Feasibility Study: Remote Sensing of Lost Snow Crab Pots in Newfoundland and Labrador

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Feasibility Study: Remote Sensing of Lost Snow Crab Pots in Newfoundland and Labrador

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ABSTRACT

The objective of this study was to develop a technique for remotely detecting lost snow crab pots and briefly test its feasibility on snow crab grounds in the Newfoundland region. The project was a collaboration of the Fisheries and Marine Institute of Memorial University, professional fish harvesters, Canadian Centre for Fisheries Innovation, Department of Fisheries and Aquaculture, and the Fish Food and Allied Workers.

While side scan sonar has been available for a couple decades, advances in the technology and reductions in price have only recently demonstrated its utility in fisheries applications, including its use by fishermen to locate and retrieve lost gear (e.g. Bergren-Smith, 2011). However using the technology in deep water to detect snow crab pots was an unknown. This short feasibility project tested the effectiveness of the technology in the province of Newfoundland and Labrador.

During the period of November 23-26, 2012, a feasibility assessment on the remote sensing of lost snow crab pots was conducted on traditional snow crab grounds in Conception Bay, Newfoundland and Labrador. Figure 1 indicates the location of the study area where the (target) snow crab pots were deployed - coordinates 47° 32’ 21.4” South latitude, 53° 09’ 05.6” East longitude - 47° 32’ 43. 37” North latitude 53° 09’ 15.56” West longitude.

Figure 1. Location of the study area where the snow crab pots were deployed in Conception Bay, Newfoundland and Labrador.
1.0 INTRODUCTION

The snow crab (*Chionoecetes opilio*) fishery is Newfoundland and Labrador’s most economically valuable commercial fishery. In 2011, the fishery landed 52,946 tons of snow crab with a landed value of approximately $251 million (DFA, 2011). According to the snow crab management plan (DFO, 2009), this fishery is prosecuted using a maximum of approximately 2,700 licenses and 1.19 million crab traps. A small proportion of these traps are lost annually due to bad weather, heavy ice conditions, cutting of ropes, or traps being snagged on the seabed (Bullimore et al., 2001). While accurate estimates of the number of traps lost or abandoned each year are unknown, the phenomenon of ghost-fishing is well documented (Breen, 1989). In Newfoundland and Labrador, Miller (1977) estimated an 8% annual trap loss during the snow crab fishery. However this is likely to be a dynamic value and it would be expected to vary between years, regions, and fleets. The economic impact that lost traps cause to the provincial snow crab fishery is difficult to estimate. Empirical studies with defendable data have simply not been conducted. The only related study was conducted in the Gulf of St. Lawrence using a different trap type (Hebert et al., 2001). The authors of that study investigated the numbers of crab that continued to enter intentionally lost traps over a period of 318 days. The findings were highly variable and it is uncertain whether the results are representative of what would be expected in smaller Japanese-style traps used in Newfoundland and Labrador. Nonetheless, the proponents of this study agree that efforts should be undertaken to mitigate any effect that lost pots might have on the sustainability of the resource.

Side scan sonar is a system used to create images of the seafloor. It is a commonly used tool to detect and identify debris and other objects on the seafloor. It is designed to look sideways and at a downward angle from both sides of a towed unit, called a "towfish". The seafloor and any objects sitting on the sea floor reflect sound waves back to the towed array and from this information an image is produced. Using this type of system, very large areas of the seafloor can be mapped quickly and easily (Figure 2). Small obstacles such as crab pots may be detected if an appropriate acoustic frequency and view geometry are used. Most side scan sonar’s operate using sound frequencies in the range from 100 to 1200 KHz, the higher the frequency the better the resolution, however higher frequencies also are limited in the range in which they can “see” (Natural Resources Canada, 2008). At 100 KHz, typical ranges are 300-500 m per side, while higher frequencies such as 500 KHz are limited to 100-150 m per side.
During the period of November 23-26, 2012, a feasibility assessment on the remote sensing of lost snow crab pots was conducted on traditional snow crab grounds in Conception Bay, Newfoundland and Labrador. The project was inspired by a similar study conducted in Chesapeake Bay (U.S) where side scan sonar was successful in the retrieval of 700 Blue Crab pots. In that study, detection depth using side scan sonar was limited to 14 - 63 meters. Newfoundland waters by comparison are significantly deeper (>200 m), necessitating a short technical study to assess the feasibility of the technology.

The Marine Institute vessel the *M/V Anne S. Pierce* was used for 2 days to conduct the at-sea research. A multi-disciplinary team consisting of professional harvesters, fisheries technologists, ocean mapping specialists and a side-scan sonar specialist participated in this study.
2.0 MATERIALS AND METHODS

The study was carried out in Conception Bay, NL, during November 23-26, 2012. The Marine Institute’s near shore research vessel *M/V Anne S. Pierce* departed St. John’s on Nov 23rd and steamed to the community of Long Pond in preparation for the project. The two subsequent days (Nov 24 and 25) were used to assess the feasibility of the side scan sonar.

On Day One, a total of twenty-five (25) snow crab pots and one (1) sea rom device (solid circular target) were deployed in a single fleet with high flyers on both ends. The fishing gear was deployed on known fishing grounds under the advice of the professional fish harvesters onboard. Pots were spaced 36 meters apart, at depths of ~ 200 – 220 meters. Once in position, the pots were surveyed with the sonar equipment under ‘controlled’ conditions. The potential impacts of height of the tow fish off the seabed, across-track range, and sonar frequency (100 kHz versus 500 kHz) on the ability to detect pots were all evaluated.

On Day Two, the vessel re-located to a new area within the Bay and completed a search pattern in a known fishing zone in order to determine if any lost pots within the area could be located using the side scan sonar. An area with a more concentrated fishing effort was initially suggested (industry partners) but was abandoned because of inclement weather. All acoustic data was compiled, mapped, and analyzed at the Marine Institute.

The final day of the project (Nov 26) was used for demobilization and return voyage of the vessel to St. John’s.
3.0 RESULTS

Day One: With the side scan sonar deployed, the vessel was directed to conduct a series of overlapping transects parallel to the fleet of crab pots. The ideal frequency was determined to be 500 KHz, which yielded an across track range of 150 meters per side for a total of a 300 meter wide transect. The snow crab pots were detected on the seafloor resting in a depth of 218 m (118 fathoms). Figure 3 illustrates a ‘screen grab’ of the sonar image. In the image, we see the echoes of 5 crab pots placed in a fleet along the seabed (denoted by red arrows) as well as the polyethylene rope (mainline) floating between each crab pot (denoted by blue arrows). On this particular pass, the side scan sonar was flying approximately 40 meters (22 fathoms) off the seafloor at a vessel speed of 4.5 knots. The maximum across track distance that a pot was detected was 130m.

![Figure 3. Side scan sonar image (left side) of a fleet of snow crab pots on the seafloor at a depth of 218 m. Red arrows denote crab pots. Blue arrows denote the mainline of the fleet that connects the pots together.](image)
Day Two: The vessel re-located to a new area within the Bay and completed a search pattern in a known fishing zone in order to determine if any lost pots within the area could be located using the side scan sonar. Several overlapping transects were conducted. Figure 4 illustrates a mosaic of the sonar imagery overlaid onto a nautical chart. While several interesting features were detected on the seafloor, unfortunately no lost (ghost) pots were detected.

Figure 4. Side scan sonar search pattern conducted on Day 2 in search of lost snow crab pots in Conception Bay, Newfoundland.
4.0 DISCUSSIONS

4.1 Outcome

The results of this study demonstrated that side scan sonar can successfully detect snow crab pots at depths up to 215 m and a maximum across track range of 130 m when the tow fish was situated 40 m from the seafloor. To our knowledge, this is the first time side scan sonar has been used to detect snow crab pots at significant water depths. The results build upon existing literature documenting the use of side scan sonar to detect lost fishing gear at sea (Bergren-Smith, 2011).

Our ability to detect crab pots in this study faced a couple of challenges:

First, due to limitations experienced with the vessels hydraulics, we were unable to dynamically pilot the side scan sonar in real time. This necessitated us to tow the instrument in ‘safe mode’ at greater distances off the seabed in order to avoid collisions with the seabed. This limited our use of higher frequencies, reducing image quality, and pot detectability. A small modification to the hydraulic system to limit overheating (i.e., installation of a cooling unit) would overcome this obstacle.

Second, the vessel speed could not be easily reduced below 4.5 knots. This limited our ability to tow at slower (more preferred) speeds of 1 to 3 knots. We speculate that this may have reduced image quality and therefore pot detectability. Should future side scan sonar work be conducted on this vessel, we recommend that the engineer and captain investigate methods to navigate the vessel at slower speeds.

4.2 Project Highlights

- Collaborative research development between the Marine Institute and fishing industry.
- Non-traditional or innovative use of the technology (i.e. in the fish harvesting sector).
- Highly relevant to industry - especially with declining crab stocks.
- Fostered multi-disciplinary collaboration between internal departments of the Marine Institute (i.e., CSAR, CTec, and SOT programs).
- Provided an industrial training exercise for local students – ocean mapping students participated in the study and were able to gain experience in applied industrial research and development.
4.3 Project Team Members

- Henry Manning “captain” and Crew – Marine Institute vessel ‘M/V Anne S. Pierce’.
- Rennie Sullivan - Project lead – mobilization of fishing gear and equipment.
- Doug Cartwright – Data analysis and mapping.
- Finley Beaton - Side scan sonar technologist.
- Georgina Bishop – SOT instructor (ocean mapping).
- Chris Keats – SOT instructor (ocean mapping).
- Students – Observe first hand R & D in action.

4.4 Industry Perspective

Two professional fish harvesters (Rodney Mercer and Dean Ackerman) participated in the study. The following section documents their thoughts and comments collected via telephone interview following the study. They were asked whether they thought the technology could be successfully deployed on commercial fishing vessels similar to Bergren-Smith (2011).

Rodney Mercer – industry partner

- No problem setting up and using the side-scan sonar on a 34’ 11” up to a 64’ 11’ commercial fishing boat.
- All fishing boats are equipped with some kind of a winch.
- Tow fish (sonar) can be towed using the boom over the stern or over the side of the vessel.
- Would be interesting to see sonar image of pots containing crab…certainly would make for better acoustic target.
- With regard to doing a survey of known snow crab grounds, it would be more feasible to do it during the summer just after harvest time when you mostly have good calm weather (July-August).
- All fishing vessels are categorized and limited to how far offshore they can go. This is based on the length of the vessel. For example, a 39’ 11” vessel is not allowed to fish outside of 20 nautical miles.
- Most fishing vessels have a lower idle speed (1- 2 knots) which keeps everything consistent when pulling the tow fish.
- Side scan sonar equipment can be set up in the wheelhouse.
- A technician from the Marine Institute could come along for a couple of days to make sure everything is up and running properly and then you can continue on your own.
Dean Ackerman - industry partner

- There would not be a problem with regards to the whole operational side, such as deploying the winch, and putting the side scan sonar over the stern on fishing vessels 35 to 40 feet and up,
- Any reasonable size fishing boat will have a wheelhouse capable of housing the electronics.
- Weather wise the summer rather than winter would be a better time to do a side scan survey.
- We speculated that if the pots were full of crab, they might be easier to detect.
- Trying different water depths and bottom type might enhance pot detection.

5.0 SUMMARY AND RECOMMENDATIONS

During the period of November 23-26, 2012, a feasibility assessment on the remote sensing of lost snow crab pots was conducted on traditional snow crab grounds in Conception Bay, Newfoundland and Labrador.

The results of this study demonstrated that side scan sonar can successfully detect snow crab pots at depths up to 215 m and a maximum across track range of 130 m when the tow fish was situated 40 m from the seafloor. To our knowledge, this is the first time side scan sonar has been used to detect snow crab pots at significant water depths. The results build upon existing literature documenting the use of side scan sonar to detect lost fishing gear at sea (Bergren-Smith, 2011).

Side scan sonar can be an effective tool for locating lost snow crab fishing gear; several potential impacts could be imagined:

- Creation of an industry-led retrieval program similar to Bergren-Smith (2011) in which fishing enterprises are equipped and trained to locate and retrieve lost gear.
- Arresting the active ghost-fishing of pots, thereby improving ecosystem functioning, public perception of fishery, and the likelihood of fishery certification.
- Decrease the economic loss of crab mortality due to ghost fishing in Newfoundland and Labrador.
6.0 ACKNOWLEDGEMENTS

Financial and in-kind contribution for this project was provided through the partnership of the Canadian Centre for Fisheries Innovation (CCFI), Government of Newfoundland & Labrador (FTNOP program), Fish Food and Allied Workers (FFAW), and the Marine Institute (MI) of Memorial University of Newfoundland.

Special thanks to Capt. Henry Manning and crew of the M/V Anne S. Pierce who assisted in the successful completion of this project, as well as the advisory support of Eric Davis, Randy Gillespie and Paul Brett.

7.0 LITERATURE CITED


APPENDIX I - PICTURES TAKEN DURING THE FEASIBILITY STUDY

Picture 1: M/V Anne S. Pierce rounding Cape St. Francis enroute to study site.

Picture 2: Deploying snow crab pots to selected study area.
**Picture 3:** Technologists and crew readying side scan sonar equipment.

**Picture 4:** Side scan sonar technologist putting the finishing touches to the “tow fish” prior to deployment.
**Picture 5:** Tow fish being lowered over the stern of the Anne S. Pierce.

**Picture 6:** Side scan sonar electronic equipment “set up” (dry lab).
Picture 7: Students from the School of Ocean Technology get some “hands on” instruction from side scan sonar technologist.

Picture 8: Students from the School of Ocean Technology observe R&D in action.
Picture 9: Detected images of snow crab pots (left side) recorded by side scan sonar.