Project

# Experimental evaluation of the behavior of the Southern King crab trap fishery groundline, and its potential impact in whale entanglements off Patagonia and Tierra del Fuego (Argentina)

## Final Report (April, 2025)

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## Rationale

Groundlines used in the Southern king crab (*Lithodes santolla* Molina 1782) trap fishery (SKC-TF) are the main source of whale entanglement off Patagonia and Tierra del Fuego (Argentina). No study has measured the curvature, movement or elevation of the ropes above the seabed in this fishery, and tested if negatively buoyant ropes effectively could decrease the risk of entanglement. Additional information on the effect of changes in the length of groundline between individual traps is also needed.

At least four whale species have been recorded to die in this fishery, all of them legally protected at both the international and national level. Fishery regulations proposed the use of negatively buoyant groundlines (Federal Fisheries Council [CFP] Resolution 12/18, Art.28; uploaded), but itis still not fully implemented. The SKC-TF fishery was included in the NOAA's Final List of Foreign Fisheries (LOFF) in 2020, with near 70% of the catch currently exported to the US. Since March 2022, this fishery is certified under MSC standards [[i]]. Thus, there is a need to develop a regulatory and mitigation program to reduce the whale bycatch, which is in concordance with the National Plan for reducing marine mammal - fisheries interactions that Argentina established in 2015 [[ii]]

The present project focuses on the analysis of the groundline curvature and elevation from the seabed in experimental trawls with different rope buoyancy and separation between individual traps, in order to propose trawl configurations that minimize the potential threat to whales.

To fulfill this objective, the following specific objectives (SO) were stated:

1. Assess the elevation distance of positively and negatively buoyant groundlines above the seabed, with two different separation lengths between traps.

2. Compare the curvature of positively and negatively buoyant groundlines, with two different separation lengths between traps.

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[i] https://fisheries.msc.org/en/fisheries/southern-king-crab-central-patagonian-stock-traps-with-escape-rings-fishery-in-argentine-sea/

[ii] Available at https://cfp.gob.ar/wp-content/uploads/2017/09/LIBRO_PAN-MAM.pdf

## Activities

To determine the behavior of groundlines, a series of experimental trials in coastal areas near Mar del Plata (Argentina; Figure 1) were originally proposed to the Consortium for Wildlife Bycatch Reduction. As the project progressed, it was also possible to carry out direct measurements during a fishing season off southern Patagonia and Tierra del Fuego (Figure 1). This report summarizes the information available so far.

## Experimental design

A series of 4 experiments with king crabs trap lines were conducted between May and June 2023. The design of each line included a positively buoyant groundline and a negatively buoyant groundline, each with three traps (Figure 2). The diameter of the lines used was 18 and 24 mm. Two methods were used to measure the depth of each type of line.

a) Measurement of the depth of the line by dataloggers.

b) Filming of the position of the groundline above the bottom by autonomous diving.

Two types of self-contained dataloggers (Star Oddi DST Centi TD and DST Tilt), which are located in protective housings, that were attached to the groundlines (Figure 3), were used to measure the depth of the ropes. The sensors record depth with a resolution of 0.03% of the selected range.

The instrumentation of eight commercial traps were performed in October 2023 and March 2024 (Figure 4). Due to depth and security limitations, no filming was performed by divers. The SKC-TF trawls include 80-150 cone shaped traps (1.4 to 1.6 mts of maximum diameter; 0.55 to 0.75 mts in height), which are fixed by bridles and gangions to the groundline,with distances of 18-25 meters between individual traps.

## Results

The basic information on both the experimental and commercial instrumentations is summarized in Table 1.

| Date | Type | Depth (m) | Flotability | Latitude | Longitude | Record duration (hrs; days) | Line diameter (mm) | Datalogger records | Film duration |
|---|---|---|---|---|---|---|---|---|---|
| 19/05/2023 | Experimental | 17.7 | Both | 38.09049 | 57.29400 | 2:00h | 24 | 45 | 54 min |
| 01/06/2023 | Experimental | 20.4 | Both | 38.09020 | 57.29327 | 2:27h | 18 | 42 | -- |
| 03/06/2023 | Experimental | 17.4 | Both | 38.09076 | 57.29639 | 1:51h | 18 | 44 | 34 min |
| 07/06/2023 | Experimental | 21.5 | Both | 38.09063 | 57.29401 | 2:09h | 24 | 30 | 25 min |
| 6/10/2023 | Commercial | 75.2 | Negative | 53.0069 | 67.2988 | 6.6d | 24 | 318 | -- |
| 7/10/2023 | Commercial | 90.2 | Positive | 52.4434 | 67.0024 | 6.1d | 18 | 591 | -- |
| 12/10/2023 | Commercial | 40.4 | Negative | 53.0724 | 67.5547 | 4.4d | 24 | 212 | -- |
| 13/10/2023 | Commercial | 70.2 | Positive | 54.0121 | 66.2718 | 4.1d | 24 | 199 | -- |
| 17/10/2023 | Commercial | 68.1 | Negative | 52.4431 | 67.5231 | 4.9d | 18 | 235 | -- |
| 18/10/2023 | Commercial | 98.3 | Positive | 53.0120 | 66.3015 | 4.3d | 18 | 207 | -- |
| 23/03/2024 | Commercial | 96.2 | Positive | 45.3500 | 65.2875 | 6.6d | 18 | 367 | |
| 26/03/2024 | Commercial | 88.2 | Negative | 45.3787 | 65.4010 | 7.1d | 18 | 340 | |

*Table 1: Basic information of each trial.*

## Experimental trials

Dives were conducted on 3 of the 4 experimental lines, with a total of about 2 hours of filming (**Table 1**). During the dives, the group of divers followed the trajectory of the lines, filming their entire trajectory to determine the position of the lines in relation to the bottom.

Underwater footage clearly showed the differences in behavior between positively and negatively buoyant lines, with no apparent distinction between the line diameters used. The groundline (GL) on the positively buoyant lines clearly separated from the bottom, unlike the negatively buoyant lines which remained on the seafloor from the bridle attachment point (Figure 5; Figure 6). Trap-to-trap groundline tracking also showed that while the negatively buoyant lines remained on the bottom along their entire length, the positively buoyant lines separated several meters from the bottom (Figure 5; Figure 6). At the weight of the junction between the positive and negative buoyancy lines (Figure 7), the contrasting behavior between the two typesof lines is clearly seen.

Measurements of the average depth of the lines showed that the positive buoyancy lines were on average 3.8 meters above the traps (22.4 ± 1.8m versus 18.6 ± 2.8m) in the first section of the line (T1; Figure 8), while in the second leg (T2) this distance was slightly less than 1 meter (20.6 ± 1.2 versus 19.7 ± 1.7m); the average depth of the anchor line (17.5 ± 4.2m) was also approximately 3 meters shallower than the depth of the traps (Figure 8). In contrast to this, the average depths of the negatively buoyant lines showed no difference from the depth of the traps, indicating that the lines remain in close proximity to the seafloor (Figure 8). These depth data are expressed as an overall average, since the low number of experiments (n=4) does not allow robust statistical comparisons between sections within the experimental line or between rope diameters (18 versus 24 mm). The behavior of the lines throughout the experiment confirms that the negatively buoyant GLs maintain their depth, coinciding with the separation of the seafloor by the positively buoyant GLs (Figure 9; Figure 10).

## Commercial trials

Dataloggers were placed on 8 commercial lines (Table 1), 4 with negatively buoyant lines and 4 with positively buoyant ones. The operating depths of the lines were between 70 and 100 meters. The behavior of the negatively buoyant lines was very similar to that recorded in the experimental trials, with the GLs remaining at the same depth as the traps, showing that they did not rise from the bottom (Lines 54, 73, 76 and 68; Figure 11; Figure 12). In contrast, the positively buoyant lines (Lines 70, 75, 90 and 50; Figure 11; Figure 12) show a constant elevation of the seabed, clearly above the depth of the trap.

The anchor lines show a different behavior to the GLs, because regardless of the buoyancy of the lines, they always rise positively from the bottom (Line 75 = 7.2 ± 3.7m; Line 90 = 9.0 ± 5.8m; Line 54 = 1.6 ± 0.1m).

## Conclusions

The present study presents preliminary information on the behavior of lines of different buoyancy and should be considered as a first approach to the problem of whale entanglement in the Southern king crab trap fishery. Nevertheless, there are certain elements that allow us to have an initial view of the different behavior of both types of buoyancy.

In summary

1. Positive buoyancy lines in experimental trials are clearly separated from the seafloor, in sufficient distances to allow the entanglement of whales. Considering that specimens can entangle in different parts of the body (Mauna et al., 2018; Rodriguez et al., 2021; 2023; Mandiola et al., 2023), the seafloor separation distances found (1-3 meters on average) are sufficient to produce entanglement. In commercial trials (performed in deeper waters 70-100m), preliminary data supports the same behavior.
2. Negative buoyancy lines stay close to the bottom, making potential entanglement more difficult for whale species that feed in the water column, in both experimental and commercial trials. Seafloor feeding species may still be vulnerable to ground line entanglement.
3. Anchor lines that run between the initial weight and the first trap (and the last trap and final weight) should be considered among the mitigation measures, because the show a tendency of separating from the seabed, regardless the differences in line buoyancy. This long line, whether low or high above the seafloor, poses a threat of entanglement to whales.
4. The bridles also exhibit behavior that can potentially facilitate entanglement, as they separate by several centimeters above the trap and float for a distance until they reach the groundline. If the buoyancy of the lines is modified, bridles should also be considered in the regulations.
5. The dataloggers provide relevant information to evaluate the behavior of bottom lines, so it is proposed to repeat the study in future fishing seasons, increasing the number of tests to produce statistically robust information.

## References

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Mauna, C., C.Firpo, V.Mango, P.Lértora (2018). Medidas de mitigación de la captura incidental de mamíferos marinos sugeridas para la pesquería de centolla. Informe de Asesoramiento y Transferencia INIDEP, 105/18, 14pp.

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## ANNEX – Figures

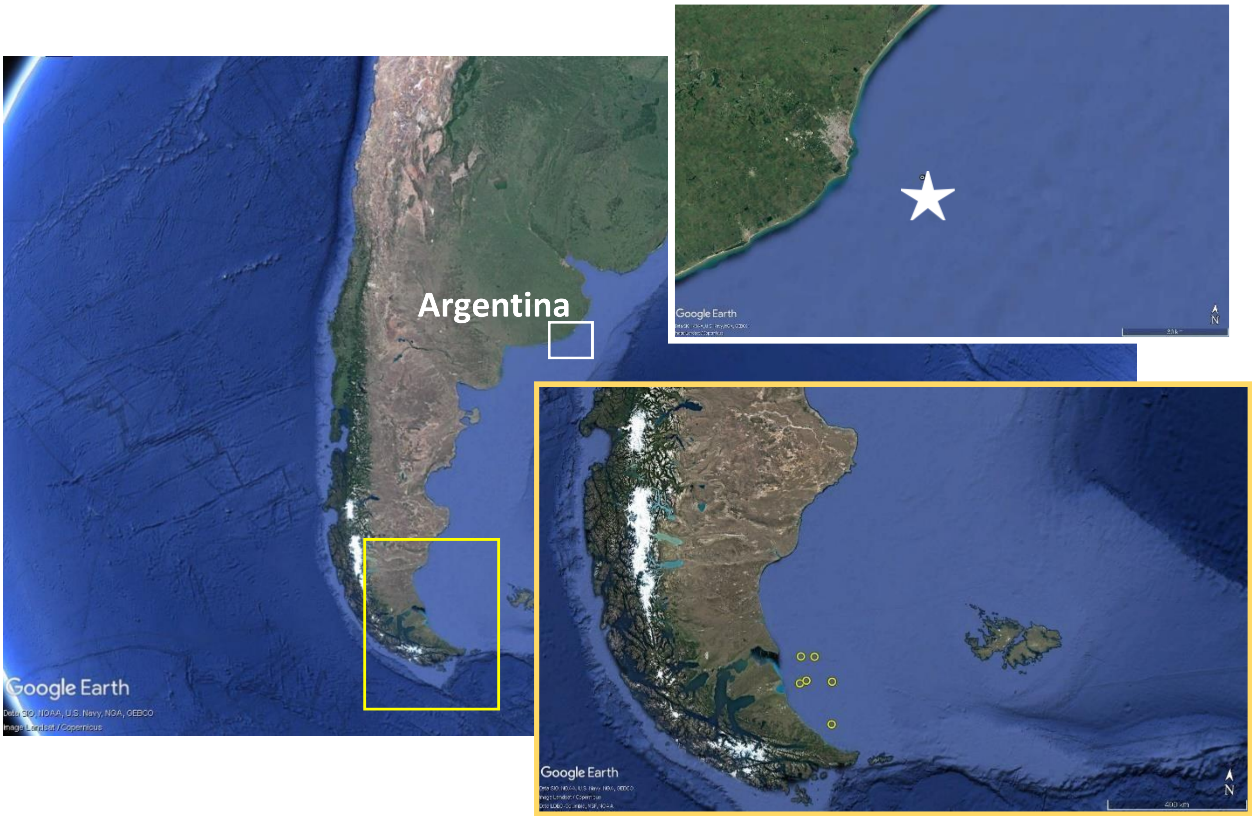


*Figure 1: Map of southern Argentina, showing the experimental trial location (Mar del Plata, White star), and the commercial trials (Tierra del Fuego, yellow circles).*

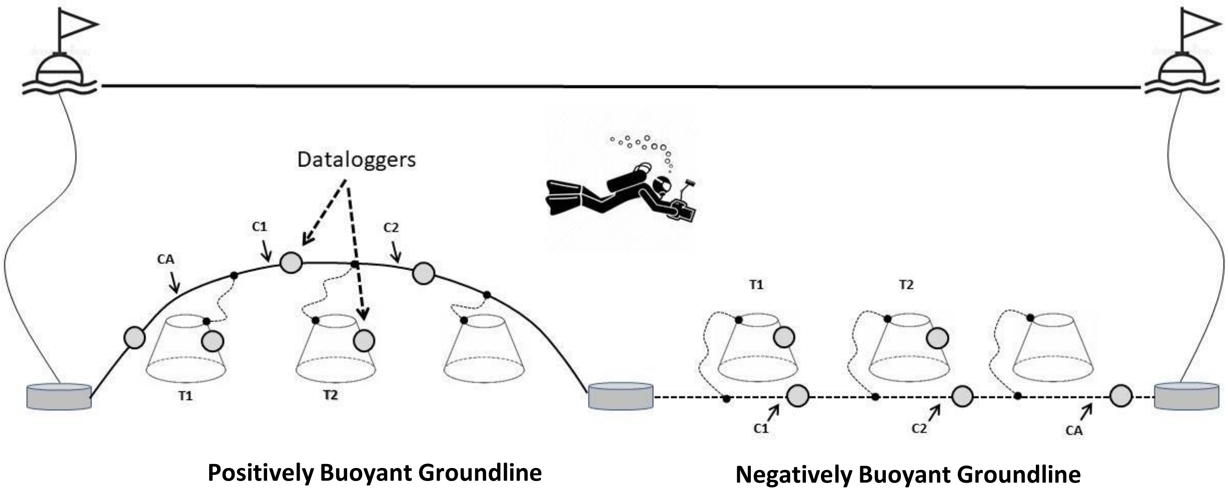


*Figure 2: Design of experimental trials, showing the position of the traps (T), the groundlines (C), and the anchor lines (CA).*


*Figure 3: Dataloggers with housings, and their attachments in experimental lines.*

*Figure 4: Dataloggers with housings, and their attachments in commercial traps and lines*

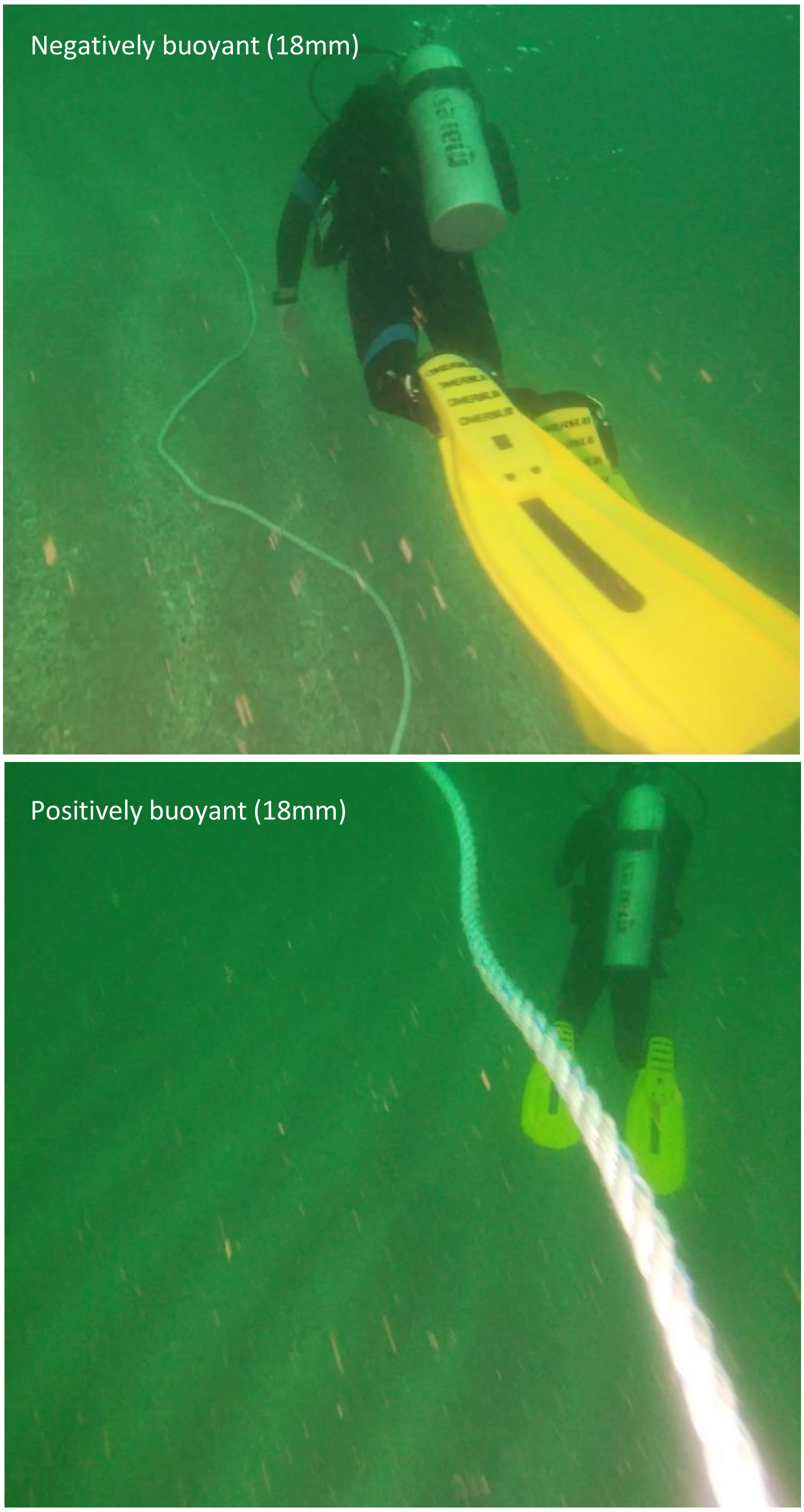


*Figure 5: Position of the positively and negatively buoyant lines in relation to the seafloor, considering that the diver is moving over the bottom.*

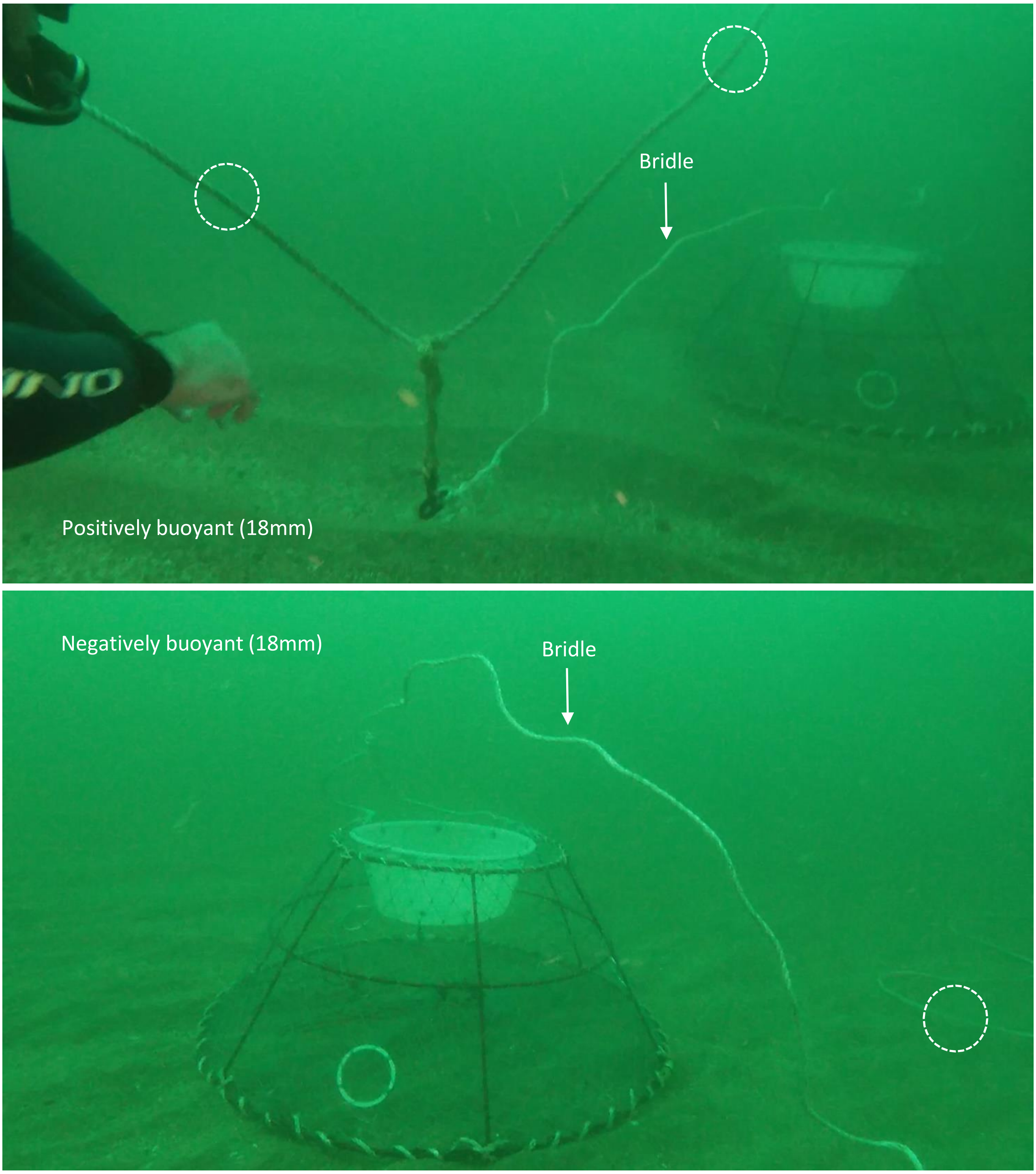


*Figure 6: Experimental king crab trap with positively (top) and negatively (bottom) buoyant lines, both 18 mm in diameter. The circle indicates the groundline trajectory. Note that the positively buoyant line sinks in the presence of a metal shackle connect*

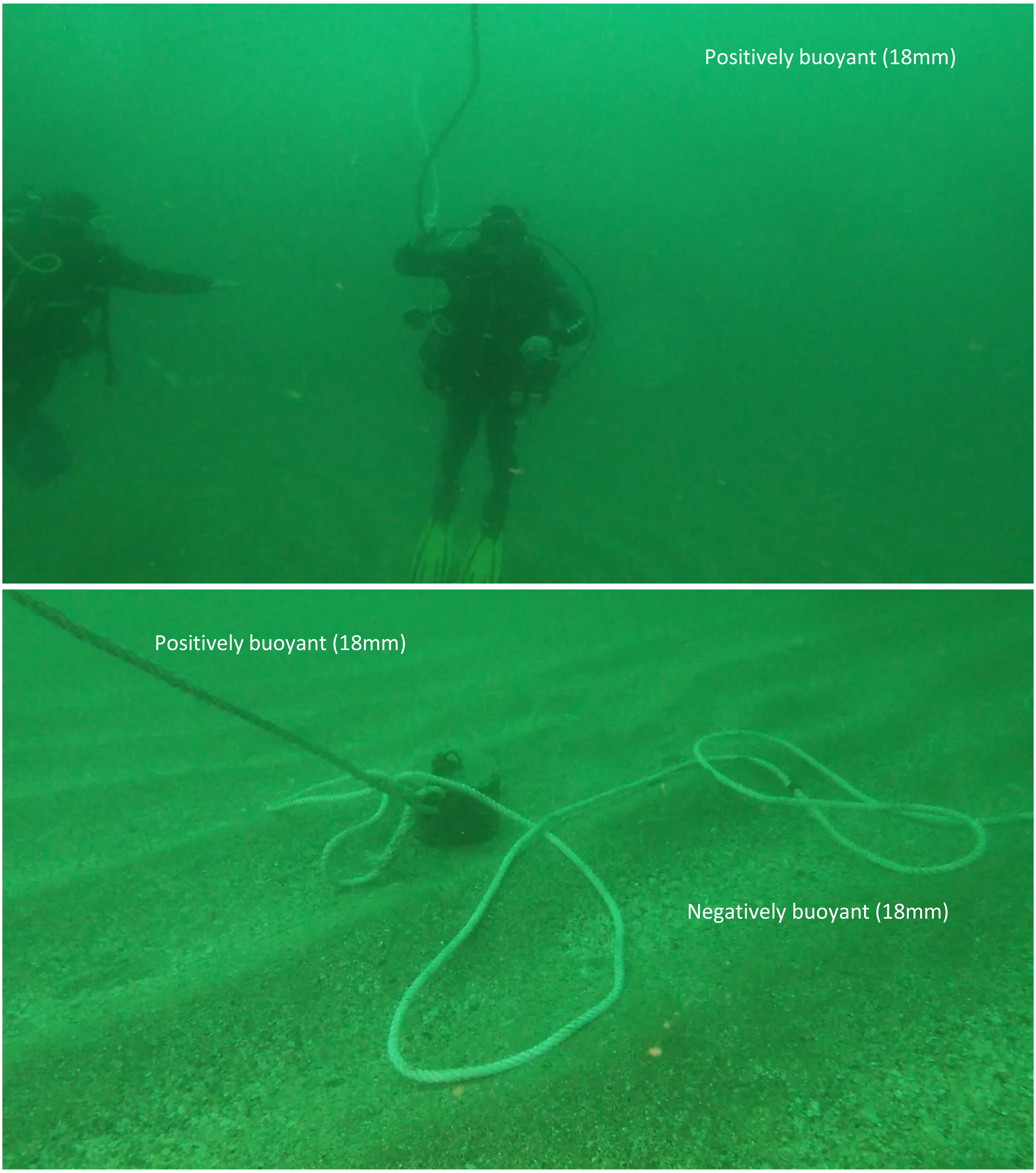


*Figure 7: Positively buoyant anchor line (upper) being sunk by hand by the diver. Dead weight connecting the experimental lines of positively (leftward) and negatively (rightward) buoyant anchor lines.*

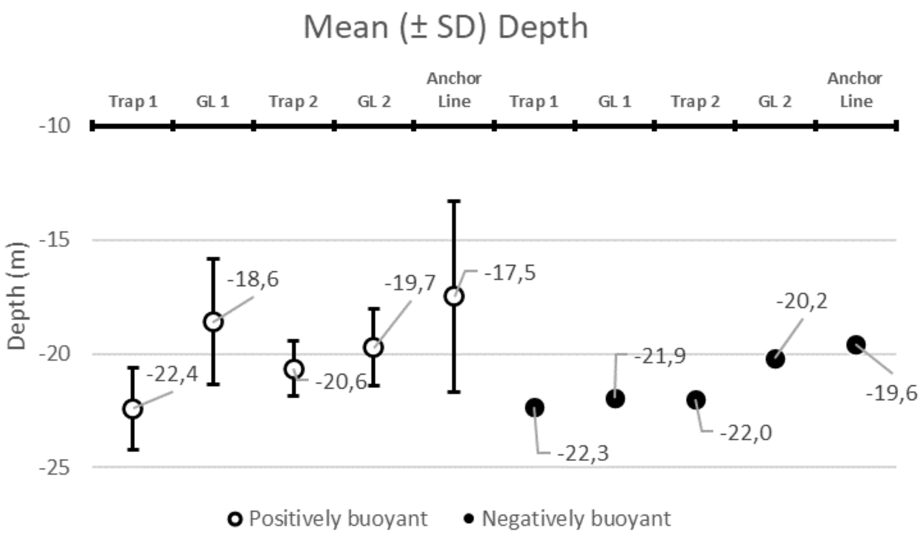


*Figure 8: Average depth (± SD) of positively and negatively buoyant lines in each of the components of the experimental lines.*


*Figure 9: Groundline and anchor line behavior in experimental trials*


*Figure 10: Groundline and anchor line behavior in experimental trials (cont.)*


*Figure 11: Groundline and anchor line behavior in commercial trials*

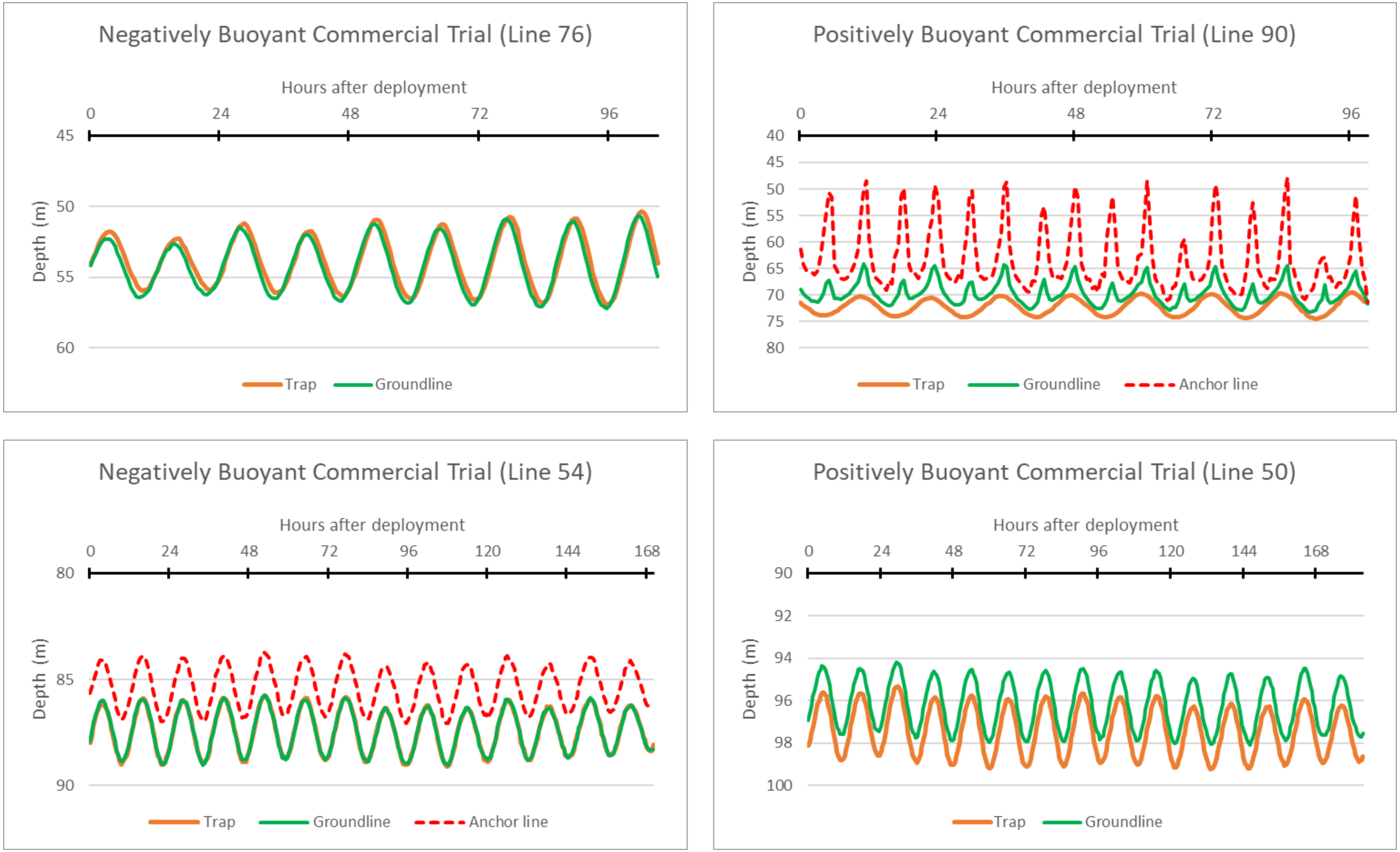


*Figure 12: Groundline and anchor line behavior in commercial trials (cont).*