



Autonomous Survey in Northern Environments

Derrick R. Peyton
Rory MacKenzie
Martyn Day

IIC Technologies

Introduction

- Project Goals
- Survey Area
- Equipment
- Mobilisation
- Workflow
- Lessons Learned
- Arctic Operations



Project Goals

- Evaluate autonomous technology for remote operations
- Test equipment limitations
- Complete survey of a Secondary Low Impact Shipping Corridor



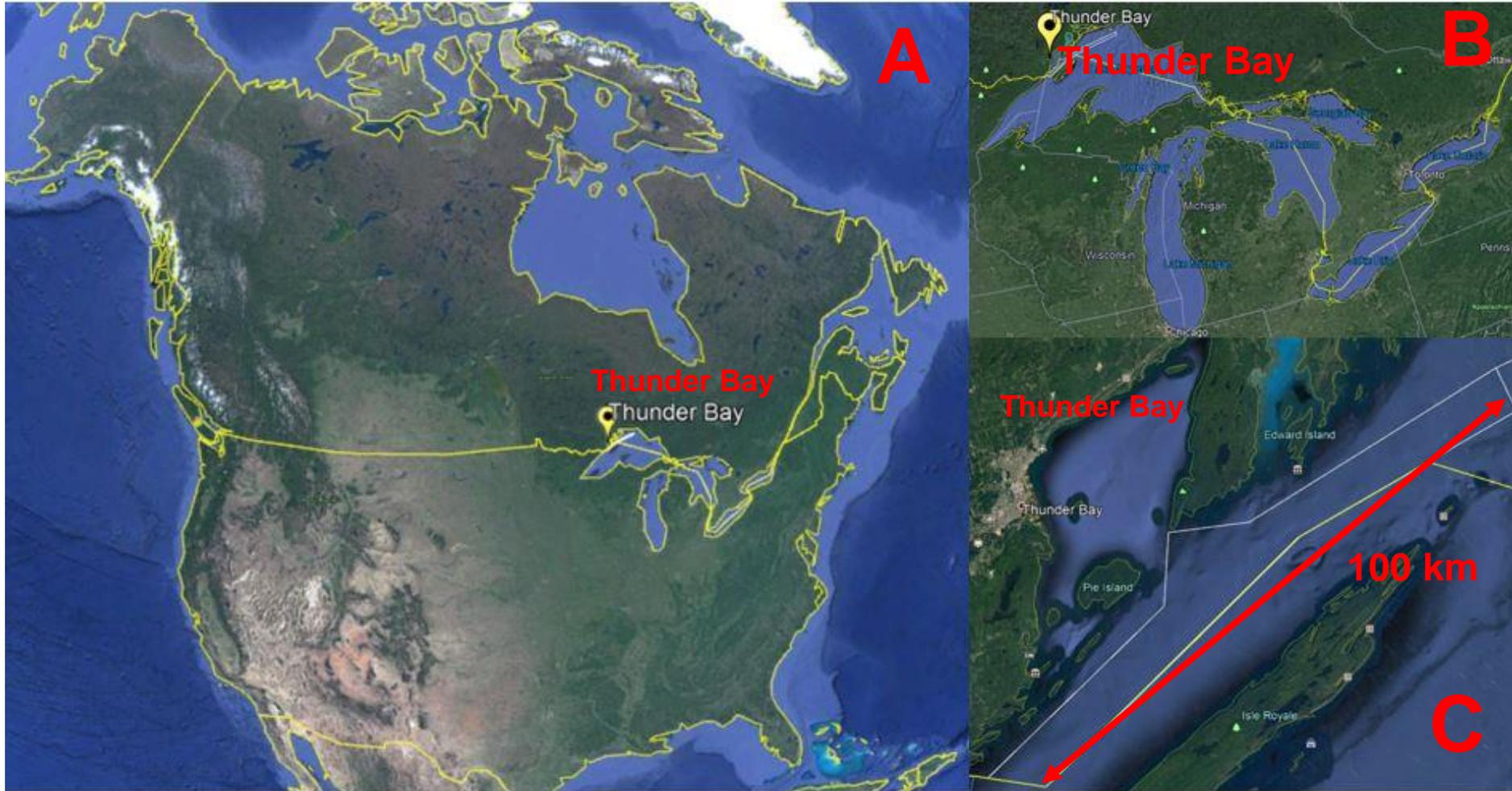
Partnership



- Party Chief
- Onsite Crew
- Data Processing
- Equipment Maintenance

- XO-450 Uncrewed Surface Vessels
- Master Mariners
- Online Surveyors
- Technical support

Survey Area



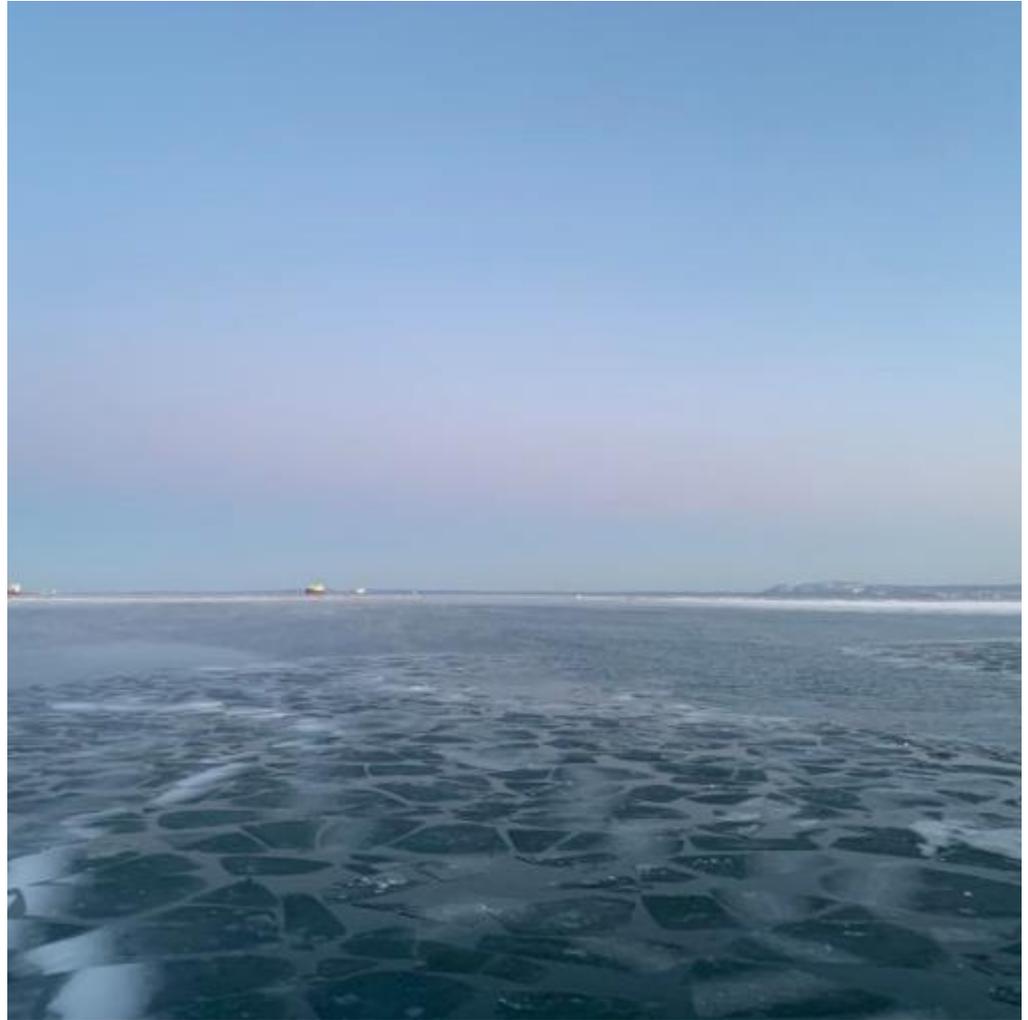
Lake Superior

- One of the largest bodies of fresh water on the planet (largest by surface area)
- Temperature Drops rapidly in the winter
- Susceptible to rapid freezing starting late November



Lake Superior

- Average Observed wind of 25 knots
- Max observed sea state of 6 with an average of 4
- Famous for November Storms
- Not suitable for manned operations



Thunder Bay



- Closest City to the survey site
- Provided access to
 - Stores
 - Contractors
 - Shipping Centers
 - Accommodations
- Created Excellent Testing Location



Equipment

Two XO-450 Uncrewed Surface Vessels

AIS	
Rotating Thermal Image Camera	
Sounding Signal Device	
360 deg Visual Light Camera	
2x – GNSS Antenna	Trimble
IMU + Positioning	Applanix
Realtime Correction	MarineStar
Kongsberg MBES	2040P
Surface SV	AML
SVP	Valeport
QINSy	QPS



XO-450 Unmanned Surface Vessel



- Roughly the size of a car and weight 750kg (shipping container)
- Single Cylinder Diesel Engine coupled with solar panels
- Cruising 4 knots / Survey 2.8 knots
- Endure up to Sea State 6 on Beaufort Scale
- Survey up to Sea State 4



XO-450 Unmanned Surface Vessel



- Situational Awareness
 - AIS
 - 360° visual light cameras
 - Rotating Thermal Imaging Camera
 - Sound Signaling Device



Uncrewed Over the Horizon Operation

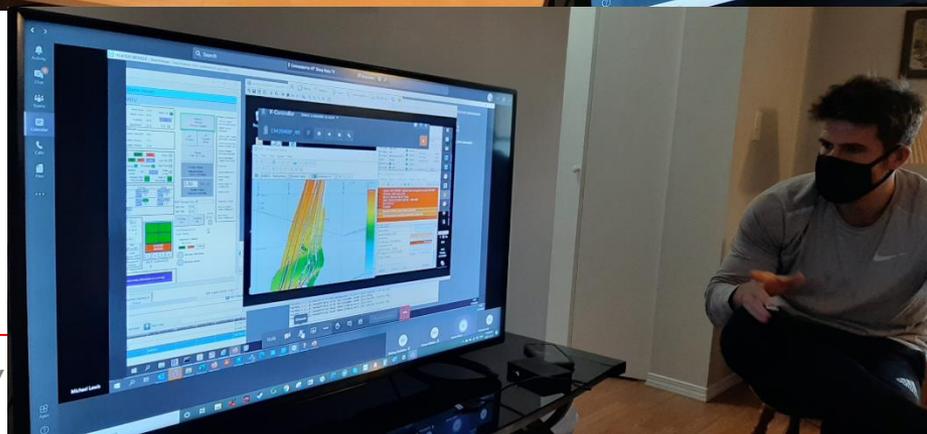


- USV Communicates via satellite to control room
- Vessel monitored by pilots for safety (master mariner overseeing operation live via satellite met Transport Canada regulatory requirements).
- Surveyors monitor survey data and set line plans



A

B



C

Mobilization

- Completed Offsite
- Allowed for rapid launch after equipment arrived on site
- Pre-packaged with all tools and materials
- Minimal interaction with the public and social distancing



A

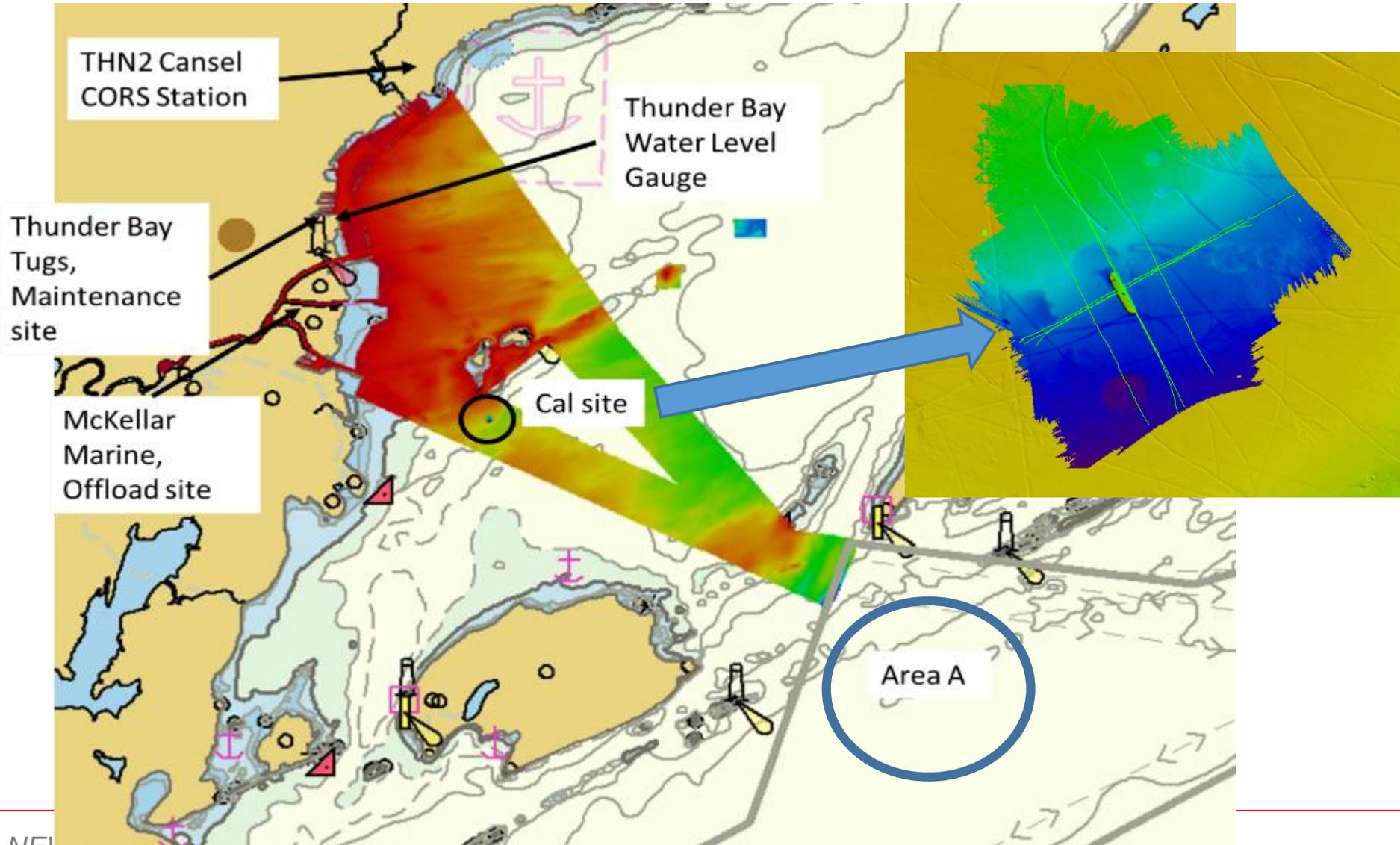


B



C

Calibration



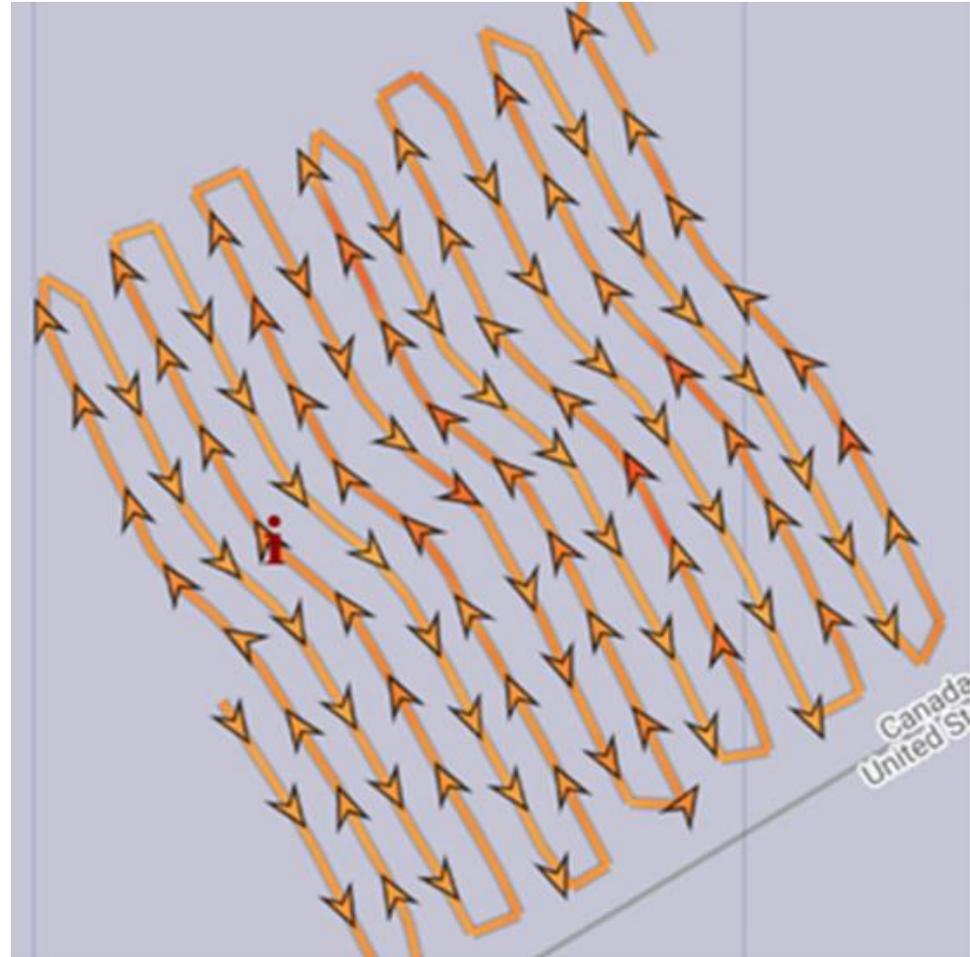
Workflow (leaving harbour)

- USV Launched at local ramp
- Manually Piloted through Harbour
- Once clear operators in Europe assumed control



Workflow (on survey site)

- Units surveyed fully autonomously
- Latest ENC was used as a base chart
- Course automatically adjusted using the QPS QINSy Autoswath function
- SVP casts performed using an auto winch



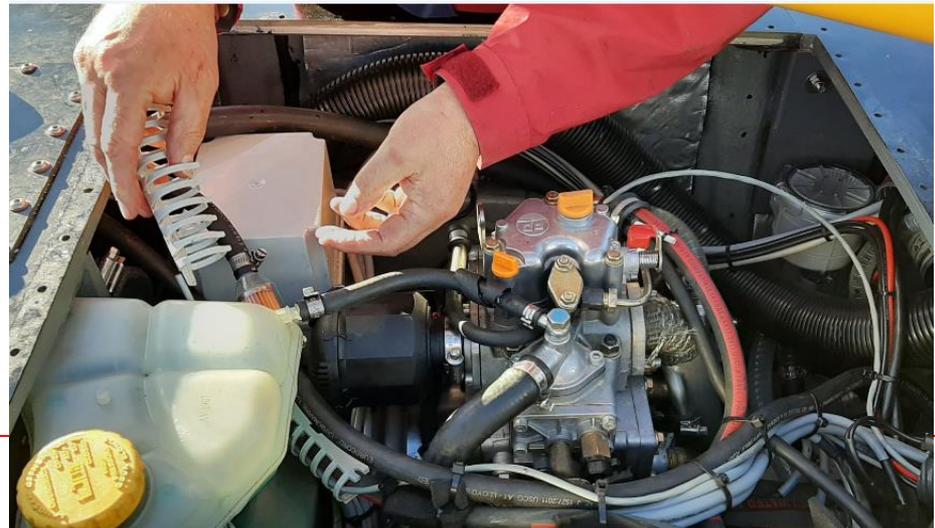
Workflow (data download)

- USV deployed for a week or until weather deteriorated
- Download Data
- Perform Maintenance
- Vessel relaunched ASAP
- Processors QC data

A



C



B

Lessons Learned



USV
Transportation

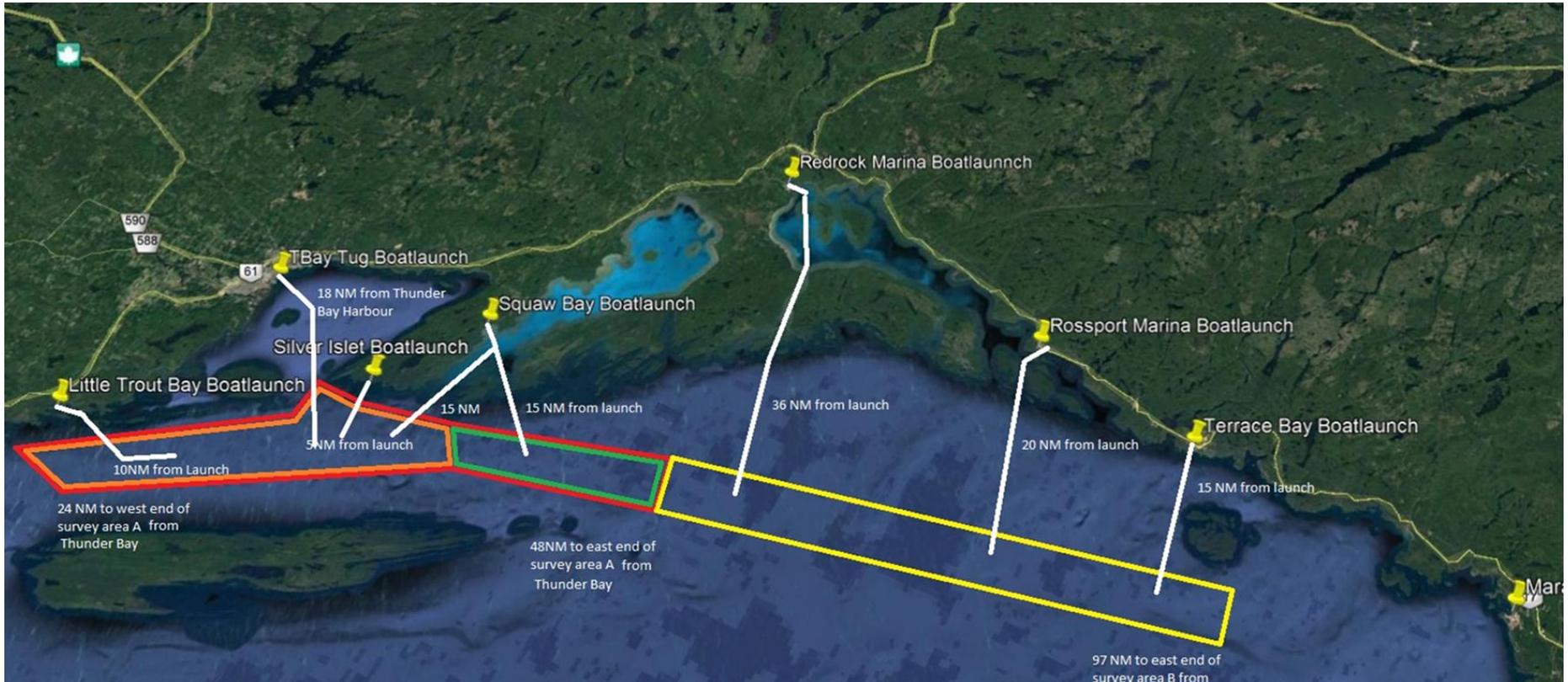


Field Repairs



Freezing Spray

Transportation: By Road



Transportation: Chase Boat



- The need for a chase boats creates a limiting factor for survey conditions
- Having a large vessel just for recovery may not be cost effective
- Having the Chase Boat as a Survey vessel could be more efficient



Replacement Parts



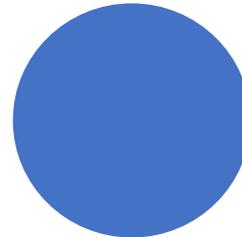
USVs are relatively easy to work on compared to boats



Parts can be replaced in the field



Limiting factor was part delivery time not repair time



Multiple USVs with spare parts on site are crucial for efficiency

Freezing Spray

- Common for vessels to have ice build up on the Great Lakes
- Mariners are often required to break ice
- Failure to do so can cause vessel to become unstable
- Operators were concerned that USV would be impacted



Photo by Jones Leslie, provided by Boston Public Library

Freezing Spray

- Ice build up did not affect stability of USV
- Low surface area and low to water design limited ice volume
- Important to consider impact of ice when selecting USVs



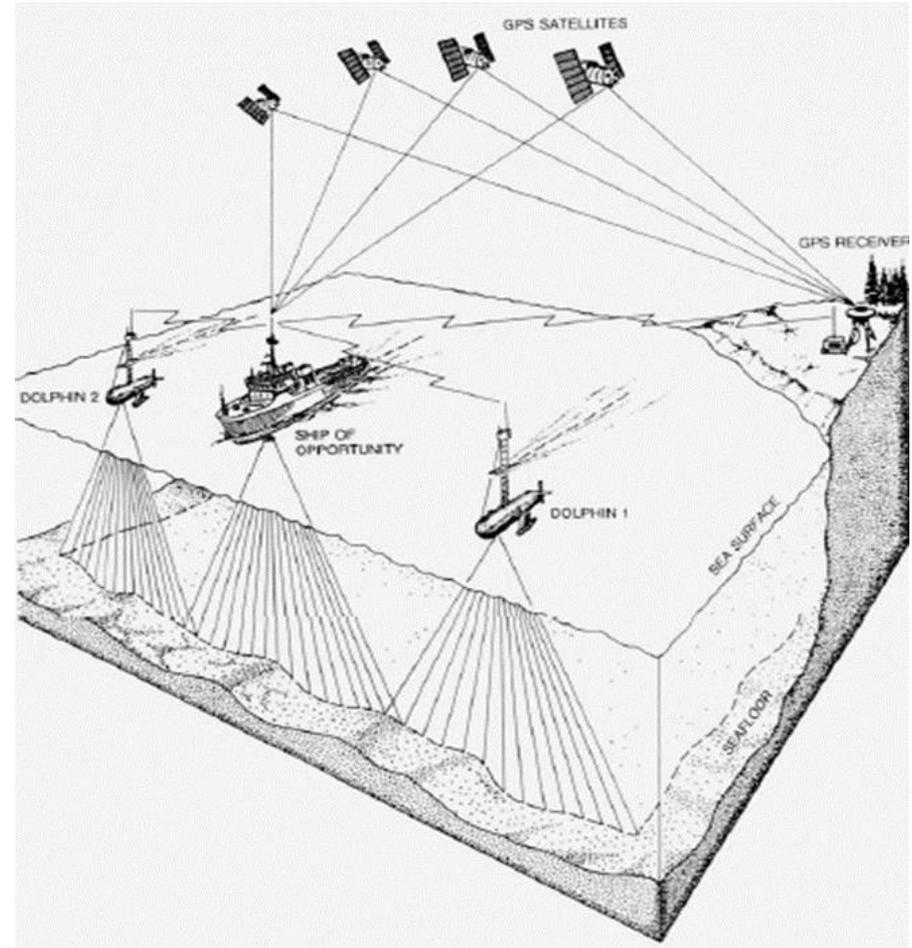
Freezing Spray

- Ice build up blocked air intake on gantry
- Field modifications were made to have secondary intake close to water
- Potential application of Hydrophobic sprays or coatings



Arctic Operations

- Force Multiplier in Arctic Operations
- Increased Efficiency for short survey season
- Planning, Planning, Planning



The Hydrographic Journal, 1992

Thank You