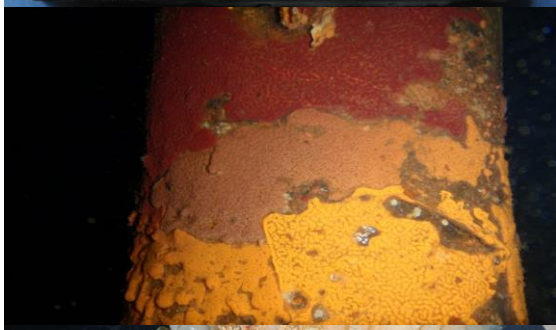
The performance of biocide and non-biocide coatings to prevent biofouling by invasive and non-native species in Newfoundland

Ashley Bungay [1 2] , Cynthia H. McKenzie [2] , Kyle Matheson [2] , Erika F. Merschrod S. [3] , Cyr Couturier [1] .

1 Fisheries and Marine Institute of Memorial University of Newfoundland
2 Fisheries and Oceans Canada
3 Memorial University of Newfoundland

Biofouling in Newfoundland Coastal Waters

- Biofouling is the unwanted growth of aquatic organisms on the surface of submerged substrates.
- Biofouling occurs in four steps
  - Conditioning film
  - Primary colonizers
  - Macroalgal zoospores
  - Invertebrate larvae
- Newfoundland has a subarctic climate with a water temperature range of ⁻1–16°C throughout the year
- In Newfoundland there are three invasive tunicate species which foul different surfaces
  - Golden Star (*Botryllus schlosseri*)
  - Violet (*Botrylloides violaceus*)
  - Vase (*Ciona intestinalis*)



Biofouling and the Aquaculture Industry

- Biofouling affects the aquaculture industry
  - Physical damage to the shells of shellfish
  - Mechanical interference of the shells for shellfish
  - Competition and reduction of nutrients
  - Increase weight and loss of stock and equipment
  - Creating suitable habitats for harmful pathogens
- Biofouling control in Aquaculture
  - In Situ cleaning
  - Lime, brine, acetic acid, fresh water immersions
  - High pressure washing
  - Air drying
  - Antifouling net coatings
- Vase tunicate has had a large impact on aquaculture in other parts of Atlantic Canada
  - It was estimated that fouling by tunicates in PEI costs $5 million annually to control[1]

1. Cordell et al., 2013

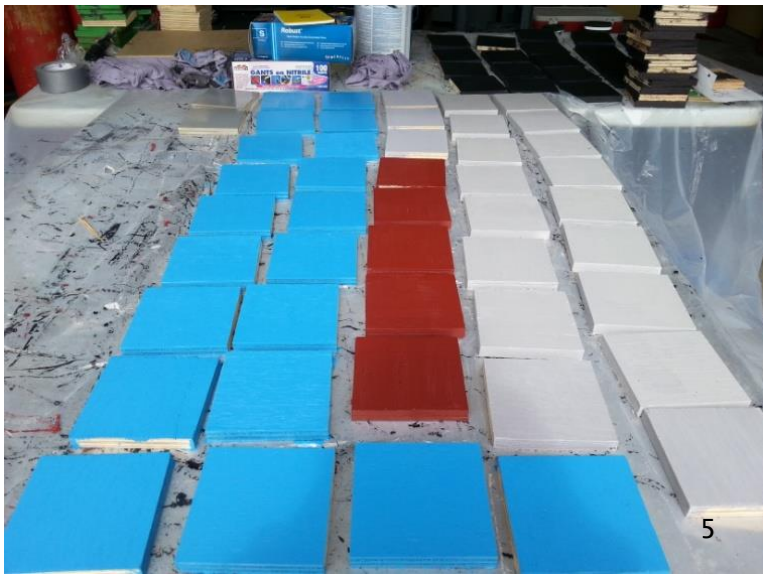
Types of Antifouling Coatings

- Biocide Antifouling Coatings
  - Self polishing copolymers (SPC)
    - Release biocides through a reaction with water[2]
- Non-Biocide Antifouling Coatings
  - Fouling release coatings (FRC)
    - Relies on physical properties (smoothness) to reduce the attachment strength of fouling organisms[3]

2. Ciriminna et al., 2015
3. Daffron et al., 2011

Biocide Toxicity

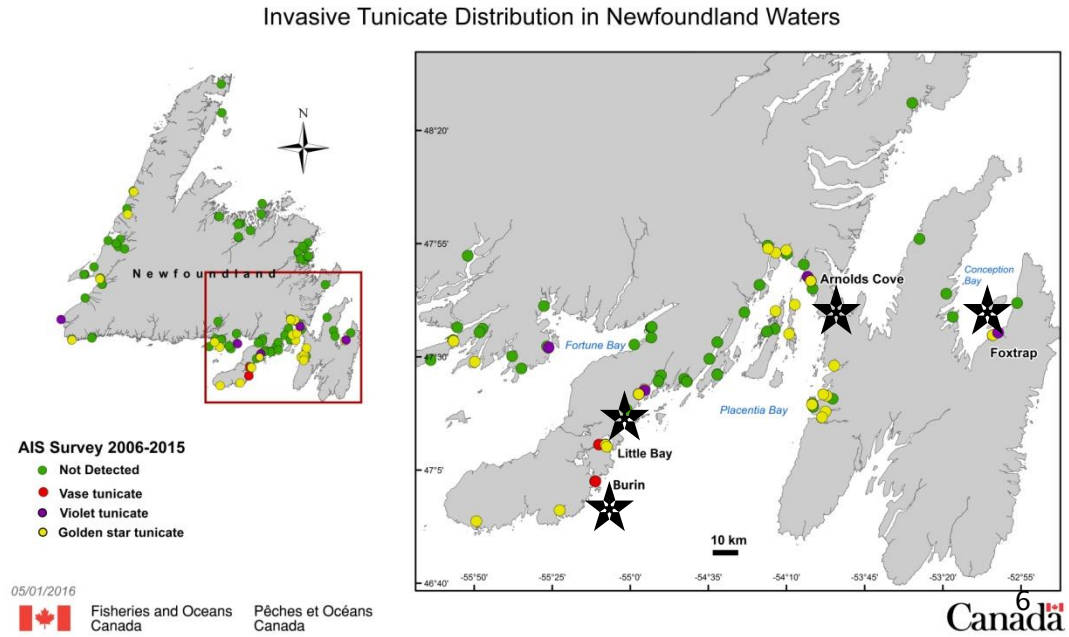
- Tin was the most commonly used SPC coating before is global ban in 2008 due to its high toxicity[4]
- Today copper is the most common biocide used
- Because of copper's toxicity other coatings such as FRC are being used



4.Ytreberg et al., 2015

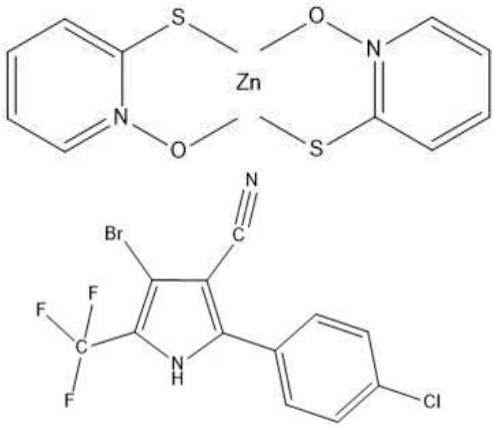
Methodology–Antifouling Potential

- 12 different antifouling coatings and 2 wood controls
- Random distribution of the coatings on painted back panel
- 5 panels were deployed at each of four sites
  - Foxtrap
  - Arnold's Cove
  - Little Bay
  - Burin



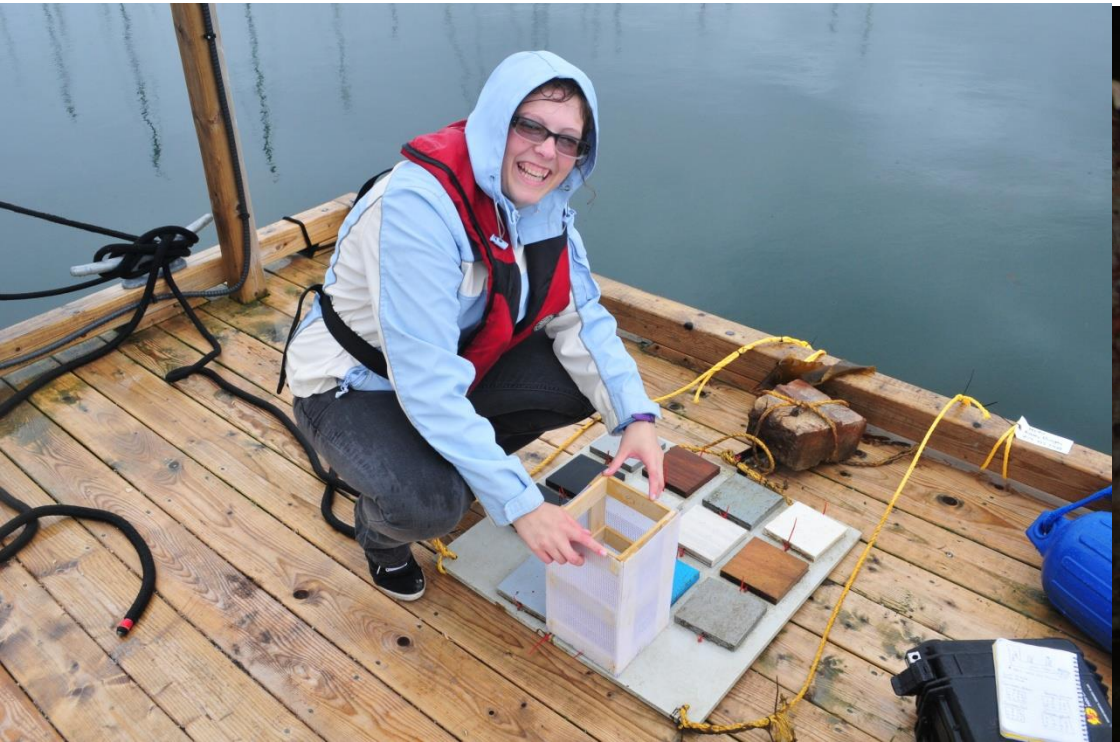
Methodology–Antifouling Products

Paint	Antifouling Property	Biocide/Non-Biocide
Interlux Micron CSC	Cuprous oxide	Biocide
Interlux Epoxycop	Cuprous oxide	Biocide
Interlux BottomKote	Cuprous oxide	Biocide
Interlux Tri-Lux II	Cuprous thiocyanate	Biocide
ePaint ZO	Zinc pyrithione	Biocide
ePaint ECOMINDER	Zinc pyrithione	Biocide
Micron CF	Zinc pyrithione/Econea	Biocide
ePaint EP21	Silicone	Non-Biocide
Hullspeed 3000 series	Silicone	Non-Biocide
Interlux Brightside	Polyurethane	Non-antifouling
Matchless Super Marine	Enamel	Non-antifouling

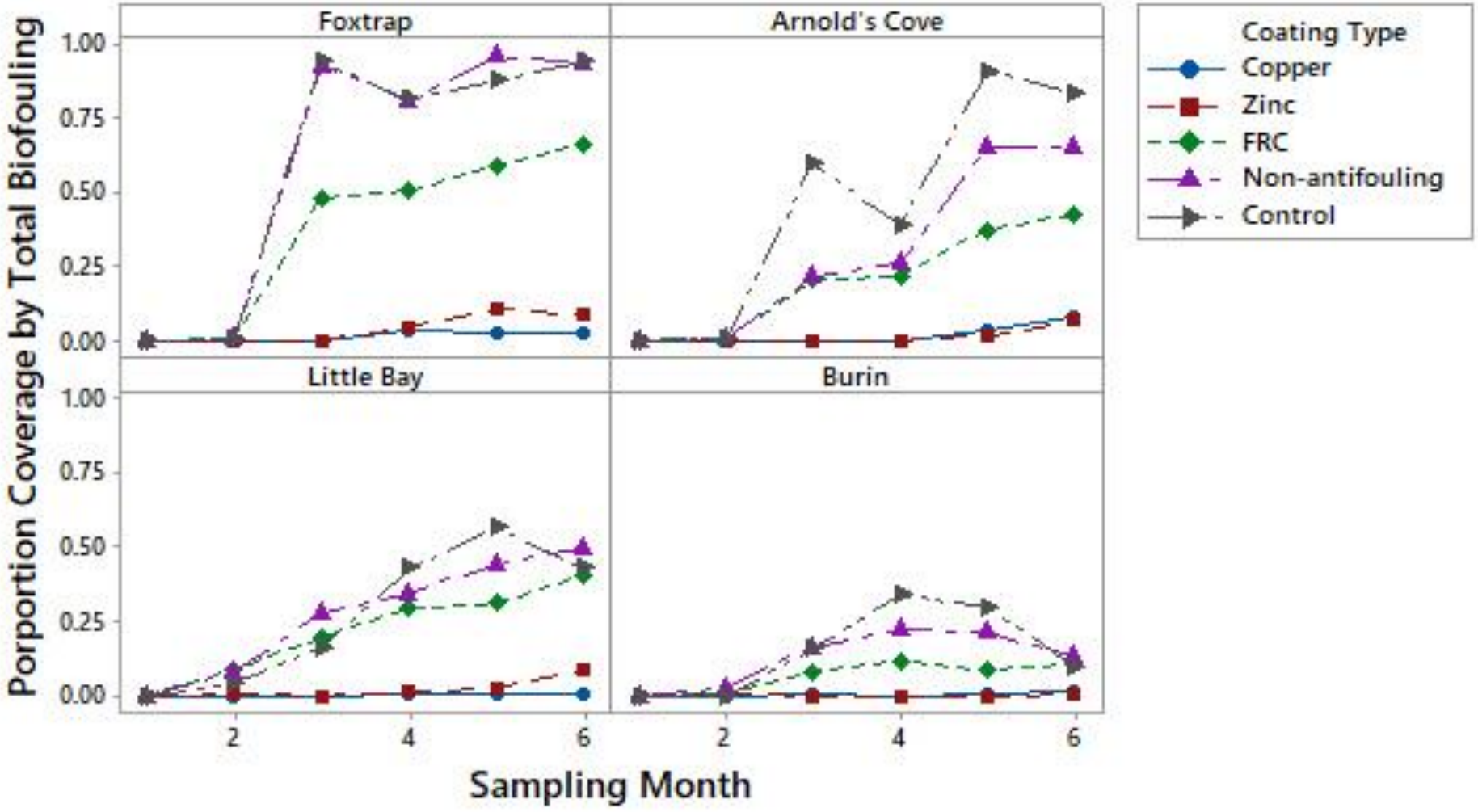


Methodology–Antifouling Potential

- Monthly photos taken from June to December
- Percent coverage of biofouling calculated
- Photos processed using GIMP ver.2.8.18 and Image J ver. 1.50i

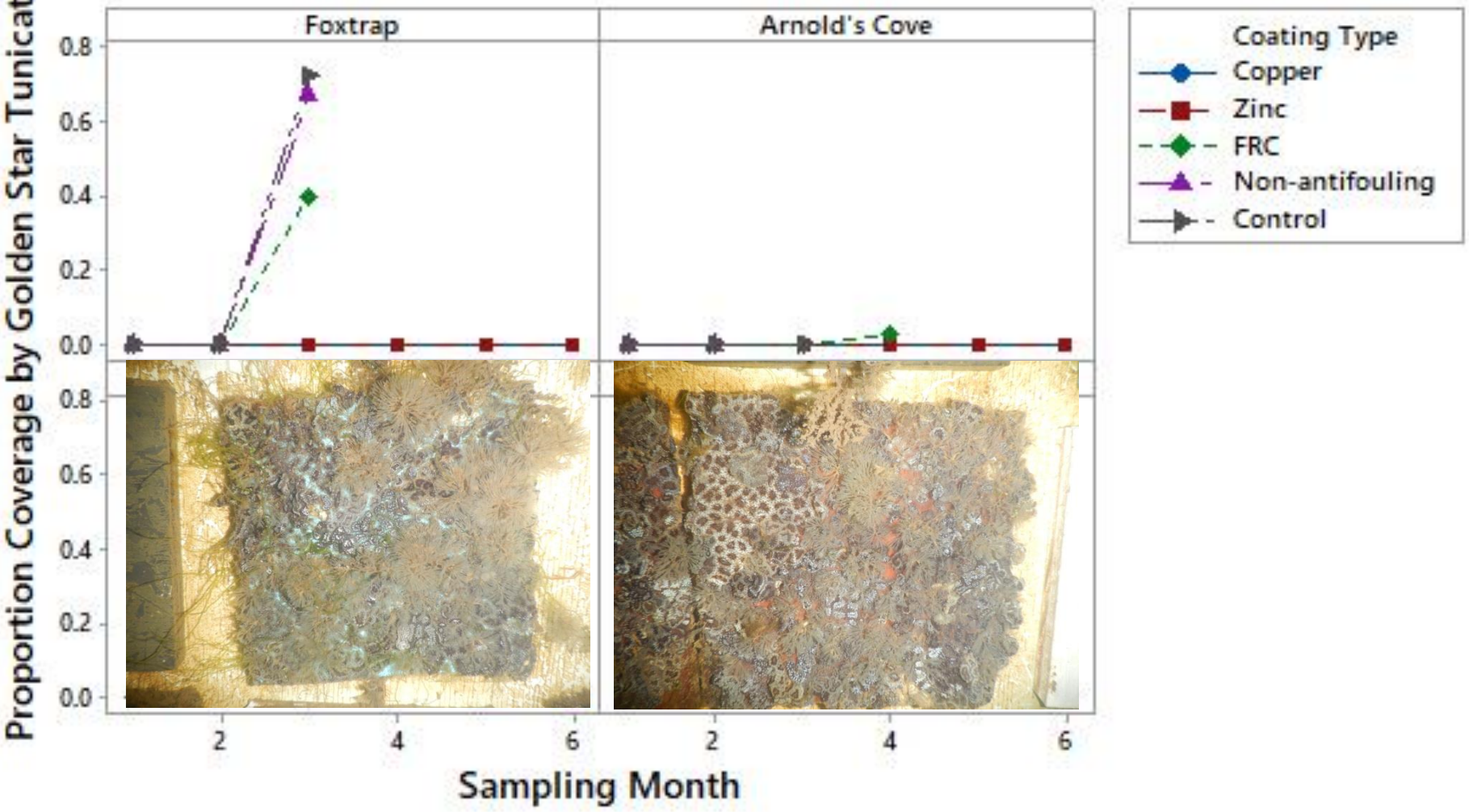


Plot of the Proportion Coverage by Total Biofouling with Respect to Different Coating Types and Sites



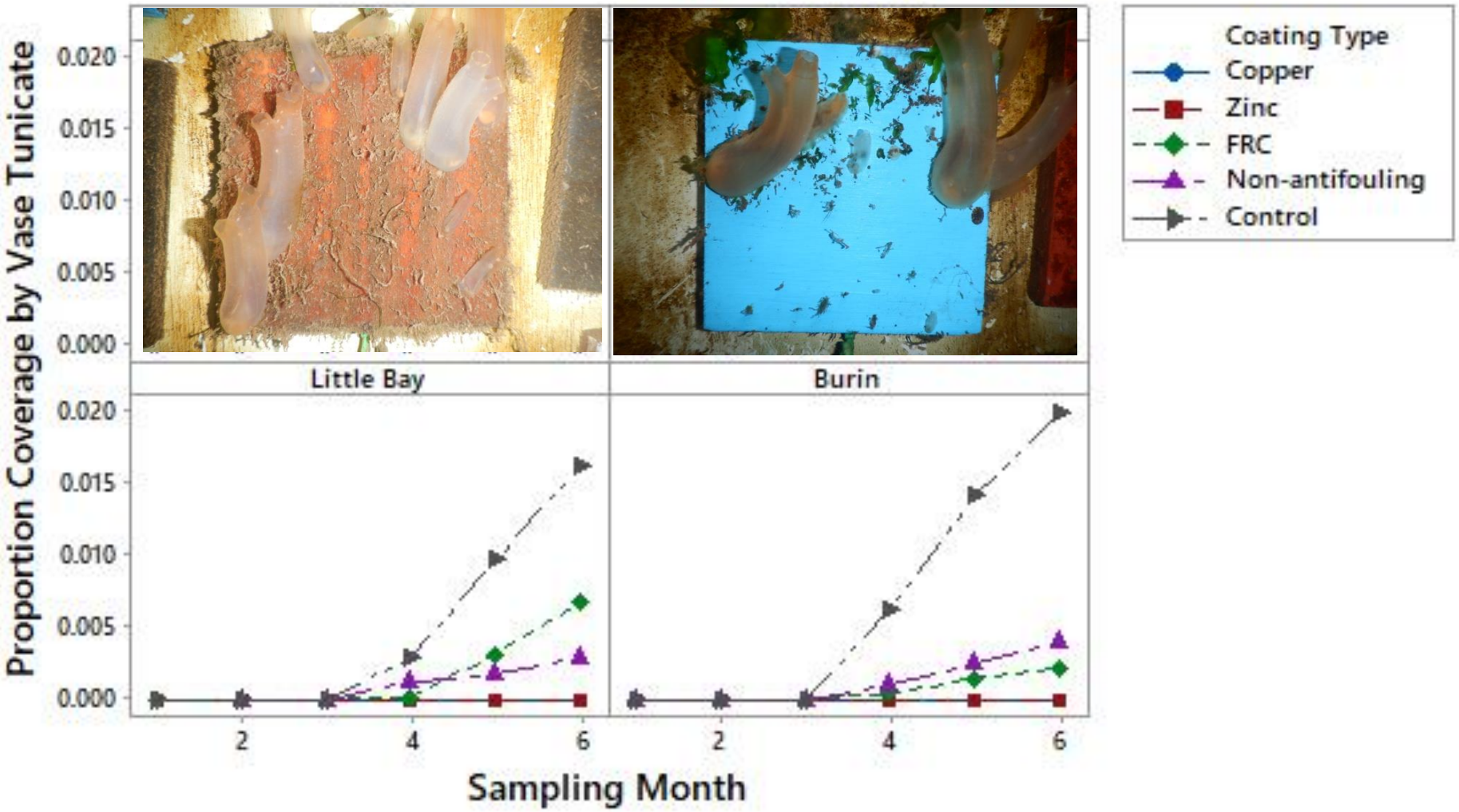
There is a significant difference of percent coverage by total biofouling with respect to coating type G=513.814,p<2.2E-16
There is a significant difference in the percent coverage by total biofouling with respect to sampling date G=473.07,p<2.2E-16
There is a significant difference in the percent coverage by total biofouling with respect to site G=33.067,p=3.118E-7

Plot of the Proportion Coverage by Golden Star Tunciate with Respect to Different Coating Types and Site



There is a significant difference in the percent coverage by golden star with respect to coating type G=299.3,p<2.2E-16
There is a significant difference in the percent coverage by golden star with respect to sampling date G=122.52,p<2.2E-16
There is a significant difference in percent coverage by golden star with respect to site G=259.19,p<2.2E-16

Plot of the Proportion Coverage by Vase Tunciate with Respect to Different Coating Types and Sites



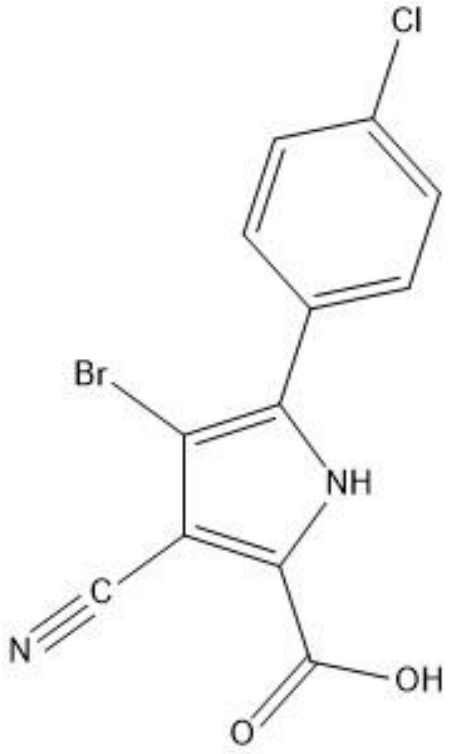
There is a significant difference in the percent coverage by vase with respect to coating type G=151.07,p<2.2E-16
There is a significant difference in the percent coverage by vase with respect to sampling date G=91.527,p<2.2E-16
There is a significant difference in the percent coverage by vase with respect to site G=70.545,p=3.262E-15

Summary

- Copper and Zinc based coatings were the most effective against biofouling
- FRC were not used to manufacturers specification and would act differently on a vessel
- Non-antifouling marine paints are not effective against biofouling and should not be used on the hull of a vessel

Future Work

- Scanning Electron microscopy to get surface topography information
- Determine leaching rates from select paints



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Questions?

anb2127@mun.ca