COAST Internship: Vessel Biofouling Management

Figure 1: Me on the bridge of a research vessel taken by Fred Gareeb.

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Introduction

Vessel biofouling is the growth of an organism or a group of organisms attached to the surface of a vessel, which is usually found at the propeller, thrusters and rudder. Along with ballast water, biofouling is one of the factors that can lead to the spread of unwanted or invasive species in our waters. Some examples of organisms that are found on the hull of a vessel are barnacles, mussels and algae.

Over the past ten weeks, I have been working on three different projects that involved going to the LA/LB Port on inspections with the inspectors from MEPD, taking photos of the waterline of the vessel's hull and analyzing data taken from an ROV specifically looking for tubeworms. Throughout this paper, I will be talking about each of the three projects, which will include the methods I used, the graphs/charts I made and an analysis which was concluded from the data.

Part 1: ROV Survey Video Analysis

A. Background

The OOCL America is a container vessel that was being used to test out the new dock at E25. It was sitting in the harbor for a period of six months with trips out to sea periodically. Scientist, Chris Scianni and his team were able to visit the vessel from October 2015 to February 2016 and take two 100 meter transects of the hull with the ROV each time visiting the vessel. I then used the videos as data to evaluate the percent coverage of tubeworms along the transects by using two different techniques to compare and contrast the difference between each. In the future, this analysis can help inspector protocols when an inspector will be able to have the chance to bring the ROV on an inspection with them to check out the hull of the ship for fouling.

Figure 2: Picture of the OOCL America Container Vessel

B. Methods

I used a variety of different software for the analysis on the computer. I started with Pinnacle Studio 15 in which I uploaded the videos from and used the Frame Grabbing Tool to grab the specific frame grabs that I was looking for. Then depending on which techniques I was using, I would grab the necessary frame grab. The two different techniques were random and stoppage. For the random technique, using random.org I started with fifty samples and took many, many samples within the fifty and graphed in excel. From then I used the standard deviation and found out that the perfect sample size was thirty. Thus the rest of the random samples I used thirty as the sample size. For the stoppage technique, I stopped the video whenever I saw a different patch of tubeworms throughout the whole transect. From then, I used Photo Quad software to analyze the exact percent coverage and surface area of the tubeworms.

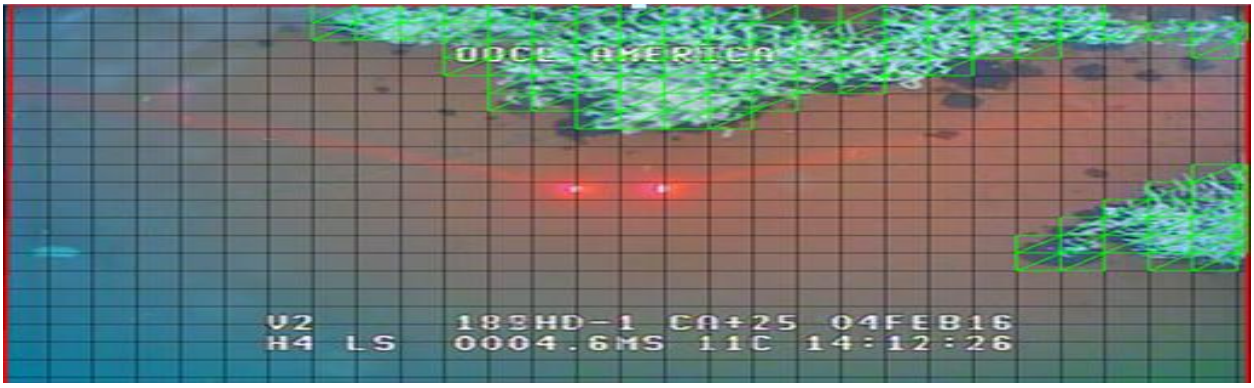

Figure 3: What the picture frame looks like when analyzed in Photo Quad

C. Graphs

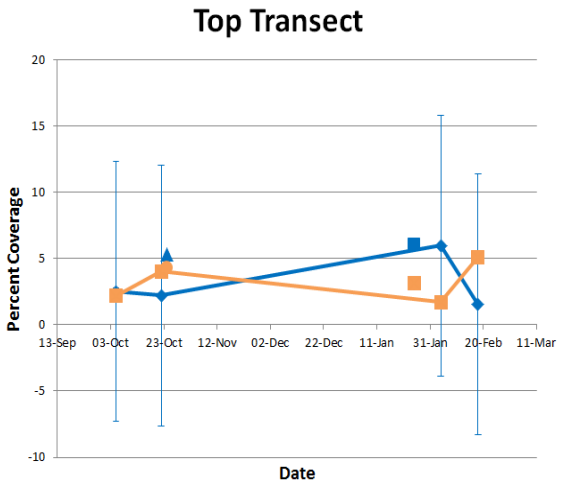

Figure 4: Top transect data points

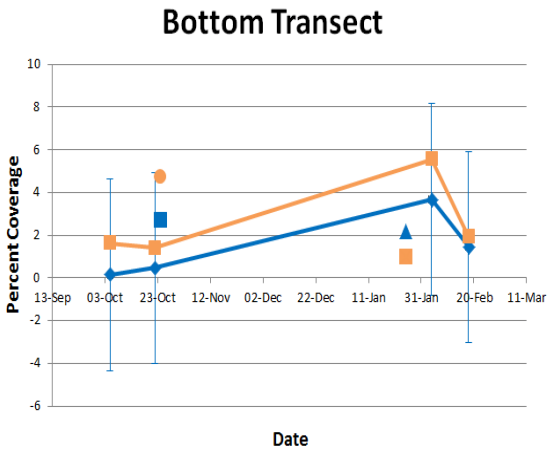

Figure 5: Bottom transect data points

For the graphs above, the orange is the stoppage technique and the blue is the random. There are six data points, however only four are attached to the line. That was because we initially had six points, but we had to exclude two points because one was on the other side of the vessel and the other point had a piece of the transect that was missing. From the graphs, the bottom transect looks nicer than the top transect because the random and the stoppage are both similar in the trends.

D. Analysis

The stoppage is the true percent coverage of tubeworms and by comparing both we can see that the random isn't up to par with the stoppage technique. We saw that the random doesn't work that well compared to stoppage because of the large error bars on the random percent coverage which shows a lot of variability within that data set. This shows that if we have an option to do only one of the techniques that the stoppage is more accurate and would provide better data. Also, I found that there is a large gap between the months of November and December. If we had a few data points from those months, the data could look a bit different. Lastly, along with any scientific research, the more data the better analysis. Thus, with more data points a better understanding can be found from the data and also showing more significance.

Part 2: Waterlines Project

A. Background

I went out about two to three times a week with an inspector looking at the hull of a vessel and determining the level of fouling. The level of fouling was on a scale from zero to five. A zero was clean and right out of dry dock and because of that I didn't see any zeros and a five is 41-100% of the hull covered in large organisms. Therefore, the ones I saw the most of had a LoF of one which was covered in a biofilm or slime. By doing this project, the data can help form the future risk based inspection priority matrix by looking for relationships with the vessels that are at a higher risk than others by looking at the data from the Hull Husbandry Reporting Form. From the information that the vessels put in the annual HHRF that they submit before coming into port, I was able to graph many possible relationships.

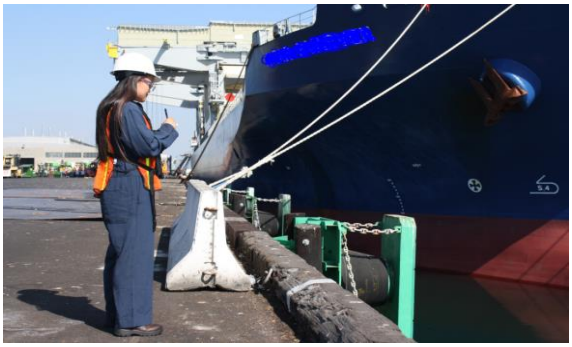

Figure 6: Me collecting data from a vessel (PC: Ben Potter)

B. Methods

I tagged along with an inspector in the morning and joined them on the vessels that they were going to do a ballast water or oil inspection. Then with permission from the dock security and the chief mate, I took photos from the Bow, Middle Section and the Stern of the vessel. After, I recorded the level of fouling from 0-5 and repeated all of the steps multiple times. Our initial target was forty vessels which were about seven of each vessel type give or take a little. However, I ended up going out and getting many ships a day and therefore ended up with a total of fifty-two vessels.

Figure 7: Example of LoF of 1

Figure 8: Example of LoF of 5

C. Graphs

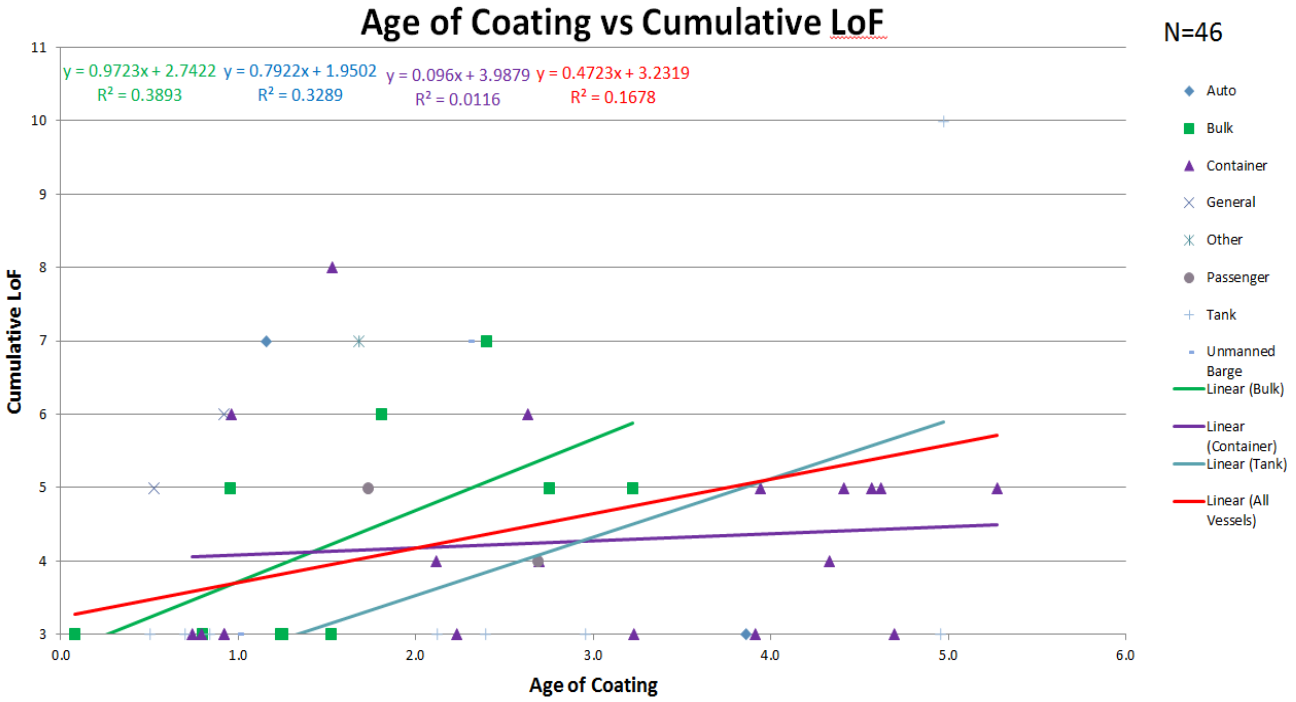

Figure 9: Age of Coating vs Cumulative LoF

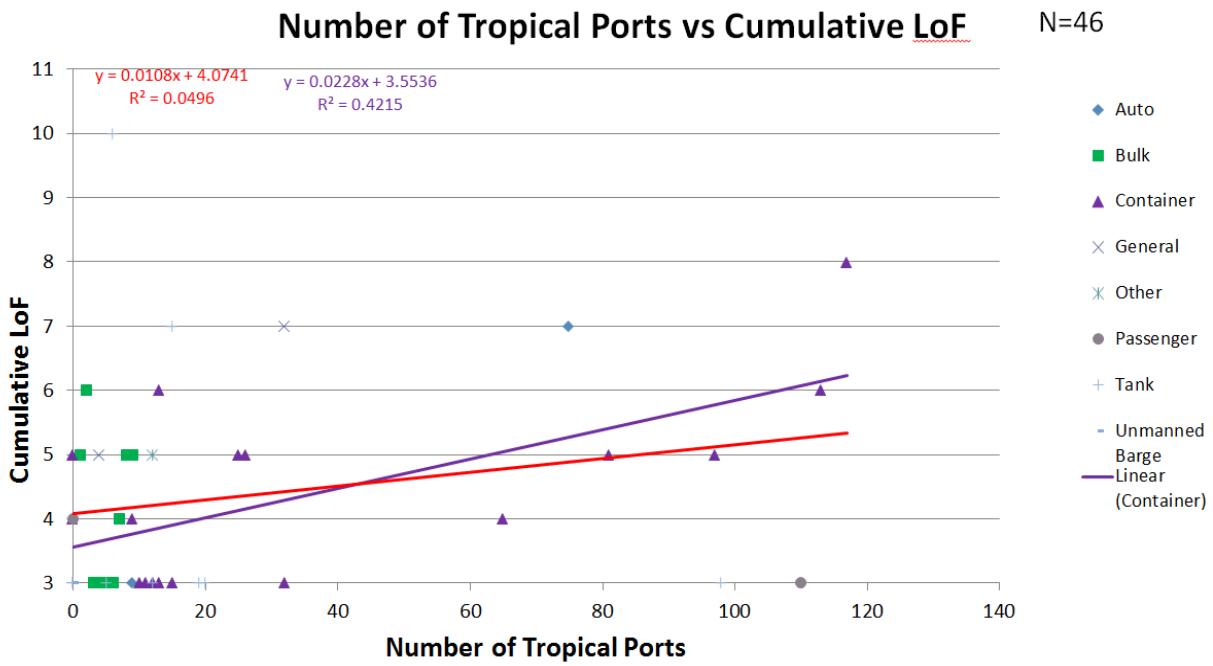

Figure 10: Number of Tropical Ports vs Cumulative LoF

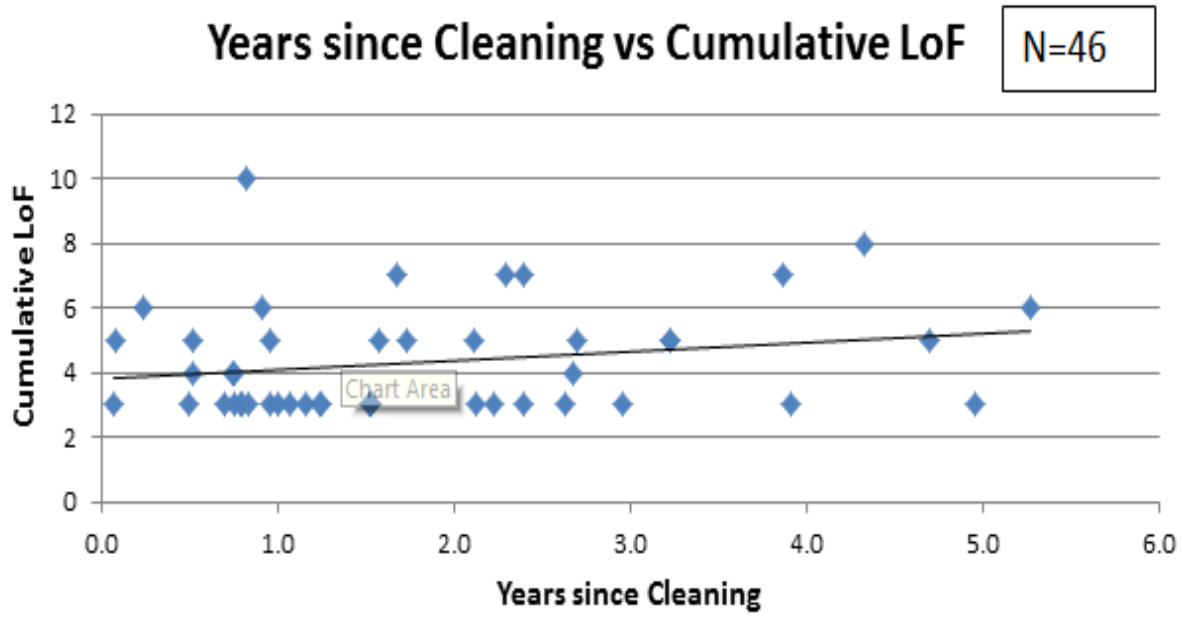

Figure 11: Years since Cleaning vs Cumulative LoF

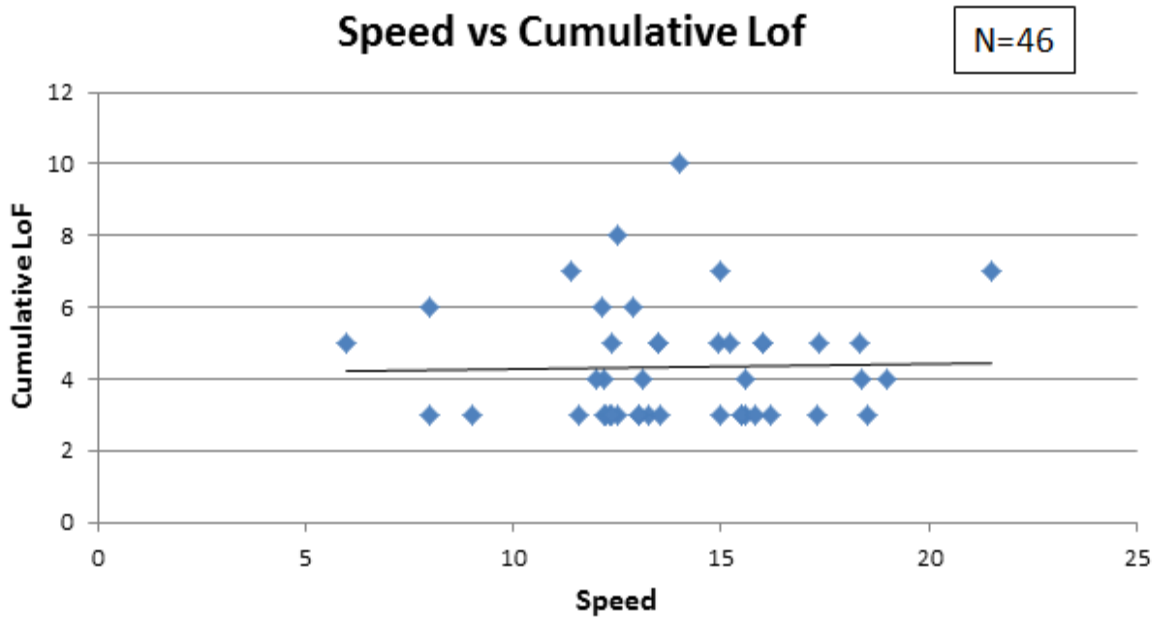

Figure 12: Speed vs Cumulative LoF

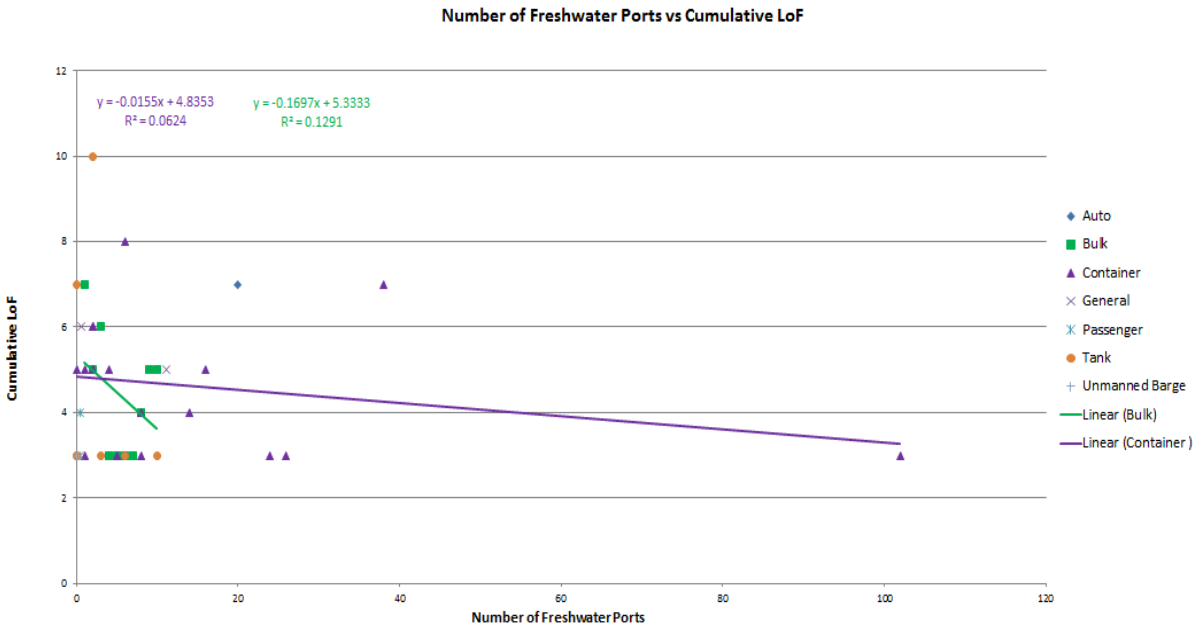

Figure 13: Number of Freshwater Ports vs Cumulative LoF

In each graph, all container vessels and its trend line is purple, the bulkers and its trend line is green and the red lines shown in a few is the trend line within all the vessels. The corresponding r^2 value is in the color of the vessel type.

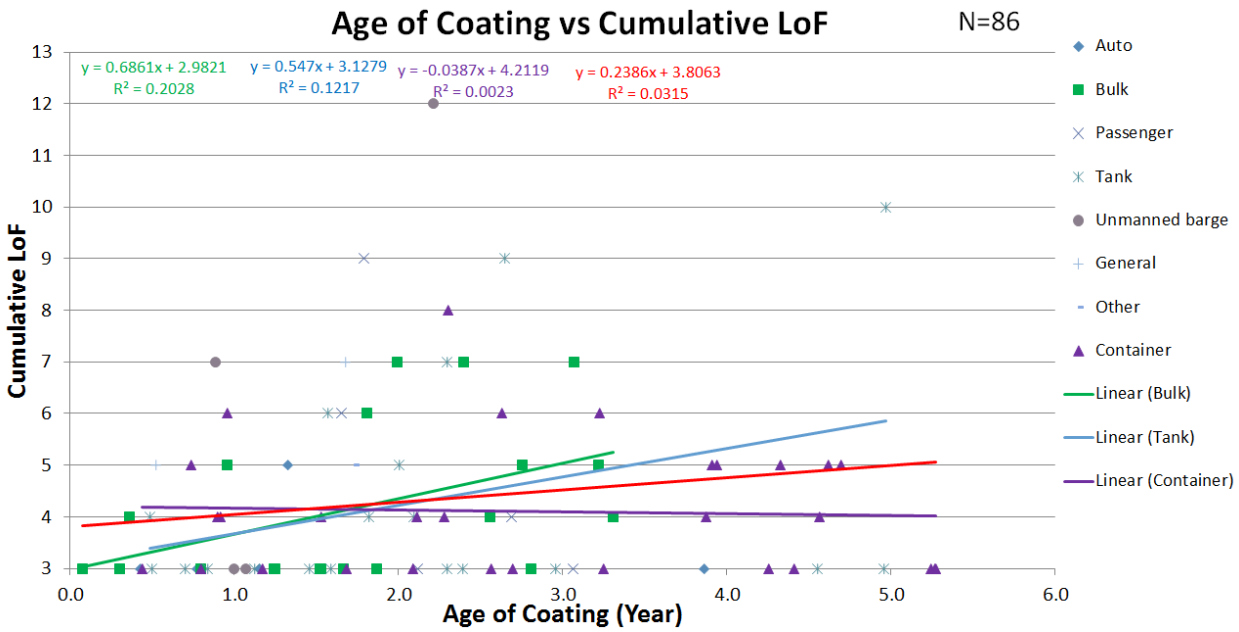

Figure 14: Alice x Chrissy: Age of Coating vs Cumulative LoF

In this graph above, I put the data I collected together with the intern last year who was working on the same project. Our total number of vessels is 86 (Chrissy collected 40 and I collected 46).

D. Analysis

From the six graphs above, the first three show the relationships that worked the best which include Age of Coating, Number of Tropical Ports and Years since Cleaning all vs the Cumulative LoF. The last two show the graphs that did not show any relationship or did not work the best which include the Speed and the Number of Freshwater Ports both vs the Cumulative LoF. The last one is the graph that contains Chrissy, the last intern, and my data put together. I was assuming that if my data showed a relationship that including her data could also help show that relationship.

A trend that I noticed was that within specific vessel types, the trend line was stronger than the trend line of all the vessels combined. This is because within each vessel type such as the bulkers, each bulker is very similar and shows very little variation. However, when analyzing all the vessels together because each vessel type differs from the other, the variation is larger and thus shows a weaker trend line when looking at all the vessels together.

Part 3: IMO Biofouling Management Plans Project

A. Background

The IMO Guidelines were established in 2011 and as of now are voluntary. However, once the biofouling policies are put into action, the IMO Guidelines will be

mandatory. By boarding the vessels I was able to measure the implementation of the guidelines, to see which vessels would be compliant now by having a Biofouling Management Plan and corresponding Record Book.

B. Methods

My methods were very simple for this project. I boarded each vessel with an inspector and asked the chief mate if they had a Biofouling Management Plan and Record Book on board. If they did have a Management Plan I would ask if it was in a separate binder or together with their Ballast Water Management Plan, which I did see a few times.

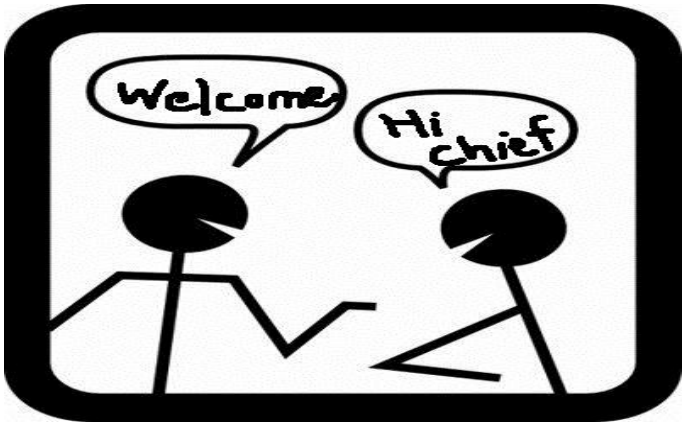

Figure 15: Picture of me talking to a chief mate

C. Graphs

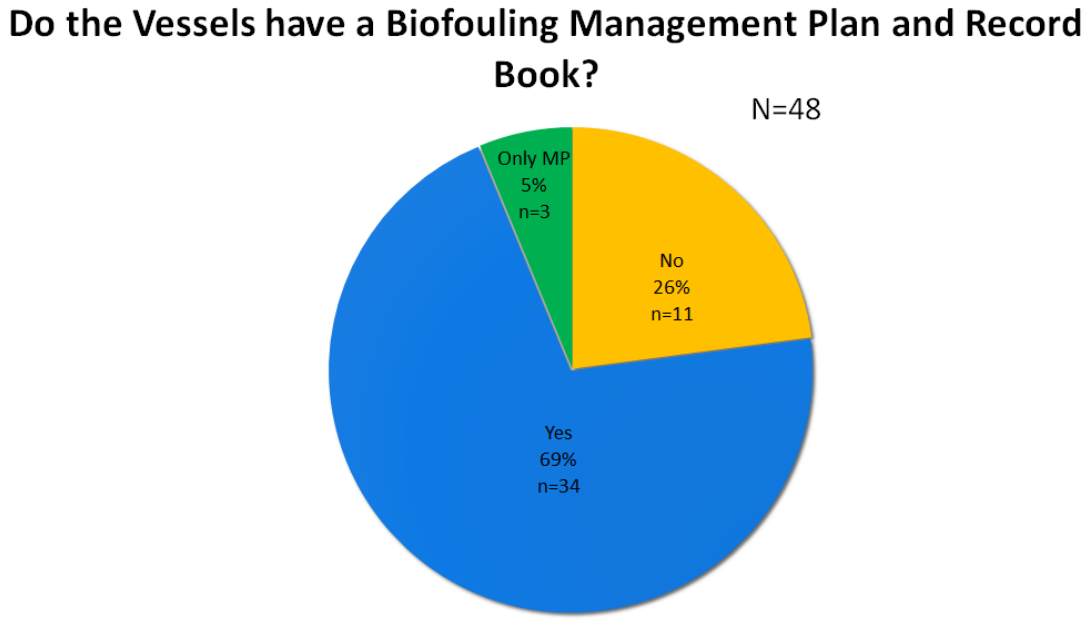

Figure 16: Pie Chart of the distribution if the vessels had a MP or not

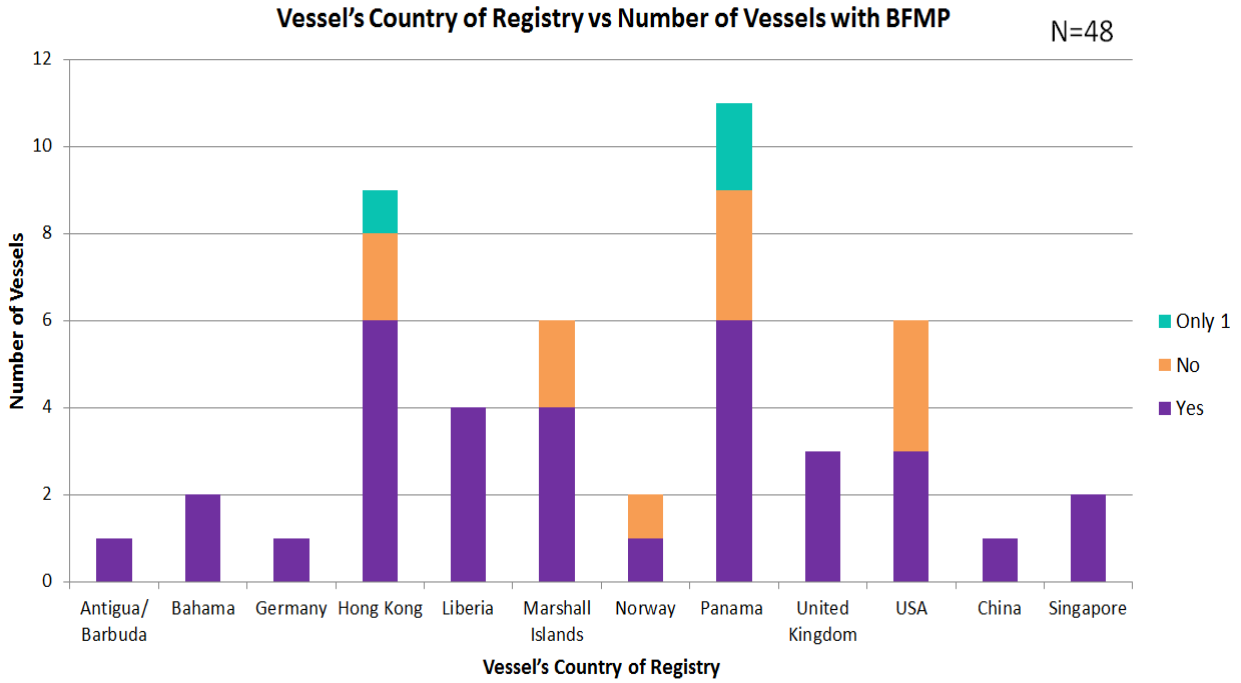

Figure 17: Distribution of the Vessel's Country of Registry that I sampled from

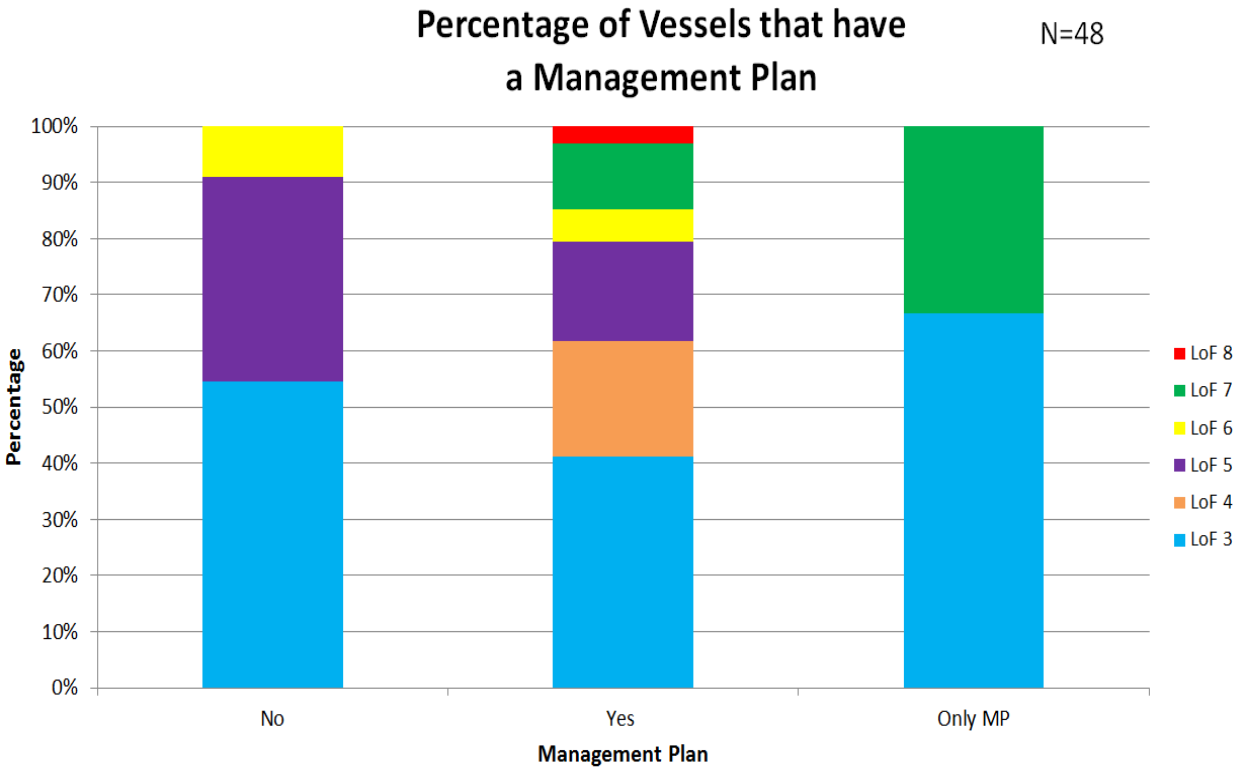

Figure 18: Percentage of Vessels that had a Management Plan with their corresponding LoF

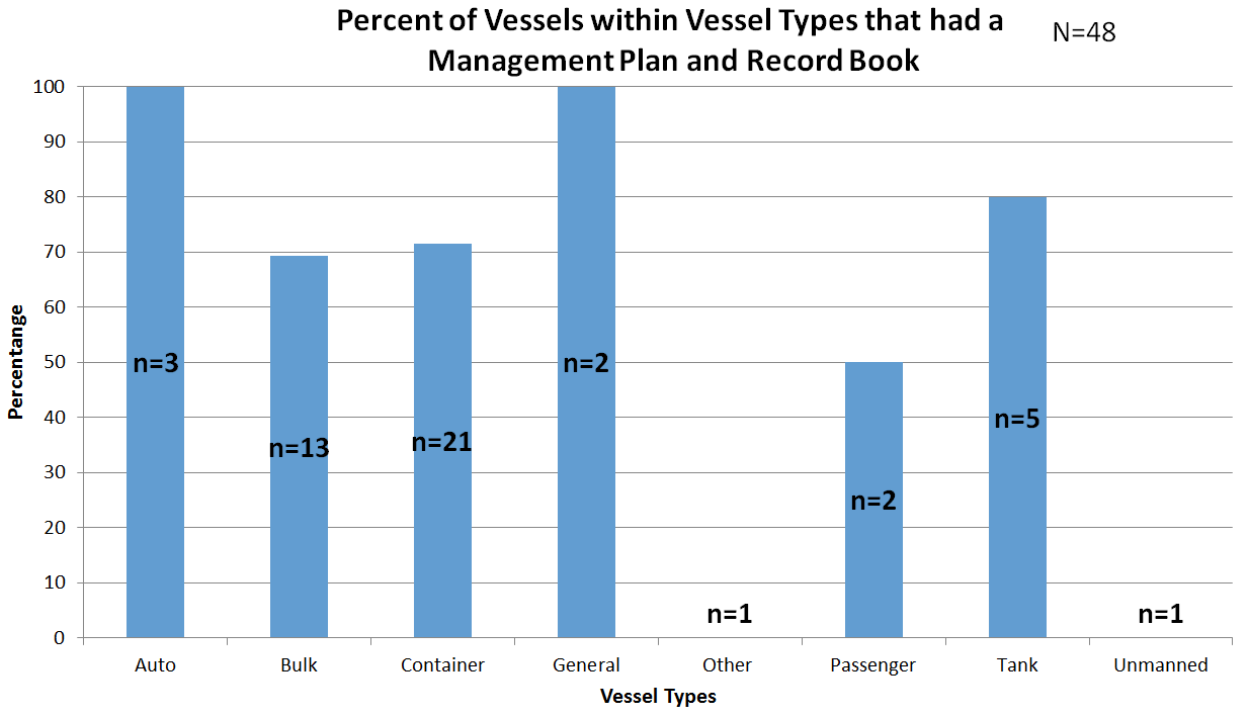

Figure 19: Distribution of the type of vessels that I sampled and their percentage that had a Management Plan

The graphs above are different ways to analyze all the data. The most important one to look at is Figure 12 because it shares with us the most information.

D. Analysis

All the graphs and charts give us an understanding of the implementations of the IMO Guidelines and to see how they are being used. The pie chart in Figure 10 shows an overall look at the IMO Guidelines. We assumed 50% in the beginning, however our data showed that about 69% of the 48 that we sampled did have a Biofouling Management Plan and Record Book.

The Bar Graph in Figure 11 shows a distribution of all the vessels I sampled and where their vessel is registered to. I like it because from the all the vessels sampled, it shows some of the major countries involved in the multi-billion dollar industry of exporting and importing goods. These countries are Panama, Hong Kong, the Marshall Islands and USA.

The Bar Graph in Figure 12 is the most important because it shows us key information that even if a vessel has a Biofouling Management Plan it doesn't necessarily mean that they use it. This is shown by the No having a larger percentage of the Cumulative LoF of a 3 than the Yes column has. The Yes column should have a higher percentage of 3's because that would mean that their vessel's hull is clean possibly because they are aware of the IMO Guidelines and are actively trying to prevent fouling

on the hull. It is also shown because the highest Lof is an 8 and is on the Yes column. We were expecting it to be on the No column because if they don't have a Management Plan they wouldn't be aware of the Biofouling Guidelines and have a dirtier hull than a vessel with a Management Plan.

Lastly, in the Bar Graph in Figure 13 shows the distribution of the different types of vessels that I sampled from and their percentage of vessels within the vessel types that did have a Management Plan. Looking at the graph, it shows that Auto ships have a 100% of vessels sampled that had a Management Plan. Although it shows 100%, we have to take into consideration the sample size and because the sample size is three, we cannot assume that any Auto Vessel will have a Management Plan from this data set. However, we can look at the Container and Bulker Vessels percentage because we do have a larger sample size in each. The Containers had about 71% and the Bulkers had about 69% of all vessels sampled that did have a Management Plan.

With all the data sampled from the vessels the take home message is that with the data and analysis, we have to consider the sample size. We can make conclusions from what we have, however it would be more accurate if we had a larger sample size.

Conclusion

Coming into the internship, I was very hesitant because this was my first opportunity to be in the real world to see what a future career could be. On my first day I was nervous, yet excited to dive into the data and to learn. I learned so much from this experience and I had an amazing time here at the State Lands in Long Beach. They welcomed me with open arms and a friendly smile everywhere I turned. I bonded with each inspector I went out with and interacted with each person on the MISP team. However, one of the best parts was being under the wings of my boss Chris and learning from him. We met at least once every week to talk about my project and how it was going. He wanted me to succeed in my data collection and analysis, yet succeed as a person and gain valuable knowledge that I can take with me for the rest of my studies and into my career, wherever that may lead me.

Being a Biological Sciences major, there are so many different paths that one can take with their degree. This internship has given me skills such as learning different software such as Pinnacle Studio 15, Photo Quad, Image J, Arc GIS and the Survey 123 App to communication skills by learning how to talk to an interact with my coworkers and work as a team to get one job done. I also learned about myself on this experience because I became more confident as a person and being calm, cool and collective when in the work place and out in the field.

I think my data can be used in the future to help the future risk basked inspection matrix with knowledge of the different relationships that I graphed. I also think with my data, the next intern can add his/her data to expand the sample size especially on the

waterlines project and the IMO Guidelines project to see how the implementation of the Guidelines has changed within a year.

Figure 20: Me in front of a vessel that I just sampled