using bottles filled with an explosive mixture [4].

- Very cost **effective** and **efficient** method for fish collection[1].
- This practice is alluring for fishermen due to the high initial value of catches.
- Extremely destructive as it **indiscriminately** kills fish and invertebrates in the area.
- **Value of successive catches rapidly drop**[1] and potentially cause disruptions to coral reef communities.

Figure 1a. After a blasts fish are stunned and corals are decimated to rubble.

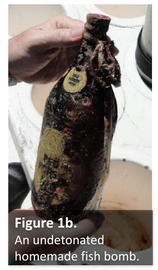

Figure 1b. An undetonated homemade fish bomb.

Photos by Adrian Chan

This study was conducted in **Lankayan** and **Tun Sakaran**, Malaysia.

- These two locations are part of the SIMCA Marine Protected Areas (MPAs)[5].
- Blast fishing still occurs due to a lack of enforcement and socioeconomic issues[5].

Lankayan Island, Malaysia
Photo by: Peter Wong 2009

Tun Sakaran Semporna, Malaysia

Objective & Hypothesis

The objective of this study was to:

1. Determine **how fish communities in Sabah, Malaysia were being affected by blast fishing**.
2. Decipher whether a **correlation between number of blasts and fish density** could be found.

Since blasts destroy vast sections of coral reefs, the decimation of this habitat can potentially alter the reef ecology. **We hypothesized that as the amount of blasts increases, the number of small, medium, and large fishes will decrease**.

Methods & Materials

- **Blast Detectors** (Fig. 2a and 2b) were installed in chosen study sites (Fig. 3)
- **Video transects** were recorded using GoPros (Fig. 2c) at each site for 15 minutes maintaining approximately 4 meters above the reef [2].
- **Fish were counted** using the quarter count method and **categorized** into three size classes:
  - **Small: < 15cm** **Medium: 15 cm ~ 30 cm** **Large: > 30 cm**

Figure 2a. Blast detector attached to steel rebars molded on concrete blocks for stability and resistance from blast impacts.

Figure 2a. Blast detector inconspicuously installed near coral reefs at TS-1.

Figure 2c. GoPro cameras were used due to their wide availability, ease of use and reliability underwater.

Results

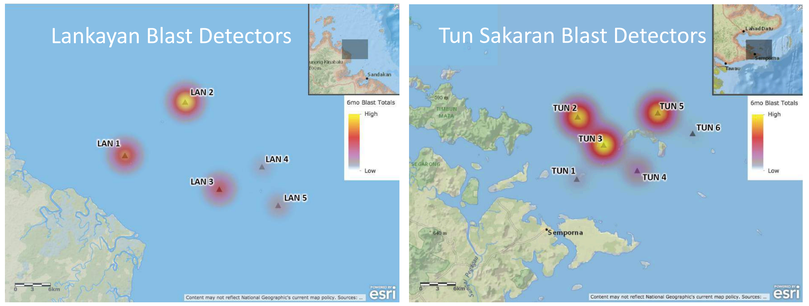

Figure 3. Map displaying the locations and ranges of blast detectors in Lankayan and Tun Sakaran. The intensity of recorded blast over a 6 month period are indicated by the scale. Maps created with ArcGIS ESRI.

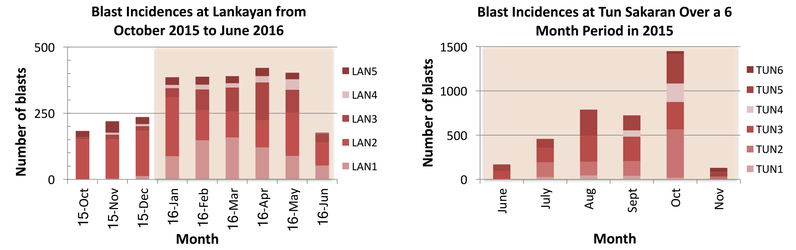

Figure 4. Temporal graph showing the number of blasts recorded at each site (hues) every month.

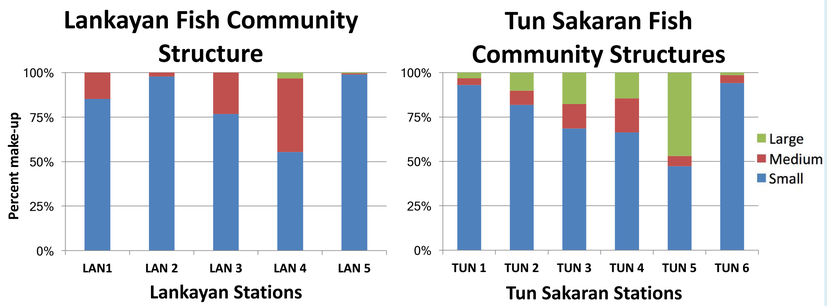

Figure 5. Graphs displaying fish community dynamics of Lankayan and Tun Sakaran. The percentages of small (blue), medium (red), and large (green) fish were calculated for each site.

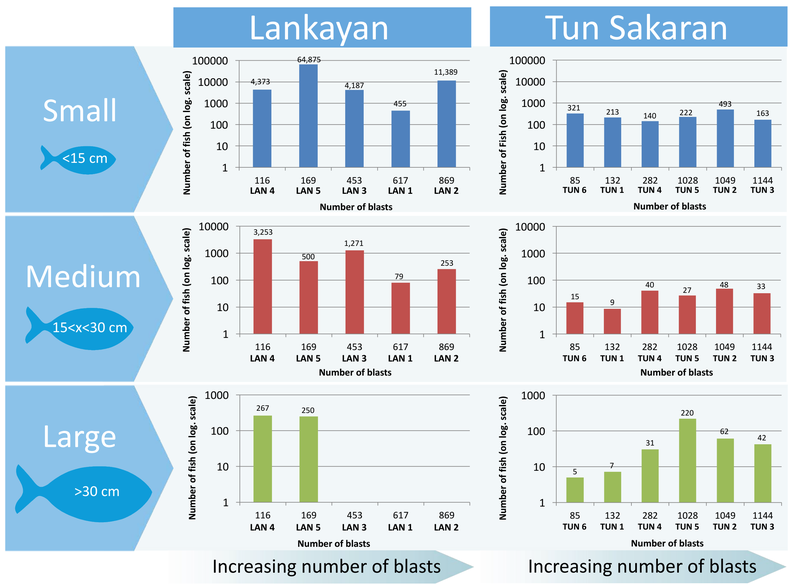

Figure 6. Graph depicting the correlation between blast incidences and fish community dynamics. The number of blasts over a six month period before the fish data collection was summed.

Discussion

The ratio of small fish was consistently more abundant than medium and large fish in all communities, except TS 5 (Fig. 5). Lan 4 had the greatest proportion of medium and large fish compared to other Lankayan stations.

Lankayan

- **General trend of decreasing fish as the number of blasts in the area increased**
- Almost no large fish were present in the three most heavily blasted areas
- The second highest concentration of small fish occurred in the most blasted area
  - Likely due to decreased predation by larger fish
  - Perhaps fishermen are selectively targeting larger fish
  - Possible that more small and medium fish naturally occurred in those locations

Tun Sakaran

- The highest abundance of small and medium fish, and second highest abundance of large fish were located at the second most blasted location
- The highest abundance of large fish occurred in TS 5, which was the third most blasted area
  - Potentially due to environmental differences of stations around the reefs

Conclusions

- The pattern was not consistent between Lankayan and Tun Sakaran
- Possible explanations include:
  - **Variation of physical conditions**
    - Upwelling nutrient rich water
    - Key area of larval recharge
  - **Naturally higher numbers of fish**
    - Breeding grounds/nurseries
    - Key migratory stopovers
  - **Varying fishing practices**
    - Selectively targeting certain fish
    - Using other extractive forms of fishing
  - **Factor of time**
    - Longer history of blasting
    - Lagged oscillating affect
    - Trend will become more evident with time if blast fishing continues[3]

Figure 7. Map of the world, Malaysia is highlighted in red.

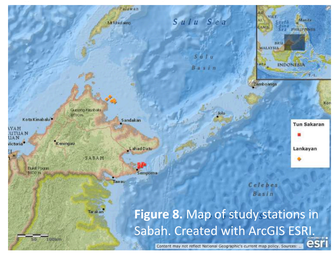

Figure 8. Map of study stations in Sabah. Created with ArcGIS ESRI.

Future Directions

- Further studies should determine **how blast fishing affects biodiversity** by identifying individual species and recording population abundances.
- Data from this study can be used **for monitoring programs to identify heavily affected areas** that need more attention[4].
- This data can also be used **in temporal analyses** to assess how fish communities and environmental conditions change in the future[6].

Acknowledgements

I would like to thank all those who have contributed to the collection of the data. I would also like to give special thanks the individuals who have contributed to the development of this project at the University of San Diego, especially Professor Cathcart and Dr. Boudrias, as well as the other many professors and students whom have given advice and guidance on certain aspects of the project. I thank Oceanway Corporation Ltd. for giving me the opportunity to be a part of this captivating venture.

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Assessing Anthropogenic Impacts on Coral Reefs in the Bocas del Toro Archipelago

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Environmental Studies

INTRODUCTION:

- Coral reefs support more species per unit area than any other marine environment ("Importance of Coral Reefs", 2008).
- Reef communities all over the world are under great threat from anthropogenic effects (Seemann et. al, 2013).
- The Bastimentos National Marine Park in Bocas del Toro, Panamá is designed to protect and improve the coral reefs found in its environment.

STUDY OBJECTIVE:

- To compare water quality metrics in reefs within the Marine Protected Area (MPA) to those near anthropogenic outputs in the Bocas del Toro Archipelago.

STUDY SITE:

- The study was conducted in Bocas del Toro, Panamá.
- This experiment evaluated water quality at 14 individual sites.
- The sites were split evenly: Locations inside and outside the MPA (Fig 1).

The sites inside the MPA: Zapatilla and Bastimentos
The sites outside the MPA: Almirante, Cayo Coral, and San Cristobal

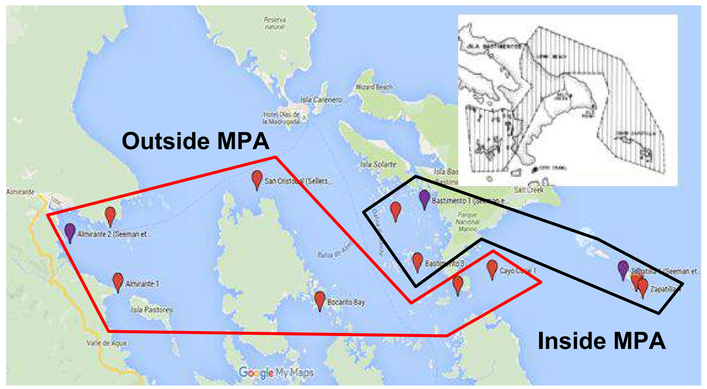

Fig 1: (Main): Map of study site locations. (Top-Right): Excerpt of Bastimentos National Marine Park (Guerron-Montero, 2005).

METHODS:

- **Each site:**
  - 5 transects of 25 m laid at least 1 m apart
  - Benthic fauna recorded on a dive slate:
    - Every 0.1 m was accounted for
  - If an organism was unknown:
    - Recorded for distance along the transect
    - Labeled as unknown
  - If multiple organisms covered the same distance:
    - Both were recorded
    - Distance was recorded twice
  - Water clarity was tested using Collins et al. methodology:
    - White secchi disk = 30.48 cm radius

Fig 2: Main Researcher performing a secchi disk test to assess turbidity.

Fig 3: An example of *A. palmata*

RESULTS:

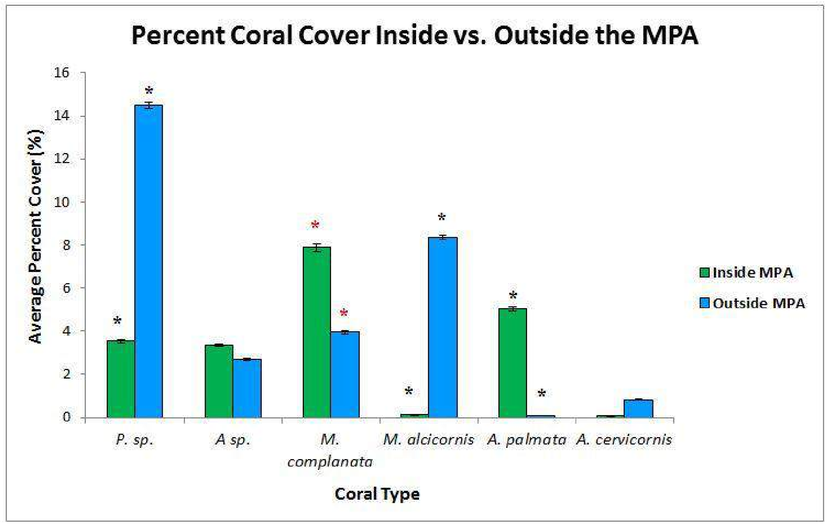

Fig 4: Percent Coral Cover Inside vs. Outside the MPA. Data are means ± SE. n = 70. A black asterisk indicates statistical significance to a p value < 0.05. A red asterisk indicates statistical significance to a p value < 0.1.

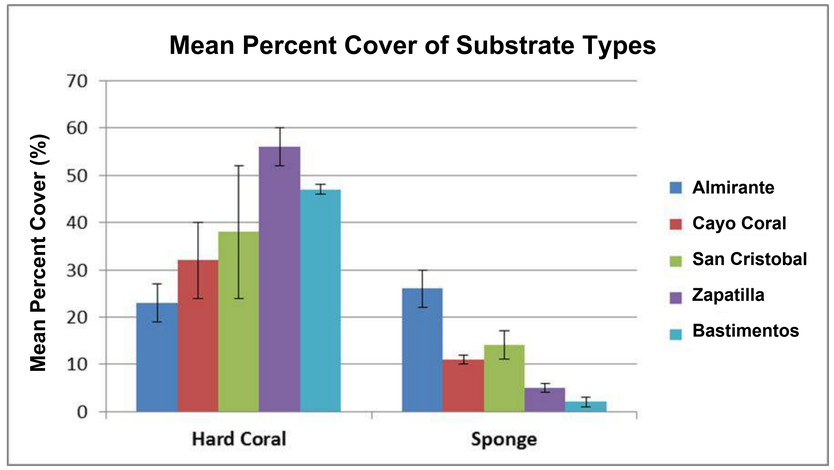

Fig 5: Mean Cover of Substrate Types.. Data are means ± SE. n = 70.

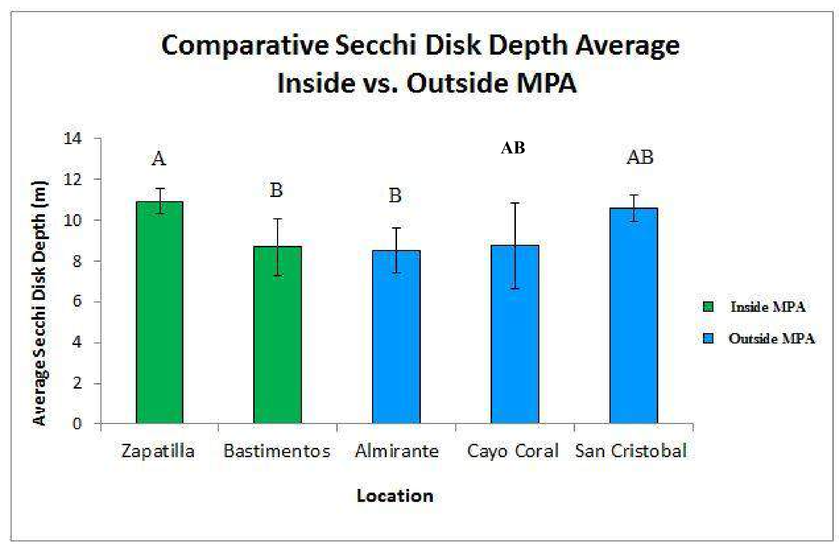

Fig 6: Comparative Secchi Disk Depth Average Inside vs. Outside the MPA. Data are means ± SE. n = 3-9. Different letters indicate statistical significance (p value < 0.05). Similar letters indicate no statistical significance.

RESULTS/DISCUSSION:

- *A. palmata and A. cervicornis* do not thrive well in turbid waters (Fabricius et al., 2004).
  - *A. palmata* was five times more abundant inside the MPA (Fig 4).
- *P. sp. and M. alcicornis* thrive in highly turbid waters (Fabricius et al., 2004).
  - *P. sp.* was five times more abundant outside the MPA (Fig. 4).
  - *M. alcicornis* was eight times more abundant outside the MPA (Fig 4).

Fig 7: *P. sp.*

Fig 8: *A. cervicornis.*

- The trend of mean coverage of hard coral: Higher inside the MPA (Fig. 5).
- The trend of mean coverage of sponge: Higher outside the MPA (Fig 5).
- Did the benthos shift from coral dominated to sponge dominated?
  - Further studies are strongly advised to support these findings.

Fig 9: Coral Reef Benthic Composition.

Fig 10: Sponge Reef Benthic Composition.

- Secchi Disk Depth: Significantly higher at Zapatilla than Almirante (Fig 6).
  - Higher Secchi Disk Depth = Better water clarity for sensitive corals.
- Secchi Disk Depth: Significantly lower at Bastimento than Zapatilla (Fig 6)
  - Bastimentos inside MPA: High boat traffic = More sediment suspension.

Fig 11: Clear Waters.

Fig 12: Highly turbid waters.

CONCLUSION:

- This study showed water quality inside the MPA was significantly more favorable for sensitive corals than outside the MPA.
- The water clarity inside the MPA was more favorable for sensitive coral species and for a coral reef dominated benthos.
- Follow up studies are necessary to monitor the ongoing performance of the coral reefs to determine the continued success of the MPA.

ACKNOWLEDGEMENTS:

- The author gratefully acknowledges the key financial and field logistical support provided by the School for Field Studies, Center for Tropical Island and Biodiversity Studies, Bocas del Toro, Panamá.
- This project would not have been possible without the help and support from Dr. A. Maldonado.

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Variance in meiofaunal abundance and distribution throughout Mission Bay

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Introduction

Mission Bay is a modified, shallow estuary fed by freshwater inlets and storm drains from highly urbanized areas. The bay can be separated into three main regions, a well mixed front bay, a variable middle bay, and poorly mixed back bay. In previous studies, Mission Bay is seasonably hypersaline- higher salinity and warmer water temperature in the summer months and cooler, less saline waters during the winter months. The distribution and abundance of meiofauna in marine communities is greatly affected by sediment type, oxygen availability, tidal influence, and other abiotic factors (Coull 1999). Nematoda, Copepoda, and Polychaeta are the most abundant meiofauna taxa found in estuarine waters (Clark 2001).

What is Meiofauna?

- They are microscopic invertebrates, which can pass through a 500 µm mesh sieve, but is retained on 63-45 µm sieves (Schaffner 2007)
- Important to benthic habitats because they keep microbial communities active by burrowing which enhances productivity and nutrient cycling (Schaffner 2007)
- Serve as bioindicators for pollution and human activity in a community (Coull 1999)

Figure 1. Nematoda, Amphipoda, and Copepoda taxa under a dissecting microscope, 100x.

Objectives

- Testing the abundance and distribution of benthic meiofauna in different regions of an estuary in San Diego, California
- Biological assessment of Mission Bay at a higher sampling resolution than past studies to serve as a baseline for future studies
- A previous study found that Ventura Point, Front Bay in our study, had the highest abundance of meiofaunal organisms. (Elliot and Kaufmann 2007)
- Another study done by The Southern California Ocean Studies Consortium (SCOSC) found that nematodes are the most abundant meiofauna taxon

Results

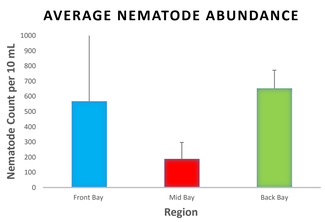

Figure 3. Abundance of nematode species collected by region per 10 ml sample. Error bars represent standard deviation.

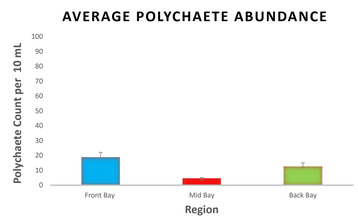

Figure 4. Abundance of polychaete species collected by region per 10 ml sample. Error bars represent standard deviation.

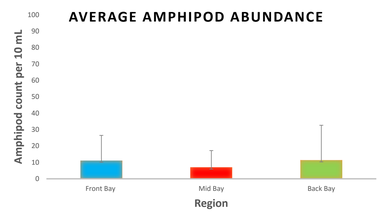

Figure 5. Abundance of amphipod species collected by region per 10 ml sample. Error bars represent standard deviation.

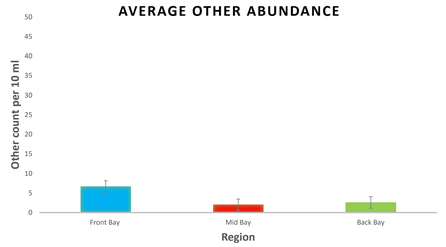

Figure 6. Abundance of all other meiofauna species collected by region per 10 ml sample. Error bars represent standard deviation.

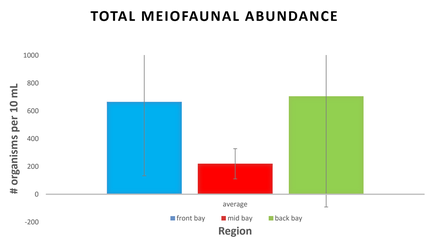

Figure 7. Abundance of meiofauna taxa collected by region per 10 ml sample. Error bars represent standard deviation.

Methods

Field:

- Samples collected over two weeks from October 27th, 2015 to November 5th, 2015
- Sediment collected via Ekman grab sampler (Fig 2a) and a 5 mL core was subsampled for meiofauna
- Meiofauna samples preserved (100% ethanol) and dyed (rose Bengal)

Lab:

- 39 meiofauna samples were processed (Fig 2b)
- Meiofauna samples placed in a nested 500µm and 63µm sieve and rinsed over a waste ethanol container to remove the preservative
- Any sample left on 500µm sieve was discarded. All of the sample left on the 45 µm sieve was placed into a 500 mL beaker. Tap water was added to resuspend the meiofauna and decant organisms
- Once sediments had settled out (about 30 seconds) the water was poured on the 63µm sieve. The remaining material was sorted in a gridded petri-dish using a dissecting scope and sorting sheet
- The rinsing, sieving, and sorting was repeated until the entire sample was processed

Figure 2a. Ekman grab sampler emptying sediment from the bottom of Mission Bay(Photo by Antonella Cantanello).

Figure 2b. Map of the study area. Blue= Front Bay region, Red= Mid Bay region, Green= Back Bay region.

Discussion

- Nematodes were the dominant species in all three regions (Figure 3)
- Back Bay had highest abundance of nematodes and least variability (Figure 3)
- All species in all regions show high variability in abundance
- Back Bay region has highest abundance of total meiofauna (Figure 7)
- High abundance of nematodes in regions of Mission Bay match results of the SCOSC and Kaufmann et al (2007)
- Mouth of the bay showed high abundance of polychaetes, but low diversity as previously found by Dexter and Crooks (2000)

Acknowledgements

A special thank you to my advisor and mentor throughout the last four years at USD, Dr. Nathalie Reyns.

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Zoobotryon verticillatum as a Habitat for Indigenous Species in Mission Bay

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BACKGROUND

Zoobotryon verticillatum is an invasive bryozoan, specifically a colonial ascidian, in Mission Bay.

Z. verticillatum thrives in warm water, so is commonly abundant in summer months and diminishes in the winter (Winston 1995).

Due to its quick colonization, *Z. verticillatum* is often considered a threat to local areas; however, there is evidence it could be a suitable habitat for indigenous species.

The objective of this study is to determine the abundance and species diversity of the organisms living within the *Z. verticillatum* in Mission Bay over the last month it is present.

Figure 1. A colony of *Zoobotryon verticillatum*.

METHODS

- *Z. verticillatum* colonies collected weekly from the South Shores dock in Mission Bay, San Diego
- Wet weight and volume of colonies recorded
- Colonies and communities preserved in ethanol
- Organisms within the colonies counted and identified

Figure 2. Mission Bay in San Diego, CA. The sample site is marked by the red arrow.

RESULTS

Table 1. Diversity indices of the populations within the colonies collected on each day. The species richness and evenness increased each week.

Diversity Index	Oct. 6	Oct. 13	Oct. 20	Oct. 27
Shannon-Wiener (H)	0.8	1.1	1.2	1.4
Simpson's (D)	0.4	0.6	0.7	0.8

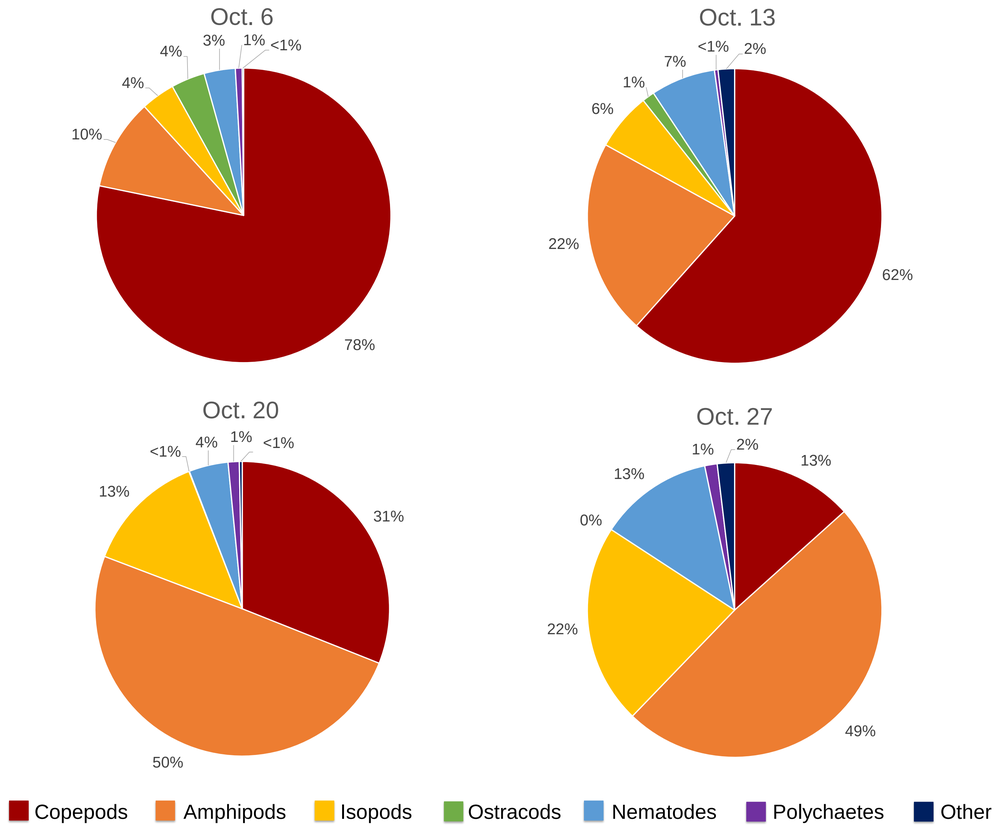

Figure 3. Community composition within the collected colonies on each sampling date.

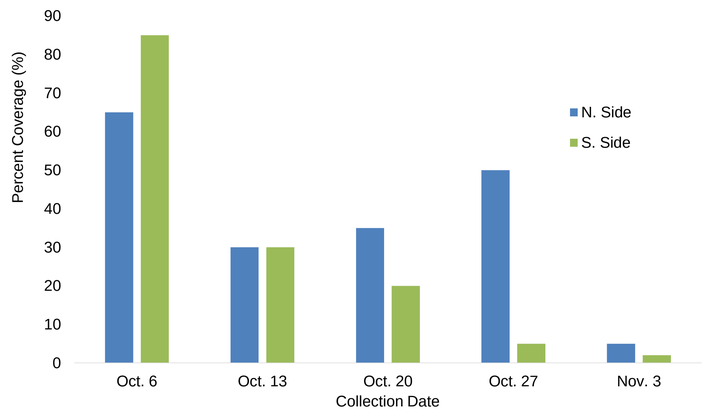

Figure 4. The percent coverage of *Z. verticillatum* on both sides of the South Shores dock over time. Both sides had a high coverage of *Z. verticillatum* in the first week of October, but by November 3 almost all of the colonies had disappeared.

DISCUSSION

- The decrease in copepods and increase in both amphipods and isopods as the health of the *Z. verticillatum* colonies declined with time makes biological sense because the latter two species are able to consume decaying organisms, while former thrives in healthy conditions.
- There is a shift from smaller to slightly larger organisms in the community with a slightly better swimming ability.
- The communities essentially lost their habitat and disappeared.
- Boats dock on the north side of the dock, which could push the colonies off.

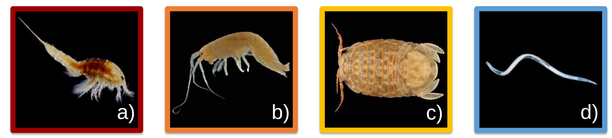

Figure 5. a) Copepod, b) Amphipod, c) Isopod, d) Nematode

CONCLUSIONS

- *Zoobotryon verticillatum* serves as a viable habitat for a variety of indigenous species in Mission Bay.
- The presence of a high percentage of organisms carrying eggs indicates that *Z. verticillatum* is a stable breeding ground.
- The inverse change in coverage of *Z. verticillatum* on the north and south sides of the dock suggests that colonies moved in depth or location in response to changing environmental conditions.
- Future studies should explore what happens to the community when the colonies disappear.
- Additionally, it should be explored whether the colonies will return and if this is a repeating ecological process.

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ACKNOWLEDGEMENTS

Special thanks to Dr. Michel Boudrias for his guidance in this project. Another special thanks to Christian and Christina Garcia for their support in pursuing environmental research.

Raise Your Voice: Social, Environmental and Educational Concerns, a Case Study of Adult Students in Pilcopata, Peru

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Environmental Studies

INTRODUCTION

Area of Study: **Pilcopata Peru**

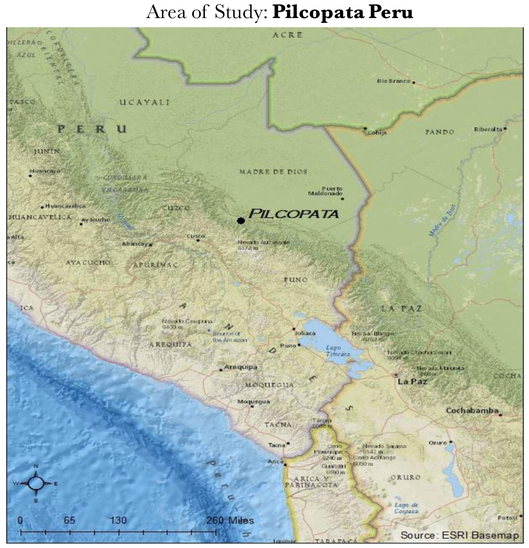

Fig. 1. Map showing Peru, specifically Pilcopata Peru, shown in black bold.

- I am particularly interested in the social and environmental concerns currently impacting the community of Pilcopata.
- Overall I wanted to know how we could improve the quality of life in the future and take preventative measures to mitigate these concerns.
- Specifically focused on what adult students in rural communities believe to be the largest social and environmental concerns in their lives and how that has specifically affected them as students.

METHODS

Research was conducted following Indigenous methodologies and PAR (Participatory Action Research)

Methods of data collection included:

?

- Photovoice
- Focus Groups
- The focus group identified the baseline for several of the topics we discussed.
- Interviews
- The main focus of the interviews was to discuss solutions for the future
-

RESEARCH QUESTIONS

- Show me what obstacles you face in your daily life as a student?
  - This became a category of economic concern.
- What do you see as the greatest environmental concerns facing Pilcopata?
- What do you see as the greatest social concerns facing Pilcopata?

RESULTS

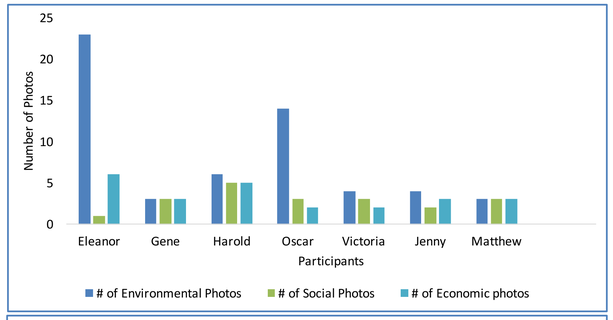

Fig 2. Shows the number of photos each participant took for each category. Results show a higher interest in environmental photos across the majority of participants.

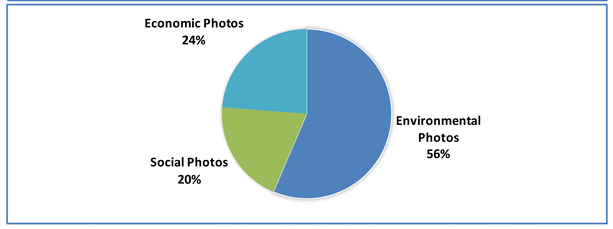

Fig 3. Shows the total percentage of photos under each category. Results show environmental photos to be of highest concentration.

Fig. 4. Environmental concerns focused on improper waste management and its effects on water contamination and basic street cleanliness.

Fig. 5. The largest student obstacles were identified to all spur from low-income living.

Fig. 6. For social concerns the baseline was education both sexual health and drug/alcohol education.

DISCUSSION

- **Environmental concerns:**
- The three concerns that were identified as most important were: trash, rotational farming, and contaminated water. While the three problems are very different from one another, a lack of proper waste management is a major cause for concern in general.

- **Economic concerns:**
- For obstacles facing students in their daily lives, it was identified that the root cause for most concerns was a low income living. It was mentioned that low income living spurs poor nutrition, since unhealthier foods tend to be cheaper. Furthermore, low income often requires students to work low wage jobs for long hours, thus limiting their access and time for education. Finally, low income affects not only the students but their teachers as well as the infrastructures in which are provided for students.

- **Social Concerns:**
- After discussing with students in the focus group/interview about their take and perspectives on the topics, it became quite clear that the main cause for concern was unanimously sexual health and drug/alcohol education of adolescents. The lack of engaging activities for the younger generation in Pilcopata has created a binge drinking culture amongst adults as well as amongst teenagers below the legal age.

Fig. 7. The Students heading to class.

Fig. 8. The dusty, unmaintained roads.

CONCLUSIONS & THE FUTURE

- Organize community events combining different organizations in town: the health center, market vendors, teachers, etc.
- Organize health seminars for substance use and sexual health information
- Environmental education projects
- Placement of more trash and recycling bins around town
- Advocate for students for more representation in state for education affairs.
- Future Directed Research could focus specifically on educational rights.

ACKNOWLEDGEMENTS

I would sincerely like to thank all the Pilcopata residents whom agreed to participate in this project. If it was not for their interest in helping to answer questions and take photos, this study would not have been able to have been completed.

I would also like to thank Dr. Katie MacDonald, my research director, for being an excellent support and guiding me in all the right directions.

Lastly, I would like to thank The School for Field Studies for giving me the opportunity to work in an amazing location alongside very talented and inspirational educators and students.

Tourist Viewing Preferences and Valuation of Large Mammal Species in Serengeti National Park

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Dr. John Kioko, The School for Field Studies

[+]Santa Clara University, [*]Franklin & Marshall College

Introduction

Tanzania is an east African nation with a wealth of culture, rare species, and many unique natural phenomena such as the Great Migration[3] which attract millions of tourists annually. This makes tourism important economically and environmentally for Tanzania. Serengeti National Park (SNP) is one of Tanzania's most iconic parks. Research shows that tourism is attracted by a few charismatic megafauna, which concentrates negative human impacts in select areas of SNP. Thus, to capitalize park management and conservation efforts, it is important to understand tourist viewing patterns and preferences. This study researches three questions:

1. What attracts tourists to SNP?
2. What are tourists game-viewing patterns in SNP?
3. How do tourists value large mammals in SNP?

Goal: Attain sustainability ecologically, socially, and economically for conservation efforts throughout Tanzania with effective national park tourism management specifically in SNP.

Methods

Study Area

- Tourist viewing preferences and species availability were studied in SNP, Tanzania
- Questionnaires and interviews to assess tourist wildlife valuation were conducted in Mto Wa Mbu, Tanzania, a popular town along the wildlife tourism circuit

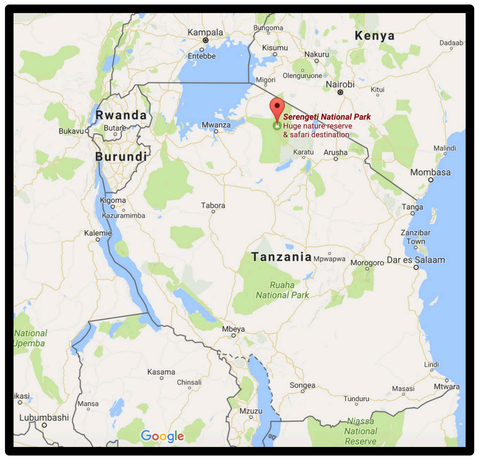

***Figure 1**. Map of Tanzania*

Data Collection

Revealed and stated preference approaches were studied. Tourist demographics and stated preferences were identified with questionnaires. Revealed preferences were determined in SNP by observing tourist vehicles for stops, duration, and species of interest.

Data Analysis

Relationships between tourist demographics, tourist viewing preferences, and valuation were investigated with descriptive statistics using the program IBM SPSS Statistics 22.

Results

- 95.6% of tourists are satisfied with their game-viewing experience in SNP
- Tourists do not visit Serengeti for plants or birds

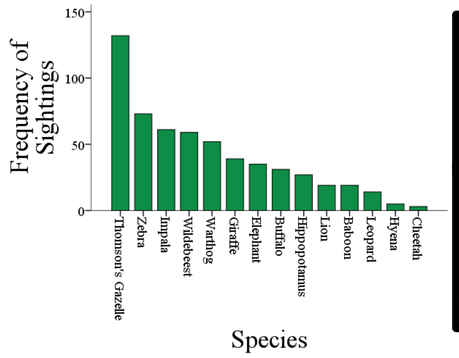

***Figure 2.** Frequency of sightings by species.*

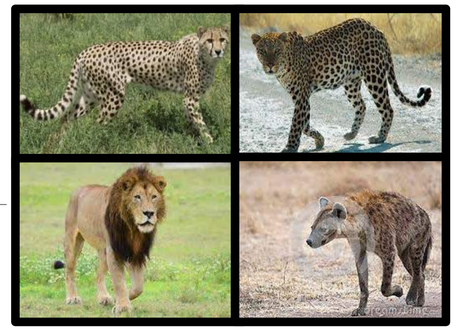

***Figure 3.** Most viewed species: Cheetah, Leopard, Lion, Hyena.*

- Amount of time spent viewing increased with species rarity (Figure 2)
- Most time spent viewing cheetahs (17 min), leopards (13 min), lions (12 min), hyenas (7 min) (Figure 3)
- Most time spent in kopje habitat-type (11 min) (Figure 5)

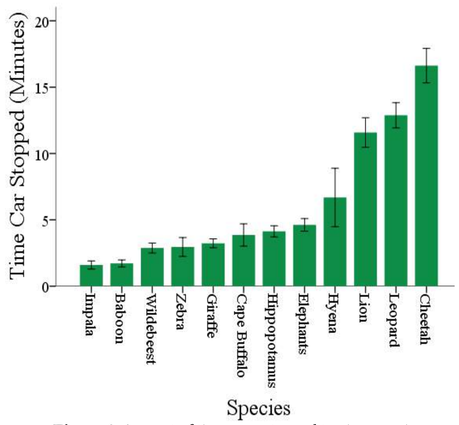

***Figure 4.** Amount of time cars stopped to view species.*

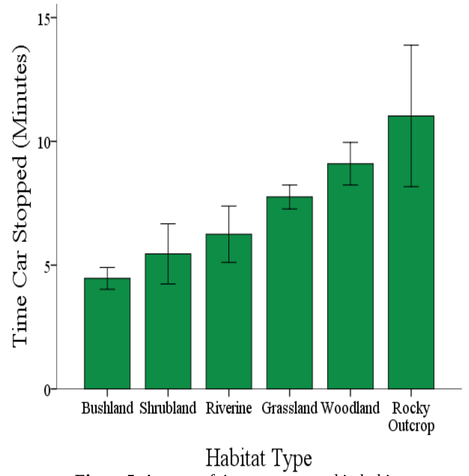

***Figure 5**. Amount of time cars stopped in habitat types.*

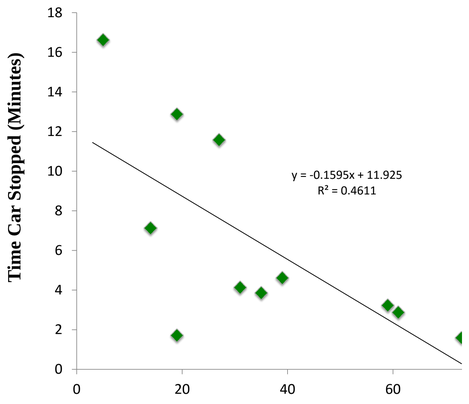

***Figure 6.** Time cars stopped compared to species abundance.*

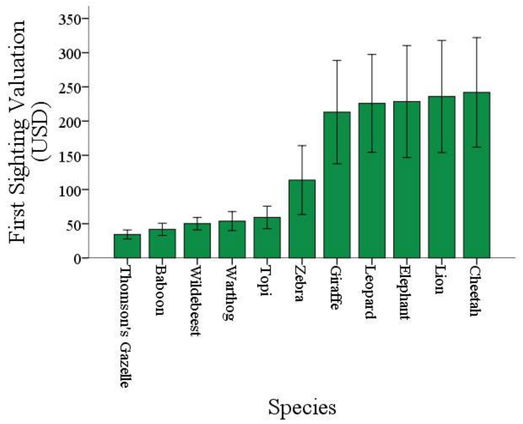

***Figure 7**. Species first-time valuation in USD.*

- **Valued most**: Cheetahs, lions, elephants, leopards (Figure 8)
- **Valued least**: Thomson's gazelles, baboons (Figure 9)
- 80% are willing to pay an extra conservation fee

Discussion

- Species' taxonomic order resulted as the most influential factor in tourist game-viewing patterns in SNP
- Tourist viewing preferences and patterns in SNP are found to be narrow and concentrated on big cats (*Carnivora)* and predator species[1]
- As a result, spatial density of tourist activity is concentrated in grassland and rocky outcrop (kopje) habitats, posing potential threats to habitat and biodiversity conservation
- Regardless of demographics, large predators and mega-herbivores were consistently valued the highest
- 80% of visitors said they would an increase in the entry fee
- Respondents' willingness to pay is positively associated with education and age

***Figure 8.** Most highly valued species: Cheetah, Lion, Elephant, Leopard.*

***Figure 9.** Lowest valued species: Thomson's gazelle, Baboon, Wildebeest, Warthog.*

Management Implications

- Because game viewing in the Serengeti is geared towards large cats management efforts should be put to promoting diversity of park attractions (scenery, endemic species, birds) through advertisement and educational material
- Parks ought to consider a small, additional fee that goes towards conservation efforts

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Acknowledgements

I would like to thank Dr. John Kioko and the School for Field Studies for directing and facilitating this research. I would like to thank the residents and my friends of Mto Wa Mbu for their guidance. I would also like to thank the many tourists for their time spent responding to our questionnaire and Serengeti National Park Authority for providing our study area .

The Impacts of Ocean Acidification on the Diversity and Mean Sizes of Pteropods

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Environmental Studies

Introduction

- Our study aimed to determine the impacts of ocean acidification on pteropods
  - Specifically, we were interested in learning how pH values related to the mean sizes and diversity of pteropod species.
- Majority of past and current studies suggests that the health of pteropods are compromised by ocean acidification—under acid conditions, the shells of pteropods degrade, it becomes more difficult for Pteropods to form shells and many other adverse effects.
- Using diversity and mean size as functions of health—we hypothesized that the lower the pH, the less diverse and the smaller pteropods would be. Conversely, the higher the pH, the more diverse and the bigger pteropods would be.

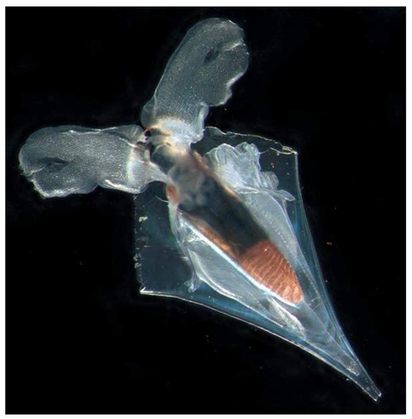
Methods

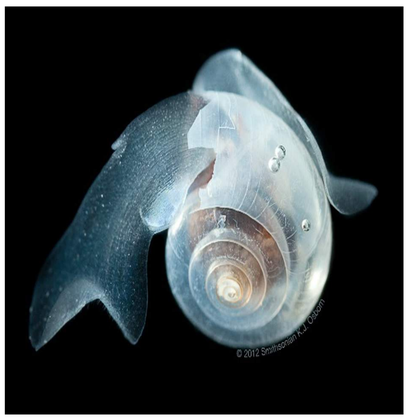
- A meter net at two knots was towed down to a depth of 200m.
- Pteropods were sorted and a microscope was used to determine mean length and width of each sample.
- Statistical analysis was done to compare the measured size with species diversity.
- Clayton and Byrne's (1993) spectrophotometric technique was performed to determine pH.
- Sampling stations were strategically chosen to cover a variety of marine environments, including the coastal temperate zone and subtropical zone, while also covering a wide range of pH values.

Results

Table 1: Pteropod species found in each sampling location. Included is mean length and width, abundance and species name.

Station	Pteropod Species	Amount Collected	Mean Length (mm)	Mean Width (mm)
003 MN	Cavolinia Inflexa	3	6.79	4.55
	Cavolinia Tridentata	3	14.33	10.27
	Clio Pyramidata	9	11.28	6.49
	Cuvierina Columnela	8	9.75	3.08
	Diacria Trispinosa	3	8.32	7.6
007 MN	Clio Cuspidata	1	12.79	8.69
	Cuvierina Columnella	2	10.67	3.1
	Diacria Trispinosa	2	9.9	7.37
009 MN	Cavolinia Tridentata	6	14.21	11.21
	Cuvierina Columnella	6	9.33	3.01
	Diacria Trispinosa	4	6.88	6.39
018 MN	Cavolinia Tridentata	2	14.43	11.2
022 MN	Cavolinia Tridentata	2	14.38	10.78
	Clio Cuspidata	2	14.36	6.68
	Diacria Trispinosa	3	9.53	6.15





Discussion

- One of our study's biggest constraints is the inability to directly assess the calcification and dissolution rates of pteropods.
  - Limited access to equipment like a Scanning Electron Microscope (SEM)
- Ability to consistently tow in pteropod samples, since a bigger sample size reduces the potential for error in our calculations.
  - Our meter net deployments towed in unusually large quantities of salp and gelatinous material, which very likely confounded our data.
- pH data we gathered and used.
- The presence of ocean currents
  - East Auckland Current off the east coast of the North Island.
  - Three warm core eddies, the North Cape Eddy, the East Cape Eddy, and the Wairarapa Eddy, are associated with this current (Roemmich and Sutton, 1998).

Recommendations

- Our methodology is a macro-level study in that we attempted to look at larger population trends rather than examining each individual organism.
- More time and access to a SEM
- Site locations - find areas with more higher variance in pH

Acknowledgements

We would like to thank Dr. Jan Witting for his guidance in both the labratory and and field. We also would like to thank Matthew Hirsch for his assistance throughout the research project.

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Making Sense: Data Visualization and the USD Climate Action Plan

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INTRODUCTION

The University of San Diego Climate Action Plan (CAP) was developed in Fall 2016 by the USD Office of Sustainability. In keeping with the USD 2024 Strategic Plan, the CAP highlighted opportunities and objectives for reducing campus greenhouse gas (GHG) emissions.

The goal of this project was to:

1. Create a comprehensive and readable public CAP document for approval by the USD Board of Trustees, Provosts, and University President.
2. Translate all technical data into engaging, understandable charts and symbols.
3. Effectively communicate the importance of a Climate Action Plan to USD's future infrastructure.

Using technical data developed by USD's Energy Policy Initiative Center (EPIC) to create the Climate Action Plan document, this project aims to demonstrate the importance of creating understandable scientific findings to engage the public and stakeholders. The hope is that a solid and available CAP document will position USD to be a leader in climate adaptation and mitigation for college campuses nationwide.

METHODS

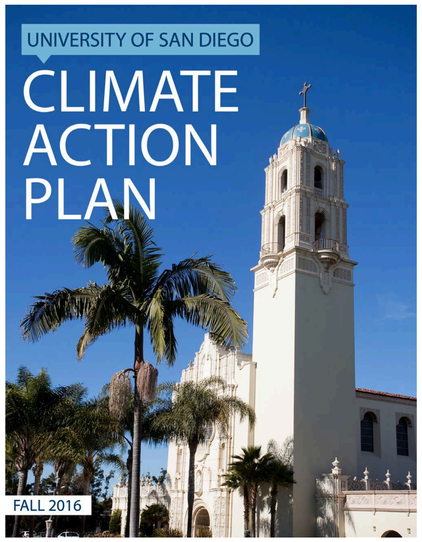
The visual CAP document was created based on a technical document written by EPIC and the USD Office of Sustainability. All of the data presented in the technical document was either stated within text or in a table (Table 1). Using Adobe InDesign, a design-based document was created based on the information and data included in the original technical document. The purpose of adding a visual element to the CAP was to make the technical data more understandable and readable.

Table 1: Raw GHG targets from technical CAP document.

Strategy and Policy	Targets			Emission Reduction (MT CO2e)		
	2020	2030	2035	2020	2030	2035
Strategy 1: Increase energy efficiency and clean & renewable energy sources				**5,226**	**7,588**	**10,817**
Reduce projected electricity use by %	25%	30%	35%	2,395	1,632	643
Reduce projected natural gas use by %	30%	33%	35%	2,048	2,596	2,999
Increase on-campus renewable and clean energy production	6.5%	10%	15%	363	1,148	2,095
Purchase additional electricity from renewable sources beyond California RPS	7.5%	20%	40%	419	2,212	5,080
Strategy 2: Increase cleaner and alternative modes of transportation in commuter fleet				**154**	**673**	**815**
Reduce miles driven for commuting by %	2%	10%	12%	154	673	815
Strategy 3: Reduce air travel and offset associated emissions				**4,238**	**4,958**	**5,318**
Offset study abroad travel by %	100%	100%	100%	2,497	2,922	3,134
Offset directly financed air travel by %	100%	100%	100%	1,741	2,036	2,184
Strategy 4: Achieve zero waste in USD operations				**387**	**575**	**682**
Increase solid waste diversion to %	60%	70%	75%	387	575	682
Strategy 5: Increase cleaner and alternative modes of transportation in USD fleet				**60**	**174**	**262**
Reduce projected fossil fuel consumption of USD fleet through optimized use	5%	10%	15%	31	72	116
Reduce projected fossil fuel consumption of USD fleet by increasing clean-fuel vehicle use	5%	15%	20%	29	102	146
Strategy 6: Increase water efficiency in USD operations				**87**	**99**	**127**
Reduce projected water use by %	20%	25%	30%	87	99	127
Reduction from Statewide Policies				**3,479**	**9,744**	**11,301**
Renewable Portfolio Standards (RPS)				1,845	5,529	6,350
California Advanced Clean Cars program				1,634	4,215	4,951
Total Projected GHG Emission Reductions				**13,632**	**23,811**	**29,322**

The design went through stages of approval with the arrow/icon graphics added towards the end of the design process. The technical document was finalized and formatted into the visual CAP in October 2016. The visual CAP document was then approved by the USD Sustainability Task Force and passed onto the Board of Trustees, the Provost, and the University President. The final CAP document was approved and electronically published in November 2016.

RESULTS



The result of this project was the physical Climate Action Plan document. A total of forty-six pages long, the CAP includes sections such as a history of sustainability at USD, climate resiliency, cross-cutting initiatives, and reduction goals for Energy, Commuting, Air Travel, Zero Waste, Fleet, and Water. Each GHG category includes consistent, color-coding, so as to establish continuity throughout the document and to create an easy-to-follow outline.

Figure 1: Sample GHG target section for Commuting

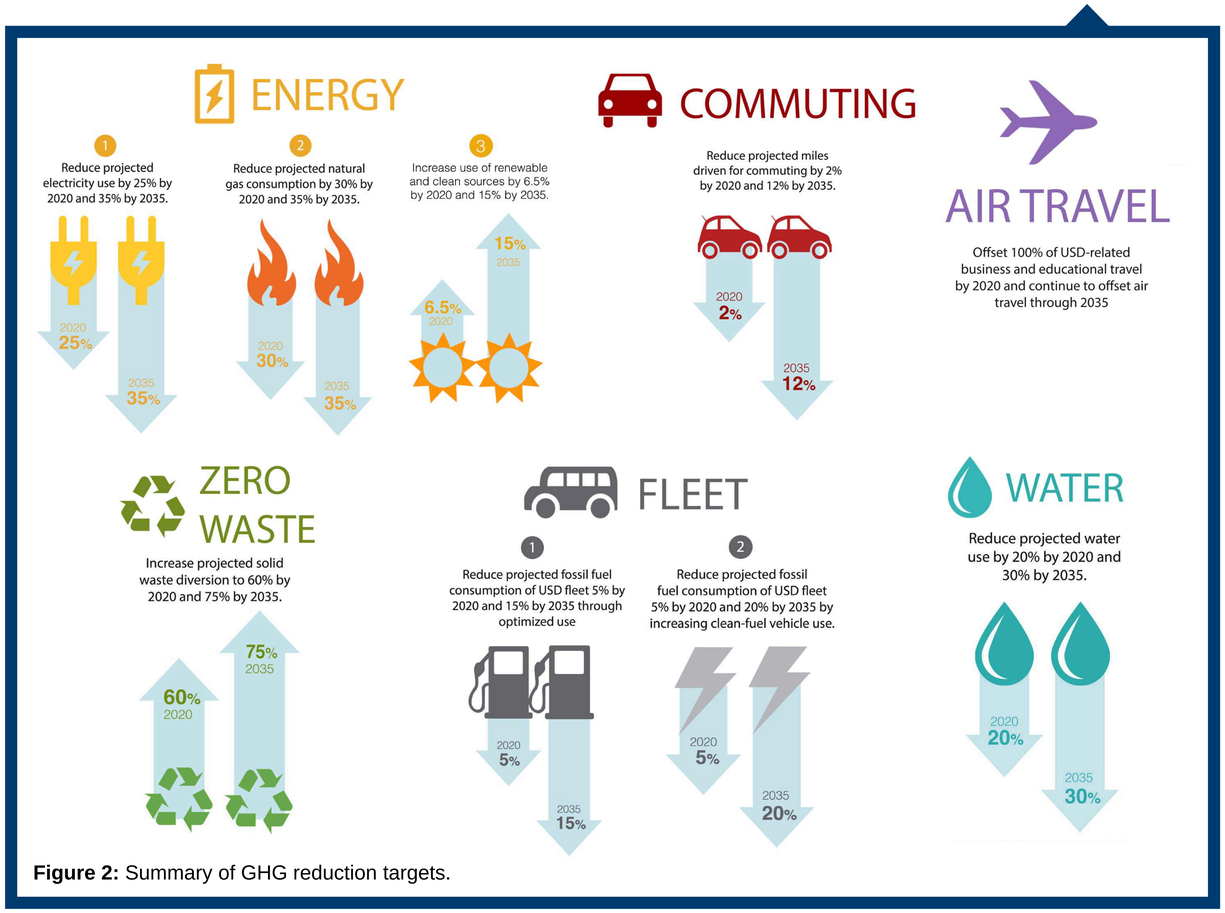


Figure 2: Summary of GHG reduction targets.

DISCUSSION

Data visualization for the University of San Diego Climate Action Plan is essential to communicating the importance of USD greenhouse gas emission reductions to the general campus community and the larger public sphere.

The implications of the CAP document are as follows:

- The readability of the final Climate Action Plan document demonstrates the importance of translating data for a non-science based audience. The final form of the CAP is intended to be understandable to climate scientists, stakeholders, the campus community, and the general public.
- By creating a readable CAP document, the positive effects of CAP initiatives were better communicated, which made it more likely to get approved by stakeholders.
- The comprehensive CAP document will be a reference for various stakeholders and community members, particularly in regards to the implementation impacts beyond emission reduction.

WHERE DO WE GO FROM HERE?

Next steps for the Climate Action Plan and beyond:

- Market the CAP and increase campus awareness about implementation
- Begin to implement the technical steps of the CAP
- Use the CAP to create the Sustainability Strategic Plan

The physical CAP document has established the USD Climate Action Plan as a primary reference point for sustainability at USD. Because the CAP fits into the University's strategic plan (Envisioning 2024) through the "Care for Our Common Home" pathway, the CAP plays an integral role in establishing the University of San Diego as a leader in sustainability efforts. Essentially, the CAP will shape a large part of the direction of sustainability as part of the overall University strategic plan.

ACKNOWLEDGEMENTS

Thank you to Michael Catanzaro, USD Director of Sustainability, for giving me the space and encouragement to design and create the CAP document.

Additionally, thank you to Michel Boudrais, Paula Morreale, Scott Anders and EPIC, and the USD Sustainability Task Force.

The Effects of Water Temperature on Crops in an Aquaponics System

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[1]Environmental Studies and Business Administration
Environmental and Ocean Sciences Department and School of Business

What is Aquaponics?

- It is the combination of aquaculture and hydroponics
- It is a closed loop farming technique
- It is a more sustainable farming practice

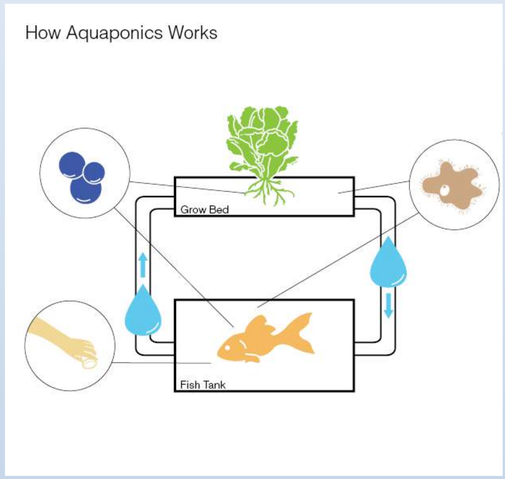

Figure 1: Graphic showing how an aquaponics system runs

Why is it Important?

- It is a form of sustainable agriculture as it mimics the natural systems, is water efficient, and has fewer environmental impacts than some forms of aquaculture[1]
- It can help countries keep up with their agriculture productions, especially countries affected by climate change[2]
- It is an easy way for an urban lifestyle to be more sustainable[3]

Figure 2: Peppers growing in gravel aquaponics system

Methods

- Clean medium carefully
- Plant crops into medium
- Record temperature and crop height once a week

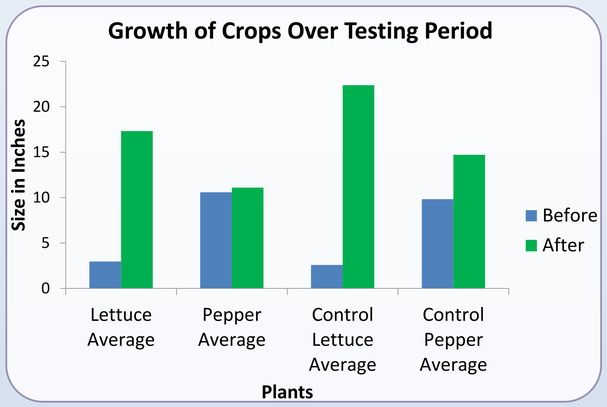

Figure 3: Shows the relationship between the growth of lettuce and bell peppers before and after during the course of the experiment

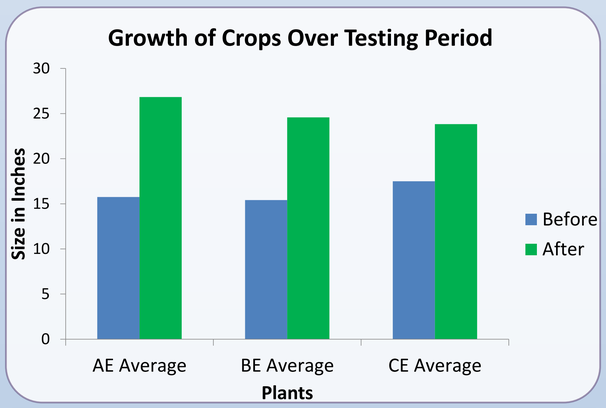

Figure 4: Shows the relationship between the growth of eggplant before and after during the course of the experiment

Figure 6: Temperature measurements over the course of the individual experiments. The dark black lines show where the different experiments begin and end.

Figure 3: Shows the relationship between the growth of Swiss chard and bell peppers before and after during the course of the experiment

Figure 5: Shows the relationship between the growth of spinach and kale before and after during the course of the experiment

Statistical Evaluation

	Total Average Percent Change
Control Pepper Average	50%
Swiss Chard Average	123%
Pepper Average	32%
Control Swiss Chard Average	233%
Control Pepper Average	46%
AE Average	70%
BE Average	59%
CE Average	51%
AK Average	35%
BK Average	59%
CK Average	33%

Discussion

- Lettuce had large increase during experiment #1
- Peppers and Swiss chard do better in the control environment in experiment #2
- Eggplant performed better in the colder water in experiment #3
- Kale did better than spinach overall in experiment #4

Conclusion

- Although lettuce at the largest increase, this is not viable because bolted lettuce is not usable
- The experiments were based solely on plant height not crop harvesting
- Water temperature does affect the growth of crops

Acknowledgements

- China Grove Organics for allowing me to use their aquaponics systems
- Jim Faaborg for funding this project and providing advice

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- [3] Nicolae, Carmen Georgeta, et al. “Low-Tech Aquaponic System Based on an Ornamental Aquarium: *Scientific Papers: Series D, Animal Science - The International Session of Scientific Communications of the Faculty of Animal Science* 58. (2015) 385-390.

Hearing Variation in Pinnipeds Based on Sex, Age and Species

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Environment and Ocean Science Department
Marine Science Biology Pathway

Introduction

- Pinnipeds, as well as most marine mammals rely heavily on hearing in performing important life functions.
- Concern regarding the effects of anthropogenic noise on these species has stimulated considerable interest and research.
  - Is anthropogenic noise disrupting communication, mating, navigation, and or leading to pre-mature hearing loss?

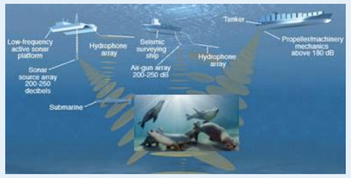

Figure 1. Multiple examples of oceanic anthropogenic noise sources that could impact Pinnipeds.

- Lack of background knowledge in regards to pinniped hearing so in order to address anthropogenic noise and its impact must first understand Pinniped hearing in general.

Objective:

- How does Pinniped aerial and aquatic hearing thresholds vary based on:
  - Sex
  - Species
  - Age

- At my internship with the Navy's Marine Mammal Program the specific focus of research was around aerial hearing threshold variance within the California sea lion (*Zalophus californianus*) based upon age. However, due to the classified nature of the research I am unable to present the projects scientific findings.
- This presentation will include a supplemental experiment similar to that conducted at my internship as well as additional integration of aspects such as sex and species that was not studied at my internship but are important for understanding Pinniped hearing threshold variance.

Methods

Sex:

- Male and Female Steller sea lions both 8 years old
- Frequencies: 0.5 to 32 kHz with a duration of 600 ms underwater

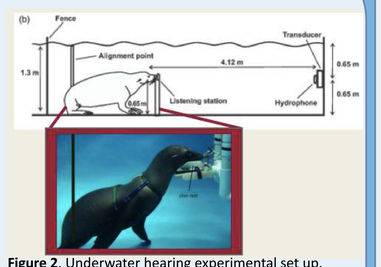

Figure 2. Underwater hearing experimental set up.

Species:

- Underwater:
  - Harbor seal, California sea lion and Northern Elephant seal were tested at respective frequencies from 100 to 6400 Hz with 500 ms duration
- Aerial:
  - The stimuli used during testing were 100, 200, 400, 800, 1600, 3200, or 6400 Hz pure tones with 500 ms duration

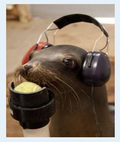

Figure 3. Aerial hearing experimental set up.

Age:

- 16 male California sea lions were put under anesthesia and hearing thresholds were measured at frequencies ranging from 0.5 to 32 kHz using auditory steady state-response (ASSR), a frequency specific AEP.
  - Ages ranged from 1-26 years old

Results

Pinniped hearing thresholds based on:

Sex:

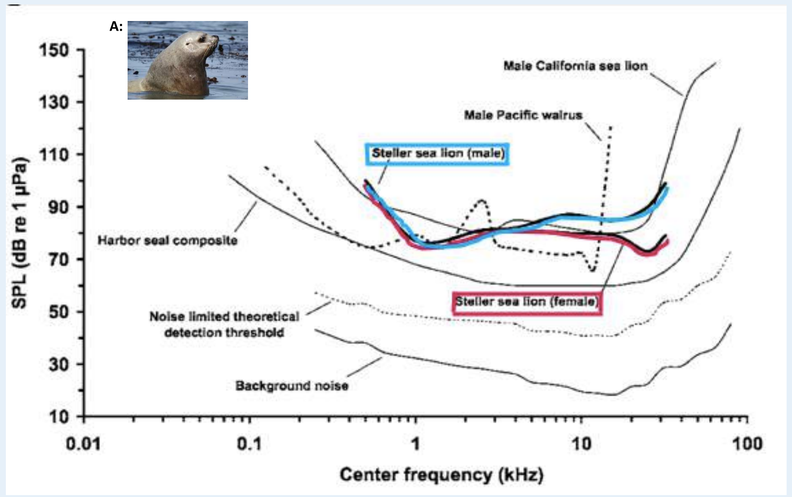

Figure 4. The mean 50% detection thresholds in dB for narrow-band FM signals obtained for the male and female Steller sea lion, *Eumetopias jubatus, (*seen in part A of figure 4) as well as other integrated information from additional studies (Kastelein et al., 2005).

Species:

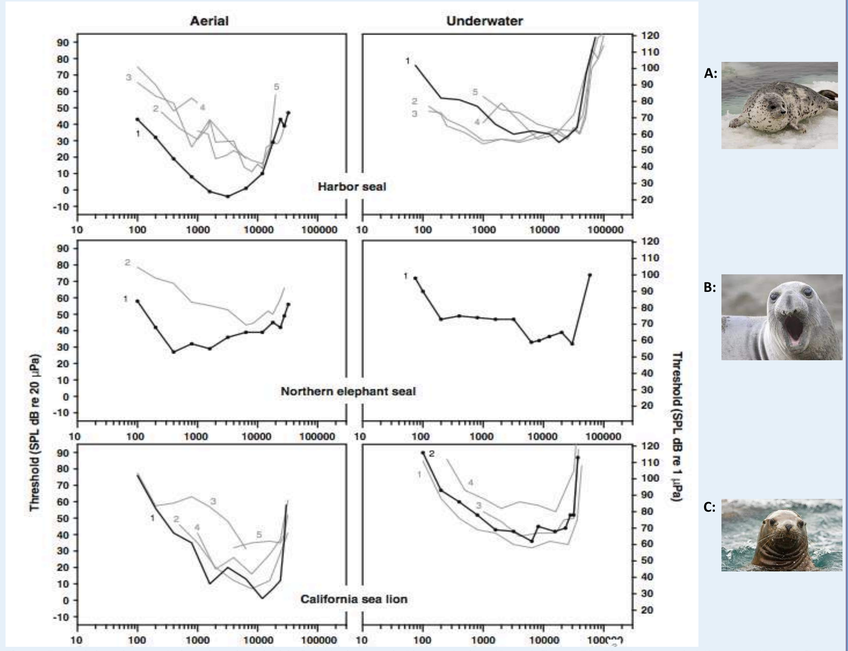

Figure 5. Aerial and Aquatic hearing thresholds for, Harbor seal, *Phoca vitulina* (Part A figure 5) , Elephant seal, *Mirounga* (Part B figure 5) and California sea lion, *Zalophus californianus* (Part C Figure 5)(Reichmuth et al., 2013).

Age:

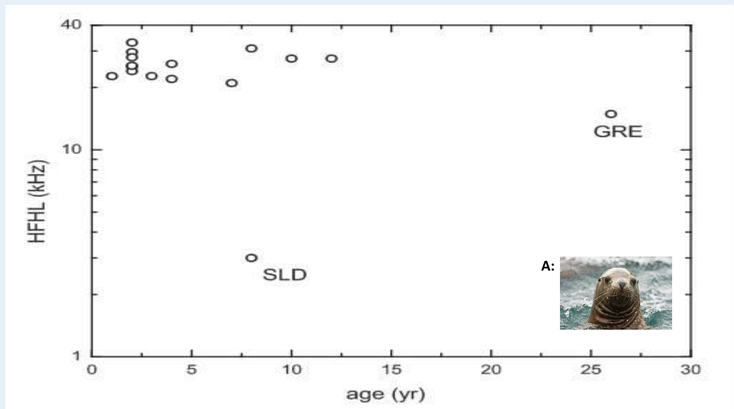

Figure 6. High- frequency hearing limit as function of age for the 16 California sea lions, *Zalophus californianus* (Part A Figure 6) for which ASSR thresholds were measured. The HFHL was defined using linear interpolation or extrapolation of the frequency corresponding to a threshold of 60 dB re 20 µPa. The lowest HFHL (SLD) and oldest age (GRE) are indicated (Mulsow et al., 2014).

Discussion

Sex:

- Male hearing threshold was higher than that of the female
- Male has poorer hearing sensitivity

Species:

- Aerial:
  - Harbor seal had most sensitive hearing
  - Elephant seal had least sensitive hearing
  - California sea lion had lowest measured threshold- similar to that of the harbor seal but shifted upwards in frequency
- Underwater:
  - Harbor seal and California sea lion both have not only similar underwater hearing thresholds but also the degree to which they can hear in aerial vs. underwater is almost the same
  - Northern elephant seal had almost identical underwater hearing thresholds as aerial thresholds

Age:

- Increased latencies and decreased amplitudes appeared to have some correlation with hearing loss as identified by the ASSR audiograms.
- Age-related hearing loss appears primarily to affect high-frequency hearing in male and female sea lions beginning at approximately 20 years of age.

Conclusions

Overall aerial and aquatic hearing thresholds did vary based on sex, species and age. This data can now be used as a source to farther understand the relationship between anthropogenic noise and its impacts on Pinnipeds. However, this data has also revealed that hearing varies also in addition on an individual basis just as it does for humans.

Acknowledgements

I would like to thank the Navy's National Marine Mammal Foundation for letting me be apart of such an incredible program and for introducing me to my new favorite marine mammal. I would also like to thank the professors within USD's Marine Science Department for always encouraging me and supporting me to follow my dreams.

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Coral Restoration Practices In Bonaire

Brendan Sullivan
Dr. Michel Boudrias, Environmental & Ocean Sciences
Environmental Studies

INTRODUCTION

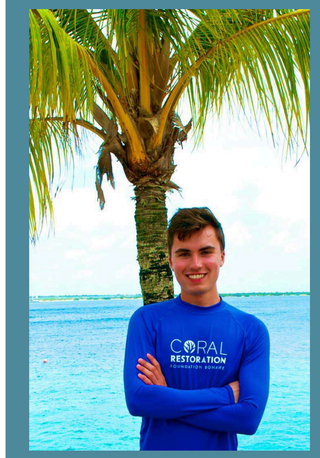

FIGURE 1) As the Boston Sea Rovers Intern, I worked with the Coral Restoration Foundation at their various restoration sites in Bonaire.

Earth's coral reefs are in the midst of a rapid and unprecedented ecological decline. In the Caribbean, the Coral Restoration Foundation seeks to mitigate this destruction by growing coral fragments in offshore nurseries and transplanting mature corals onto degraded reefs. In Bonaire, more than 9000 coral fragments are currently growing in the nurseries and over 8000 have already been transplanted back onto the reefs.

Staghorn coral, *Acropora cervicornis*, serves as the primary "reef builder" species throughout the Caribbean. As large, branching corals, they form the skeleton of the reef. Replanting this species breathes new life into the reefs by creating additional habitat and coral coverage.

METHODS

- *Acropora cervicornis* coral fragments were obtained from healthy parent corals using pliers for branch removal and mesh collection bags for safe transport.
- The fragments were fixed to "coral tree nurseries" using zip ties. The trees were made of PVC piping and fiberglass rods; they remained suspended in the water column via four sub-surface floats. The fragments were grown for approximately eight months before being replanted.
- Three restoration sites were selected around the island - each with varying light levels, depth, and water movement. Mature fragments were either planted directly on the reef using epoxy or fixed to an artificial structure made of PVC piping and metal anchors.
- To encourage sexual reproductive success, at least two genotypes of coral were planted in close proximity for successful fertilization to occur.
- Growth was monitored and observed overtime.

FIGURE 2A) "Coral Tree Nursery"

FIGURE 2B) Bar Method

FIGURE 2C) Epoxy Method

RESULTS

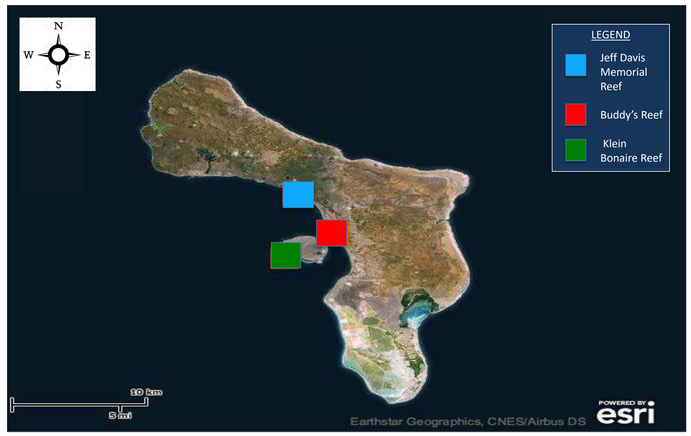

FIGURE 3) Restoration Site Map
Acropora cervicornis restoration sites were all on the leeward side of Bonaire and each had varying physical conditions and previous reef damage.

A) 1 month B) 12 months C) 24 months

FIGURE 4) Jeff Davis Memorial Reef

Davis Reef is a shallow, protected reef with large sand flats. Corals fixed to PVC structure. Observed growth rates: 12-17 cm (5-7 in) per year.

A) 1 month B) 12 months C) 24 months

FIGURE 5) Buddy's Reef

Buddy's Reef is a near shore, turbulent reef of coral rubble. Corals fixed to PVC structure. Observed growth rates: 10-15 cm (4-6 in) per year.

A) 1 month B) 12 months C) 24 months

FIGURE 6) Klein Bonaire Reef

Klein Bonaire Reef is deep and turbulent with many healthy adult corals. Corals fixed to the reef. Observed growth rates: 12-15 cm (5-6 in) per year.

DISCUSSION

- The prolific growth of *Acropora cervicornis* shows the possibility of success in coral restoration. At all three sites, strong growth was observed over the duration of two years. This provides promising data for replicating the practices elsewhere.
- At Davis Reef, the sheltered water with abundant sunlight and few predators likely contributed to its rapid growth. Coral placement in an environment with low stressors could be used to induced growth in future restoration sites.
- Buddy's Reef had slightly lower growth rates possibly due to anthropogenic influence or wave energy considering it's proximity to coastal development.
- Finally, Klein Bonaire Reef expressed moderate growth rates, possibly due to the presence of strong currents and predation on the reef. However, in comparison to other sites, the corals still preformed well despite being under stress.

CONCLUSIONS

- This restoration project yielded promising results in the quest to breathe life back into degraded coral reefs and *Acropora cervicornis* populations.
- Coral restoration can augment reef health by providing additional habitat for countless species and safeguarding against the loss of genetic diversity.
- Additional restoration practices and improved management may provide the reefs of Bonaire with long-term success in the face of mounting threats.
- Additional information and future studies are needed to properly assess the impact of coral restoration on the biodiversity and growth of the reef.

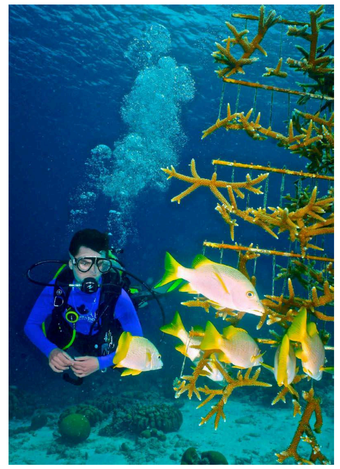

FIGURE 7) Diving in the nursery.

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Dynamic Changes of Sea Turtle Nesting Beach

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Introduction

- Over the last few decades, there have been noticeable weather patterns and changes in climate on a global scale, leading to various responses such as sea level rise
- Sea turtles are considered one of the oldest remaining reptiles, however, all sea turtle species are considered to be vulnerable or endangered due to environmental and/or anthropogenic influences (IUCN Redlist)
- IPCC (2013) predicted a sea level rise of 0.6 meters in 100 years, which could lead to a significant loss in modern available nesting beaches.
- In a four week study, the changes in elevation of six different transects were measured on the sea turtle nesting beach of Mayto in Jalisco, Mexico and compared to the data obtained the previous year

Research Objectives

- Determine the change in slope profile of the study area from 2015 to 2016.
- Determine change in beach area (m^2) from 2015 to 2016
- Predict beach area loss in 2100 if sea levels rise as predicted by the IPCC.

Methods

- Abney level method as described by Marianne Fish (2011) to measure slope of 1st kilometer of beach

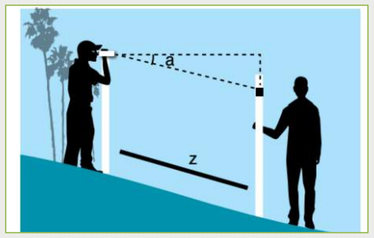

Figure 1. Graphic depicting Abney level method of measuring change in elevation.

- 6 transects measured with 5 meter segments, starting from vegetation line to the water

Figure 2. Google Earth image of study site with transect start points marked (A-F).

Results

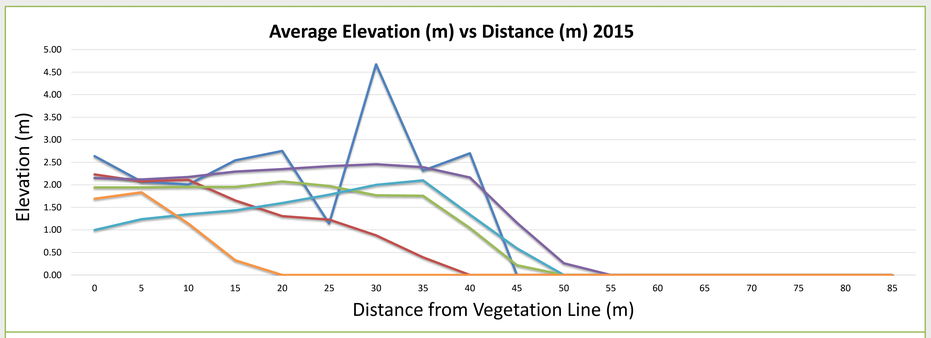

Figure 3. Comparison of average elevations in meters over 4 week study period vs the distance from vegetation line for each of the transects from 2015-2016

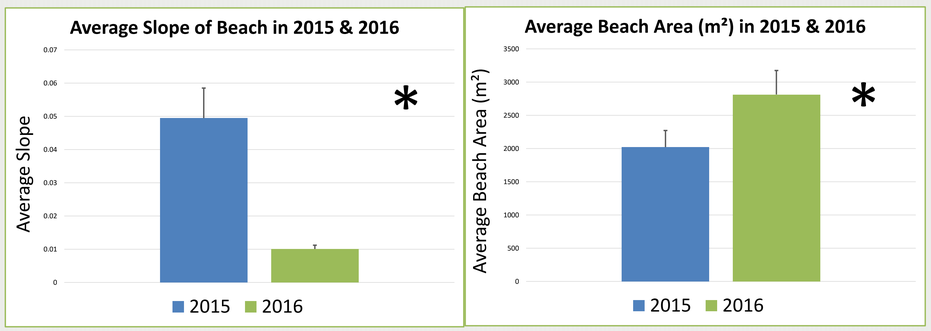

Figure 4. Comparison of average slope (left) and beach area (right) in meters² of first kilometer of Playa Mayto from 2015 to 2016. Error bars represent the standard error for each of the averages

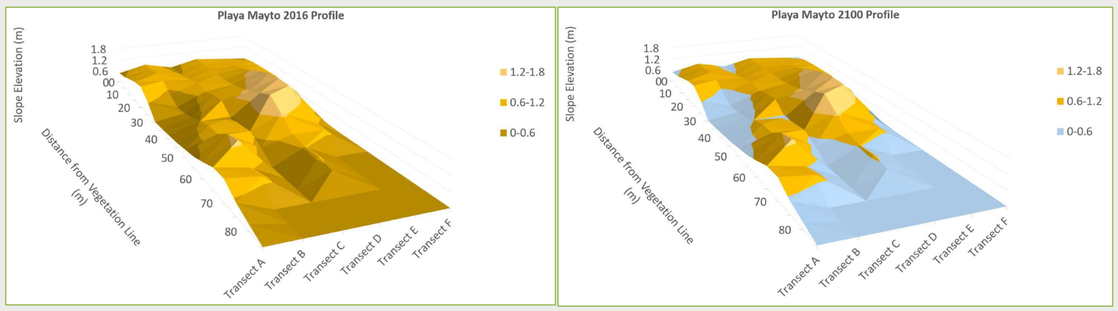

Figure 5. Side by side comparison of 2016 and 2100 to show sea level rise flooding of 0.6 meters.

Discussion

- The transect profiles varied, some being flatter as they approached the water, while others had more dips and hills
- The beach profiles of 2015 and 2016 are significantly different due to El Niño, which dramatically affected the 2015 profile
- Approximately 40% of the beach was recovered by 2016 but with a much different profile
- Although more available nesting area would lead to a larger nesting density, the number of nests depends on other factors such as migration cycles and population size
- Not developing the land around the beach as well as the continued efforts by camp staff should help the survival of the hatchling collected on the beach
- Conducting a beach profile for the entirety of the beach would be recommended to evaluate the possible impact of sea level rise and take precautions to protect the species

Figure 6. Olive ridley (*Lepidochelys olivacea)* hatchling

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