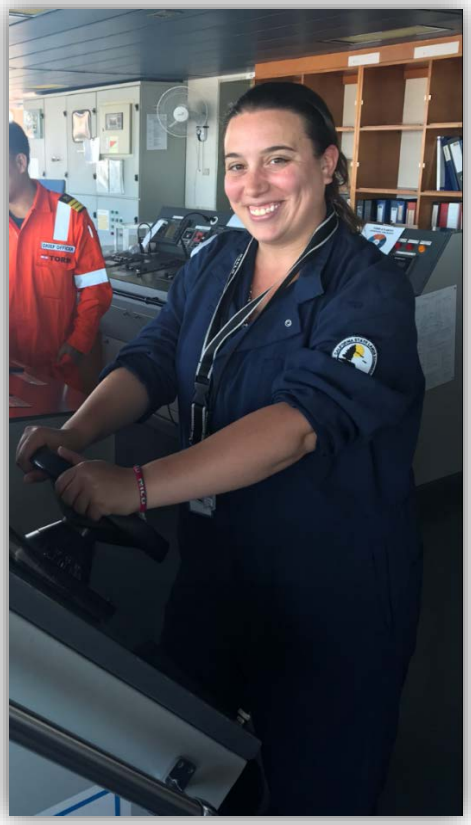
COAST Internship: Vessel Biofouling Management Through the Use of Antifouling Coatings



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Marine Environmental Protection Division

BACKGROUND:

The individual biofouling project I am responsible for involves antifouling coatings. It is estimated that biofouling is responsible for up to 60% of nonindigenous species (NIS) introduced to California waters (Ruiz et al. 2011). Antifouling coatings are one method for vessels to manage biofouling accumulation on their underwater surfaces. There are several incentives for a vessel to discourage biofouling accumulation. One of the primary incentives is from an economic perspective. Vessel biofouling can contribute to a less streamline transport. In other words, when the vessel is moving through the water, accumulated biofouling creates drag and, in turn, the fuel consumption increases, costing the vessel millions of dollars. Overall, the less fuel efficient the vessel, the more devastating the impacts could be for the shipping industry (Brown et al. 2017).

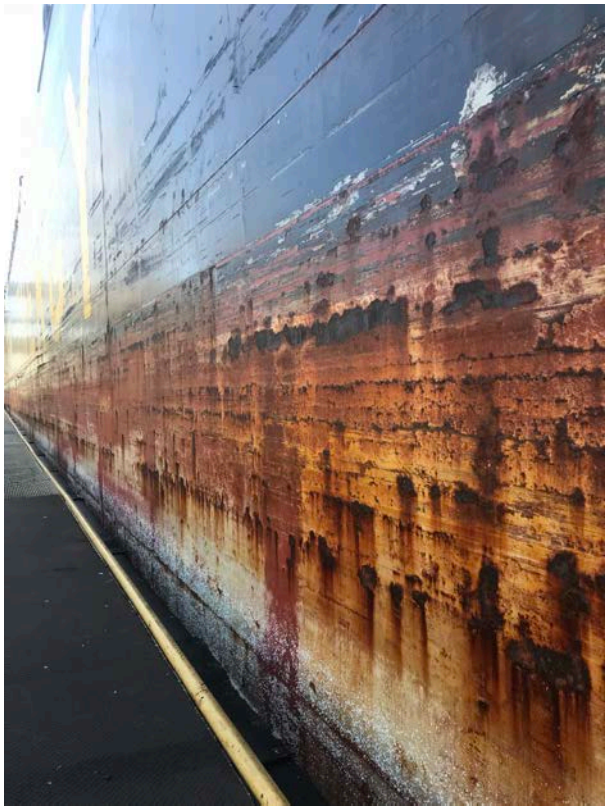
There are several types of antifouling coatings on the market. The two main types are biocidal and foul-release antifouling coatings.

- Biocidal antifouling coatings contain heavy metals (e.g. copper, zinc, etc.). Biocidal coatings prevent the settlement of biofouling by constantly releasing heavy metals and creating an inhospitable environment for larvae to settle.
- Foul-release coatings are typically made of silicon. With these coatings, settlement of organisms along wetted surfaces of the vessel is possible, however, the organisms eventually fall off when the vessel reaches the appropriate or effective speed in water. When the effective speed is reached, the organisms can no longer maintain a strong hold and fall off. This concept explains why the effective operating speed of a vessel, depending on the type antifouling coating used, is critical.
- There are other coatings available that do not have preventative biofouling properties. (Brown et al. 2017).

The Marine Invasive Species Program (MISP) is administered by the California State Lands Commission and is dedicated to preventing the introduction of Nonindigenous Species (NIS) in California waters. MISP was created through the 1999 Ballast Water Management for Control of NIS Species Act and expanded in 2003 when the Marine Invasive Species Act was approved. In 2008, MISP began collecting data on the hull husbandry practices of vessels, including the use of antifouling coatings. As far as we are aware, MISP has the most comprehensive database of geographically-specific coating use in existence today. This dataset is critical because of the efforts being taken to prevent NIS establishment. Preventing NIS is important for many reasons because they have devastating impacts on the economy, environment, and human health. NIS impact biodiversity, out-compete native species for resources, transmit diseases, and genes can become altered through interbreeding with native species. It is important to note that not all NIS are invasive, however, if the NIS becomes invasive the organism is capable of spreading at rapid rates due to a lack of natural predators in the new environment.

The goal for this project is to collect data on antifouling coatings that have, at one point or another, been used on vessels entering California waters. I was particularly interested in the effective lifespan (age of a coating for which it is expected to remain effective) and effective speed (the optimal speed for the coating to function appropriately). The Marine Invasive Species Database (MISP.IO) already contains some data on lifespans and effective speeds from a previous intern, my job was to expand the database. This was accomplished by

determining what data are still missing and contacting the appropriate parties to try and obtain the data. For the coatings that were missing effective lifespan and effective speed (in knots), I e-mailed international manufacturers of the coatings that entered California waters. The coating manufacturers received an email requesting data regarding the lifespan and speed to which a vessel should be operating for the coating to be most effective. If a vessel is travelling above or below the recommended parameters for age and/or speed given by the manufacturer, the coating is unable to ward off various organisms. If a coating exceeds the expected lifespan or does not meet the recommended speed, it could have devastating impacts to the surrounding environment, as seen in the images below.



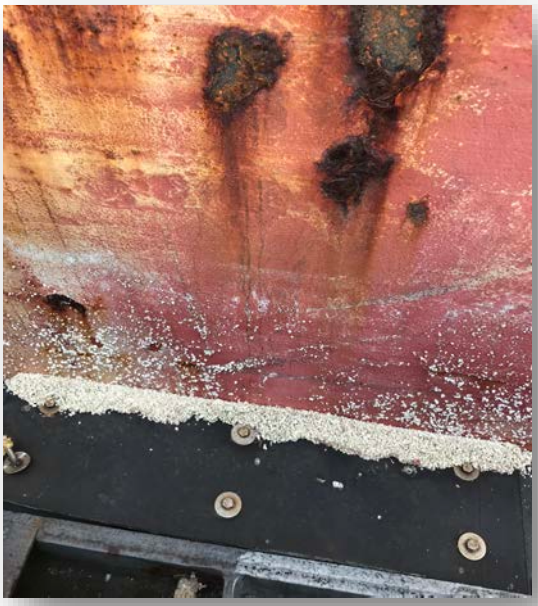
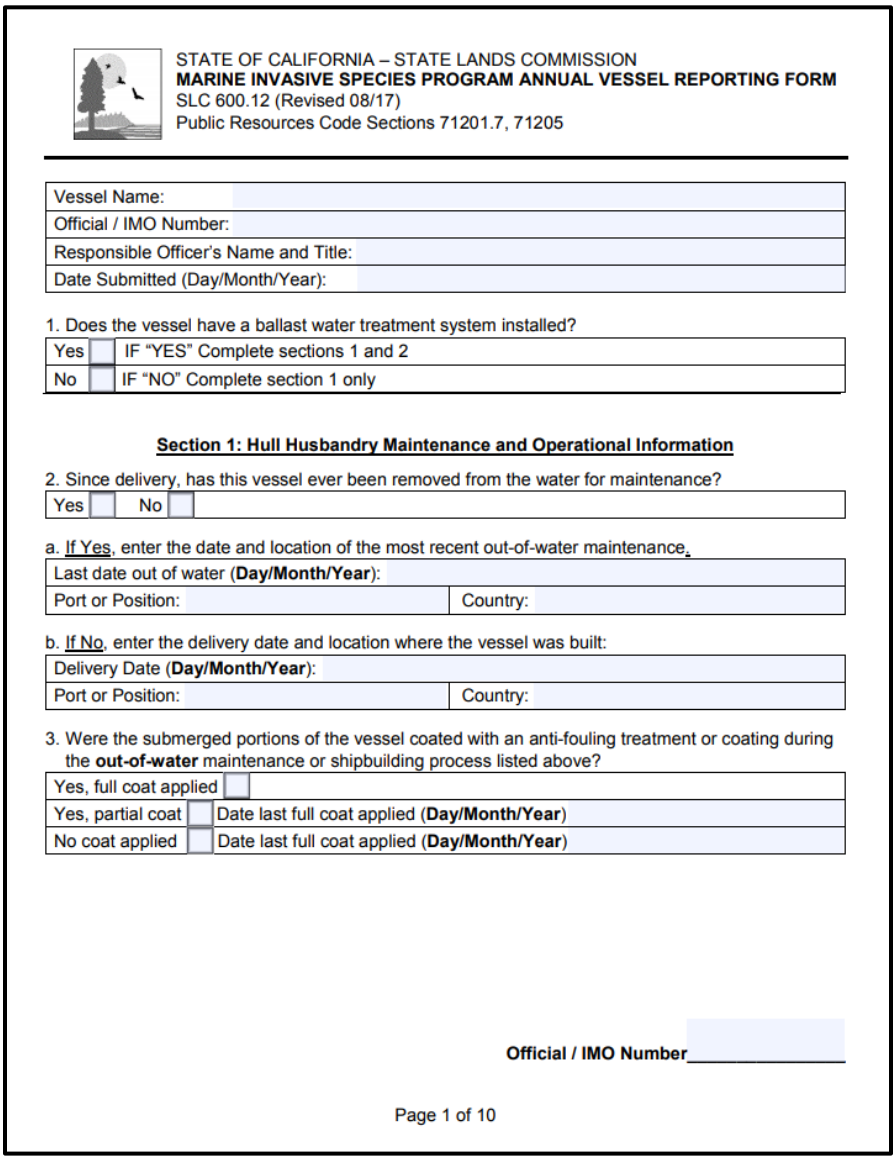


Figure 1. Rusted hull of a vessel that was inspected in Pittsburg, California. This vessel has not experienced a new antifouling coat in over 10 years. Figure 2. As cargo was loaded onto the vessel, the fender scraped off the barnacles on the side of the hull and they collected along the fender. This is a primary example of an introductory event. In this case, the vector was the vessel and it introduced a new species into the receiving environment.

The more data that we collect, the better chances we have at determining if a vessel's operating profile matches the coating specifications (e.g., effective lifespan and effective speed). It is important to note that the antifouling coating manufactures are multi-million-dollar, international corporations. Receiving a response from any of these companies listed in the database is rare.

As of October 1, 2017, all vessels entering California are required to submit an Annual Vessel Reporting Form (AVRF) and it must be submitted at least 24 hours in advance of the vessels' first arrival to California for the calendar year. The AVRF is the primary document collecting data on the overall hull husbandry practices of vessels that are 300 gross registered tons or more. Prior to the AVRF, the Hull Husbandry Reporting Form (HHRF) was used from 2008 until repealed (Title 2 California Code of Regulations (CCR) section 2298.1 et seq.) and the AVRF was adopted. It is important to note that there was no interruption between the HHRF and

AVRF. The HHRF was repealed at the same time the AVRF was implemented, therefore, no data is missing. An example of an AVRF can be found below. Even though the AVRF collects an array of hull husbandry practices, effective coating lifespan and effective speed are not included in the form. To obtain this information I researched several sources to obtain the missing data for over 300 antifouling coating products.



STATE OF CALIFORNIA – STATE LANDS COMMISSION
MARINE INVASIVE SPECIES PROGRAM ANNUAL VESSEL REPORTING FORM
SLC 600.12 (Revised 08/17)
Public Resources Code Sections 71201.7, 71205

Vessel Name:
Official / IMO Number:
Responsible Officer's Name and Title:
Date Submitted (Day/Month/Year):

1. Does the vessel have a ballast water treatment system installed?

Yes	☐	IF "YES" Complete sections 1 and 2
No	☐	IF "NO" Complete section 1 only

Section 1: Hull Husbandry Maintenance and Operational Information

2. Since delivery, has this vessel ever been removed from the water for maintenance?

Yes	☐	No	☐

a. If Yes, enter the date and location of the most recent out-of-water maintenance.

Last date out of water (**Day/Month/Year**):	
Port or Position:	Country:

b. If No, enter the delivery date and location where the vessel was built:

Delivery Date (**Day/Month/Year**):	
Port or Position:	Country:

3. Were the submerged portions of the vessel coated with an anti-fouling treatment or coating during the **out-of-water** maintenance or shipbuilding process listed above?

Yes, full coat applied	☐	
Yes, partial coat	☐	Date last full coat applied (**Day/Month/Year**)
No coat applied	☐	Date last full coat applied (**Day/Month/Year**)

Official / IMO Number_____

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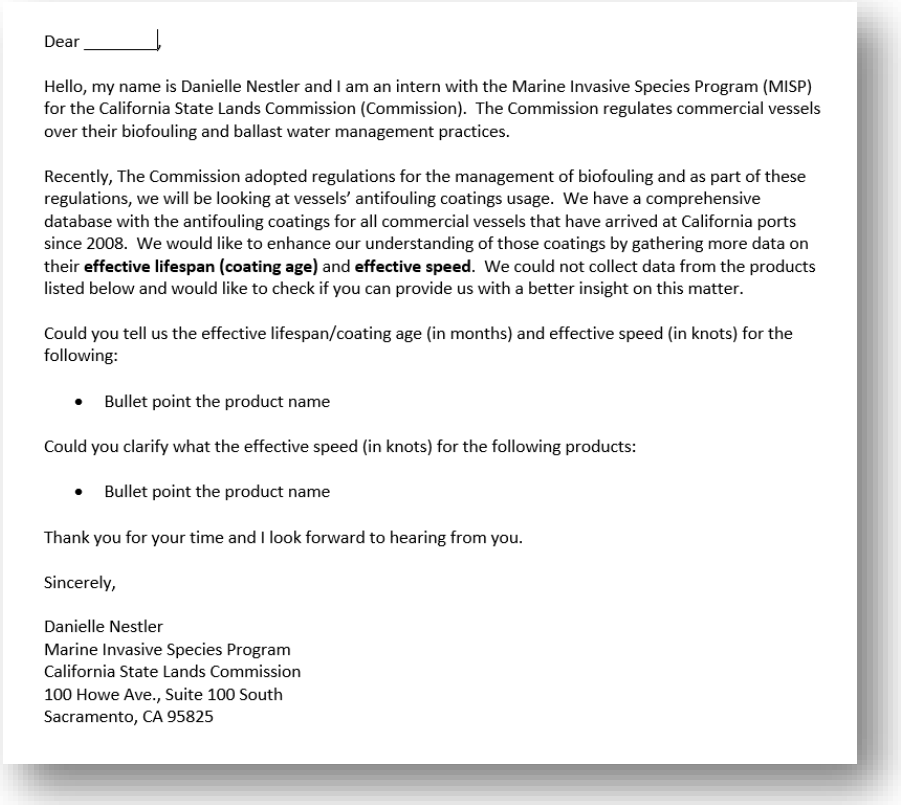
Figure 3. This image is the first of six pages in the Annual Vessel Reporting Form (not counting instructions).

METHODS:

The MISP.IO database has an alphabetical list of coating products, coating manufacturers, biocides, coating delivery mechanisms, effective coating age, and effective coating speed for all vessels that have entered California since 2008. Raya Nedelcheva and I used Microsoft Access to query the data and I copied it into Excel to organize the information. The columns I focused on were product name, manufacturer, coating effective age, and coating effective speed. The

data in Excel were color coded to identify what products had data for effective speed or lifespan, rows that were 100% complete, and unspecified data points that were not relevant or duplicated. In total we pulled 464 coatings from the database. Once the spreadsheet was color coded, I used the sort function in Excel to organize the highlighted regions. Blue, pink and yellow were assigned to the products missing varying degrees of information. Green was assigned to the products with completed information. The output was 305 products that were missing all or some information and 88 completed products. The remaining 71 coatings were duplicate copies depending on the query Access pulled the data from. The duplicates were not included in the data analysis. The highlighted green sections were disregarded for the purpose of this project as they were already completed. After determining the products with missing information, I spent the first two weeks of the internship researching manufacturers' websites for the missing information that may have been available to the public. If it was not identifiable through their website (it almost never was), Raya and I created a template to reach out to the manufacturer through email. Many of these manufacturers had a newer model coating they were trying to promote and did not have information available for the coatings we were interested in.



Dear _____,

Hello, my name is Danielle Nestler and I am an intern with the Marine Invasive Species Program (MISP) for the California State Lands Commission (Commission). The Commission regulates commercial vessels over their biofouling and ballast water management practices.

Recently, The Commission adopted regulations for the management of biofouling and as part of these regulations, we will be looking at vessels' antifouling coatings usage. We have a comprehensive database with the antifouling coatings for all commercial vessels that have arrived at California ports since 2008. We would like to enhance our understanding of those coatings by gathering more data on their **effective lifespan (coating age)** and **effective speed**. We could not collect data from the products listed below and would like to check if you can provide us with a better insight on this matter.

Could you tell us the effective lifespan/coating age (in months) and effective speed (in knots) for the following:

- Bullet point the product name

Could you clarify what the effective speed (in knots) for the following products:

- Bullet point the product name

Thank you for your time and I look forward to hearing from you.

Sincerely,

Danielle Nestler
Marine Invasive Species Program
California State Lands Commission
100 Howe Ave., Suite 100 South
Sacramento, CA 95825

Figure 2. Example of a template email sent to manufacturers of the antifouling coating product.

When the template was finished, I was given a collection of business cards (collected by MISP over the years) with several manufacturers' emails. If we did not have access to a manufacturers' business card, I searched the internet for a source of contact. After receiving several responses, I updated the database with the missing effective lifespan and speeds.

Maurya Falkner, Raya, and I pulled vessel data for 2015 and 2016 and compared the actual age of the coating to the effective lifespan of the coating used to see if it was expired or not. In the future I anticipate doing the same for the effective speed.

RESULTS:

I received response to approximately 27% of the 26 emails I sent out. As of August 18, 2018, there are several emails without responses. One company advised their coating products were no longer in production and only gave the latest product version's lifespan and speed. Another manufacturer gave the antifouling lifespan and not the effective speed. Two manufacturers responded with a detailed table of the effective lifespan and speed for 10-12 different products, this was very helpful and informative.

In 2015, 97.9% of vessels used antifouling coatings that were within their lifespan. A grand total of 1681 antifouling coatings were analyzed during this year and 38 of them were expired (Figure 3).

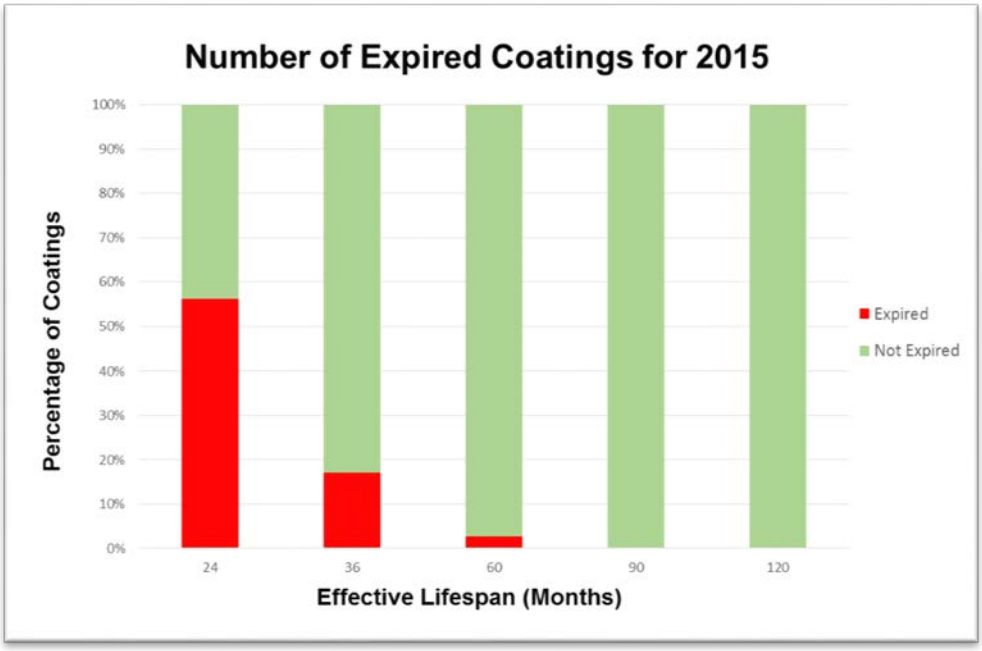


Figure 3. Number of antifouling coatings operating within and outside their effective lifespan applied on vessels that visited California in 2015.

Continuing with 2015, approximately 97.7% of vessels observed did not have expired coatings. I analyzed 1171 vessels in the Microsoft Excel spreadsheet and 23 of the vessels had expired coatings.

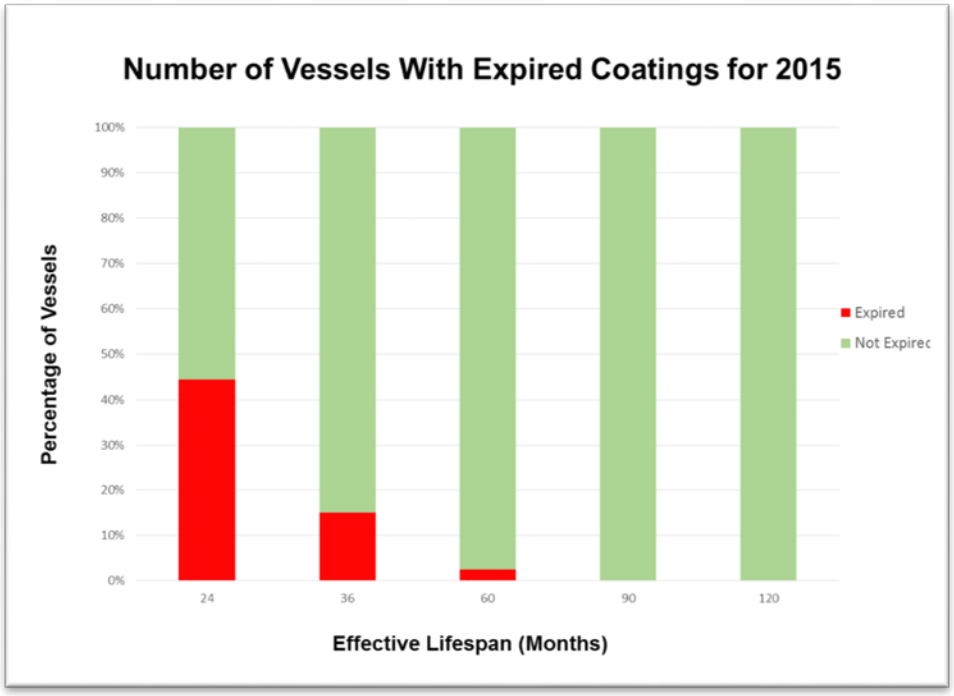


Figure 4. Number of vessels operating within and outside their effective lifespan applied on vessels that visited California in 2015.

In 2016, 97.8% of coatings observed were within their effective lifespan. The grand total of antifouling coatings pulled during this year was 1601, 35 of those coatings were expired.

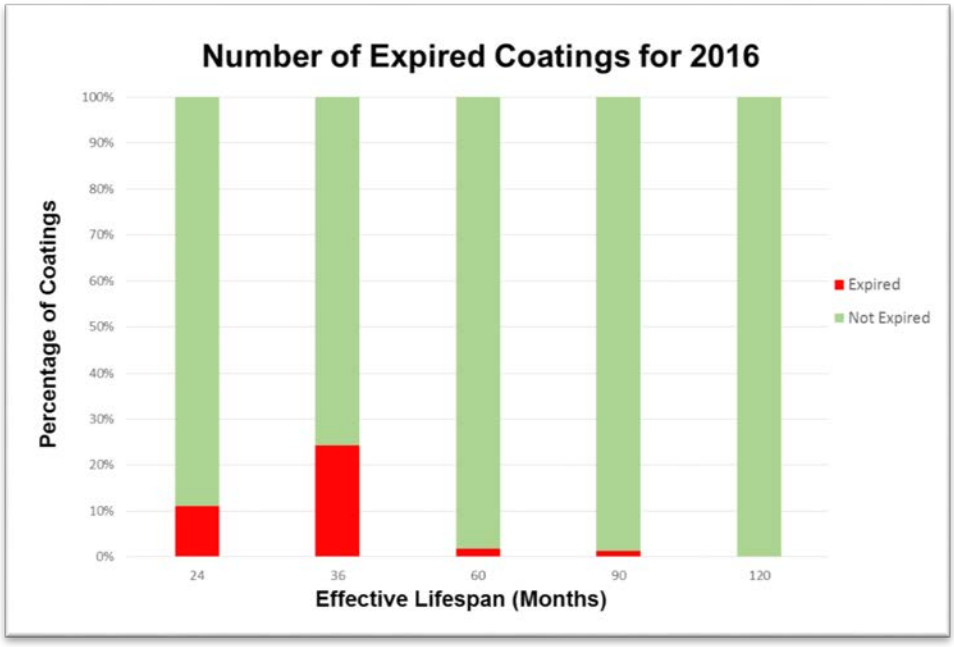


Figure 5. Number of antifouling coatings operating within and outside their effective lifespan applied on vessels that visited California in 2016.

Continuing with 2016, 97.9% of the vessels observed did not have and expired coating. The grand total was 1188 vessels that were pulled from the database and 24 of them were expired.

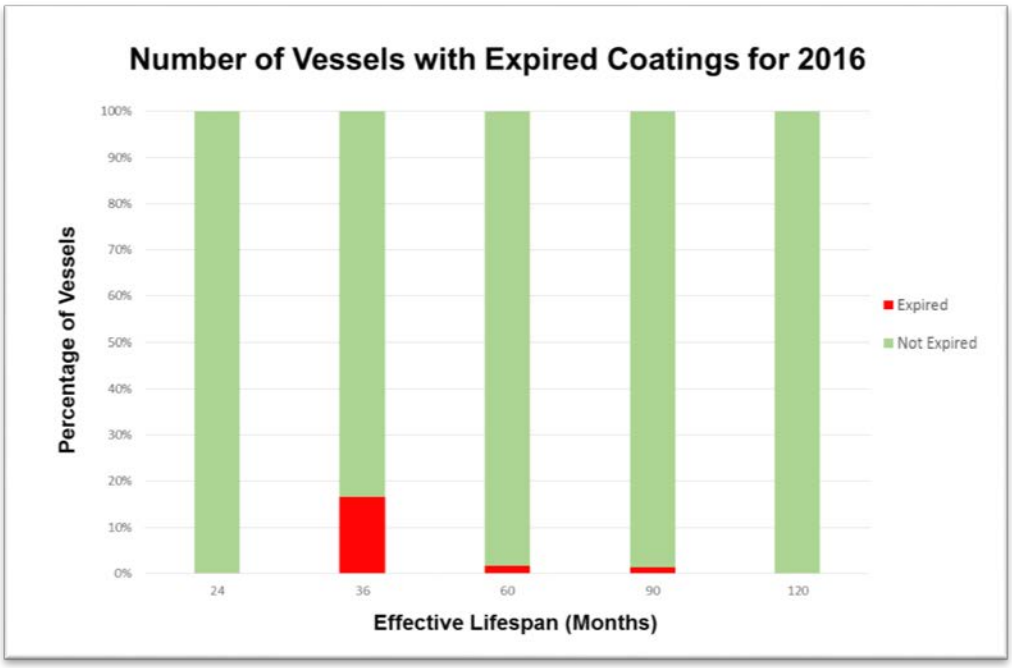


Figure 6. Number of vessels operating within and outside their effective lifespan applied on vessels that visited California in 2016.

DISCUSSION:

Collecting coating data can be a very tedious task that is mostly reliant on manufacturers' response. Many of the manufacturing companies are large, international corporations. At times, it can be difficult to get a hold of the company, let alone their data. Some of the companies we reached out to issue very specific data and others were not as precise. There were companies that found it unnerving that we were asking for this information and wanted more information on our intention. One of the biggest challenges observed was when the coating was no longer in production. At that point, there is hardly any information the company or the webpage will have available.

It has been a fascinating experience to witness these massive international companies reply to an email you know they might never see. There are many variables that contribute to the effectiveness of an antifouling coating and many manufacturers want you to know it has a lot to do with how many coats are applied. Additionally, this information is critical in understanding how effective this biofouling management process is if the vessel is not even operating within the necessary parameters.

CONCLUSION:

The goal moving forward is to merge the collected data from the last several months with the existing data in the MISP.IO database. Eventually the objective is to create a completed database that can determine if the vessels are using their antifouling coatings appropriately or

not and to provide MISP with an additional analysis tools to determine the risk the vessel presents to California waters.

MISP.IO coatings database is the most complete set of data within any geographical region. The data I collected from the manufacturers is critical in expanding the usefulness of this dataset. The expanded database will be used to evaluate the risk a vessel may present when they enter California waters. In the future, I intend on using the database to analyze the optimal speed a vessel should be travelling and the actual speed travelled, similar to the coating lifespan analysis, to ensure the vessel being evaluate is operating in the appropriate parameters.

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