

# Autonomous Vehicles for the Real-Time Mapping of Water Quality and Bathymetry

TIM FINEGAN

REAL-TIME WATER MONITORING WORKSHOP - NOVEMBER 7, 2023



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# Tim Finegan

Systems Engineer West Coast and Canada, YSI

- Tim has worked for YSI (Xylem) for 18 years in different roles.
- YSI/Sontek/Xylem offer water quality and water quantity monitoring instrumentation. Our integrated systems division designs complete water monitoring stations and vehicles for the autonomous water monitoring



# Agenda

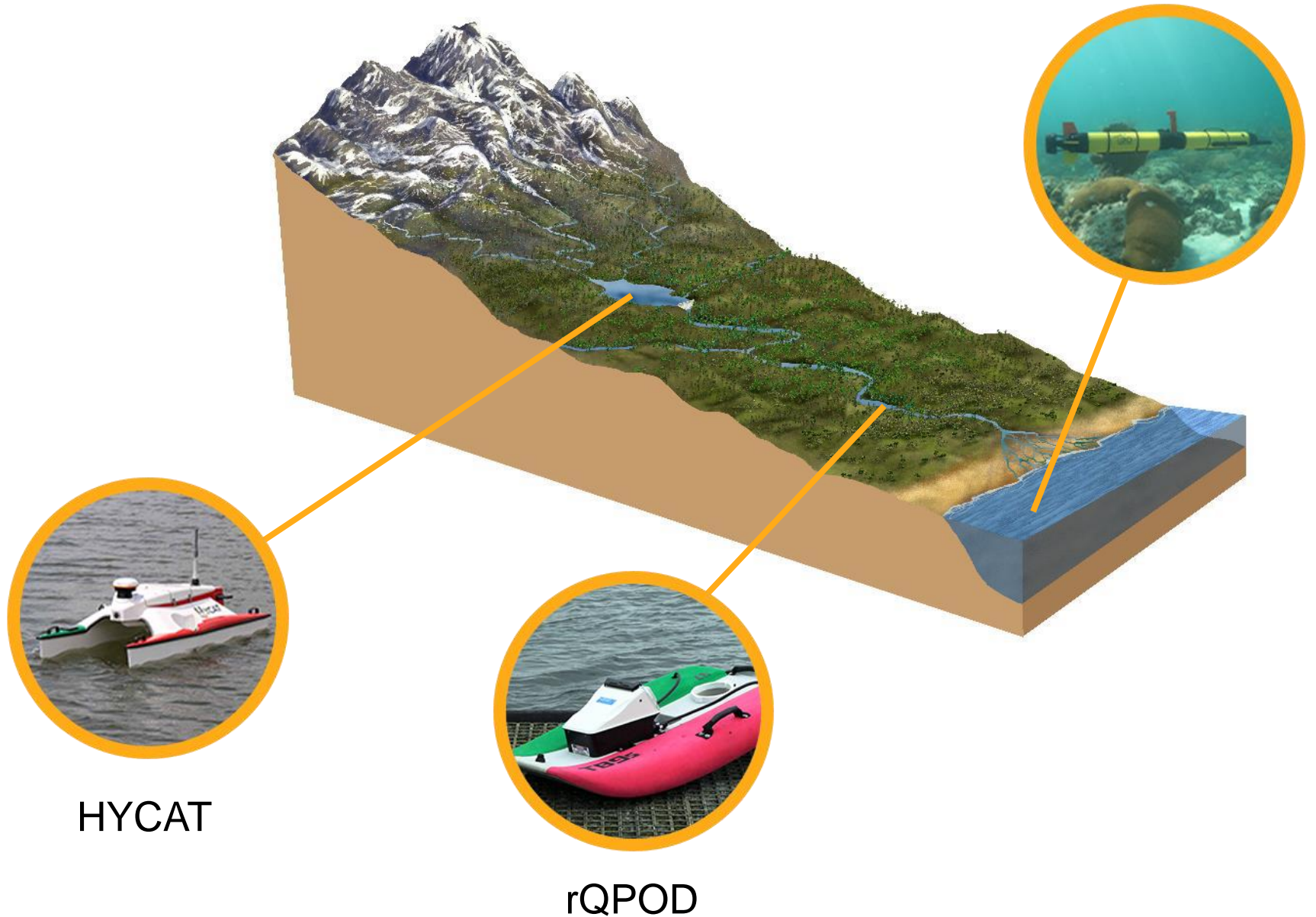
- Vehicle Platforms

rQPOD

HYCAT

i3XO EcoMapper

i3XO EcoMapper



# 1

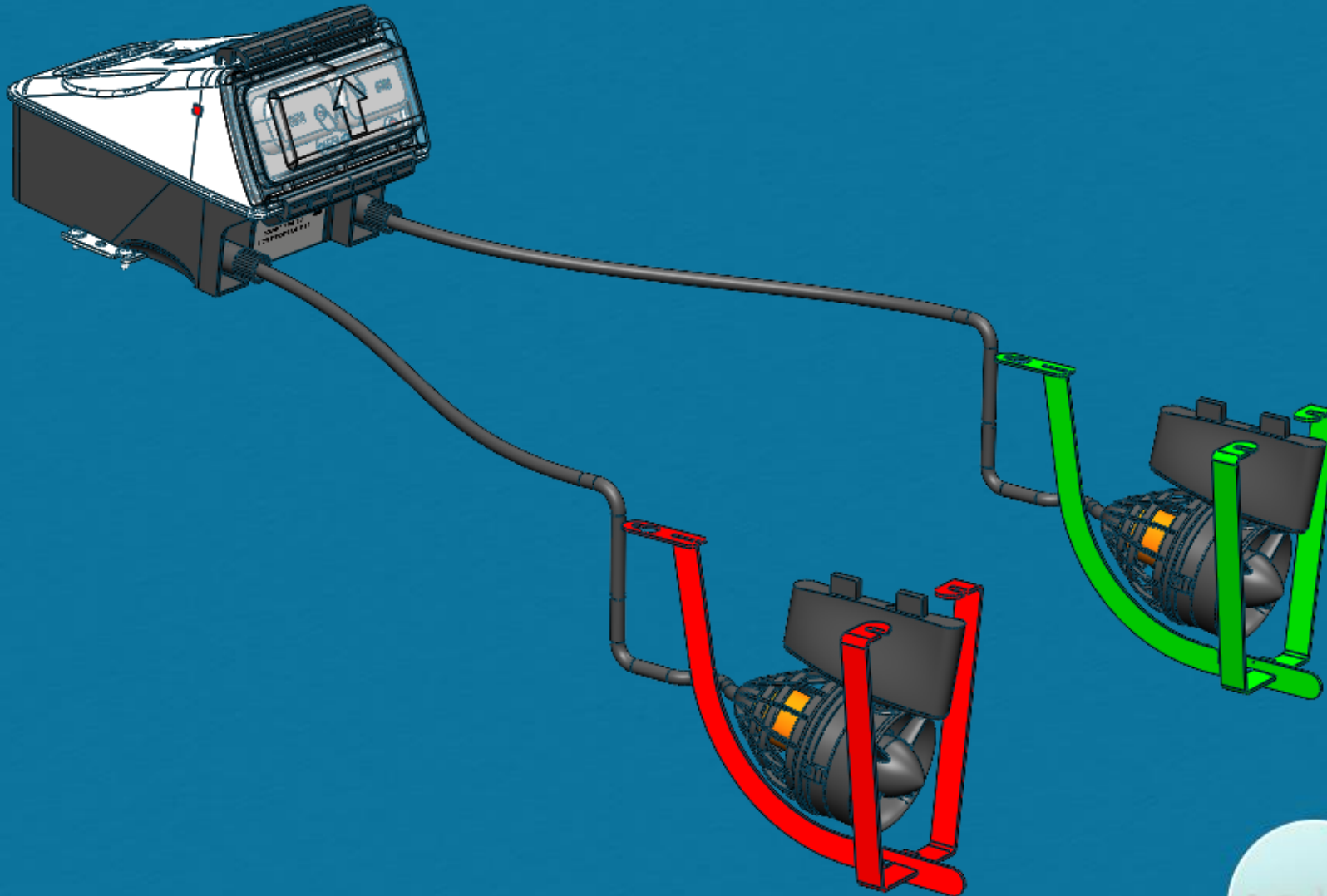
## rQPOD



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# What is the rQPOD?



- 1.5m/s max
- 3 to 4 hours run time at 0.8/s
- Swappable drone batteries
- Manual or autonomous options
- Modular system
- Many instrument combinations
- Fits on multiple platforms
- Engines are easy to replace



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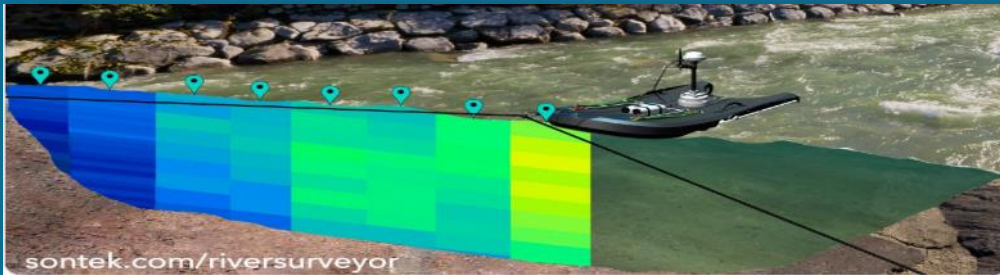


HYCAT



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# Virtual Anchor – needs autonomous upgrade

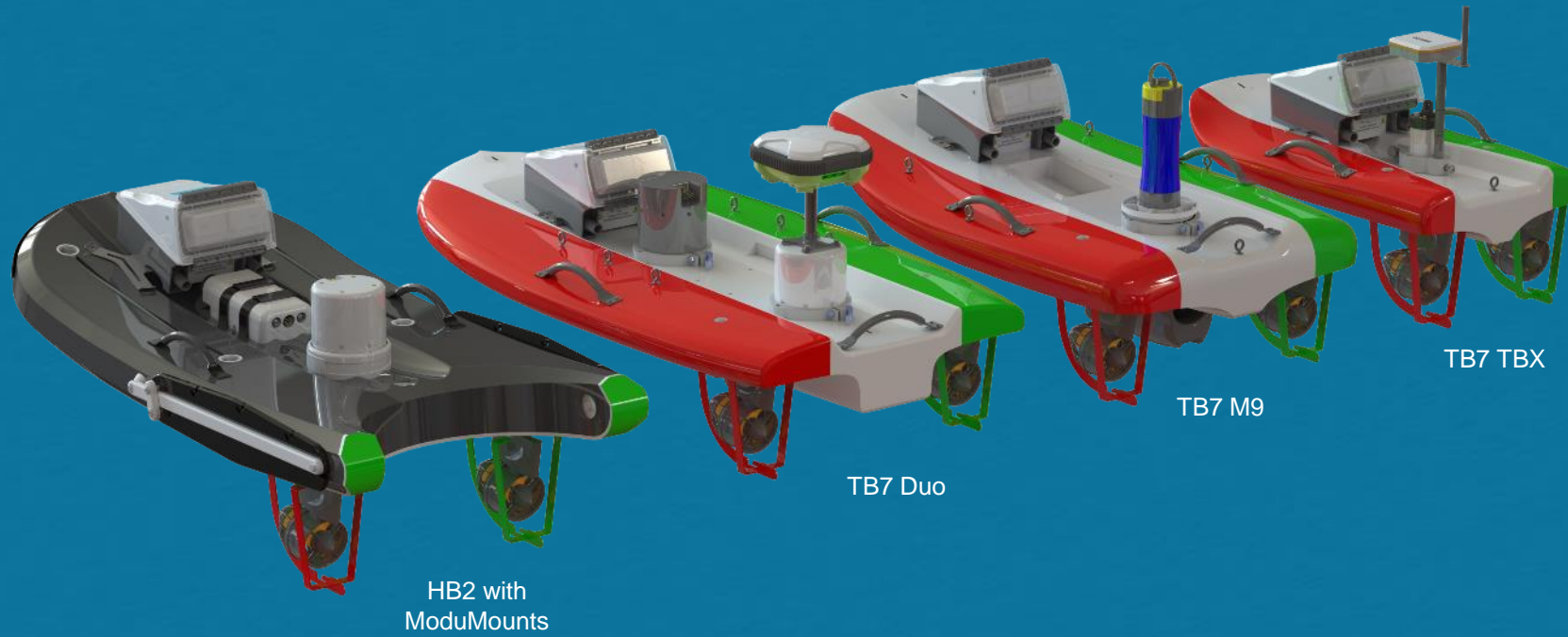


*Just flick the switch no  
programing required,  
only gps signal.*





# rQPOD Platforms



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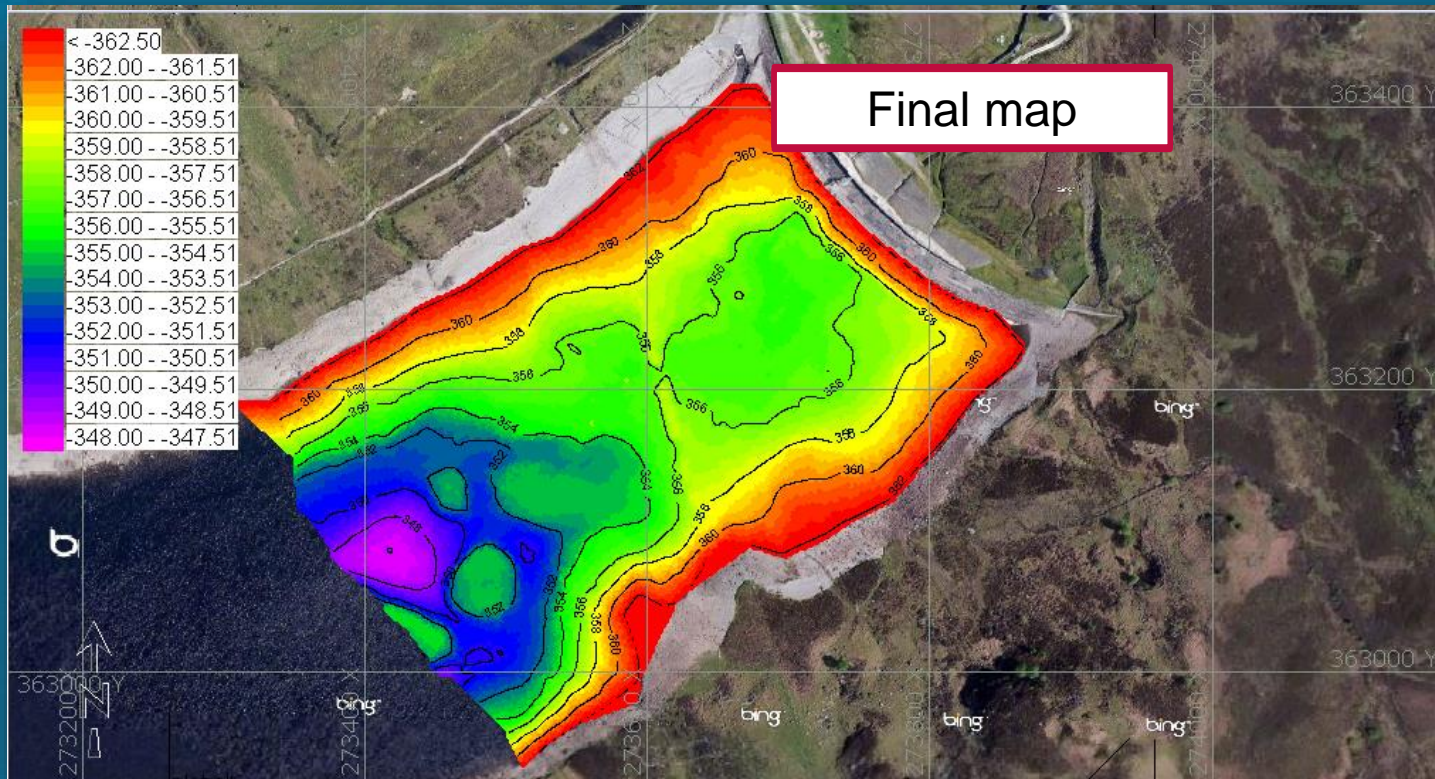
# rQPOD Case Studies



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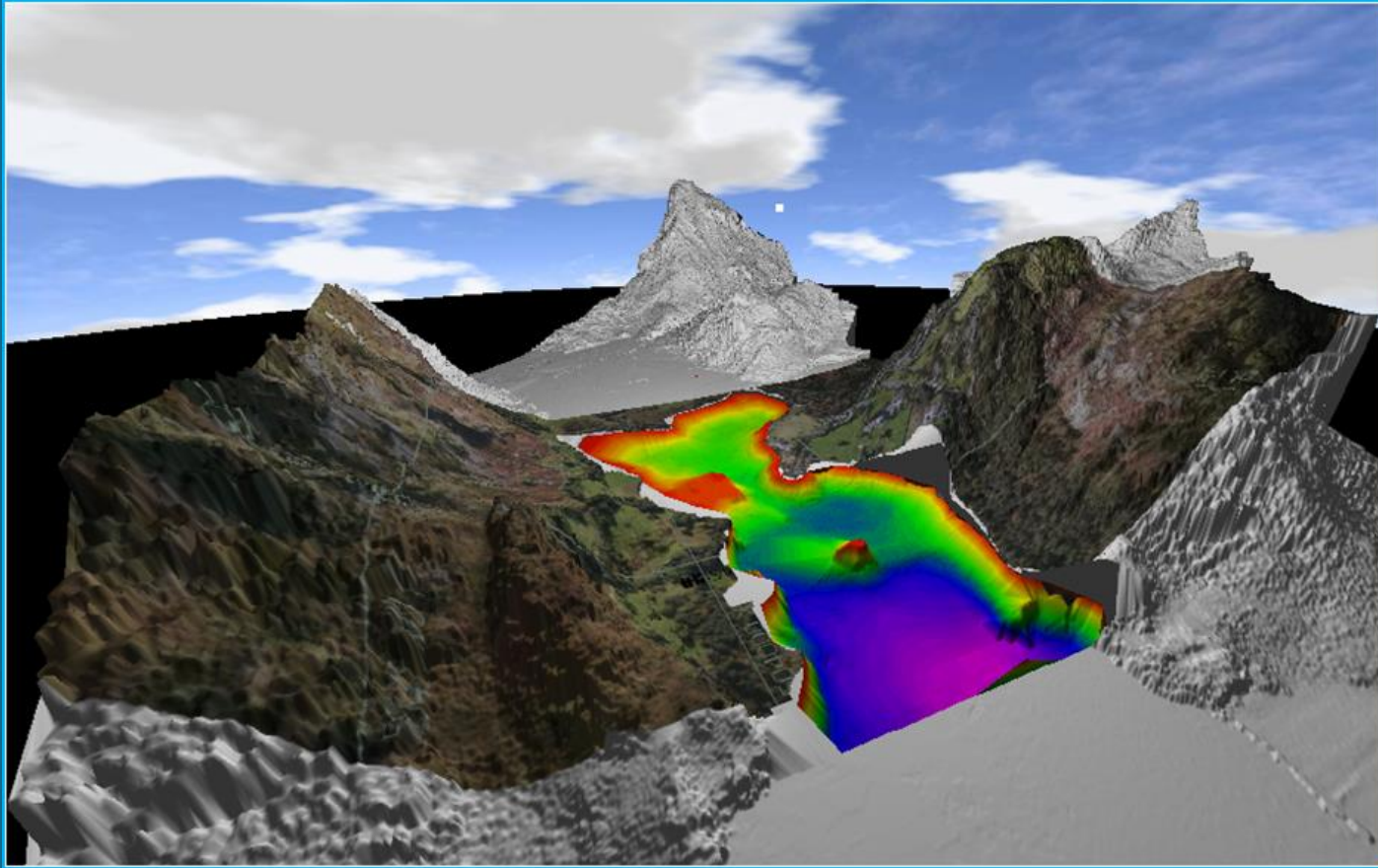
# Bathymetry Case Study



- Mission or line plan created in Hypack
- Uploaded to ArQPOD via USB
- Started/stopped using RC handheld
- Range is 6 to 9km (2 to 3 hours)
- Survey speed is 1.5knots
- Steers and follows line using GPS and compass
- Hold position at end waypoint



# Bathymetry Case Study



**HYPACK**  
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**SonTek**  
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HYCAT



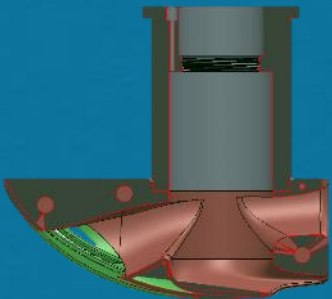
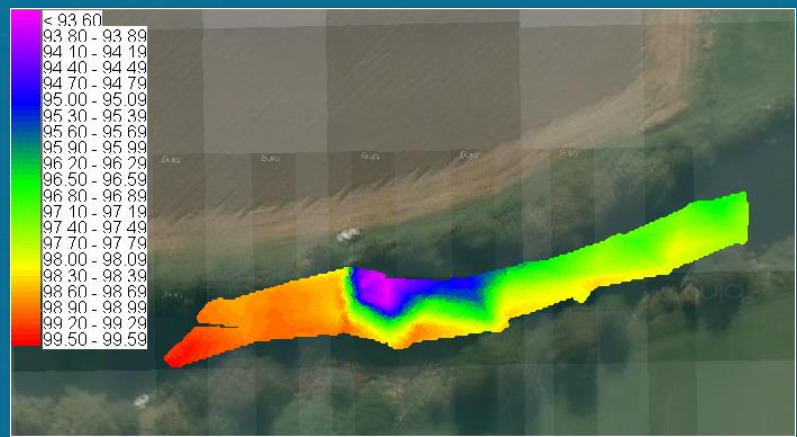
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# EXOWhale Mount For Water Quality Surveys



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# EXOWhale - Using the handset



## Advantages

- Cheapest way
- GPS tagged using the handheld
- Good for long missions

## Disadvantages

- Have to download and post process the data in Hypack
- Can't see live data



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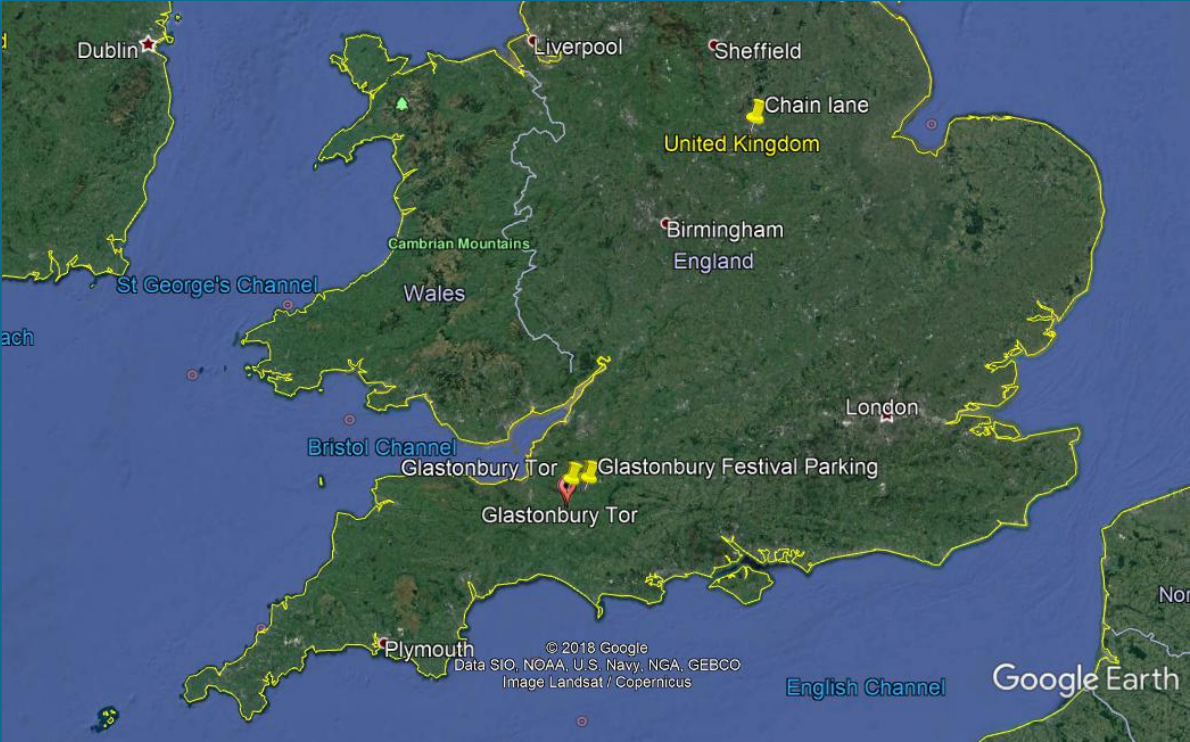
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# Location

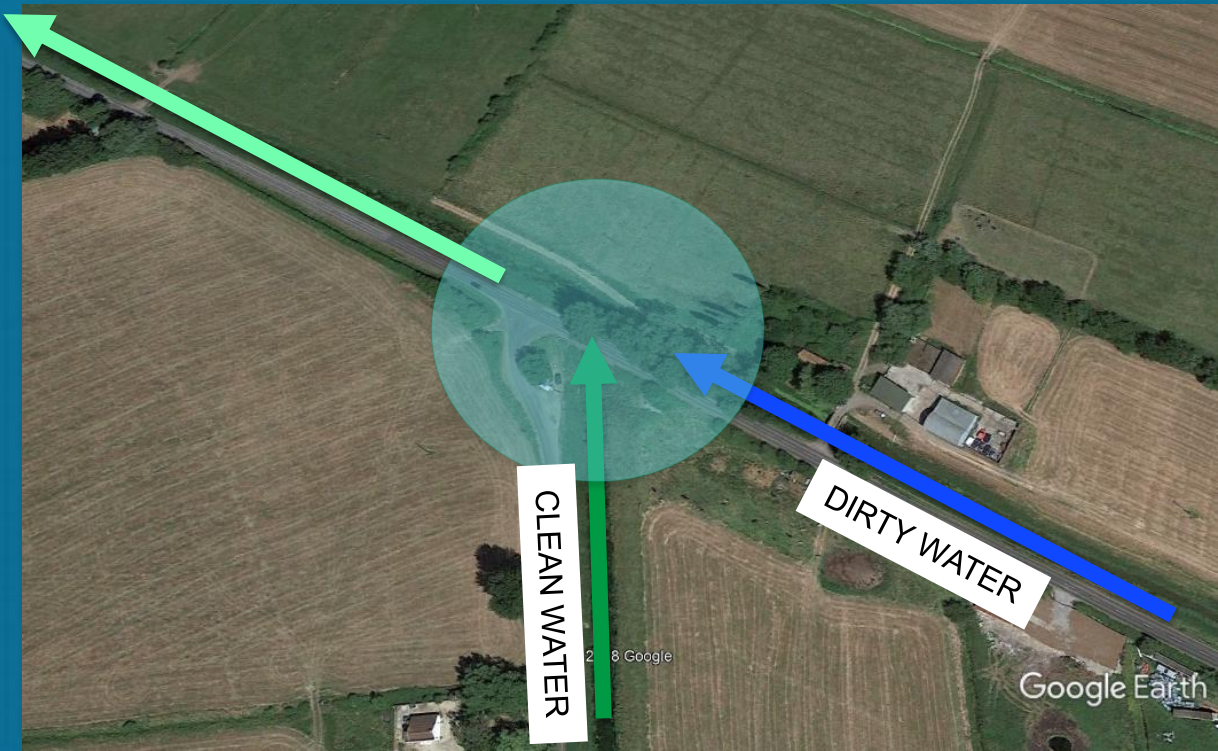




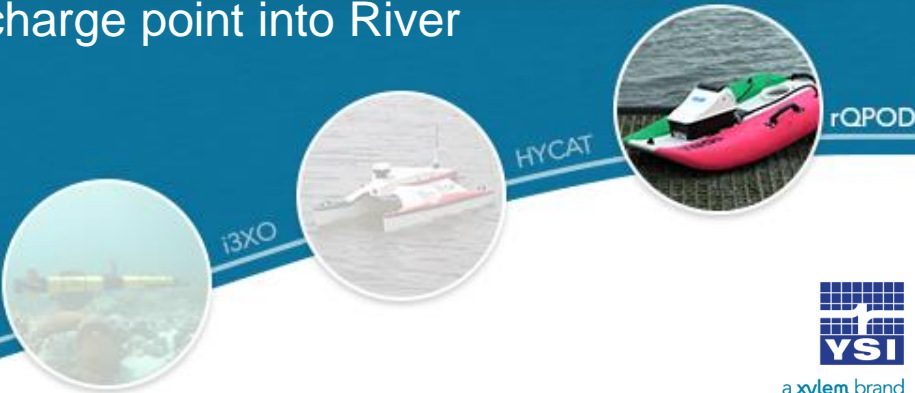
# Sampling Point



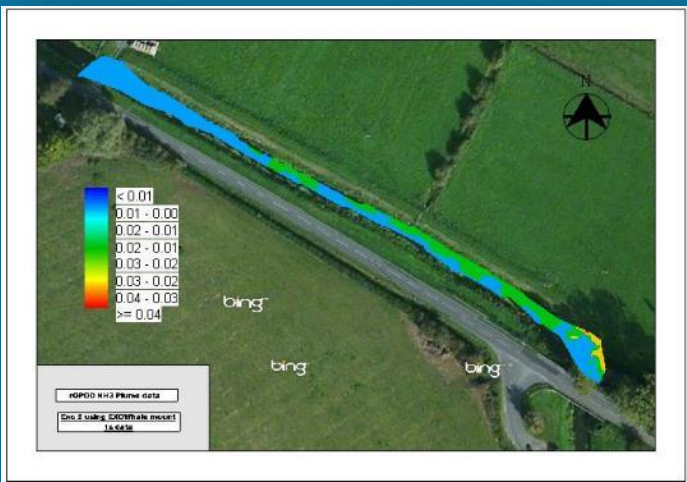
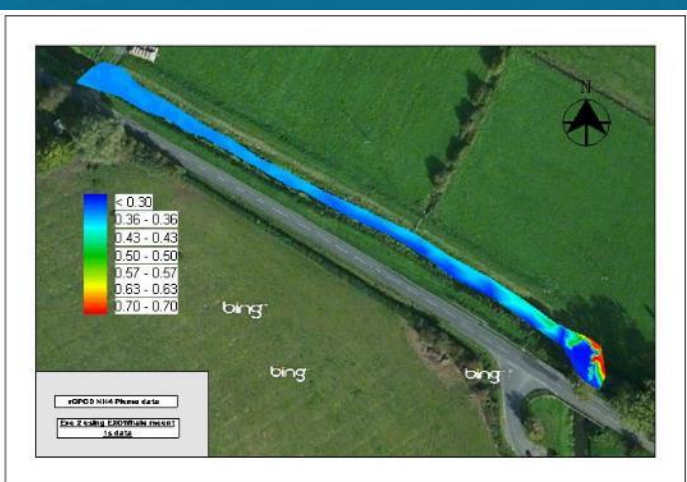
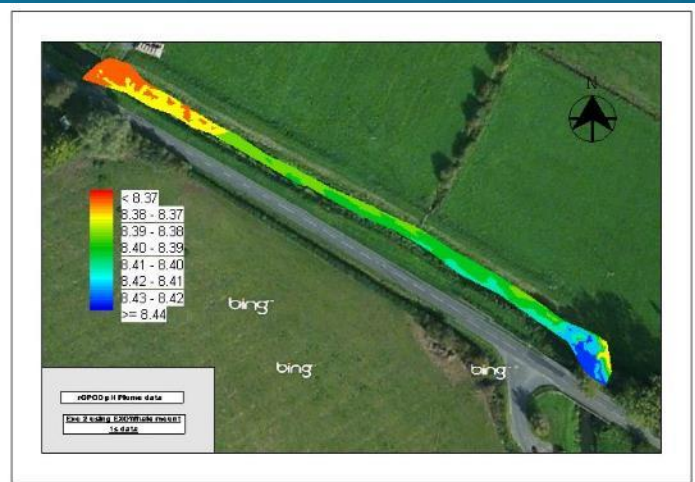
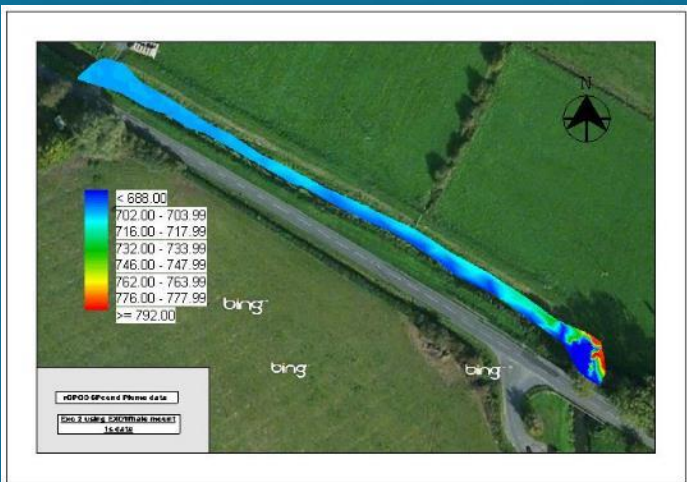
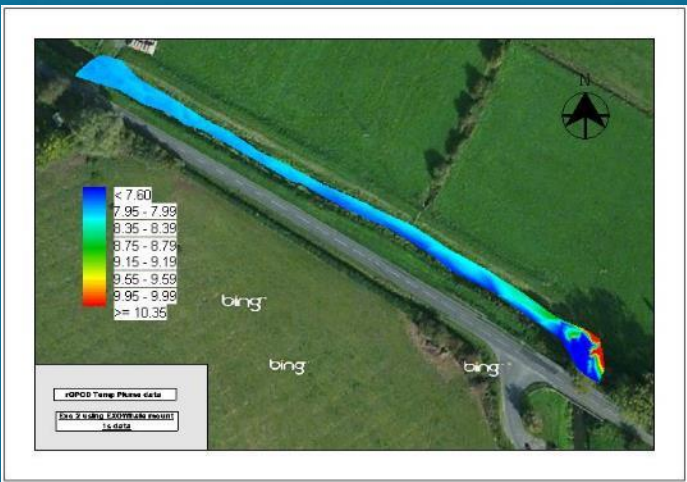
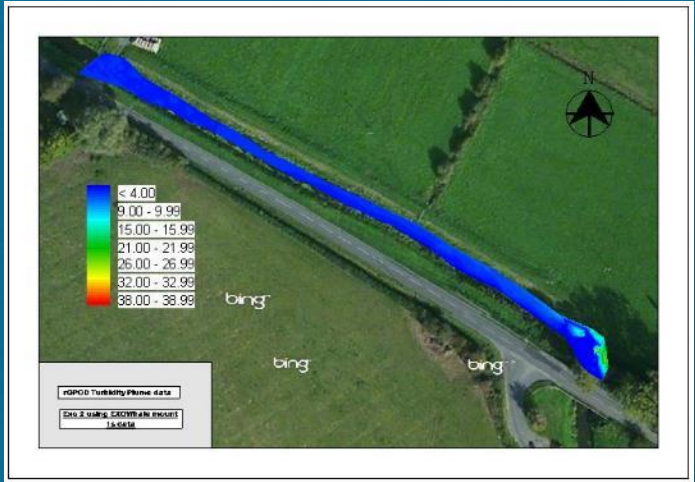
3kms from works



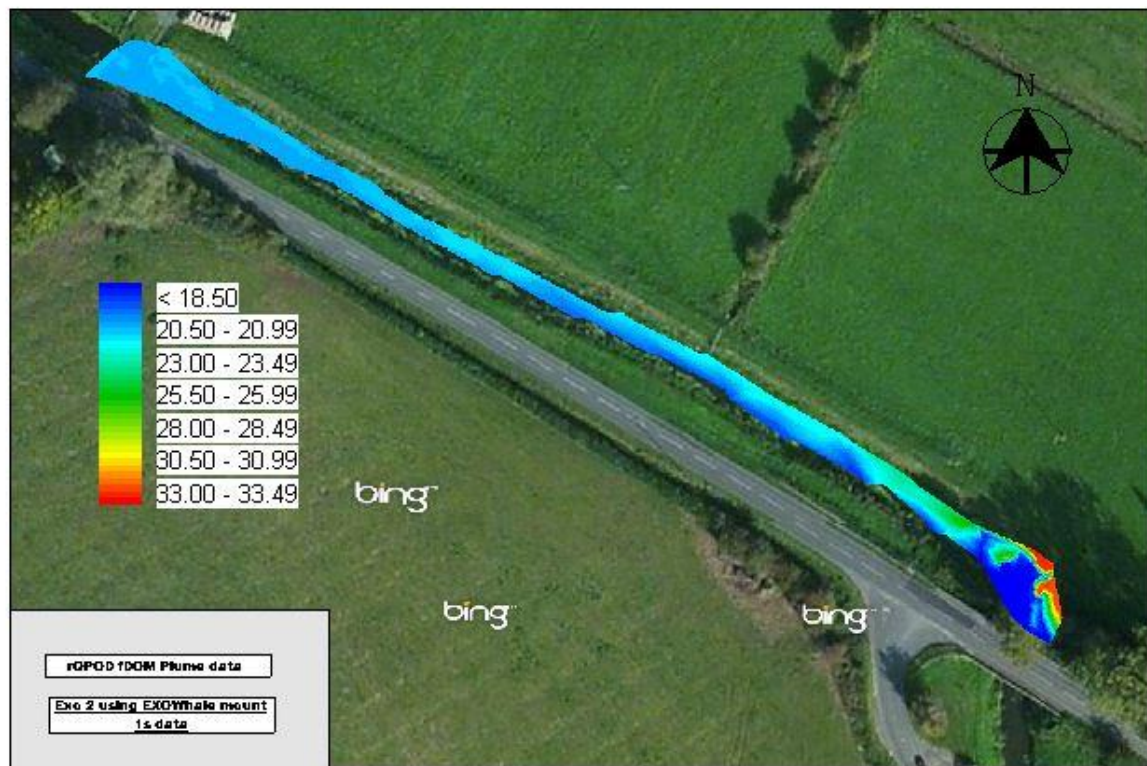
Discharge point into River











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# 2

# HYCAT



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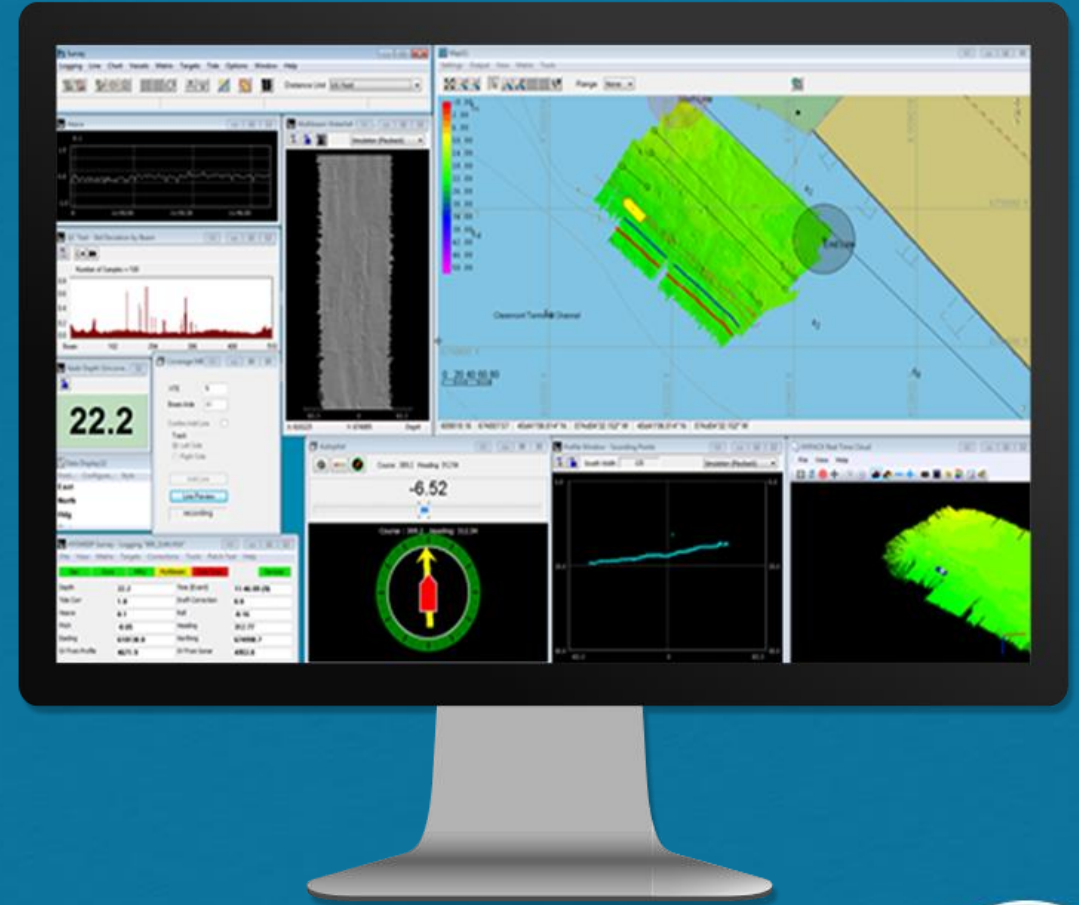
# HYCAT Specifications

- 1.8 M Long X 0.86 M Wide
- Weight: 53kg
  - 2 person deployable
- Top Speed: 7.8 Knots
- Endurance: 2.7 – 8 hours (speed depending)
  - Survey Speed ~ 3 knots = 6 hours
  - Steering: Differential thrust
- Operational State: Beaufort Wind Scale 4



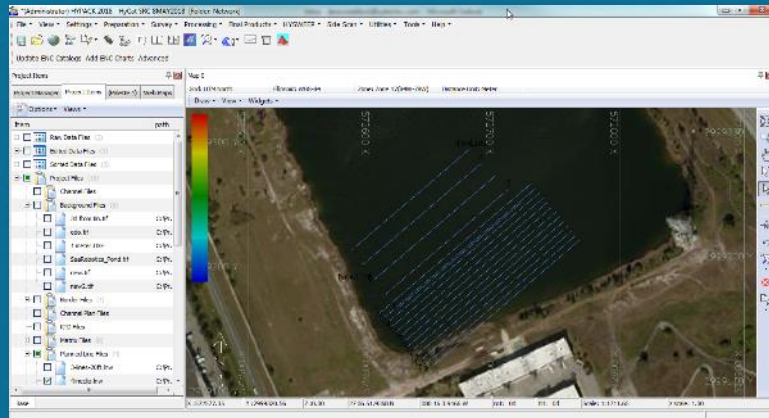
# HYCAT HYPACK Driver

- Xylem HYPACK developed operating system
  - One software package to run EVERYTHING
- Mission Planning, Surveying, and post processing
  - Data collection with base station connected to ASV
- Real-Time data, Real-Time decision making
  - Change mission while underway
- All data collected and stored in one location

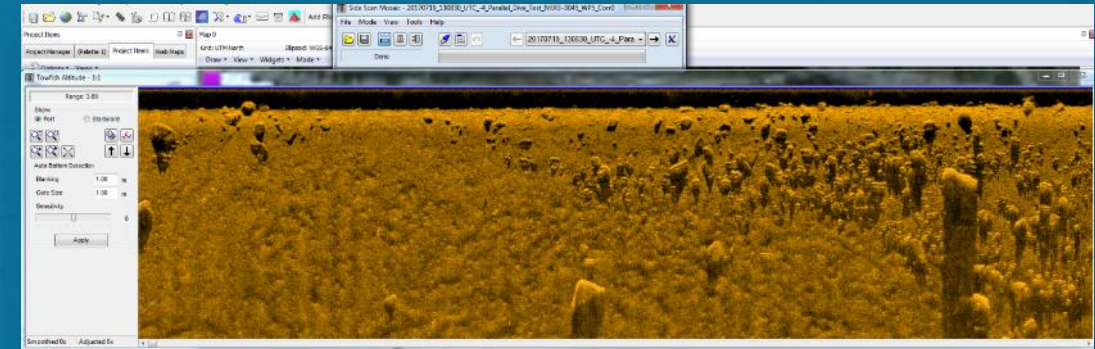




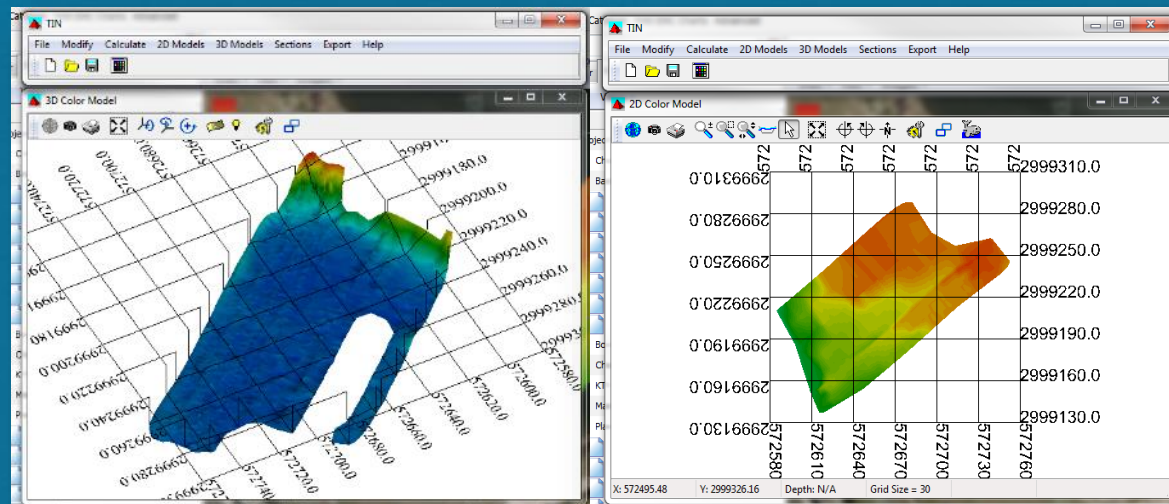
## Line Editor



## Side Scan Targeting & Mosaicking



## Bathymetry Tin Models



## On-Board Sensor Interface and Visualization

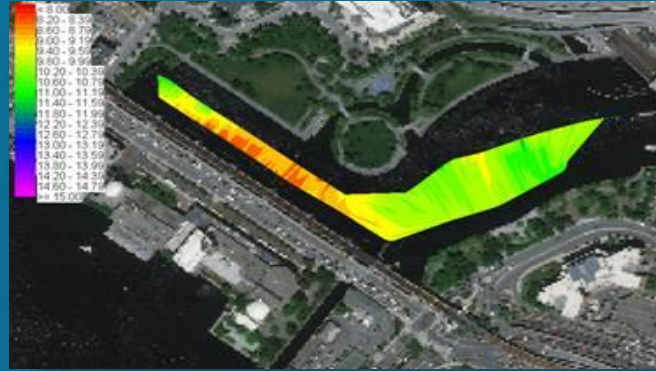




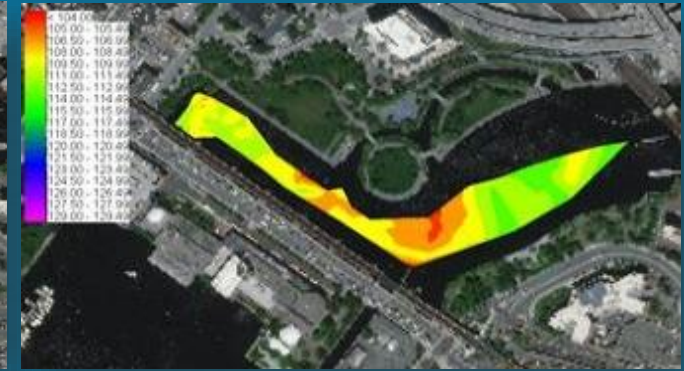
# HYCAT Applications

- North Point Park, Boston, MA
  - Water Quality Survey of urban park to determine the health of water for swimming & recreation
  - Survey Time – 30 minutes
  - Speed – 3 knots
  - Crew – 2 personnel
  - Time on Site – 1 hours
- Outcome: Collection of multiple WQ parameters enabling decision making

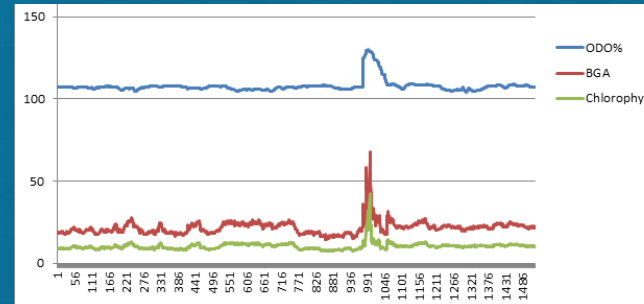
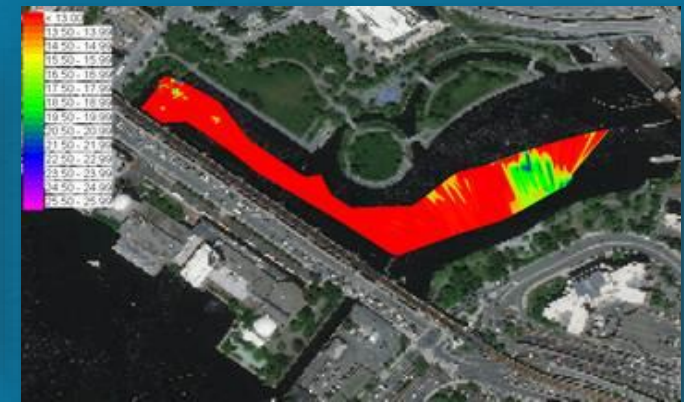
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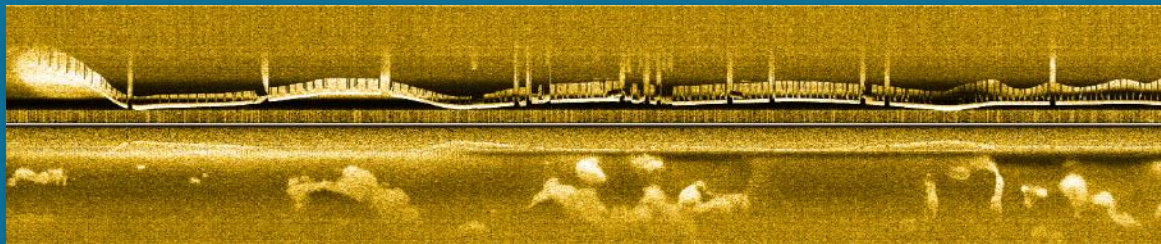
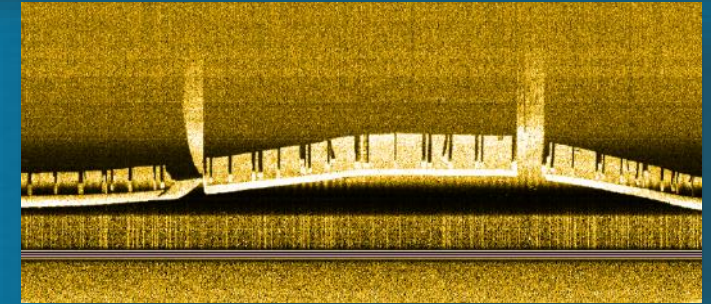
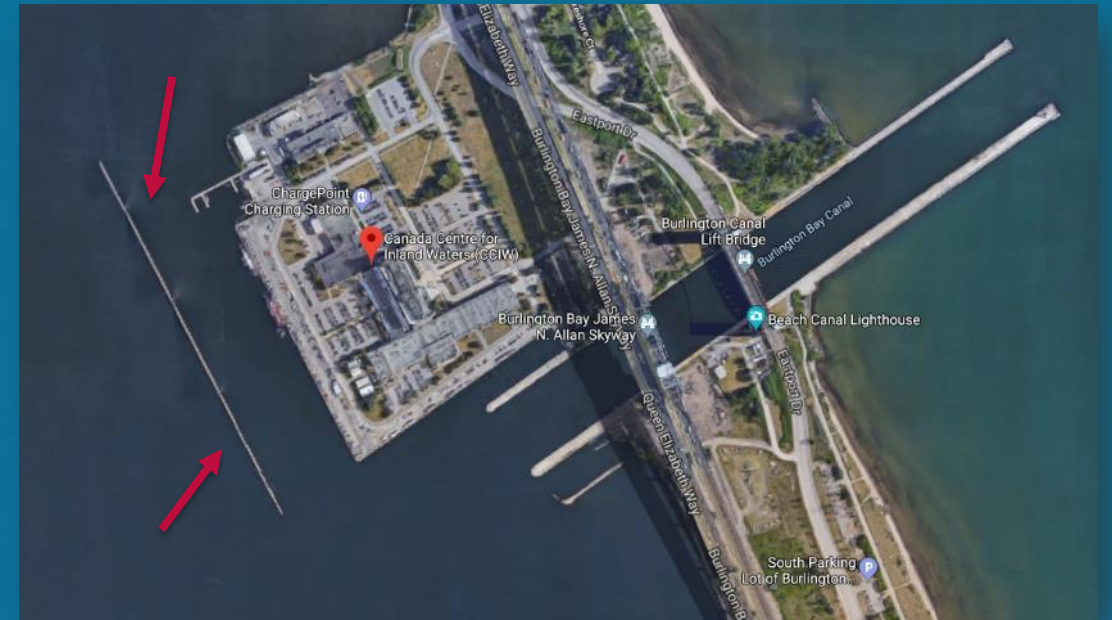


BGA



# HYCAT Applications

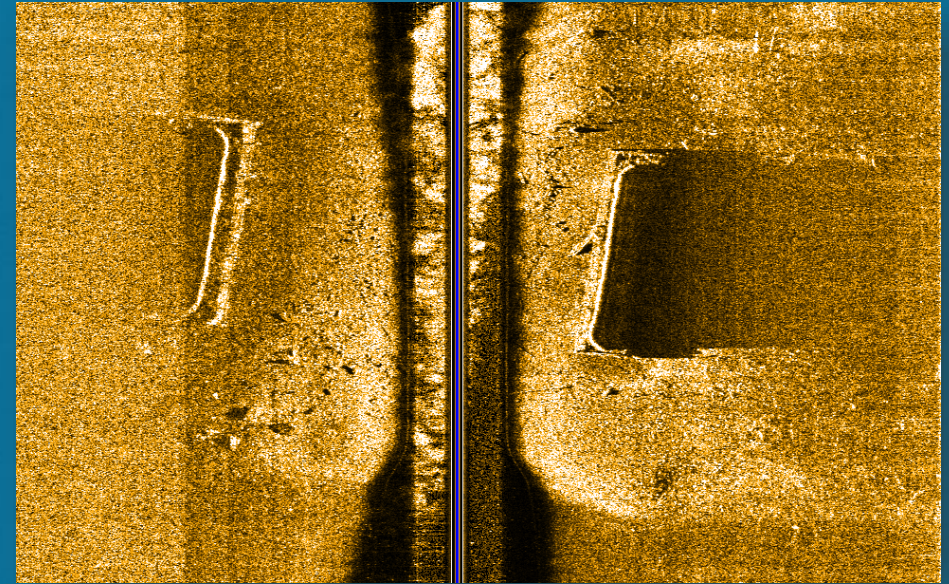
- Inspection of a Breakwater
  - SideScanSonar imaging of breakwater looking for missing or damaged barriers
  - Survey Time - 15 minutes
  - Speed – 2 knots
  - Crew – 2 personnel
  - Time on Site – 30 minutes
- Outcome: Identification, in Real-Time, of missing sections.





# HYCAT Applications

- Bridge Scour/Inspection
  - Scour measurements around footings and main channel, looking for debris and sediment buildup. Terrestrial inspection of underside of bridge.
- Survey time – 15 minutes
- Speed – 3 knots
- Crew – 2 personnel
- Time on site – 45 minutes
- Outcome: Minimal debris detected



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HYCAT



rQPOD

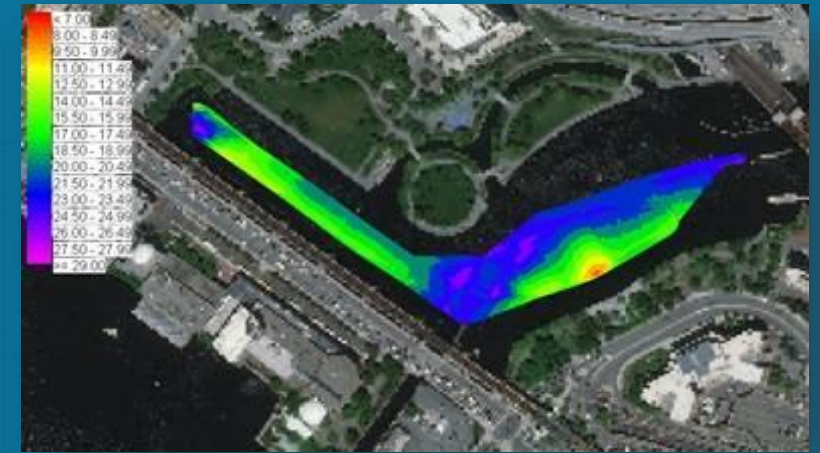
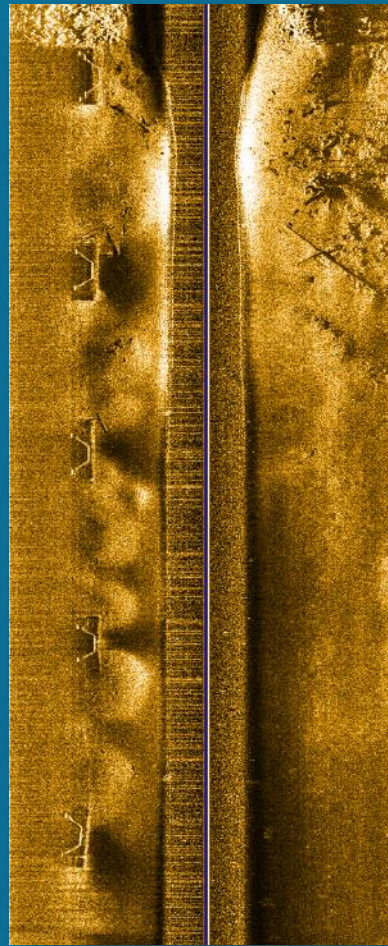


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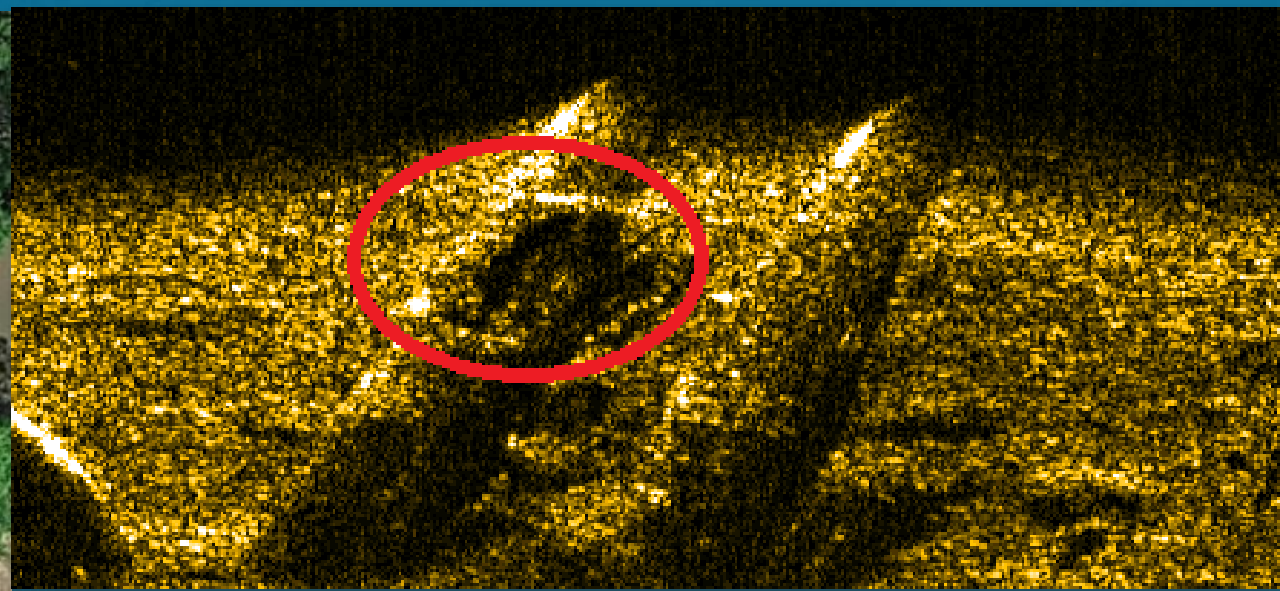
# HYCAT Applications

- Hydrographic Survey
  - Multibeam survey of proposed swimming area
  - Survey time – 15 minutes
  - Speed – 3 knots
  - Crew – 2 personnel
  - Time on site – 45 minutes
- Outcome: water depth determined to be 15 ' – 20 ' , minimum debris and scouring from inlets on edge

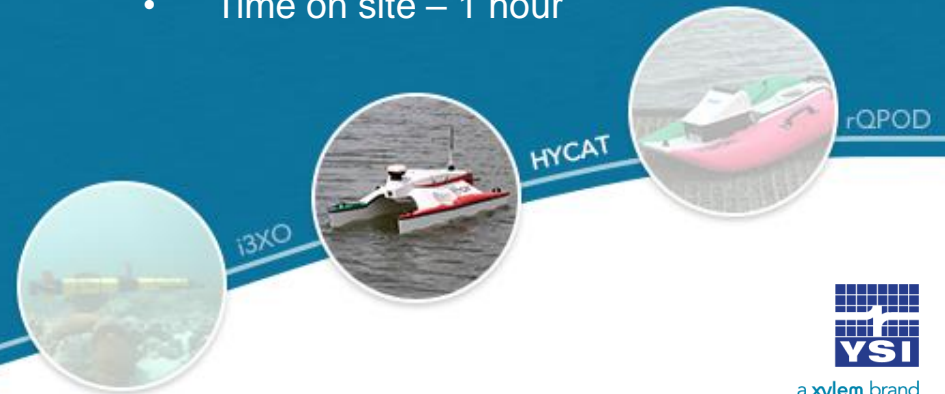




# HYCAT Applications



- Pipeline Survey
- SideScanSonar imaging of damaged pipeline
- Outcome: Imaging shows impact damage to one of two drainage pipes
- Survey time – 15 minutes
- Speed – 2.5 knots
- Crew – 2 personnel
- Time on site – 1 hour



# 3

## i3XO EcoMapper



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# i3XO EcoMapper Specifications

- Length: 1.5-2 Meters long (configuration depending)
- Weight: 27-45 kg (configuration depending)
- Depth Rating: 100 Meters
- Speed: 1-4 Knots
- Endurance: 6-10 Hours (speed and configuration depending)
- Integrated EXO1 OEM with 3 additional water quality sensor ports (C/T sensor required)
- Bottom Tracking: up to 81 Meters



i3XO



HYCAT



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# i3XO EcoMapper Advantages

- Underwater missions up to 100 Meters depth
- Different mission types depending on requirements:
  - Height from Bottom
  - Depth from Surface
  - Undulation
- Capable of running in high boat traffic areas
  - With INS, vehicle has error of less than 0.3% of distance traveled
- Record water quality, side scan, bathymetry, and photogrammetry in one mission



# i3XO EcoMapper Applications

- Most Suitable Applications
  - Lakes
  - Estuaries
  - Reservoirs
  - Near-Coastal
  - Slow moving rivers



- What is not?
  - High-Flow River Applications
  - Deep Ocean Studies
  - Fast Current Environments



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# VectorMap Software

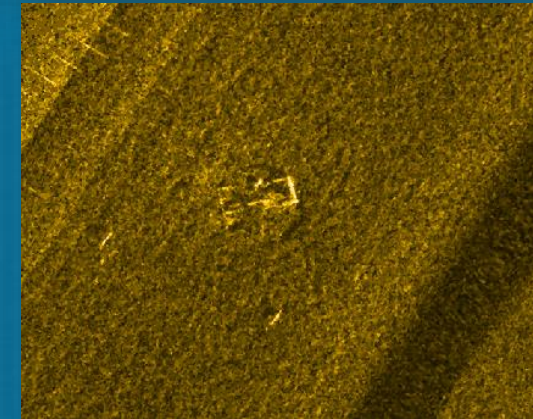
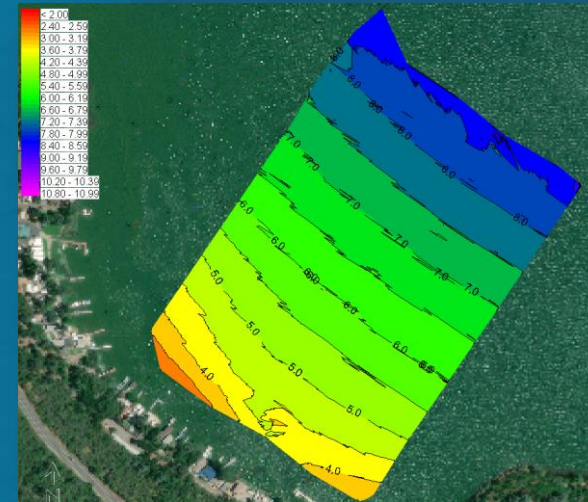
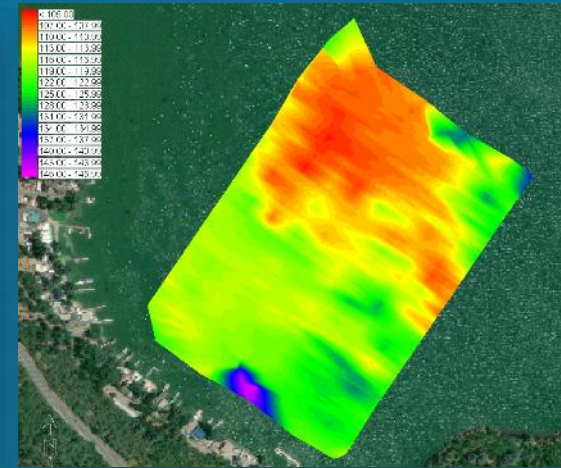
- VectorMap software allows quick and easy mission planning
- Accepts a variety of geo-referenced maps
- Missions drawn directly on geo-referenced maps through point and click method
- Easily create full coverage mission plans using the lawnmower feature
- Quickly and easily modify missions on the fly
- VectorMaps can also be used to quickly process data from missions to allow adjustments for next mission





# i3XO EcoMapper Applications

- California
  - Water quality, bathymetry, and side scan sonar survey of a harbor, all in one mission.
  - Survey Time – 1 hour 27 minutes
  - Speed – 2 Knots
  - Mission Length – 6650 Meters



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HYCAT

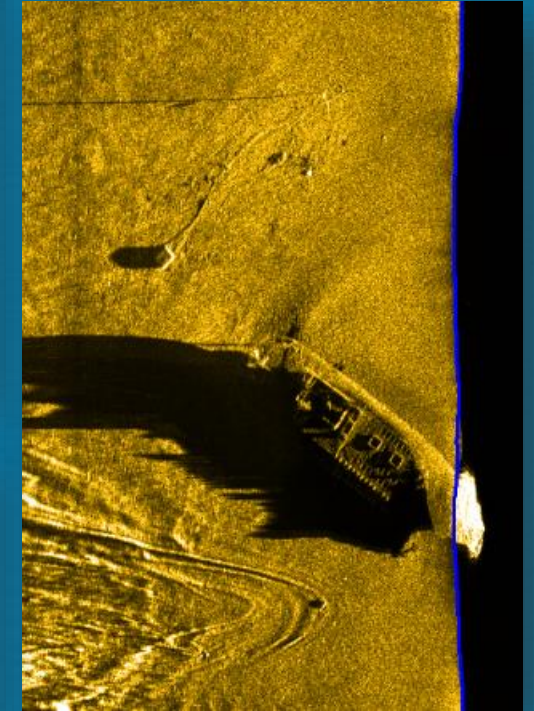
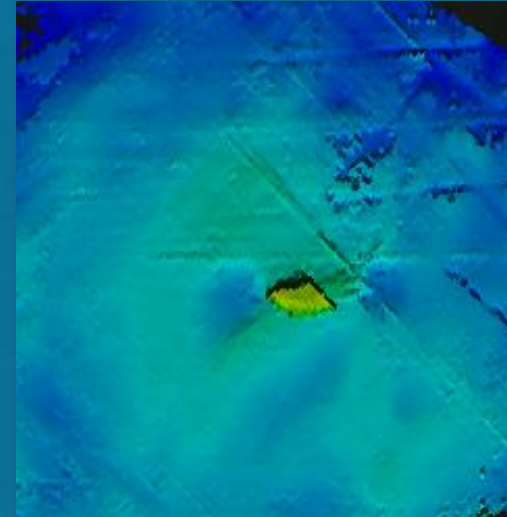
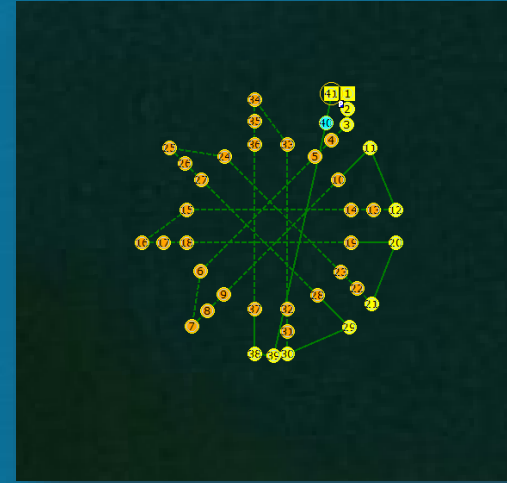
i3XO



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# i3XO EcoMapper Applications

- Narragansett Bay, Rhode Island
  - Bathymetric and Side Scan survey of boat wreckage
- Survey Time – 33 minutes
- Speed – 2 Knots
- Mission Length – 2532 Meters
- Mission Type – 8 Meters HFB



i3XO



HYCAT



rQPOD

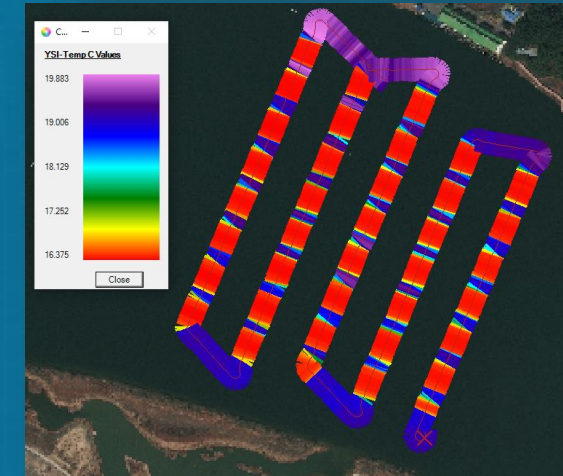
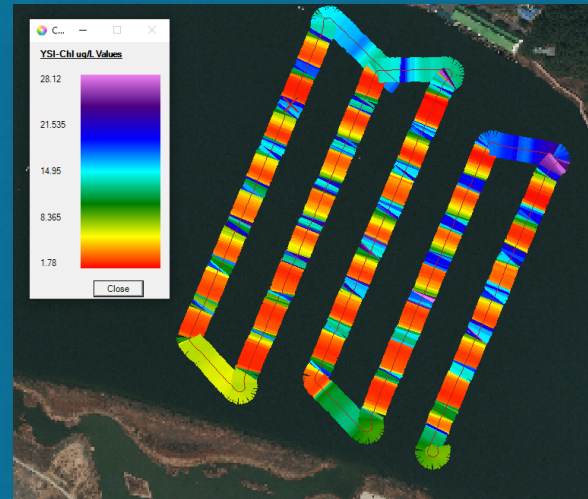
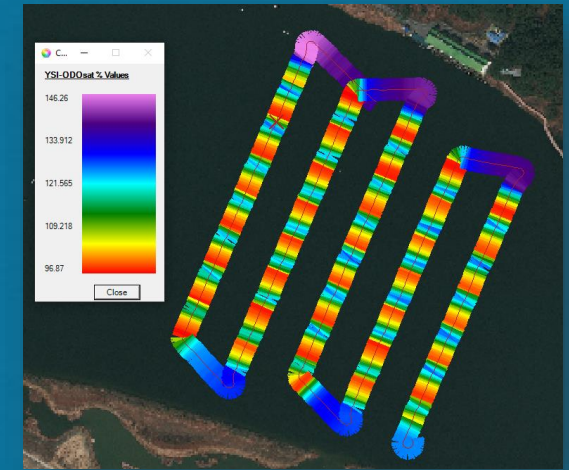


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# i3XO EcoMapper Applications

- Daegu City, South Korea
  - Water quality survey near water treatment plant
- Survey Time – 33 minutes
- Speed – 2 Knots
- Mission Length – 2532 Meters
- Mission Type – Undulation from surface to 2 Meters HFB



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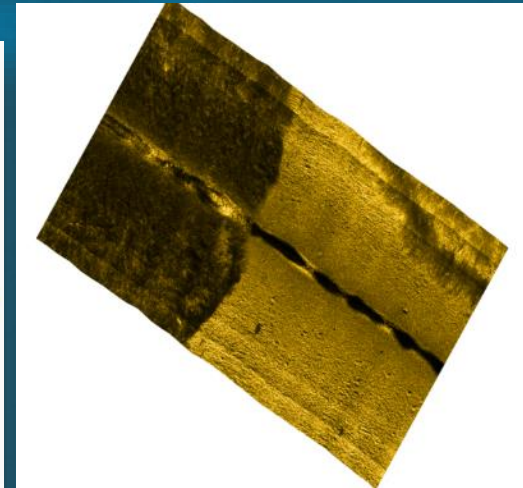
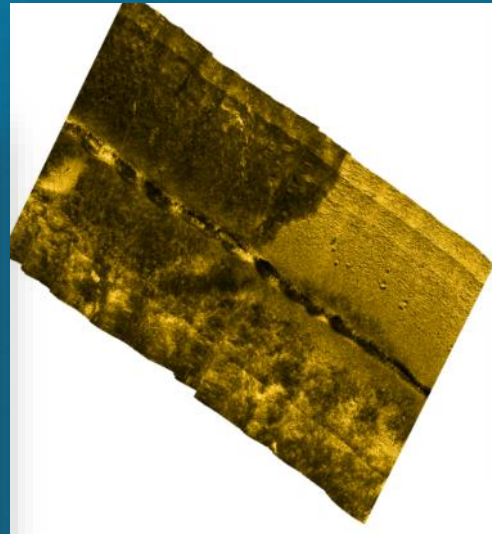
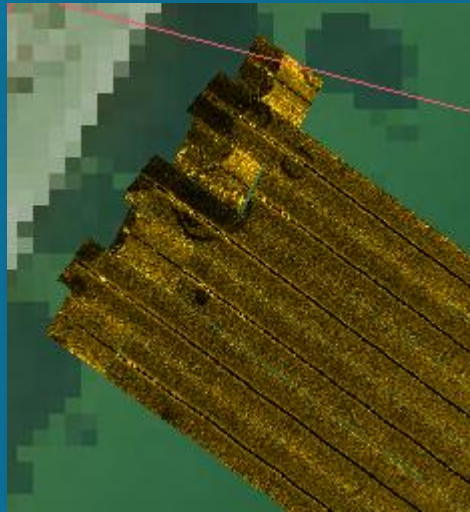
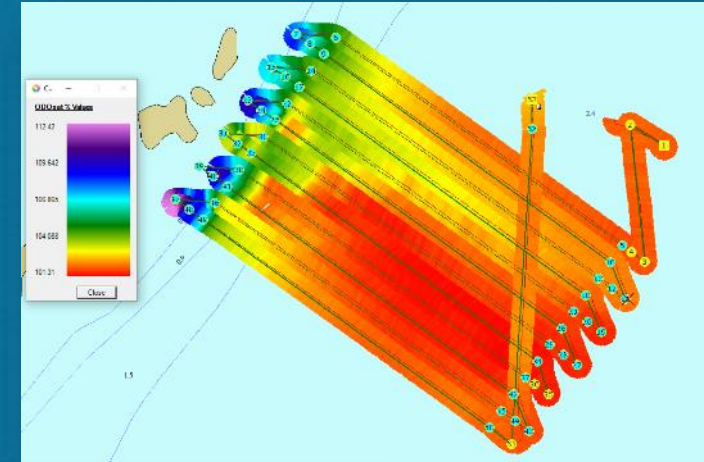
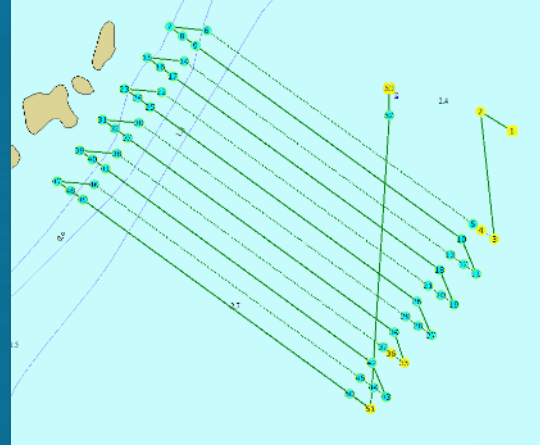
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# i3XO EcoMapper Applications

- Tampa Bay, Florida
  - Side Scan Survey to detect eel grass
  - Survey Time – 1 hour 50 minutes
  - Speed – 2 Knots
  - Mission Length – 8330 Meters
  - Mission Type – 1 Meter DFS



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# 4

# Questions?



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