MMP3: Feasibility of Real-Time Shipboard Cavitation Monitoring and Management

Project Synopsis for CISMaRT 2020

Project Objective

- MMP3: *Evaluate the operational feasibility and impact on operations (safety, cost, effectiveness) for the Master to take measures to minimize cavitation when operating in at-risk whale species' critical habitat, and evaluate the potential to reduce the vessel's noise contribution to the environment*

Cavitation Monitoring System Uses

- Understand speed vs noise: 10 knot slow-down and noise?
- Reduce cavitation by optimizing loading / trim?
- Measure long-term changes in cavitation as an indication of propeller condition or wake field changes
- Look at differences in URN for different Captains' or operating conditions.

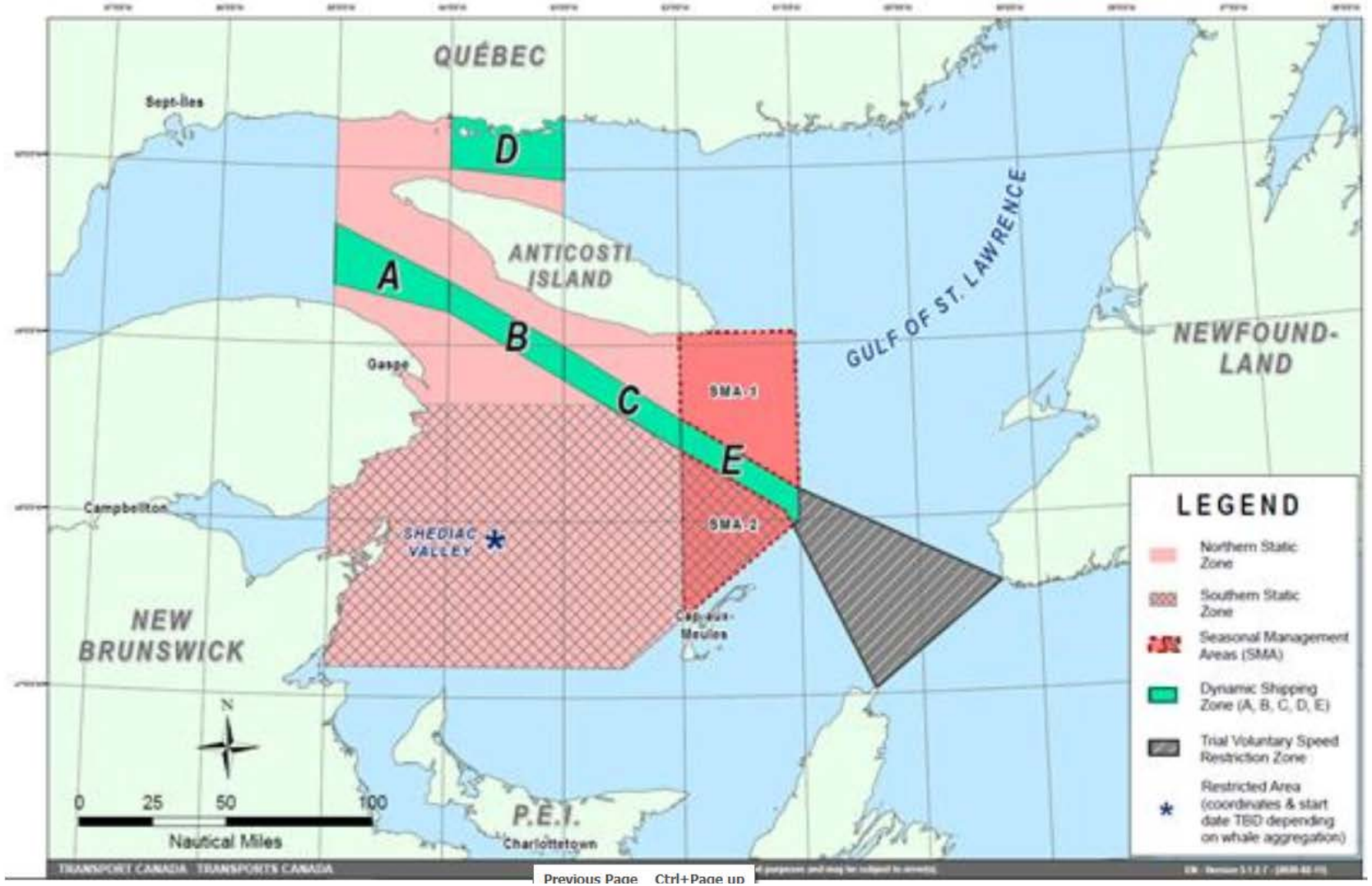
Partner Vessel

CSL *Ferbec*

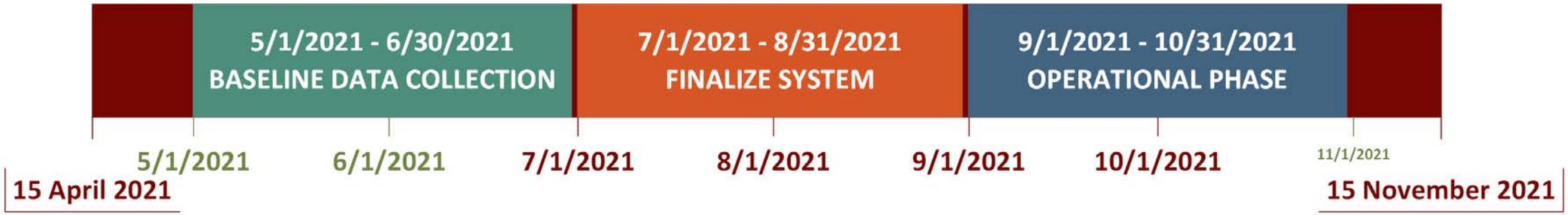
- Handymax
- Single-prop, fixed pitch
- 187.5m, 49500 dwt
- Cruising speed 12.3-13.1 knots
- 20-40 Passages planned for 2021 Sorel ←→ Havre St. Pierre

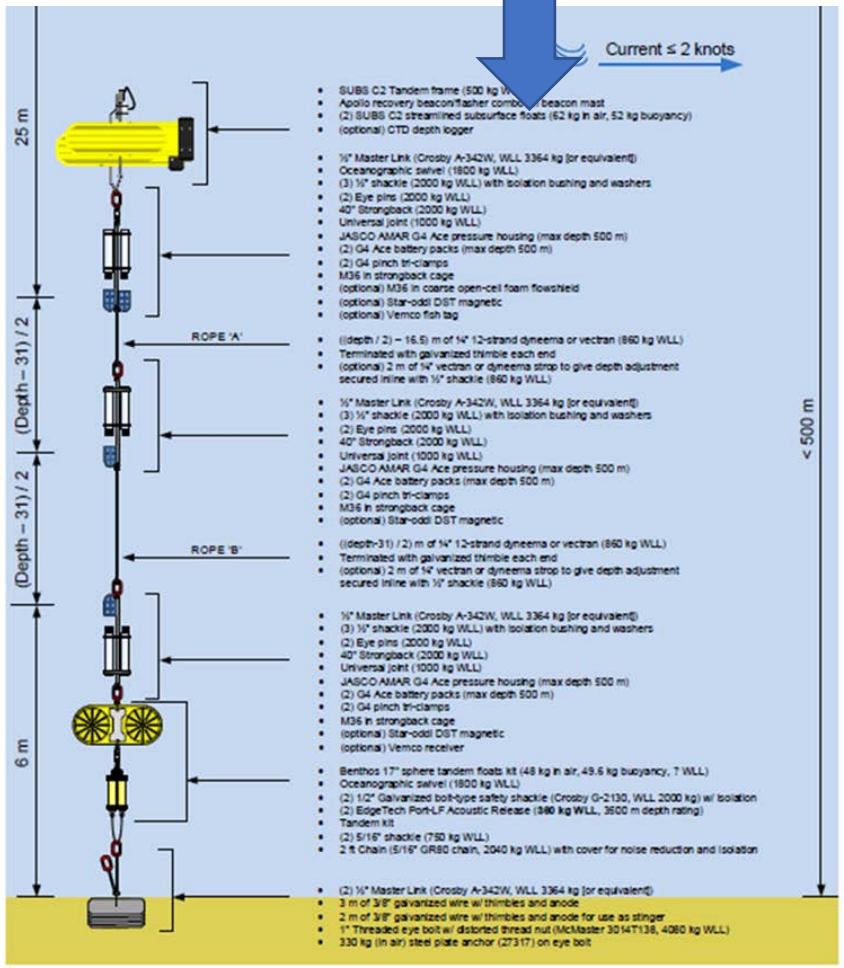
Ferbec Operating Constraints

As per CSL's policy to protect the North Atlantic Right Whales, the Ferbec is sailing at 10 knots in all static and dynamic management areas at all times between April and November.

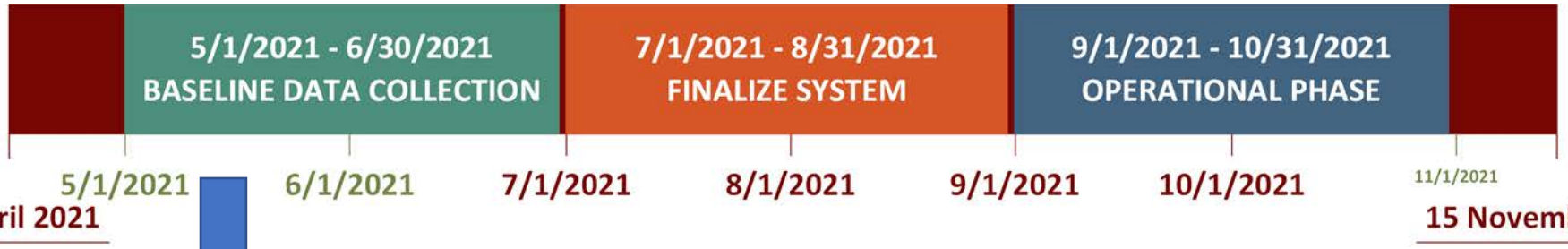


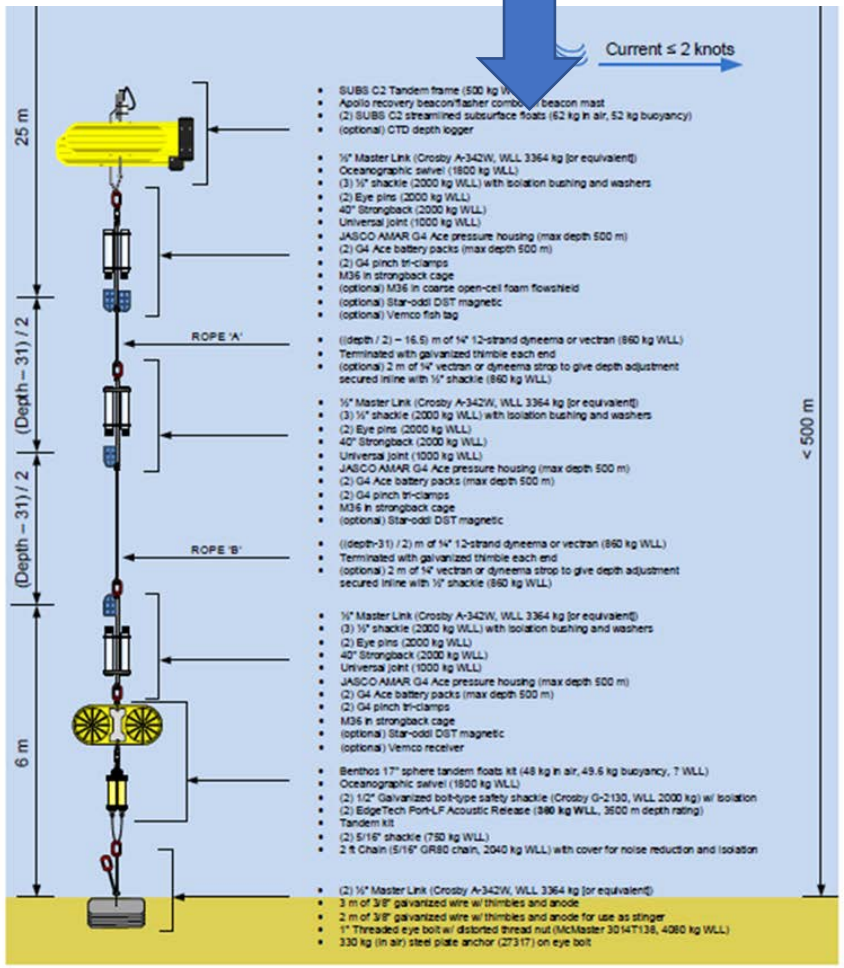
System Development & Evaluation

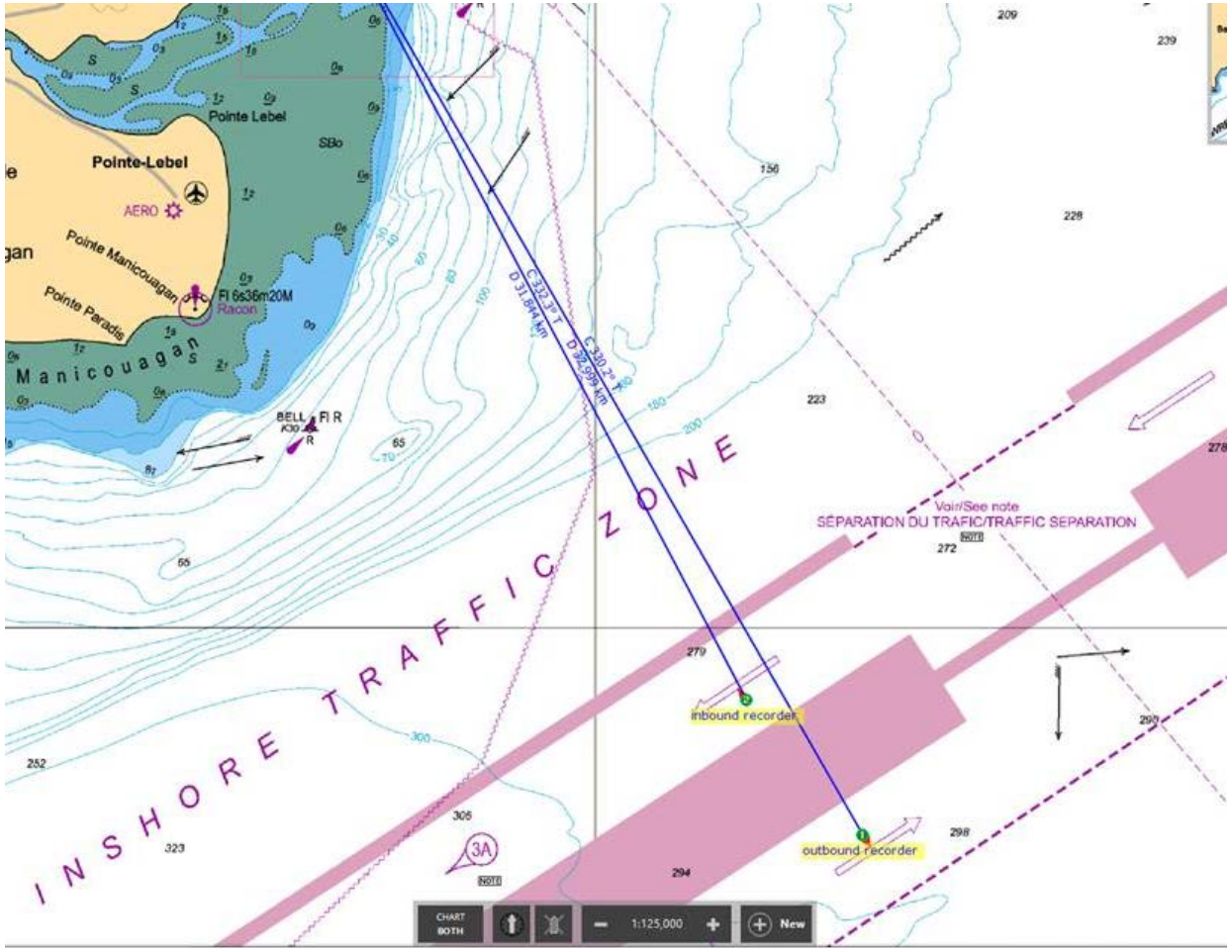


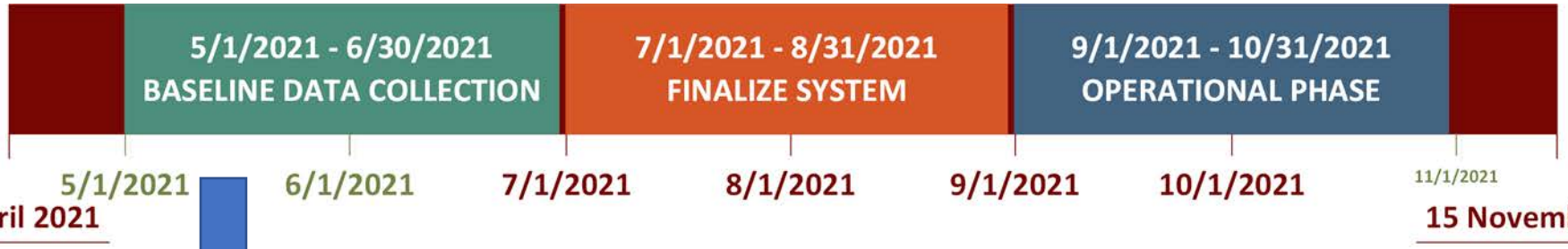


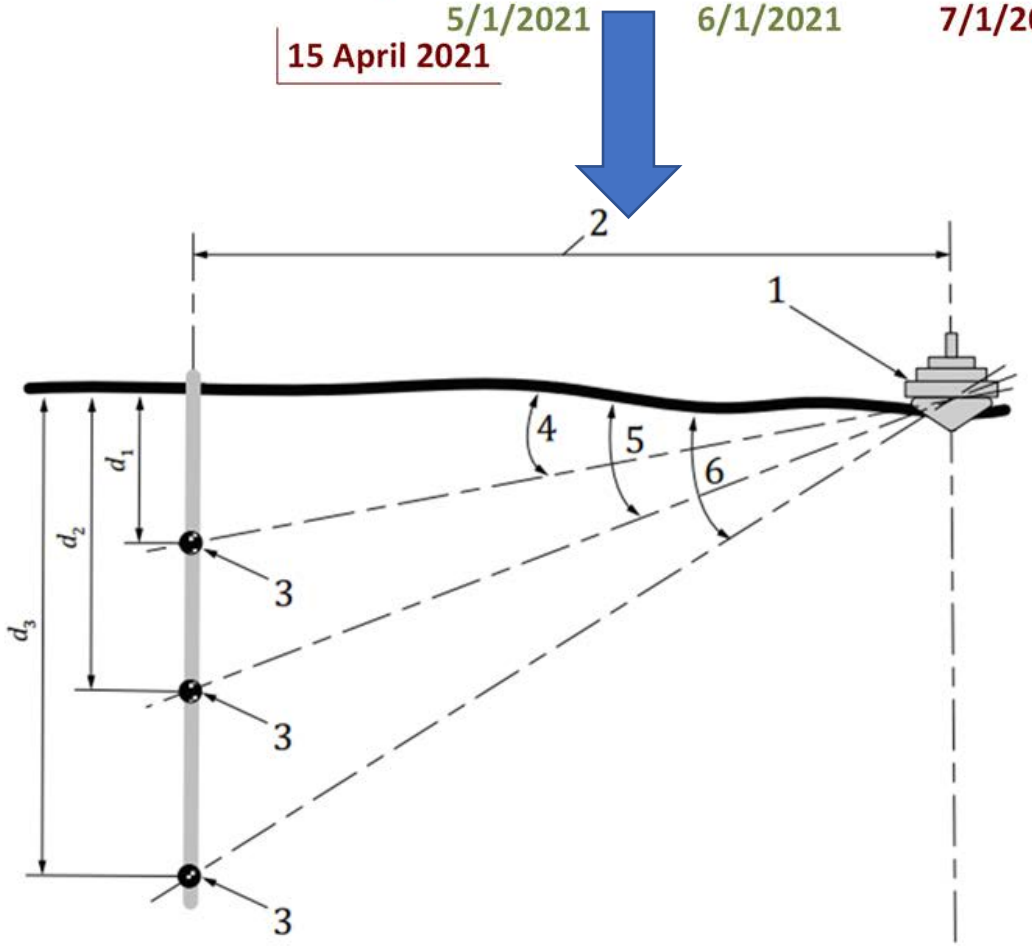
- Collect data off Baie Comeau and on vessel.
- ISO 17208-1/2 Compliant source level measurements
- Multiple speeds, speed stable for 10 min per passage.
- ~10 passage laden, ~10 passages in ballast.
- Ballast changes after Les Escoumis
- Ballast measurement mooring will be bottom only

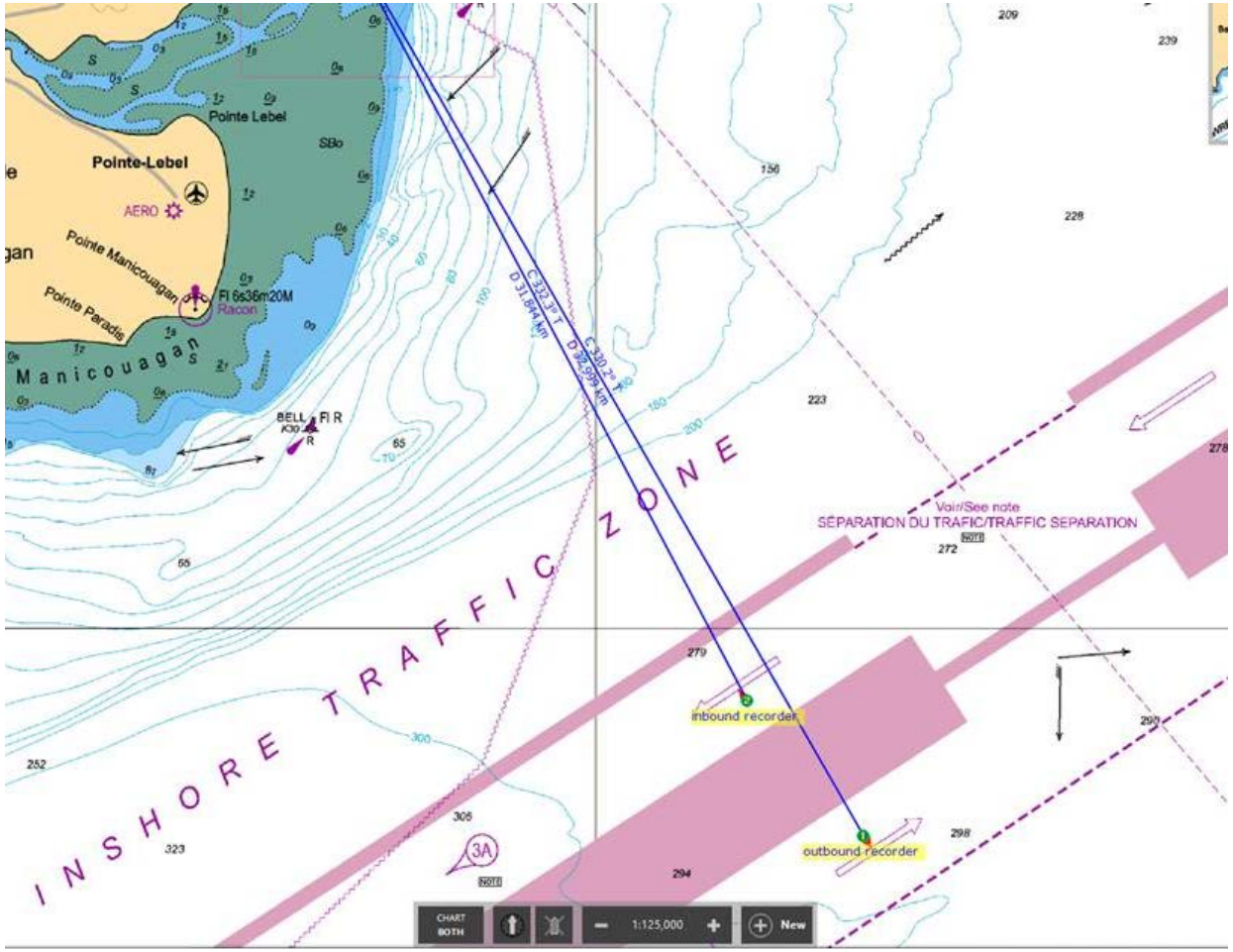

5/1/2021 - 6/30/2021
BASELINE DATA COLLECTION
7/1/2021 - 8/31/2021
FINALIZE SYSTEM
9/1/2021 - 10/31/2021
OPERATIONAL PHASE
5/1/2021
6/1/2021
7/1/2021
8/1/2021
9/1/2021
10/1/2021
11/1/2021
15 April 2021
15 November 2021


Current ≤ 2 knots
25 m
(Depth – 31) / 2
(Depth – 31) / 2
6 m
< 500 m
ROPE 'A'
ROPE 'B'
SUBS C2 Tandem frame (500 kg W
Apollo recovery beacon/flasher combo / beacon mast
(2) SUBS C2 streamlined subsurface floats (62 kg in air, 52 kg buoyancy)
(optional) CTD depth logger
½" Master Link (Crosby A-342W, WLL 3364 kg [or equivalent])
Oceanographic swivel (1800 kg WLL)
(3) ½" shackle (2000 kg WLL) with isolation bushing and washers
(2) Eye pins (2000 kg WLL)
40" Strongback (2000 kg WLL)
Universal joint (1000 kg WLL)
JASCO AMAR G4 Ace pressure housing (max depth 500 m)
(2) G4 Ace battery packs (max depth 500 m)
(2) G4 pinch tri-clamps
M36 in strongback cage
(optional) M36 in coarse open-cell foam flowshield
(optional) Star-oddi DST magnetic
(optional) Vemco fish tag
((depth / 2) – 16.5) m of ¼" 12-strand dyneema or vectran (860 kg WLL)
Terminated with galvanized thimble each end
(optional) 2 m of ¼" vectran or dyneema strop to give depth adjustment secured inline with ½" shackle (860 kg WLL)
½" Master Link (Crosby A-342W, WLL 3364 kg [or equivalent])
(3) ½" shackle (2000 kg WLL) with isolation bushing and washers
(2) Eye pins (2000 kg WLL)
40" Strongback (2000 kg WLL)
Universal joint (1000 kg WLL)
JASCO AMAR G4 Ace pressure housing (max depth 500 m)
(2) G4 Ace battery packs (max depth 500 m)
(2) G4 pinch tri-clamps
M36 in strongback cage
(optional) Star-oddi DST magnetic
((depth-31) / 2) m of ¼" 12-strand dyneema or vectran (860 kg WLL)
Terminated with galvanized thimble each end
(optional) 2 m of ¼" vectran or dyneema strop to give depth adjustment secured inline with ½" shackle (860 kg WLL)
½" Master Link (Crosby A-342W, WLL 3364 kg [or equivalent])
(3) ½" shackle (2000 kg WLL) with isolation bushing and washers
(2) Eye pins (2000 kg WLL)
40" Strongback (2000 kg WLL)
Universal joint (1000 kg WLL)
JASCO AMAR G4 Ace pressure housing (max depth 500 m)
(2) G4 Ace battery packs (max depth 500 m)
(2) G4 pinch tri-clamps
M36 in strongback cage
(optional) Star-oddi DST magnetic
(optional) Vemco receiver
Benthos 17" sphere tandem floats kit (48 kg in air, 49.6 kg buoyancy, 7 WLL)
Oceanographic swivel (1800 kg WLL)
(2) 1/2" Galvanized bolt-type safety shackle (Crosby G-2130, WLL 2000 kg) w/ isolation
(2) EdgeTech Port-LF Acoustic Release (380 kg WLL, 3500 m depth rating)
Tandem kit
(2) 5/16" shackle (750 kg WLL)
2 ft Chain (5/16" GR80 chain, 2040 kg WLL) with cover for noise reduction and isolation
(2) ½" Master Link (Crosby A-342W, WLL 3364 kg [or equivalent])
3 m of 3/8" galvanized wire w/ thimbles and anode
2 m of 3/8" galvanized wire w/ thimbles and anode for use as stinger
1" Threaded eye bolt w/ distorted thread nut (McMaster 3014T138, 4080 kg WLL)
330 kg (in air) steel plate anchor (27317) on eye bolt


Pointe Lebel
Pointe-Lebel
AERO
Pointe Manicouagan
Fl 6s36m20M
Racon
Pointe Paradis
Manicouagan
BELL
Fl R
INSHORE TRAFFIC ZONE
Voir/See note
SÉPARATION DU TRAFIC/TRAFFIC SEPARATION
inbound recorder
outbound recorder
CHART BOTH
1:125,000
New

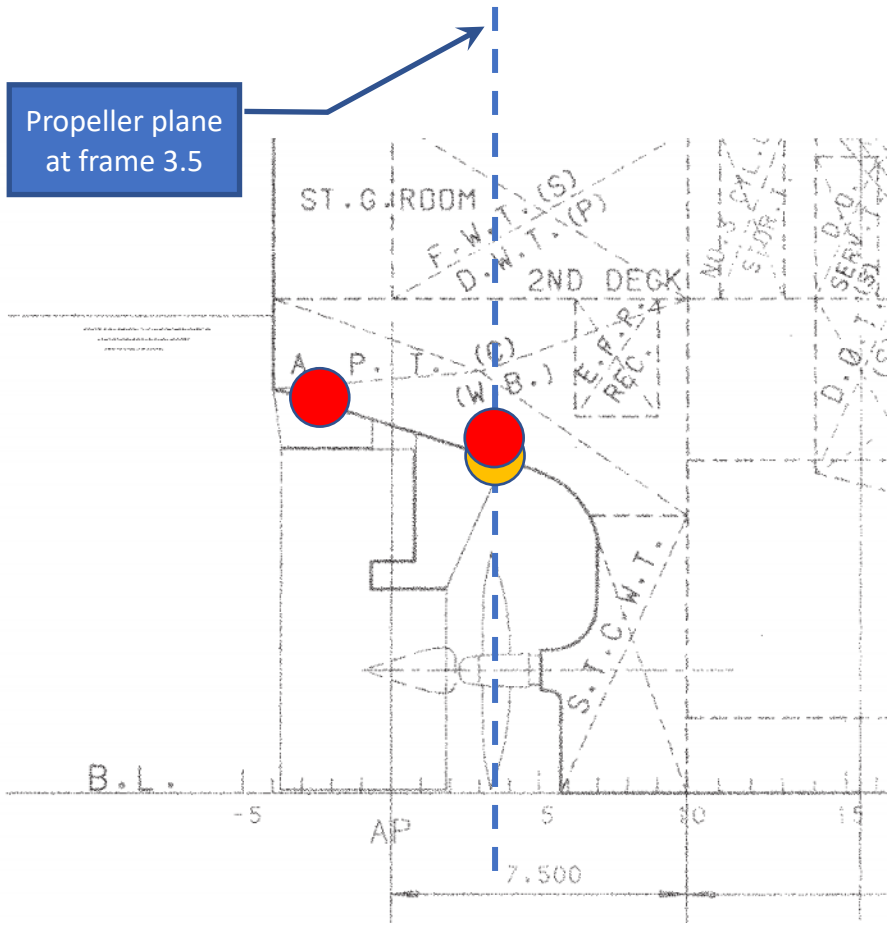


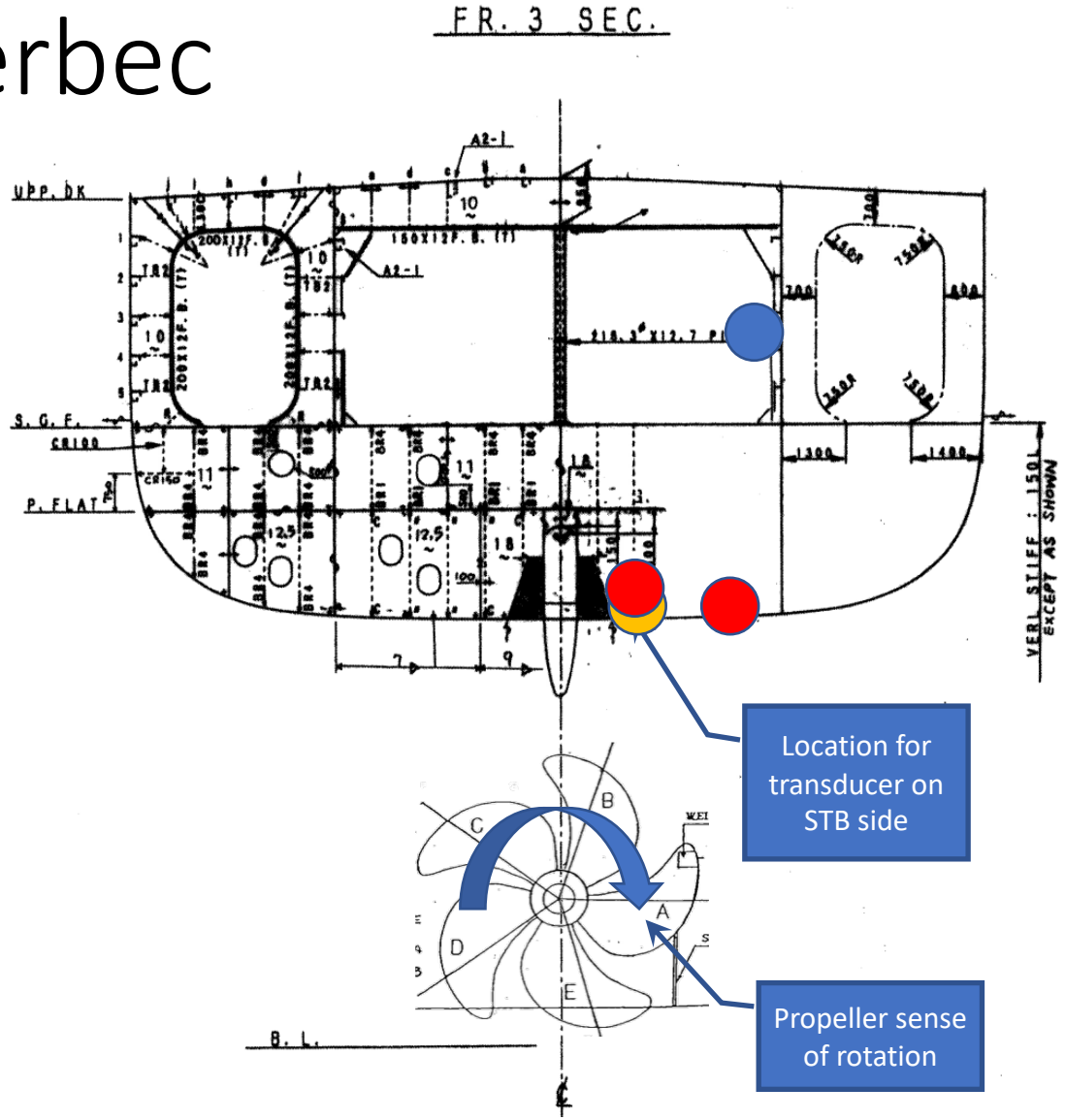




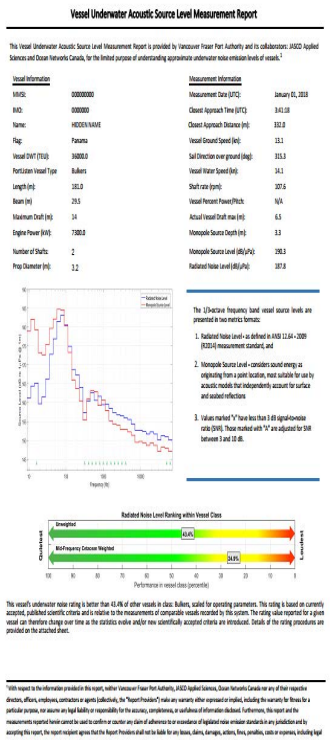
Continuous recording at 128 kHz

Data Collection – On Ferbec





Red: pressure transducer
Orange: pressure + accelerometer
Blue: Data Collection computer in steering gear compartment



Vessel Underwater Acoustic Source Level Measurement Report

This Vessel Underwater Acoustic Source Level Measurement Report is provided by Vancouver Fraser Port Authority and its collaborators: JASCO Applied Sciences and Ocean Networks Canada, for the limited purpose of understanding approximate underwater noise emission levels of vessels.[1]

Vessel Information		Measurement Information	
MMSI:	000000000	Measurement Date (UTC):	January 01, 2018
IMO:	0000000	Closest Approach Time (UTC):	3:41:18
Name:	HIDDEN NAME	Closest Approach Distance (m):	332.0
Flag:	Panama	Vessel Ground Speed (kn):	13.1
Vessel DWT (TEU):	36000.0	Sail Direction over ground (deg):	315.3
PortListen Vessel Type	Bulkers	Vessel Water Speed (kn):	14.1
Length (m):	181.0	Shaft rate (rpm):	107.6
Beam (m):	29.5	Vessel Percent Power/Pitch:	N/A
Maximum Draft (m):	14	Actual Vessel Draft max (m):	6.6
Engine Power (kW):	7300.0	Monopole Source Depth (m):	3.3
Number of Shafts:	2	Monopole Source Level (dB) (μPa):	198.3
Prop Diameter (m):	3.2	Radiated Noise Level (dB) (μPa):	187.8

The 1/3-octave frequency band vessel source levels are presented in two metrics formats:

1. Radiated Noise Level – as defined in ANSI 12.64 – 2009 (R2014) measurement standard, and
2. Monopole Source Level – considers sound energy as originating from a point location, most suitable for use by acoustic models that independently account for surface and seabed reflections
3. Values marked "Y" have less than 3 dB signal-to-noise ratio (SNR). Those marked with "A" are adjusted for SNR between 3 and 10 dB.

Radiated Noise Level Ranking within Vessel Class

Unweighted

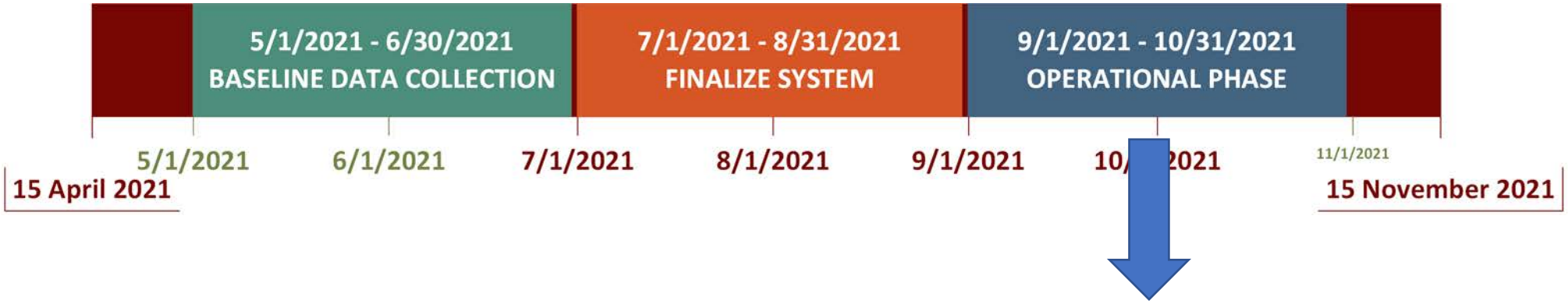
Mid-Frequency Cetacean Weighted

Performance in vessel class (percentile)

This vessel's underwater noise rating is better than 43.4% of other vessels in class: Bulkers, scaled for operating parameters. This rating is based on currently accepted, published scientific criteria and is relative to the measurements of comparable vessels recorded by this system. The rating value reported for a given vessel can therefore change over time as the statistics evolve and/or new scientifically accepted criteria are introduced. Details of the rating procedures are provided on the attached sheet.

[1] With respect to the information provided in this report, neither Vancouver Fraser Port Authority, JASCO Applied Sciences, Ocean Networks Canada nor any of their respective directors, officers, employees, contractors or agents (collectively, the "Report Providers") make any warranty either expressed or implied, including the warranty for fitness for a particular purpose, nor assume any legal liability or responsibility for the accuracy, completeness, or usefulness of information disclosed. Furthermore, this report and the measurements reported herein cannot be used to confirm or counter any claim of adherence to or exceedance of legislated noise emission standards in any jurisdiction and by accepting this report, the report recipient agrees that the Report Providers shall not be liable for any losses, claims, damages, actions, fines, penalties, costs or expenses, including legal fees, arising from the use of this report for any purpose whatsoever.

- From in-water: Compute monopole SL & RNL vs speed
- From Ferbec: how to interpret pressure and accelerometer signals to detect cavitation onset
- Combined: Predict URN from pressure & accelerometer data
- Determine relationship between cavitation and speed
  - Determine relationship with trim and draft if possible



- Install system on Ferbec
- Obtain feedback from CSL and Captain's on operational utility.