Michigan Tech Great Lakes Research Center Updates

GLASS – Great Lakes Association of Science Ships 28th Annual Science Vessel Coordination Workshop
Thursday, January 11, 2024

Presented by:
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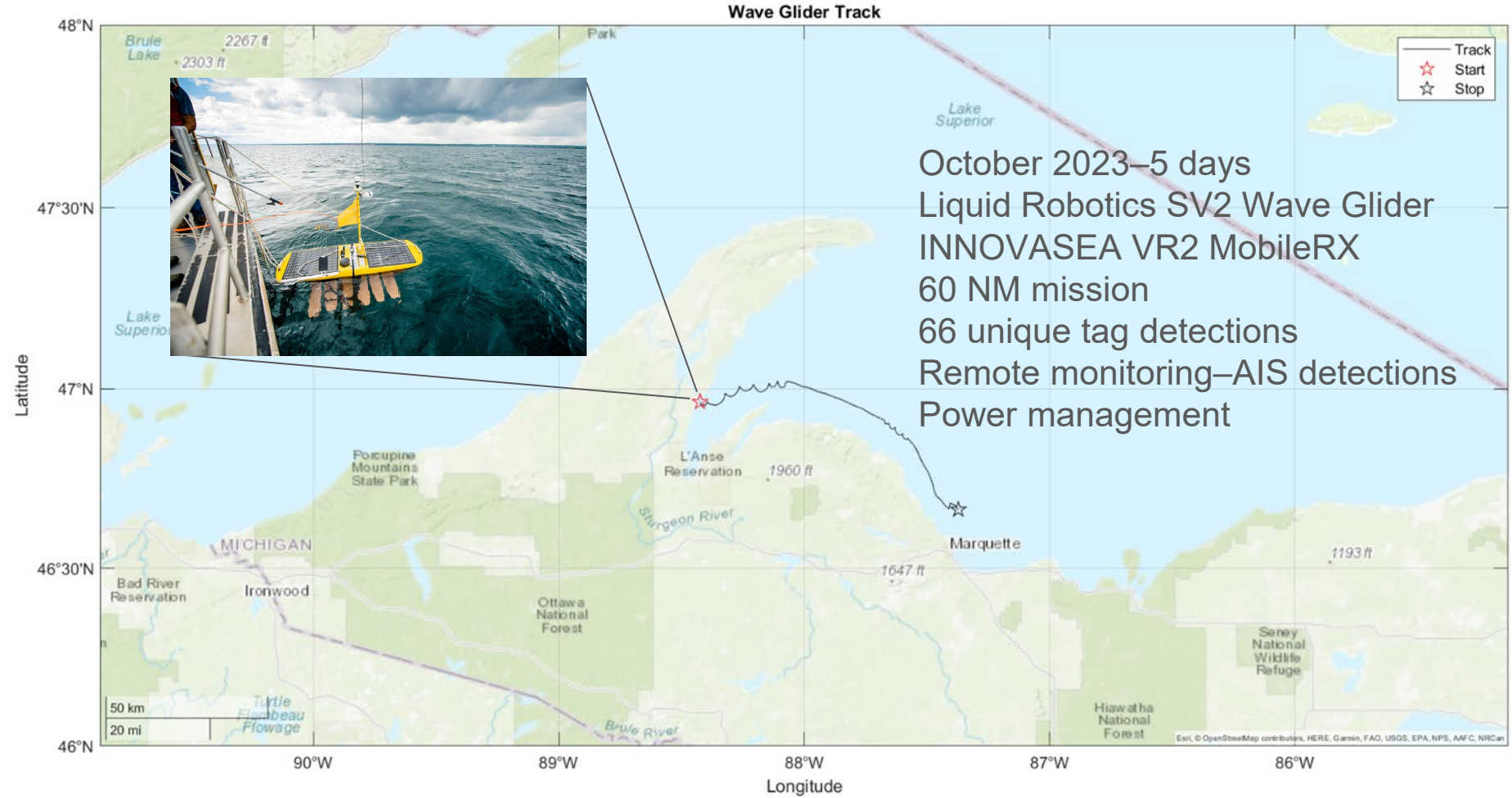
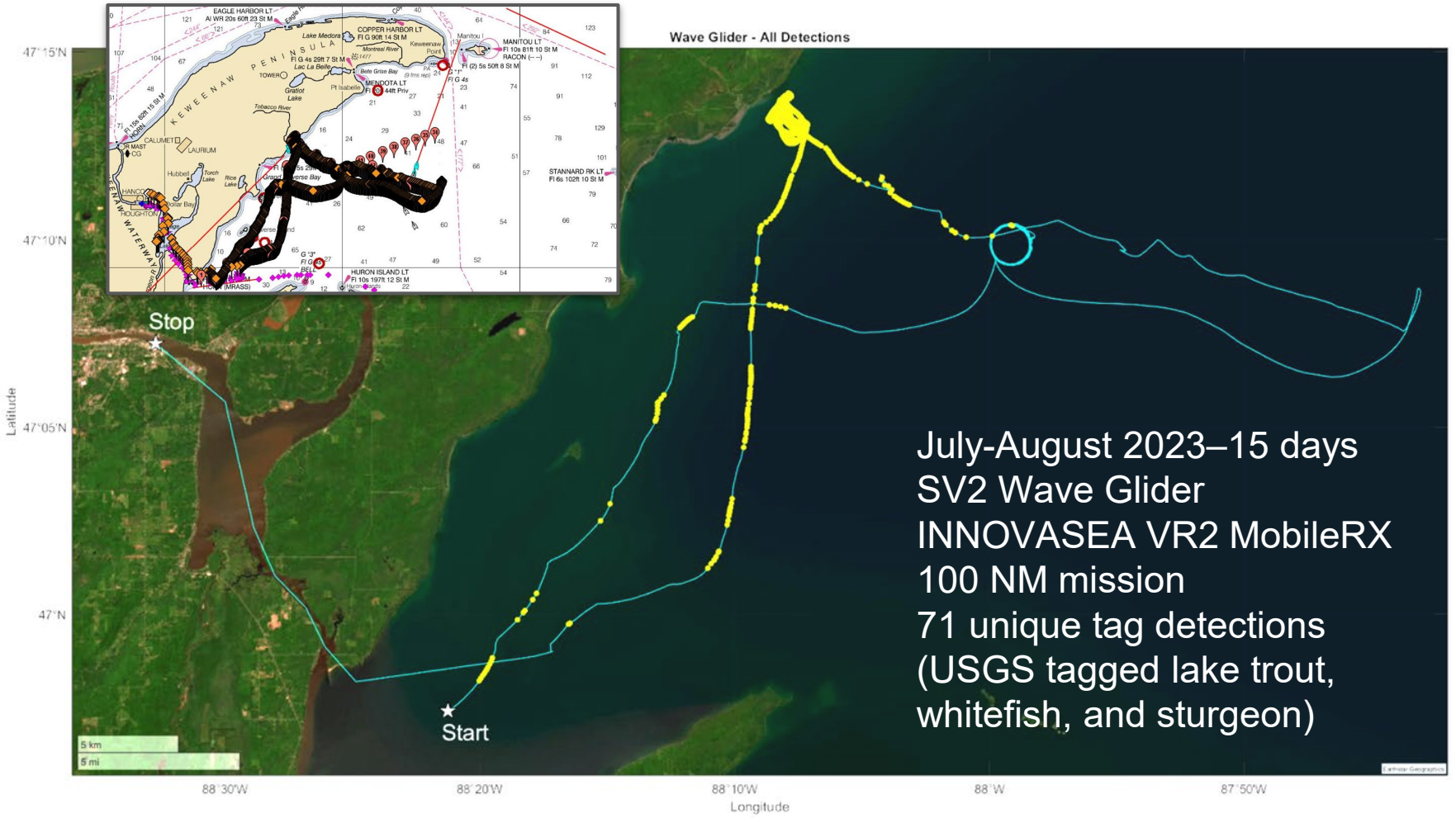
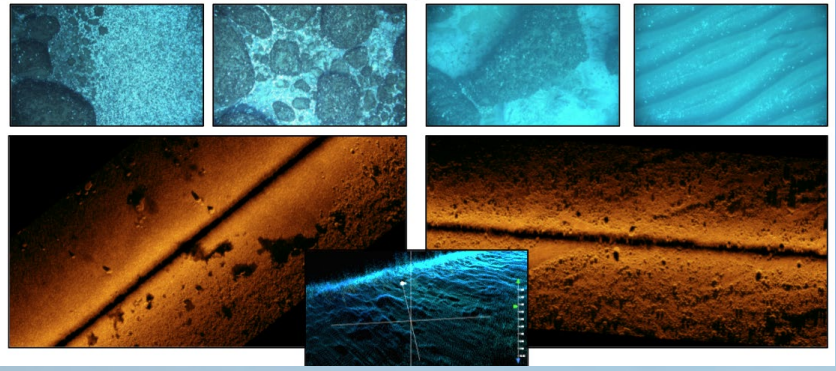
WORKSKIFF CMDR SERIES DEEP V - 25' X 8.5'
Twin Mercury 150 FourStroke
150 Gallons Fuel
200# Lift Capacity


Wave Glider Track
Track
Start
Stop
October 2023–5 days
Liquid Robotics SV2 Wave Glider
INNOVASEA VR2 MobileRX
60 NM mission
66 unique tag detections
Remote monitoring–AIS detections
Power management
Latitude
Longitude
48°N
47°30'N
47°N
46°30'N
46°N
90°W
89°W
88°W
87°W
86°W
Brule Lake
2267 ft
2303 ft
Park
Lake Superior
Porcupine Mountains State Park
L'Anse Reservation
1960 ft
Sturgeon River
Marquette
1193 ft
1647 ft
MICHIGAN
Bad River Reservation
Ironwood
Ottawa National Forest
Seney National Wildlife Refuge
Hiawatha National Forest
Turtle Flambeau Flowage
Brule River
50 km
20 mi
Esri, © OpenStreetMap contributors, HERE, Garmin, FAO, USGS, EPA, NPS, AAFC, NRCan


Wave Glider - All Detections
Stop
Start
July-August 2023–15 days
SV2 Wave Glider
INNOVASEA VR2 MobileRX
100 NM mission
71 unique tag detections
(USGS tagged lake trout,
whitefish, and sturgeon)
47°15'N
47°10'N
47°05'N
47°N
Latitude
88°30'W
88°20'W
88°10'W
88°W
87°50'W
Longitude
5 km
5 mi
KEWEENAW PENINSULA
EAGLE HARBOR LT
COPPER HARBOR LT
MANITOU LT
MENDOTA LT
HURON ISLAND LT
STANNARD RK LT
CALUMET
LAURIUM
HANCOCK
HOUGHTON
Lake Medora
Lac La Belle
Gratiot Lake
Torch Lake
Rice Lake
Portage Lake
Keweenaw Waterway
Tobacco River
Montreal River
Bete Grise Bay
Pt Isabelle
Keweenaw Point
Manitou I
Huron Islands

Example AUV Survey Images and Sonar Data



L3Harris (Ocean Server) IVER 3 AUV
200 mission hours in 2023
Lake Superior, Lake Ontario, Lake Michigan


Industry Partnership with Ocean Infinity America
C-Worker 8m ASV stationed at GLRC
Available for collaborative use
Multi-role work class ASV
Offshore/coastal tasks (e.g. environmental monitoring, surveying)
Custom payloads (e.g. MBES, USBL, CTD, ADCP, acoustic devices)
3kW payload power

ARMADA 8: USV GENERAL SPECIFICATIONS

General		
Year Built	2018	
Hull Type	Mono / Aluminium / Self Righting	
Max Sea State (design)	Sea State 5	
Weight	3.7te/4.8te	~8200 lbs dry
Length	7.61m	25’ OAL
Beam	2.14m	7’ beam
Draft * (*minimum)	0.99m	3.3’ draft
Engines	Twin Yanmar 4JH 45HP Diesel	
Propulsion	2 x Yanmar SD80 Sail Drives	
Fuel Capacity	1,200 Ltr	317 gallons
Max Speed	10kts	
Endurance	7 Days @ 4tks	


Navigation/Safety
Class B AIS TX/RX
FLIR thermal cameras
5x HD video cameras
Kongsberg maritime
broadband radios
Simrad 4G radar
Airmar DT800
Redundant propulsion,
communications, power

ARMADA 8: USV - MAST

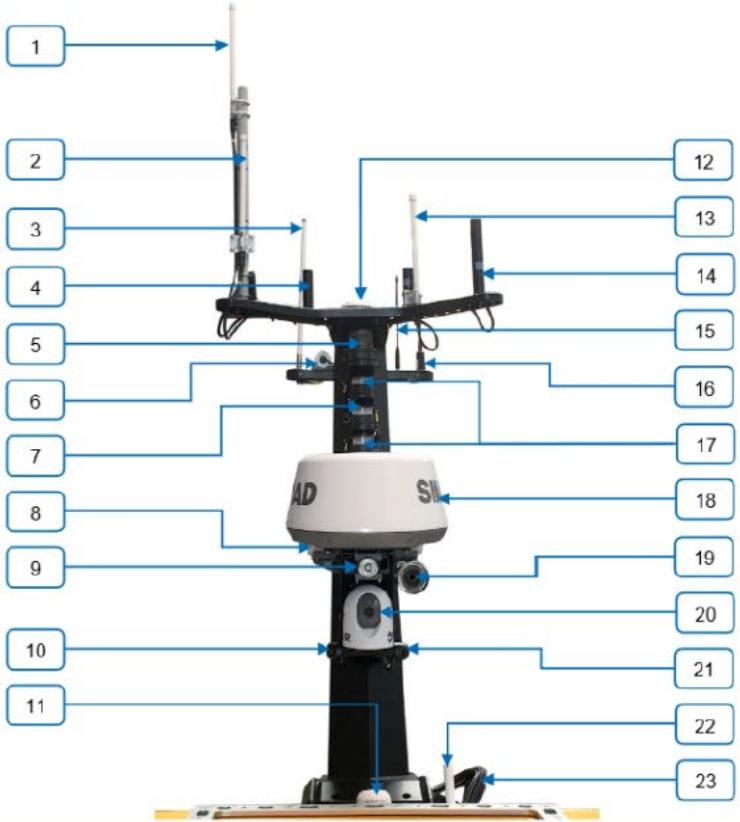
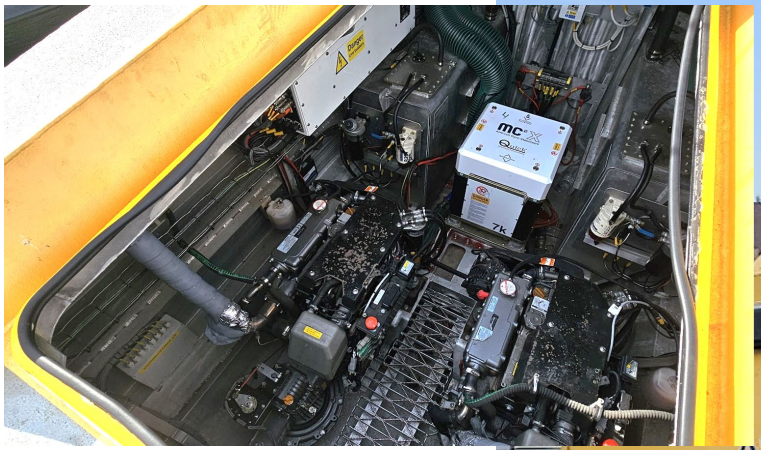
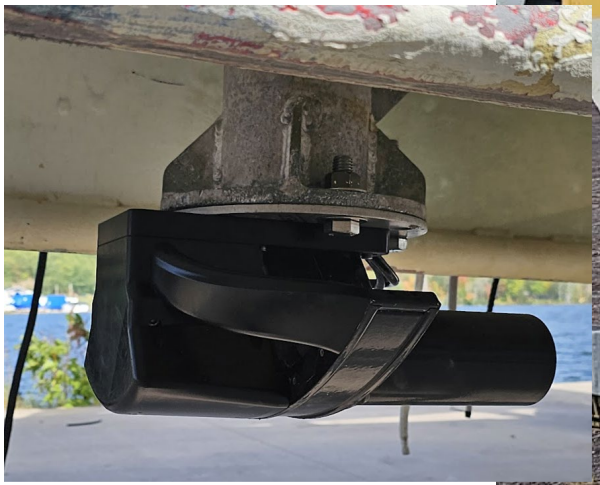


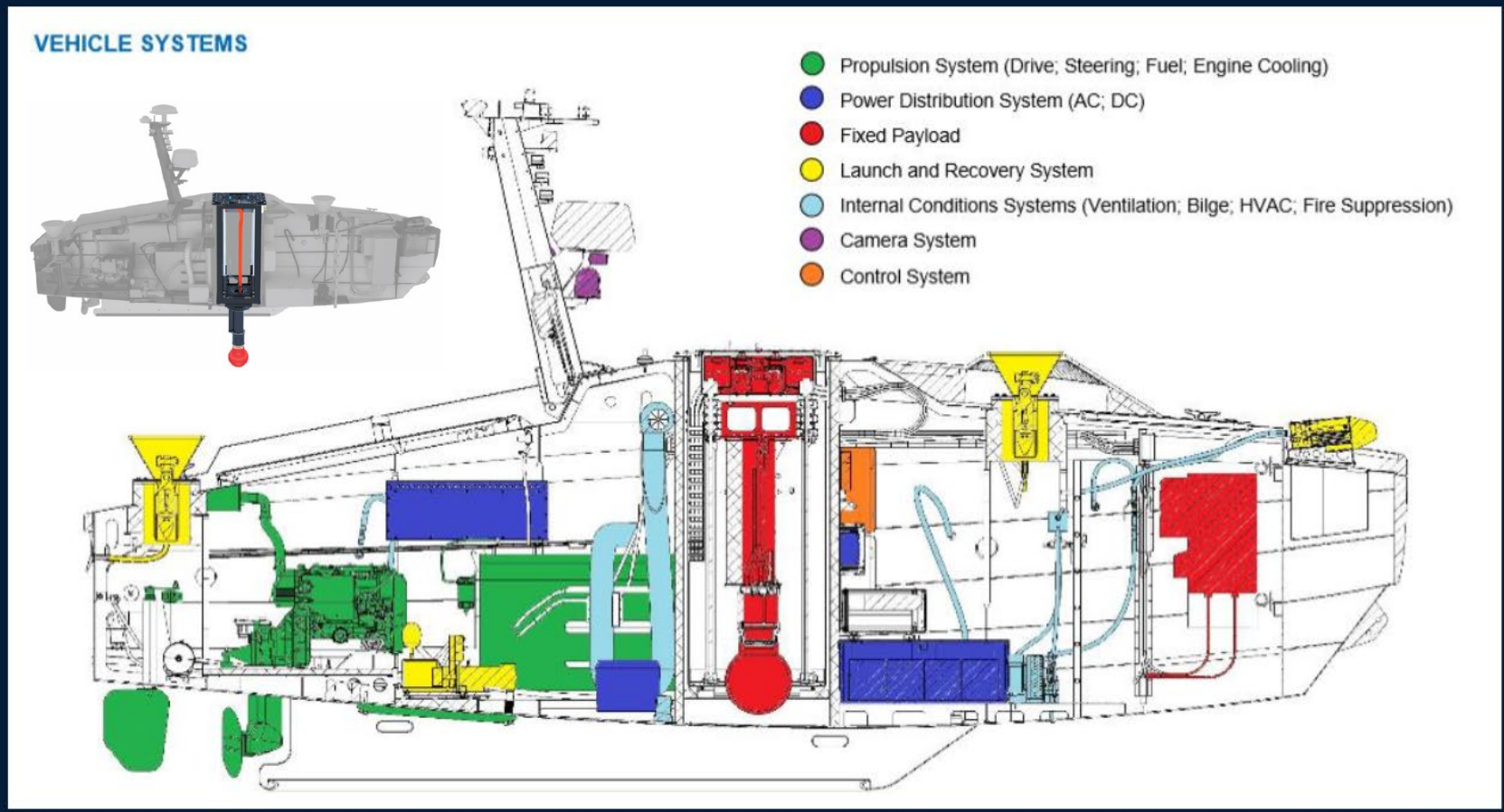
Figure 15	
1	KM MBR antenna
2	KM MBR antenna
3	Secondary radio (WiFi) antenna
4	Spare antenna mount
5	Masthead white light
6	Aft facing camera
7	Signalling light – white
8	Side facing camera (P&S)
9	Forward facing camera
10	Starboard navigation light – green
11	GPS receiver
12	GNSS antenna
13	5 GHz mesh radio antenna
14	900MHz mesh radio antenna mount (antenna not fitted)
15	UHF antenna
16	AIS VHF antenna
17	Signalling lights – red
18	4G radar
19	Signalling horn
20	Thermal camera
21	Port navigation light – red
22	Iridium antenna
23	Cabling (P&S)


mc

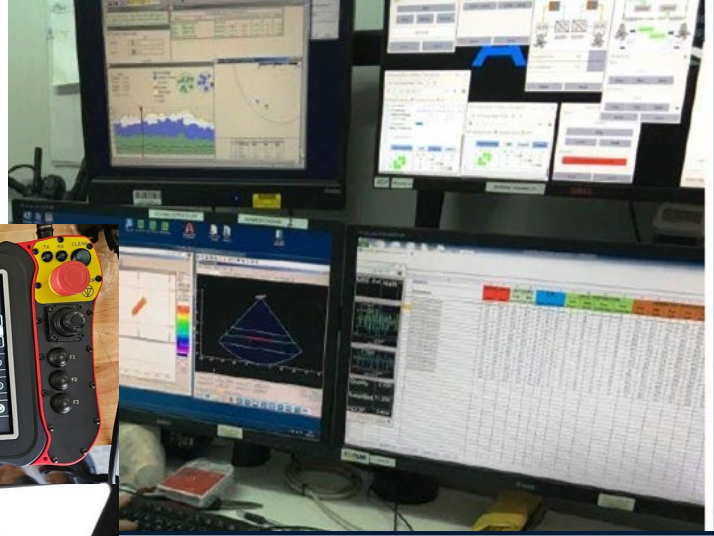



SIMRAD
SeaWorker 2
ASV

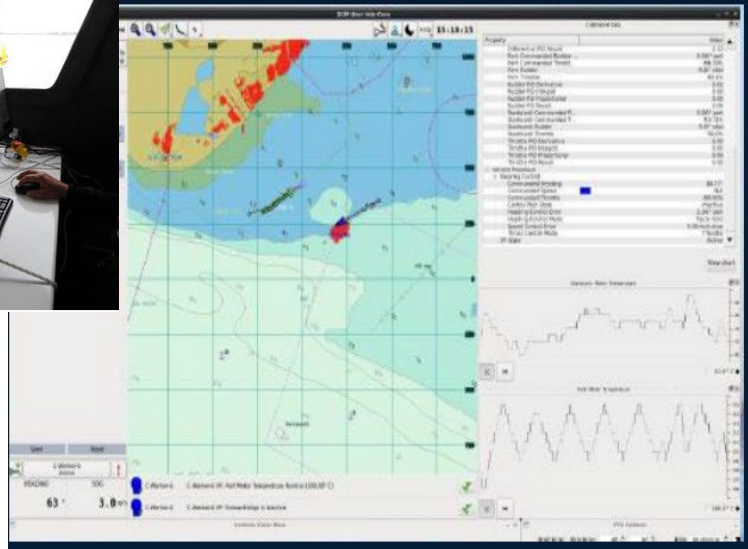
ARMADA 8: USV – VESSEL SYSTEMS




ASView-Helm




ASV
unmanned



ARMADA 8: USV NAVIGATIONAL / SIGNALLING SYSTEMS

Navigation System	
Signalling horn	Force 4, 160047 (Qty 1)
Standalone Iridium GPS tracker	Rock Seven, RockSTAR (Qty 1)
Masthead white light	C-Quip, 02-3855-101 (Qty 1)
Port navigation light	C-Quip, 3851001000 (Qty 1)
Starboard navigation light	C-Quip, 3850001000 (Qty 1)
Stern navigation light	C-Quip, 3850001000 (Qty 1)
Red signalling light	C-Quip, 02-3854-161 (Qty 2)
White signalling light	C-Quip, 02-3854-001 (Qty 1)

AIS transponder	McMurdo, Smartfind M10 (Qty 1)
AIS VHF antenna	Shakespeare, MD23-AIS (Qty 1)
AIS GPS antenna	2J Antenna, 2J7501B (Qty 1)

Signaling

Signaling is used to control SeaWorker's navigation lights, signaling lights, foghorn and AIS transmitter.

The Signaling dashboard is accessed by clicking the *Dashboard Menu* button, and selecting *Signaling* from the drop-down menu.

Lights Menu

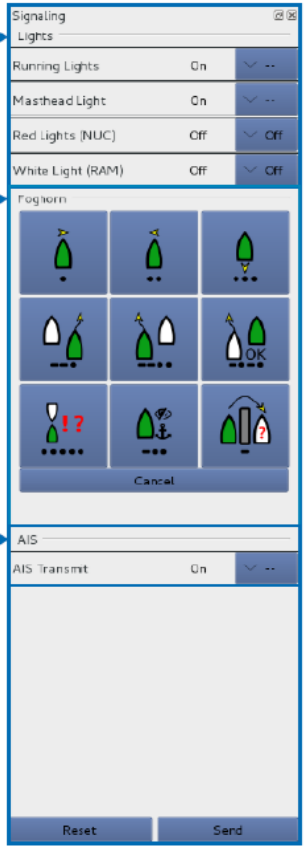
Used to switch on/off SeaWorker's various lights.

Foghorn Menu

Used to sound the horn using pre-programmed signals. Mouseover any of the options to show a brief description on screen.

AIS Menu

Used to switch on/off AIS transmit.



2023 Smart Ships Coalition / SNAME Annual Workshop

1.5 days of presentations, networking, and demos
~75 industry participants
15 speakers/panelists
USCG & Transport Canada Participation

USCG Automated and Autonomous Vessel Policy Council (AutoPoCo)

- Purpose: Develop policies and COAs to address operations of automated and autonomous vessels in U.S. waters
- Objectives:
  - ID existing regs and policies that apply
  - Develop guidance documents for field units and industry
  - ID reg and policy gaps
  - Serve as clearing house for unique projects
  - Make recommendations for training and education programs
- Organization:
  - Advisors: CG-5PS, CG-5PW, CG-5PC
  - Chair member: CAPT Cost (CG-ENG), CAPT Neeland (CG-CVC)
  - Core members:
    - CG-CVC
    - CG-MMC
    - NAVCEN
    - CG-WWM
    - CG-NAV
    - MSC
    - CG-OES
    - CG-INV

U.S. Department of Homeland Security
United States Coast Guard

Commandant
United States Coast Guard

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16711/Serial No. 1358
CG-CVC Policy Letter 22-01
February 16, 2022

From: M. EDWARDS, CAPT
COMDT (CG-CVC)

To: Distribution

Subj: GUIDELINES FOR HUMAN-SUPERVISED TESTING OF REMOTE CONTROLLED AND AUTONOMOUS SYSTEMS ON VESSELS

Ref: (a) 46 United States Code § 8301
(b) 46 Code of Federal Regulation part 15
(c) Marine Safety Manual Vol. III, Marine Industry Personnel, COMDTINST M16000.8 (series)
(d) IMO MSC Circular.1/1638, Outcome of the Regulatory Scoping Exercise for the Use of Maritime Autonomous Surface Ships (MASS)

1. PURPOSE. This policy letter provides guidelines for testing, under human supervision, of remote controlled and autonomous systems on vessels. These tests, which shall not reduce vessel manning below that prescribed by law or regulations, may be conducted in order to evaluate the effectiveness of remote controlled and autonomous vessel systems under human supervision.

Transport Canada Marine Safety and Security

- **Policy on the Oversight of Small Maritime Autonomous Surface Ships (SMASS policy)** sets requirements for vessels:
  - not more than 12 metres in length as defined in the Small Vessel Regulations, or not more than 15GT
  - Remotely controlled (level of autonomy 3 as defined by IMO)
- The policy does not apply to MASS that have crew on board or are tethered to a mother vessel or a shore installation.

Transports Canada Transport Canada

1 Policy objective

1.1 This policy aims to set the requirements for the operation of small Canadian Maritime Autonomous Surface Ships (MASS) when operated within Canadian waters. MASS do not have a crew or passengers on board and therefore will require alternative arrangements to comply with the existing regulatory requirements applicable under the *Canada Shipping Act, 2001* for manning, the prevention of collision at sea, and navigation safety.

2 Policy statement

2.1 The Authorized Representative (AR) of a small MASS must prepare a risk assessment before operating.

2.2 The risk assessment shall include proposed mitigating measures, to ensure the safety of navigation during the MASS operation provides a level of safety at least equivalent to a regularly crewed vessel.

2.3 The risk assessment must be made in accordance with an appropriate standard such as the **MASS UK Industry Conduct Principles and Code of Practice 2021 (V5)** [1] published by UK Maritime and as updated from time to time and take into account the elements and conditions stated in Annex 1 of this policy.

2.4 The AR must apply to the Marine Technical Review Board (MTRB) for approval before operation. Elements to be considered and provided when applying to the MTRB are listed in **Annex 1**.

2.5 Small MASS, including pleasure craft, of not more than 2 metres in length and gross weight not more than 100 kg are not required to perform a risk analysis nor submit an MTRB application, provided they operate within the conditions stated in Annex 2 of this policy.

3 Scope

3.1 This policy applies to small MASS of degree of autonomy three or four that are not more than 12 m in length as defined by the *Small Vessel Regulations*, or not more than 15 Gross Tonnage.

3.2 The policy does not apply to MASS that has a crew or passenger on board.

3.3 This policy does not apply to small MASS that are physically tethered to a mother vessel, or a shore installation and that cannot interfere with other vessels' navigation during their operation.

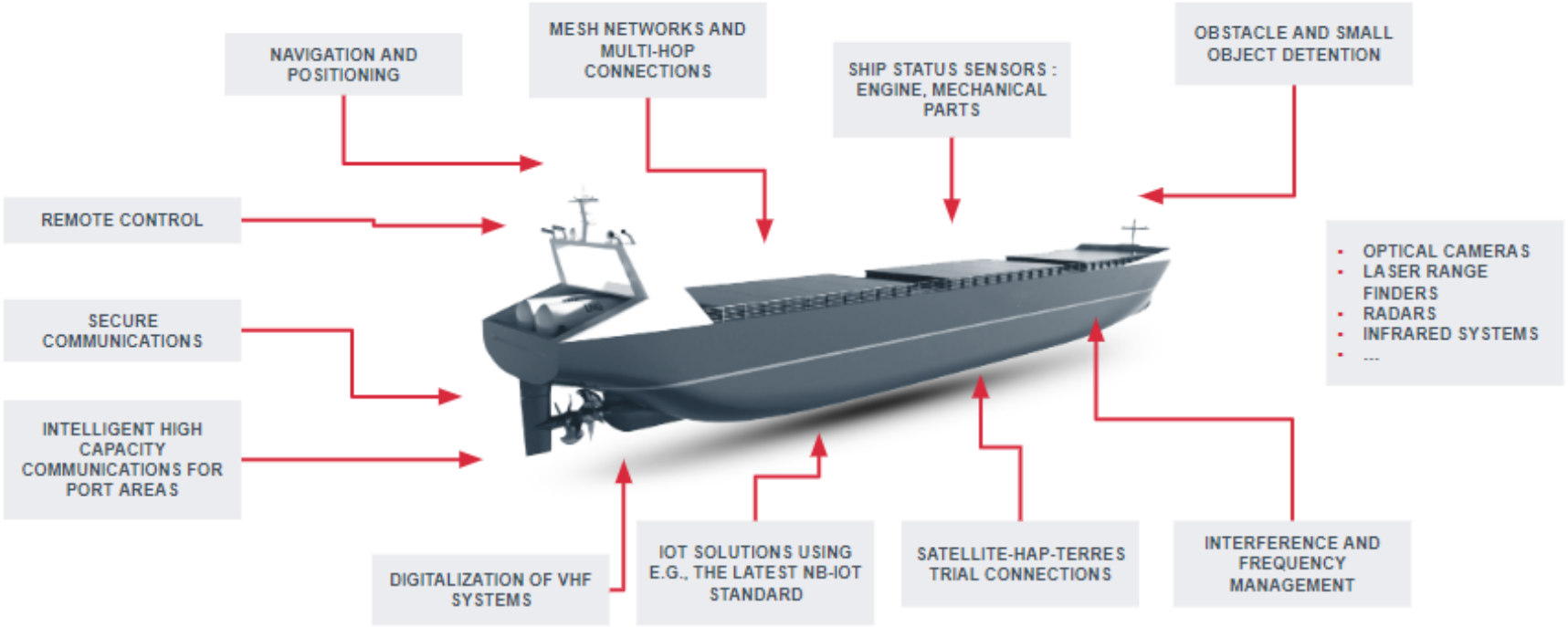
MARITIME INNOVATION ROADMAP

Business Case	Data Sources	Connectivity	Cloud Infra	Data Ingestion	Data Sharing	Reporting	Modeling	Automation
Use Cases Influencing Variables	3rd party sources / Open Data Business applications IoT sensors / Digital Twin Edge Computing	VSAT LEO LTE / 5G	Cloud Architecture Cyber Security	Data Architecture Data Governance	IMO Mapping APIs	Real-Time / "HMI" Analytics / Business Intelligence	Machine Learning Federated Machine Learning	Edge AI / Assisted Navigation Levels of ship autonomy AI - Ship - Fleet - Ecosystem / SaaS

Internal operational process optimizations

THE FOUNDATION FOR SHIPPING AUTONOMY

What's everything that goes into levels of an autonomous ship?



MARITIME OPERATOR AI USE CASES

Increase **safety with predictive maintenance** and automated responses

Maximize the **usage of ship's capacity with computer-vision** fueled positioning systems

Adjust to the changing market realities, **fluctuating demand**, and unpredicted events **with dynamic pricing** algorithms

Calculate the **most efficient route forecasting in terms of fuel consumption**

Improve the cost-effectiveness and **productivity of their processes with advanced planning and scheduling tools**

PROPOSAL: A COLLECTIVE MISSION STATEMENT

Let's call it the GREEN VOYAGE

Co-Creating the Green Voyage with AI

- Industry players collaborate
- To optimize the schedule, time and fuel for each voyage
- **By sharing relevant anonymized data and applications**
- Through APIs
- On AI-powered maritime data aggregation platforms
- That create consistent and self-improving actionable patterns, insights and routes
- For the maritime regional ecosystem & to the benefit of all stakeholders.

MARITIME DATA INPUTS INFLUENCING THE GREEN VOYAGE

Data Assets influencing routes, fuel and scheduling for the Green Voyage

OPERATORS SHIPS

Inputs Data Sets

SHIP
- Ship type / model / Hullm and rudder loads / engine and propellor models / Windage / Service and fouling margins
- Ship owner
- Ship agent
- Speed over ground
- Speed over water
- Power
- Autopilot gain
- Turning radius
- Main RPM
- Auxiliary RPM
- Propeller pitch
- Dock power source : auxiliary engine or shore power

CARGO
- Type
- Electric equipment during loading usage
- Electric equipment during discharging usage
- Hotel load
- Cargo weight
- Deadweight

FUEL
- Bunker quantity
- Average consumption
- Price

Inputs Data Sets

NAVIGATION
- Voyage ID
- Direction / course
- Orientation / heading

GEOGRAPHY
- Position
- Navigation zone
- Fore Draft
- Aft Draft
- Environmental regulations

OUTSIDE FORCES
- Draft and trim
- Water levels
- Tides
- Wind
- Current
- Fouling
- Ice

PEOPLE
- Pilot
- Pilot availabilities
- Pilot schedule
- Crew availabilities

Recap of Great Lakes Uncrewed Systems Practitioners Roundtable Discussion (Spring 2023)

- Shortage of pilots, difficult for operators to be familiar with all of the proprietary control systems for many different uncrewed platforms; opportunity to leverage experienced people from other organizations to fill in gaps
- Challenge to communicate and coordinate uncrewed missions across commercial and recreational channels; no common practice for sharing float plans
- Great Lakes region inventory of surface and subsurface vehicles and capabilities needs to be developed w/ detailed descriptions using common terminology
- Develop and distribute SOPs with deployment guidance and other information for ASV/AUV missions
- Form consensus around data collection, operating procedures, and standards; guidance on identifying the right platform and sensors based on different mission needs and conditions
- Feedback from USCG is not totally consistent on the regulatory consequences of small/scientific uncrewed system operations; is the ship captain ultimately responsible for UxS deployed from their vessel even when remotely piloted from shore
- A pre/post season meeting of this group would be helpful to discuss mission planning and deployment strategies, document close calls, failures, lost equipment, and share other feedback
- Communicate with Lake Carriers Association to share information about science missions and inform commercial operators about the types of equipment being deployed

Great Lakes Science Ships Community–Next Steps, Use of ASV/AUVs

Action: Create ad hoc committee on priorities for deployment and use of AUVs?

- Inventory of AUVs
- Data, information sharing, communications needs
- Accessible database / web interface (asset “registration”, operators, training opportunities, standard operating procedures, deployment guidance, other useful resources, interactive live/historical mission tracking, synthetic (virtual) AIS configuration for small assets
- Resources to support (champions to lead action items, organizational capacity to sustain)

Thanks you! Questions?

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