nature portfolio

Peer Review File

Repeated narwhal interactions with moorings challenge safety assumptions of passive acoustic monitoring in the Arctic

Corresponding Author: Professor Evgeny Podolskiy

This manuscript has been previously submitted at another journal. This document only contains information relating to versions considered at Communications Biology.

This file contains all reviewer reports in order by version, followed by all author rebuttals in order by version.

Version 0:

Reviewer comments:

Reviewer #1

(Remarks to the Author)
Review of Nature paper
Thank you for preparing this paper, it will undoubtedly impact how oceanographic moorings and research is designed, implemented and executed -however findings apply to a broader suite of ocean equipment outside of scientific equipment. Prior to accepting this paper there is need for clarity and details throughout the paper, along with strengthened writing, some comments/suggestions below to convince the reader of your findings or proposed impactful interactions. There is need to convince audience or show some validation in several areas, for example a demonstration of validation that that the detections heard are associated with narwhal hitting the instrument (perhaps removing the statement that the noise is not prey from the manuscript will help). Draw a stronger link with the narwhal curiosity and entanglement - more evidence/information is needed. ALso proper treatment of Inuit Knowledge is needed and should follow ethical practices (see UNDRIP). Other details such as - how many moorings were placed out and how many disappeared, were the drawings from the Inuit reflective of two moorings that went missing from their mission? Can instruments on the mooring provide any detection of movement or being at the surface? The authors provided a picture in a figure of a narwhal with 2 tusks, were the authors trying to link tusk activity with entanglement? If the tusk is not believed to be putting the animal at greater risk it would help place importance of these findings to other vulnerable species like beluga whales. Some more text is needed on how does hitting the instrument (presumably with the head) result in the tail entanglement described? For example describing the amount of free line available to get tangled-does this line remain tight?
These findings and impacts could extend to almost anything thrown in the water, not just scientific instruments, so consider mentioning the benefits of scientific studies (could include some citations or reviews of hydroacoustic or oceanographic studies from which a net good has been generated) and discuss weighing the benefits against the risks when considering a study, while still rethinking design.
I've asked for clarity on sections below and provide suggestions to strengthen components. One item that needs attention the inclusion of Inuit observations/knowledge. First this needs to be treated properly either through a proper citation or inclusion of this information as fully part of the study – for example doing an interview with the Inuit (following ethical protocols) and more clearly sharing their knowledge.
Lastly while it may be seen outside the scope of the paper, some attention to mitigations is needed given the magnitude of these findings.

Detailed comments:
Abstract
A suggestion, the first two sentences be reconsidered for the opening statements of the abstract
Introduction
Ln 35, consider providing a depth range for the deep recorders
Ln 37: this is a strong statement, that Indigenous (capital I) Peoples are well aware of deadly entanglements – are you specifically referring to the moorings here? It would be ideal to have either a citation or pers com about this critical observation. I see you include details in the discussion and supplemental-can you also cite here and the supplemental

drawings. Note the Journal should have policies in place to properly recognize these observers and their knowledge.
Ln 39-44 – this section seems obvious and not worth mentioning, instead replace with examples of impacts related to scientific or monitoring equipment – if available-consider terrestrial systems.
Methods:
Were only files analyzed with narwhal presence? To be more convincing it would be beneficial to manually analyze a subset of files without narwhal presence to confirm the absence of any knocking sounds.
Results
Ln 52-53 – this sentence is unclear, 'such strong interaction' unclear what you are referring to here. why not say 5-11% had a strong interaction or simply 'contained hits'
Ln 58 how was the 'wobbling of the setup' determined?
Ln 59 – the description of the 'attack' buzz is better suited to the discussion section
Ln68- again some of this text may fit in the discussion rather than results.
Ln 69-70: this statement needs to be justified and/or supported – and the evaluation of other potential animals should be demonstrated, then the statement of sounds not being prey better suited to the discussion.
Ln 77, if Bowdoin only recorded acoustic signals, what did the other sites measure in addition?
Ln 85 – again discussion type statement here.
Ln 94 – Please describe the 16 narwhal, size, age, sex etc.
Question: Was there a diel pattern of narwhal presence in general? If so was this accounted for in the diel presence of hits?

Discussion:
Generally I think the discussion can be strengthened to clearly identify the what was measured, the link to past entanglement documentation (Inuit drawings), then the need to mitigate this field of research. How does the hit -presumably with the front of the body result in the tail entanglement – general play? Could there be too much slack in the line? Etc, spend a moment exploring other circumstances.
Ln 210, I would rephrase that PAM is currently considered non or minimally invasive (remove previously)
Regarding the impacts had on narwhal, can you specifically speak to the interaction with the tusk and did the tusk make them more or less vulnerable to the entanglement? As this may implicate or not implicate other arctic cetaceans like the very curious beluga whale.

Provide a few more concrete ideas on mitigation for this entanglement

Reviewer #2

(Remarks to the Author)
Review of "Whale repeated and lethal interaction with moorings questions the non-intrusiveness of a key scientific method"

General comments:
- This paper presents important new information on how oceanographic moorings (including PAM ones) may not be as harmless as previously thought. Narwhals appear to be attracted to the recorders, investigate them with echolocation, and sometimes "hit" them, either in a feeding attempt or for other unknown reasons. Considering dead narwhals have been found by native Greenlanders, due to entanglements in moorings, this study investigates one aspect of narwhal behavior in relation to moorings, namely the seeming curiosity in relation to the recorders.
- The paper would benefit from focus, possibly some shortening, and clarifications. Also, some of the details of the acoustic analyses choices are surprising. For example, why are standard underwater sound units (and standard analysis procedures) not used? There may also be an error in one of the calculations. See the detailed comments below.

Line 7: suggest "The present study, however, identified ..." (better English)
Line 9: "explained" is too strong a word. You show that narwhals interact with moorings, but their curiosity only provides a possible contributing factor. What may be the main contributing factor to entanglement is the length of the mooring, yet this factor is not well discussed in the paper. (Is there a reason the mooring was so long?)
Line 13: suggest "free-ranging" instead of "unconfined"
Line 15: "and poses a risk to their well-being"
Line 16: suggest " ... and accounted for in mooring design."
Line 24: suggest "... does no harm while yielding an understanding ..."
Line 36: for clarity, you may want to say "repeatedly physically hit by narwhals."

Fig. 1: why are sound levels (here and in the text) only reported in Pascals and not in the standard dB re 1 µPa for underwater sound? Also, the 9.4 ms Hamming window is an extremely short window size, compared to the 64 ms length of the FFT (the window size more commonly matches the FFT size), which is also unexpectedly short. Why were these parameters chosen?

Line 52: the authors keep referring to "the hydrophone". If you actually mean the sensor itself, positioned at one end of the SoundTrap, then fine, but if you mean the recorder, then please refer to it as "the SoundTrap" or "the recorder", for example.
Line 54: please express "600 Pa" in dB re 1 µPa.
Line 56: it looks like Fig. S2a shows successive buzzes on the instrumentation, but not necessarily the hit and rub shown in Fig. 1 c&d, is that right? What proportion of the time was a buzz followed by a hit? It may be worth mentioning this, as a buzz without a hit may indicate that the whale realized the recorder is not prey. Actually, I now feel confused about how often you

detected buzzes with physical hits versus buzzes alone.
Line 57: use a log scale on the y-axis to better show the LF hit.
Line 58: isn't it possible that the "rubbing" comes from the whale taking the recorder in its mouth? It's hard to explain that sound otherwise.
Line 63: please justify why you divide by 4 instead of 2 in the equation.
If the speed of sound is 1500 m/s, then 3 m are covered in 2 ms, but since it's a round trip it's 1.5 m. I therefore do not understand how you get 0.7 m. (If the equation is incorrect, then there are errors in the rest of the paragraph also.)
Line 77: "... only recorded acoustic signals" – unclear, please be more specific. Also, as far as I can tell Fig. S1 does not distinguish between "acoustic" and other signals.
Line 88: suggest "Most hit detections (65% ..."

Figure 2: blue dotted lines are hard to see and the end one for Heilprin is missing. Times in blue bar insets could be labelled more logically (e.g., 0-8-16-24 or 0-6-12-18-24).

Figure 3: this figure feels a bit like a filler and could be removed if space is an issue. The double-tusked narwhal in the picture is never even discussed from the perspective of the paper's goals.

Line 108: use of "hydrophone" when I think you mean "recorder" or "SoundTrap". Also, 1.5 L of air, is that after the batteries have been installed? (it seems like a lot) Please specify.
Line 117-118: I suggest the authors expand a bit on this subject and add some more recent references. The lack of knowledge about narwhals' hearing abilities is not to blame – as echolocating odontocetes feeding on a variety of prey items, there is no reason to think they would not have developed the abilities described in other odontocetes to tell prey items apart. The more interesting question is whether the echoes from a SoundTrap600 look enough like those from a cod that narwhals would be fooled. That would be an interesting question to investigate.
Line 125: replace "hydrophone" with "recorder"
Line 126: again, I assume you mean "recorder" when you say "hydrophone", or do you mean the hydrophone sensor?
Line 126: this is the first mention of "secondary events" – please explain what these are and how they were discovered if they were not accompanied by narwhal echolocation.
Line 127: "collision" as in accidental? Considering narwhals echolocate almost constantly during their foraging dives it is difficult to imagine such collisions would occur accidentally ...
Line 150: "one or three" – I assume "one to three"?
Line 160: the sentence starting here and the next one make a correct point (i.e., if you make a deep dive and are "cheated" out of food, you incur an energetic loss) but is the potential effect of it (with a few moorings over a huge area) important enough to even mention? I imagine narwhals make (at least partially) unsuccessful foraging dives all the time.
Line 163: sentence starting with "However, there is neither ...". Please rephrase, I do not understand intended meaning.
Line 165: suggest rephrasing the sentence to "Furthermore, we cannot explain why the whales interacted with the moorings at Tracy and Heilprin fjords but not near Bowdoin Glacier."
Line 167: the authors refer to previously archived seismometer data with no detected interactions. Please confirm the comparison is reasonable, i.e., recorders measuring at same frequency ranges, data analyzed the same way, same type of air-filled recorders?
Line 200: if narwhals feed mainly on cod, then solid recorders (containing no air) may not attract the animals' attention in the same way. Nevertheless, the main issue here is likely the length of the mooring.
Line 212-216: if it is part of the animal's natural behavior to be curious and investigate items in its environment, then investigating a man-made item on the seafloor is part of its natural behavior!
Line 238: with "short", do you mean the length from top to bottom of the mooring, which in this case is 22 m? In my experience that is far from "short"; designs I am familiar with have had a total height above the seafloor of only a few (<5) meters.
Line 273: the ACI was developed to identify times of rich bird song in the presence of anthropogenic sound sources, which is not the situation here. It is therefore unobvious to me why the authors did not simply compute levels in the 20-32 kHz band as a function of time to identify the presence of narwhals. Please explain why the ACI was used in place of (simply) band filtered data.

Supplementary information
Line 420: again, how about putting emphasis on the natural state of the animal rather than the confined state and therefore use "free-ranging" instead of "unconfined".
Line 425: analysed
Fig. S2: please present acoustic data in dB re 1 µPa. Also, as described above, why the very short FFT size and extremely short window size? It affects how the spectrograms look, some of the "hits" are practically invisible.
Fig. S3: a log scale on the y-axis of the spectrogram may better illustrate the actual hit, which is barely visible on the current plot.

Version 1:

Reviewer comments:

Reviewer #2

(Remarks to the Author)
Review of resubmitted version of paper "Whale repeated and lethal interaction with moorings questions the non-

intrusiveness of a key scientific method"
The authors have addressed comments from my first review to my satisfaction, with one exception: the comment on line 63 (original submission) about how the calculation was done to estimate the distance to prey. The papers the authors are relying on for this justification are quite old (35-50 years) in a field that has been expanding explosively! I maintain my point that yes, we expect that inter-click intervals should be a little longer than the two-way travel time (since the animal must process the received echo), but “twice the two-way travel time” at very close distances is not a concept I have seen in any recent papers (see for example Ladegaard et al. 2019 "Dolphin echolocation behaviour during active long-range target approaches" but I found many more), in fact some recent papers clearly contradict that statement (again, particularly when the odontocete is close to the prey). I would therefore strongly encourage the authors to update that section.

Submitted: 11 Nov 2024
Invited to revise: 22 Feb 2025

Dear Editors and Reviewers,

Thank you for evaluating our paper and suggesting ways to strengthen it. We used this opportunity to improve the manuscript and kindly ask you to consider the revision. Our responses are enclosed.

Sincerely,
the authors

Reviewer #1

Thank you for preparing this paper, it will undoubtedly impact how oceanographic moorings and research is designed, implemented and executed - however findings apply to a broader suite of ocean equipment outside of scientific equipment. Prior to accepting this paper there is need for clarity and details throughout the paper, along with strengthened writing; some comments/suggestions below to convince the reader of your findings or proposed impactful interactions.

> **Thank you very much for your feedback. We hope that by addressing your comments where possible, the clarity of writing was strengthened. We included more details to convince the reader about our interpretations and their implications.**

There is need to convince audience or show some validation in several areas, for example a demonstration of validation that that the detections heard are associated with narwhal hitting the instrument (perhaps removing the statement that the noise is not prey from the manuscript will help).

> **Such demonstration was added; the text on prey was revised and moved to the discussion.**

Draw a stronger link with the narwhal curiosity and entanglement - more evidence/information is needed.

> **In response to detailed comments by both reviewers, we included more discussion about possible reasons that attract narwhals and lead to entanglement, with more citations.**

Also proper treatment of Inuit Knowledge is needed and should follow ethical practices (see UNDRIP).

> **We have carefully read the UNDRIP and ensured that no confusing language presents lost-and-found moorings as traditional knowledge.**

Other details such as - how many moorings were placed out and how many disappeared, were the drawings from the Inuit reflective of two moorings that went missing from their mission?

> **We clarified that the moorings on the drawings were not ours and mentioned how many moorings had troubles. However, it is unknown how many were deployed in recent years as there are several groups working without sharing information.**

Can instruments on the mooring provide any detection of movement or being at the surface?

> **We did not use instruments that can directly detect movement or being at the surface.**

The authors provided a picture in a figure of a narwhal with 2 tusks, were the authors trying to link tusk activity with entanglement? If the tusk is not believed to be putting the animal at greater risk it would help place importance of these findings to other vulnerable species like beluga whales.

We removed this photograph at the request of another reviewer but discussed the potential vulnerability of narwhal due to the tusk.

Some more text is needed on how does hitting the instrument (presumably with the head) result in the tail entanglement described? For example describing the amount of free line available to get tangled-does this line remain tight?

We added such discussion, including the importance of free line and a reference to another known incident of tail entanglement (as described below).

These findings and impacts could extend to almost anything thrown in the water, not just scientific instruments, so consider mentioning the benefits of scientific studies (could include some citations or reviews of hydroacoustic or oceanographic studies from which a net good has been generated) and discuss weighing the benefits against the risks when considering a study, while still rethinking design.

We highlighted this delicate situation in the final paragraph of the discussion.

I've asked for clarity on sections below and provide suggestions to strengthen components. One item that needs attention the inclusion of Inuit observations/knowledge. First this needs to be treated properly either through a proper citation or inclusion of this information as fully part of the study – for example doing an interview with the Inuit (following ethical protocols) and more clearly sharing their knowledge.

We ensured that there is no confusion with traditional knowledge since entanglements into scientific moorings are not such, and we added proper citations.

Lastly while it may be seen outside the scope of the paper, some attention to mitigations is needed given the magnitude of these findings.

Our advice about possible precautions were included into the discussion.

Detailed comments:

Abstract

A suggestion, the first two sentences be reconsidered for the opening statements of the abstract

Removed to follow the word limit.

Introduction

Ln 35, consider providing a depth range for the deep recorders

Provided.

Ln 37: this is a strong statement, that Indigenous (capital I) Peoples are well aware of deadly entanglements – are you specifically referring to the moorings here? It would be ideal to have either a citation or pers com about this critical observation. I see you include details in the discussion and supplemental-can you also cite here and the supplemental drawings. Note the Journal should have policies in place to properly recognize these observers and their knowledge.

We added citations. However, there is no overstatement as rumors spread fast through a small Inuit village, and locals are aware of the deadly entanglements referred to in the paper.

Ln 39-44 – this section seems obvious and not worth mentioning, instead replace with examples of impacts related to scientific or monitoring equipment – if available-consider terrestrial systems.

We clarified that we referred exclusively to marine systems. However, as there are no papers on entanglements in moorings, these examples provide a very important context, as not many oceanographers are familiar with the scale of the issue.

Methods:
Were only files analyzed with narwhal presence? To be more convincing it would be beneficial to manually analyze a subset of files without narwhal presence to confirm the absence of any knocking sounds.

We clarified that we could not find any knocking sounds in the absence of narwhals, and the main purpose of our very laborious manual analysis was to ensure that we did not confuse knocking sounds with icebergs.

Results
Ln 52-53 – this sentence is unclear, ‘such strong interaction’ unclear what you are referring to here. why not say 5-11% had a strong interaction or simply ‘contained hits’

Revised as suggested.

Ln 58 how was the ‘wobbling of the setup’ determined?

Narwhals are unable to produce such low-frequency sounds.

Ln 59 – the description of the ‘attack’ buzz is better suited to the discussion section

We kindly ask your permission to leave this description of the terminal buzz. Without it, the result of range-to-target calculation appears out of the blue and confusing for the Reader.

Ln68- again some of this text may fit in the discussion rather than results.
Ln 69-70: this statement needs to be justified and/or supported – and the evaluation of other potential animals should be demonstrated, then the statement of sounds not being prey better suited to the discussion.

The corresponding lines 68-70 were moved to the discussion. Please note that the statement referred to previously described properties of the hit signal, while cod does not make a buzz, etc. We also mentioned that there were no other animals able to produce ultrasound in the area.

Ln 77, if Bowdoin only recorded acoustic signals, what did the other sites measure in addition?

We clarified that Bowdoin station did not record hits, while other sites did.

Ln 85 – again discussion type statement here.

Moved to Discussion.

Ln 94 – Please describe the 16 narwhal, size, age, sex etc.

Described. Detailed information, except age, was shown in Supplementary Information.

Question: Was there a diel pattern of narwhal presence in general? If so was this accounted for in the diel presence of hits?

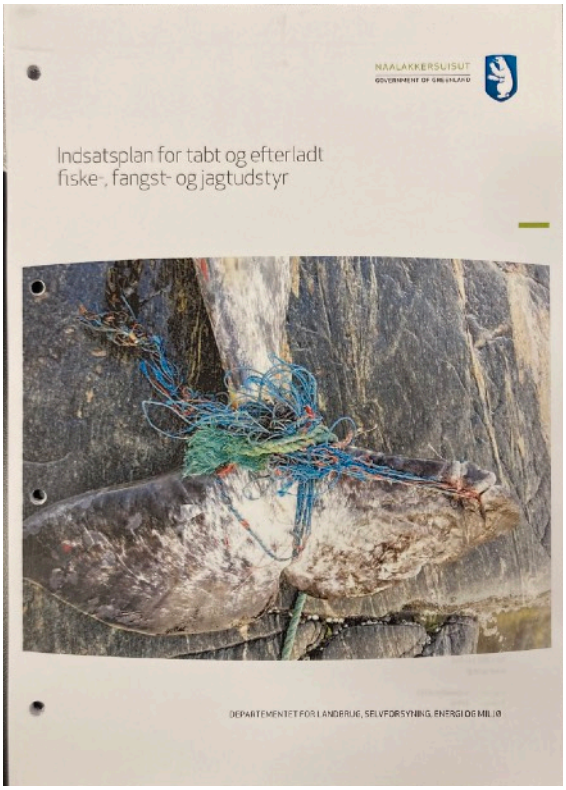
Yes, except for Bowdoin station (shown in Supplementary Information), as expected, because hits have not been observed in the narwhal absence.

Discussion:
Generally I think the discussion can be strengthened to clearly identify the what was measured, the link to past entanglement documentation (Inuit drawings), then the need to mitigate this field of research.

We strengthened the discussion by reiterating what was measured, further elaborating on the past entanglement (including citing a governmental report showing a similar tail entanglement), and identifying what further research and mitigation are needed.

How does the hit -presumably with the front of the body result in the tail entanglement – general play? Could there be too much slack in the line? Etc, spend a moment exploring other circumstances.

We explored this question in the corresponding section and also cited a governmental report on fishing gear, which shows the same type of tail entanglement in narwhal (photo below).



Ln 210, I would rephrase that PAM is currently considered non or minimally invasive (remove previously)

Rephrased.

Regarding the impacts had on narwhal, can you specifically speak to the interaction with the tusk and did the tusk make them more or less vulnerable to the entanglement? As this may implicate or not implicate other arctic cetaceans like the very curious beluga whale.

We added that it is reasonable to suggest that the tusk might make narwhals more vulnerable to entanglement than other arctic cetaceans (because it makes it easier to enter a loop in the mooring, for instance, by moving along the line).

Provide a few more concrete ideas on mitigation for this entanglement.

We provided the directions to explore and precautions to be taken.

Reviewer #2

General comments:
-This paper presents important new information on how oceanographic moorings (including PAM ones) may not be as harmless as previously thought. Narwhals appear to be attracted to the recorders, investigate them with echolocation, and sometimes “hit” them, either in a feeding attempt or for other unknown reasons. Considering dead narwhals have been found by native Greenlanders, due to entanglements in moorings, this study investigates one aspect of narwhal behavior in relation to moorings, namely the seeming curiosity in relation to the recorders.
-The paper would benefit from focus, possibly some shortening, and clarifications. Also, some of the details of the acoustic analyses choices are surprising. For example, why are standard underwater sound units (and standard analysis procedures) not used? There may also be an error in one of the calculations. See the detailed comments below.

Thank you very much for your review. We followed all detailed comments to improve the focus and clarity and did some shortening (e.g., removing the energy budget text and the photograph). We explained that standard analysis procedures are misleading in continuous iceberg noise with lots of broadband energy (e.g., Podolskiy et al., 2022). We also added dB-scale. As we detailed below, Pascals [Pa] are common in cetacean-acoustic literature and appropriate as they represent physical metrics (i.e., sound pressure), while the pseudo-unit of “dB” does not (e.g., Boebel et al., 2017). Finally, we rechecked the calculations and confirmed that there was no error.

Line 7: suggest “The present study, however, identified ...” (better English)

Revised.

Line 9: “explained” is too strong a word. You show that narwhals interact with moorings, but their curiosity only provides a possible contributing factor. What may be the main contributing factor to entanglement is the

length of the mooring, yet this factor is not well discussed in the paper. (Is there a reason the mooring was so long?)

Here, we added "partially". In the main text, we mentioned that shorter moorings might be a solution with more details about why marine scientists may need long moorings.

Line 13: suggest "free-ranging" instead of "unconfined"

Revised.

Line 15: "and poses a risk to their well-being"

Revised.

Line 16: suggest " ... and accounted for in mooring design."

Revised.

Line 24: suggest "... does no harm while yielding an understanding ..."

Revised.

Line 36: for clarity, you may want to say "repeatedly physically hit by narwhals."

Revised.

Fig. 1: why are sound levels (here and in the text) only reported in Pascals and not in the standard dB re one µPa for underwater sound? Also, the 9.4 ms Hamming window is an extremely short window size, compared to the 64 ms length of the FFT (the window size more commonly matches the FFT size), which is also unexpectedly short. Why were these parameters chosen?

The dB-scale was added. However, Pascals are standard in textbooks on passive acoustic monitoring of cetaceans (Zimmer, 2011; Au & Lammers, 2016). Moreover, considering that our paper aims to share our concerns about potentially harmful scientific activities with a broad audience, expressing pressure only in the pseudo-unit of "dB" can be confusing. Finally, we are greatful for checking the properties of the spectrogram. Larger window size blurred short clicks. To follow the reviewer's suggestion, we kept sufficiently high temporal resolution by decreasing FFT size, which yielded visually identical results.

Line 52: the authors keep referring to "the hydrophone". If you actually mean the sensor itself, positioned at one end of the SoundTrap, then fine, but if you mean the recorder, then please refer to it as "the SoundTrap" or "the recorder", for example.

Revised as "the recorder" throughout the manuscript.

Line 54: please express "600 Pa" in dB re 1 µPa.

Expressed.

Line 56: it looks like Fig. S2a shows successive buzzes on the instrumentation, but not necessarily the hit and rub shown in Fig. 1 c&d, is that right? What proportion of the time was a buzz followed by a hit? It may be worth mentioning this, as a buzz without a hit may indicate that the whale realized the recorder is not

prey. Actually, I now feel confused about how often you detected buzzes with physical hits versus buzzes alone.

Following your suggestion (below), we improved Fig. S2a, which now shows more clearly successive hits preceded by buzzes. For this paper, we detected only physical hits, which always appear after buzzes, as we did not aim to detect buzzes alone. Interpreting a buzz without a hit will be difficult; on the one hand, we agree that it might indicate that the whale realized something unusual; on the other hand, as Fig. S2 illustrates, buzzes can be weak and easy to miss, or could be coming from a narwhal foraging nearby.

Line 57: use a log scale on the y-axis to better show the LF hit.

Revised.

Line 58: isn't it possible that the "rubbing" comes from the whale taking the recorder in its mouth? It's hard to explain that sound otherwise.

In the discussion, we mentioned this hypothesis and that the friction between the recorder and the skin during the sliding of the animal a few meters long also seems a reasonable explanation.

Line 63: please justify why you divide by 4 instead of 2 in the equation. If the speed of sound is 1500 m/s, then 3 m are covered in 2 ms, but since it's a round trip it's 1.5 m. I therefore do not understand how you get 0.7 m. (If the equation is incorrect, then there are errors in the rest of the paragraph also.)

This equation from the cited literature is correct and based on observations that false-killer whales and belugas use click intervals twice the two-way travel time.

Line 77: "... only recorded acoustic signals" – unclear, please be more specific. Also, as far as I can tell Fig. S1 does not distinguish between "acoustic" and other signals.

We meant the absence of hits, as now clarified.

Line 88: suggest "Most hit detections (65% …"

Revised.

Figure 2: blue dotted lines are hard to see and the end one for Heilprin is missing. Times in blue bar insets could be labelled more logically (e.g., 0-8-16-24 or 0-6-12-18-24).

The visibility of the blue lines was improved; we clarified in the caption that Heilprin's recording ended in 2024. The inset labels were revised to match the legend.

Figure 3: this figure feels a bit like a filler and could be removed if space is an issue. The double-tusked narwhal in the picture is never even discussed from the perspective of the paper's goals.

The length of the article and the number of display items were ~60% of what the journal recommends. As the key goal of the paper is to share our concerns, we believed it was essential to show the unique anatomy of a narwhal, which was the last thing any oceanographer would think of while designing their ocean moorings. Since the Reviewer

feels that the paper may benefit from some shortening, we removed this photo of a tusked narwhal and references to it.

Line 108: use of “hydrophone” when I think you mean “recorder” or “SoundTrap”. Also, 1.5 L of air, is that after the batteries have been installed? (it seems like a lot) Please specify.

Revised as “recorder” and “0.2–1.3 L” to account for the batteries (after consulting with the manufacturer on April 10, 2025).

Line 117-118: I suggest the authors expand a bit on this subject and add some more recent references. The lack of knowledge about narwhals’ hearing abilities is not to blame – as echolocating odontocetes feeding on a variety of prey items, there is no reason to think they would not have developed the abilities described in other odontocetes to tell prey items apart. The more interesting question is whether the echoes from a SoundTrap600 look enough like those from a cod that narwhals would be fooled. That would be an interesting question to investigate.

As suggested, we elaborated on the biosonar abilities of odontocetes and added more recent references. The suggested potential research question has also been mentioned.

Line 125: replace “hydrophone” with “recorder”

Revised as recorder.

Line 126: again, I assume you mean “recorder” when you say “hydrophone”, or do you mean the hydrophone sensor?

Revised as recorder.

Line 126: this is the first mention of “secondary events” – please explain what these are and how they were discovered if they were not accompanied by narwhal echolocation.

Thanks for noticing this. These events were discussed later and were removed here.

Line 127: "collision" as in accidental? Considering narwhals echolocate almost constantly during their foraging dives it is difficult to imagine such collisions would occur accidentally …

We replaced “collision” with “interaction”.

Line 150: “one or three” – I assume “one to three”?

Yes, thanks; corrected.

Line 160: the sentence starting here and the next one make a correct point (i.e., if you make a deep dive and are “cheated” out of food, you incur an energetic loss) but is the potential effect of it (with a few moorings over a huge area) important enough to even mention? I imagine narwhals make (at least partially) unsuccessful foraging dives all the time.

The potential effect is unclear because the frequency and success rate of foraging dives in this area are unknown. We removed this.

Line 163: sentence starting with “However, there is neither ...”. Please rephrase, I do not understand intended meaning.

This sentence was removed, as explained above.

Line 165: suggest rephrasing the sentence to “Furthermore, we cannot explain why the whales interacted with the moorings at Tracy and Heilprin fjords but not near Bowdoin Glacier.”

Rephrased.

Line 167: the authors refer to previously archived seismometer data with no detected interactions. Please confirm the comparison is reasonable, i.e., recorders measuring at same frequency ranges, data analyzed the same way, same type of air-filled recorders?

We clarified that the sea-floor seismometer had a SoundTrap recorder.

Line 200: if narwhals feed mainly on cod, then solid recorders (containing no air) may not attract the animals’ attention in the same way. Nevertheless, the main issue here is likely the length of the mooring.

This possibility has been added, while the length is mentioned at the end of the paragraph.

Line 212-216: if it is part of the animal’s natural behavior to be curious and investigate items in its environment, then investigating a man-made item on the seafloor is part of its natural behavior!

We included this suggestion that interaction with man-made items is natural.

Line 238: with “short”, do you mean the length from top to bottom of the mooring, which in this case is 22 m? In my experience that is far from“short”; designs I am familiar with have had a total height above the seafloor of only a few (<5) meters.

We have removed this adjective and acknowledge that it is subjective (e.g., we are more accustomed to oceanographic moorings hundreds of meters long).

Line 273: the ACI was developed to identify times of rich bird song in the presence of anthropogenic sound sources, which is not the situation here. It is therefore unobvious to me why the authors did not simply compute levels in the 20-32 kHz band as a function of time to identify the presence of narwhals. Please explain why the ACI was used in place of (simply) band filtered data.

We explained that iceberg noise prevents us from relying on such simple approaches.

Supplementary information

Line 420: again, how about putting emphasis on the natural state of the animal rather than the confined state and therefore use “free-ranging” instead of “unconfined”.

Corrected.

Line 425: analysed

Corrected.

Fig. S2: Please present acoustic data in dB re 1 µPa. Also, as described above, why the very short FFT size and extremely short window size? They affect how the spectrograms look; some of the "hits" are practically invisible.

The decibel scale was added and the window size was adjusted. The hits were emphasized by zooming and using a log scale on the y-axis.

Fig. S3: a log scale on the y-axis of the spectrogram may better illustrate the actual hit, which is barely visible on the current plot.

Revised as suggested. A relative decibel scale was also added.

Once again, we thank the Reviewers for their feedback on our manuscript.

Resubmitted: 12 Apr 2025
Invited to revise: 29 Jul 2025

Dear Editors and Reviewers,

Thank you for assessing the revised version of our paper. We used this opportunity to polish the manuscript and are pleased to resubmit it for your final checks. Our responses are enclosed.

Sincerely,
the authors

Reviewer #1

Review of resubmitted version of paper "Whale repeated and lethal interaction with moorings questions the non-intrusiveness of a key scientific method". The authors have addressed comments from my first review to my satisfaction, with one exception: the comment on line 63 (original submission) about how the calculation was done to estimate the distance to prey. The papers the authors are relying on for this justification are quite old (35-50 years) in a field that has been expanding explosively! I maintain my point that yes, we expect that inter-click intervals should be a little longer than the two-way travel time (since the animal must process the received echo), but "twice the two-way travel time" at very close distances is not a concept I have seen in any recent papers (see for example Ladegaard et al. 2019 "Dolphin echolocation behaviour during active long-range target approaches" but I found many more), in fact some recent papers clearly contradict that statement (again, particularly when the odontocete is close to the prey). I would therefore strongly encourage the authors to update that section.

> **We updated this section and cited Ladegaard et al. (2019). Specifically, range-to-target estimation with the "two-way travel time" concept yielded 1.5 m, which is also less than the narwhal tusk length. However, this also translates into an unrealistically high dive speed of 6.75 m/s.**

Regarding author response to Reviewer #1- please note that even though I have worked with indigenous people in Alaska and Greenland, I am not familiar with the details of the UNDRIP document referred to by reviewer #1. It is therefore difficult for me to gauge whether the paper's authors have addressed reviewer #1's comments about ethical practices.

> **In our previous rebuttal letter, we explained that comments about ethical practices were addressed by proper citations and clear language (e.g., accounts of lost-and-found moorings are not presented as traditional indigenous knowledge).**

- I started by checking the detailed comments. Most of them were addressed, except possibly * Ln 59, where the authors want to leave their odd "attack buzz" description. In addition, the authors say "Without it, the result of range-to-target calculation appears out of the blue and confusing for the Reader." It turns out that I have an issue with their range-to-target calculations, as I expressed in my own review.

> **This was resolved in response to the first remark above. In the absence of experimental studies on narwhals, we cannot judge which concept should be chosen, and more research is undoubtedly needed.**

* Ln 68, 69-70: it's unclear to me if they addressed the comment

We confirm that we addressed this (p. 3 of the previous rebuttal letter). The corresponding lines 68-70 were moved to the discussion. We also mentioned that there were no other animals able to produce ultrasound in the area.

- In general, the initial (more general) comments were addressed, but I did not have the time to go through them in detail, as it requires hunting for statements or subjects of discussion in the text.

We confirm that our previous rebuttal letter addressed every single remark with point-by-point replies and corresponding changes shown in the track-changes file. Once again, we thank the Reviewer(s) for their feedback on our manuscript.