

Referee Anonymous 1.

#### General comments

**Opportunistic passive acoustic recordings made over several weeks in May during two years were used to identify the presence of sei whales and describe their calls. The objective of the study to describe sei whale acoustic behavior for this region where sei whale calls have to date have been sighted but not acoustically characterized is very valuable to forward knowledge on the distribution and occurrence of this elusive whale species. However, there are several methodological aspects that are not sound enough to convince that the calls recorded have actually been produced by sei whales. The main issue that I see, is that at least three other baleen whale species that also occur in the region produce highly similar calls. These downswep calls are so similar between these species, that the possibility of (purely acoustically, i.e. without sighting information) attributing them to a specific species with certainty is heavily debated among experts. The sei whale downswep described here falls within the acoustic ballpark' of these baleen whale downsweps. Without further cues, i.e. the association to other calls, sightings, it cannot be concluded with certainty that these calls are actually produced by seies. Other issues that blur the results relate to the description of the acoustic specifications of the recording equipment which is not complete, the way acoustic measurements of the calls were conducted (selection of measurement points, consistency in measurements) and the potential effect of varying background noise conditions which may have affected the measurements leading to different outcomes between years. All in all, I suggest that the authors take aboard the suggestions and continue their measurements in the field to obtain more robust data and carry out acoustically sound analyses to further the knowledge status of sei whales in Patagonian waters.**

*Response: We appreciate the suggestions and comments provided by reviewer one, specifically regarding the concern about the calls are actually from Sei whales. Much work has gone into making a more straightforward and easier to read manuscript. For example we introduces photos of sei whales in the area when we detected acoustically and a better description of the methods.*

#### Specific comments and Technical corrections

##### **Abstract**

**P2, line 13: I don't agree with this statement given that there are many other whale species that are even less know. Least known baleen whale species could be, anyway, it is not a contest, so I would suggest to spend these words differently.**

*Response: the sentence has been reword as follow: The sei whale (*Balaenoptera borealis*) is one of the least known whale species. Information on sei whales distributions and its regional variability in the south-eastern Pacific Ocean are even more scarce than that from other areas. Vocalizations of sei whales from this region are not described yet.*

**Line 13-15: Information on their distribution and their occurrence – given that it is such a rare species - (that can be deducted from the PAM data) are of greater relevance than regional vocal variation, in my opinion.**

*Response: The PAM data not only provide information about the regional vocal variation, but also it is a very useful tool to determinate distribution and occurrence as the reviewer state. However, a different experimental design is need it to archive that goal. It is the future work.*

**Line 17: calls were identified to be sei whale downsweeps or calls were attributed to sei whales**

*Response: calls were identified to be sei whale downsweeps*

## **Introduction**

**P3, line 31: least known baleen whale species**

*Response: the sentence has change to: It is also one of the least known whales.*

**Line 37-38: Kanda et al. 2006 investigated sei whale samples collected only in the Northern Hemisphere, so this is not the correct evidence for the statement that there is no clarified genetic separation between populations from different hemispheres.**

*Responses: Sentence has change to: North Atlantic, North Pacific and Antarctic populations are separated and probably subdivided into geographic stocks (Horwood, 1987; Kanda et al., 2006; Huijser et al., 2018). International Whaling Commission in 1991 divided the global sei whale population in “stocks” (based on the distribution of catches, sightings and mark-recapture data) for management purposes (Donovan, 1991). However, genetic studies provide a different population distribution.*

**P5, line 59: pelagic whaling**

*Response: change it as the reviewer suggestion.*

**Line 93-95: Replace: „...cetaceans by recording their vocal signals. Passive acoustic data can then be used to characterize...”**

*Response: change it as the reviewer suggestion*

**Line 96: „poorly known (Prieto et al., 2011). To date, vocalizations have been described...”**

*Response: change it as the reviewer suggestion*

**P6, line 101-103: A description of the soundscape would encompass all biotic, abiotic and anthropophonic sound sources that occur in the area. Given that this study only describes the sei whale signatures, it is not a soundscape baseline. I also think it should be made clearer in the objectives of the study how passive acoustic recordings can add to knowledge about this population and species. What are the questions that you could answer once you known which sounds they produce? There is a lot of information provided in the paragraphs above on how their**

stock structure is so unclear, but these remain unconnected to what acoustics can add. This connection and clear stating of the objectives needs to be improved.

*Response: We appreciate the comments. However, all of those are part of the manuscript discussion, not part of the introduction.*

## Methods

**Line 109: Is this the actual name of the hydrophone? It sounds to me as if this is the icListen from Ocean Sonics, could this be? The frequency response does not go until 200kHz, is this correct?**

*Response: the methodology has been modified as follow: Two different hydrophones were used for the recordings: an icListenHF hydrophone (sensitivity -171 dBV re 1  $\mu$ Pa with pre-amp; frequency response 10–200kHz from Ocean Sonic, Canada); and a SoundTrap 202 STD hydrophone (sensitivity -205 dBV re 1  $\mu$ Pa; frequency response 60000Hz  $\pm$ 3 dB from Ocean Instruments, New Zealand). Also, we made stereo recordings on several occasions with an HTI-96-MIN hydrophone (flat frequency response from 0.02 to 30 kHz) connected to a handy recorder (H4nPro from ZOOM).*

**Line 112: To what recording device were the hydrophones connected and what were the recording specs of these?**

*Response: the response above explain better the idea.*

**Line 115: Was the engine still running during this time?**

*Response: The question was explained by the following sentence: During all the recordings, the engine vessel was turn off.*

**P7, lines 121-123: There is a lot information missing here: How were these parameters measured? From the spectrogram? With which settings? Were these kept consistent, how? Were these done by hand or was the Raven tooling used? Why was the data first analysed with Audacity and the measurements done with Raven? What was the precision of the measurements (i.e. were the measurements repeated for a subset to see if the data could be reproduced and if so with which precision)?**

*Response: the methodology was change as follow: Audio data were analyzed using Raven Pro 1.5 (Cornell University, Ithaca, NY). Low and high frequency (Hz), frequency range (Hz), peak frequencies (the frequency at which the maximum power occurred within a call) and duration (s) for all calls found and attributed to sei whales were analysed from spectrograms and waveform plots created in Raven Pro 1.5 (Hann window; 50% overlap; window size 14563 samples; DFT 16384 samples).*

**Line 123: Can you visualize how the parameters were extracted from the spectrogram?**

*Response: the response above explain better the idea.*

## Results

**P 9, line 129: How were you sure that these were sei whales? Was there a visual confirmation that sei whales were in the vicinity?**

*Response: the figure 01 visualize where sei whale were sighted. In addition, the results state sei whale sightings. The only other baleen specie sighted was a humpback whale one day in 2017.*

**Line 133: How was high quality defined? How was a high signal to noise ratio defined, was it measured? Was there a snr threshold?**

*Response: the methodology was change as follow: only sei whale sounds were detected without associated calls. Only calls with high-visual quality were measured.*

**Line 134: Different naming of hydrophone then in methods**

*Response: change it as: an icListenHF hydrophone// SoundTrap 202 STD hydrophone*

**Line 135 and Fig 02: How did you distinguish from the frequency modulated signatures produced by other baleen whale species? Blue, fin and minkes are all known to produce similar type calls. What characteristics distinguish the sei whale downsweeps from the sweeps produced by other species? I am highly sceptical that this is possible and if these are the only calls that were attributed the sei whales, there needs to be a clear elaboration added to the method section of the manuscript explaining the call characteristics that allowed attributing these to sei whales with certainty. Did you also look into associated calls (i.e. calls produced preceding and following these downsweeps)?**

*Response: the results are explained as follow: In acoustic data from 2016, sei whale calls were detected when sei whales were sighted closer the vessel (fig 02). In 2017, between May 8<sup>th</sup> and 10<sup>th</sup>, sei whales were sighted in the area were after sei whale calls had been recorded (fig 02). Sei whale calls from 2016 were recorded around midday, while in 2017 they were recorded in the late afternoon or at night (Table 1).*

## **Discussion:**

**P 12, Line 154-157: This is not a very strong argument given that the calls recorded are also not that typical in acoustic structure. Baleen whale downsweeps have been estimated to still have a detection range in the orders of tens of kilometers, so do not necessarily have to be sighted to be heard. Especially given that the ship was on station during recording, the area that was, acoustically surveyed' was not particularly large. I suggest a more elaborate explanation of why the recorded calls are not produced by fins, blues or minkes. This would be strongest if you also had downswept calls of these species in your recordings that you attributed to other species than seis.**

**Also for the community to be able to use your data and information to identify Chilean sei whales in their recordings, the description of the calls needs to be much more elaborate.**

*Response: the following sentence has been added: Given that recordings from this project were opportunistic and without digital acoustic recording tags (DTAG) deployed in sei whales we*

cannot prove the origin of the calls. However, we can confirm with reasonable certainty that vocalizations recorded off The Penas Gulf were produced by sei whales, due to the sightings of this species during the recordings and the expeditions. Blue whales (*Balaenoptera musculus*), fin whale (*Balaenoptera physalus*) or minke whales (*Balaenoptera acutorostrata*) produce downsweep as well (Thompson *et al.*, 1996; Schevill and Watkins, 1972; Watkins, 1981). Bryde whales (*Balaenoptera brydei*) has also several call types, included downsweep, but inhabit tropical and subtropical waters and we do not have any record in this area yet (Omura, 1959; Wade and Gerrodette, 1993; Oleson, *et al.*, 2003). Generally, fin whales downsweep have initial frequencies below 35 Hz and final frequencies around 20-18 Hz (Watkins, 1981), similar than minke whales but with shorter durations (0.2-0.3 sec) and higher frequencies (130-60 Hz) (Schevill and Watkins, 1972). Minke whales in the North Atlantic produce long pulse trains (Mellinger *et al.*, 2000), these were not recorded in this area, fin and minke whales downsweep are definitively different than our recordings. Only downsweeps from blue whales described in Chile, through the DTAG data, has a lower peak frequency and duration; low frequency is higher and downsweep had been accompanied in the recorders by the Southeast Pacific type 2 (SEP2) (Saddler *et al.*, 2017), supporting our results, that these records are really from sei whales. Only downsweeps from blue whales described in Chile, through the DTAG data, has a lower peak frequency and duration; low frequency are higher and downsweep had been accompanied in the recorders by the Southeast Pacific type 2 (SEP2) (Saddler *et al.*, 2017), supporting our results, that these records are really from sei whales.

**Line 157-165: This explanation and argumentation is not sufficient, blues, fins and minkes also typically produce low frequency downswept calls as part of their vocal repertoire.**

*Response: the response above explain better the idea.*

**P13, line 177-179: Do you mean the call described here in this manuscript, or is there another record of sei whale calls from these waters?**

*Response: we were describing the call from this manuscript, there is no other acoustic study in these waters.*

**Line 182: Replace: „During this study, no four-call series were recorded as have been recorded in...”**

*Response: change it as the reviewer suggestion.*

**Line 188-191: Given these facts, how can you assume that the recorded calls are sei whales? For a study to first describe the calls produced by a species that can be so variable in ist acoustic signature, there seems to be no solid basis for the assumption that the calls recorded are produced by sei whales. Also, you write that seis were sighted during the expedition? How did the sightings relate in space and time to the recordings? Were they recorded long before the sighting or within minutes?**

*Response: we have provided new information to the discussion to strength our results.*

**P14, line 214-217: Did you also investigate to what extent the background noise conditions differed between the recording sessions and if this might have affected the quality of the recordings in one year and as a result may have affected the measurements? How do you explain the differences in characteristics in the recorded calls between years?**

*Response: Background noise was not part of this investigation. Future research will be conducted to characterize acoustic pollution background and traffic.*

Referee Anonymous 2.

General comments

**This study summarizes the results of passive acoustic data collected in the region of the Golfo de Penas in 2016 and 2017, part of the same area in which an incredible mass stranding of sei whales occurred in 2015. As no data have been available on the acoustic occurrence and characteristics of sei whale vocalizations from this region, this study has the potential to provide useful, new information. However, currently the manuscript is lacking essential detail, and needs to be carefully reconsidered by the authors. There are two broad issues with the current presentation of the data. First, the authors need to provide further justification as to the assignment of these calls to sei whales. As has been pointed out in previous publications (i.e. Rankin and Barlow 2007), most balaenopterid whales produce low-frequency downsweeps, and some of them are very similar. Where the authors of the current study have concluded that the downsweeps recorded in their region have higher frequencies and longer durations than those published from other ocean basins, it becomes necessary to even more carefully evaluate species assignment. In particular, the authors should evaluate their results in comparison to blue whales, which are also known to occur in the coastal region of southern Chile, and address how they are able to distinguish the downsweeps of these two species. Part of this should include whether vocalization of other species were also acoustically detected in the same dataset. Second, the authors need to provide more detail on their data collection and analysis protocols, which are only cursorily summarized in the current manuscript, and take care not to draw conclusions that their analyses do not support. For example, they present no analysis of the diel patterns in call occurrence, but then discuss their observation of nighttime calling behavior. Similarly, they present no visual sightings data, but then mention sightings in the discussion. Discussions such as these need to be grounded in an appropriate presentation of the data first. With a bit more work, this study could provide a useful contribution to the literature.**

*Response: We appreciate the suggestions and comments provided by reviewer one, specifically regarding the concern about the calls are actually from Sei whales. Much work has gone into making a more straightforward and easier to read manuscript. For example we introduce photos of sei whales in the area when we detected acoustically and a better description of the methods and discussion.*

Specific comments are given below:

**Introduction: Line 31: I think you might mean to say “least known” rather than “least unknown”. Either way, there are other species that are arguably at least as poorly studied; Bryde’s whales come to mind. You might simply say that they are poorly known.**

*Response: the sentence has been reword as follow: The sei whale (*Balaenoptera borealis*) is one of the least known whale species. Information on sei whale’s distributions and its regional variability in the south-eastern Pacific Ocean are even more scarce than that from other areas. Vocalizations of sei whales from this region are not described yet.*

**Lines 37-38: A recent study published in Conservation Genetics (Huijser et al 2018) addresses population structure of sei whales between the North Atlantic and North Pacific.**

*Response: : We appreciate the information, the sentence has change to: North Atlantic, North Pacific and Antarctic populations are almost certainly separated and probably subdivided into geographic stocks (Horwood, 1987; Baker et al., 2004; Kanda et al., 2006; Huijser et al., 2018). International Whaling Commission in 1991 divided the global sei whale population in “stocks” (based on the distribution of catches, sightings and mark-recapture data) for management purposes (Donovan, 1991). However, genetic studies provide a different population distribution. For example, at North Atlantic Ocean, the sei whale population from Iceland, the Gulf of Maine and the Azores share the same genetic diversity, showing the wide latitudinal and longitudinal ranges they moved. Furthermore, it is well known the genetic divergence between North Pacific and North Atlantic stocks, but no studies of this genetic structure between hemispheres or within the Southern Ocean have been presented (Huijser et al., 2018).*

**Line 40: This is a misinterpretation of the data discussed in Donovan 1991. He mentioned that eight “concentrations” of whales had been identified in the North Atlantic, but that these did not necessarily represent different stocks. In fact the IWC recognizes 3 management units in the North Atlantic, though actual stock delineation is unclear.**

*Response: the response above explain better the idea.*

**Line 49: There is a general inappropriate use of apostrophes throughout the paper. In this example, this sentence should begin with: “Population boundaries” not “Popula- tion’s boundaries”. In other instances, for example on line 42, the text should read “sei whale sightings”, not “sei whale’s sightings”. Line 75, there should be no apostrophe in “strandings”. Please check for this and correct throughout the manuscript.**

*Response: We appreciate the corrections, changes it as the reviewer suggestion*

**Methods: Much more detail needs to be included in the methods; in its current form, this section is completely lacking a large body of necessary information.**

*Response: we introduce figures and tables to explain better the methodology and the results, the methodology text was change as follow: Two cruises to the Tres Montes Gulf (46.2-48.0° S,*

74.0-75.4° W) aboard the motor sailing vessel Saoirse were carried out in May 2016 and May 2017 during which biological, oceanographic and acoustics studies were carried out (fig 01). Marine mammals were identified visually with binoculars and the naked eye for a team of experienced marine mammal observers in the vessel.

Two different hydrophones were used for the recordings: an icListenHF hydrophone (sensitivity -171 dBV re 1  $\mu$ Pa with pre-amp; frequency response 10–200kHz from Ocean Sonic, Canada); and a SoundTrap 202 STD hydrophone (sensitivity -205 dBV re 1  $\mu$ Pa; frequency response 60000Hz  $\pm$ 3 dB from Ocean Instruments, New Zealand). Also, we made stereo recordings on several occasions with an HTI-96-MIN hydrophone (flat frequency response from 0.02 to 30 kHz) connected to a handy recorder (H4nPro from ZOOM).

Opportunistic and planned recordings were carried out depending on the weather conditions and the vessel location. In 2017 the hydrophones were deployed for 2 to 5 days in 3 locations. In these cases, hydrophones were deployed at a depth of 5 or 10 meters on rocky bottom with no more than 40 meters depth. Hydrophones were hold on a row with an anchorage in the end and superficial buoys in the opposite side. In both years, during the day or night, hydrophones were deployed at a depth of 5 and 10 meters from the stationary vessel. In the opportunistic recordings, recordings were continuously, but in the night when the vessel was anchorage, the recordings were in intervals between 10-30 minutes each hour for guarantee the capacity of the acoustic personal to study the recording in the next day.

During all the recordings, the engine vessel was turn off. All the recordings were stored in the internal card memory of the equipments, and at the end of the day these were download in a portable computer.

Audio data were analyzed using Raven Pro 1.5 (Cornell University, Ithaca, NY). Low and high frequency (Hz), frequency range (Hz), peak frequencies (the frequency at which the maximum power occurred within a call) and duration (s) for all calls found and attributed to sei whales were analysed from spectrograms and waveform plots created in Raven Pro 1.5 (Hann window; 50% overlap; window size 14563 samples; DFT 16384 samples).

**Line 109: what is an “HF 200kHz hydrophone”? Is this a hydrophone model?**

*Response: this hydrophone is icistenHF.*

**Line 114: The hydrophone deployment method is a little unclear. Was the hydrophone suspended for up to 5 days over the side of the vessel? How many recording stations were conducted? What were the positions (lat/longs)? What was the sampling rate? How were the data recorded? Are these archival recorders, or were you using a computer, a recording deck, etc, and if so, what equipment was included?**

*Response: the methodology was change as follow: Opportunistic and planned recordings were carried out depending on the weather conditions and the vessel location. In 2017 the*



hydrophones were deployed for 2 to 5 days in 3 locations. In these cases, hydrophones were deployed at a depth of 5 or 10 meters on rocky bottom with no more than 40 meters depth. Hydrophones were held on a row with an anchorage in the end and superficial buoys in the opposite side. In both years, during the day or night, hydrophones were deployed at a depth of 5 and 10 meters from the stationary vessel. In the opportunistic recordings, recordings were continuously, but in the night when the vessel was anchored, the recordings were in intervals between 10-30 minutes each hour for guarantee the capacity of the acoustic personal to study the recording in the next day.

**Lines 119-123: This section is completely lacking in any detail on the analyses. How were the sounds reviewed? Using spectrograms? What page size, what FFT? How were signals from sei whales distinguished from other species, such as blue whales (which also produce similar low-frequency downsweeps)? How were measurements conducted? Issues with measurements such as low and high frequency that are strongly affected by spectrogram parameters and SNR have been recognized in the literature; Raven and other software packages (i.e. Ishmael) offer a set of more “robust” analyses; these need to be used as well. It appears that two software packages were used (Audacity and Raven). What was each one used for?**

*Response: the methodology was change as follow:* Audio data were analyzed using Raven Pro 1.5 (Cornell University, Ithaca, NY). Low and high frequency (Hz), frequency range (Hz), peak frequencies (the frequency at which the maximum power occurred within a call) and duration (s) for all calls found and attributed to sei whales were analysed from spectrograms and waveform plots created in Raven Pro 1.5 (Hann window; 50% overlap; window size 14563 samples; DFT 16384 samples).

**Results: Line 128: It is difficult to understand the recording scheme; the math as currently presented does not add up. 16 days of recording would be 384 hours, not 136.**

*Response: the recordings were not continuous. The results was change as follow:* Sound was recorded during 16 days in 2016 and during 19 days in 2017. A total of 363 hours was recorded between both expeditions, because the recordings were not continuous during every day, 136 hours in 2016 and 227 hours in 2017. Sei whale calls were found in 8 archives for 3 days, on 7 May 2016 and 10-11 May 2017, at 2 different locations (one in 2016 and other in 2017) (Table 1). In acoustic data from 2016, sei whale calls were detected when sei whales were sighted closer the vessel (fig 02). In 2017, between May 8<sup>th</sup> and 10<sup>th</sup>, sei whales were sighted in the area were after sei whale calls had been recorded (fig 02). Sei whale calls from 2016 were only recorded around midday, while in 2017 they were recorded in the late afternoon or at night (Table 1).

**Were the recordings duty cycled? In the methods, you describe that the hydrophones were deployed from 2-5 days at a time, so it would seem that you'd have many more hours of recording over 16 days and 19 days. Please clarify this both in the methods section and here.**

*Response: the response above explain better the idea.*

**Line 133: What SNR was used to determine quality?**

*Response: the methodology was change as follow: only sei whale sounds were detected without associated calls. Only calls with high-visual quality were measured.*

**Figure 1: Which whale tail corresponds to which year? Also, the area where putative sei whales were detected appear very close to recording sites where they were not detected. Is there any explanation for why this might be?**

*Response: we incorporate a table with more detail about the sei whale recordings at the Penas Gulf and we explain this difference in the discussion: The few calls obtained in both expeditions maybe was due the duration of recorded in each site since they were opportunistic recordings, so visual observations, tagging efforts and genetic studies are needed to verify this hypothesis.*

**Discussion: Overall, there is no discussion of one of the main outcomes of this study – that despite the number of sites sampled, putative sei whales were only detected very rarely, and only in two locations. Why might this be? Could this have to do with the sampling scheme (ie duration of sampling at each site) or noise conditions (ie masking of signals)? How does this conform to your expectation?**

*Response: the response above explain better the idea.*

**Line 157: No information on visual survey data collection was given to support this statement. Were visual surveys conducted during this expedition? If so, and if that information is to be used as supporting evidence, then details on data collection methodology and results need to be presented.**

*Response: we incorporate a table with more detail about the sei whale recordings at the Penas Gulf and we introduces photos of sei whales in the area when we detected acoustically and a better description of the methods*

**Line 160: Johnson et al (2010) did not describe sei whale calls. Their report only shows two example spectrograms from recordings during different periods and/or places, and the report cited actually concluded that no sei whale calls were recorded during that period at that site. This citation should be removed from the manuscript.**

*Response: we appreciate the correction, changes it as the reviewer suggestion*

**Line 196-217: With a sample of only 41 calls, it is doubtful that you have enough data to assess diel trends. However, if you would like to attempt this, you need to quantify your recording effort**

**by diel period, and present the results accordingly. As it stands, there is no foundation for this section of the discussion.**

*Response: We appreciate the comments and we are conscient that we cannot do formal diel trends because our data were opportunistic, for this, we only reflected our diel results, and future work will be necessary to establish better these patterns.*