

Ballast Water Management System Testing at Golden Bear Facility

Challenges, Solutions, and Successes - Update

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What is Golden Bear Facility?



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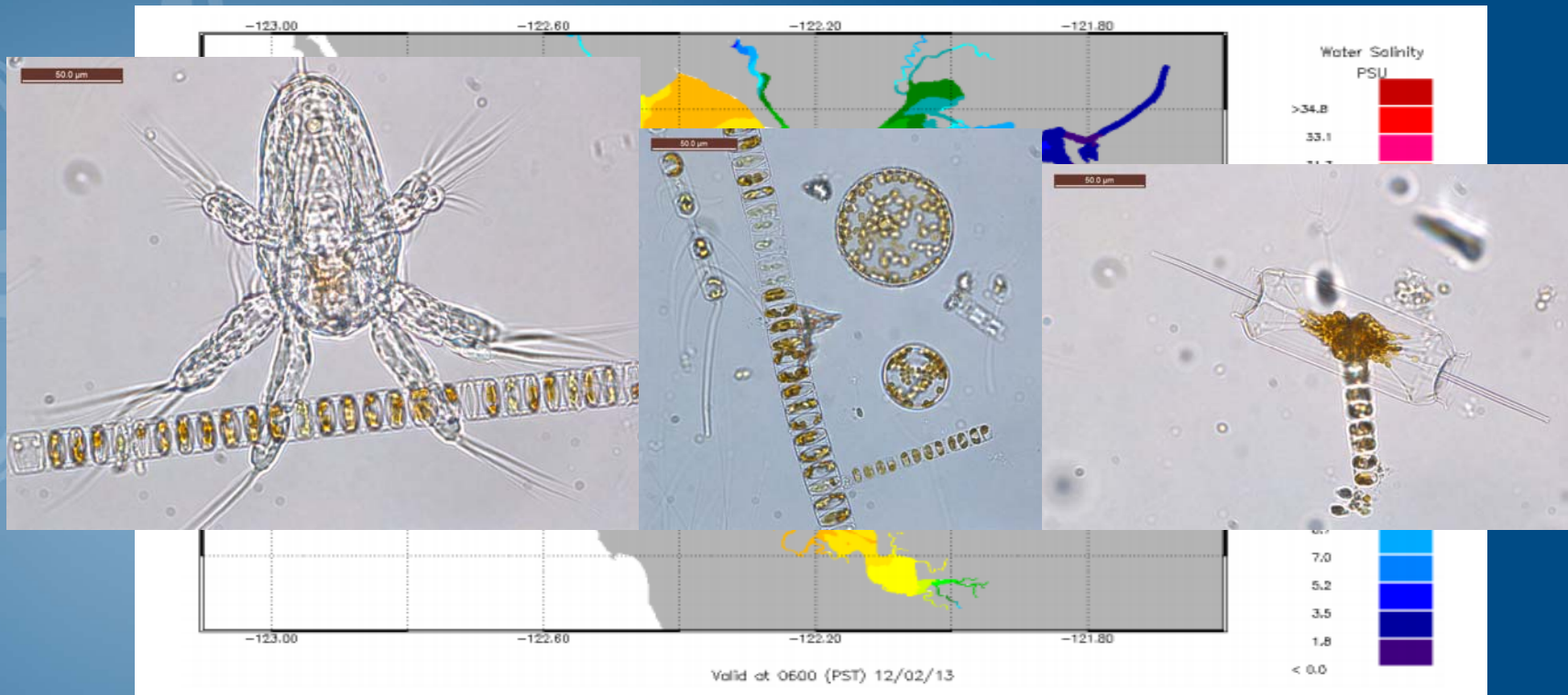


Approved by the USCG in November 2013 to work as sub-laboratory to DNV-GL for land based and shipboard type approval Ballast Water Management System testing

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Advantages of GBF for BWMS testing

Carquinez Strait and SF Bay provide salinity variability and biologically diverse testing ground



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Advantages of GBF as Testing Facility

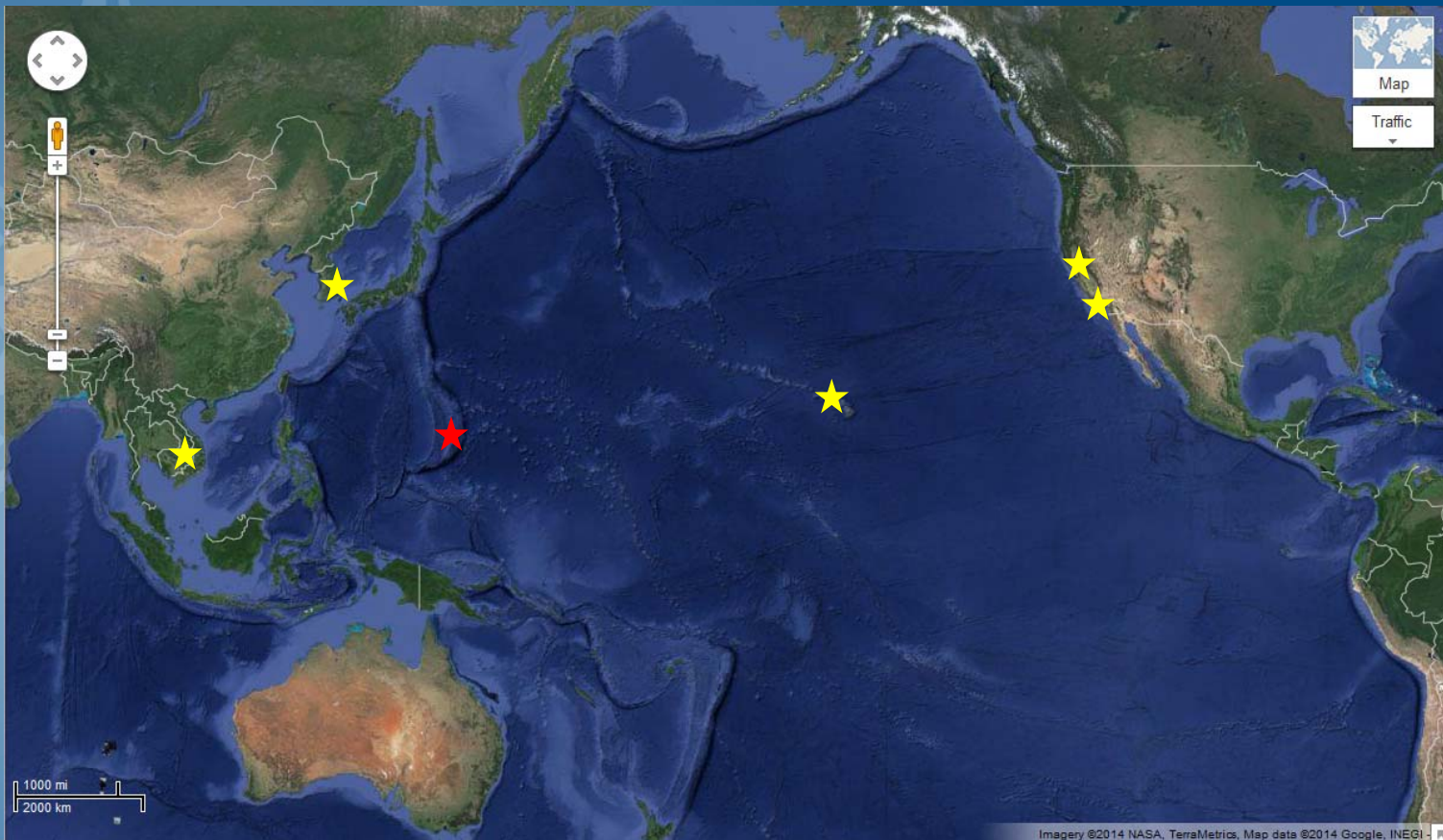


Perform shipboard and land-based ballast treatment testing with Cal Maritime operations team and MLML science team

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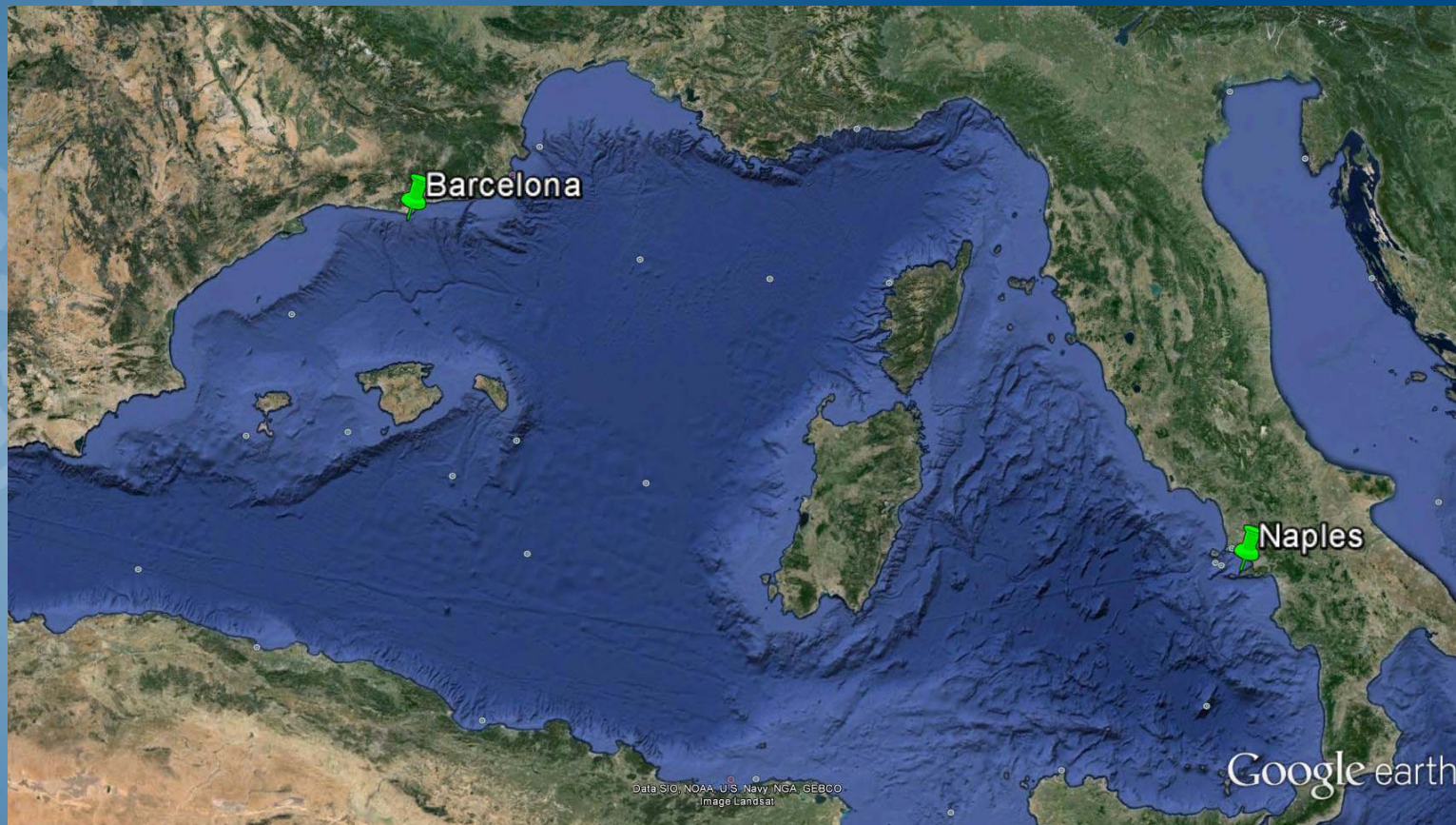
Advantages of GBF as Testing Facility

TS Golden Bear removes shipboard testing 'ship of opportunity' problem



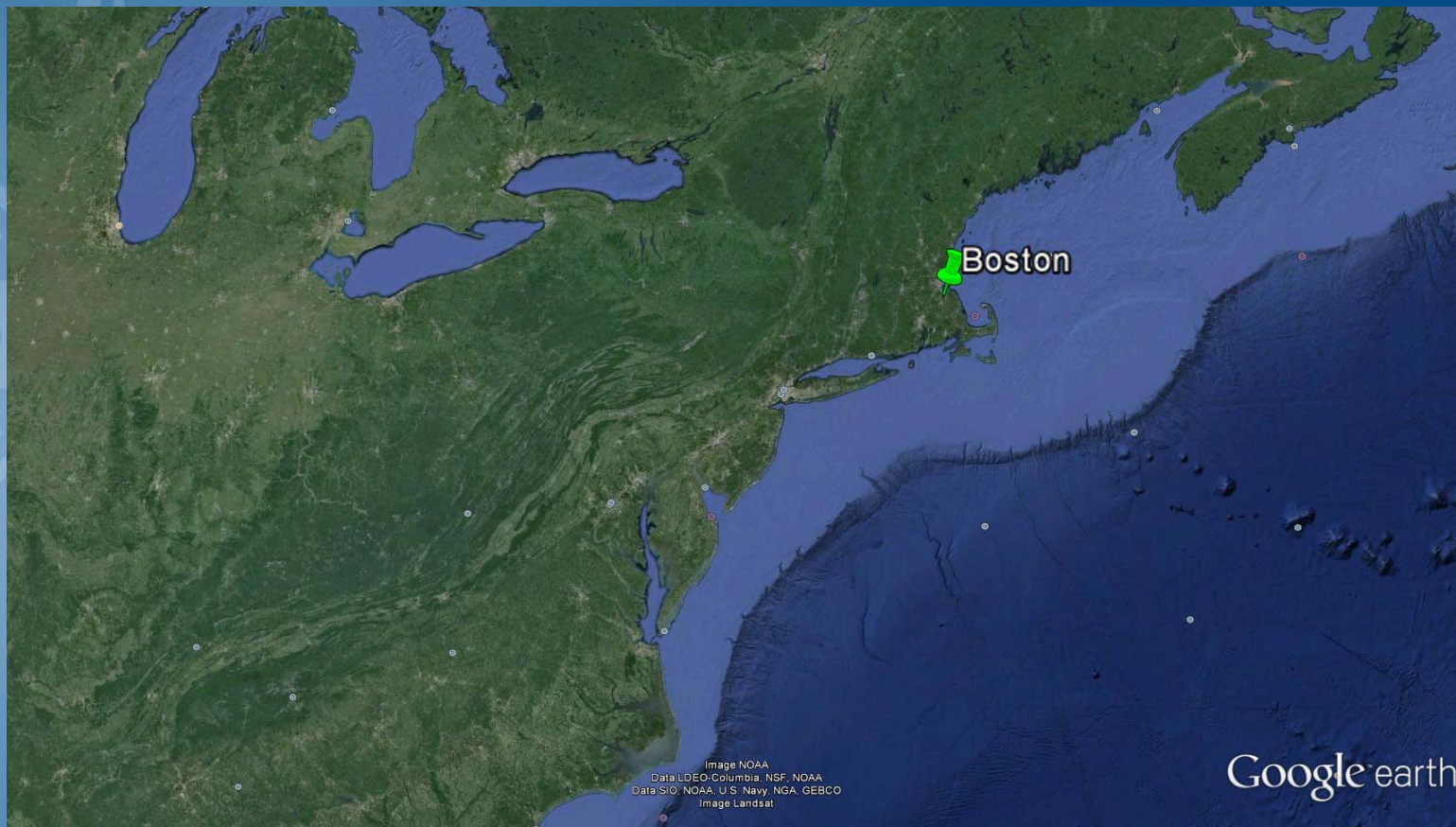
Advantages of GBF as Testing Facility

TS Golden Bear removes shipboard testing 'ship of opportunity' problem



Advantages of GBF as Testing Facility

TS Golden Bear removes shipboard testing 'ship of opportunity' problem



Completed/Pending Projects



- IMO Shipboard
 - 2 completed (2012 & 2013)
- IMO/USCG Shipboard
 - 1 complete (2014)
 - 1 – completion (2016)
 - 1 contracted (2016 to 2017)
- USCG Land based
 - 2 contracted (2015 to 2017)
 - 1 contracted (2016 to 2017)
- R&D Projects
 - Several full and small scale

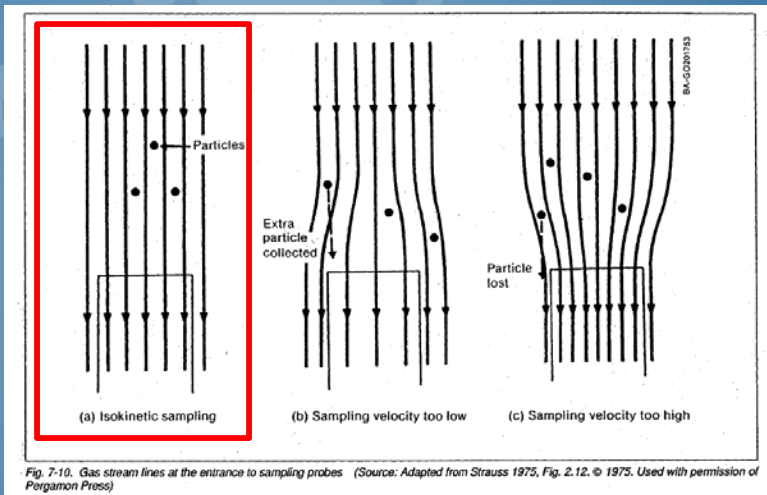
Challenges – Solutions - Successes

- 
1. FACILITY DEVELOPMENT
FROM GROUND UP
 2. CREATING A FUNCTIONING
SCIENCE LABORATORY
 3. MEETING TESTING
REQUIREMENTS FOR TYPE
APPROVAL

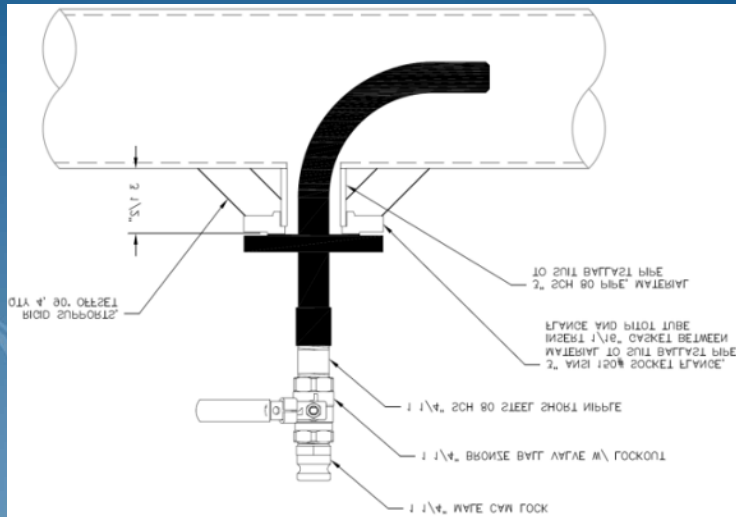
Facility - Challenges



- Must be capable of handling high flow rates through BWMS
- Piping/pump easy on organisms
- Varied salinity for land-based testing
- Isokinetic sampling directly from ballast stream for biological and water quality sampling

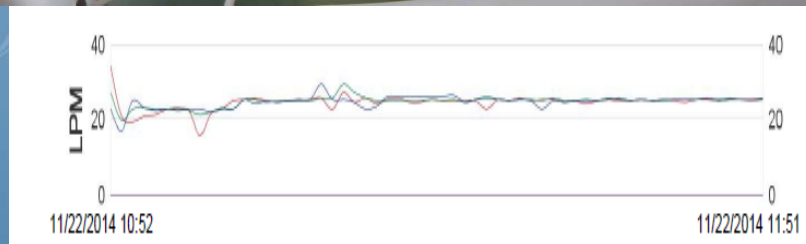
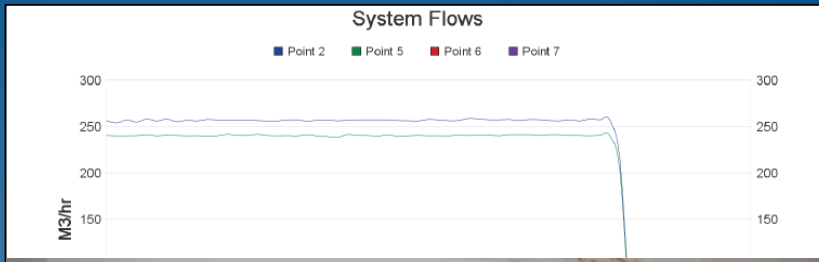


Facility - Solutions



- Larger diameter piping
 - Original diameter 5"
 - Upgraded piping 8-10"
- Valves to balance inlet/outlet pressure
- Piping angles softened
- Pump/piping was tested to confirm ease on organisms
- Sampling pitots and rig designed by independent engineering firm
- Go get the fresh water from the source

Facility - Successes



- High flow rates suitable for shipboard ballasting (up to 500 m³/hr unencumbered)
- No significant effect on live organism concentrations
- isokinetic pitot connects to sampling rig capable of variable flow rates and sampling for zooplankton

Facility - Successes

- To date we've been successful at testing a treatment system at the Golden Bear facility with fresh water with ambient organisms



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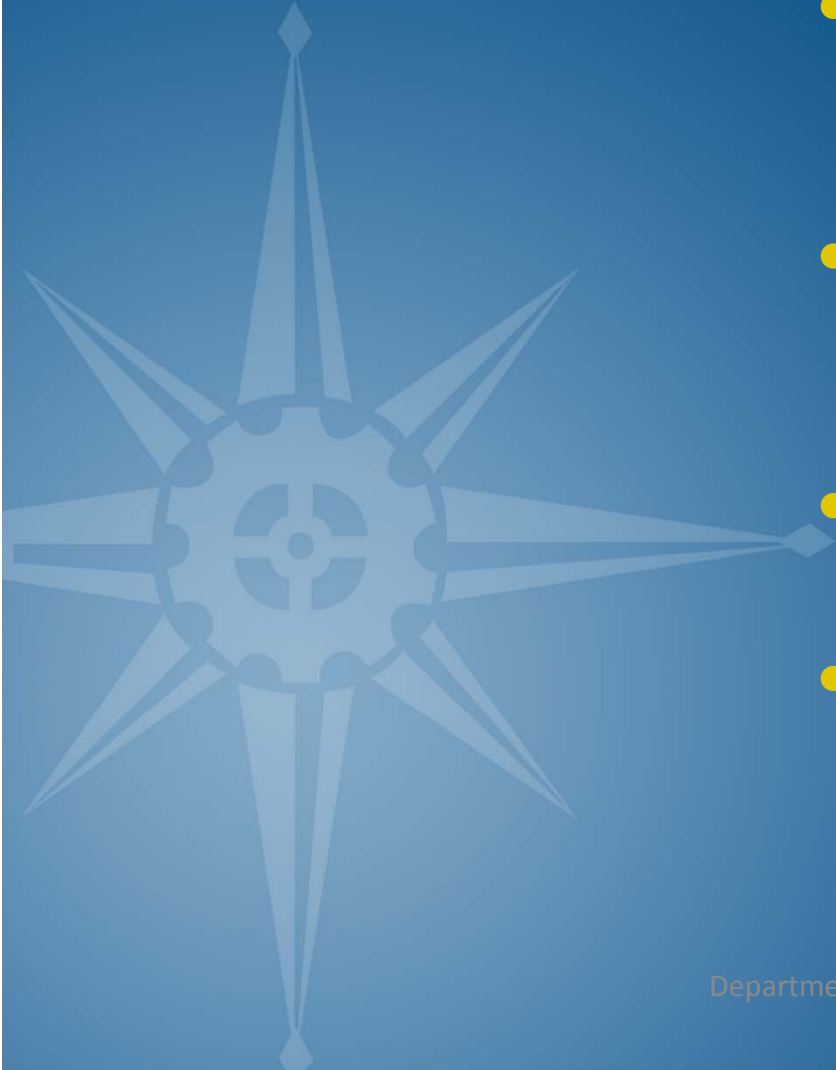
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Laboratory - Solutions



- From storage/dark room to full scale lab
- Contracted Labs that conduct WQ and QA/QC
- Regularly scheduled instrument calibration
- Cal Maritime Science coordinator plus MLML full science team with two lead technicians – team of 7-10 per test

Laboratory - Successes

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- Everything conducted onboard TSGB except two water quality analyses
 - Reliable services from contracted labs with appropriate QA/QC
 - Contracted data managers/auditors
 - Able to finish ALL required and corroborative assays well within 6 hour ETV time requirement

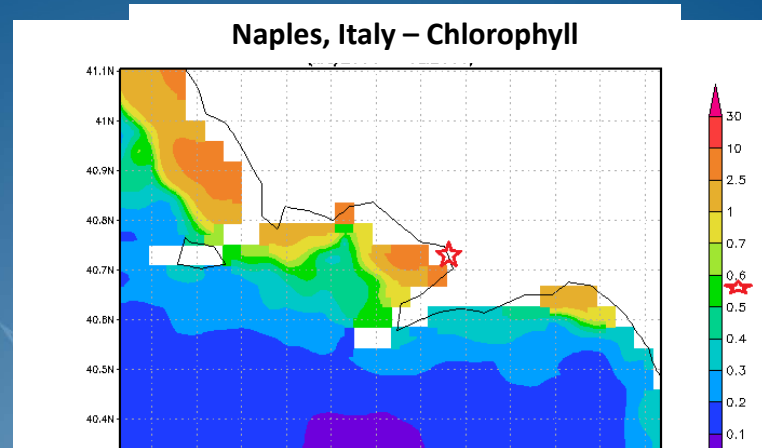
Testing Requirements – Land based Challenges

Parameter	IMO	USCG
Temperature (°C)	--	4 to 35
Salinity (psu)	Two salinities, >10 psu difference	Freshwater <1 Brackish 10 to 20 Marine 28 to 36
Total suspended solids (mg/L)	>50	≥24
Particulate organic carbon (mg/L)	>5	≥4
Dissolved organic carbon (mg/L)	>5	≥6
Organisms ≥50 µm (per m ³)	>100,000	>100,000 with at least 5 species present across 3 phyla
Organisms ≥10 µm and <50 µm (per mL)	>1,000	>1,000 with at least 5 species present across 3 phyla
Organisms <10 µm (per mL)	>10,000	>1,000 as culturable aerobic heterotrophic bacteria
All Organisms	Naturally occurring, or cultured species that may be added to the test water	Ambient assemblage supplemented by the addition of organisms

Testing Requirements – Shipboard Challenges

Parameter	IMO	USCG
Organisms $\geq 50 \mu\text{m}$ (per m^3)	>100	>100
Organisms $\geq 10 \mu\text{m}$ and $< 50 \mu\text{m}$ (per mL)	>100	>100
Testing Locations	Uptake/Discharge in different locations	Provide acceptable range of geographic and seasonal variability conditions

Testing Requirements - Solutions

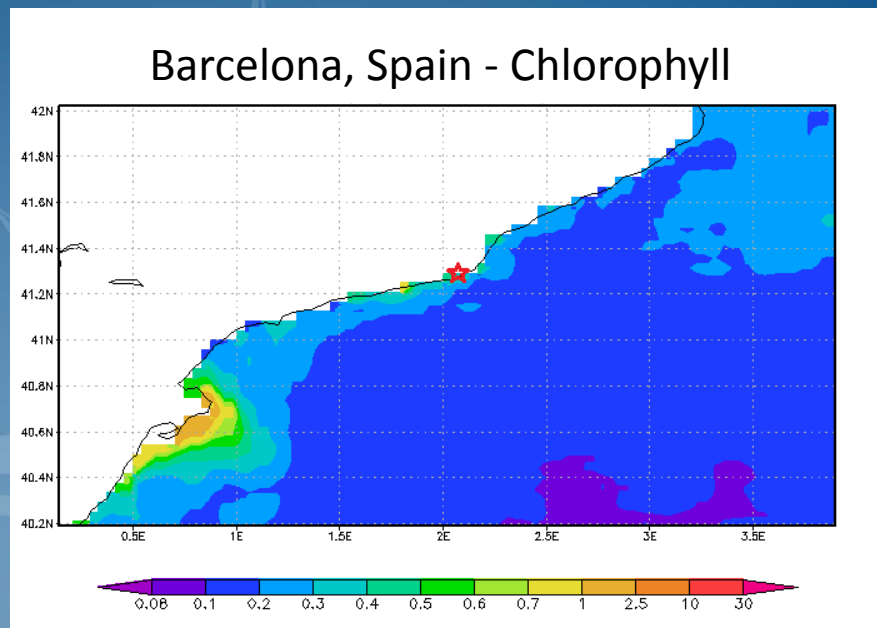


- Design, test, and validate land based WQ augmentation protocols and compounds
- Preset cruise plan that is different every year



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Testing Requirements - Successes



- Consistently successful at meeting biological and WQ requirements
- Shipboard testing - 4 consecutive successful summers
- Satellite imagery not perfect but very informative

Future Work



- Continuously improving and streamlining facility and operations
 - Freshwater collection and augmentation
 - Laboratory equipment
 - Storage
- Lots of inquiries for type approval testing
- Training students on operation and different types of BWMS
- Providing ground work for student knowledge of BWMSs

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Thank you!



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