Lessons Learned in Performing Underwater Advanced Geophysical Classification Operations in Shallow Water

Presenter:

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The Task

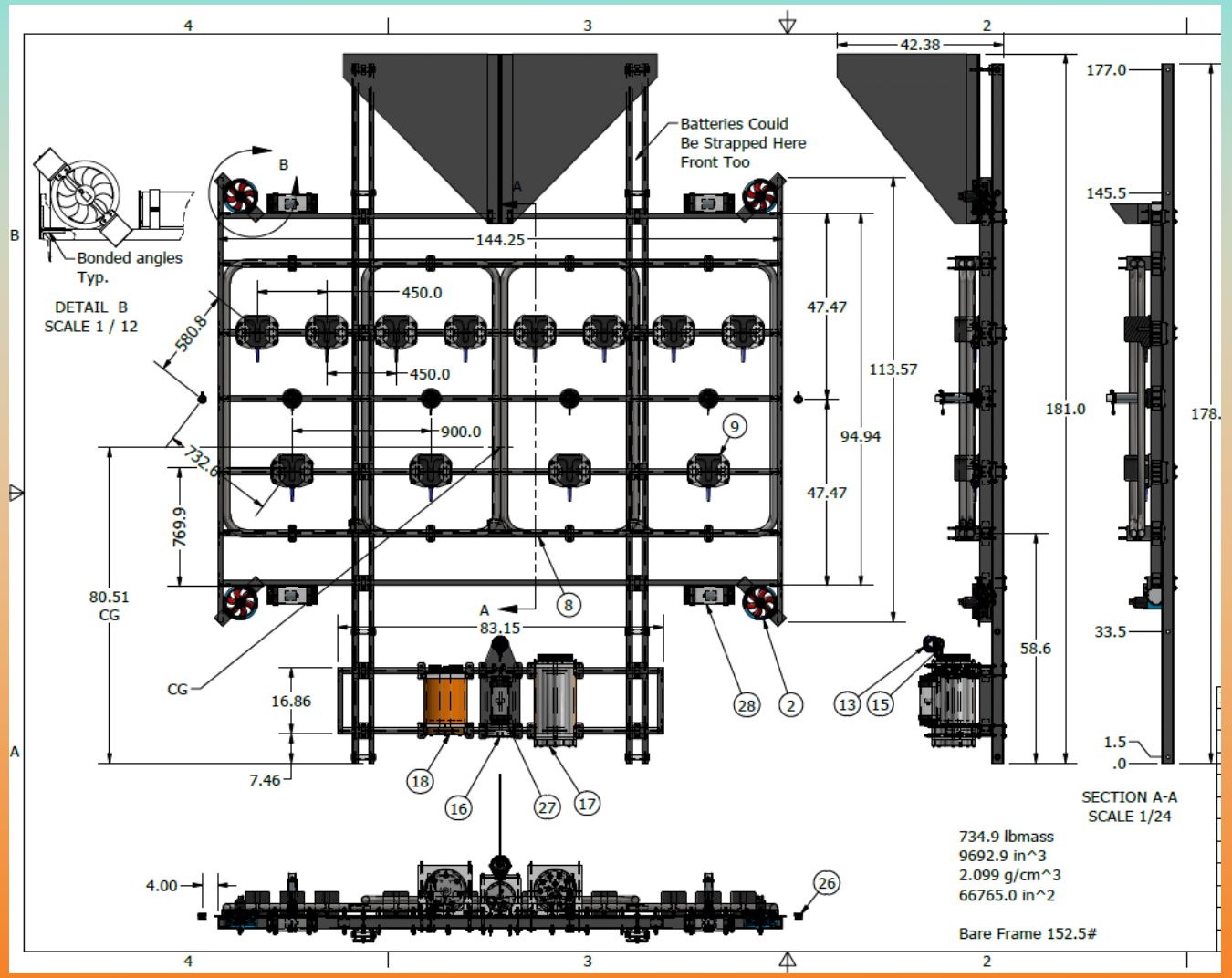
Known Challenges and their solutions

Discovered Challenges and their solutions

Achieved Results

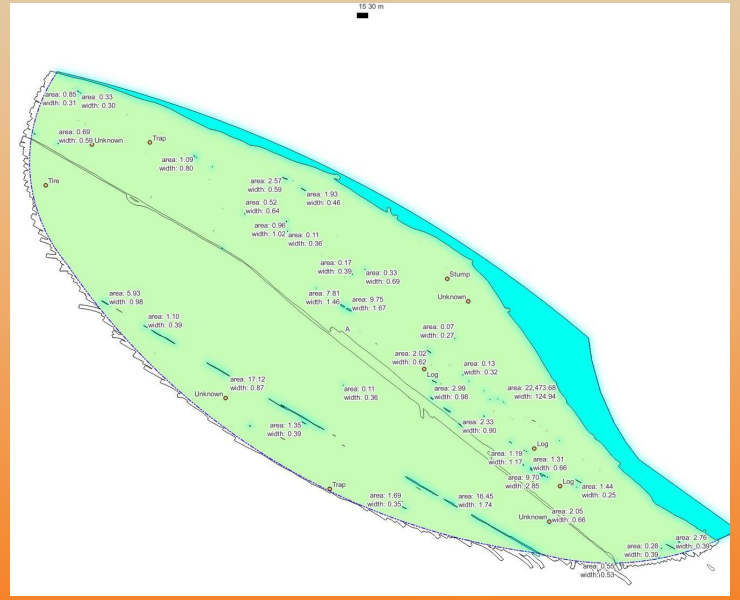
Ongoing Challenges

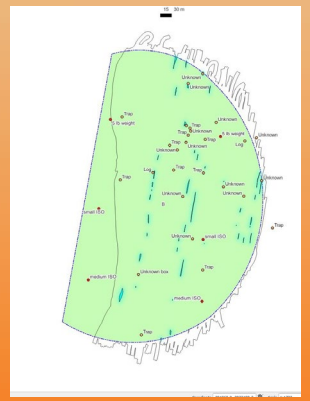
Active Towed Array

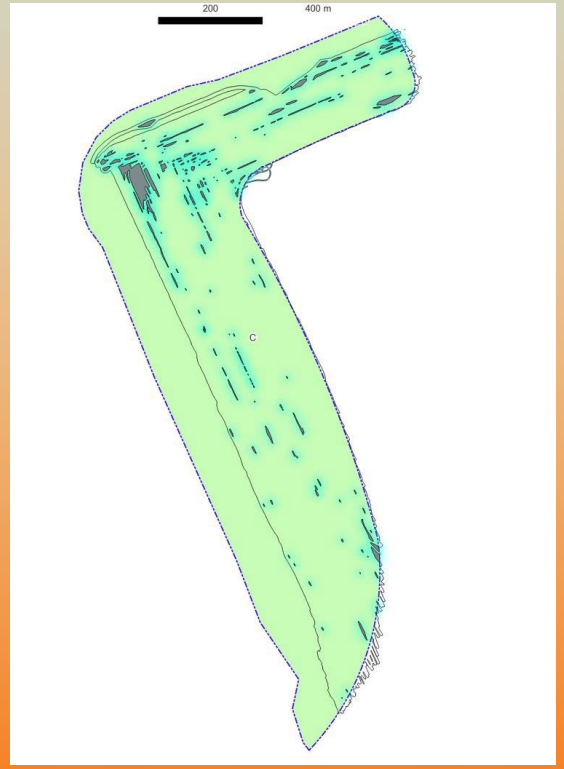


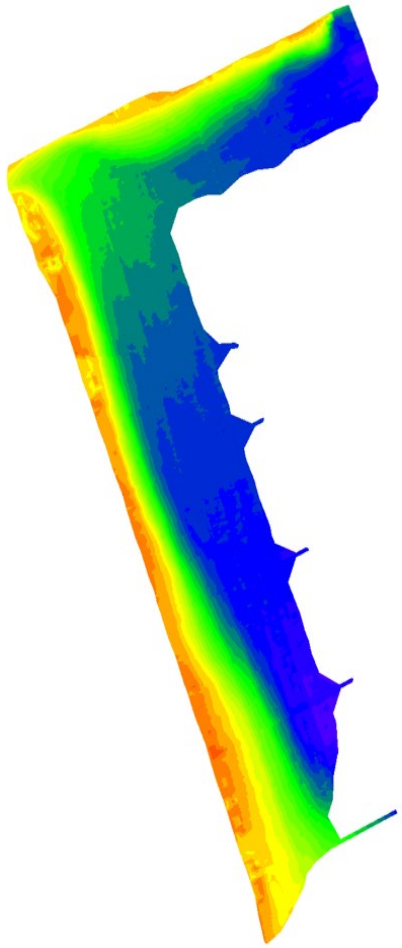
The Task

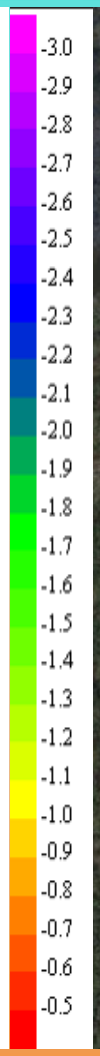
- Perform 100% coverage of Underwater Advanced Geophysical Classification (UWAGC) of 172 acres of estuarine waterway.
- Minimum water depth: Shoreline
- Maximum water depth: 3.3m







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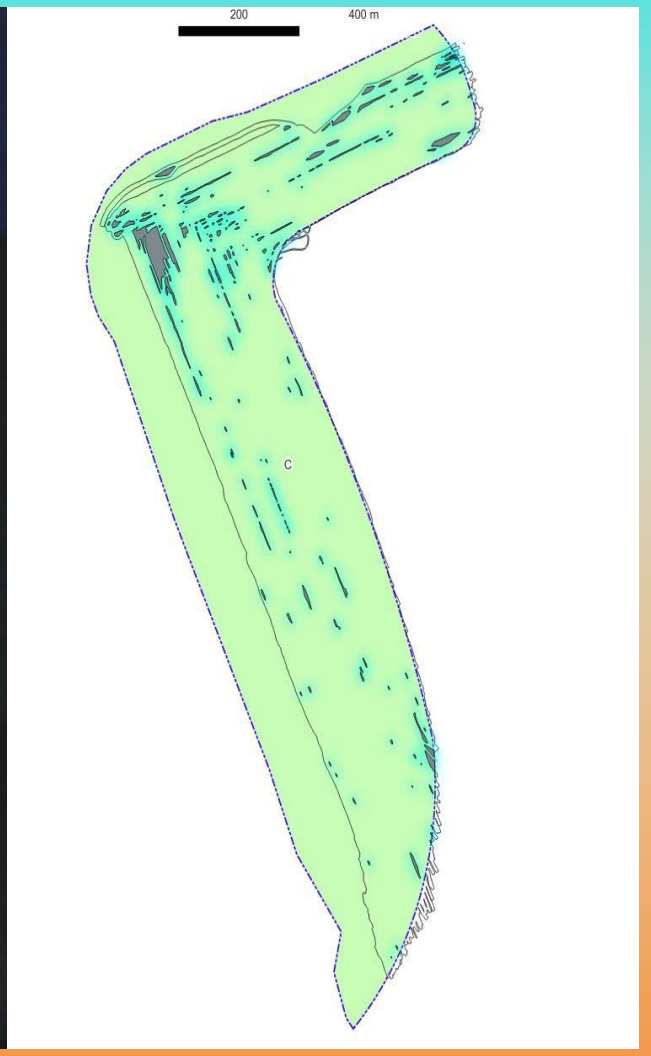
Grey Point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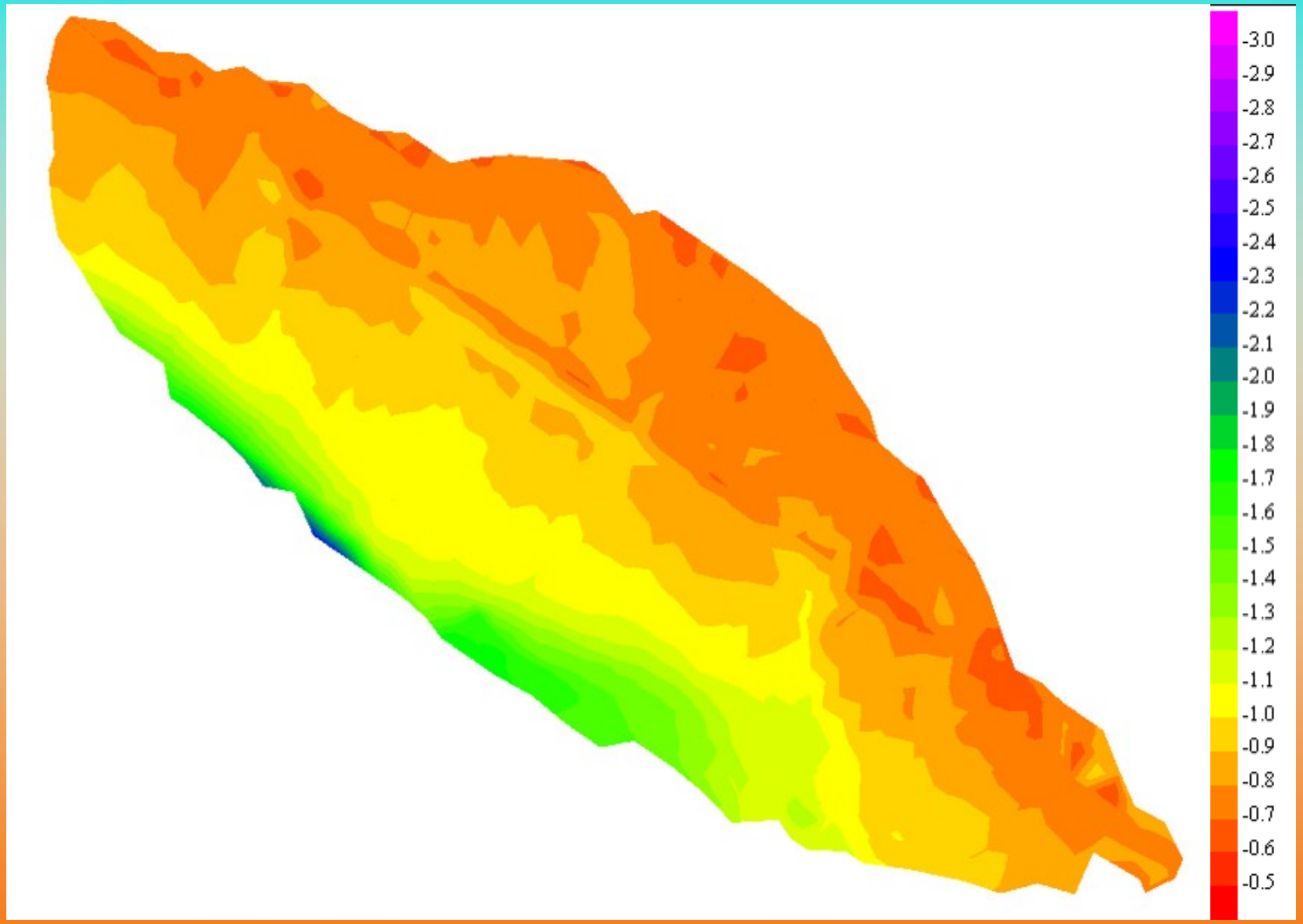
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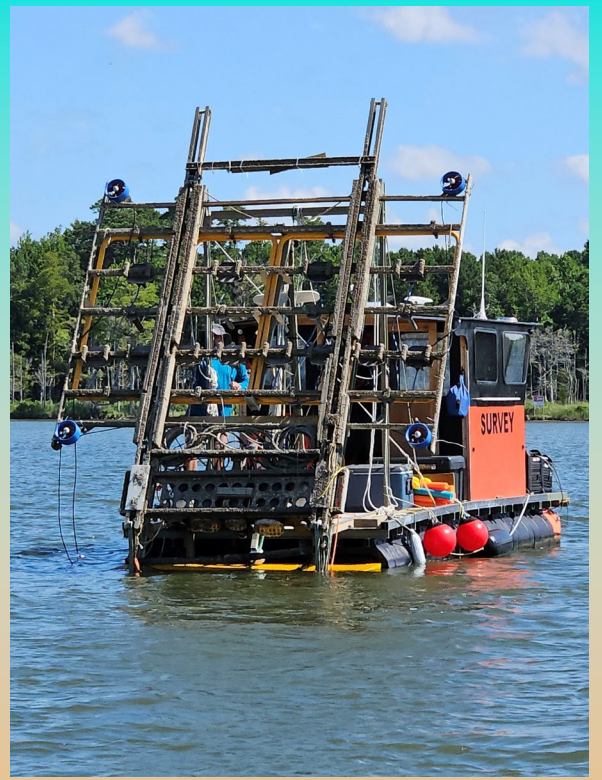
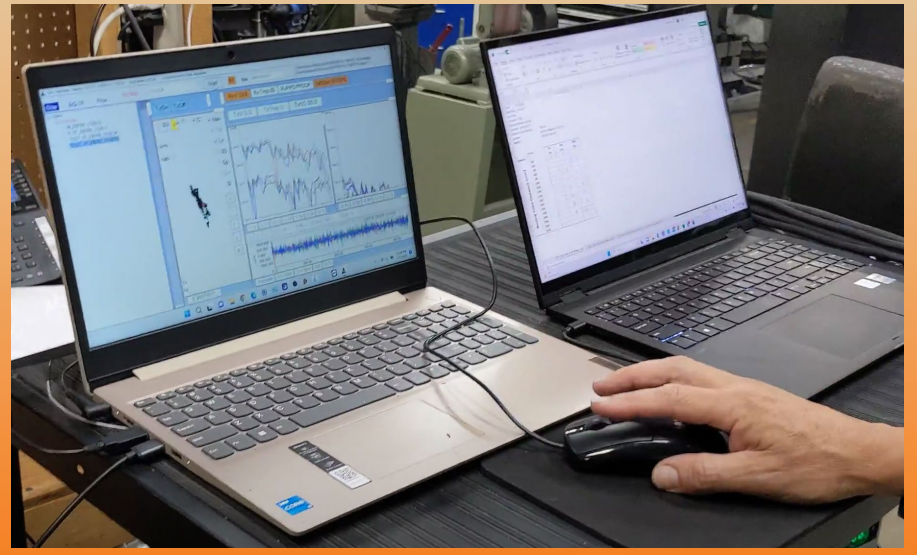
Shallow Water Challenges: Anticipated at Outset

CHALLENGES	SOLUTIONS
Vessel Draft. Contracted to survey down to 18” (450mm)	Build custom vessel with draft of 9” (220mm)
Risk of touching seabed.	Bathy/SSS survey prior to UWAGC survey.
Weather/Exposed shoreline.	Monitor weather and budget for time. Mooring for the vessel onsite.
Interference from survey vessel.	Build non-conductive vessel.
Thruster EMI.	Extensive testing of thruster options.
Need to steer very accurate transects.	Introduce 2kw BLDC trolling motor.

Known Requirement: Need to mitigate thruster noise

- Four brushless DC thrusters permit us to keep the array parallel and at a fixed height, 0.5m from the seabed. Able to negotiate obstacles efficiently.
- Thrusters are intrinsically noisy but noise can be mitigated.
- EM noise is a function of thruster power and the distance of the Electronic Speed Controller (ESC) from the motor.
- Tested three thruster models to find the best available.





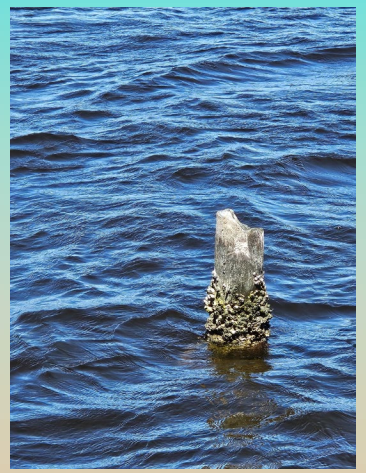
Known Requirement: Non-conductive vessel for conducting UWAGC in shallow water

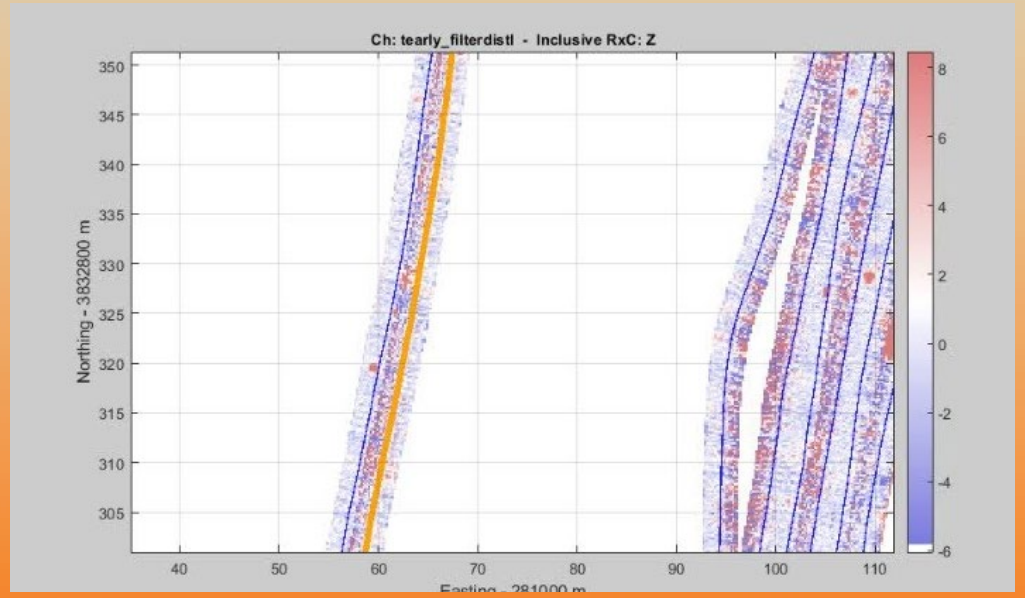
DESIGN CRITERIA

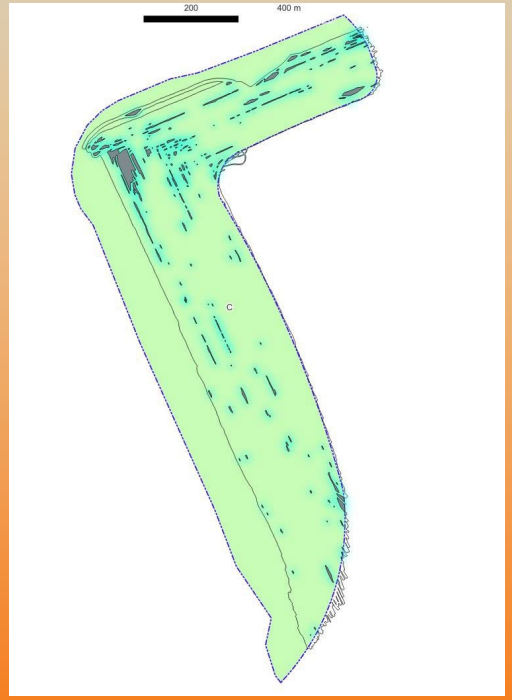
- <26ft to allow the vessel to be operated by non-USCG licensed operators.
- <8’ 6” to allow for road transport without permit.
- “Non-conductive” body to allow the array to be towed very close without the vessel hull interfering with data.
- Protected workspace.
- Able to carry/launch/recover 450lbs array on A-frame.
- Provide Clean, uninterrupted, power.
- Able to place array
  +/- 0.5m of transect.
- Able to survey ~1.3kts.
- Operate in inclement weather.

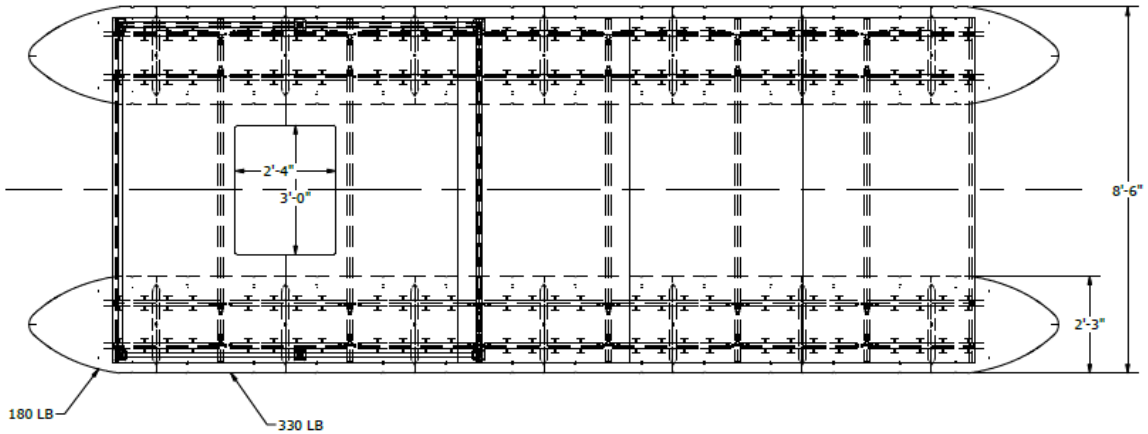
Known Requirement: Ability to drive accurate transects

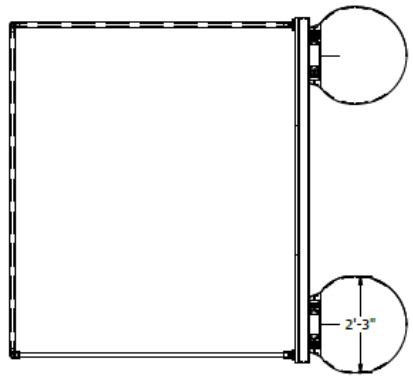
- Garmin “Kraken” 2Kw trolling motor.
- Steer to waypoint.
- Semi-automated modes.

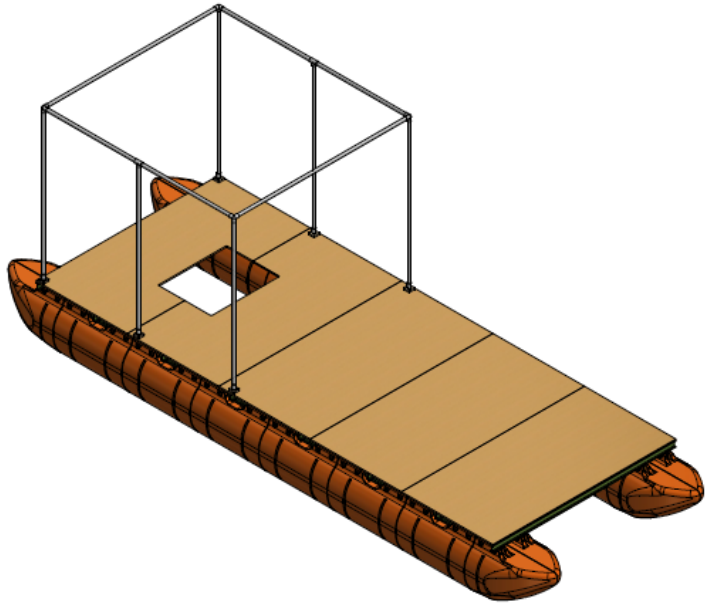


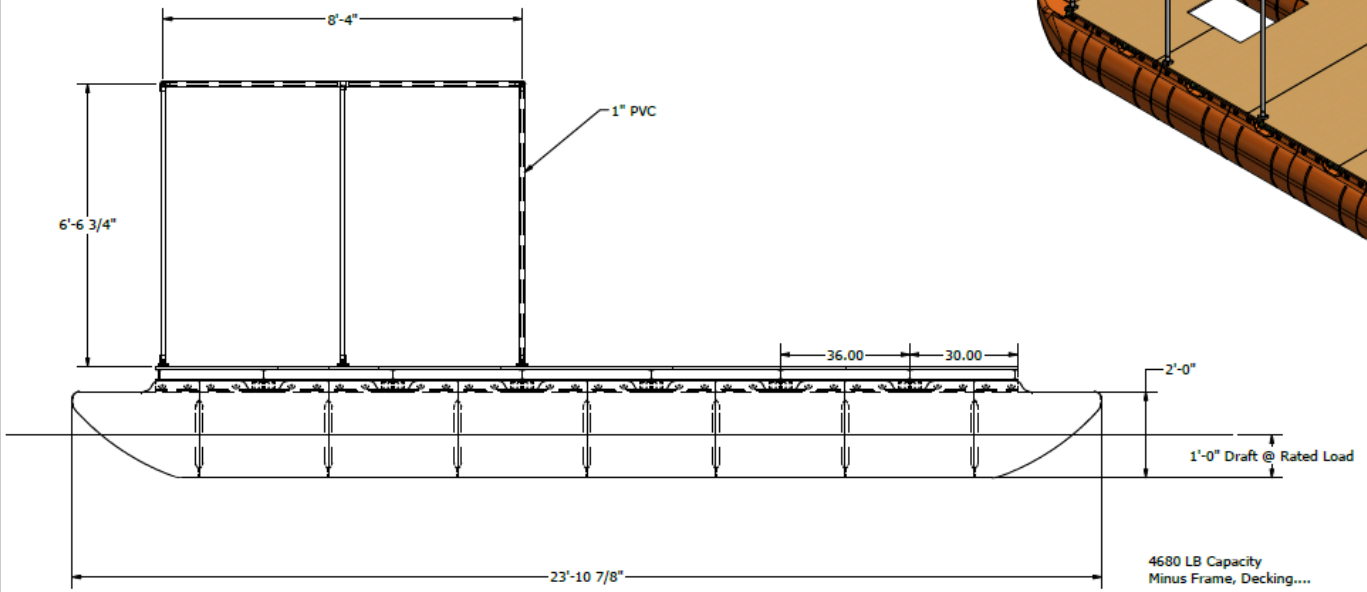






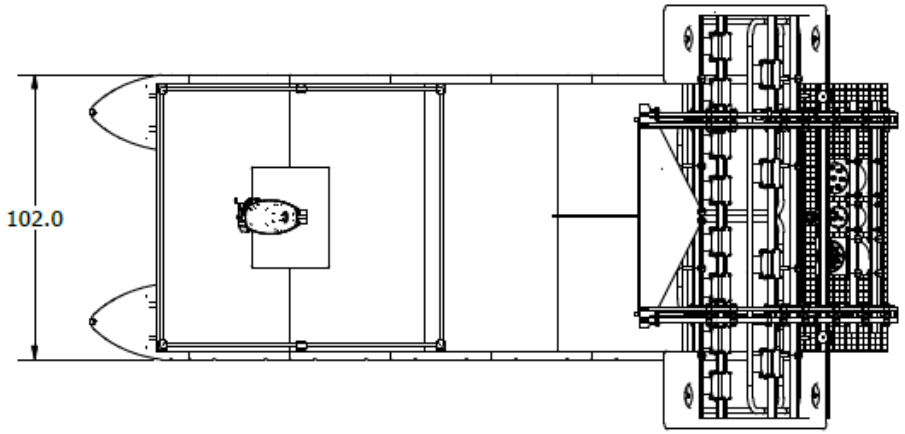






Weights
Pontoons Weight 895.2 lb
Fiberglass Frame Without Hardware 190 lb
Decking 3/4" Wood 72 lb each

4680 LB Capacity
Minus Frame, Decking....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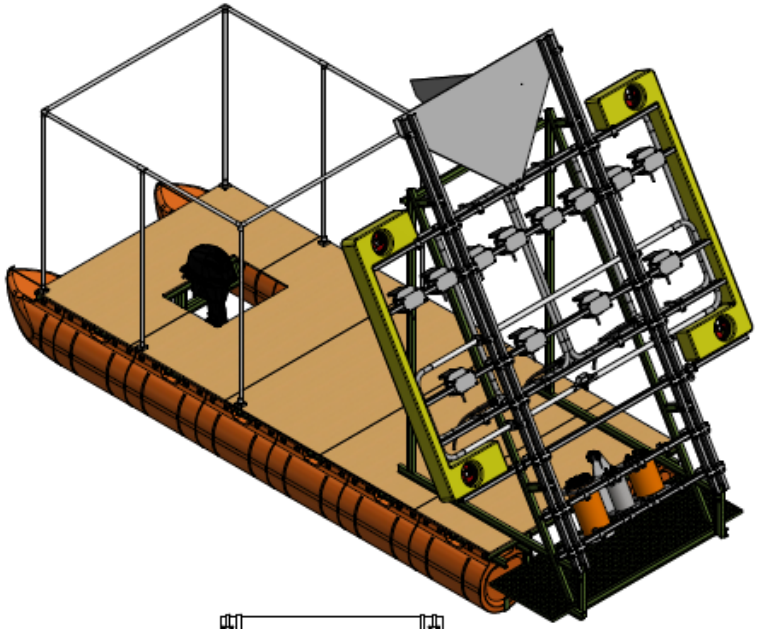

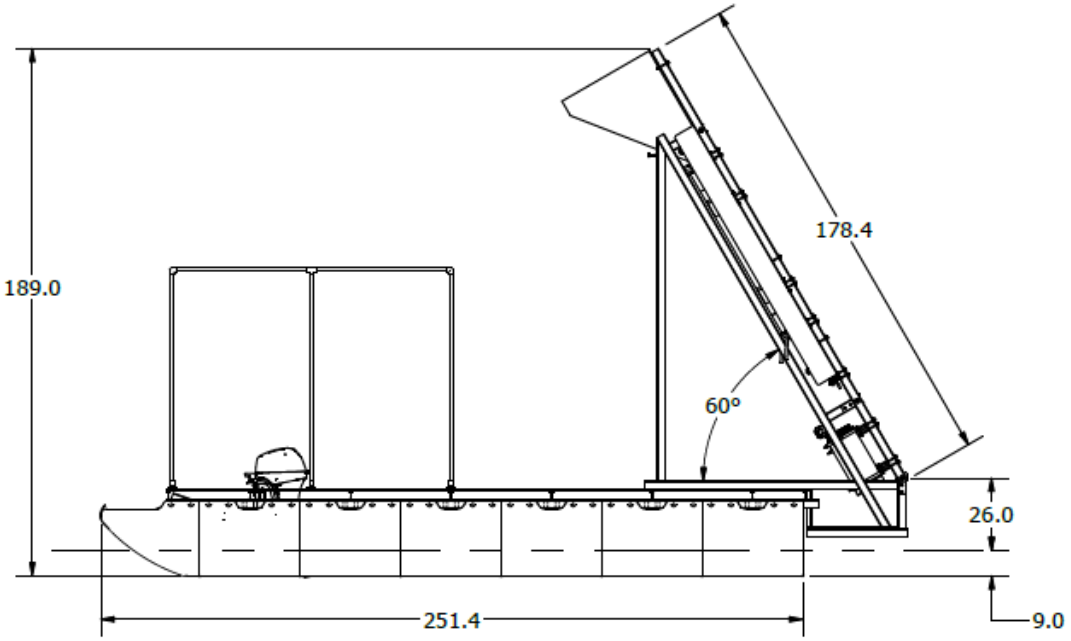
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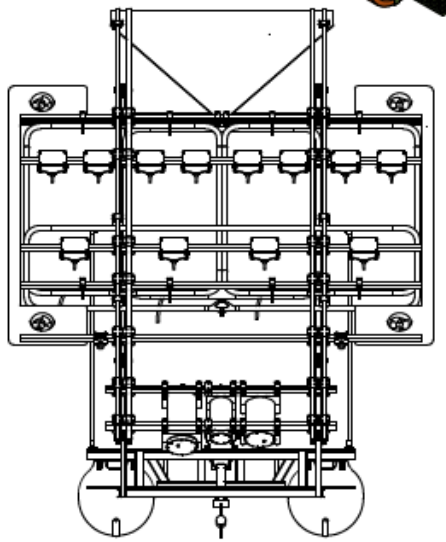
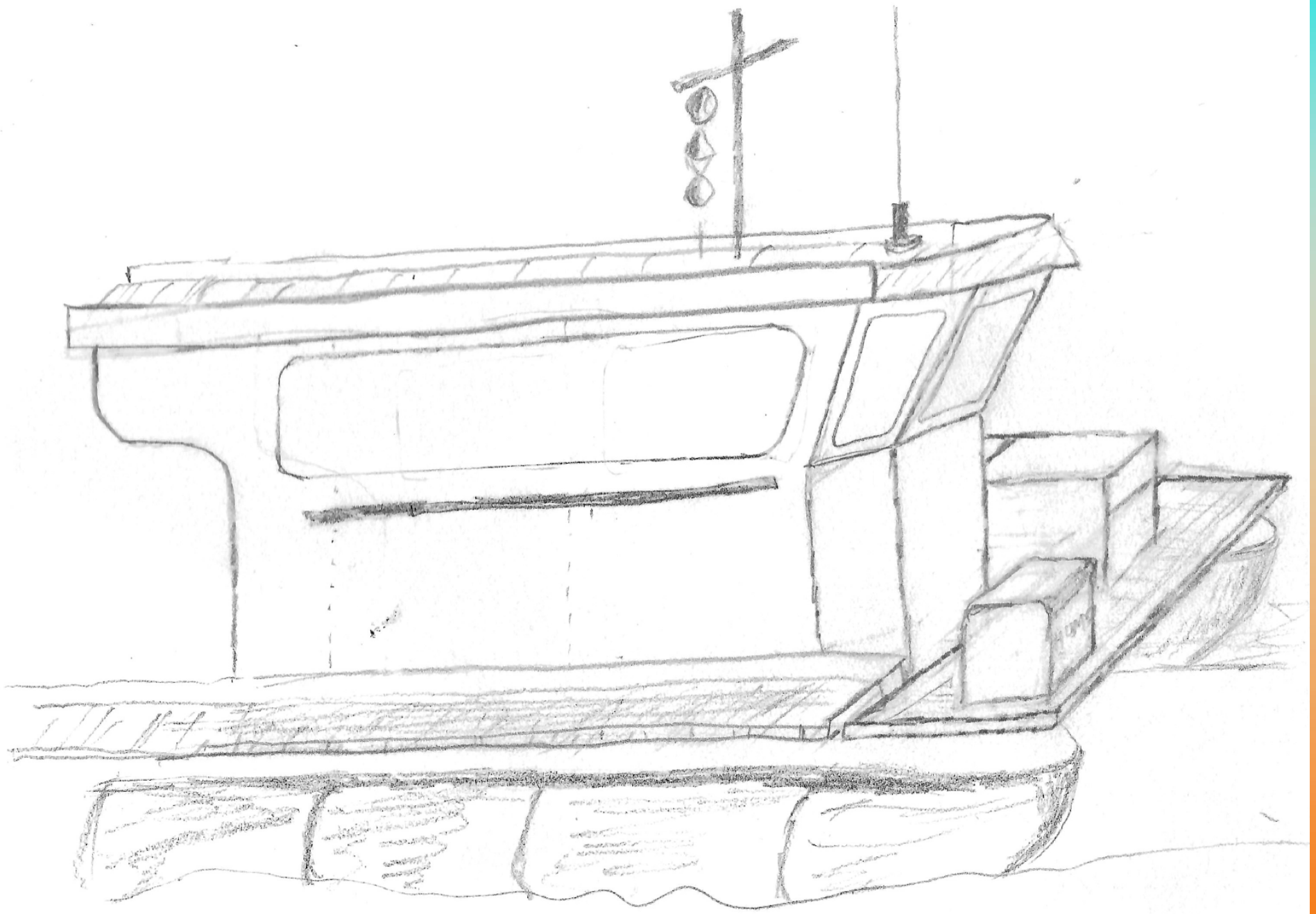





SEAVIEW
GEOPHYSICAL
SEAVIEW
GEOPHYSICAL


Kingspan
GreenGuard


GARMIN
GARMIN


GARMIN

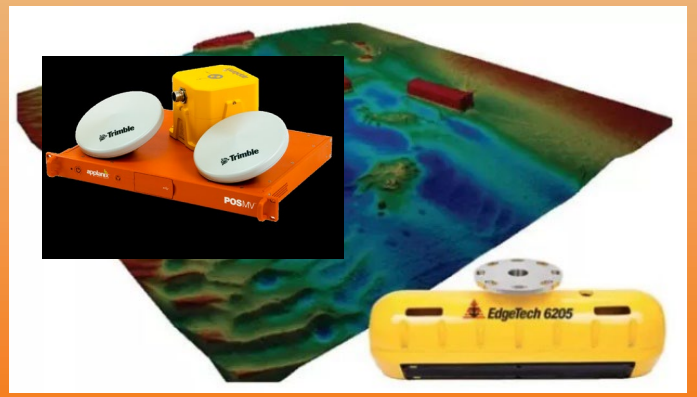

DANGER
NO DIVING
SHALLOW WATER
NO SWIMMING
LAUNCH AREA


APPLIED MOLECULES
LOADING DOCK


SURVEY
MC5906UY
GeoSearch
SeaView
GEOPHYSICAL

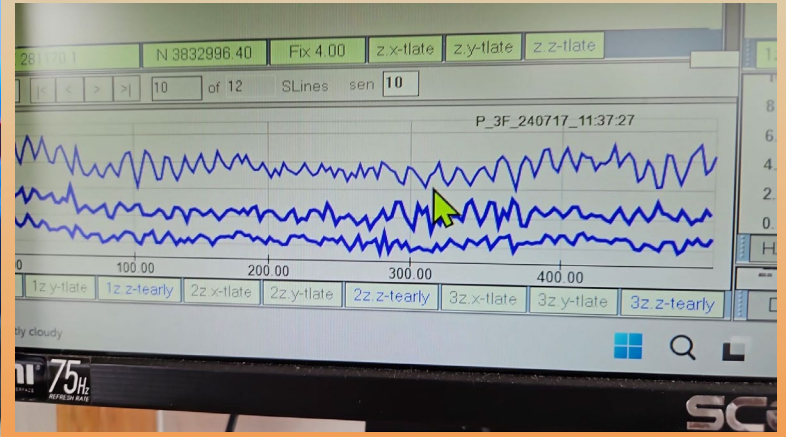
Known Requirement: Ability to perform Bathy/SSS survey in very shallow water.

- ASV or survey boat: Very productive and accurate in quiet conditions.
- EdgeTech 6205 Bathy/SSS multi-phase echosounder or 2205 on ASV: Performed well down to 440m.
- 24ft skiff with jacking plate (sonar draft ~ 0.5m): Better option for all but the most shallow conditions.



Discovered Challenges: Outboard Propeller Wash Causing Bearing Wear and Altimeter Dropouts

- Sand washed off of seabed by the outboard caused the thruster bearings to wear quickly and dramatically.
- Altimeters lost track of the seabed as soon as the outboard propeller wash started.
- Wobble of propeller assembly generated low-frequency noise.



Low frequency noise generated by wobbling thruster propellers

Propeller Wash Solution: Jet-drive outboards

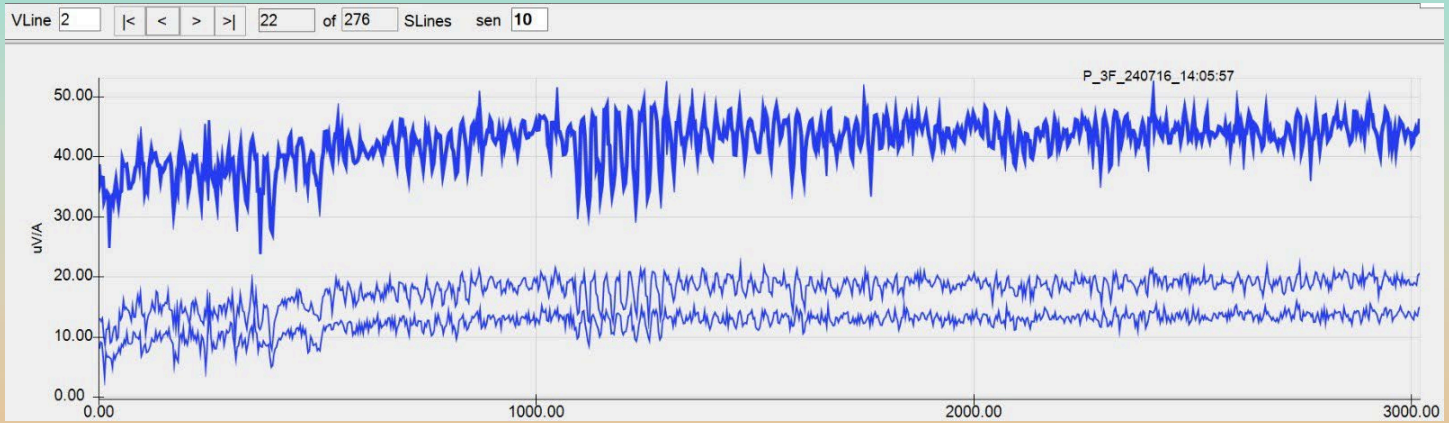
- Introduced 2ea 40hp outboards
- Outboards bolt onto vessel during setup
- Eliminate wash around the array, resulting in very low thruster bearing wear or altimeter dropouts.
- Secondary benefit: Improved tracking of vessel/tighter transects.

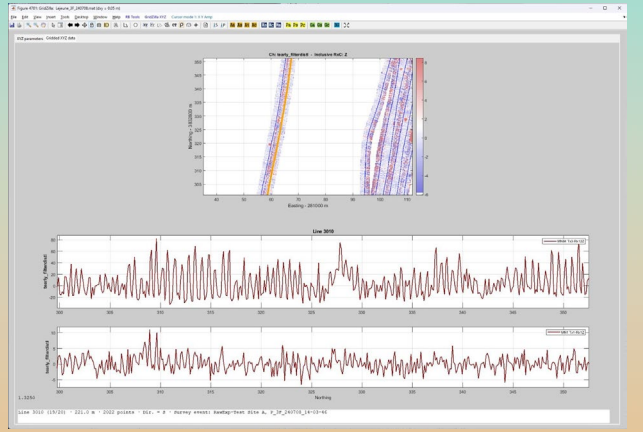
Discovered Challenges: Weed

- Weed common in water depth of 3ft or less.
- Quickly clogged thrusters, sometimes resulting in thruster failure.


Bandit
Airdrives
MODEL: BANDIT 30

Discovered Challenge: EM Noise from inverter generators and battery chargers as well as thrusters



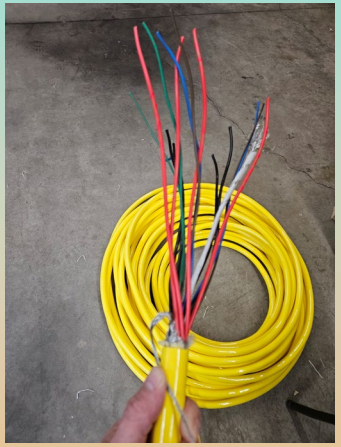


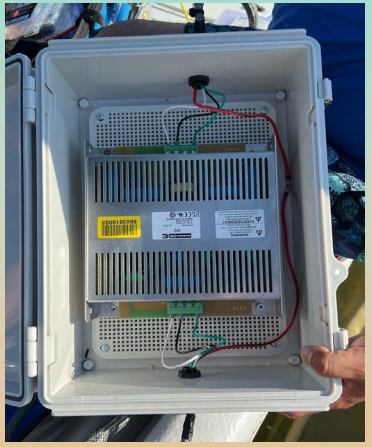
- Noise occasionally 20-25 uV/A p-p
- Nominal acceptable noise <5uV/A p-p

EM Noise Solution

Solutions

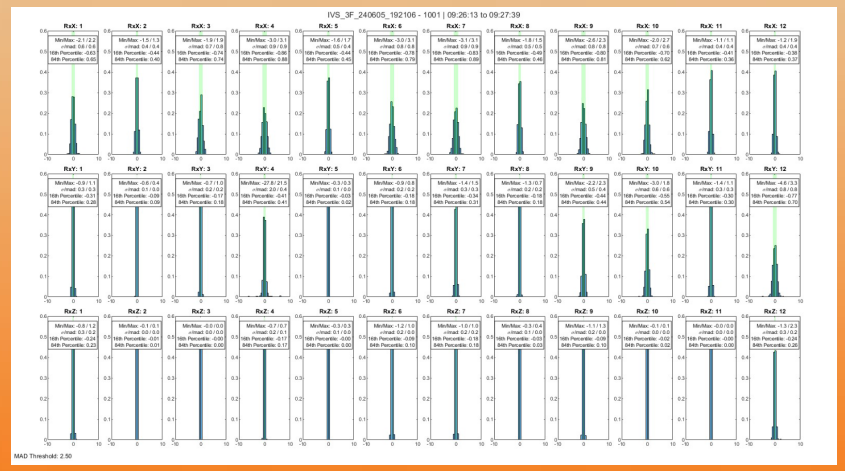
- Custom shielded cable.
- RF Filtering.
- Toroidal Ferrites.
- Cable routing





BEFORE

AFTER

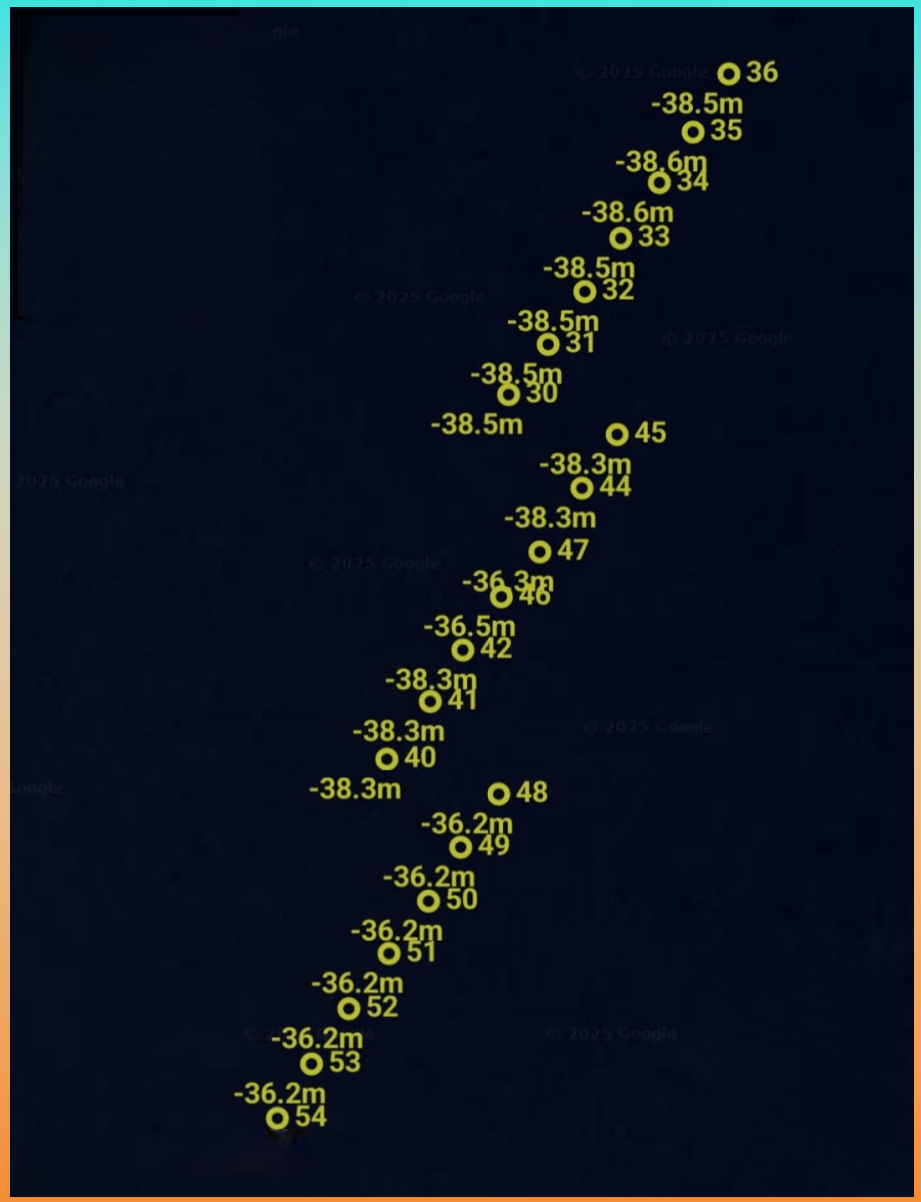


Discovered Challenge: Transit Time

- Survey site was several miles end-to-end
- 20 minute launch/recovery.
- Losing nearly 1 day a week in launch and recovery evolutions due to localized IVS.

Transit Solution

- Install one IVS at each location
- Build IVS so that each receiver saw at least two of each kind of target.
- Designed for success and not as a driving accuracy test.



Discovered Challenge: Wildlife

Alligators

- Don’t get in the water!
- Active in summer months.

Thieving Varmints

- Approximately $6000 of equipment was stolen off the GeoSearch while it was sitting on its mooring.
- Like alligators, the thieves appeared to show once the weather warmed up.
- The remedy is to provide adequate security:
  - Night security
  - Cameras
  - Run to the marina (and incur the associated transit inefficiency)

Shallow Water Challenges: Discovered

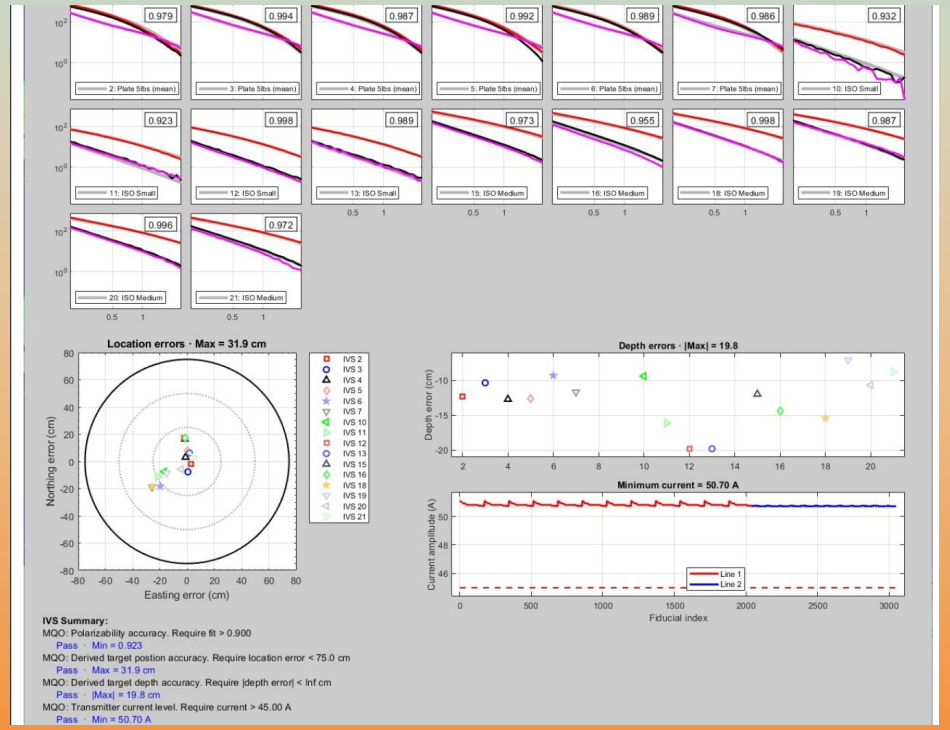
CHALLENGE	SOLUTION
LF noise caused by worn thruster bearings.	Transition to jet-drive propulsion.
Lost altimeter tracking in wash from outboard.	Transition to jet-drive propulsion.
Unable to survey with thrusters in shallow water due to weed.	Build airboat to shunt array in shallow water (open operating window from > 18”water depth to >6”).
EM noise in data caused by generator and battery charger.	Improve EM filtering. Change the charging regimen.
Thruster EM noise effected by weather conditions.	Learn to manage weather and monitor the thruster current draw.
Excessive transit times	Install one IVS at each location
Wildlife (Alligators. Thieves).	Stay out of harm’s way. Security.

Achieved Results:

- 99.1% of accessible coverage achieved
- Operated in water depths ranging from 0.1m to 3.3m (contracted 0.45m to 3.3m)
- 168 acres of “full coverage” AGC performed in 117 days (including setting and surveying 3 Instrument Verification Strips)
- Best day’s production 10.7 acres using airboat.

Achieved MQO’s

- Pitch >90% +5/-5 deg, Roll +/- 5deg
- Continuous RTK over distances >5m
- Morning/Evening function test
- Morning/evening IVS <0.75m (typically <0.25m)
- Altitude above riverbed: Initially 0.45m, later relaxed to 0.8m through concern of hitting seabed in uneven terrain.



Initial IVS Results

Ongoing Challenges

- **Improve Seaworthiness:** Stiffening and increasing buoyancy for more weather tolerance
- **Reduce thruster noise:** Extending the array to get thrusters further away from receiver cubes
- **Reduce generator shutdowns:** Removing CO shutdowns and installing generators in protected housing
- **Reduce NTRIP drops:** Supplementing Starlink with cellular
- **Reduce inverter charger noise:** Remove battery charger/inverter. Install UPS

Sailing by weather

Sailing to a schedule

Black Tusk
GEOPHYSICS

Questions?