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Feasibility Study for Detection of Shrimp Feed Pellets on Pond Bottom Substrate Using a Scientific Sonar System

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Shrimp Feed Accounts for 70% of the Total Production Cost

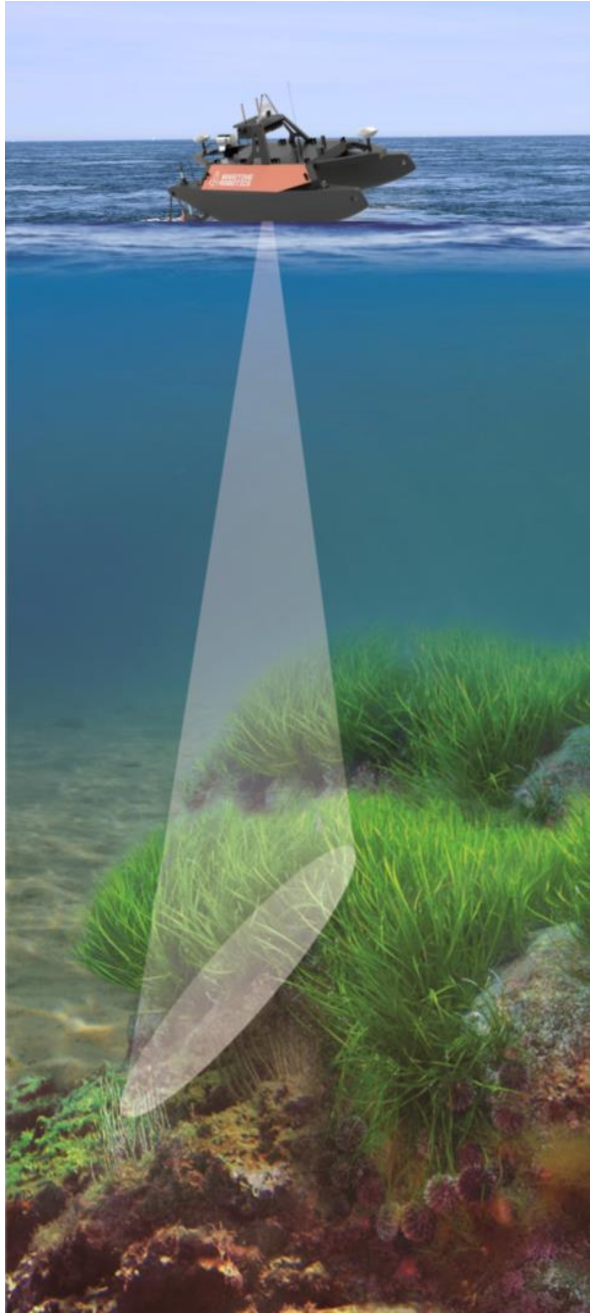
- Feeding the maximum amount the population will consume, without overfeeding, is an ongoing challenge to shrimp farming operat ors.
- Underfeeding slows the time it takes the population to achieve optimal harvest weight, increasing production costs.
- Overfeeding wastes costly feed and can cause detrimental effects to the production environment.
- Feed Conversation Rates (FCR) are relatively well understood
- It is nearly impossible to assesses total biomass of a pond population and calculate the amount to feed using the biomass / F CR method

Empirical Measurement of Wasted Feed Could Be an Effective Way to Optimize Feeding

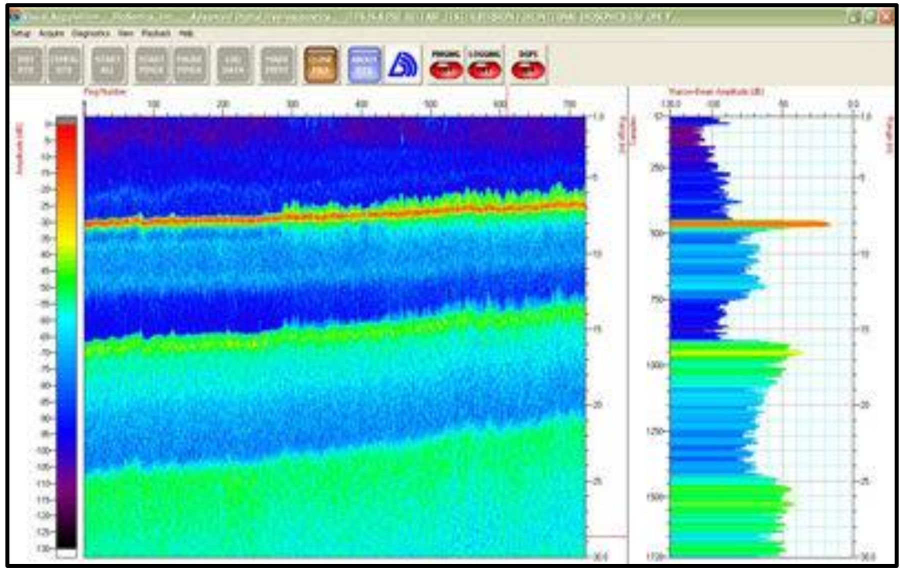
- Feed is delivered at the pond surface and slowly sinks to the bottom (2+/- meters depth)
- Feed is usually consumed in the water column as it sinks
- Uneaten feed settles on the bottom and is largely wasted
- Studies have shown that common waste amounts settled into the bottom are between 50 – 250 grams per square meter
- 50 grams / square meter waste is acceptable. More waste is not acceptable.

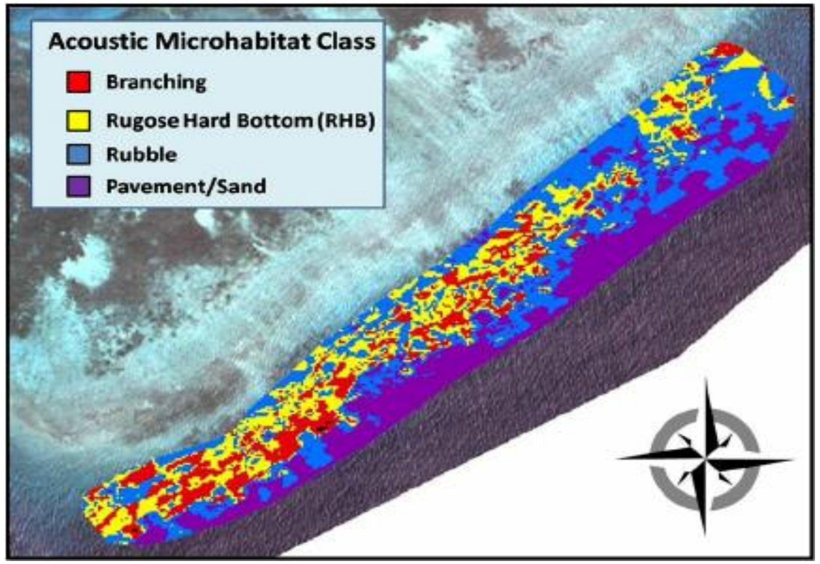
Is it possible to use remote sensing to detect and quantify wasted feed and use this this as an effective empirical method to optimize feeding ?

Feasibility Study for Detection of Shrimp Feed Pellets on Pond Bottom Substrate Using a Scientific Sonar System



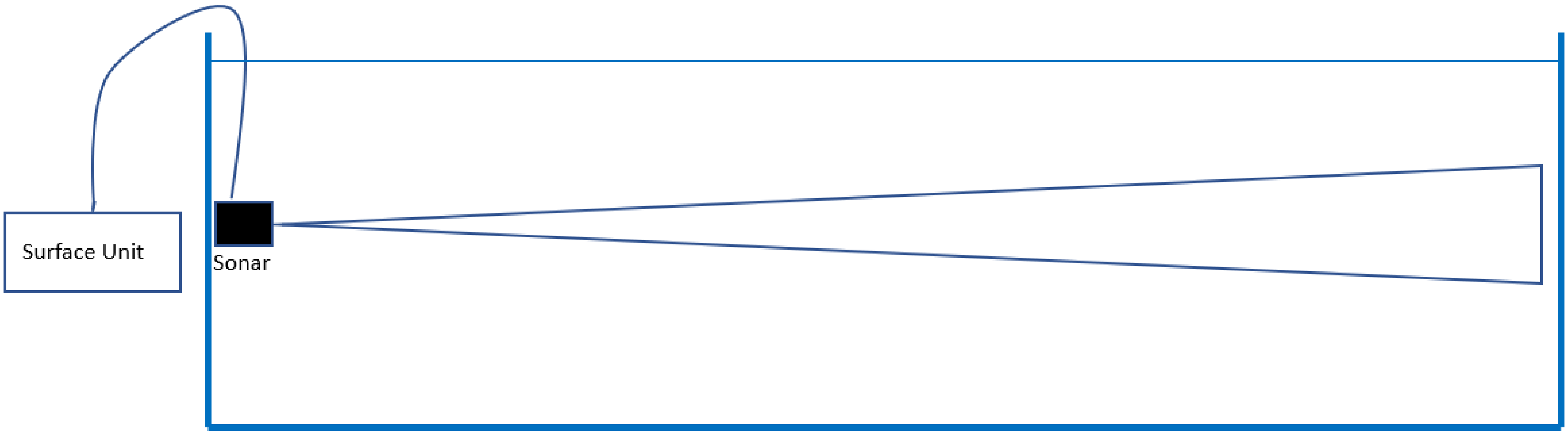
- In a lab setting, use actual shrimp feed and simulate 50 and 250 gram / square meter bottom distributions and collect data using a scientific sonar system
- Use existing bottom typing sonar data analysis techniques to assess feed detection and quantification capability



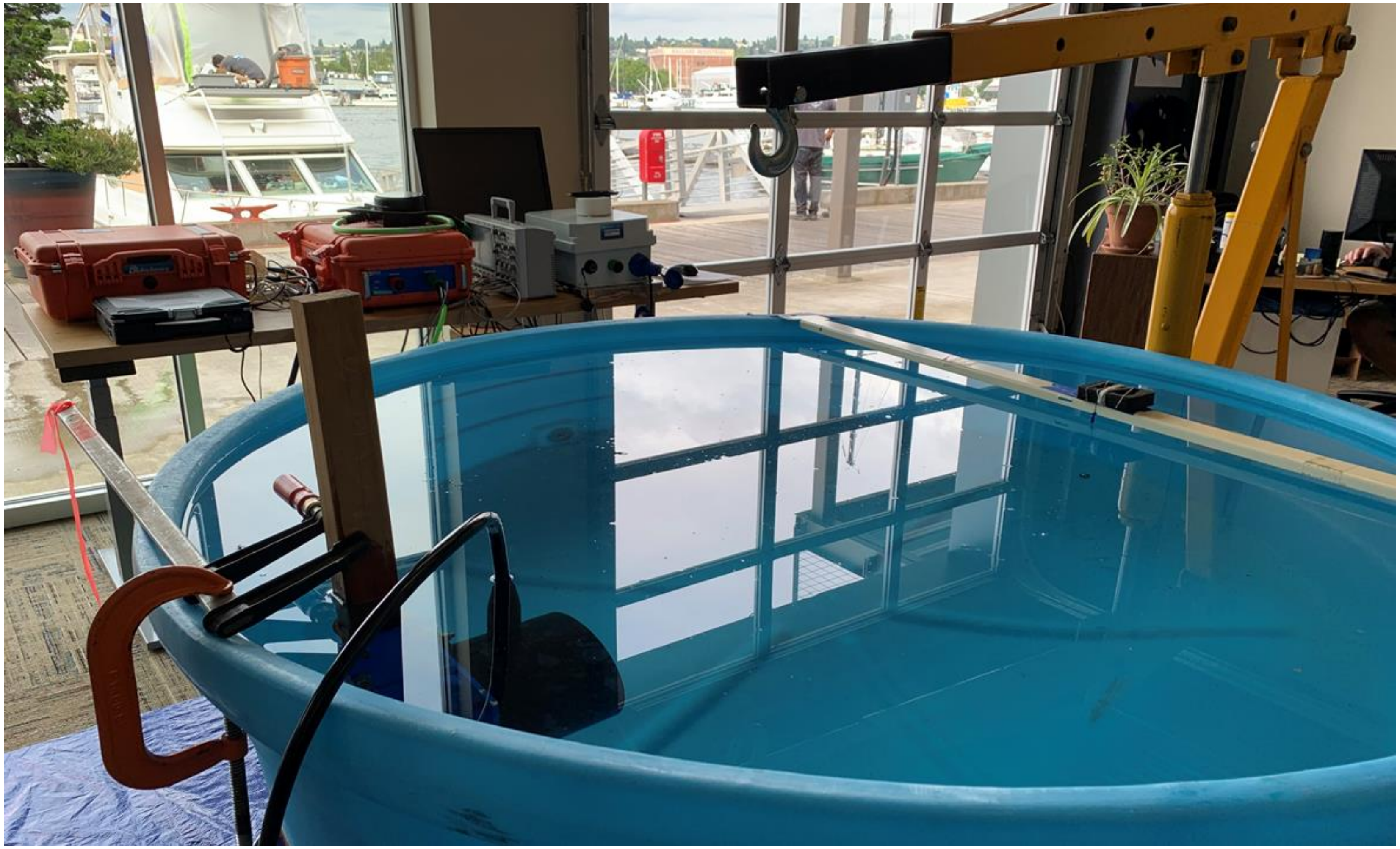


Methodology

- Use side looking method for easier experimental control
- Deploy 420kHz 6-degree split beam transducer, surface unit and data collection computer

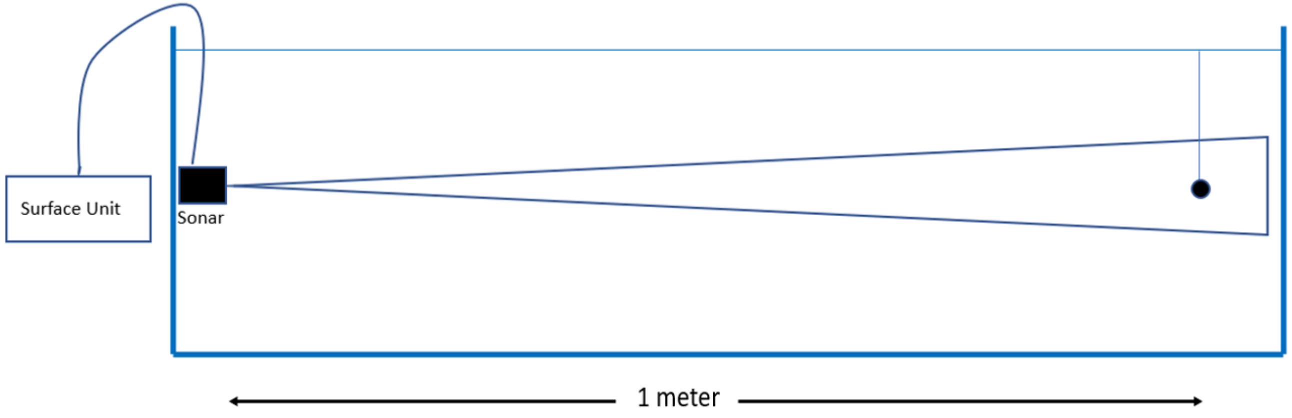


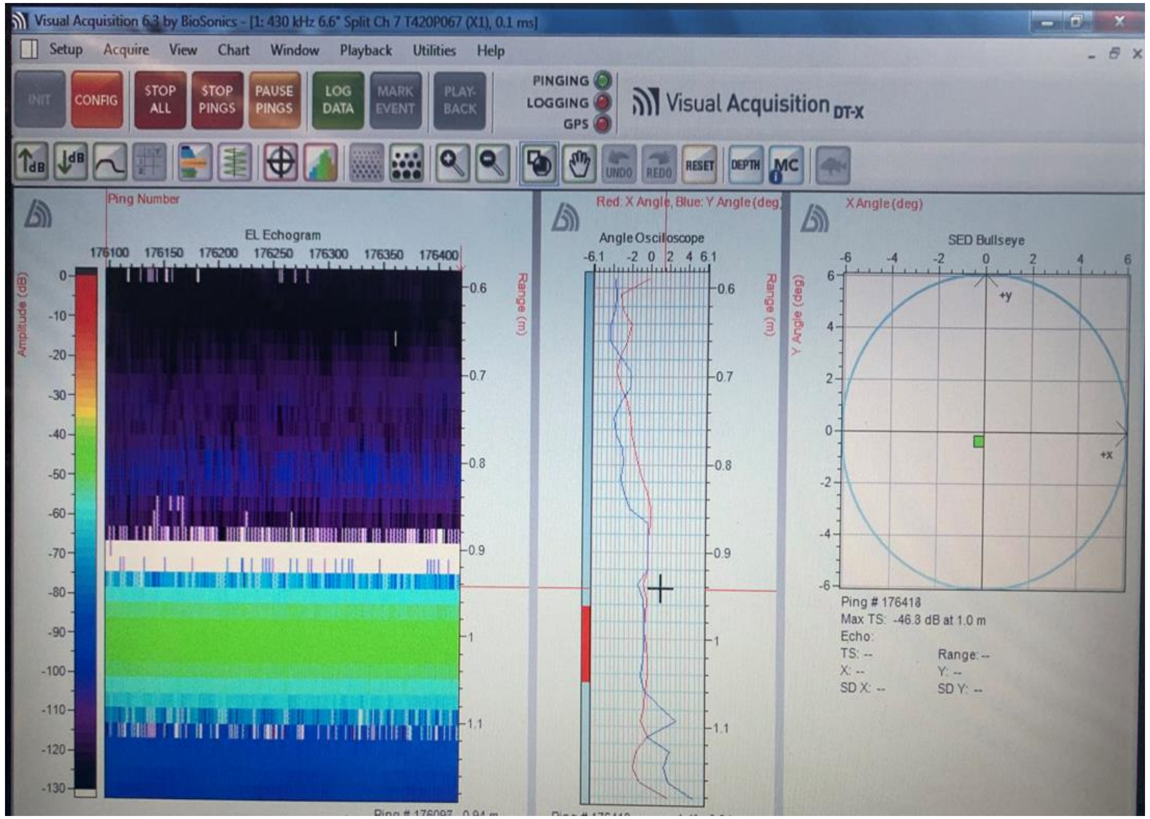
Methodology



Calibration

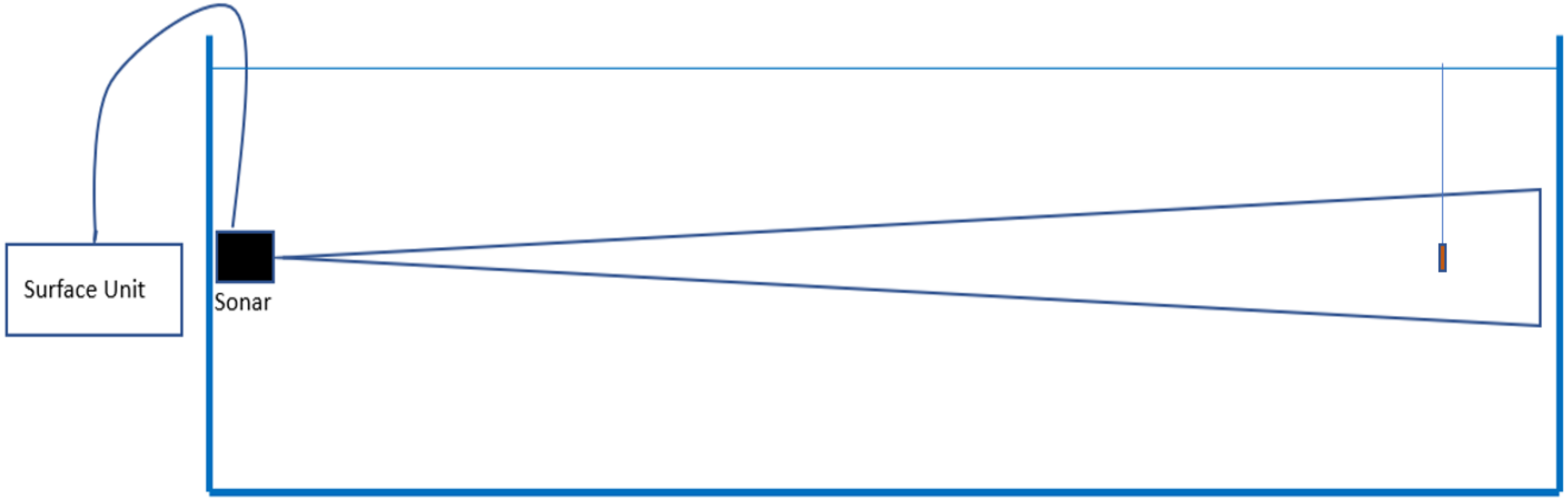
System calibration was conducted using a standard tungsten carbide reference sphere positioned at a range of 1.0 meters from the sonar





Feed Pellet Detectability and Target Strength Measurement

The sonar signature of an individual feed pellet was measured using the calibrated sonar system. This was accomplished by gluing a feed pellet to a fine filament and positioning the suspended pellet in the sonar beam in open water.



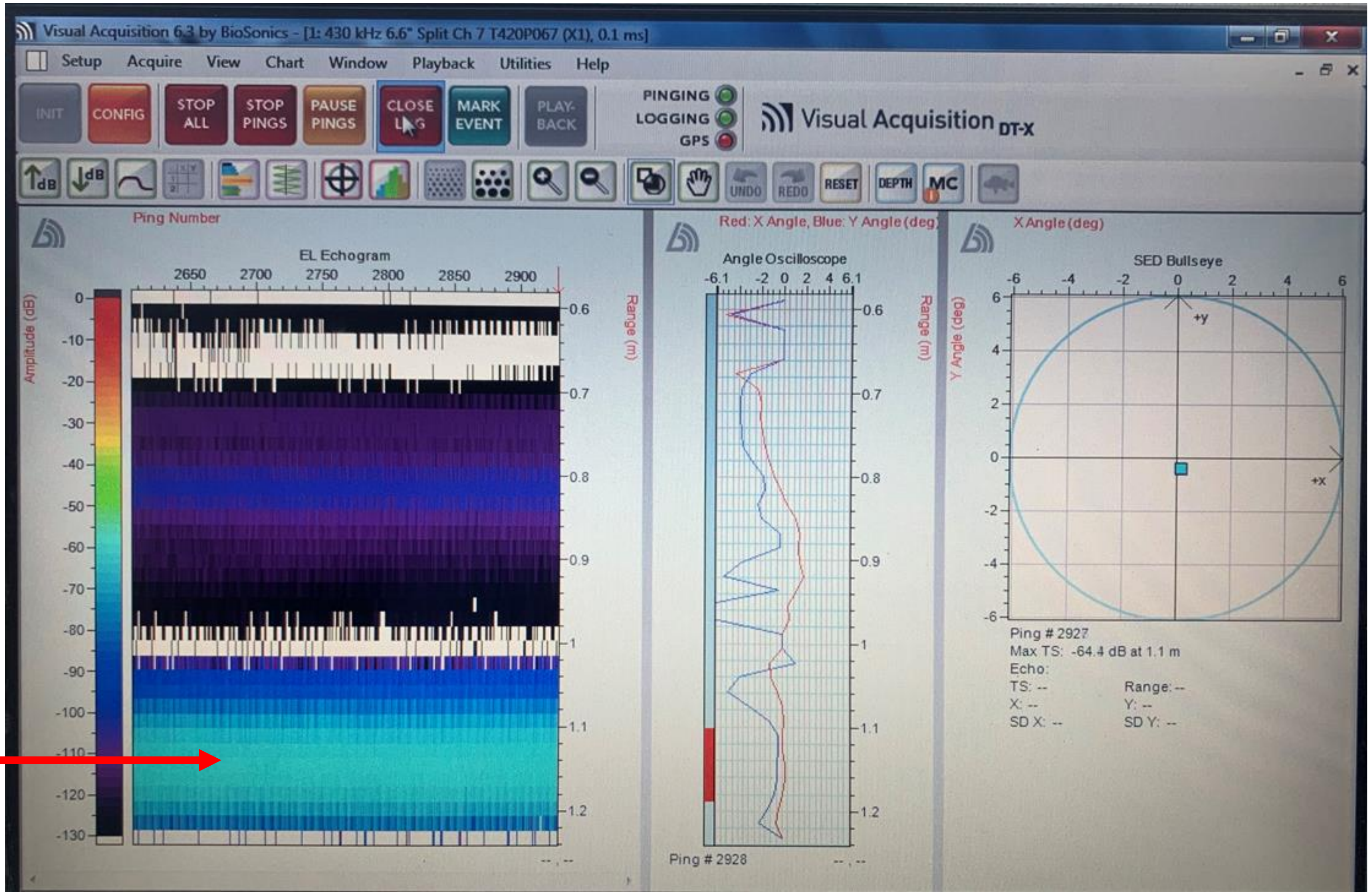
Feed Pellet Detectability and Target Strength Measurement

Data was collected on the suspended pellet for six hours to determine the initial sonar signature (target strength in decibels) and to quantify any degradation in the value over time as the pellet disintegrated.

The target strength of the pellet was measured at - 65 decibels (dB) on initial testing and did not significantly change (decrease) over a six-hour testing period.

Numerous pellets were tested simultaneously and did not significantly vary in target strength.

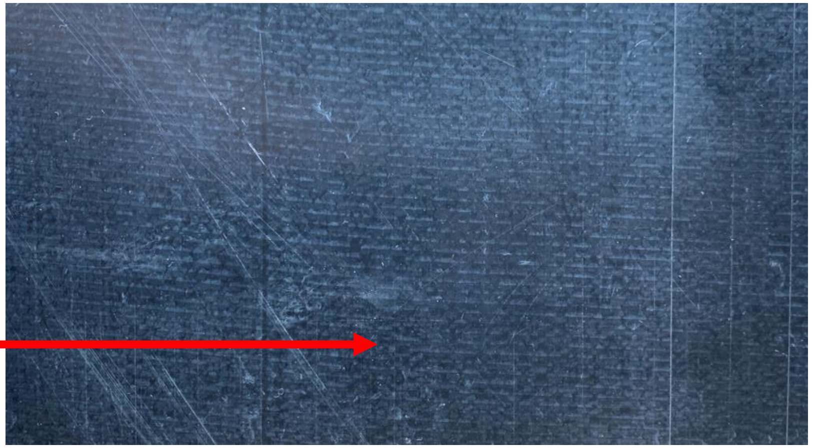
Time series data collected on an individual feed pellet suspended in open-water, 1.1 meters from the sonar



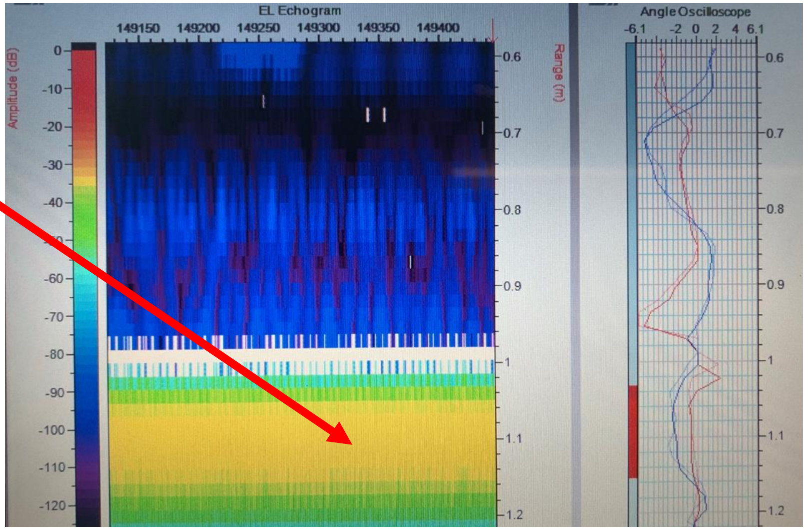
Feed Pellet Detection on Simulated Substrate

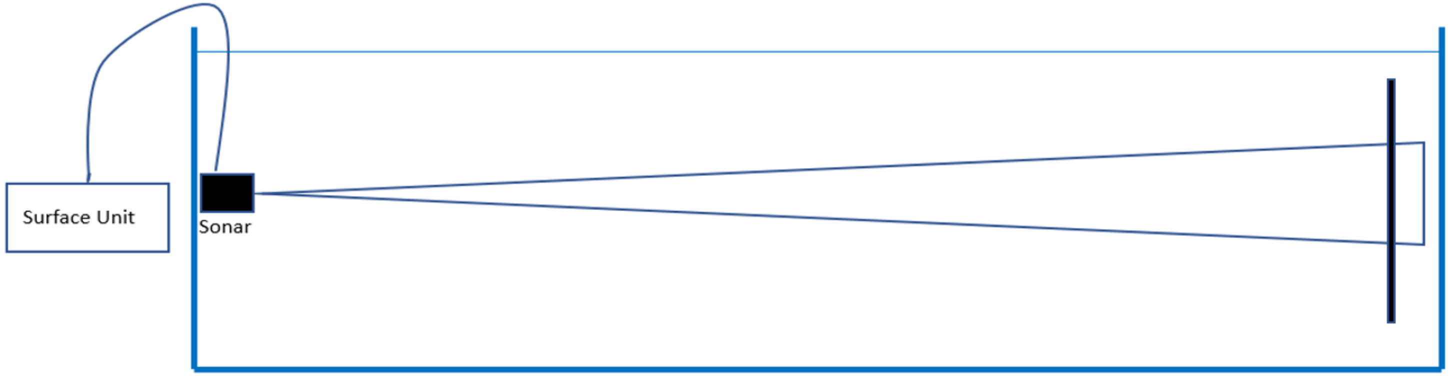
Once it was determined that the feed pellets did have an actual and consistent sonar signature, personnel could begin with the critical experiment of measuring sonar pellets at various suggested realistic densities on a simulated bottom substrate.

The simulated bottom substrate chosen was a sheet of Polyoxymethylene (Delrin) plastic. This material was chosen for the fact that it is somewhat transparent to the sonar but is reflective enough to simulate a flat sandy bottom.



Baseline data was collected on the simulated substrate and the sonar signature was established at -35 dB. Typical for a flat, sandy bottom. Note that this is a much more highly reflective value than the -65 dB value established for the feed pellets.

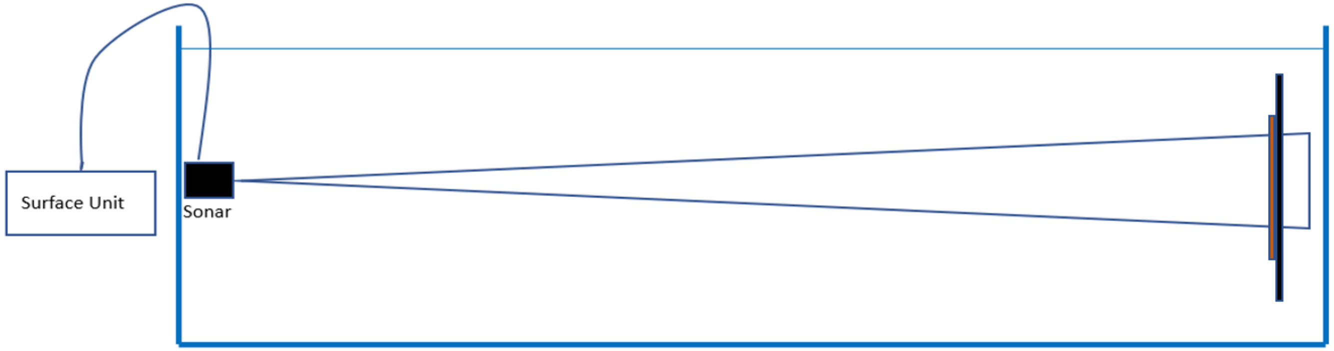




Feed Pellet Detection on Simulated Substrate

Three simulated pellet waste densities were selected, and these examples were prepared by physically gluing pellets directly to Polyoxymethylene sheets in the appropriate distributions

The three prepared examples were each positioned at the same range and orientation as the baseline Polyoxymethylene example and data was collected and analyzed



50 gram per square meter density

250 gram per square meter density

I kilogram per square meter density

Feed Pellet Detection on Simulated Substrate

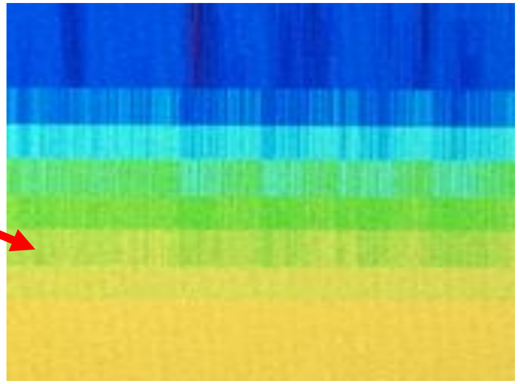
Data analysis of pellet distributions glued to the simulated bottom substrate was conducted using all available methods and proved insufficient in all density distributions in discriminating the pellets against the substrate.

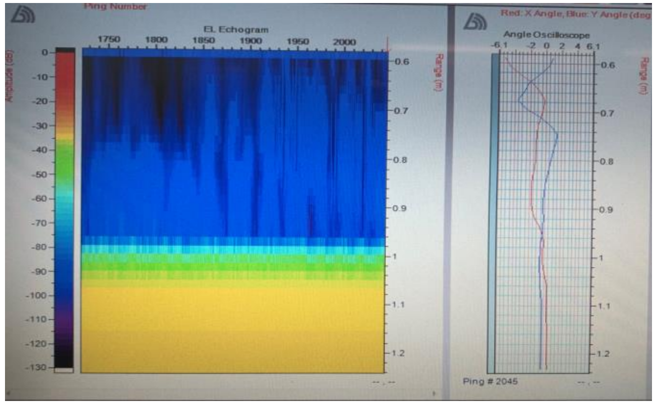
Causes of the inability to discriminate the pellets are attributed to:

A) The pellet thickness is approximately 1mm and therefore can not present any significant topographic projection against the substrate that is measurable.

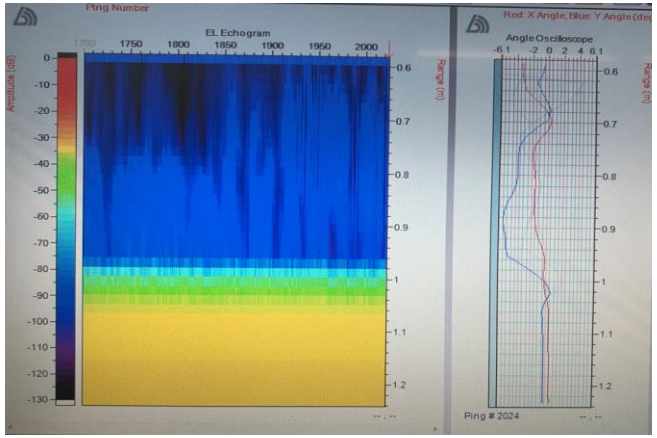
B) The pellet target strength of -65 dB is significantly lower than the -35 dB target strength of the simulated substrate and this results in target "masking"

Pellet target "masking"
by highly reflective substrate





50 gram per square meter density data



250 gram per square meter density data

Conclusions and Recommendations

The shrimp feed pellets have a significant and stable sonar signature that does not appear to diminish, even after 6 hours of submersion in the test tank. The pellets can easily be detected, and target strength measured using standard scientific sonar methods when isolated in the water column.

Numerous pellets passing through a fixed side looking sonar could detected and counted

The shrimp feed pellets were not easily detectable using any method when on a substrate that simulates a sandy bottom and would likely be similarly difficult to detect when distributed on any type of typical bottom.

It is possible that detection would be successful if the distribution was much mere extensive, covering the bottom, but as discussed, this is not a realistic scenario.

It is still unclear how to assess feed waste on the bottom of shrimp pond using any practical method

If you have ideas, please suggest, as the industry needs a solution !

Thank You AFAS 2021

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