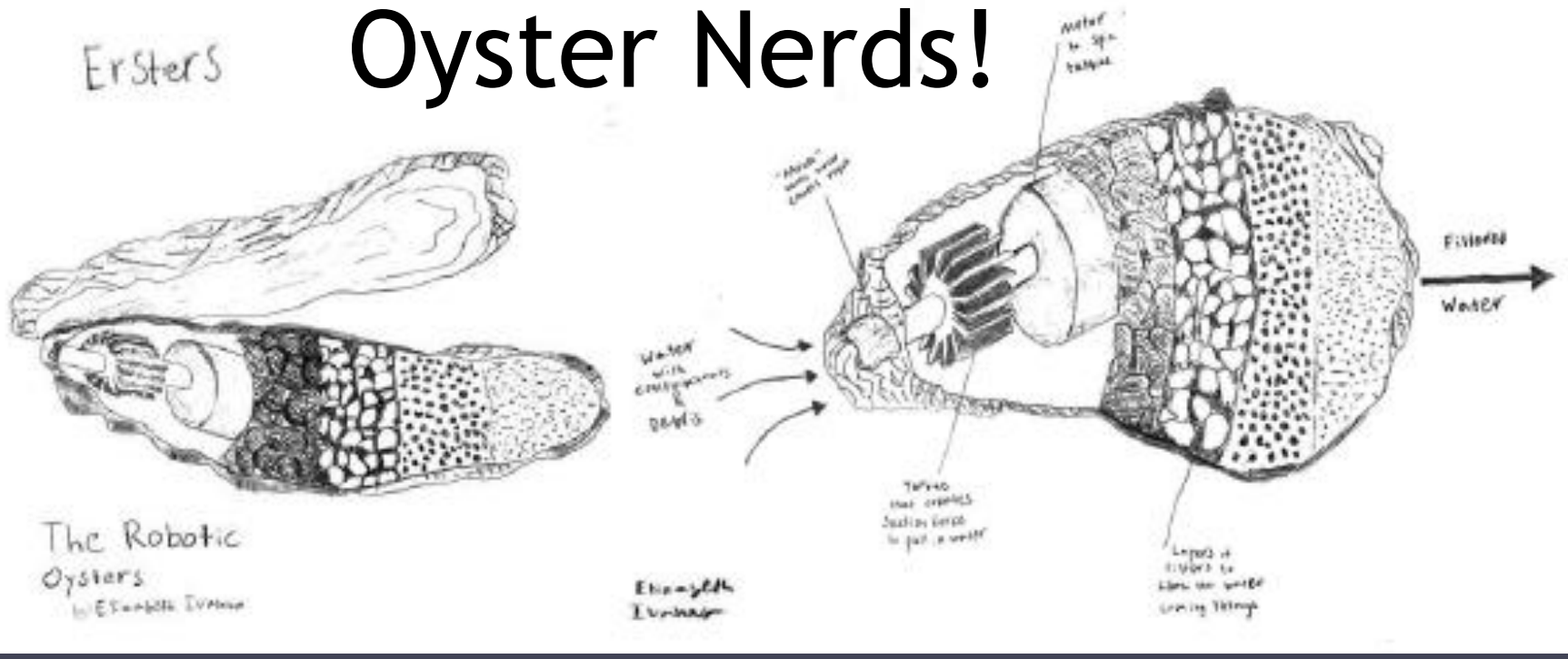
# Oyster Nerds!




Dale Leavitt
Blue Stream Shellfish, LLC
Fairhaven, MA

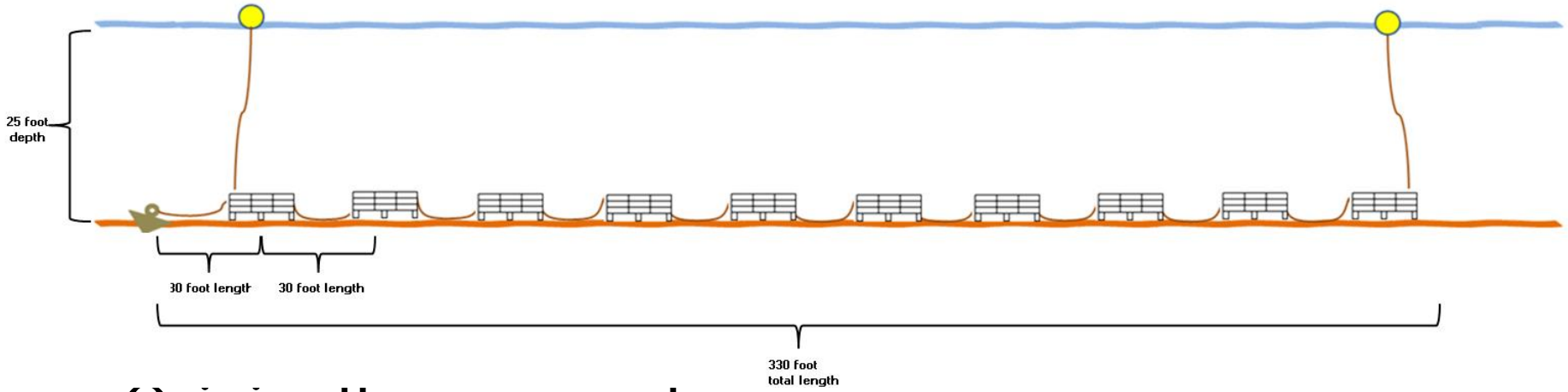
BLUE STREAM SHELLFISH

# The Problem:

- Vertical lines in the marine environment are under intense scrutiny in areas where there is risk of entanglement with marine megafauna.
  - i.e. buoy marker lines
- As shellfish aquaculture moves into deeper waters, the challenge is to reduce or eliminate vertical lines in those areas
- Case in point:
  - Blue Stream Shellfish has a licensed growing area (Seal Rock Farm) that is in the vicinity of a megafauna entanglement risk
    - In the eyes of the regulatory agencies
      - No whales reported in this area over the past 50 years, that I can find
      - Occasional leatherback & loggerhead sea turtles have been observed
  - Federal Army Corps license was conditioned to reduce the number of vertical lines by one-half and remove them entirely, if possible.
  - State license required 600 lb breakaway links on vertical lines

# Blue Stream Shellfish – Seal Rock Farm

# Seal Rock Farm Operations




- Originally proposed
  - 3 x 3 (9-bay) wire cages
  - 10 cages per trawl line = 90 oyster bags per line
- Evaluating
  - Four 3 x 3 cages merged into one unit = 36 bay cage
  - 3 cages per trawl line = 108 oyster bags per line

# Question?

- Can we retrieve cage trawls without any surface buoy markers?

- Option 1:
  - Grapple for the trawl line to retrieve cages
  - A random chance to snag the cage/line
  - Even more random that one snags a targeted line
  - Potential to damage a cage if grappled incorrectly

- Option 2:
  - Locate the targeted cage from the surface
  - Deploy a tool to retrieve the targeted cage

# Can a fish finder find more than fish?

**Option 2 - Question 1 – Locating a cage on the bottom?**

**The application of side-scan technology for visualizing cages on the bottom**

Dale Leavitt

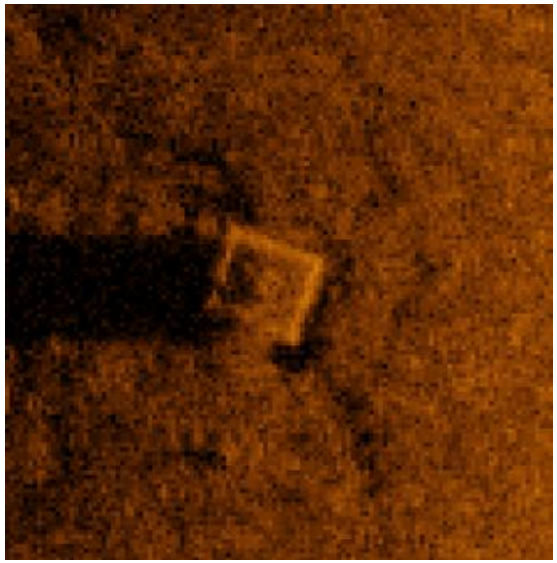
BLUE STREAM SHELLFISH

# Rationale

- Oyster farms are moving from shallow water (<2 feet depth) to deeper water (>20 feet depth) as local nearshore areas become limiting
- The technology to properly manage those deeper water cages is lacking
  - For example: in placing cages on the bottom – how do you ensure that you have
    - The proper cage orientation
      - Sitting upright on supporting runners
    - A distribution pattern that optimizes space use on the farm
    - An ability to see bottom cages without surface buoys for retrieval

# An option?

- In 2019, I became aware of a project in Delaware retrieving derelict crab pots using a fish finder to visualize traps on the bottom
  - Crab traps = Oyster cages?
- Communicated with Kate Fleming (DE Sea Grant) and Art Trembanis (U Del) to get more info on their technology
- They referred me to Vince Capone of Black Laser Learning Inc. for more details



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# Farmer's Grant

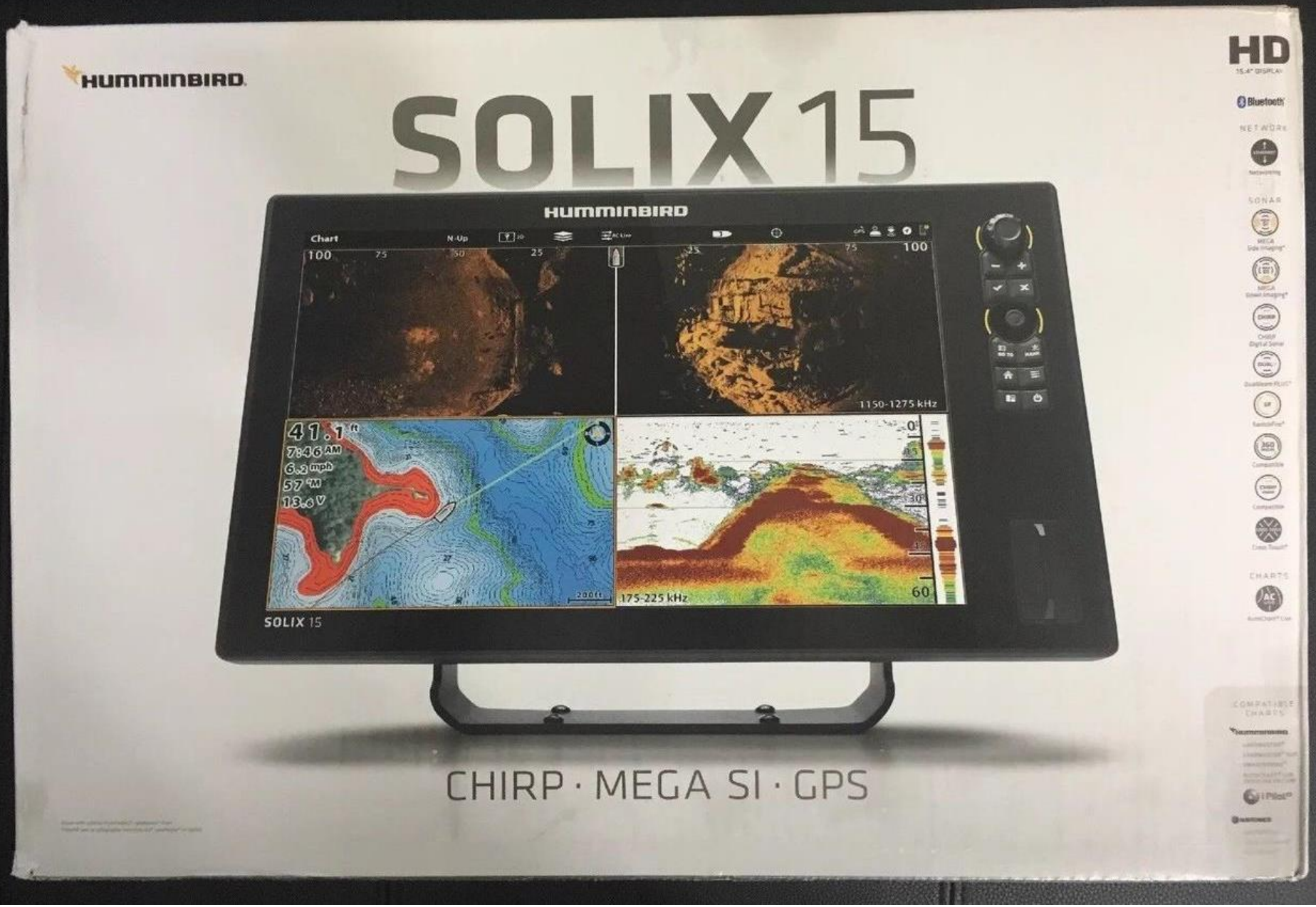
- Develop a method to visualize the orientation and placement of cages on the bottom using commercially available "fish finder" technology
- With the application of sidescan sonar, can one observe a three-dimensional representation of the array of oyster cages on the bottom with fine enough resolution to monitor:
  - Overall placement relative to other cages
  - Orientation of the cage as it lands

# Conventional Sidescan

- Towed “fish”
  - May need special winch and davit to tow properly
  - Challenging to tow fish among a array of buoyed lines
- Requires separate laptop attached to operate
- Cost
  - Starfish 452f = $7,000
  - “Ruggedized” Laptop computer = $2,000-$4,000

# What we needed:

- System simple to operate
- Contained in one integrated unit
  - No separate laptop
- Portable between different vessels
- Reasonable cost




Humminbird Solix 15 Fish Finder with top-down and side-scan sonar capabilities


Example of a sidescan image (left side) and navigational aid (right side) in a split plot display on a Humminbird Solix 15 Fish Finder

# Portability?

# Portability?


Humminbird Solix 15
Size Dimension
16.53" (L) x 4.83" (W) x 10.46" (H)

Humminbird Solix 15
Size Dimension
16.53" (L) x 4.83" (W) x 10.46" (H)

Universal Sewing Machine Hard
Carrying Case For Freearm Style
Portable Machine
Inside Dimensions
17.5” (L) x 8” (W) x 13.5” (H)


The Humminbird Solix 15 installed in the unopened carrying case


The Humminbird Solix 15 installed in the opened carrying case


The Humminbird Solix 15 powered by transportable 12 vdc deep cycle battery.

The transom-mount transducer required for the Humminbird Solix 15.

The transducer mounted on a 6’ removable pole (1” galvanized electrical conduit)

# ProControll EZ Mount II

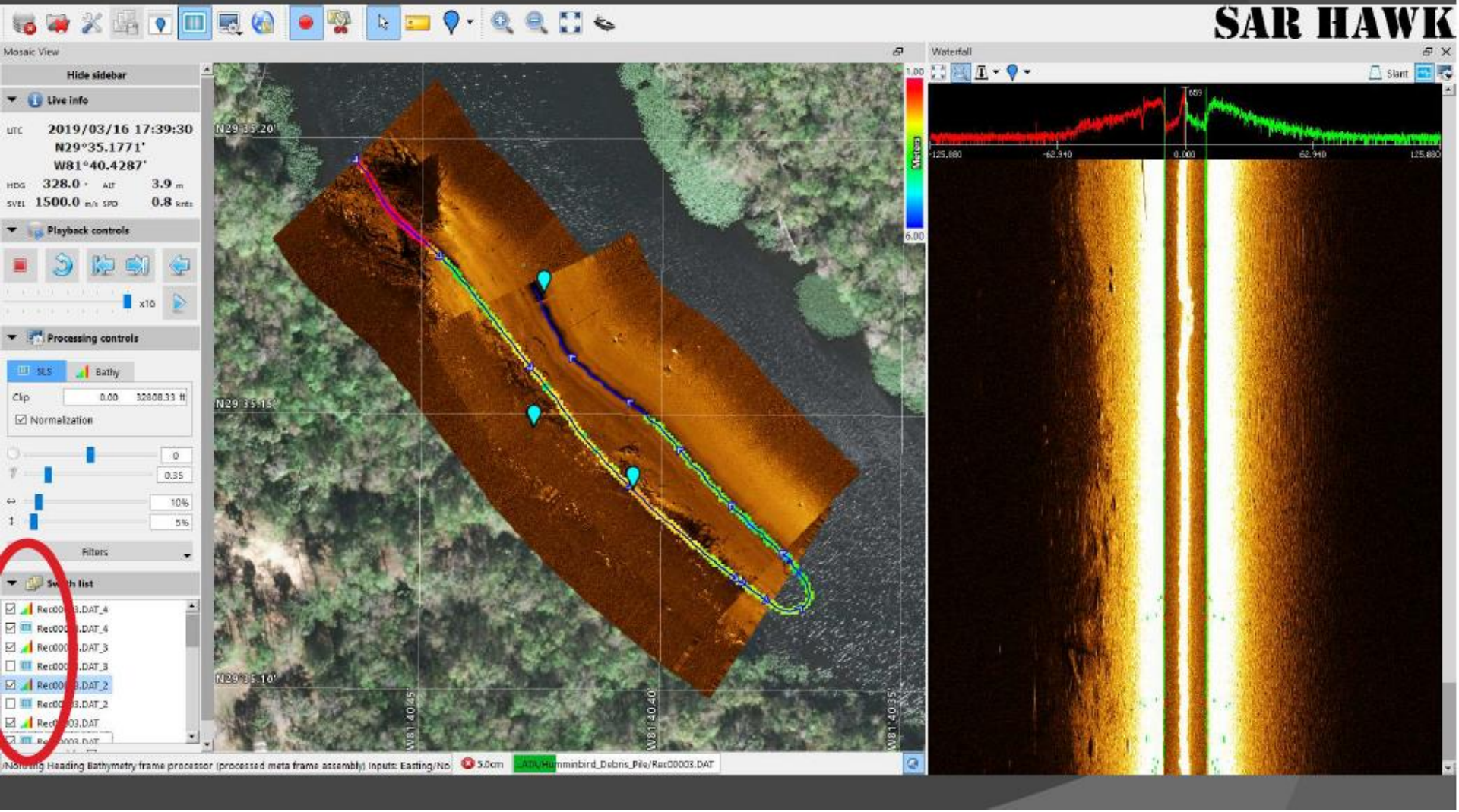

The fiberglass reinforced electric trolling motor replacement mount modified to accept the transducer mounted pole

The fiberglass reinforced electric trolling motor mount with transducer mounted pole clamped to the bow of our 21’ Carolina Skiff

- Humminbird Solix 15 Fish Finder in place on the farm work skiff

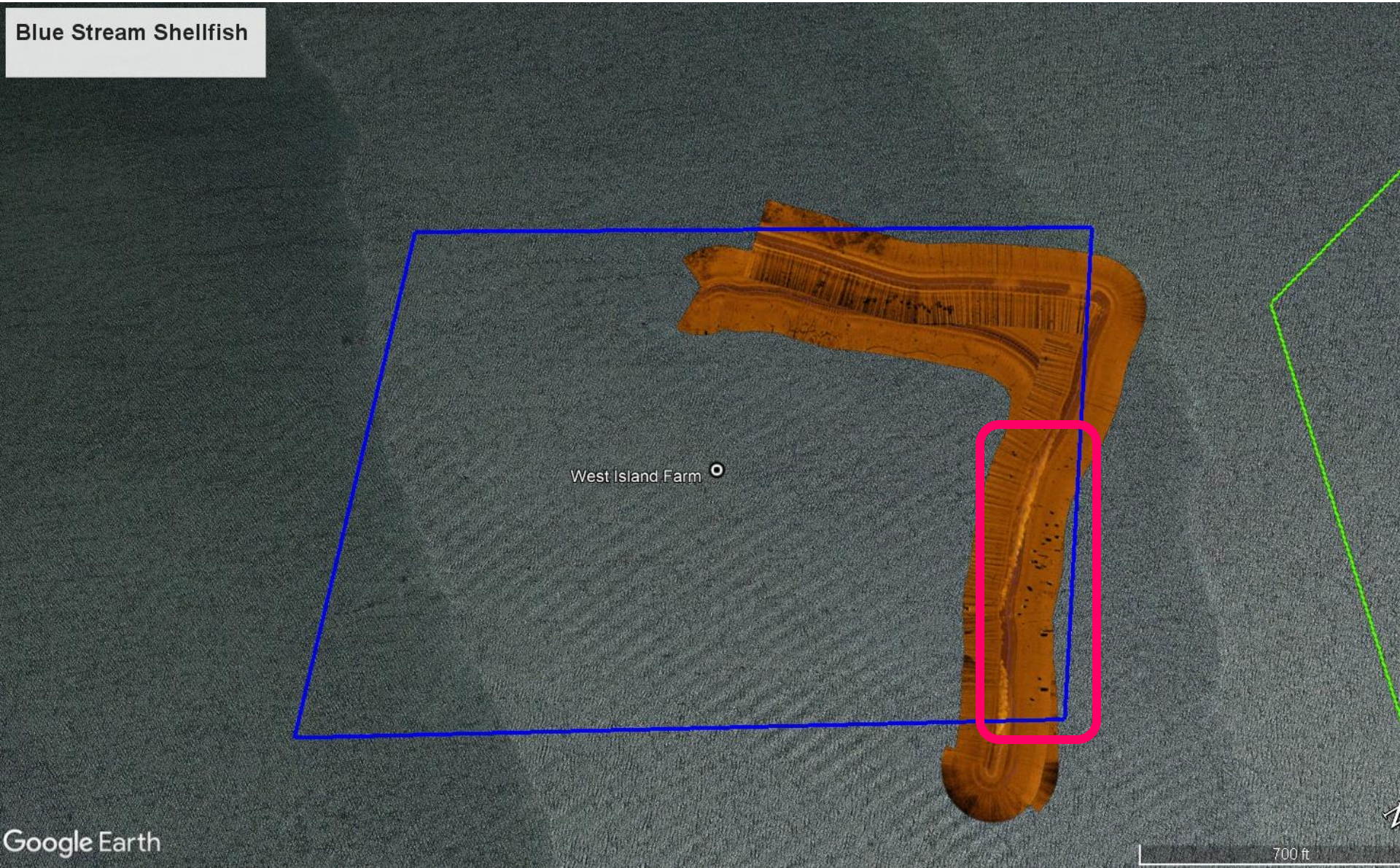

Search and Rescue software to generate sidescan mosaic image (Black Laser Learning)
SAR HAWK
FIND WHAT YOU'RE MISSING
SAR HAWK
FIND WHAT YOU'RE MISSING
SAR HAWK
15964602

# SAR HAWK : Mosaic (coverage map)

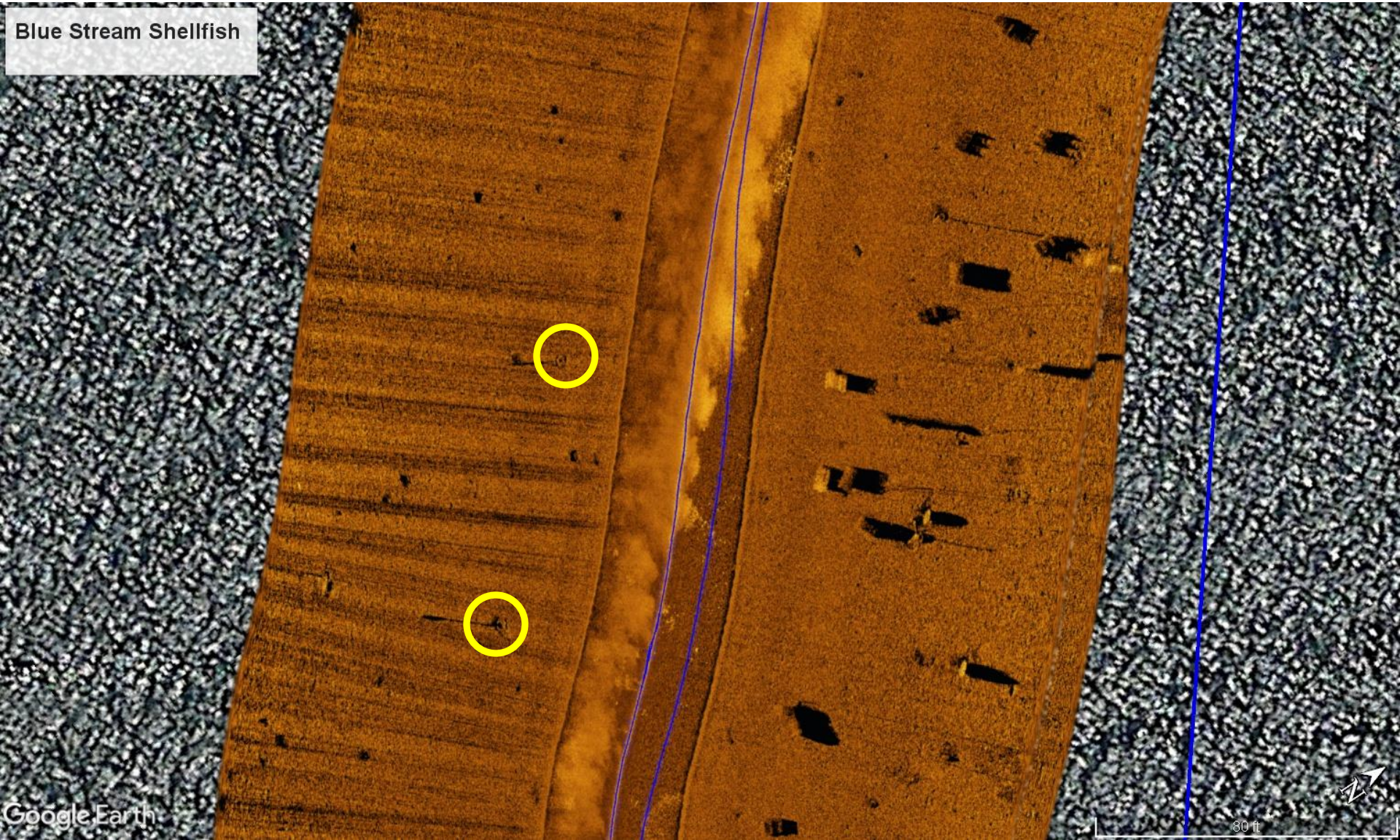


# Out to the farm(s)

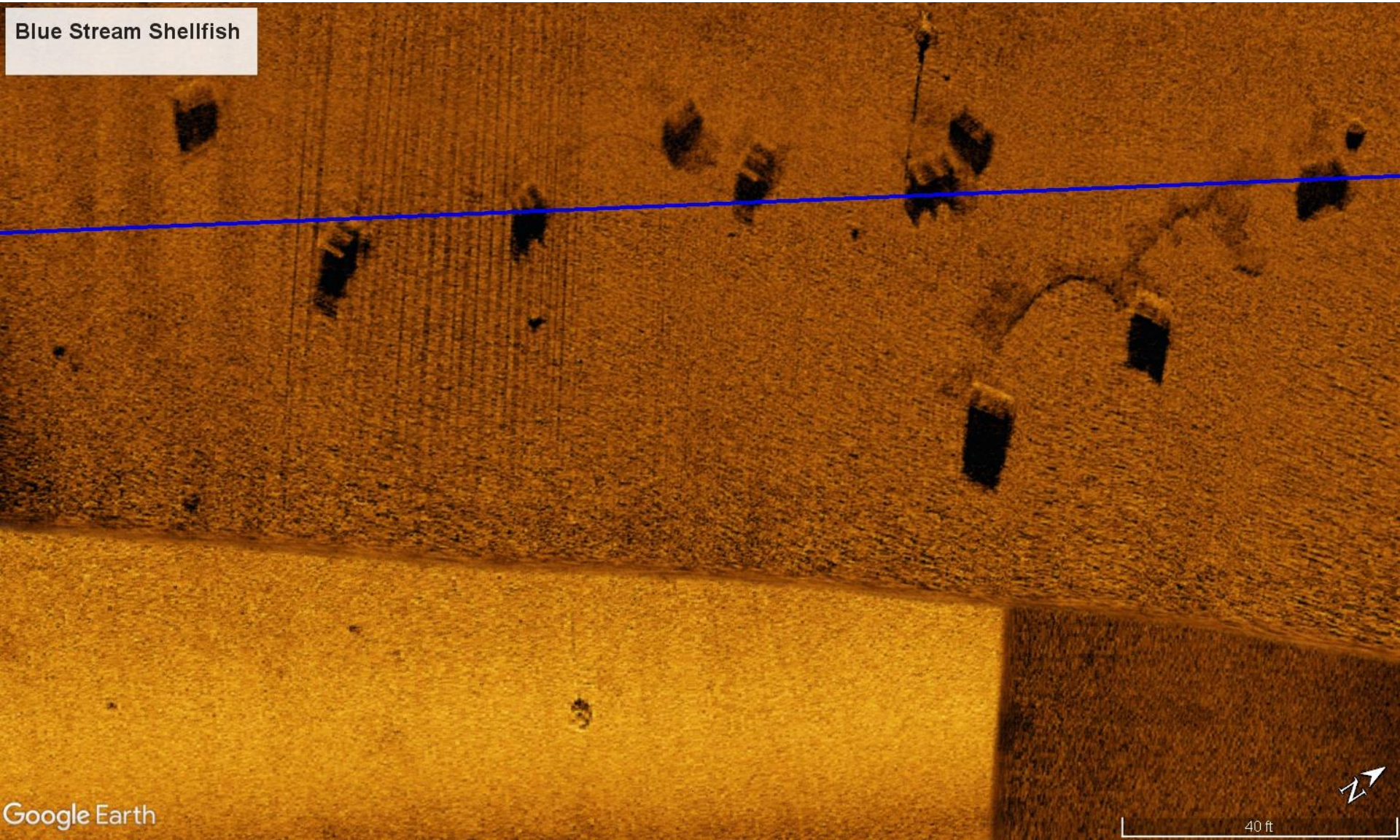
# West Island Farm – January 2023



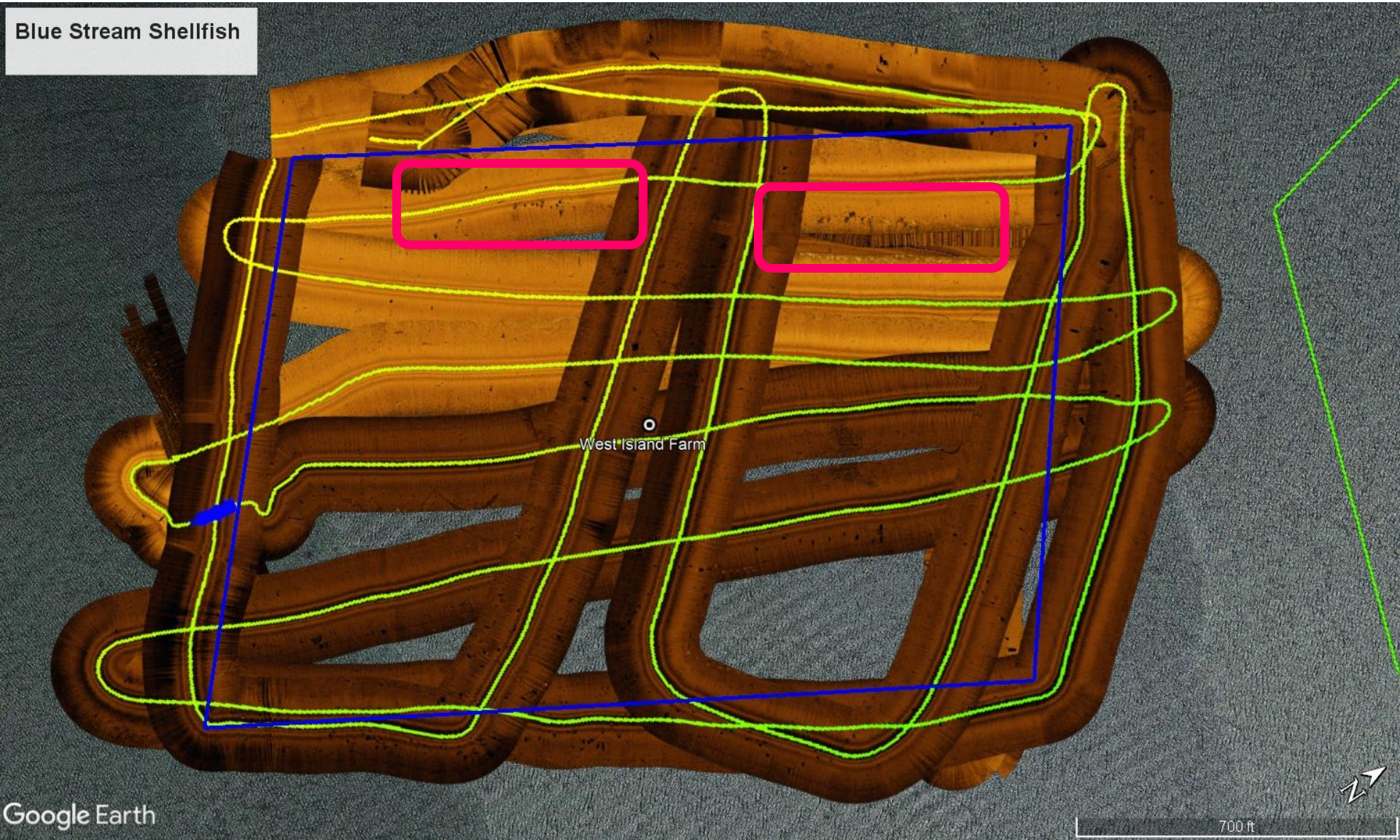
# West Island - Seed cages on the bottom



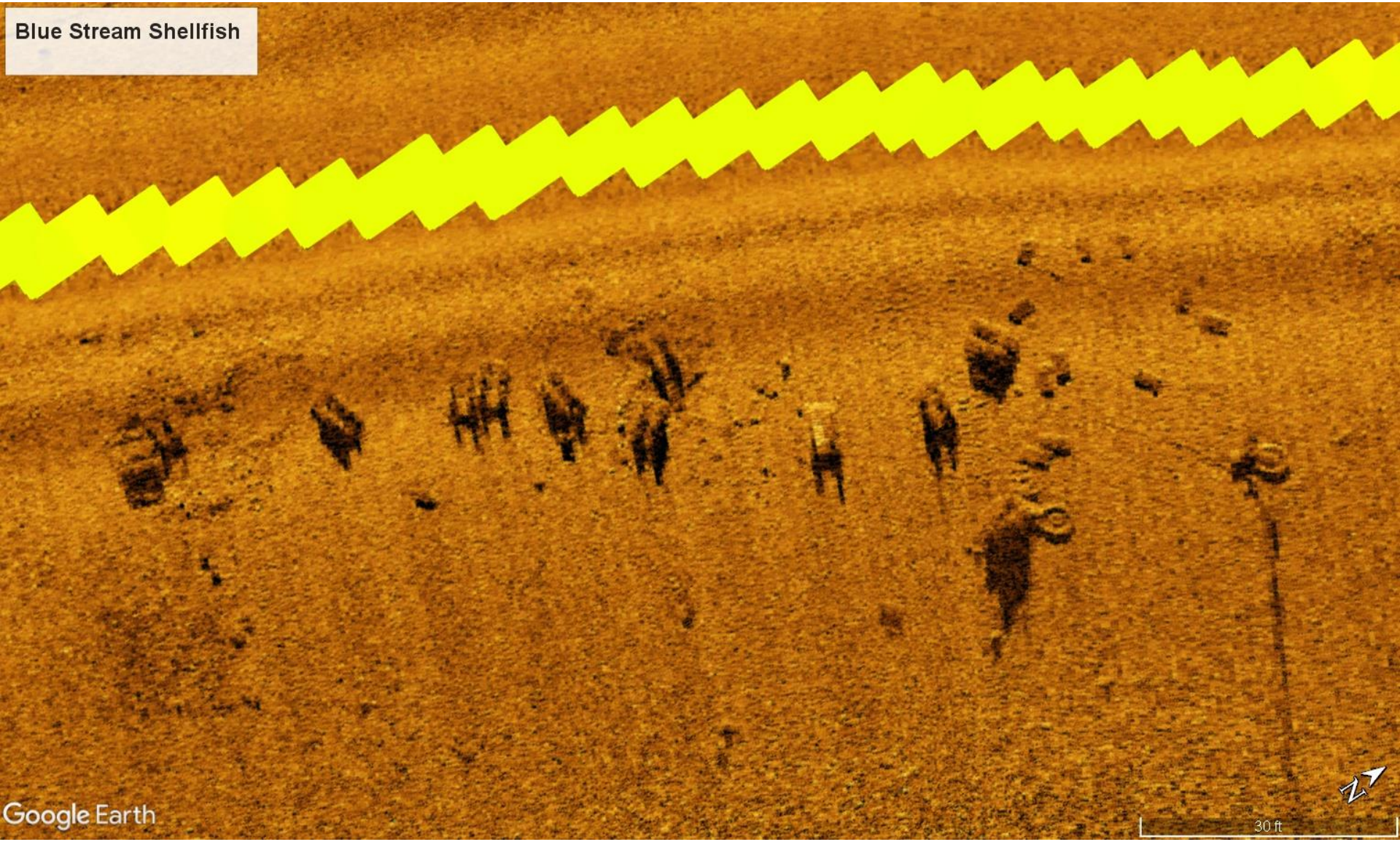
# West Island – Trawl line of 9-bay cages



# West Island Farm – January 2023



# West Island – Lost floating cages



# Results

- Do we have the ability to “see” bottom cages without surface buoys for retrieval? – **YES**!
  - Cue in the “OysterBot”
- Can we use the fish finder to assess the proper cage orientation (sitting upright on supporting runners)? – **YES**!
- Can we monitor the on-bottom distribution pattern to optimize space use on the farm? – **YES**!
- **Caveat** - But it is going to take some time spent working with the instrument to be effective.

# The Bottom Line

- Humminbird Solix 15 = $3,600
- Pro Controll EZ Mount 2 = $50
- 6 feet of 1” galvanized conduit = $22
- SAR Hawk software = $749

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# Developing the OysterBot for oyster cage retrieval

**Option 2 – Question 2:**

**Deploy a tool to retrieve the cage?**


Molly Curran
Applied Ocean Physics and Engineering
Woods Hole Oceanographic Institution
Woods Hole, MA

Dale Leavitt
Blue Stream Shellfish
Fairhaven, MA


Woods Hole Oceanographic Institution 1930

Blue Stream Shellfish

# Retrieve a Targeted Cage?

- A random walk in the woods with my dog!
  - Encountered another dog walker
  - Exchanged pleasantries and discovered she was a robotics engineer at WHOI
  - Pitched the idea of a cage retrieving ROV and Molly bought it!
- Funding acquired through USDA Northeast SARE Farmer's Grant

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# The “OysterBot” Wish List

- Weight & Dimensions
  - Weight <20 kg (44 lbs)
  - Dimensions <60 cm (24“) in any dimension
  - Tether length ≥25 m (82’)
- Sensory Capacity
  - Real-time video display
  - Direction & Speed Sensor
  - Depth Sensor
  - Temperature Sensor
- Mechanical Capacity
  - Onboard manipulator/gripper
- Performance
  - Thruster configuration for maximum maneuverability
  - Payload ~1 kg
  - Maximum depth >10 m
  - Autocontrol for depth, direction, & speed
  - Lighting available
- Battery Duration
  - 2 – 4 hours

# Basic Platform

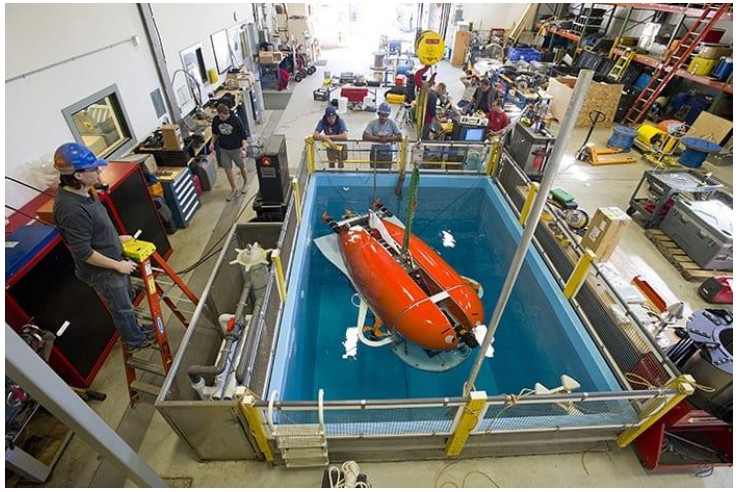
- Recommended Provider
  - https://bluerobotics.com/
- Base Unit - BlueROV2 Kit

# The Parts List

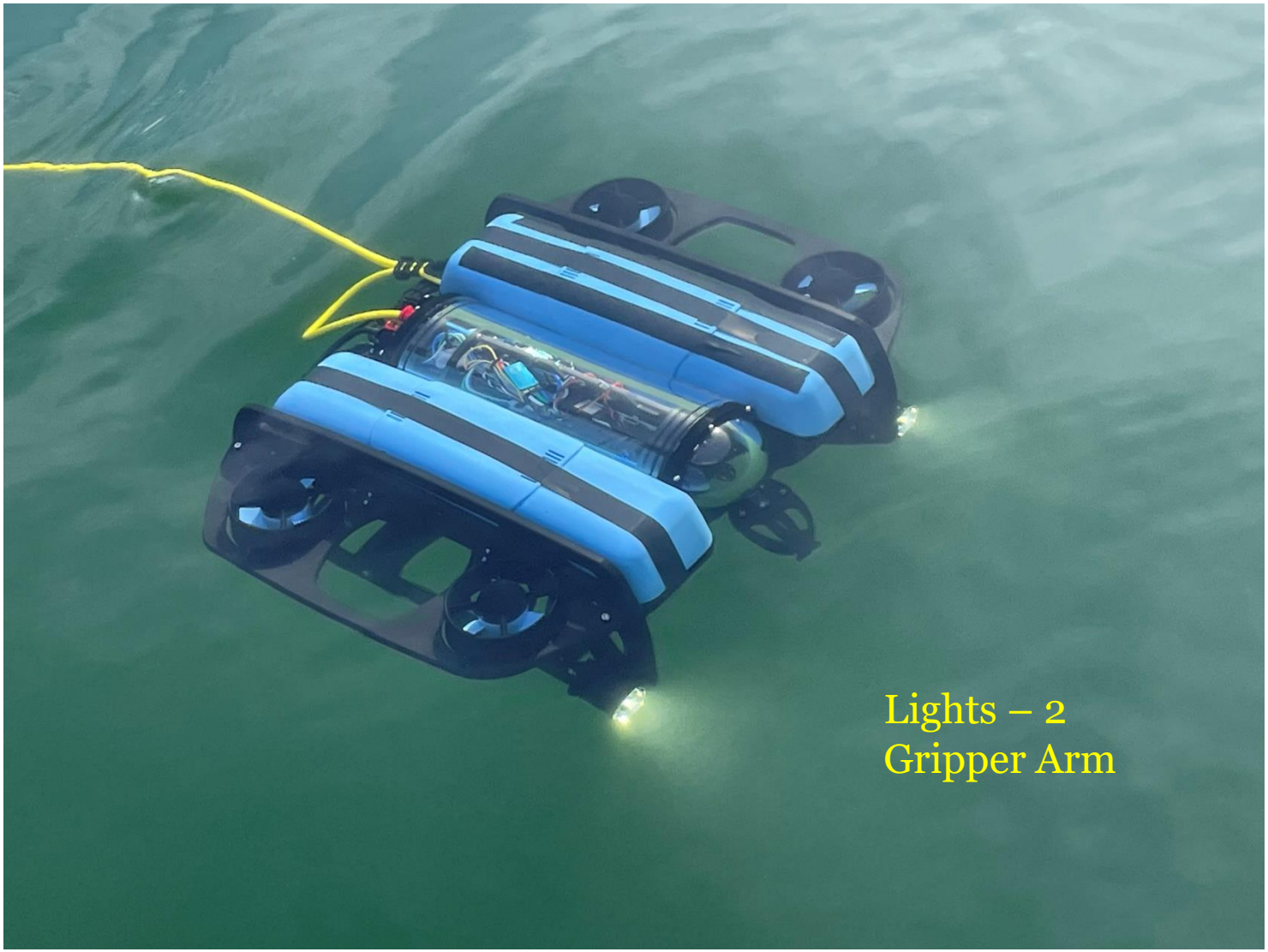
| Item | Vendor | Est, cost |
|---|---|---|
| BlueROV2 Kit | Blue Robotics | $3,490.00 |
| Fathom ROV Tether – 50 m | Blue Robotics | $ 375.00 |
| Lumen Subsea Light x 2 | Blue Robotics | $ 325.00 |
| Fathom Tether Spool | Blue Robotics | $ 680.00 |
| BlueROV2 Heavy Configuration Retrofit Kit | Blue Robotics | $ 740.00 |
| Payload Skid | Blue Robotics | $ 279.00 |
| Newton Subsea Gripper | Blue Robotics | $ 590.00 |
| Low light HD USB Camera | Blue Robotics | $ 99.00 |
| Mount for USB Camera | Blue Robotics | $ 4.00 |
| Camera Tilt System | Blue Robotics | $ 60.00 |
| Bar30 High Resolution 300m Depth/Pressure Sensor | Blue Robotics | $ 85.00 |
| PCB for Bar30 High Res Depth/Pressure Sensor | Blue Robotics | $ 50.00 |
| JST gH to DF13 Adapter, 4-pin | Blue Robotics | $ 10.00 |
| Celsius Fast-Response Temperature Sensor | Blue Robotics | $ 70.00 |
| I²C Bus Splitter | Blue Robotics | $ 14.00 |
| Lithium-Ion Battery (14.8V 15.6Ah) x 2 | Blue Robotics | $ 330.00 |
| H6 PRO Lithium Battery Charger | Blue Robotics | $ 160.00 |
| H6 PRO Battery Charger Cable | Blue Robotics | $ 10.00 |
| Battery Cell Checker | Blue Robotics | $ 15.00 |
| BlueROV2 Spares Kit | Blue Robotics | $ 289.00 |
| SOS Leak Sensor | Blue Robotics | $ 32.00 |
| SOS Probe Tips | Blue Robotics | $ 3.00 |
| T200 Thruster (spare) | Blue Robotics | $ 200.00 |
| Speed Controller: Basic ESC (spare) | Blue Robotics | $ 36.00 |
| Xbox Series X\|S Wireless Controller | Target | $ 59.99 |
| VISIONHMD Bigeyes H3 Portable 2.5K (optional) | Amazon | $ 129.00 |

# The Down Side!

- Someone has to put it together!
  - I naively thought it was a relatively simple task
  - Molly!
- And test it!
  - The scary part
  - Molly!



# OysterBot on the Farm (December 2022)



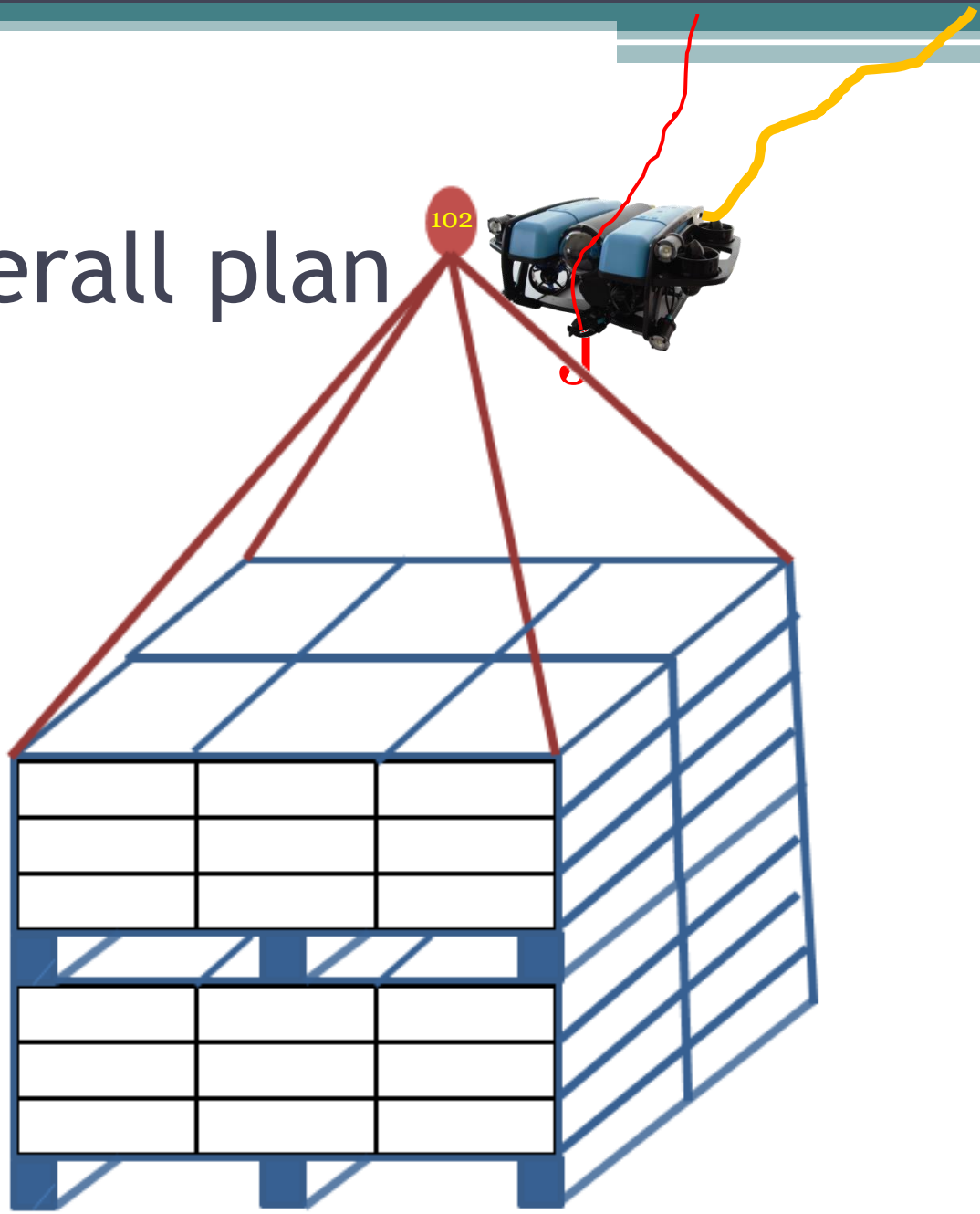
# OysterBot on the Farm - Operations

- Need to work through a few glitches
  - Autodepth control needed to be dialed in better
  - Visibility was difficult in full sunlight
    - Vision HMD Bigeyes

# OysterBot on the Farm

# OysterBot on the Farm

# The overall plan



# OysterBot on the Farm

# M/V Phoenix

# Work to be completed

- Develop the hook apparatus
  - Add buoyancy to make neutral in seawater
  - Use light-weight high-strength Spectra-type lifting line to Phoenix
- Test out Bigeye goggles for visibility in bright sunlight
  - Without inducing motion sickness?
- Evaluate ability to find and engage targeted bottom cages for lifting
- Train crew in the use of the system
  - Uses X-Box controller to fly ROV

# Lessons learned to date

- The components to be used for assembling the OysterBot are off-the-shelf technology that is non-proprietary in its application and readily available.
  - Estimated cost is about $8,000 for all the parts
- It has become obvious that assembly of an ROV from component parts is not something that can be routinely completed by an individual with limited experience in mechanical and electronic assembly.
  - The levels of cleanliness and attention to detail required during assembly may be problematic for an inexperienced assembly person.
- Debugging the assembled OysterBot has proven to be necessary as mechanics, firmware, and software controls need to be adjusted for the individual build.
  - While these tasks are not insurmountable, it does take a technical person to make these final adjustments and, again, are probably not achievable by an inexperienced assembler.
- However, the resulting operational ROV appears to be very successful in advancing our goal towards ropeless cage retrieval, at this point in our preliminary evaluation.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# Thank you

BLUE STREAM SHELLFISH

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