**2021 Snow Crab Survey Experimental Protocol**

**Context:**

The vessel change during the 2019 snow crab survey was accompanied by significant increases in survey catches of 30-40% among male and mature female snow crab from 35mm to 95 mm CW. The scale and size range of these increases ruled out natural processes (recruitment, migration or low mortality) as a likely causes, implying that the catch increases were caused by some unknown artificial mechanism. The impact of these mechanisms on survey catches of legal-sized crabs is unknown, raising concerns of over-estimation of commercial abundance and biomass indices for 2019 and 2020.

Investigations into a causal mechanism revealed that the vessel change in 2019 was accompanied by a significant increase in the duration of a latent bottom trawling phase during hauling of the net, referred to as the passive trawling phase, suggesting that this mechanism may be the issue. This passive trawling phase is not used for standardizing survey catches and thus represents a source of bias. Attempts to control the extent of the passive phase during the 2020 survey largely failed, despite some changes in trawling protocol.

For the 2021 survey, we propose that a short experiment be performed at the start of the survey to determine the best approach to control the extent and variability of the passive trawling phase. The experiment will be as follows:

* The current survey vessel will trawl a total of 20 tows over a period of two days.
* A single location will be chosen at a depth of 60-80 meters, ideally containing high densities of snow crab suitable for comparing catch levels.
* Two different net hauling procedures will be tested, applied to 10 tows each, with each procedure attempting to minimize movement of the trawl after the end of active trawling.
* The **first procedure** will minimize trawl movement by reversing the vessel’s speed and approach the trawl position at the end of active trawling while hauling.
* In contrast, the **second procedure** will attempt to minimize trawl movement by increasing the survey vessel’s speed while hauling at an increased winch speed, ostensibly leading to sufficient tension in the cables to lift the trawl from the bottom.
* Consistency in the application of winch speed is desirable.
* A suite of **probes** will be attached to various parts of the trawl to monitor the trawl configuration during the experiment, including:

1. Depth probe(s) on the trawl headline.
2. Tilt-depth probes on each of the trawl doors.
3. Tilt-depth probes in the center and on either side of the trawl footrope.
4. A device for measuring the cable hauling speed during winching.

**Key questions:**

* Which end-of-tow procedure result in less trawl movement after active trawling has ceased?
* Are there practical considerations for each procedure must be considered if they are to be applied for the greater survey?
* Is the trawl footrope making efficient contact with the bottom during winching of the trawl cables?
* How many crab does the passive phase trawling seem to be adding to observed trawl catches?
* Which procedure is to be used for the 2021 snow crab survey?

**Deliverables:**

* Procedural recommendation for the 2021 snow crab survey.
* Communication of preliminary results with stakeholders at the onset of the survey.

Wing

Star Oddi-TD

Star Oddi-Tilt

eSonar probe

Wing

Depth

Headline

Footrope

Cod end

Wing

Bridle

Door

Height

Floaters

**Figure 1**: Suggested placement of sensors to monitor trawl geometry during the pre-survey experiment. Data gathered by these probes will aid in determining the best end-of-tow procedure to control the extent of the passive trawling phase for the 2021 survey.

**Table 1:** Summary of different measurement variables proposed ahead of the 2021 snow crab survey season to address current survey catchability issues, along with a description of each, their intended purpose and frequency of observation.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Data variable** | **Description** | **Purpose** | **Data source** | **Frequency** |
| Footrope contact | Gather data to see how contact footrope along its length varies on different bottoms, debris loads, as well as during the passive trawling phase. | Relate differences in survey catches to variations in footrope contact. Characterize passive trawl phase catchability. | Tilt-depth probe (e.g. Star Oddi) | Small number of tows in different sediment types. |
| Door contact | Gather data to see how trawl door contact varies during trawling, especially during winching and lift-off. | Determine the relationship between the trawl lifting off of the trawl doors and trawl geometry during the passive trawling phase. | Tilt-depth probe (e.g. Star Oddi) | Infrequent random monitoring of survey |
| Trawl-vessel distance | Measure the distance between the trawl and survey vessel. | Validate indirect methods used to determine trawl position. | Trawl acoustic probe | Small number of tows |
| Winch speed and/or cable tension. | Measure how winch speed and/or cable tension varies during the passive trawling phase. | Improve methods used to determine the trawl position relative to the survey vessel in 2021 and previous survey years. |  | Small number of tows |
| Video monitoring or 3D sonar imaging probe. | Attach video and lighting equipment, or a 3D sonar imaging probe to monitor the behavior of the survey trawl. | Improve knowledge of trawl dynamics and crab catchability during trawling. | e.g. GoPro | Special experiment at the beginning of the survey. |
| Trawl symmetry | Measure whether the trawl configuration is symmetrical (i.e. equal) on either side. | Ensure that the trawl is not skewed relative to the survey vessel. |  | Regular monitoring during the survey |
| Fixed stations | Sample a representative subset of the original random sampling stations from 2013. | Check whether survey indices are biased due to relocation of survey sampling stations since 2013 |  | 50-100 survey stations |
| Double-trawl experiment | Re-analyze data from a double-trawl experiment performed in 2002, featuring a trawl-within-a-trawl design. | Directly estimate size-dependent catchability using the 2002 experiment data, used to possibly standardize catches relative to size or to validate population model size-based catchability estimates. | 2002 experiment | n/a |