Update on Ballast Water Research in Canada

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Recent/Current Projects

- Testing tools for compliance
  - RV METEOR
- Representative Sampling
  - In-tank vs. In-line
  - Modeling Statistical Confidence
- Arctic Shipping Vectors
  - Coldwater treatment testing

METEOR VOYAGE M116/2

- Evaluate ballast sampling devices and analytic tools
- Coordinated effort with 19 researchers from 10 countries

BSH
BUNDESAMT FÜR SEESCHIFFFAHRT UND HYDROGRAPHIE

Canada
Department of Fisheries & Oceans

RV METEOR: German research vessel

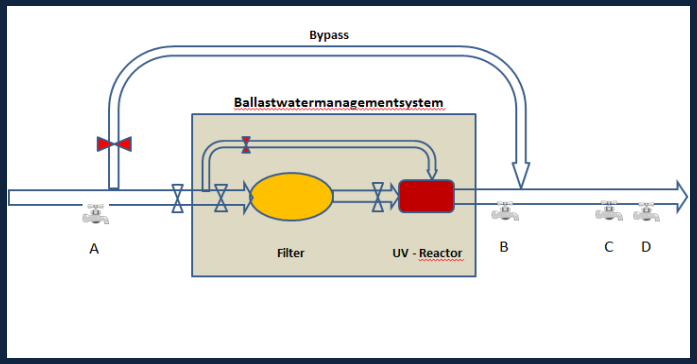
- 97.5 metres

- Transit from Mindelo, Cape Verde to Hamburg, Germany
- Performed 28 experiments during voyage
- Large range of organism densities: oligotrophic to high density waters

METEOR VOYAGE M116/2

Sampling Devices

- Traditional net sampling
- SGS sampling skid
- Triton sampling skid (NP 6007 TG 18)
- Sampling skids in open and closed configurations



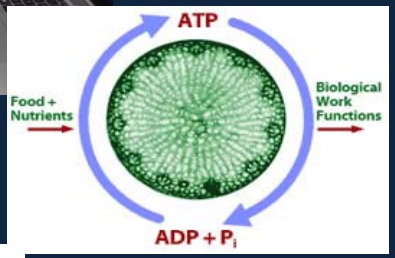
Microscopy

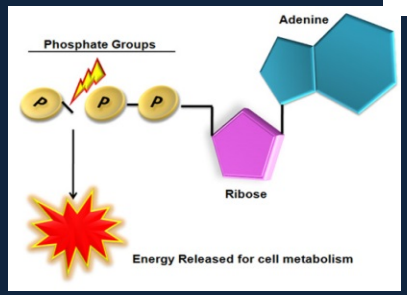
2 methods:

- Visual inspection (>50 only)
- FDA staining

ATP Methods

- Detect ATP- the energy carrier of living cells



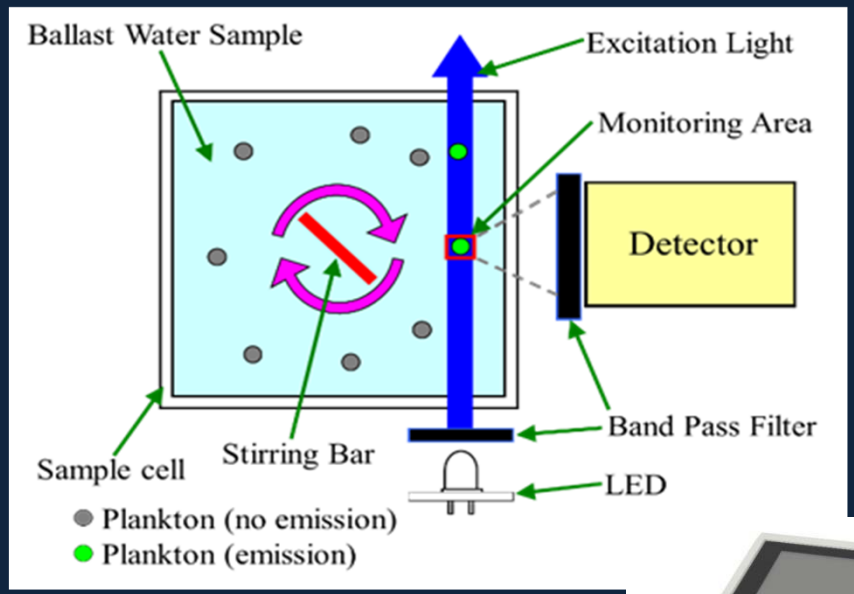


Bulk FDA

- FDA = fluorescein diacetate
  - Stain that measures both enzymatic activity and cell-membrane integrity
- FDA → fluorescein by natural enzyme activity in live cells.
- Provides quantitative measurements of total living biomass contained in ballast water samples

Satake Pulse Counter

Instrument counts pulses from viable organisms stained by FDA to estimate the number of viable organisms.



PAM Methods

4 methods:

- Walz-Water PAM
- bbe 10cells
- Turner Designs BallastCheck2
- Hach BW680 fluorometer

- Measurement is based on the natural fluorescence of algal cells

Flow cytometer

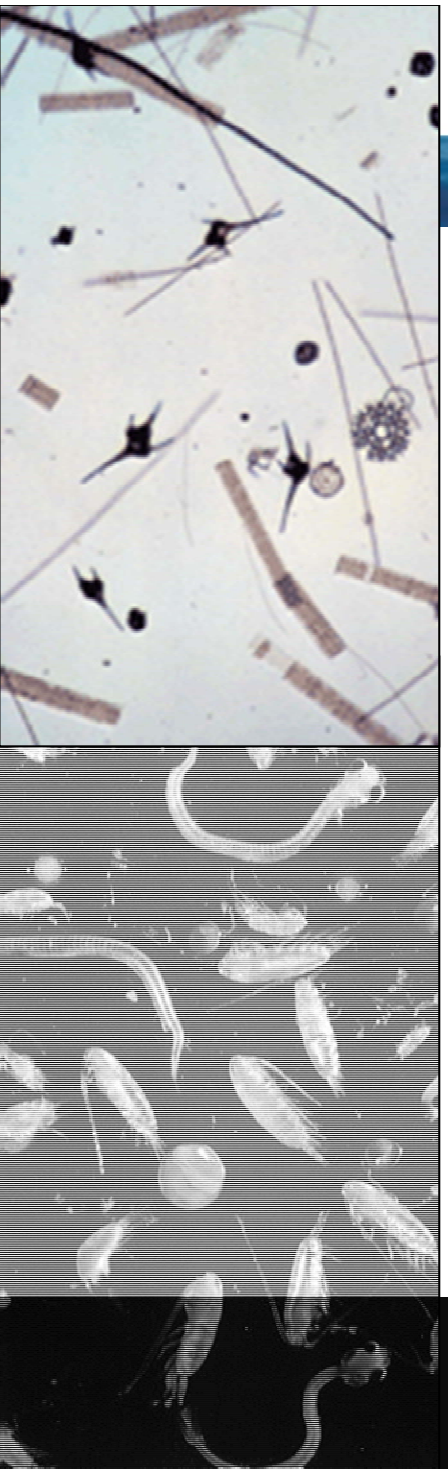
- Measures total phytoplankton
- Number determined based on red fluorescence indicating presence of chlorophyll

Results

- Differences were observed in the number of viable organisms collected by the sampling devices, but these differences were not consistent across size classes;
- Several promising indicative methods were identified which showed high correlation with microscopy results, but allow much quicker processing
- Initial analyses complete – currently preparing report for BSH
- Journal publications will follow in 2016

Representative Sampling

- Project Goal: to develop science advice on appropriate methods for collecting samples for compliance testing
- Any ballast water sample collected to measure compliance with incoming IMO standards must be representative of the whole volume-of-interest
- New methods, such as time-averaged sampling from the ship's ballast discharge line, have been proposed but no study has measured the errors associated with traditional vs. integrative methods



Scientific Objectives

1. To determine the nature of distributions (homogeneity and stratification) of plankton in ballast water, and to identify robust mathematical/statistical methods for estimating densities given those distributions;

2. To compare density estimates given by traditional vs. novel sampling methods using the models identified above and identify appropriate methods for representative sampling for compliance testing;

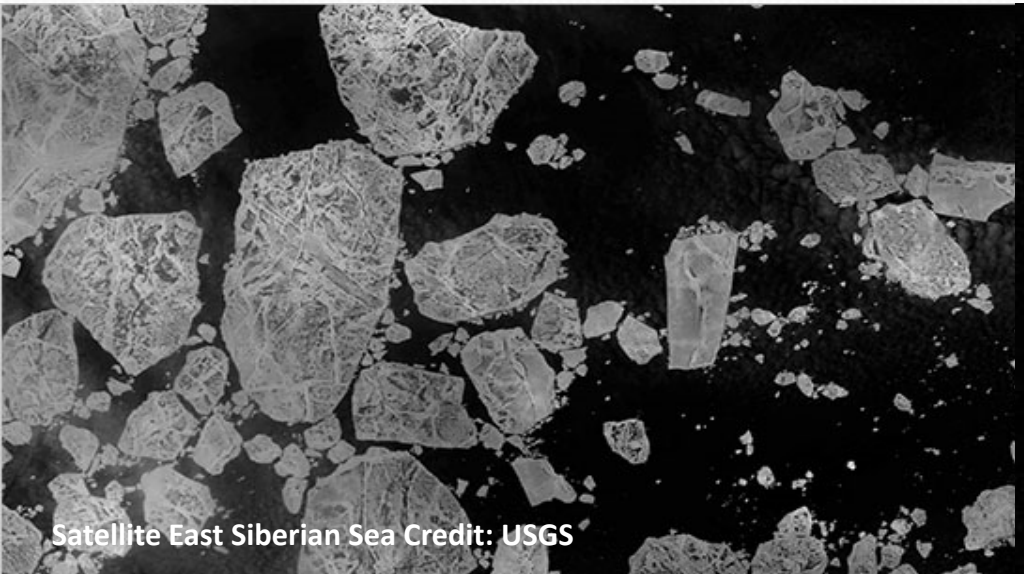
3. To identify mathematical and statistical criteria for setting up discharge density threshold limits to inform enforcement action decisions.

Progress To Date

- 2 experiments completed in 2015 for single tank
- Manhole sampling by plankton net (upper 10 feet) and pump with stratified hose placement (5 depths)
- In-line sampling conducted for as long as practical
- Many challenges identified for both methods…
- Aim to complete 4 more tests in 2016

Arctic Shipping Vectors

- Which species are being transported?
- What is likely to survive?
- Will it make a difference?
- How will changes be monitored?
- How can risk be reduced?



Satellite East Siberian Sea Credit: USGS

Credit: Earth Institute, Columbia University

What are the potential risks of ballast water treatment in cold conditions?

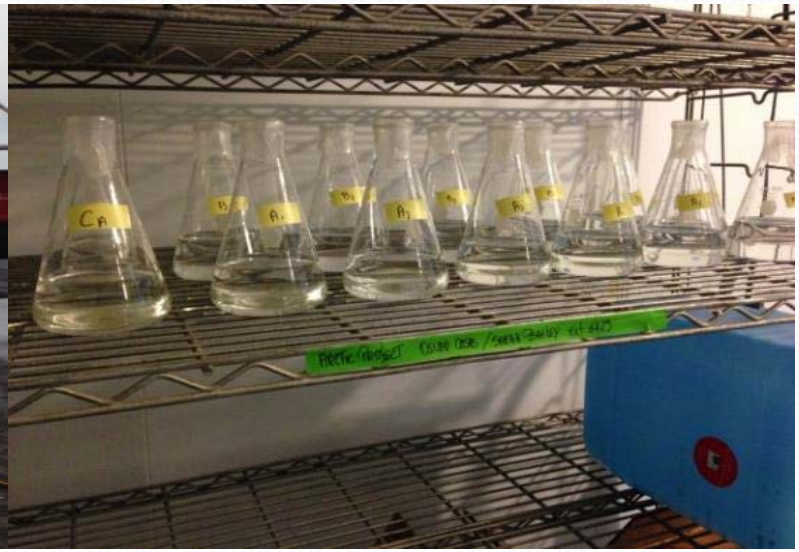
- Chemical reactions slower (Q10 rule, degradation rate)
- Physical challenges (ice obstructions)
- Cold-tolerant organism sensitivity unknown
- Higher O_2 solubility/lower consumption (less O_2 stress)

➢ Potential for reduced biological efficacy/increased environmental threat



Lab Tests: Chlorine

- Testing Lake Ontario water samples during fall, winter, spring (2-10°C) – surrogate for Arctic conditions
- Examined the effect (kill rate) of a range of chlorine concentrations
- Early results indicate chlorine is more effective in cold water



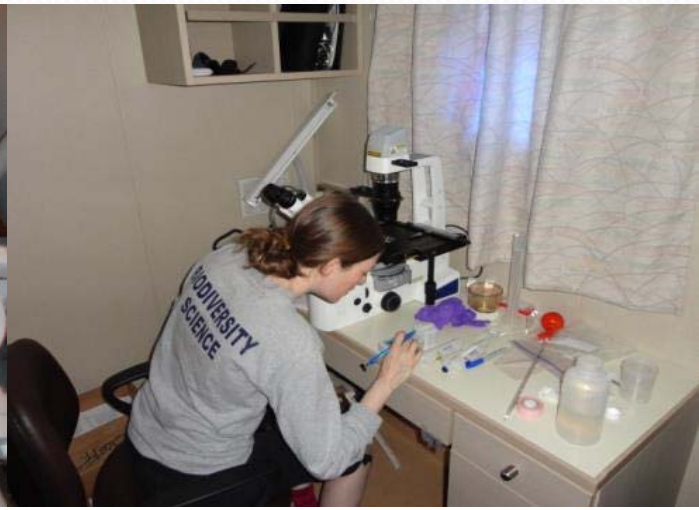
Shore-side Tests: filtration+UV

- Shore-side container built to conduct larger scale testing
- Testing Lake Ontario water samples during winter, spring, summer (2-18°C)
- Early results indicate no effect of temperature for zooplankton, but temperature may reduce UV efficacy for phytoplankton – additional tests needed to confirm

Ship-based tests: ozone

- Treatment system was unreliable
- Indicates that BWE might be important to keep as a back-up strategy… particularly to protect freshwater ports
- More work is needed to see if treatment+exchange would be a benefit for marine ports





Acknowledgements

Thanks to lab members, CAISN students, academic / gov't collaborators, and industry partners!

J Bradie, O Casas-Monroy, F Chan, J Kydd, R Linley, H Rajakaruna, J Vanden Byllaardt

Funding Partners:

Transport Canada Transports Canada

Fisheries and Oceans Canada Pêchés et Oceans Canada

NSERC CRSNG

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