IN THE HIGH COURT OF SOUTH AFRICA

(EASTERN CAPE DIVISION, GRAHAMSTOWN)

Case No: 3941/2021

In the matter between:

SUSTAINING THE WILD COAST NPC	First Applicant
MASHONA WETU DLAMINI	Second Applicant
DWESA-CWEBE COMMUNAL PROPERTY ASSOCIATION	Third Applicant
NTSINDISO NONGCAVU	Fourth Applicant
SAZISE MAXWELL PEKAYO	Fifth Applicant
CAMERON THORPE	Sixth Applicant
ALL RISE ATTORNEYS FOR CLIMATE AND THE ENVIRONMENT NPC	Seventh Applicant

and

MINISTER OF MINERAL RESOURCES AND ENERGY	First Respondent
MINISTER OF ENVIRONMENT, FORESTRY AND FISHERIES	Second Respondent
SHELL EXPLORATION AND PRODUCTION SOUTH AFRICA B V	Third Respondent
IMPACT AFRICA LIMITED	Fourth Respondent
BG INTERNATIONAL LIMITED	Fifth Respondent

NOTICE OF MOTION

KINDLY TAKE NOTICE that the Applicants intend applying to the above Honourable Court for the relief set out hereunder:

1 This application is treated as a matter of urgency in terms of Rule 6 (12).

2 The Applicants are granted leave to submit the supplementary affidavit of Reinford Sinegugu Zukulu and all annexures, supporting affidavits, and reports annexed to it.

3 Any Respondent opposing the application is ordered to pay the Applicants' costs.

KINDLY TAKE FURTHER NOTICE that the affidavit of Reinford Sinegugu Zukulu will be used in support of this application.

KINDLY TAKE FURTHER NOTICE that the Applicants have appointed the address of their attorneys set out below as the address at which they will accept notice and service of all process in these proceedings.

KINDLY TAKE NOTICE FURTHER that if you intend to oppose the application for the relief in paragraph 3 above you are required -

(a) to give written notice thereof to the Applicants' attorneys at the physical or email address stated below by no later than **16h00 on Wednesday, 08 December 2021,** and to furnish in such a notice a physical and/or email address where you will accept notice and delivery of any further documents or process in this matter; and

(b) to deliver any answering affidavit at the same time as delivering the answering affidavit to the founding affidavit on **16H00 on Friday, 10 December 2021** to the Registrar of the above Honourable Court and the Applicants attorneys at the email address stated below.

KINDLY ENROLL THE MATTER FOR HEARING ACCORDINGLY

DATED at Makhanda on this 7th day of December 2021.

APPLICANT'S ATTORNEYS
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Email: wilmien@lrc.org.za, khanya@rsinc.co.za, johan@rsinc.co.za

TO: **THE REGISTRAR OF THE HIGH COURT**

AND TO: **Minister of Mineral Resources and Energy**
First Respondent

C/0 State Attorney
Per M Botha (Mrs)
29 Western Road Central
Gqeberha
E-mail : MicBotha@justice.gov.za

AND TO: **Minister of Forestry, Fisheries and the Environment**
Second Respondent
C/0 State Attorney
Per M Botha (Mrs)
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AND TO: **Shell Exploration and Production South Africa B V**
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Ridgeside Office Park
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Per email: sampson@wylie.co.za

AND TO: **Impact Africa Limited**
Fourth Respondent
6th Floor
119 Hertzog Boulevard
Foreshore
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AND TO: **BG International Limited**
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24 Richefond Circle

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and

MINISTER OF MINERAL RESOURCES AND ENERGY	First Respondent
MINISTER OF ENVIRONMENT, FORESTRY AND FISHERIES	Second Respondent
SHELL EXPLORATION AND PRODUCTION SOUTH AFRICA B V	Third Respondent

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IMPACT AFRICA LIMITED Fourth Respondent

BG INTERNATIONAL LIMITED Fifth Respondent

SUPPLEMENTARY AFFIDAVIT

I, the undersigned,

REINFORD SINEGUGU ZUKULU

do hereby make oath and say:

1 I am an adult male residing at Baleni village which forms part of the Amadiba Traditional Community in Winnie Madikizela-Mandela Local Municipality in the Eastern Cape.

2 I am authorised to depose to this affidavit on behalf of the First Applicant. I deposed to the founding affidavit in this matter.

3 Save to the extent that the context indicates otherwise the facts deposed to herein are within my personal knowledge and belief. To the extent that I make legal submissions in this affidavit, I do so on the advice of my legal representatives, whose advice I believe to be correct.

4 In this affidavit, I will use the same terms as used in the founding affidavit.

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I. OVERVIEW

5 The Applicants' founding papers were signed on Thursday, 02 December 2021 and served on the respondents by email the same day and by Sheriff the next day.

6 I note that Shell has opposed the application, while the First and Second Respondents have indicated their attention to abide.

7 As noted in the papers, the founding papers were prepared under extreme urgency. It is therefore necessary to submit this additional affidavit to bring in evidence that was simply not ready on 02 December 2021.

II. MARINE EXPERTS ON HARM

8 Several experts volunteered to set out the risks of harm associated with seismic surveys in general, and on the Wild Coast in particular.

9 These reports will be filed with the Court under affidavits from these experts. I ask that they be read as if specifically pleaded by the Applicants.

10 In the following, I briefly summarise the reports for the Court.

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Dr I)ouglas Nowacek

11 Dr Douglas Nowacek is one of the, if not the, leading experts on the behavioral and acoustic ecology of marine animals, with particular expertise in the subject of anthropogenic noise. In 2019, Dr Nowacek provided an expert opinion to a United States court which summarised scientific evidence about the impacts of seismic air guns on marine life, and in particular on North Atlantic right whales.

11.1 In summary, having reviewed the relevant sections of the 2013 EMPr Dr Nowacek found the following:

11.2 Sound is of unparalleled importance to marine species for biological activities that are essential to their survival and reproduction. Exposure to unwanted sound causes behavioral and physiological harm to these animals.

11.3 Marine animals exposed to seismic air gun noise contend with both loud individual pulses every 10 to 15 seconds and continuous reverberating energy in the periods between the pulses. Studies indicate that seismic surveys that interfere with whale communication and induce chronic stress can aggregate into species-level consequences, which are particularly concerning for endangered populations of whales in the Transkei coast.

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11.4 Noise from seismic surveys will be felt by cetaceans over large areas of ocean. This noise will likely adversely impact the cetaceans in at least three ways: by inducing a physiological stress response; by disrupting biologically essential behaviour such as vocalizing, mating, or foraging; and by masking acoustic communication, including communication between mothers and calves.

11.5 Since the EM Pr was completed in 2013, the field of acoustics in the marine environment has evolved substantially. While in 2013 the EMPr found that the overall impacts of seismic noise onto marine animals ranged from negligible to low, these findings are contradicted by recent scientific literature on the impacts to species such as zooplankton, endangered African penguins, and acoustically sensitive beaked whales.

12 Dr Nowacek concludes that in his opinion, because the 2013 EMPr did not use acoustic modeling and relied upon eight-year-old, outdated information on the presence and abundance of animals in the seismic surveying area, and outdated scieince regarding acoustic impacts on marine species, the seismic survey will likely cause significant harm to marine animals, and the proposed mitigation measures will be ineffective. ~~Further, the seismic survey may cause irreparable harm to species at both individual and population levels~~.

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Doctors Harris, Olbers, and Wright

13 Doctors Jean Harris, Jennifer Olbers, and Kendyl Wright - each leading experts on marine science - survey the concerns of significant harm to marine wildlife by Shell's seismic survey.

14 They conclude that, in their expert opinions, "seismic surveys do cause harm to both species and the ecology, and that significant direct harm to individual animals and harm to populations of endangered species is the most likely scenario in the case of the seismic survey underway off the east coast of South Africa."

15 Their report sets out their reasons for this conclusion with reference to recent research not covered in the EMPr. Notably, the report:

15.1 raises grave concerns that turtle hatchlings will be affected by the seismic survey and none of the mitigation measures will address this;

15.2 cites the growing appreciation for the vital role that sound plays in species' survival in the sea, and the disruption that sesmic surveys can bring;

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15.3 notes recent research that zooplankton can be impacted by seismic surveys at a range of over 1km, a far bigger area than the 10m cited in the EMPt; and

15.4 questions the efficacy of the EMPr's mitigation measures.

Lynton Francois Burger

16 Mr Lynton Burger was the founding Managing Director of Environmental Resources Management Southern Africa ("ERM"), which prepared the 2013 EMPr. He has 30 years of environmental management, corporate sustainability and research experience.

17 In summary, Mr Burger's assessment of ERM's 2013 EMPr and the 2020 audit is as follows:

17.1 The authors of the EMPr and the audit are inadequately qualified as they appear to lack any professional marine science or marine environmental training.

17.2 The 2013 EMPr is out of date. It is not industry best practice for consultants to stand by such an old EMPr, especially noting the

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advancements in scientific knowledge regarding seismic surveys. The old EMPr means that the mitigation measures it proposes are inadequate because they focus on an outdated and list of potential impacts, and that the public consultation with interested and affected parties, which was already limited because a full environmental impact assessment was not conducted, is also outdated.

17.3 The EMPr does not consider the mounting scientific studies and government reviews which expose the full impacts of seismic surveys on marine organisms and ecosystems. Many of these studies and reviews were published after the 2013 EMPr.

17.4 The EMPr mitigation measures are also inadequate because they are heavily reliant on supposed independent onboard observers, that is, junior-level observers. These junior-level observers' ability to detect cetaceans is severely limited to fleeting surface appearances. During night-time surveying, which is half of the survey time, there are effectively no mitigation measures, which the EMPr glosses over.

17.5 Most importantly, the full impacts of the seismic surveying to plankton, the very building blocks of ocean ecosystems, cannot be monitored or

mitigated by onboard observers, because plankton occur as vast undetected biomasses over the ocean. This is left unaddressed by both the EMPr and the audit.

Public Letter

18 Mr Burger also attaches an open letter to his affidavit signed on to by South Africa's leading marine experts. He confirms the letter's validity.

19 Importantly, the letter makes the following finding:

> *"There is a growing body of evidence pointing to the immediate and long-term, and largely unmitigable, negative impacts (including irreparable harm) of this invasive method on marine creatures, from large (including acoustically sensitive whales and dolphins) to small (e.g. plankton, upon which all ocean trophic systems depend), that make up our valuable marine ecosystems, and upon which our coastal communities and economies depend."*

20 In light of the current data, the experts call for the halt of Shell's seismic survey.

David Russell

21 David Russell is a fisheries consultant based in Namibia. Mr Russell has followed Shell's seismic surveys in Namibia for several years.

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22 Mr Russell notes that when Shell's seismic surveys commenced in 2012, there was a 'sudden drop in catches' that had a 'devastating economic impact on the albacore tuna industry.' Following this, Mr Russell notes Shell's engagement with the tuna fishing sector to better design its seismic surveys to manage impacts.

23 Mr Russell concludes by saying "we would consider it an unwise decision if South Africa relied on the apparently less accountable Environmental Management Programme of 2013 to guide its seismic activities," encouraging Shell to communicate positively with small-seal! fishers "whose meager livelihood could be significantly negatively impacted if the fish run away due to seismic survey noise."

Professor Mike Bruton

24 Professor Bruton is one of the world's leading experts on the extremely rare Coelacanths.

25 In his affidavit, Professor Bruton:

25.1 explains why Coelacanths have such iconic status;

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25.2 articulates why it is almost certain that there are Coelacanths in the seismic study area; and

25.3 notes the high risk to the Coelacanth population if even a small number are adversely impacted by the seismic survey.

Dr Alexander Claus Winkler

26 Dr Winkler is an inshore fisheries expert with expertise in fish behaviour and life-history assessment.

27 In summary, Dr Winkler says the following about EMPr:

27.1 Any human effect on the ecosystem is likely to have unseen indirect effects on the entire ecosystem, causing subtle and slow trophic cascades that may only reveal themselves decades later.

27.2 The EMPr states that "information on feeding success of fish (or larger predators) in association with seismic survey noise is lacking". But since 2013, due to technological advances in fish biotelemetry, in-depth scientific studies on the effects of seismic surveys on fish in the wild have been published, including a survey finding reduced foraging behaviour

among such fish, which may result in them having less energy to perform tasks that use considerable amounts of excess energy, such as reproduction, growth and migrations.

27.3 It is likely that the seismic survey will cause similar changes to the rhythmic diurnal foraging behaviour of these species in the surveyed area.

27.4 The Transkei and Algoa Bay are also thought to be population strongholds for several fish species that are under threat of extinction. In the absence of evidence that the seismic survey will have no direct or indirect effect on these species of such dire conservation concern, the precautionary approach is imperative if we are to conserve them into the future.

27.5 Given the slow and lethargic nature of Coelacanths, there is no doubt that if they do in fact inhabit the deep reefs of the Transkei they will be directly or indirectly affected by the seismic survey.

28 Dr Winkler concludes that updated literature, technological advances and a growing global concern around the subtle indirect effects of noise pollution on

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marine ecosystems have revealed severe shortfalls in the EMPr. Noting this, the seismic survey will at the very least have lasting indirect energy budget effects on the Transkei and Algoa Bay's marine fish fauna, which will in tum probably effect certain species' processes such as reproduction and migration.

III. COSTS

29 If the Applicants are unsuccessful in this interdict application, we submit that section 32(2) of NEMA should apply, and costs should not be awarded against us. We intended to make this point in the founding affidavit and neglected to do so.

30 In the event that a person fails to secure the relief sought in respect of any breach or threatened breach of any provision of NEMA, or of any provision of a specific environmental management Act, or of any other statutory provision concerned with the protection of the environment or the use of natural resources, section 32(,2) of NEMA provides that a court may decide not to award costs against the unsuccessful parties if the court is of the opinion that they acted reasonably out of a concern for the public interest or in the interest of protecting the environment and had made due efforts to use other means reasonably available for obtaining the relief sought.

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31 In bringing this application the Applicants have acted reasonably out of concern for the public interest and in the interest of protecting the environment. We are seeking this interdict because of Shell's apparent breach of NEMA and the MPRDA, to the detriment of the environment and the public's environmental rights, as well as our own rights. We have been compelled to act because, despite the First and Second Respondents' constitutional obligations to protect the environment and the public's environmental rights, they have failed to do so.

IV. CONCLUSION

32 We note that it is not common to introduce additional evidence after the founding affidavit. Given the extreme urgency the founding affidavit was prepared under, as well as the assistance the evidence provides to the court, we submit we had no alternative. We ask this Court to have regard to the reports.

33 In the circumstances, the Applicants persist with their prayer for the relief sought in our notice of motion, including costs with the costs of two counsel.

REINFORD SINEGUGU ZUKULU

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I certify that the above signature is the true signature of the deponent who has acknowledged to me that h nows and understands the contents of this affidavit was signed and sworn to at ;Y/fIS t ? MS___ cm this the QJ_ of _P9£et::-Ml}.f1;:..2021 in accordance with the provisions of Regulation R128 dated 21 July 1972 as amended by Regulation R1648 dated 19 August 1977, R1428 dated 11 July '1980 and GNR 774 of 23 April 1982.

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COMMISSIONER OF OATHS

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IN THE HIGH COURT OF SOUTH AFRICA
(EASTERN CAPE DIVISION, GRAHAMSTOWN)

Case No: 3941**/**2021

In the matter between:

SUSTAINING THE WILD COAST AND OTHERS Applicants

and

MINISTER OF MINERAL RESOURCES AND ENERGY AND OTHERS Respondents

---

SUPPORTING AFFIDAVIT

I, the undersigned,

DOUGLAS NOWACEK

do hereby make oath and say:

1 I am an adult male and the Repass-Rodgers Chair of Marine Conservation Technology in the Nicholas School of the Environment and the Edmund T. Pratt School of Engineering, at Duke University in Durham, North Carolina, United States of America.

2 The contents of this affidavit are to the best of my knowledge true and correct. Unless I indicate otherwise, or the contrary appears from the context, they are within my personal knowledge and belief.

3 My CV is attached marked DN1. I confirm that it is accurate.

Background and Expertise

4 I have studied the behavioral and acoustic ecology of marine animals throughout my professional career, with particular expertise in the subject of anthropogenic noise. I have authored or co-authored more than 100 publications on marine animal ecology and acoustics, with about one quarter of those papers and reports specifically focused on ocean noise, from analyses of acoustic sources to impacts on marine animals to the mitigation of those impacts.

5 In January of 2019 I provided an expert declaration that was filed in a United States court and which provided the court with a summary of scientific evidence about the impacts of seismic airguns on marine life, and in particular on North Atlantic right whales ("Expert Declaration"). Because of the short timeframe and urgency of this matter, I attach and incorporate herein the Expert Declaration (attached marked DN2), and use this declaration to clarify the Expert Declaration's applicability to the proposed seismic survey at issue here and identify other applicable scientific evidence (attached marked DN3).

6 I continue in my role at Duke University as the Repass-Rodgers Chair of Marine Conservation Technology in the Nicholas School of the Environment and the Edmund T. Pratt School of Engineering, at Duke University. The Expert Declaration describes in more detail my experience and background. Expert Decl. ¶¶ 2- 4.

7 For this opinion, I have reviewed Shell Exploration and Production South Africa notification letter for the Transkei Survey, dated 29 October 2021. I have also reviewed sections of the 2013 Environment Management Programme (EMPr) describing the seismic survey and mitigation measures for cetaceans. I also have reviewed the chart of threatened and protected cetacean, bird and fish species present in the survey area included in the report by Simon Elwin and Tess Gridley, dated 2 December 2021.

8 It is my understanding that the EMPr for the project was completed in 2013. According to the EMPr, a vessel will tow an airgun array with up to 12 or more lines of hydrophones spaced 5 to 10 meters apart and between 3 and 25 meters below the water surface. The array can be upwards of 12,000 meters long and 1,200 meters wide. The airgun would be fired at approximately 10 to 20 second intervals, and would be expected to produce sound levels of around 220 decibels.

Expert Declaration's Conclusions May be Applied to Seismic Surveying Activities in South Africa

9 My Expert Declaration describes how seismic airgun noise travels in the ocean and discusses harms from seismic surveys to marine mammals, Expert Decl. ¶¶ 7- 15. I summarize some of the key points below.

10 Seismic airgun noise has a number of characteristics that give it a remarkably large acoustic footprint. The sounds that seismic arrays produce are among the loudest that humans regularly introduce into the ocean, exceeded only by the occasional

use of explosives. Seismic noise can also travel great distances and has been heard at distances of up to nearly 4000 kilometers (km). Seismic airgun noise also has a broad temporal scale. While airgun arrays are loudest when they are firing, they also significantly elevate background levels of noise between shots. The sound that results is said to “spread” across the interval between pulses, becoming virtually continuous at distance. Seismic airguns are, in effect, a hybrid source, producing both a powerful impulsive sound that can be damaging if the receiver is too close and a virtually continuous sound that raises ambient noise levels at much greater distances, Expert Decl. ¶¶ 37-38. Thus, marine animals exposed to noise from seismic airguns must contend with both loud individual pulses every 10 to 15 seconds and with continuous reverberating energy in the periods between the pulses.

11 In addition to describing these general harms, my Expert Declaration focuses in detail on the impacts to North Atlantic right whales from acoustic surveys, Expert Decl. ¶¶ 16 – 39, relying on, as well, studies on baleen and bowhead whales to draw informed opinions, Expert Decl. ¶ 18. North Atlantic right whales, *Eubalaena glacialis*, are the same genus as Southern right whales, *Eubalaena australis*, which are found in the Transkei seismic survey area between July and November. Because they are from the same genus, scientifically the studies and general conclusions (i.e. those that do not relate to activities or bathymetry specific to the Atlantic) may be interchangeably applied.

12 Studies on bowhead and other baleen can be relied upon to make informed opinions about other whales that are in the Shell survey area because baleen whales are all members of the sub-order *Mysticeti*, and share common features amongst themselves; this makes them appropriate proxies for assessing impacts on other baleen whales found in the seismic surveying area. According to the 2013 EMPr, the baleen whales in the seismic survey area include: Southern right whales (*Eubalaena australis*), Humpback whales (*Megaptera novaeangliae*), Minke (*Balaenoptera bonaerensis*), Dwarf minke (*Balaenoptera acutorostrata*), Fin whale (*Balaenoptera physalus*), Antarctic blue whale (*Balaenoptera musculus musculus*), Sei whale (*Balaenoptera borealis*), Bryde's (inshore) (*Balaenoptera brydei (edeni)*), and Pygmy right (*Caperea marginata*). While we have very limited data on many of the species in this list, the general conclusions about impacts (i.e. those that do not relate to activities or bathymetry specific to the Atlantic) may be applied to the baleen whales that will subject to seismic surveys taking place in the Transkei.

13 The following main findings from my Expert Declaration are applicable to the Transkei survey:

13.1 Noise from the seismic activity will likely adversely impact the cetaceans in at least three ways: 1) by inducing a physiological stress response; 2) by disrupting biologically essential behavior such as vocalizing, mating, or foraging; and 3) by masking acoustic communication, including communication between mothers and calves, Expert Decl. ¶¶ 19 – 39.

13.2 The noise from seismic surveys would be felt by cetaceans over large areas of ocean because sound travels farther and faster in water than in air and the acoustic energy from airguns can propagate hundreds to thousands of kilometers in marine environments. Expert Decl. ¶¶ 7– 15, 35 – 39.

13.3 The noise from seismic surveys experienced by sound-dependent marine animals, would not be limited to the pulse of the airgun shot and includes an increase in the median ambient noise in the ocean even at a distance of 100 kilometers. Expert Decl. ¶¶ 35 – 39.

13.4 Mitigation measures such as time-area closures, visual observers, and passive acoustic monitoring and “soft starts” or “ramp ups” are inadequate to protect cetaceans present year-round or deep-diving beaked whales. Expert Decl. ¶¶ 40 – 47.

Scientific Understanding of Acoustic Impacts on Marine Animals Has Evolved Since 2013

14 Like the ocean, science is dynamic. The field of acoustics in the marine environment has evolved substantially since 2013 when the EMPr was completed.

15 The EMPr, even prior to the consideration of the lowering effect of mitigation factors, found overall impacts to marine animals by seismic noise during the operational phase of activities that ranged from negligible (phytoplankton & zooplankton; invertebrates, including squid) to low (fish; turtles; seabirds, including penguins) to

medium (cetaceans). EMPr 6-11 to 6-42, and table 6.3 at 6-53 to 6-54. Recent scientific literature that was not considered in 2013 contradicts these findings.

16 A 2021 literature review provided a systematic assessment of 538 scientific papers relating to the “effects of impacts of anthrophony and other human alterations to ocean soundscapes on marine animals” (Duarte et al., 2021). The review examined published literature since 1970 and demonstrated that there was a significant post-2010 uptick in published papers on this subject (Duarte et al., 2021). That same review demonstrated that 74.4% of those studies statistically testing the impacts of seismic surveys on marine animals found significant negative impacts to these animals from the surveys (medium-high confidence) (Duarte et al., 2021). For another example, a 2017 study found that a single airgun blast kills over 50% of zooplankton within a 1 kilometer radius, contradicting the 2013 EMPr’s assertion that the seismic surveys will have negligible impacts on phytoplankton and zooplankton (McCauley et al., 2017). As an intermediary between primary producers (plankton) and fish, marine mammals, and birds, zooplankton are vital to ocean productivity and healthy ocean ecosystems. Similarly, while the EMPr found a medium impact on cetaceans, scientists have found that even slight disturbances which result in the displacement of acoustically sensitive beaked whales may have population level effects, certainly an impact beyond medium significance. (New, 2013).

17 Lastly, important studies have taken place prior to and since 2013 that demonstrate the harms of seismic testing and anthropogenic noise on cetaceans. Post-2013

studies include examples of negative effects on cetaceans generally (Dunlap et al, 2021; Gomez et al., 2016; Castellote and Lorens, 2016; Nowacek et al. 2015) and specifically on physiological stress effects (Expert Decl. ¶¶ 20 – 23; Lemos et al., 2021 – gray whales); behavioral disruptions (Expert Decl. ¶¶ 24-31; Dunlop, 2015, 2020 – humpback whales; Bröker et al., 2015 - gray whales; Miller et al., 2015 & DeRuiter et al., 2013 – beaked whales; Pirotta et al., 2014 - porpoises), and communication disruptions (Expert Decl. ¶¶ 32-34; Tennessen and Parks 2016 - North Atlantic right whales; Cerchio et al., 2014 – humpbacks; Blackwell et al., 2013, 2015 – bowhead whales).

18 Since 2013, we have also come to understand much better how seismic gun noise is not limited to the airgun pulses themselves, but also increases ambient noise. Expert Decl. ¶¶ 35-39.

19 Lastly, presence and abundance can change in an eight-year period. Climate change for example is increasingly causing shifts in the timing and duration of migrations, changes in distribution, habitat loss, and reduced fecundity (van Weelden et al. 2021). Notably, at the time of the EMPr in 2013, humpback whales were presumed to be seasonal in the surveying area. See Table 6.4 of EMPr at 6-54. Without accurate data on which species are in the seismic survey area, how many, and when, there is a significant risk that mitigation measures could be rendered ineffectual.

Modeling

20 It is standard practice in the United States to model the acoustic footprint of the proposed survey over appropriate time and space scales. The effects could extend over hundreds of square kilometers. The EMPr contains no such modelling.

21 In addition, such modeling must analyze the aggregate sound field, not just the specific airgun survey, to estimate the overall influences of changes in the acoustic environment at appropriate ecological scales, the potential impacts on marine life, and the potential effects on populations (Southall et al., 2013). Given our rapidly improving understanding of the spatial, temporal, and spectral scales of the acoustic footprints generated by these seismic activities, the single-source regulatory approach is no longer appropriate (Southall et al., 2021; Nowacek et al., 2015).

22 Without acoustic modeling, the EMPr could not have accurately assessed the harms that the seismic survey could cause.

Mitigation Measures

23 An assessment for the harms of a seismic surveying activity that does not use the most current science and does not contain acoustic modeling cannot accurately assess the harms that this seismic surveying will cause. This means that mitigation measures could be inutile and misdirected. The mitigation measures proposed for seismic surveying in the Transkei include measures such as using visual observers,

passive acoustic monitoring, and the use of a “ramp-up” or a “soft start.” These may be ineffective. The essential point is that, without any modelling, it is simply not possible to conclude that mitigation measures are effective at either reducing or eliminating harm.

24 In discussing the residual impact on cetaceans after mitigation measures, the EMPr characterizes the duration of the surveying activities of four-five months as “short.” EMPr at 6-42. Four to five months of continuous seismic in an area of 6,011 km^2 is not short, particularly in the context of seasonal use of the area by a sensitive marine mammal. This is especially true when the data relied upon are at least eight years old.

Conclusion

25 In my opinion, the Transkei seismic survey which lasts four to five months will likely cause harm to marine mammals. The EMPr assessment did not use acoustic modeling and relied upon what is now eight-year old science regarding acoustic impacts on marine species and outdated information on the presence and abundance of animals in the seismic surveying area. Therefore, the proposed mitigation measures are of unknown efficacy, because the acoustic footprint of the survey remains unknown.

DOUGLAS NOWACEK

Thus signed and sworn to before me at _____on this _____ day of _____ 2021 by the deponent who has acknowledged that he knows and understands the contents of this affidavit, that he has no objection to taking the prescribed oath and that the prescribed oath is binding on his conscience.

NOTARY PUBLIC

NAME:
CAPACITY:
ADDRESS:

Exhibit A
CURRICULUM VITAE

DOUGLAS PAUL NOWACEK

Repass-Rodgers Chair of Marine Conservation Technology
University Professor
Division of Marine Science and Conservation, Nicholas School of the Environment
&
Department of Electrical and Computer Engineering, Pratt School of Engineering
Duke University
135 Duke Marine Lab Rd.
Beaufort, NC 28516
e-mail: dpn3@duke.edu

EDUCATION:

B.A.	Ohio Wesleyan University, Delaware, Ohio; Zoology; *summa cum laude* & Phi Beta Kappa (1991)
Ph.D.	Woods Hole Oceanographic Institution & Massachusetts Institute of Technology, Biological Oceanography (1999)

Dissertation Title:
Sound use, sequential behavior, and ecology of foraging bottlenose dolphins, *Tursiops truncatus*

Dissertation Advisor:
Peter L. Tyack

POSITIONS:

Professor, Duke University, Nicholas School of the Environment & Pratt School of Engineering (2018-present)
Associate Professor, Duke University, Nicholas School of the Environment & Pratt School of Engineering (2008-2018)
Visiting Scholar, Institute of Marine and Antarctic Sciences, University of Tasmania, Hobart, Tasmania, Australia (2013)
Adjunct Professor, Department of Biology and Marine Biology, University of North Carolina Wilmington (2008-present)
Assistant Professor, Department of Oceanography, Florida State University (2003–2008)
Guest Investigator, Woods Hole Oceanographic Institution (2002–2003)
Staff Scientist, Sensory Biology and Behavior Program, Center for Marine Mammal and Sea Turtle Research, Mote Marine Laboratory (2002–2003)
Postdoctoral Research Associate, National Research Council/National Oceanic and Atmospheric Administration, Northeast Fisheries Science Center (2000–2002)
Postdoctoral Fellow, Department of Biology, Woods Hole Oceanographic Institution (1999–2002)

ACADEMIC AND RESEARCH AWARDS & DISTINCTIONS

2017	*Sally Connally Hardie Visiting Researcher*, University of St Andrews, Scotland
2015	Invited Testimony, U.S. House of Representatives, Committee on Natural Resources, Oversight Hearing on "The Fundamental Role of Safe Seismic Surveying in OCS Energy Exploration and Development"
2013	*Visiting Fellow*, University of Tasmania
2003-05	*Young Investigator Award*, Office of Naval Research
2000-2002	*National Research Council, Research Associate Fellowship*, National Academy of Sciences
1993-1995	*National Defense and Science and Engineering Graduate Fellowship*, Office of Naval Research
1987-1991	*Presidential Scholarship*, Ohio Wesleyan University

CURRENT PROFESSIONAL SERVICE

Western Gray Whale Advisory Panel, The International Union for the Conservation of Nature (IUCN), Gland, Switzerland
Invited Guest Editor, *Marine Ecology Progress Series*
Atlantic Scientific Review Group, NOAA Fisheries
Cetacean Specialist Group, Species Survival Program, IUCN, Switzerland
Technical Working Group on Biologically Relevant Sound Levels, Department of Conservation, Government of New Zealand
Expert Assessor, Research Council of Norway
Invited contributor, Cetacean Tagging Best Practices Guidelines.

PAST PROFESSIONAL SERVICE

North Atlantic Right Whale Consortium, Chair & Board Member
NSF Graduate Research Fellowship Program, Panel Member, 2015
Associate Editor, *Marine Mammal Science*
Society for Marine Mammalogy, Member of Board of Governors
National Fish and Wildlife Foundation, Reviewer (2007)
NSF Biological Oceanography Panel, Reviewer (2006)
Independent Scientific Review Panel, The World Conservation Union (IUCN), Gland, Switzerland (2005)
NOAA Right Whale Program, Reviewer (2004)
NOAA, National Marine Fisheries Service, Atlantic Large Whale Take Redcution Team, Northeast Implementation Team (2000-02)
Acoustical Society of America, Animal Bioacoustics Committee

GRANTS

Selected list, full list provided in separate document.
Total received by Duke with Nowacek as PI or Co-PI since 2012 ~$5.88M

Pending:

Sigma Xi. Hormone responses to acoustic stimuli in short-finned pilot whales (*Globicephala macrorhyncus*). $1749, **D.P. Nowacek** (PI) with Ms. Jillian Wisse (Duke PhD student).

Current:

2017-2020 NSF Office of Polar Programs. Collaborative Research: Foraging behavior and ecological role of the least studied Antarctic krill predator, the Antarctic minke whale (*Balaenoptera bonaerensis*). $177,322, **D.P. Nowacek** (Duke PI), D.W. Johnston (Co-PI).

2017-2020 Bureau of Ocean Energy Management (BOEM). Spatial and Acoustic Ecology of Marine Megafauna (SPAM). $2,334,438. D. Ann Pabst (UNC Wilmington) lead PI. **D. P. Nowacek**, Co-PI and Duke PI.

2017-18 Naval Facilities Engineering Command, via HDR. "Multi-Scale Behavioral Response Studies of Cetaceans and MFAS Along the US East Coast." $473,409. B.L. Southall, Southall Environmental Associates and UC Santa Cruz lead PI; Duke PIs Read (lead) and **D.P. Nowacek** (Co-PI).

2016-19 Office of Naval Research, "Acoustic Startle Responses as Aversive Reactions and Hearing Indicators in Cetaceans". $572,304, V. Janik (Univeristy of St. Andrews) lead PI, **D.P. Nowacek** (Duke PI) with A.J. Read (Co-PI).

2016-18 Socioambiental Consultorers, Brazil, "Acoustic, Behavioral and Foraging Ecology of Cetaceans off the Coast of Brazil: A Baseline Study". $252,014 **D.P. Nowacek** (PI) with D. Haas (Duke PhD student).

2016-18 Office of Naval Research, "Developing a bioenergetic model for baleen whales to assess population consequences of disturbance - Phase 1" $110,416.00, F. Christiansen, Murdoch University, lead PI, Co-PIs L. Bejder (Murdoch), P.T. Madsen (Aarhus University, Denmark), and **D.P. Nowacek.**

2016-17 Naval Facilities Engineering Command, "North Atlantic Right Whale Tagging and Tracking on the Southeast US Calving Grounds". $347,475, **D.P. Nowacek** (PI), Co-PIs A.J. Read and S.E. Parks (Syracuse University)

2015-17 Marine Corps Air Station Cherry Point, via HDR Inc. "Autonomous Passive Acoustic Monitoring." $188,587, **D.P. Nowacek** (PI).

2015-18 National Science Foundation, HBCU-UP Research Initiation Award, "Physical forces impacting the temporal variability of mesopelagic prey at the Cape Hatteras marine top-predator diversity hotspot". $282,106, A. Kaltenberg, Savannah State (PI) with collaborators **D.P. Nowacek** and D. Savidge.

2015-20 NSF Long Term Ecological Research Program, "LTER Palmer, Antartica (PAL): Land Shelf Ocean Connectivity, Ecosystem Resilience and Transformation". $6.4M (Mammal group ~$120,00/year), Lead PI Hugh Ducklow (Columbia), A.S. Friedlaender lead mammal group PI. Duke PI D.W. Johnston, Co-PIs A.J. Read and **D.P. Nowacek.**

2014-17 Morris Animal Foundation, "Morris Animal Foundation fellowship training grant". $67,868, **D.P. Nowacek** (PI) with R. Cassoff, VMD (Duke PhD student).

Past:

2015-16 BOEM, "Studies to Inform the Delineation of Wind Energy Areas within the Published Areas of Interest for North Carolina". C. Peterson (UNC-CH) lead PI. $15,000, **D.P. Nowacek** Duke PI.

2011-15 Strategic Environmental Research & Development Program, "Delphinid Cetaceans: Quantifying Behavioral Ecology and Response to Predators Using a Multi-Species Approach". $1,476,412, A.J. Read (PI), **D.P. Nowacek** (Co-PI)

2014-15 Naval Facilities Engineering Command, "North Atlantic Right Whale Tagging and Tracking on the Southeast US Calving Grounds". $336,760, **D.P. Nowacek** (PI), Co-PIs A.J. Read and S.E. Parks (Syracuse University).

2013-15 Office of Naval Research, "WIZARD: A moored system for measuring the temporal variability of prey fields of deep diving predators off Cape Hatteras". $421,450, **D.P. Nowacek** (PI).

2013-14 The Ocean Foundation, "Comparing humpback whale feeding ecology: Pacific, Atlantic and Antarctic". $270,817, A.S. Friedlaender (PI), **D.P. Nowacek** and D.W. Johnston (Co-PIs).

2013-14 Naval Facilities Engineering Command, "North Atlantic Right Whale Tagging and Tracking on the Southeast US Calving Grounds". $289,339, **D.P. Nowacek** (PI), Co-PIs A.J. Read and S.E. Parks (Syracuse University).

2013-14 National Science Foundation, "A SAFE vessel: Advancing research capabilities to the Gulf Stream". $141,101, C.L. van Dover (PI), **D.P. Nowacek** and J.E. Hench (Co-PIs).

2012 National Oceanic and Atmospheric Administration (NOAA), "Duke University Seminar on Methods in Marine Bioacoustics". $20,000, **D.P. Nowacek** (PI).

2012-13 National Science Foundation, "RAPID: Linking the movement patterns and foraging behavior of humpback whales". $76,833, A.S. Friedlaender (PI) and **D.P. Nowacek** (Co-PI).

2011-14 Office of Naval Research, "Improving Attachments of Non-invasive (Type 3) Electronic Data Loggers to Cetaceans". M.J. Moore (WHOI) lead PI. $182,717, **D.P. Nowacek** (PI) and D. Rittschof (Co-PI).

2009-12 National Science Foundation, Office of Polar Programs. "Collaborative Research: The ecological role of a poorly studied Antarctic krill predator". $473,898, **D.P. Nowacek** lead PI, Co-PIs Friedlaender, A.S., Johnston, D.W., and Read, A.J. and 1 non-Duke Co-PI.

2008-12 National Oceanographic Partnership Program: Office of Naval Research, "Prey fields and habitat of deep divers: 3D characterization and modeling of beaked and sperm whale foraging areas in the Tongue of the Ocean". $530,475. **D.P. Nowacek** lead PI with P. Halpin, P. Tyack, and T. Stanton (WHOI).

Recent, unsuccessful proposals:

2017 National Aeronautics and Space Administration, "Cross scale assessment of phytoplankton biogeochemistry and mammal movement ecology across energetic ocean fronts". $1,293,099, Z.I. Johnson lead PI, Duke Co-PIs **D.P. Nowacek** and D.W. Johnston and 4 non-Duke Co-PIs.

2016 BOEM, Department of Interior, "Atlantic Deepwater Ecosystem Observatory (ADEON): An Integrated System". $6,499,977, **D.P. Nowacek** lead PI, Duke Co-PI P.N. Halpin and 8 non-Duke Co-PIs.

2016 National Science Foundation, "EAGER: Citizen Science with CBET and Enviornmental Engineering". $99,863, E. Dimattia (PI) and **D.P. Nowacek** and D.W. Johnston Co-PIs.

2016 Office of Naval Research, invited proposal, "The Involvement of Lung Compression in the Detection of Cetaceans as Active Sonar Targets". $385,119, **D.P. Nowacek** PI.

2015 NOAA Office of Explorarion, invited proposal, " Integrating scientific echosounders into autonomous ocean gliders to measure pelagic communities" $540,687, **D.P. Nowacek** lead PI, Co-PIs Schofield and Kohut (Rutgers) and J.C. Taylor (NOAA).

2014 Southeast Coastal Ocean Observing Regional Association, "Marine Biodiversity in the Southeast U.S.: A Regional Demonstration of a National Network". $1,737,195, P.N. Halpin lead PI, Co-PIs D.P. Nowacek and six non-Duke.

2013 National Science Foundation, "Collaborative research: Krill Predators of the Peninsula, Sharing a Resource in the Western Antarctic Peninsula". $785,086, **D.P. Nowacek** lead PI, Co-PIs D.W. Johnston, A.J. Read, and 3 non-Duke.

PEER REVIEWED PUBLICATIONS

Published or In Press:
Nowacek mentored *postdoc, **graduate student, ***undergraduate student. #authors contributed equally. Papers in red are included in top publications.

97. Howle, L.E., Kraus, S.D., Werner, T.B., and Nowacek, D.P. 2018. Simulation of the entanglement of a North Atlantic right whale (*Eubalaena glacialis*) with fixed fishing gear. *Marine Mammal Science* DOI: 10.1111/mms.12562
96. Priyesh, P., Boyla, M., Carmelo, M., Nowacek, D.P., Collins, L. and Karra, R. 2018. Acoustic Signatures of Left Ventricular Assist Device Thrombosis. ASME Journal of Engineering and Science in Medical Diagnostics and Therapy doi:10.1115/1.4041529
95. Tyson, R. B., Piniak, W. E., Domit, C., Mann, D., Hall, M., Nowacek, D. P., & Fuentes, M. M. (2017). Novel bio-logging tool for studying fine-scale behaviors of marine turtles in response to sound. *Frontiers in Marine Science*, *4*, 219.
94. Stanistreet, J, Nowacek, D, Bell, J, Cholewiak, D, Hildebrand, J, Hodge, L, Van Parijs, S, and Read, A. "Spatial and seasonal patterns in acoustic detections of sperm whales Physeter macrocephalus along the continental slope in the western North Atlantic Ocean." *Endangered Species Research* 35 (January 15, 2018): 1-13. Full Text
93. Narazaki, T, Isojunno, S, Nowacek, DP, Swift, R, Friedlaender, AS, Ramp, C, Smout, S, Aoki, K, Deecke, VB, Sato, K, and Miller, PJO. "Body density of humpback whales (Megaptera novaengliae) in feeding aggregations estimated from hydrodynamic gliding performance." *Plos One* 13, no. 7 (January 2018): e0200287-null. Full Text
92. Rycyk, AM, Deutsch, CJ, Barlas, ME, Hardy, SK, Frisch, K, Leone, EH, and Nowacek, DP. "Manatee behavioral response to boats." *Marine Mammal Science* (January 1, 2018). Full Text
91. Stanistreet, JE, Nowacek, DP, Baumann-Pickering, S, Bell, JT, Cholewiak, DM, Hildebrand, JA, Hodge, LE, Moors-Murphy, HB, Van Parijs, SM, and Read, AJ. "Using passive acoustic monitoring to document the distribution of beaked whale species in the western North Atlantic Ocean." *Canadian Journal of Fisheries and Aquatic Sciences* 74, no. 12 (December 2017): 2098-2109. Full Text Open Access Copy
90. Davis, GE, Baumgartner, MF, Bonnell, JM, Bell, J, Berchok, C, Bort Thornton, J, Brault, S, Buchanan, G, Charif, RA, Cholewiak, D, Clark, CW, Corkeron, P, Delarue, J, Dudzinski, K, Hatch, L, Hildebrand, J, Hodge, L, Klinck, H, Kraus, S, Martin, B, Mellinger, DK, Moors-Murphy, H, Nieukirk, S, Nowacek, DP, Parks, S, Read, AJ, Rice, AN, Risch, D, Širović, A, Soldevilla, M, Stafford, K. 2017. Long-term passive acoustic recordings track the changing distribution of North Atlantic right whales (Eubalaena glacialis) from 2004 to 2014. *Scientific reports*, *7*(1), 13460.
89. Pallin, LJ, Baker, CS, Steel, D, Kellar, NM, Robbins, J, Johnston, DW, Nowacek, DP, Read, AJ, and Friedlaender, AS. "High pregnancy rates in humpback whales (Megaptera novaeangliae) around the Western Antarctic Peninsula, evidence of a rapidly growing population." *Royal Society Open Science* 5, no. 5 (May 2, 2018): 180017-null. Full Text
88. Root-Gutteridge, H, Cusano, DA, Shiu, Y, Nowacek, DP, Van Parijs, SM, and Parks, SE. "A lifetime of changing calls: North Atlantic right whales, Eubalaena glacialis, refine call production as they age." *Animal Behaviour* 137 2018: 21-34. Full Text
87. Albertson, G.R., Friedlaender, A.S., Steel, D.J., Aguayo-Lobo, A., Bonatto, S.L., Caballero, S., Constantine, R., Cypriano-Souza, A.L., EngelC. Garrigue, M. H., Flórez-González, L., Johnston, D.W., **Nowacek, D.P**., Olavarría, C., Poole, M.M., Read, A.J., Robbins, J., Sremba, A.L., and Baker, C.S. 2017. Temporal stability and mixed-stock analyses of humpback whales (*Megaptera novaeangliae*) in the nearshore waters of the Western Antarctic Peninsula. *Polar Biology* doi:10.1007/s00300-017-2193-1.

86. Wilson, R.M., Tyson, R.B., Nelson, J., Balmer, B.C., Chanton, J.P., and **Nowacek, D.P.** 2017. Niche differentiation and prey selectivity among common bottlenose dolphins (*Tursiops truncatus*) sighted in St. George Sound, Gulf of Mexico. *Frontiers in Marine Science, Marine Conservation and Sustainability* 4:235. doi: 10.3389/fmars.2017.00235
85. Tyson, R.B., Piniak, W.E. D., Domit, C. Mann, D., Hall, M., **Nowacek, D.P.,** & Fuentes, M.M.P.B. 2017. Novel bio-logging tool for studying fine-scale behaviors of marine turtles in response to sound. *Frontiers in Marine Science 4:219* https://doi.org/10.3389/fmars.2017.00219
84. Beattie, M***., **Nowacek, D.P**., Bogdanoff, A.K.**, Akins, L., & Morris, J.A. 2017. The roar of lionfishes *Pterois volitans* and *Pterois miles*. *Journal of Fish Biology* doi:10.1111/jfb.13321
83. Paxton, A. B.**, Taylor, J. C., **Nowacek, D. P**., Dale, J., Cole, E.***, Voss, C. M., & Peterson, C. H. 2017. Seismic survey noise disrupted fish use of a temperate reef. *Marine Policy*, *78*, 68-73.
82. Quick, N. J., Isojunno, S., Sadykova, D., Bowers, M.**, **Nowacek, D. P**., & Read, A. J. 2017. Hidden Markov models reveal complexity in the diving behaviour of short-finned pilot whales. *Scientific Reports*, *7*, 45765.
81. van der Hoop, J. M.**, **Nowacek, D. P**., Moore, M. J., & Triantafyllou, M. S. 2017. Swimming kinematics and efficiency of entangled North Atlantic right whales. *Endangered Species Research*, *32*, 1-17.
80. Golden, J.S., Virdin, J., **Nowacek, D.P**., Halpin, P.N., Bennear, L. and Patil, P.G. 2017. Making sure the blue economy is green. *Nature Ecology and Evolution* 1, 0017 DOI: 10.1038/s41559-016-0017
79. Nowacek, D.P. and Southall, B.L. 2016. Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys. Gland, Switzerland: IUCN. 42pp. DOI: http://dx.doi.org/10.2305/IUCN.CH.2016.07.en
78. Stanistreet, J. E.**, **Nowacek, D. P**., Read, A. J., Baumann-Pickering, S., Moors-Murphy, H. B., & Van Parijs, S. M. 2016. Effects of duty-cycled passive acoustic recordings on detecting the presence of beaked whales in the northwest Atlantic. *The Journal of the Acoustical Society of America*, *140*(1), EL31-EL37.
77. Southall, B. L., **Nowacek, D. P.**#, Miller, P. J.#, & Tyack, P. L.# 2016. Experimental field studies to measure behavioral responses of cetaceans to sonar. *Endangered Species Research* Vol. 31: 293–315, 2016 doi: 10.3354/esr00764
76. Kraus, S. D., Kenney, R. D., Mayo, C. A., McLellan, W. A., Moore, M. J., and **Nowacek, D.P.** 2016. Recent Scientific Publications Cast Doubt on North Atlantic Right Whale Future. *Frontiers in Marine Science*, *3*, 137.
75. Quick, N.J.*, Scott-Hayward, L., Sadykova, D., **Nowacek, D.P**.#, & Read, A.J.# 2016. Effects of a scientific echo sounder on the behavior of short-finned pilot whales (*Globicephala macrorhynchus*). *Canadian Journal of Fisheries and Aquatic Sciences*, *74*(5), 716-726.
74. Hooper, J.A.**, Baringer, M. O., St. Laurent, L. C., Dewar, W. K. and **Nowacek, D.P.** 2016. Dissipation processes in the Tongue of the Ocean, *J. Geophys. Res. Oceans*, 121: 3159– 3170, doi:10.1002/2015JC011165.
73. Tyson, R.B.**, Friedlaender, A. S., and **Nowacek, D. P.** 2016. Does optimal foraging theory predict the foraging performance of a large air-breathing marine predator? *Animal Behaviour*, *116*, 223-235.
72. Friedlaender, A.S., Johnston, D.W., Tyson, R.B.**, Kaltenberg, A.*, Goldbogen, J.A., Stimpert, A.K., Curtice, C., Hazen, E.L., Halpin, P.N., Read, A.J., and **Nowacek, D.P.** 2016. Multiple-stage decisions in a marine central-place forager. *R. Soc. Open Sci*. 3: 160043. http://dx.doi.org/10.1098/rsos.160043

71. **Nowacek, D.P**., Christiansen, F., Bejder, L., Goldbogen, J.A, and Friedlaender, A.S. 2016. Studying cetacean behaviour: New technological approaches and conservation applications. *Animal Behaviour* 120: 235-244 *http://dx.doi.org/10.1016/j.anbehav.2016.07.019*

70. Brooke, M., Cole, E.***, Dale, J., Prasad, A.***, Quach H.***, Bau, B.***, Bhatt, E.***, and **Nowacek, D.P.** 2015. An Ocean Sensor for Measuring the Seawater Electrochemical Response of 8 Metals Referenced to Zinc, for Determining Ocean pH. IEEE Sensing Technology (ICST) http://hdl.handle.net/10161/11159

69. **Nowacek, D.P**., Clark, C.W., Mann, D.A., Miller, P.J.O., Rosenbaum, H.C., Golden, J.S., Jasny, M., Kraska, J., and Southall, B.L.. 2015. Marine seismic surveys and ocean noise: time for coordinated and prudent planning. *Frontiers in Ecology and Environment* 13(7): 378-386 doi:10.1890/130286

68. Thornton, S.W.**, McLellan, W.A., Rommel, S.A., Dillaman, R.M., **Nowacek, D.P.**, Koopman, H.N., and Pabst, D.A. 2015. Morphology of the nasal apparatus in pygmy (*Kogia breviceps*) and dwarf (*K. sima*) sperm whales. *The Anatomical Record* 298:1301–1326.

67. Xian, Y.**, Thompson, A., Qiang Qiu, Nolte, L., **Nowacek, D.P**., Jianfeng Lu, and Calderbank, R. 2015. Classification of whale vocalizations using the Weyl transform. IEEE International Conference on Acoustics, Speech and Signal Processing (ICASSP): 773 - 777, DOI: 10.1109/ICASSP.2015.7178074

66. Bouveroux, T.**, Tyson, R.B., and **Nowacek, D.P.** 2014. Abundance and site fidelity of bottlenose dolphins in coastal waters near Panama City, Florida. *Journal of Cetacean Research and Management* 14: 37–42.

65. Risch, D., Gales, N.J., Gedamke, J., Kindermann, L., **Nowacek, D.P**., Read, A.J., Siebert, U., Van Opzeeland, I.C., Van Parijs, S.M., and Friedlaender, A.S. 2014. Mysterious bio-duck sound attributed to the Antarctic minke whale (*Balaenoptera bonaerensis*). *Biology Letters* 10(4): 20140175 doi: 10.1098/rsbl.2014.0175.

64. Friedlaender, A.S., Goldbogen, J.A., **Nowacek, D.P**., Read, A.J., Johnston, D., and Gales, N. 2014. Feeding rates and under-ice foraging strategies of the smallest lunge filter feeder, the Antarctic minke whale (*Balaenoptera bonaerensis*). *The Journal of Experimental Biology* 217(16): 2851-2854.

63. Nousek-McGregor, A.E.**, Miller, C.A., Moore, M.J., **Nowacek, D.P.** 2014. Effects of body condition on buoyancy in endangered North Atlantic right whales. *Physiological and Biochemical Zoology* 87(1): 160-171.

62. Wilson, R.M.**, Chanton, J.P., Balmer, B.C.**, **Nowacek, D.P.** 2014. An evaluation of lipid extraction techniques for interpretation of carbon and nitrogen isotope values in bottlenose dolphin (*Tursiops truncatus*) skin tissue. *Marine Mammal Science* 30(1): 85-103. DOI: 10.1111/mms.12018

61. Crain, D. D., Friedlaender, A. S., Johnston, D. W., **Nowacek, D. P**., Roberts, B. L., Urian, K. W., Waples, D. M. and Read, A. J. 2014. A quantitative analysis of the response of short-finned pilot whales, *Globicephala macrorhynchus*, to biopsy sampling. *Marine Mammal Science* 30(2): 819-826. DOI: 10.1111/mms.12074

60. **Nowacek, D.P.**, Bröker, K., Donovan, G., Gailey, G., Racca, R., Reeves, R.R., Vedenev, A.I., Weller, D.W., and Southall, B.L. 2013. Responsible Practices for Minimizing and Monitoring Environmental Impacts of Marine Seismic Surveys with an Emphasis on Marine Mammals. *Aquatic Mammals* 2013, *39*(4), 356-377, DOI 10.1578/AM.39.4.2013.356

59. Friedlaender A.S., Tyson R.B.**, Stimpert A.K., Read A.J., and **Nowacek D.P**. 2013. Extreme diel variation in the feeding behavior of humpback whales along the Western Antarctic Peninsula during autumn. *Marine Ecology Progress Series*, *494*, pp.281-289.

58. Wilson, R.M.**, Nelson, J.A., Balmer, B.C.**, **Nowacek, D.P.** and Chanton, J. P. 2013. Stable isotope variation in the northern Gulf of Mexico constrains bottlenose dolphin (Tursiops truncatus) foraging ranges. *Mar Biol* DOI 10.1007/s00227-013-2287-4

57. Goldbogen, J.A., Friedlaender, A.S., Calambokidis, J., McKenna, M.F., Simon, M. and **Nowacek, D.P**., 2013. Integrative approaches to the study of baleen whale diving behavior, feeding performance, and foraging ecology. *BioScience*, *63*(2), pp.90-100.
56. Buckstaff, K.C., Wells, R.S., Gannon, J.G., & **Nowacek, D.P.** 2013. Responses of bottlenose dolphins to construction and demolition of coastal marine structures. *Aquatic Mammals* 39 (2): 174-186. doi:10.1578/AM.39.2.2013.174
55. Stimpert, A.K., Peavey, L.E., Friedlaender, A.S., and **Nowacek, D.P.** 2012. Humpback whale song and foraging behavior on an Antarctic feeding ground. PLoS ONE 7(12): e51214. doi:10.1371/journal.pone.0051214.
54. Espinasse, B. Zhou, M., Zhu, Y., Hazen, E.L., Friedlaender, A.S., **Nowacek, D.P**., Chu, D., and Carlotti1, F. 2012. Austral fall−winter transition of mesozooplankton assemblages and krill aggregations in an embayment west of the Antarctic Peninsula. *Mar Ecol Prog Ser* 452: 63–80, doi: 10.3354/meps09626
53. Rolland, R.M., Parks, S.E., Hunt, K.E., Castellote, M., Corkeron, P.J., **Nowacek, D.P.,** Wasser, S.K., and Kraus, S.D. 2012. Evidence that ship noise increases stress in right whales. *Proceedings of the Royal Society B: Biological Sciences.* doi: 10.1098/rspb.2011.2429.
52. Johnston, D.W., Friedlaender, A.S., Read, A.J., and **Nowacek, D.P.** 2012. Preliminary density estimates of humpback whales (*Megaptera novaeangliae*) in the inshore waters of the Western Antarctic Peninsula during the late autumn. *Endangered Species Research* 18:63-71.
51. Kot, B.W., Sears, R., Anis, A., **Nowacek, D.P**., Gedamke, J., and Marshall, C.D. 2012. Behavior response of minke whales (*Balaenoptera acutorostrata*) to experimental fishing gear in a coastal environment. *Journal of Experimental Marine Biology and Ecology.* 413: 13-20.
50. Wilson R.M.**, Kucklick, J.R., Balmer, B.C., Wells, R.S., Chanton, J.P., and **Nowacek, D.P.** 2012. Spatial distribution of bottlenose dolphins (*Tursiops truncatus*) inferred from stable isotopes and priority organic pollutants. *Science of the Total Environment*. 425: 223-230.
49. Klein, M.*** and **Nowacek, D.P**. 2012. Use of social sounds by humpback whales (*Megaptera novaeangliae*) in the Western Antarctic Peninsula feeding grounds. *J Acoust Soc Am* 132:1979-1979.
48. **Nowacek, D. P**., Vedenev, A., Southall, B. L., and Racca, R. 2012. Development and implementation of criteria for exposure of Western gray whales to oil and gas industry noise. *Advances in Experimental Medicine and Biology* 730:523-528. DOI 10.1007/978-1-4419-7311-5_119
47. Richardson, J.**, Wood, A.G., Neil, A., **Nowacek, D.P**. and Moore, M.J. 2012. Changes in distribution, relative abundance, and species composition of large whales around South Georgia from opportunistic sightings: 1992 to 2011. *Endangered Species Research* 19:149-156.
46. Tyson, R. B.**, A. S. Friedlaender, C. Ware, A. K. Stimpert, and **Nowacek, D. P**. 2012. Synchronous mother and calf foraging behaviour in humpback whales Megaptera novaeangliae: insights from multi-sensor suction cup tags. *Marine Ecology Progress Series* 457: 209–220.
45. Robbins, J., Dalla Rosa, L., Allen, J.M., Mattila, D.K., Secchi, E.R., Friedlaender, A.S., Stevick, P.T., **Nowacek, D.P**., and Steel, D. 2011. Return movement of a humpback whale between the Antarctic Peninsula and American Samoa: a seasonal migration record. *Endangered Species Research* 13(2): 117-121.
44. Parks, S.E., Searby, A., Célérier, A., Johnson, M.P., **Nowacek, D.P**., and Tyack, P.L. 2011 Sound production behavior of tagged individual North Atlantic right whales: implications for passive acoustic monitoring. *Endangered Species Research* 15(1): 63-76.
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42. Hazen E.L.**, **Nowacek D.P.**, St. Laurent L., Halpin P.N., and Moretti D.J. 2011. The relationship among oceanography, prey fields, and beaked whale foraging habitat in the Tongue of the Ocean. *PLoS ONE* 6(4): e19269. doi:10.1371/journal.pone.0019269
41. Kucklick, J., Schwacke, L., Wells, R., Hohn, A., Guichard, A., Yordy, J., Hansen, L., Zolman, E., Wilson, R., Litz, J., **Nowacek, D.P.**, Rowles, T., Pugh, R., Balmer, B.**, Sinclair, C., and Rosel, P. 2011. Bottlenose dolphins as indicators of persistent organic pollutants in the Western North Atlantic Ocean and Northern Gulf of Mexico. *Environ Sci Technol* 45(10): 4270-4277 DOI: 10.1021/es1042244
40. Parks, S.E., Johnson, M., **Nowacek, D.P.**, and Tyack, P.L. 2011. Individual right whales call louder in increased environmental noise. *Biology Letters*, 7(1): 33-35 DOI:10.1098/rsbl.2010.0451
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37. Tyson, R.B.**, S.M. Nowacek, and **Nowacek, D.P.** 2011. Community structure and abundance of bottlenose dolphins *Tursiops truncates* in coastal waters of the northeast Gulf of Mexico. *Marine Ecology Progress Series*, 438: 253-265 DOI: 10.3354/meps09292.
36. Friedlaender, A.S., **Nowacek, D.P.**, Johnston, D.W., Read, A.J., Tyson, R.B.**, Peavey, L.E. and Revelli, E. 2010. An exceptional sighting of a large group of Arnoux's beaked whales (*Berardius arnouxi*) in the Gerlache Strait, Antarctica. *Marine Mammal Science*, 26(1): 246-250.
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33. Wilson, R.M.**, Chanton, J., Lewis, G., and **Nowacek, D.P.** 2009. Isotopic variation (δ^{15}N, δ^{13}C, and δ^{34}S) with body size in post-larval estuarine consumers. *Estuarine, Coastal and Shelf Science* 83(3): 307-312.
32. Southall, B.L. and **Nowacek, D.P.** 2009. Acoustics in marine ecology; innovations in technology expands the use of sound in ocean science. *Marine Ecology Progress Series,* 395:1-3.
31. Hogg, C.**, Rogers, T.L., Shorter, K.A., Barton, K., Miller, P.J.O., **Nowacek, D.P.** 2009. Determination of steroid hormones in whale blow: It is possible. *Marine Mammal Science* 25(3): 605-618.
30. Friedlaender, A.S., Hazen, E.L., **Nowacek, D.P.**, Halpin, P.N., Ware, C., Weinrich, M.T., Hurst, T., and Wiley, D. 2009. Diel changes in humpback whale *Megaptera novaeangliae* feeding behavior in response to sand lance *Ammodytes* spp. behavior and distribution. *Marine Ecology Progress Series* 395: 91-100.
29. Brownell, R.L., **Nowacek, D.P.**, & K. Ralls. Hunting cetaceans with sound: a worldwide review. 2008. *Journal of Cetacean Research and Management* 10(1): 81-88.

All papers since this time published after appointment at Duke

28. Balmer, B.C.**, Wells, R.S., Nowacek, S.M., Nowacek, D.P., Schwacke, L.S., McLellan, W.A., Scharf, F.S., Rowles, T.K., Hansen, L.J., Spradlin, T.R. & D. A. Pabst. Seasonal

abundance and distribution patterns of common bottlenose dolphins (*Tursiops truncatus*) near St. Joseph Bay, Florida, USA. 2008. *Journal of Cetacean Research and Management* 10(2): 157-167.

27. **Nowacek, D.P.** and P.L. Tyack. 2008. Assessing effects of anthropogenic noise on the behaviour of marine mammals. *Bioacoustics* 17: 338-341.
26. Tyson, R.B.***, Nowacek, D.P., & P.J.O. Miller. 2007. Nonlinear phenomena in the vocalizations of North Atlantic right whales (*Eubalaena glacialis*) and killer whales (*Orcinus orca*). *Journal of the Acoustical Society of America* 122(3): 1365-1373.
25. Dobbins, P.F. and **Nowacek, D.P**. 2007. Passive azimuth localization of dolphin whistles using acoustically small sensors. *Proceedings of the Institute of Physics* 29(3): 149-156.
24. **Nowacek, D.P**., Thorne, L.H., Johnston, D.W., & P.L. Tyack. 2007. Responses of cetaceans to anthropogenic noise. *Mammal Review* 37(2): 81-115.
23. Chapla, M.E.**, **Nowacek, D.P**., Rommel, S.A., & V.M. Sadler. 2007. CT scans and 3D reconstructions of Florida manatee (*Trichechus manatus latirostris*) heads and ear bones. *Hearing Research* 228: 123-135.
22. Dobbins, P. and **Nowacek, D.P.** 2007. Azimuth localization in Pod-Track - a passive acoustic monitoring system for wild dolphins IEEE Oceans, DOI: 10.1109/OCEANSE.2007.4302248
21. Remage-Healey, L.**, **Nowacek, D.P**., & A.H. Bass. 2006. Dolphin foraging sounds suppress calling and elevate stress hormone levels in a prey species, the Gulf toadfish. *Journal of Experimental Biology* 209: 4444-4451.
20. Parks, S.E., **Nowacek, D.P**., Johnson, M.P., and Tyack, P.L. 2006. Right whales – Social sounds. *Journal of the Acoustical Society of America* 119(5), pt. 2: 3402-3403.
19. Dewar, W.K., Bingham, R.J., Iverson, R.L., **Nowacek, D.P**, St. Laurent, L.C., and Wiebe, P.H. 2006. Does the marine biosphere mix the ocean? *Journal of Marine Research* 64(4): 541-561.
18. Mann, D.A., O'Shea, T.J., and **Nowacek, D.P**. 2006. Nonlinear dynamics in manatee vocalizations. *Marine Mammal Science* 22(3): 548-555.
17. **Nowacek, D.P.** 2005. Acoustic ecology of foraging bottlenose dolphins (*Tursiops truncatus*), habitat-specific use of three sound types. *Marine Mammal Science* 21(4): 587-602.
16. Kraus, S.D., Brown, M.W., Caswell, H., Clark, C.W., Fujiwara, M., Hamilton, P.K., Kenney, R.D., Knowlton, A.R., Landry, S., Mayo, C.A., McLellan, W.A., Moore, M. J., **Nowacek, D.P**., Pabst, D.A., Read, A.J. and Rolland, R.M. 2005. North Atlantic right whales in crisis. *Science* 309: 561-562.
15. Reeves, R.R., Brownell, R.L., Burdin, A., Cooke, J.C., Darling, J.D., Donovan, G.P., Gulland, F.M.D., Moore, S.E., **Nowacek, D.P**., Ragen, T.J., Steiner, R.G., VanBlaricom, G.R., Vedenev, A., and Yablakov, A.V. 2005. Report of the Independent Scientific Review Panel on the Impacts of Sakhalin II Phase 2 on Western North Pacific Gray Whales and related Biodiversity. International Union for Conservation of Nature and Natural Resources (IUCN), Gland, Switzerland and Cambridge, UK. 123 pp.
14. Gannon, D.P.**, Barros, N.B., **Nowacek, D.P**., Read, A.J., Waples, D.M., & R.S. Wells. 2005. Prey detection by bottlenose dolphins (*Tursiops truncatus*): an experimental test of the passive listening hypothesis. *Animal Behaviour* 69(3): 709-720.
13. Maresh, J.L.***, Fish, F.E., **Nowacek, D.P**., Nowacek, S.M., & R.S. Wells. 2004. High performance turning capabilities during foraging by bottlenose dolphins (*Tursiops truncatus*). *Marine Mammal Science,* 20(3): 498-509.
12. Nowacek, S.M., Wells, R.S., Owen, E.C.G., Speakman, T.R., Flamm, R.O., & **Nowacek, D.P**. 2004. Florida manatees, *Trichechus manatus latirostris*, respond to approaching vessels. *Biological Conservation,* 119: 517-523.
11. **Nowacek, D.P**., Johnson, M.P., & P.L. Tyack. 2004. Right whales ignore ships but respond to alerting stimuli. *Proceedings of the Royal Society B: Biological Sciences*, 271: 227-231.

10. **Nowacek, D.P**., Casper, B.M., Wells, R.S., Nowacek, S.M., & D.A. Mann. 2003. Intraspecific and geographic variation of West Indian manatee (*Trichechus manatus* spp.) vocalizations. *Journal of the Acoustical Society of America*, 114(1): 66-69.
9. **Nowacek, D.P.** 2002. Sequential foraging behaviour of bottlenose dolphins, *Tursiops truncatus,* in Sarasota Bay, FL. *Behaviour*, 139 (9): 1125-1145.
8. Matthews, J.N., Brown, S., Gillespie, D., Johnson, M., McLanaghan, R., Moscrop, A., **Nowacek, D.P**., Leaper, R., & P.L. Tyack. 2001. Vocalisation Rates of the North Atlantic Right Whale. *Journal of Cetacean Research and Management* 3(3): 271–282.
7. Miksis, J.L., Grund, M.D., **Nowacek, D.P**., Solow, A.R., Connor, R.C., & P.L. Tyack. 2001. Cardiac responses to acoustic playback experiments in the captive bottlenose dolphin *Tursiops truncatus*. *Journal of Comparative Psychology*, 115 (3): 227-232.
6. **Nowacek, D.P**., Johnson, M.P., Tyack, P.L., Shorter, K.A., McLellan, W.A., & D.A. Pabst. 2001. Buoyant balaenids: the ups and downs of buoyancy in right whales. *Proceedings of the Royal Society B: Biological Sciences*, 268: 1811-1816.
5. **Nowacek, D.P**., Wells, R.S., & P.L. Tyack. 2001. A platform for continuous behavioral and acoustic observation of free-ranging marine mammals: Overhead video combined with underwater audio. *Marine Mammal Science* 17(1): 191-199.
4. Flamm, R.O., Owen, E.C.G., Weiss, C.F., Wells, R.S., & **D.P. Nowacek**. 2000. Aerial videogrammetry from a tethered airship to assess manatee life-stage structure. *Marine Mammal Science*, 16(3): 617-630.
3. **Nowacek, D.P**., Tyack, P.L., Wells, R.S., & M.P. Johnson. 1998. An onboard acoustic data logger to record biosonar of free-ranging bottlenose dolphins. *Journal of the Acoustical Society of America* 103(5), Pt. 2: 2908.
2. Jacobs, M., **Nowacek, D.P**., Gerhart, D.J., Cannon, G., Nowicki, S., & R.B. Forward, Jr. 1992. Seasonal changes in vocalizations during behavior of the Atlantic bottlenose dolphin. *Estuaries*. 16(2): 241-246.
1. Grant, D.C., Ligibel, J.A., **Nowacek, D.P**., Horsburgh, S.E., Link, M.A., Ngu, M.N., Furr, K.I., & C.M. Hall. 1991. Impact of feral horse migration on soft bottom infaunal community structure. *The Journal of the Elisha Mitchell Scientific Society*. 107(1): 13-20.

In review or prepration:

Wilson, R.M., Tyson, R.B., Nelson, J.A., Balmer, B.C., Chanton, J.P., and **Nowacek, D.P.** Stable isotopes highlight differences in prey selectivity among common bottlenose dolphins (*Tursiops truncatus*) sighted in St. George Sound, Gulf of Mexico. In review *Frontiers in Marine Science*

Wang, Z-T, **Nowacek, D.P**., Akamatsu, T., Wang, K-X., Liu, J-C.,Duan, G-Q., Cao, H-J., Wang, D. In prep. Diversity fish sound types in the Pearl River Estuary, China

Stanistreet, J.E., **Nowacek, D.P**., Bell, J.T., Cholewiak, D.M., Hildebrand, J.A., Hodge, L.E.W., Van Parijs, S.M., Read, A.J. In prep. Spatial and seasonal occurrence patterns of sperm whales (*Physeter macrocephalus*) measured with passive acoustics along the western North Atlantic shelf slope.

Howle, L.E., Kraus, S.D., Werner, T., and **Nowacek, D.P**. In prep. Simulation of the Entanglement of a North Atlantic Right Whale (*Eubalaena glacialis*) with Lobster Trap Gear.

Root-Gutteridge, H., Cusano, D.A., Shiu, Y., **Nowacek, D.P**., Van Parijs, S.M., and Parks, S.E. A lifetime of changing calls: North Atlantic right whales (*Eubalaena glacialis*) continue to refine call production as they age.

SCIENTIFIC CORRESPONDENCE

Gannon, D.P., Johnston, D.W., Read, A.J., & D.P. Nowacek. 2004. Resonance and Dissonance: Science, Ethics, and the Sonar Debate. *Marine Mammal Science*, 20(4):898-899.

POPULAR ARTICLES AND BOOKS

Clark, C.W., Gillespie, D., Nowacek, D.P., & S.E. Parks. 2007. Listening to their world: Acoustics for monitoring and protecting right whales in an urbanized ocean. In: Kraus, S.D. & R.M. Rolland (eds). *The Urban Whale: North Atlantic Right Whales at the Crossroads*. Harvard University Press.

Nowacek, S.M., & D.P. Nowacek. 2006. *Discovering Dolphins*. Colin Baxter Photography, Voyageur Press.

BOOK REVIEWS

Echolocation in Bats and Dolphins. 2004. Thomas, J.A., Moss, C.F. & M. Vater (editors). University of Chicago Press, Chicago, IL. Reviewed at the request of the Press.

RESEARCH EXPEDITIONS LED

2016 *R/V Neil Armstrong*, PI, Deployment of WIZARD acoustic mooring
2010 *R/V Nathaniel B Palmer*, Chief Scientist, Multi-Scale and Interdisciplinary Study of humpback whales and prey, NSF Award
2009 *R/V Laurence M Gould*, Chief Scientist, Multi-Scale and Interdisciplinary Study of humpback whales and prey, NSF Award

TEACHING AND GRADUATE TRAINING

Courses Taught:

Marine Bioacoustics, Duke University (2011-present)
Ocean Engineering, Pratt School of Engineering, Duke University (2012-present)
Conservation Biology and Policy (aka Marine Conservation Summer Institute) (2011-present)
Marine Ecology, Duke University (2011-2013)
Marine Ichthyology, Duke University (2009-2011)
Acoustics and Hearing, Pratt School, Duke (2008)
Applied Ocean Acoustics, Florida State University (2006–2008)
Marine Vertebrates Field Course, Florida State University (2006)
Bioacoustics, Florida State University (2005–2008)
Marine Nekton, Florida State University (2004–2008)
Biology of Marine Mammals, Florida State University (2004–2008)
Biology of Marine Mammals, Eckerd College (2000)
Biology of Marine Mammals, Duke University (1999–2004)
Marine Mammals, Boston University Marine Program (1999)

Advisor for current students in:

Ph.D. Program in Ecology, Duke University (2)
Ph.D. Program in Marine Science and Conservation, Duke University (5)
Masters in Environmental Management, Duke University (3)

Advisor for Ph.D. Graduates from Florida State and Duke Universities:

Stanistreet, J.E. 2016. Ecology of Beaked Whales and Sperm Whales in the Western North Atlantic Ocean: Insights from Passive Acoustic Monitoring. Duke, University Program in Ecology.
Phillips, G. 2016. Passive Acoustics: A Multifaceted Tool for Marine Mammal Conservation. Duke, Marine Science and Conservation.
Bowers, M.T. 2016. Behavioral Ecology of the Western Atlantic Short-finned Pilot Whale (*Globicephala macrorhynchus*). Duke, Marine Science and Conservation.
Xian, Y*. 2015. Detection and classification of whale acoustic signals. Duke, Electrical and Computer Engineering. *Co-Advisor with Dr. Loren Nolte.
Reny B Tyson. 2014. Fine-Scale Foraging Behavior of Humpback Whales *Megaptera novaeangliae* in the Near-Shore Waters of the Western Antarctic Peninsula. Duke, Marine Science and Conservation.
Rycyk, A.M. 2013. Environmental, behavioral, and experiential factors that affect the likelihood and type of a manatee's response to approaching boats. FSU, Earth, Ocean and Atmospheric Sciences.
Wilson, R.M. 2010. Using chemical tracers to evaluate feeding habits in coastal marine ecosystems: stable isotopes and organic contaminants. FSU Department of Oceanography.
Anna Nousek-McGregor. 2010. The costs of locomotion in North Atlantic Right Whales (*Eubalaena glacialis*). Duke, Marine Science and Conservation, Nicholas School of the Environement.

Advisor for Masters in Environmental Management Graduates from Duke University:

Elliott, B. 2017. Analyzing the Role of Sound in the Endangered Species Act: A Petition for Sperm Whale (*Physeter macrocephalus)* Critical Habitat in the Gulf of Mexico.
Alcaraz, N. 2017. Spatial Assessment of Antarctic Krill (*Euphausia superba*) in the Palmer Long-Term Ecological Research (LTER) Study Site using Acoustic Doppler Current Profiler (ADCP) Technology.
Nasgovitz, M. 2017. Mapping anthropogenic noise in the Arctic.
Hartigan, K. 2017. Using Acoustic Indices to Determine Changes in Biodiversity off the Coast of Cape Hatteras, NC
Heywood, E. 2016. Ambient noise in the Kitimat Fjord system.
Wagner, A. 2015. A comparative analysis of the status of the U.S. marine mammal stock assessment program.
Guttenplan, K. 2015. Investigating Boat Noise in Wellfleet Harbor, MA
Carnal, H.L.B. 2014. Geospatial analysis and comparison of habitat costs for resident Sarasota Bay bottlenose dolphins (*Tursiops truncatus*).
Bonamusa, J. 2014. Spatial and temporal variability of sea surface temperature and fisheries distribution with the North Atlantic Oscillation.
Latchford, L.E. 2013. Conservation or culture? An analysis of shark fin soup in America.
Carduner, J. 2013. Best practices for baseline passive acoustic monitoring of offshore wind energy development.
Jessica Richardson 2012. Evaluating opportunistic sighting records of large whales around South Georgia Island.
Gabriell Vires 2011. Echosounder Effects on Beaked Whales in the Tongue of the Ocean (Bahamas)
Casey Dziuba. 2011. Sea level rise education and outreach for coastal North Carolina.
Jaime L. Budzynkiewicz. 2011. A comparison of Environmental Impact Statement methodologies for assessing sound propagation, density determination and impacts of protected marine mammals: BEOMRE & the U.S. Navy.
Kimberly Gordon. 2010. Catch share management: An appropriate tool for New England?

Advisor for Masters in Engineering Management Graduates from Duke University:

Jonathon Buie 2017. Blue Devil Ocean Engineering XPrize IMU.

Advisor for M.Sc. Graduates from Florida State University:

Reny B. Tyson. 2008. Abundance of bottlenose dolphins in the Big Bend region of Florida: St. Vincent Sound to Alligator Harbor.

Athena Rycyk. 2007. Acoustic ecology of the bottlenose dolphin (*Tursiops truncatus*) in the Big Bend region of Florida. Current position – Ph.D. student, Department of Oceanography, Florida State University, D.P. Nowacek, advisor.

Marie E. Chapla. 2006. Florida manatee (*Trichechus manatus latirostris*) outer and middle ear morphology: Potential sound pathways and middle ear mechanism. Current position – Research associate, NOAA, National Marine Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, HI.

Graduate Thesis Committees:

Duke University
University of North Carolina at Wilmington
Florida State University
North Carolina State University

PRESENTATIONS AT SCIENTIFIC MEETINGS

First-Author Presentations (*Invited):

***Nowacek, D.P.** and Southall, B.L. 2016. Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys. World Congress, International Union for the Conservation of Nature, Honolulu, HI.

***Nowacek, D.P.** Cetacean Ecology of the Antarctic Peninsula. Department of Environmental Sciences, University of Virginia, 13 October 2016.

***Nowacek, D.P.** Ocean Noise: Impacts and Ideas for Management. Department of Marine and Coastal Sciences, Rutgers University, 11 April 2016.

***Nowacek, D.P.** Seismic surveys and marine wildlife: Ideas for managing real and perceived impacts. Society for Exploration Geophysicists, Annual Meeting, 18-23 October, 2015. New Orleans, USA.

***Nowacek, D.P.** Seismic surveys and marine wildlife: Impacts, the lack thereof and thoughts on managing both. Hot Topics in Acoustics, Session 3pID, 170th Meeting of the Acoustical Society of America. Jacksonville, FL 2-6 November 2015.

***Nowacek, D.P.** Invited witness at House of Representatives hearing, 'The Fundamental Role of Safe Seismic Surveying in OCS Energy Exploration and Development'. **House Natural Resources Committee, Energy and Minerals Subcommittee.** 14 July 2015.

Nowacek, D.P., Clark, C.W., Mann, D.A., Miller, P.J.O., Rosenbaum, H.C., Golden, J.S., Jasny, M., Kraska, J., and Southall, B.L. 2015. Marine seismic surveys and ocean noise: Mitigation, monitoring and a plan for international management. 21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA.

***Nowacek, D.P.**, Bowers, M., Cannon, A., Hindell, M., Howle, L.E., Murray, M.M., Rittschof, D., Shorter, K.A., and Moore, M. The next generation of multi-sensor acoustic tags: sensors, applications and attachments. 2014. 166th Meeting of the Acoustical Society of America in San Francisco, CA.

***Nowacek, D.P.**, Parks, S.E., and Read, A.J. 2015. Tagging and Tracking of North Atlantic Right Whales in the SE U.S. U.S. Marine Mammal Commission Annual Meeting, Charleston, SC.

***Nowacek, D.P.** Seismic surveys: Potential impacts on animals and ideas for mitigation, monitoring and management. 2015. U.S. Marine Mammal Commission Annual Meeting, Charleston, SC.

Nowacek, D.P., Hindell, M., Howle, L.E., Murray, M.M., Rittschof, D., Shorter, K.A., and Moore, M. The next generation of multi-sensor tags: improving attachments of non-invasive tags with bio-compatible glues and microstructure. 2014. The 5th International Bio-Logging Science Symposium, 22-26 September, Strasbourg, France.

Nowacek, D.P.& P.L. Tyack. 2007. Assessing effects of anthropogenic sound on behavior of marine mammals. International Conference on the Effects of Noise on Aquatic Life, Nyborg, Denmark.

***Nowacek, D.P.** 2007. Biological functions of acoustic communication and the effects of noise on marine animals. Potential Application of Vessel-Quieting Technology on Large Commercial Vessels. Convened by NOAA, National Marine Fisheries Service - Acoustics Program, Washington, DC.

Nowacek, D.P. 2006. Application of tagging data to the design and implementation of right whale ship strike mitigation, U.S. Marine Mammal Commission Review of Right Whale Research, Marine Biological Labs, Woods Hole, MA

Nowacek, D.P.& D.A. Mann. 2006. GNOMES – Gulf of Mexico noise monitoring system. Part of 'Understanding Acoustic Impacts on Marine Animals: National Lecture Series', NOAA Acoustics Program, held at Duke University, Nicholas School of the Environment and Earth Sciences.

***Nowacek, D.P.**2006. Methods for assessing the response of cetaceans to seismic exploration. International Whaling Commission, Scientific Committee, St. Kitts.

***Nowacek, D.P.**, Mann, D.A., Remage-Healey, L., & A.H. Bass. 2006. Dolphin foraging sounds suppress calling and elevate stress hormones in a prey species, the Gulf toadfish. Carnivores 2006, St. Petersburg, FL.

***Nowacek, D.P.**2005. Do dolphins have language? Philosophy Department, Case Western Reserve University, Cleveland, OH.

Nowacek, D.P., Renner, W., Cavanagh, R., & A. Eller. 2005. Transmission of Vessel Noise Through Right Whale Environments. 16th Biennial Conference on the Biology of Marine Mammals, San Diego, CA.

Nowacek, D.P., Barton, K., Bocconcelli, A., Johnson, M.P., Moore K.C., Parks, S.E., Shorter, K.A., & P.L. Tyack. 2005. Response of right whales at the surface to alert/alarm signal. North Atlantic Right Whale Consortium, New Bedford, MA.

Nowacek, D.P.2005. Behavioral Ecology of Marine Mammals. Southeast and Mid-Atlantic Marine Mammal Symposium, University of North Carolina Wilmington.

Nowacek, D.P.2005. Detection of boats by manatees. Manatee Forum IV, Florida Fish and Wildlife Conservation Commission. St. Petersburg, FL.

Nowacek, D.P.2004. Behavioral ecology and bioacoustics of cetaceans: 'tales from tagging'. Hopkins Marine Station, Stanford University.

Nowacek, D.P., Renner, W., Cavanagh, R., & A. Eller. 2004. Transmission Of Vessel Noise Through Right Whale Environments. North Atlantic Right Whale Consortium, New Bedford, MA.

Nowacek, D.P.2004. Effects of Shipping Noise on Marine Mammal Behavior. NOAA Fisheries Symposium: "Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology", Washington, DC.

Nowacek, D.P.2004. Behavioral responses of marine mammals to human generated noise. Part of 'Understanding Acoustic Impacts on Marine Animals: National Lecture Series', NOAA Acoustics Program', held at Mote Marine Laboratory, Sarasota, FL.

Nowacek, D.P., Tyack, P.L., & M.P. Johnson. 2003. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alarm signal. 15th Biennial Conference on the Biology of Marine Mammals, Greensboro, NC.

Nowacek, D.P., Tyack, P.L., & M.P. Johnson. 2003. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alarm signal. Environmental Consequences of Underwater Sound, San Antonio, TX.

***Nowacek, D.P**., Tyack, P.L., & M.P. Johnson. 2003. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting signal. Hawaiian Islands humpback whale National Marine Sanctuary, Vessel collision avoidance workshop, Wailea, Maui, Hawaii.

***Nowacek, D.P**., Tyack, P.L., & M.P. Johnson. 2003. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting signal. U.S. Marine Mammal Commission, Annual Meeting, Newport, RI.

Nowacek, D.P., Johnson, M.P., & Tyack, P.L. 2003. North Atlantic right whales ignore ships but respond to alerting stimuli: have we found the 'right whale deer whistle'? 15th Biennial Conference on the Biology of Marine Mammals, Greensboro, NC.

Nowacek, D.P., Tyack, P.L., Johnson, M.P., Allen, B.D., Argo, E., Biassoni, B., Bocconcelli, A., Carson, C., Loer, A., Parks, S., Partan, J., Samuels, A., Shorter, K.A., Waples, D, & M. Zani. 2002. Playback experiments to study risk factors for vessel collision in right whales. North Atlantic Right Whale Consortium, New Bedford, MA.

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IN THE UNITED STATES DISTRICT COURT
FOR THE DISTRICT OF SOUTH CAROLINA

SOUTH CAROLINA COASTAL CONSERVATION LEAGUE; CENTER FOR BIOLOGICAL DIVERSITY; DEFENDERS OF WILDLIFE; NATURAL RESOURCES DEFENSE COUNCIL, INC.; NORTH CAROLINA COASTAL FEDERATION; OCEANA; ONE HUNDRED MILES; SIERRA CLUB; AND SURFRIDER FOUNDATION,

Plaintiffs,

v.

NATIONAL MARINE FISHERIES SERVICE; WILBUR ROSS, in his official capacity as the Secretary of Commerce; and CHRIS OLIVER, in his official capacity as the Assistant Administrator for Fisheries,

Defendants.

Civ. No. 2:18-cv-3326-RMG
(Consolidated with 2:18-cv-3327-RMG)

EXPERT DECLARATION OF DR. DOUGLAS P. NOWACEK IN SUPPORT OF PLAINTIFFS' MOTION FOR A PRELIMINARY INJUNCTION

EXPERT DECLARATION OF DR. DOUGLAS P. NOWACEK

I, Douglas P. Nowacek, declare the following:

Background and Expertise

1. I submit this declaration in support of Plaintiffs' Motion for a Preliminary Injunction. The statements I make are true and correct to the best of my knowledge and, in the case of my opinions, I believe them to be true.

2. Since 2008, I have been the Repass-Rodgers Chair of Marine Conservation Technology in the Nicholas School of the Environment and the Edmund T. Pratt School of Engineering, at Duke University. Before joining Duke, I was a faculty member in the Oceanography Department at Florida State University. I hold a bachelor's degree from Ohio Wesleyan University and a Ph.D., in Biological Oceanography and Ocean Engineering, from the Massachusetts Institute of Technology and Woods Hole Oceanographic Institution. A true and correct copy of my *curriculum vitae* is attached hereto as Exhibit A.

3. I have studied the behavioral and acoustic ecology of marine animals throughout my professional career, with particular expertise in the subject of anthropogenic ocean noise. I have authored or co-authored more than 100 publications on marine animal ecology and acoustics, with about one quarter of those papers and reports specifically focused on ocean noise, from analyses of acoustic sources to impacts on marine animals to the mitigation of those impacts. I have also served as an invited editor of journal volumes dedicated to the topic and as a member of international expert panels on the issue. In 2015, I served as a peer reviewer for the National Oceanographic and Atmospheric Administration's (NOAA's) draft acoustic guidelines for marine mammals.

4. Since 1999, when I was selected as a National Research Council postdoctoral scholar, I have been studying North Atlantic right whales (*Eubalaena glacialis*), particularly their acoustic and behavioral ecology and their responses to anthropogenic impacts, including noise. My professional research experience with right whales includes: (i) tagging studies, (ii) experiments in controlled acoustic exposures, (iii) photo-identification research, (iv) studies of diving behavior, and (v) studies on the effects of noise on their behavior and acoustic activities. In addition to my own research on right whales, I served as Chair of the North Atlantic Right Whale Consortium for a three-year term and on the Board of the Consortium for nine years. I have also served on NOAA's Atlantic Scientific Review Group for 13 years, with right whales and bioacoustics as my primary areas of expertise on that panel.

5. The purpose of this declaration is to provide the court with a summary of scientific evidence about the impacts of seismic airguns on marine life, and in particular on North Atlantic right whales, *Eubalaena glacialis*. It is my expert opinion that the five airgun surveys recently authorized by the National Marine Fisheries Service (NMFS) will have adverse impacts on individual right whales in the forms of habitat abandonment, disrupted communication and social behavior, and noise-induced stress; and on the right whale population as a whole through the potential loss of young calves and through further decrements in the health of whales, including females, on whom reproduction and population growth depend.

6. In preparing this declaration, I reviewed NMFS's proposed and final incidental harassment authorizations, issued in June 2017 and November 2018, for five seismic oil and gas surveys in the Atlantic; as well as numerous technical reports from the scientific literature. A full list of the scientific journal articles cited in this declaration is appended as Exhibit B.

Overview of the Impacts of Seismic Airgun Surveys on Marine Mammals

7. It is almost impossible to overestimate the importance of sound to ocean animals. While marine animals do use chemical, visual, and even electrical cues to perceive their environment, sound is of unparalleled importance for many species. From invertebrates to whales, animals rely on sound for biological activities such as foraging, breeding, predator avoidance, and orientation that are essential to their survival and reproduction. This reliance is due in part to the efficiency with which sound moves through water, traveling five times faster in water than in air and covering long distances, particularly in the low frequencies (Croll et al. 2002). Researchers in marine bioacoustics have been documenting the fundamental importance of sound to ocean animals for many decades (Tavolga 1964).

8. It is well established that exposure to unwanted sound, or "noise," can and does cause behavioral and physiological harm to animals. A recent review of more than 300 papers in the bioacoustics literature found remarkable consistency in the types of behavioral impacts documented across both marine and terrestrial wildlife populations exposed to noise. These impacts include, in short, "altered vocal behavior to mitigate masking; reduced abundance in noisy habitats; changes in vigilance and foraging behavior; and impacts on individual fitness and the structure of ecological communities" (Shannon et al. 2016). The physiological impacts of noise on mammals, including hearing loss, immune system impacts, and acute and chronic stress, are also well documented and have been recognized for many decades (e.g., Welch and Welch 1970), although we are just beginning to understand the full extent of physiological impacts on marine species.

9. As a stressor on wildlife, ocean noise differs from airborne noise because animals suffer impacts over much larger distances, due to the much greater efficiency with which sound travels through water.

10. Seismic airgun noise has a number of characteristics that give it a remarkably large environmental footprint. To penetrate hundreds to thousands of meters of water and then potentially thousands of meters of hard substrate, seismic signals must contain tremendous amounts of energy. The multiple airguns in a seismic array are configured to focus their energy into a single pulse, so as much coherent energy as possible is injected into the water and subsequently into the substrate (Caldwell and Dragoset 2000). The array configuration is reasonably effective in focusing the sound downwards; nonetheless, substantial energy is emitted in all directions (DeRuiter et al. 2006), and this, coupled with the reverberation of the main pulse, fills the water column with noise. The sounds that seismic arrays produce are among the loudest that humans regularly introduce into the ocean, exceeded only by the occasional use of explosives.

11. The great distances at which the noise from seismic activity can be heard has been well documented in several parts of the world. For example, signals from seismic surveys off Brazil and West Africa have been recorded along the Mid-Atlantic Range, a chain of seamounts, at distances of up to nearly 4000 kilometers (km) (Nieukirk et al. 2012). In the Gulf of Mexico, another study found that a seismic survey conducted in a submarine canyon off Louisiana raised background noise levels on sensors located throughout the northern Gulf, as far as Pensacola, Florida. Noise from this survey was even detected in the extreme southeastern corner of the Gulf, some 400 km from the sensor that recorded the loudest signals (Estabrook et al. 2016).

12. Seismic airgun noise also has a broad temporal scale. While airgun arrays are loudest when they are firing, they also significantly elevate background levels of noise between shots. This effect is due to basic physics. First, the duration of the pulse lengthens as it travels through the ocean due to the multiple paths the sound takes through the water; second, the sound energy reverberates as it is reflected and refracted by the geological formations it encounters. The sound that results is said to "spread" across the interval between pulses, becoming virtually continuous at distance.

13. Acousticians often distinguish between impulsive noise, which is typically sharp and brief in duration, and non-impulsive noise, which can run continuously during a given time period. Biologically, these types of sound sources can impact animals differently. Seismic airguns are, in effect, a hybrid source, producing both a powerful impulsive sound that can be damaging if the receiver is too close and a virtually continuous sound that raises ambient noise levels at much greater distances (e.g., Guerra et al. 2016; Nieukirk et al. 2012), as described below in paragraphs 37-38. Thus, a whale exposed to noise from seismic airguns must contend with both loud individual pulses every 10 to 15 seconds and with continuous reverberating energy in the periods between the pulses.

14. Numerous studies have documented responses of marine mammals to seismic surveys. From large whales to small porpoises, toothed and baleen whales alike respond to airgun noise. For example, one study reported decreased foraging rates in sperm whales exposed to seismic airgun noise, with a substantial decrease in prey-capture sounds, or buzzes, at relatively low levels of exposure (Miller et al. 2009). Another study showed a similar result in harbor porpoises, as animals exposed to seismic survey pulses produced 15 percent fewer feeding buzzes, with the most significant impacts observed in porpoises closest to the sound

source (Pirotta et al. 2014). Responses in other important behavioral contexts, including breeding (e.g., Cerchio et al. 2014) and migration (e.g., Blackwell et al. 2013, 2015) have also been well documented, with effects detected at very low levels of noise exposure (as low as 90 decibels)[1] or at large distances from the seismic source (tens to hundreds of kilometers).

15. Other studies (some of which I describe further below) indicate that anthropogenic noise sources like seismic surveys interfere with whale communication and induce chronic stress. These effects can aggregate into what the recent literature review of noise impacts described as "impacts on individual fitness and the structure of ecological communities" (Shannon et al. 2016)—in other words, population-level consequences. Such species-level impacts are particularly concerning for endangered populations like the North Atlantic right whales discussed below.

Impacts of the Authorized Seismic Airgun Surveys on North Atlantic Right Whales

16. North Atlantic right whales are deeply imperiled. The current low birth rate and extraordinarily high death rate, particularly for females (Pace et al. 2017), leaves little margin for error for conservation of the species.

17. Given where seismic surveys are authorized to take place, it is virtually certain that right whales will be exposed at biologically meaningful levels to the noise that seismic airguns produce. We know definitively that right whales inhabit the authorized survey areas at all times of year. Researchers have documented the occurrence of right whales in Virginia waters throughout the year (Salisbury et al. 2016). Others have reported right whales in waters off

[1] Decibels (dB) are units expressing the amplitude, or "volume," of a sound. They are logarithmic in scale, meaning that every 10 dB increase represents a ten-times increase in acoustic intensity. Sounds in the ocean are conventionally referenced to one microPascal, a measure of pressure.

Georgia and North Carolina outside the winter calving period, when presence is thought to peak (Hodge et al. 2015); and have demonstrated the presence of right whales as far south as the Georgia coast during nine months of the year and as far south as the mouth of the Chesapeake throughout the year (Davis et al. 2017, Whitt et al. 2013). These empirical findings are consistent with the results of a recent study in which right whale specialists were asked to define the seasonal presence of right whales in the mid-Atlantic. In that study, experts concluded that even in July—when right whale presence in the region is expected to be at its lowest—there are likely to be females in the mid-Atlantic (Oedekoven et al. 2015).

18. In analyzing the likely impacts of seismic surveys on right whales, I will frequently refer to studies involving bowhead whales and other baleen whales. Because right whales are so critically endangered, scientists have limited opportunities to directly study their response to industrial noise like seismic surveys. However, bowhead whales are one of the closest relatives of the North Atlantic right whale and are an excellent proxy for assessing behavioral impacts to right whales. Bowhead whales are in the same family as North Atlantic right whales (the *Balaenidae*), and they have similar life histories, foraging patterns, and morphology to right whales. Bowhead responses to industrial activity, including seismic surveys, have been studied for decades, and are therefore a good indicator of the probable behavioral impacts that seismic surveys will have on right whales. Similarly, other baleen whales share common features with right whales that make them appropriate proxies for assessing impacts on right whales.

19. Noise from the authorized seismic activity will likely adversely impact right whales in at least three ways: (1) by inducing a physiological stress response; (2) by disrupting biologically essential behavior such as vocalizing, mating, or foraging; and (3) by masking

acoustic communication, including communication between mothers and calves. All three of these impacts have been observed in baleen whales in close association with, or as a direct result of exposure to, low-frequency anthropogenic noise.

Physiological Stress Effects

20. It has long been established that exposure to noise causes physiological stress in mammals (Welch and Welch 1970). That is, exposure causes an elevation in levels of stress hormones such as cortisol, cortisone, adrenaline, and noradrenaline. These are the hormones that prepare animals for the 'fight or flight' response; they influence heart rate, blood pressure, and a number of other biologically important functions. Activation of the stress response prioritizes survival over reproductive and immune function, which in the short term can benefit the animal. In the long term, however, the stress response can be extremely detrimental.

21. Chronic stress (i.e., stress response that is sustained or repeated over days to weeks) has been directly linked to severe negative consequences, including adverse effects on reproduction. In mammals, prolonged exposure to noise can result in loss of body weight, reduction of vital organs (e.g., Sackler et al. 1959), decreases in survival and recruitment (e.g., Blas et al. 2007; Halfwerk et al. 2011; MacDougall-Schackleton et al. 2009), and birth abnormalities (e.g., Møller and Swaddle 1998). Noise-related stress appears to be particularly damaging to females. Taken together, this research indicates that prolonged exposure to noise can have direct consequences for fitness, reproduction, and population health in mammals.

22. In addition to this widespread evidence of a physiological stress response to noise across mammalian species, we have strong evidence that right whales in particular exhibit the same response. In the days following the 9/11 terror attacks, shipping along much of the east coast of the U.S. and Canada came to a near halt. As a result of the near lack of shipping, noise

levels dropped dramatically in the Bay of Fundy, Canada, where researchers from the New England Aquarium were in the process of collecting right whale fecal samples and acoustic data. These scientists reported a dramatic drop in corticol steroid hormone levels in right whales in the days following 9/11 (Rolland et al. 2012). This dramatic drop in stress hormone levels in conjunction with a reduction in sound is a clear indicator that right whales, like other mammals, exhibit a physiological stress response to noise.

23. Given the density and duration of the authorized surveys and our knowledge of right whale occurrence in the mid- and south Atlantic, it is likely that individual whales will be subjected to multiple days, weeks, or possibly months of seismic survey noise. In light of the year-round presence of right whales off the mid-Atlantic, and the expert opinions that at least some of these are females, it follows that reproductively active females would be in this cohort.

Behavioral Disruptions

24. In general, seismic surveys have repeatedly been shown to disrupt vital behaviors, including foraging, breeding, and migration, in baleen whales (for reviews see Nowacek et al. 2007, 2015). For right whales, the most concerning of these impacts are displacement from prime habitat and foraging locations and reduction in vocalization and communication.

25. One of the most commonly documented behavioral responses is displacement of whales in the presence of seismic surveys. For bowhead whales in particular, displacement due to seismic surveys is well documented, and has been found to occur at distances of more than 20 km from the airgun array and at received sound levels of 120-130 dB (Richardson et al. 1999).

26. There is reason to believe right whales may be foraging off the mid- and southeast Atlantic coast. Aerial surveys sighted several groups of right whales in the area this past winter (New England Aquarium 2018), and while such survey data cannot provide definitive evidence

of feeding, these types of aggregations are characteristic of right whale foraging activity. Additionally, skim feeding has been observed in the mid-Atlantic in the past (Whitt et al. 2013). If whales have found a food patch, displacing them even temporarily from this resource, given their body condition, could impact fitness. Whales that are not displaced can also experience foraging loss from sound exposure. While some studies of acoustic impacts (e.g., McCauley et al. 2000) have documented little or no whale displacement, other studies indicate that animals will remain in an area and tolerate behavioral disturbance or otherwise deleterious effects of noise, including reduced foraging, because they have a strong biological need to stay where they are (Forney et al. 2017; Miller et al. 2009).

27. In addition to displacing whales, seismic surveys are also known to disrupt whale vocalization patterns. Such disruptions have repeatedly been observed in baleen whales across a variety of behavioral states and over large spatial scales. For example, researchers have documented the cessation of singing in fin whales, a behavior closely associated with mating, at scales of hundreds of thousands of square kilometers (Castellote et al. 2012). Another paper documented reductions in singing by humpback whales, on their breeding grounds off southwest Africa, at received sound levels that would occur tens to hundreds of kilometers from seismic arrays (Cerchio et al. 2014).

28. The most comprehensive analysis of the responses of bowhead whales to seismic surveys published to date, synthesizing more than ten years of studies, found that seismic surveys broadly disrupted vocalizations in that species (Blackwell et al. 2015). Migrating bowhead whales reacted to airgun pulses virtually as soon as the signals were audible; increased their

calling rates until the cumulative sound energy level reached about 94 decibels;[2] and began decreasing their calling rates when exposure levels exceeded approximately 127 decibels, until, when sound levels reached approximately 160 decibels, virtually none of the whales continued calling. From the perspective of a behavioral ecologist and bioacoustician, my interpretation of this behavior is as follows: When whales detect some interference (noise) in their communication channel, they attempt to compensate by increasing their calling rate. The leveling off that occurs above 94 decibels likely indicates the maximum calling rate that the whales are able to maintain to compensate for noise. When noise levels get high enough (i.e., above 127 decibels), the whales begin "giving up," as they likely perceive that they are unable to compete with the noise, and eventually shut down use of the vocal channel. This interpretation is consistent with that of the study's authors. I would expect similar impacts on right whales.

29. The importance of vocalizations for cetaceans is indisputable. Vocal behavior plays a sophisticated and critical role in various aspects of the lives of these animals, such as foraging, socializing, and mating (e.g., Quick et al. 2012; Rendell and Whitehead 2003; Videsen et al. 2017). These observations are broadly consistent with more than five decades of study in the behavioral ecology of wildlife. It is well established that vocal behavior is essential to the ecology of birds (e.g., Marler and Tamura 1964) and terrestrial mammals (e.g., Green 1975), and that sound and its patterns of production are deeply seated in the neural architecture and physiology of these species (e.g., Bottjer and Johnson 1997). In its November 2018 notice,

[2] This metric, cumulative sound energy level, represents an animal's cumulative exposure to sound over a period of time. In the case of the bowhead study, the period of time was set to 10 minutes, to capture the exposure of migrating whales as they came within the vicinity of the survey. This level will normally be only slightly higher than the loudest single pulse that occurs within the 10-minute window. Otherwise, except where noted, references to decibels in this declaration imply sound pressure levels, a metric that represents the amplitude of a single seismic shot.

NMFS appears to discount the importance of changes in baleen whale vocal behavior, particularly those associated with seismic exposure. The agency's position is inconsistent with decades of research on marine mammals and other species indicating that changes in vocal behavior represent substantial changes in behavioral patterns.

30. As indicated above, seismic surveys can disrupt important behaviors in baleen whales at exposure levels far below the 160 dB threshold that NMFS applied to the authorized surveys. Gomez et al. (2016) systematically reviewed hundreds of papers that reported behavioral responses of marine mammals to man-made noise and evaluated those changes for their severity, using a severity scale that NMFS has adopted in other contexts. Based on an assessment of 41 studies, Gomez et al. (2016) found that by 140 dB, fully half the baleen whales exposed to seismic airgun or explosive noises demonstrated a behavioral response having a "higher potential" to negatively affect the animal's foraging, survival, or reproduction. Similarly, by 160 dB, half the exposed baleen whales underwent a behavioral response considered "likely" to affect survival or reproduction, with some responses beginning at exposures below 110 dB. The 41 studies captured by the review cover a broad range of contexts of noise exposures. NMFS's adoption of a 160 dB threshold contradicts the scientific literature on the behavioral responses of baleen whales to seismic surveys and significantly understates the potential for adverse impacts on vital rates.[3]

[3] NMFS's selection of a 160 dB threshold significantly influences its assessment of the spatial scale at which impacts will occur. While physical factors (e.g., bathymetry) can and do affect propagation and must be accounted for, it is still basic physics that the area exposed to a particular level of sound increases exponentially as the sound spreads (Urick 1983). Thus, for example, the area exposed to 140 dB of sound can exceed by tens to hundreds of times the area exposed to 160 dB, and the area exposed to 120 dB can exceed by tens to hundreds of times the area exposed to 140 dB. If NMFS had chosen a lower threshold for baleen whales, its estimate of impacts on right whales and other species would have increased by similar proportions.

31. Much of the study of behavioral responses to noise have focused on immediate and short-term responses, but it is also important to consider whether any effects are prolonged and could thus be cause for additional concern. We have concrete examples of baleen whales demonstrating lasting changes in behavior in response to seismic surveys, including at relatively long ranges. Castellote et al. (2012) reported that singing fin whales changed their vocal behavior and moved away from a seismic source within 48-72 hours of the onset of the survey and that these changes persisted for approximately 14 days after the survey concluded; these effects occurred over an area of approximately 100,000 square kilometers. Blackwell et al. (2013) found that, within about 50 km of a seismic source, bowhead whales moved away, dramatically reduced their calling rate, or both, and that this effect lasted for at least seven days after the survey concluded. The persistence of these effects in baleen whales well beyond the duration of exposure is of substantial concern for right whales.

Masking of Mother-Calf Communications

32. Relatedly, seismic surveys are likely to mask right whale communications. One realistic consequence of masking for right whales is that a calf could become separated from its mother if their vocal communication channel becomes unavailable or obstructed.

33. When baleen whale calves are first born, they remain within a few meters of their mothers, making communication between mother and calf easy. But within the first month of calves' lives, they begin to spend increasing amounts of time separated from their mothers (Taber and Thomas 1982; Cartwright and Sullivan 2009). For North Atlantic right whales, this means that within weeks of birth on the calving grounds and during their northward migration from the calving grounds, temporary separations can occur naturally. Under normal circumstances, mothers and calves are able to acoustically communicate with one another

through calls and can reunite after such temporary separations. If background noise levels become elevated, however, there is a significant risk that mothers and calves will be unable to hear each other and reunite.

34. Based on the source levels of recorded right whale upcalls and what we know about right whale hearing, scientists have demonstrated that noise levels as low as 106 decibels can hinder the right whale's ability to effectively maintain contact (Tennessen and Parks 2016). The range at which seismic survey signals will raise background noise levels to 106 dB is many tens of kilometers and possibly hundreds of kilometers, depending on propagation and reverberation conditions. This threshold was derived from a study that assessed masking of adult right whale calls (Tennessen and Parks 2016). As we know that calves produce quieter vocalizations than adults (Root-Gutteridge et al. 2018) and communicate with their mothers using a different type of call that is harder to detect (Parks and Nowacek unpub. data), the threshold is quite possibly an underestimate for the potential for disruption and masking risk for mother-calf pairs. NMFS asserts that calves, when young, stay close to their mothers, from which it concludes that masking will not occur. However, the agency presents no data on mother-calf separation distances or duration. I have personally seen very young calves, less than one month old, separate from their mothers by tens to hundreds of meters, which is precisely the type of separation that could threaten an acoustically-mediated reunion at times and places of elevated background noise.

Scale of Impacts

35. Should the authorized surveys proceed, the impacts that I have described above would be experienced by right whales over large areas of ocean. It is well established that the acoustic energy from seismic airgun surveys can propagate hundreds to thousands of kilometers

in marine environments (Estabrook et al. 2016; Guerra et al. 2016; Nieukirk et al. 2012). To illustrate the sound fields generated by seismic airgun explosions, my colleagues and I modeled the sound fields generated by a 40-airgun array operating within the authorized survey area, off the Virginia-North Carolina coast.[4]

36. Because our focus was on North Atlantic right whales, we included only the seismic airgun energy in the 3rd-octave intervals spanning the 71-224 Hertz (Hz) frequency band, as this is the frequency band in which right whales produce their most common contact call. Figure 1 presents a typical illustration of the sound field produced by a large airgun array of the size included in NMFS's authorizations.[5] This figure indicates the remarkable spatial acoustic footprint of a single survey, indeed of just a few of the millions of seismic shots that NMFS has authorized. Light blue represents background ambient noise levels absent the seismic survey; noise levels increase as the colors progress from green to yellow, orange, and red. The asymmetrical pattern is due to the asymmetry of noise radiating from the airgun array, which is louder at the sides than at the front and back, and to normal variations in sound as it travels through deeper and shallower water. It is important to observe that we modeled the sound field only within a 100 km radius of a typical airgun array; the actual acoustic footprint of the array would be significantly larger.

[4] The model took into account what are typically considered the most salient environmental parameters for the propagation of sounds in water, such as the properties of the sea bottom, the speed profile of sound in the water column, and variation in water depth, as well as the acoustic characteristics of the seismic source.
[5] The sound field appears static and fairly uniform because it integrates the sound energy over multiple airgun shots, analogous to leaving a camera lens open for a number of minutes.

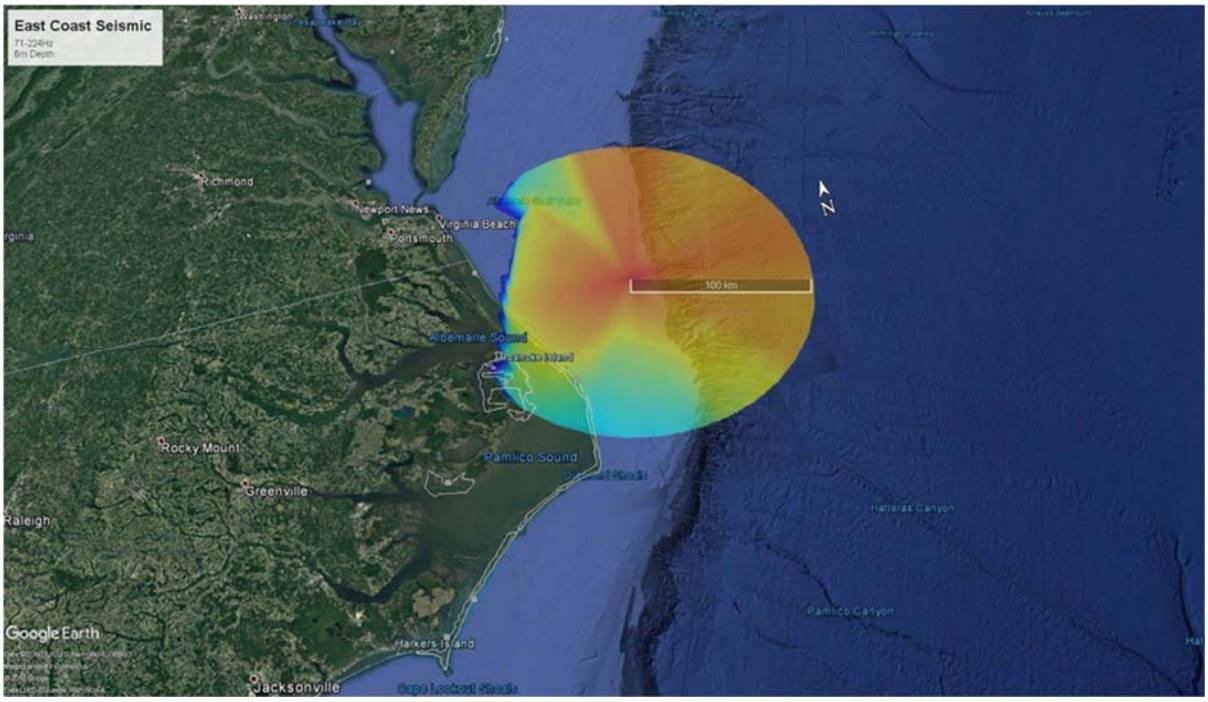


Figure 1.

37. This type of visual illustration is helpful, but it does not capture the dynamics of the sound field nor the noise levels that are present at these ranges. Figure 2, below, from Guerra et al. (2016), shows actual data recorded up to 100 km from a seismic survey near Greenland, at different intervals of time. The dark blue, light blue, yellow, and red symbols, which appear to run together due to their sheer number, show the sound received at 2.5 second intervals from the original pulse, culminating, in the red symbols, with the noise levels experienced 5 to 7.5 seconds after each shot was taken. The figure demonstrates that the survey raised background noise levels, represented by the horizontal lines, by as much as 25 decibels between shots, hardly falling off before the cycle began again. With conventional airgun surveys, there is not enough time between pulses for the sound energy to fully dissipate.

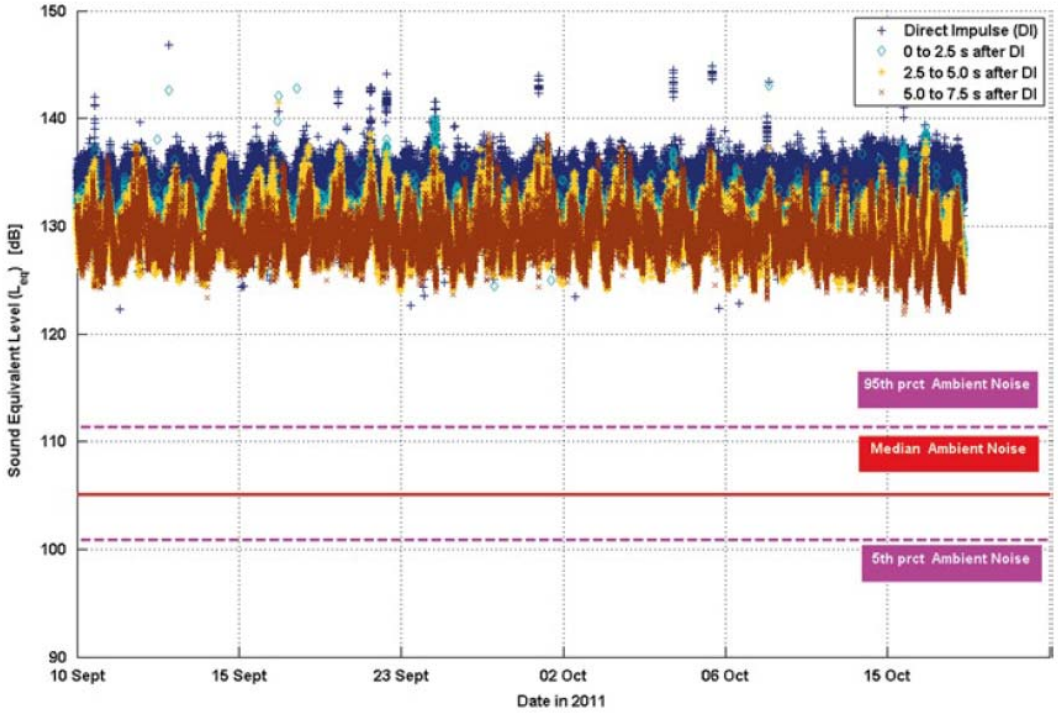


Figure 2. Seismic airgun noise recorded 60-100 km from the source, from Guerra et al. (2016)

38. This figure is noteworthy for three reasons. First, even 7 seconds after an individual pulse, noise levels were found to remain 25 decibels above the median ambient noise level. For seismic surveys like the ones NMFS has authorized, this means that there will be little to no "quiet" period between pulses. Second, the recorded noise levels were more than 30 decibels above those at which behavioral disruptions were documented in bowhead whales in the Blackwell et al. (2015) study referenced above. In other words, even at a distance of 100 km, these seismic surveys were loud enough to cause disruptions in biologically important behavior in the species that offers our best proxy for right whale responses. Third, the recorded noise levels are above those at which researchers reported elevated stress hormone levels in right whales (Rolland et al. 2012), and above those that scientists found would disrupt adult right whales in their ability to maintain communication (Tennessen and Parks 2016).

39. In sum, the authorized surveys would significantly disrupt essential behavior and induce physiological stress in right whales over large distances from each seismic array.

Ineffectiveness of NMFS's Mitigation Measures for Right Whales

40. To mitigate impacts on North Atlantic right whales, NMFS relies primarily on three measures: an exclusion of seismic activities from coastal areas at particular times of year, known as a "time-area closure"; monitoring for right whales around the seismic vessel; and a phased increase, or "ramp-up," of the airgun array at the beginning of operations. Given the distribution of right whales and the distances over which impacts are expected to occur, these mitigation measures are unlikely to prevent significant impacts on individuals or population-level impacts on this endangered species as a whole.

Inadequacy of Time-area Closures

41. Fundamentally, the time-area closures proposed by NMFS are not sufficient to protect right whales. As I have described above, low-frequency sounds, like those from ships and seismic surveys, travel extremely well through the ocean. Shallow water affects this process in that low frequencies do not travel as well through shallow waters as they do in deeper waters. Nonetheless, sound from surveys occurring at the shelf break or on the shelf will likely travel large distances up onto the shelf, ensonifying essentially all the waters utilized by right whales, including the species' only known calving grounds.

42. For example, the amount of seismic energy that would reach the right whale's calving grounds, the area of highest historic right whale densities, would be enough to cause behavioral changes (both locomotive and vocal), including changes that could jeopardize the survival of calves. I ran a propagation model, using a standard parabolic equation model employed by the U.S. Navy (Collins 1993; Margolina et al. 2018), with the seismic source

positioned at 90 km offshore.[6] At 20 km offshore, a common location for right whales in this area, the whales would receive sound pressure levels of 116 dB. This level is well above where bowhead whales show a change in vocal behavior and a full 10 dB above the level at which scientists have determined that noise can hinder adult right whales' ability to effectively maintain contact (Tennessen and Parks 2016). Thus, keeping seismic vessels out of nearshore waters will not prevent airguns from ensonifying prime right whale habitat to the point where right whale behavior is significantly affected.

43. Second, as noted above, NMFS's authorizations do not account for the best available information with respect to the times and areas occupied by right whales. Because right whales are known to occur as far south as Georgia during nine months of the year and as far south as the mouth of the Chesapeake throughout the year, and because they occur further offshore than previously thought, the time-area closures proposed by NMFS are not sufficient to protect right whales in areas and seasons not included in the closures. Additionally, NMFS intends to allow companies to conduct seismic surveys closer to shore, between 47-80 km from the coast, even during the height of right whale season, upon approval of plans for additional monitoring and mitigation. In my opinion, there is no additional mitigation plan that could reduce to acceptable the exposure and risk of having seismic operations occurring at the eastern edge of the highest-density right whale area.

[6] I ran this model at a frequency of 500 Hz because it was the closest to the 250-300 Hz range used by right whales that the model could produce. The difference in sound propagation between 300 and 500 Hz is likely to be insignificant as the propagation depends primarily on the relationship between the wavelength and the water depth. Sounds of both frequencies propagate well in waters offshore of the calving grounds.

44. With our improved and evolving knowledge of right whale distribution, and in light of the precarious status of the species, the NMFS time-area closures fall well short of the protections necessary to prevent harm to right whales on a broad spatial and temporal scale.

Inadequacy of Monitoring

45. NMFS's required monitoring scheme is also inadequate. The use of visual observers to detect right whales is imperfect at best, for several reasons. First, observers will be unable to spot whales in low light or other poor-visibility conditions, such as fog or high sea states; and second, it is very difficult to spot whales even when one is searching for them under ideal conditions. The whales must be at the surface for them to be detected visually, and what little data we have for female right whales nursing calves off the southeast U.S. coast indicates that they are available for detection from boats only half the time at most, and perhaps as infrequently as 10 percent of the time (Nowacek et al. 2018). Additionally, the area available for detection by vessel-based observers, about a 1 km radius, is dramatically smaller than the area where impacts are expected, a radius of tens to hundreds of kilometers. Visual observation from the survey vessel is helpful only in preventing immediate physical injury, although detection within this injury area still falls well short of 100 percent, particularly during poor-visibility conditions.

46. Similarly, the requirement to conduct passive acoustic monitoring will have very limited benefit for North Atlantic right whales. Although the "up-calls" produced by right whales can be an effective tool for passive acoustic monitoring in the research context (Van Parijs 2009), such monitoring has substantial limitations, especially when used for real-time mitigation in the manner that NMFS intends. As with all passive acoustic monitoring, whales will not be detected even when present if they are quiet or not vocalizing or if background noise is too high.

Results from the U.S. Navy's monitoring program indicates that passive acoustic monitoring is essentially useless for detecting mother-calf pairs off the southeastern United States due to reduced vocalization rates in this cohort and quieter mother-calf calls. For example, one female whale, tagged twice by researchers in 2016, went from calling 45 times in 5 hours when she was pregnant to not calling once in 5 hours when her calf was about 2 weeks old (Nowacek et al. 2018). In general, right whales studied off the coasts of South Carolina, Georgia, and Florida have variable vocal rates that are relatively quiet and infrequent compared to the vocal rates documented off the northeastern United States (Nowacek et al. 2018). Finally, studies show that baleen whales cease vocalizing in the presence of even low levels of seismic survey noise (e.g., Blackwell et al. 2015).

47. Related to near-vessel monitoring is the practice of "ramp-up" as a mitigation measure, to reduce the likelihood that an individual whale will be exposed to injurious levels of noise. In this practice, instead of commencing operations with all the airguns in an array, small numbers of guns are slowly added until the full array is firing. There has been no experimental confirmation that this procedure is broadly effective at reducing overall exposure (*see* Wensveen 2017). Regardless, even if it worked perfectly, this mitigation measure would reduce only the number of injuries incurred in the vicinity of the seismic vessel and does not address at all the larger body of effects.

Conclusion

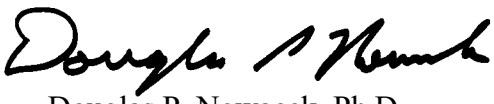
48. It is my expert opinion, especially in light of the roughly 850 survey days and the close to 90,000 trackline miles they entail, that the seismic airgun surveys authorized by NMFS will adversely affect many individual right whales. These effects will have both behavioral and physiological consequences. It is highly likely, given the species' dire conservation status and

the extent of seismic survey activity, that the surveys will cause adverse impacts at both the individual and population level due to increased noise-induced stress, displacement of whales, and/or the interruption of communication between individuals, especially mother-calf pairs.

50. I have worked professionally for more than a decade on methods and means to minimize the impacts of seismic surveys on large whales (see, e.g., Nowacek and Southall 2016). I am not an alarmist about the impacts of these activities; I generally believe that less environmentally harmful approaches are available to mitigate their effects. If NMFS had authorized a survey of a discrete area within the region for a short period of time (e.g., one month), then I would have reached a different opinion about the magnitude of impact; but this virtually unchecked level of noise being injected for as many as 850 days, in less than two years, into an environment that is clearly inhabited by right whales, is almost certain to have individual and population-level impacts on this species.

I declare under penalty of perjury that the foregoing is true and correct to the best of my knowledge and belief.

Executed on January 16, 2019, at Beaufort, North Carolina.



Douglas P. Nowacek, Ph.D.

Exhibit A
CURRICULUM VITAE

DOUGLAS PAUL NOWACEK

Repass-Rodgers Chair of Marine Conservation Technology
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&
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e-mail: dpn3@duke.edu

EDUCATION:

B.A.	Ohio Wesleyan University, Delaware, Ohio; Zoology; *summa cum laude* & Phi Beta Kappa (1991)
Ph.D.	Woods Hole Oceanographic Institution & Massachusetts Institute of Technology, Biological Oceanography (1999)

Dissertation Title:
Sound use, sequential behavior, and ecology of foraging bottlenose dolphins, *Tursiops truncatus*

Dissertation Advisor:
Peter L. Tyack

POSITIONS:

Professor, Duke University, Nicholas School of the Environment & Pratt School of Engineering (2018-present)
Associate Professor, Duke University, Nicholas School of the Environment & Pratt School of Engineering (2008-2018)
Visiting Scholar, Institute of Marine and Antarctic Sciences, University of Tasmania, Hobart, Tasmania, Australia (2013)
Adjunct Professor, Department of Biology and Marine Biology, University of North Carolina Wilmington (2008-present)
Assistant Professor, Department of Oceanography, Florida State University (2003–2008)
Guest Investigator, Woods Hole Oceanographic Institution (2002–2003)
Staff Scientist, Sensory Biology and Behavior Program, Center for Marine Mammal and Sea Turtle Research, Mote Marine Laboratory (2002–2003)
Postdoctoral Research Associate, National Research Council/National Oceanic and Atmospheric Administration, Northeast Fisheries Science Center (2000–2002)
Postdoctoral Fellow, Department of Biology, Woods Hole Oceanographic Institution (1999–2002)

ACADEMIC AND RESEARCH AWARDS & DISTINCTIONS

2017	*Sally Connally Hardie Visiting Researcher*, University of St Andrews, Scotland
2015	Invited Testimony, U.S. House of Representatives, Committee on Natural Resources, Oversight Hearing on "The Fundamental Role of Safe Seismic Surveying in OCS Energy Exploration and Development"
2013	*Visiting Fellow*, University of Tasmania
2003-05	*Young Investigator Award*, Office of Naval Research
2000-2002	*National Research Council, Research Associate Fellowship*, National Academy of Sciences
1993-1995	*National Defense and Science and Engineering Graduate Fellowship,* Office of Naval Research
1987-1991	*Presidential Scholarship*, Ohio Wesleyan University

CURRENT PROFESSIONAL SERVICE

Western Gray Whale Advisory Panel, The International Union for the Conservation of Nature (IUCN), Gland, Switzerland
Invited Guest Editor, *Marine Ecology Progress Series*
Atlantic Scientific Review Group, NOAA Fisheries
Cetacean Specialist Group, Species Survival Program, IUCN, Switzerland
Technical Working Group on Biologically Relevant Sound Levels, Department of Conservation, Government of New Zealand
Expert Assessor, Research Council of Norway
Invited contributor, Cetacean Tagging Best Practices Guidelines.

PAST PROFESSIONAL SERVICE

North Atlantic Right Whale Consortium, Chair & Board Member
NSF Graduate Research Fellowship Program, Panel Member, 2015
Associate Editor, *Marine Mammal Science*
Society for Marine Mammalogy, Member of Board of Governors
National Fish and Wildlife Foundation, Reviewer (2007)
NSF Biological Oceanography Panel, Reviewer (2006)
Independent Scientific Review Panel, The World Conservation Union (IUCN), Gland, Switzerland (2005)
NOAA Right Whale Program, Reviewer (2004)
NOAA, National Marine Fisheries Service, Atlantic Large Whale Take Redcution Team, Northeast Implementation Team (2000-02)
Acoustical Society of America, Animal Bioacoustics Committee

GRANTS

Selected list, full list provided in separate document.
Total received by Duke with Nowacek as PI or Co-PI since 2012 ~$5.88M

Pending:

Sigma Xi. Hormone responses to acoustic stimuli in short-finned pilot whales (*Globicephala macrorhyncus*). $1749, **D.P. Nowacek** (PI) with Ms. Jillian Wisse (Duke PhD student).

Current:

2017-2020 NSF Office of Polar Programs. Collaborative Research: Foraging behavior and ecological role of the least studied Antarctic krill predator, the Antarctic minke whale (*Balaenoptera bonaerensis*). $177,322, **D.P. Nowacek** (Duke PI), D.W. Johnston (Co-PI).

2017-2020 Bureau of Ocean Energy Management (BOEM). Spatial and Acoustic Ecology of Marine Megafauna (SPAM). $2,334,438. D. Ann Pabst (UNC Wilmington) lead PI. **D. P. Nowacek**, Co-PI and Duke PI.

2017-18 Naval Facilities Engineering Command, via HDR. "Multi-Scale Behavioral Response Studies of Cetaceans and MFAS Along the US East Coast." $473,409. B.L. Southall, Southall Environmental Associates and UC Santa Cruz lead PI; Duke PIs Read (lead) and **D.P. Nowacek** (Co-PI).

2016-19 Office of Naval Research, "Acoustic Startle Responses as Aversive Reactions and Hearing Indicators in Cetaceans". $572,304, V. Janik (Univeristy of St. Andrews) lead PI, **D.P. Nowacek** (Duke PI) with A.J. Read (Co-PI).

2016-18 Socioambiental Consultorers, Brazil, "Acoustic, Behavioral and Foraging Ecology of Cetaceans off the Coast of Brazil: A Baseline Study". $252,014 **D.P. Nowacek** (PI) with D. Haas (Duke PhD student).

2016-18 Office of Naval Research, "Developing a bioenergetic model for baleen whales to assess population consequences of disturbance - Phase 1" $110,416.00, F. Christiansen, Murdoch University, lead PI, Co-PIs L. Bejder (Murdoch), P.T. Madsen (Aarhus University, Denmark), and **D.P. Nowacek.**

2016-17 Naval Facilities Engineering Command, "North Atlantic Right Whale Tagging and Tracking on the Southeast US Calving Grounds". $347,475, **D.P. Nowacek** (PI), Co-PIs A.J. Read and S.E. Parks (Syracuse University)

2015-17 Marine Corps Air Station Cherry Point, via HDR Inc. "Autonomous Passive Acoustic Monitoring." $188,587, **D.P. Nowacek** (PI).

2015-18 National Science Foundation, HBCU-UP Research Initiation Award, "Physical forces impacting the temporal variability of mesopelagic prey at the Cape Hatteras marine top-predator diversity hotspot". $282,106, A. Kaltenberg, Savannah State (PI) with collaborators **D.P. Nowacek** and D. Savidge.

2015-20 NSF Long Term Ecological Research Program, "LTER Palmer, Antartica (PAL): Land Shelf Ocean Connectivity, Ecosystem Resilience and Transformation". $6.4M (Mammal group ~$120,00/year), Lead PI Hugh Ducklow (Columbia), A.S. Friedlaender lead mammal group PI. Duke PI D.W. Johnston, Co-PIs A.J. Read and **D.P. Nowacek.**

2014-17 Morris Animal Foundation, "Morris Animal Foundation fellowship training grant". $67,868, **D.P. Nowacek** (PI) with R. Cassoff, VMD (Duke PhD student).

Past:

2015-16 BOEM, "Studies to Inform the Delineation of Wind Energy Areas within the Published Areas of Interest for North Carolina". C. Peterson (UNC-CH) lead PI. $15,000, **D.P. Nowacek** Duke PI.

2011-15 Strategic Environmental Research & Development Program, "Delphinid Cetaceans: Quantifying Behavioral Ecology and Response to Predators Using a Multi-Species Approach". $1,476,412, A.J. Read (PI), **D.P. Nowacek** (Co-PI)

2014-15 Naval Facilities Engineering Command, "North Atlantic Right Whale Tagging and Tracking on the Southeast US Calving Grounds". $336,760, **D.P. Nowacek** (PI), Co-PIs A.J. Read and S.E. Parks (Syracuse University).

2013-15 Office of Naval Research, "WIZARD: A moored system for measuring the temporal variability of prey fields of deep diving predators off Cape Hatteras". $421,450, **D.P. Nowacek** (PI).

2013-14 The Ocean Foundation, "Comparing humpback whale feeding ecology: Pacific, Atlantic and Antarctic". $270,817, A.S. Friedlaender (PI), **D.P. Nowacek** and D.W. Johnston (Co-PIs).

2013-14 Naval Facilities Engineering Command, "North Atlantic Right Whale Tagging and Tracking on the Southeast US Calving Grounds". $289,339, **D.P. Nowacek** (PI), Co-PIs A.J. Read and S.E. Parks (Syracuse University).

2013-14 National Science Foundation, "A SAFE vessel: Advancing research capabilities to the Gulf Stream". $141,101, C.L. van Dover (PI), **D.P. Nowacek** and J.E. Hench (Co-PIs).

2012 National Oceanic and Atmospheric Administration (NOAA), "Duke University Seminar on Methods in Marine Bioacoustics". $20,000, **D.P. Nowacek** (PI).

2012-13 National Science Foundation, "RAPID: Linking the movement patterns and foraging behavior of humpback whales". $76,833, A.S. Friedlaender (PI) and **D.P. Nowacek** (Co-PI).

2011-14 Office of Naval Research, "Improving Attachments of Non-invasive (Type 3) Electronic Data Loggers to Cetaceans". M.J. Moore (WHOI) lead PI. $182,717, **D.P. Nowacek** (PI) and D. Rittschof (Co-PI).

2009-12 National Science Foundation, Office of Polar Programs. "Collaborative Research: The ecological role of a poorly studied Antarctic krill predator". $473,898, **D.P. Nowacek** lead PI, Co-PIs Friedlaender, A.S., Johnston, D.W., and Read, A.J. and 1 non-Duke Co-PI.

2008-12 National Oceanographic Partnership Program: Office of Naval Research, "Prey fields and habitat of deep divers: 3D characterization and modeling of beaked and sperm whale foraging areas in the Tongue of the Ocean". $530,475. **D.P. Nowacek** lead PI with P. Halpin, P. Tyack, and T. Stanton (WHOI).

Recent, unsuccessful proposals:

2017 National Aeronautics and Space Administration, "Cross scale assessment of phytoplankton biogeochemistry and mammal movement ecology across energetic ocean fronts". $1,293,099, Z.I. Johnson lead PI, Duke Co-PIs **D.P. Nowacek** and D.W. Johnston and 4 non-Duke Co-PIs.

2016 BOEM, Department of Interior, "Atlantic Deepwater Ecosystem Observatory (ADEON): An Integrated System". $6,499,977, **D.P. Nowacek** lead PI, Duke Co-PI P.N. Halpin and 8 non-Duke Co-PIs.

2016 National Science Foundation, "EAGER: Citizen Science with CBET and Enviornmental Engineering". $99,863, E. Dimattia (PI) and **D.P. Nowacek** and D.W. Johnston Co-PIs.

2016 Office of Naval Research, invited proposal, "The Involvement of Lung Compression in the Detection of Cetaceans as Active Sonar Targets". $385,119, **D.P. Nowacek** PI.

2015 NOAA Office of Explorarion, invited proposal, " Integrating scientific echosounders into autonomous ocean gliders to measure pelagic communities" $540,687, **D.P. Nowacek** lead PI, Co-PIs Schofield and Kohut (Rutgers) and J.C. Taylor (NOAA).

2014 Southeast Coastal Ocean Observing Regional Association, "Marine Biodiversity in the Southeast U.S.: A Regional Demonstration of a National Network". $1,737,195, P.N. Halpin lead PI, Co-PIs D.P. Nowacek and six non-Duke.

2013 National Science Foundation, "Collaborative research: Krill Predators of the Peninsula, Sharing a Resource in the Western Antarctic Peninsula". $785,086, **D.P. Nowacek** lead PI, Co-PIs D.W. Johnston, A.J. Read, and 3 non-Duke.

PEER REVIEWED PUBLICATIONS

Published or In Press:
Nowacek mentored *postdoc, **graduate student, ***undergraduate student. #authors contributed equally. Papers in red are included in top publications.

97. Howle, L.E., Kraus, S.D., Werner, T.B., and Nowacek, D.P. 2018. Simulation of the entanglement of a North Atlantic right whale (*Eubalaena glacialis*) with fixed fishing gear. *Marine Mammal Science* DOI: 10.1111/mms.12562
96. Priyesh, P., Boyla, M., Carmelo, M., Nowacek, D.P., Collins, L. and Karra, R. 2018. Acoustic Signatures of Left Ventricular Assist Device Thrombosis. ASME Journal of Engineering and Science in Medical Diagnostics and Therapy doi:10.1115/1.4041529
95. Tyson, R. B., Piniak, W. E., Domit, C., Mann, D., Hall, M., Nowacek, D. P., & Fuentes, M. M. (2017). Novel bio-logging tool for studying fine-scale behaviors of marine turtles in response to sound. *Frontiers in Marine Science*, *4*, 219.
94. Stanistreet, J, Nowacek, D, Bell, J, Cholewiak, D, Hildebrand, J, Hodge, L, Van Parijs, S, and Read, A. "Spatial and seasonal patterns in acoustic detections of sperm whales Physeter macrocephalus along the continental slope in the western North Atlantic Ocean." *Endangered Species Research* 35 (January 15, 2018): 1-13. Full Text
93. Narazaki, T, Isojunno, S, Nowacek, DP, Swift, R, Friedlaender, AS, Ramp, C, Smout, S, Aoki, K, Deecke, VB, Sato, K, and Miller, PJO. "Body density of humpback whales (Megaptera novaengliae) in feeding aggregations estimated from hydrodynamic gliding performance." *Plos One* 13, no. 7 (January 2018): e0200287-null. Full Text
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2. Jacobs, M., **Nowacek, D.P**., Gerhart, D.J., Cannon, G., Nowicki, S., & R.B. Forward, Jr. 1992. Seasonal changes in vocalizations during behavior of the Atlantic bottlenose dolphin. *Estuaries*. 16(2): 241-246.
1. Grant, D.C., Ligibel, J.A., **Nowacek, D.P**., Horsburgh, S.E., Link, M.A., Ngu, M.N., Furr, K.I., & C.M. Hall. 1991. Impact of feral horse migration on soft bottom infaunal community structure. *The Journal of the Elisha Mitchell Scientific Society*. 107(1): 13-20.

In review or prepration:

Wilson, R.M., Tyson, R.B., Nelson, J.A., Balmer, B.C., Chanton, J.P., and **Nowacek, D.P.** Stable isotopes highlight differences in prey selectivity among common bottlenose dolphins (*Tursiops truncatus*) sighted in St. George Sound, Gulf of Mexico. In review *Frontiers in Marine Science*

Wang, Z-T, **Nowacek, D.P**., Akamatsu, T., Wang, K-X., Liu, J-C.,Duan, G-Q., Cao, H-J., Wang, D. In prep. Diversity fish sound types in the Pearl River Estuary, China

Stanistreet, J.E., **Nowacek, D.P**., Bell, J.T., Cholewiak, D.M., Hildebrand, J.A., Hodge, L.E.W., Van Parijs, S.M., Read, A.J. In prep. Spatial and seasonal occurrence patterns of sperm whales (*Physeter macrocephalus*) measured with passive acoustics along the western North Atlantic shelf slope.

Howle, L.E., Kraus, S.D., Werner, T., and **Nowacek, D.P**. In prep. Simulation of the Entanglement of a North Atlantic Right Whale (*Eubalaena glacialis*) with Lobster Trap Gear.

Root-Gutteridge, H., Cusano, D.A., Shiu, Y., **Nowacek, D.P**., Van Parijs, S.M., and Parks, S.E. A lifetime of changing calls: North Atlantic right whales (*Eubalaena glacialis*) continue to refine call production as they age.

SCIENTIFIC CORRESPONDENCE

Gannon, D.P., Johnston, D.W., Read, A.J., & D.P. Nowacek. 2004. Resonance and Dissonance: Science, Ethics, and the Sonar Debate. *Marine Mammal Science*, 20(4):898-899.

POPULAR ARTICLES AND BOOKS

Clark, C.W., Gillespie, D., Nowacek, D.P., & S.E. Parks. 2007. Listening to their world: Acoustics for monitoring and protecting right whales in an urbanized ocean. In: Kraus, S.D. & R.M. Rolland (eds). *The Urban Whale: North Atlantic Right Whales at the Crossroads*. Harvard University Press.

Nowacek, S.M., & D.P. Nowacek. 2006. *Discovering Dolphins*. Colin Baxter Photography, Voyageur Press.

BOOK REVIEWS

Echolocation in Bats and Dolphins. 2004. Thomas, J.A., Moss, C.F. & M. Vater (editors). University of Chicago Press, Chicago, IL. Reviewed at the request of the Press.

RESEARCH EXPEDITIONS LED

2016 *R/V Neil Armstrong*, PI, Deployment of WIZARD acoustic mooring
2010 *R/V Nathaniel B Palmer*, Chief Scientist, Multi-Scale and Interdisciplinary Study of humpback whales and prey, NSF Award
2009 *R/V Laurence M Gould*, Chief Scientist, Multi-Scale and Interdisciplinary Study of humpback whales and prey, NSF Award

TEACHING AND GRADUATE TRAINING

Courses Taught:

Marine Bioacoustics, Duke University (2011-present)
Ocean Engineering, Pratt School of Engineering, Duke University (2012-present)
Conservation Biology and Policy (aka Marine Conservation Summer Institute) (2011-present)
Marine Ecology, Duke University (2011-2013)
Marine Ichthyology, Duke University (2009-2011)
Acoustics and Hearing, Pratt School, Duke (2008)
Applied Ocean Acoustics, Florida State University (2006–2008)
Marine Vertebrates Field Course, Florida State University (2006)
Bioacoustics, Florida State University (2005–2008)
Marine Nekton, Florida State University (2004–2008)
Biology of Marine Mammals, Florida State University (2004–2008)
Biology of Marine Mammals, Eckerd College (2000)
Biology of Marine Mammals, Duke University (1999–2004)
Marine Mammals, Boston University Marine Program (1999)

Advisor for current students in:

Ph.D. Program in Ecology, Duke University (2)
Ph.D. Program in Marine Science and Conservation, Duke University (5)
Masters in Environmental Management, Duke University (3)

Advisor for Ph.D. Graduates from Florida State and Duke Universities:

Stanistreet, J.E. 2016. Ecology of Beaked Whales and Sperm Whales in the Western North Atlantic Ocean: Insights from Passive Acoustic Monitoring. Duke, University Program in Ecology.
Phillips, G. 2016. Passive Acoustics: A Multifaceted Tool for Marine Mammal Conservation. Duke, Marine Science and Conservation.
Bowers, M.T. 2016. Behavioral Ecology of the Western Atlantic Short-finned Pilot Whale (*Globicephala macrorhynchus*). Duke, Marine Science and Conservation.
Xian, Y*. 2015. Detection and classification of whale acoustic signals. Duke, Electrical and Computer Engineering. *Co-Advisor with Dr. Loren Nolte.
Reny B Tyson. 2014. Fine-Scale Foraging Behavior of Humpback Whales *Megaptera novaeangliae* in the Near-Shore Waters of the Western Antarctic Peninsula. Duke, Marine Science and Conservation.
Rycyk, A.M. 2013. Environmental, behavioral, and experiential factors that affect the likelihood and type of a manatee's response to approaching boats. FSU, Earth, Ocean and Atmospheric Sciences.
Wilson, R.M. 2010. Using chemical tracers to evaluate feeding habits in coastal marine ecosystems: stable isotopes and organic contaminants. FSU Department of Oceanography.
Anna Nousek-McGregor. 2010. The costs of locomotion in North Atlantic Right Whales (*Eubalaena glacialis*). Duke, Marine Science and Conservation, Nicholas School of the Environement.

Advisor for Masters in Environmental Management Graduates from Duke University:

Elliott, B. 2017. Analyzing the Role of Sound in the Endangered Species Act: A Petition for Sperm Whale (*Physeter macrocephalus)* Critical Habitat in the Gulf of Mexico.
Alcaraz, N. 2017. Spatial Assessment of Antarctic Krill (*Euphausia superba*) in the Palmer Long-Term Ecological Research (LTER) Study Site using Acoustic Doppler Current Profiler (ADCP) Technology.
Nasgovitz, M. 2017. Mapping anthropogenic noise in the Arctic.
Hartigan, K. 2017. Using Acoustic Indices to Determine Changes in Biodiversity off the Coast of Cape Hatteras, NC
Heywood, E. 2016. Ambient noise in the Kitimat Fjord system.
Wagner, A. 2015. A comparative analysis of the status of the U.S. marine mammal stock assessment program.
Guttenplan, K. 2015. Investigating Boat Noise in Wellfleet Harbor, MA
Carnal, H.L.B. 2014. Geospatial analysis and comparison of habitat costs for resident Sarasota Bay bottlenose dolphins (*Tursiops truncatus*).
Bonamusa, J. 2014. Spatial and temporal variability of sea surface temperature and fisheries distribution with the North Atlantic Oscillation.
Latchford, L.E. 2013. Conservation or culture? An analysis of shark fin soup in America.
Carduner, J. 2013. Best practices for baseline passive acoustic monitoring of offshore wind energy development.
Jessica Richardson 2012. Evaluating opportunistic sighting records of large whales around South Georgia Island.
Gabriell Vires 2011. Echosounder Effects on Beaked Whales in the Tongue of the Ocean (Bahamas)
Casey Dziuba. 2011. Sea level rise education and outreach for coastal North Carolina.
Jaime L. Budzynkiewicz. 2011. A comparison of Environmental Impact Statement methodologies for assessing sound propagation, density determination and impacts of protected marine mammals: BEOMRE & the U.S. Navy.
Kimberly Gordon. 2010. Catch share management: An appropriate tool for New England?

Advisor for Masters in Engineering Management Graduates from Duke University:

Jonathon Buie 2017. Blue Devil Ocean Engineering XPrize IMU.

Advisor for M.Sc. Graduates from Florida State University:

Reny B. Tyson. 2008. Abundance of bottlenose dolphins in the Big Bend region of Florida: St. Vincent Sound to Alligator Harbor.

Athena Rycyk. 2007. Acoustic ecology of the bottlenose dolphin (*Tursiops truncatus*) in the Big Bend region of Florida. Current position – Ph.D. student, Department of Oceanography, Florida State University, D.P. Nowacek, advisor.

Marie E. Chapla. 2006. Florida manatee (*Trichechus manatus latirostris*) outer and middle ear morphology: Potential sound pathways and middle ear mechanism. Current position – Research associate, NOAA, National Marine Fisheries Service, Pacific Islands Fisheries Science Center, Honolulu, HI.

Graduate Thesis Committees:

Duke University
University of North Carolina at Wilmington
Florida State University
North Carolina State University

PRESENTATIONS AT SCIENTIFIC MEETINGS

First-Author Presentations (*Invited):

***Nowacek, D.P.** and Southall, B.L. 2016. Effective planning strategies for managing environmental risk associated with geophysical and other imaging surveys. World Congress, International Union for the Conservation of Nature, Honolulu, HI.

***Nowacek, D.P.** Cetacean Ecology of the Antarctic Peninsula. Department of Environmental Sciences, University of Virginia, 13 October 2016.

***Nowacek, D.P.** Ocean Noise: Impacts and Ideas for Management. Department of Marine and Coastal Sciences, Rutgers University, 11 April 2016.

***Nowacek, D.P.** Seismic surveys and marine wildlife: Ideas for managing real and perceived impacts. Society for Exploration Geophysicists, Annual Meeting, 18-23 October, 2015. New Orleans, USA.

***Nowacek, D.P.** Seismic surveys and marine wildlife: Impacts, the lack thereof and thoughts on managing both. Hot Topics in Acoustics, Session 3pID, 170th Meeting of the Acoustical Society of America. Jacksonville, FL 2-6 November 2015.

***Nowacek, D.P.** Invited witness at House of Representatives hearing, 'The Fundamental Role of Safe Seismic Surveying in OCS Energy Exploration and Development'. **House Natural Resources Committee, Energy and Minerals Subcommittee.** 14 July 2015.

Nowacek, D.P., Clark, C.W., Mann, D.A., Miller, P.J.O., Rosenbaum, H.C., Golden, J.S., Jasny, M., Kraska, J., and Southall, B.L. 2015. Marine seismic surveys and ocean noise: Mitigation, monitoring and a plan for international management. 21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA.

***Nowacek, D.P.**, Bowers, M., Cannon, A., Hindell, M., Howle, L.E., Murray, M.M., Rittschof, D., Shorter, K.A., and Moore, M. The next generation of multi-sensor acoustic tags: sensors, applications and attachments. 2014. 166th Meeting of the Acoustical Society of America in San Francisco, CA.

***Nowacek, D.P.**, Parks, S.E., and Read, A.J. 2015. Tagging and Tracking of North Atlantic Right Whales in the SE U.S. U.S. Marine Mammal Commission Annual Meeting, Charleston, SC.

***Nowacek, D.P.** Seismic surveys: Potential impacts on animals and ideas for mitigation, monitoring and management. 2015. U.S. Marine Mammal Commission Annual Meeting, Charleston, SC.

Nowacek, D.P., Hindell, M., Howle, L.E., Murray, M.M., Rittschof, D., Shorter, K.A., and Moore, M. The next generation of multi-sensor tags: improving attachments of non-invasive tags with bio-compatible glues and microstructure. 2014. The 5th International Bio-Logging Science Symposium, 22-26 September, Strasbourg, France.

Nowacek, D.P.& P.L. Tyack. 2007. Assessing effects of anthropogenic sound on behavior of marine mammals. International Conference on the Effects of Noise on Aquatic Life, Nyborg, Denmark.

***Nowacek, D.P.** 2007. Biological functions of acoustic communication and the effects of noise on marine animals. Potential Application of Vessel-Quieting Technology on Large Commercial Vessels. Convened by NOAA, National Marine Fisheries Service - Acoustics Program, Washington, DC.

Nowacek, D.P. 2006. Application of tagging data to the design and implementation of right whale ship strike mitigation, U.S. Marine Mammal Commission Review of Right Whale Research, Marine Biological Labs, Woods Hole, MA

Nowacek, D.P.& D.A. Mann. 2006. GNOMES – Gulf of Mexico noise monitoring system. Part of 'Understanding Acoustic Impacts on Marine Animals: National Lecture Series', NOAA Acoustics Program, held at Duke University, Nicholas School of the Environment and Earth Sciences.

***Nowacek, D.P.**2006. Methods for assessing the response of cetaceans to seismic exploration. International Whaling Commission, Scientific Committee, St. Kitts.

***Nowacek, D.P.**, Mann, D.A., Remage-Healey, L., & A.H. Bass. 2006. Dolphin foraging sounds suppress calling and elevate stress hormones in a prey species, the Gulf toadfish. Carnivores 2006, St. Petersburg, FL.

***Nowacek, D.P.**2005. Do dolphins have language? Philosophy Department, Case Western Reserve University, Cleveland, OH.

Nowacek, D.P., Renner, W., Cavanagh, R., & A. Eller. 2005. Transmission of Vessel Noise Through Right Whale Environments. 16th Biennial Conference on the Biology of Marine Mammals, San Diego, CA.

Nowacek, D.P., Barton, K., Bocconcelli, A., Johnson, M.P., Moore K.C., Parks, S.E., Shorter, K.A., & P.L. Tyack. 2005. Response of right whales at the surface to alert/alarm signal. North Atlantic Right Whale Consortium, New Bedford, MA.

Nowacek, D.P.2005. Behavioral Ecology of Marine Mammals. Southeast and Mid-Atlantic Marine Mammal Symposium, University of North Carolina Wilmington.

Nowacek, D.P.2005. Detection of boats by manatees. Manatee Forum IV, Florida Fish and Wildlife Conservation Commission. St. Petersburg, FL.

Nowacek, D.P.2004. Behavioral ecology and bioacoustics of cetaceans: 'tales from tagging'. Hopkins Marine Station, Stanford University.

Nowacek, D.P., Renner, W., Cavanagh, R., & A. Eller. 2004. Transmission Of Vessel Noise Through Right Whale Environments. North Atlantic Right Whale Consortium, New Bedford, MA.

Nowacek, D.P.2004. Effects of Shipping Noise on Marine Mammal Behavior. NOAA Fisheries Symposium: "Shipping Noise and Marine Mammals: A Forum for Science, Management, and Technology", Washington, DC.

Nowacek, D.P.2004. Behavioral responses of marine mammals to human generated noise. Part of 'Understanding Acoustic Impacts on Marine Animals: National Lecture Series', NOAA Acoustics Program', held at Mote Marine Laboratory, Sarasota, FL.

Nowacek, D.P., Tyack, P.L., & M.P. Johnson. 2003. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alarm signal. 15th Biennial Conference on the Biology of Marine Mammals, Greensboro, NC.

Nowacek, D.P., Tyack, P.L., & M.P. Johnson. 2003. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alarm signal. Environmental Consequences of Underwater Sound, San Antonio, TX.

***Nowacek, D.P**., Tyack, P.L., & M.P. Johnson. 2003. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting signal. Hawaiian Islands humpback whale National Marine Sanctuary, Vessel collision avoidance workshop, Wailea, Maui, Hawaii.

***Nowacek, D.P**., Tyack, P.L., & M.P. Johnson. 2003. North Atlantic right whales (*Eubalaena glacialis*) ignore ships but respond to alerting signal. U.S. Marine Mammal Commission, Annual Meeting, Newport, RI.

Nowacek, D.P., Johnson, M.P., & Tyack, P.L. 2003. North Atlantic right whales ignore ships but respond to alerting stimuli: have we found the 'right whale deer whistle'? 15th Biennial Conference on the Biology of Marine Mammals, Greensboro, NC.

Nowacek, D.P., Tyack, P.L., Johnson, M.P., Allen, B.D., Argo, E., Biassoni, B., Bocconcelli, A., Carson, C., Loer, A., Parks, S., Partan, J., Samuels, A., Shorter, K.A., Waples, D, & M. Zani. 2002. Playback experiments to study risk factors for vessel collision in right whales. North Atlantic Right Whale Consortium, New Bedford, MA.

Nowacek, D.P., Johnson, M.P., Tyack, P.L., Buckstaff, K.C. Nowacek, S.M., & R.S. Wells. 2002. Use of a multi-sensor tag to record the behavioral responses and acoustic environment of marine mammals exposed to vessels. Proceedings of the Florida Marine Mammal Health Conference, Gainesville, FL.

Nowacek, D.P., Tyack, P.L., & M.P. Johnson. 2001. Use of a multi-sensor acoustic tag to assess risk factors associated with collisions between ships and right whales. Southeast and Mid-Atlantic Marine Mammal Symposium, Duke Marine Lab, Beaufort, NC.

Nowacek, D.P., Tyack, P.L., & M.P. Johnson. 2001. Use of a multi-sensor acoustic tag to assess risk factors associated with collisions between ships and right whales. 15th Annual Conference of the European Cetacean Society, Rome, Italy.

Nowacek, D.P.2000. The acoustic ecology of bottlenose dolphins. College of Marine Science, University of South Florida, St. Petersburg, FL.

Nowacek, D.P., Johnson, M.P., Shorter, K.A. & P.L. Tyack. 1999. Right whale diving behavior, playbacks, & vessel approaches: early insights into ship strikes. North Atlantic Right Whale Consortium, Boston, MA.

Nowacek, D.P., Wells, R.S., & P.L. Tyack. 1999. Sequential foraging behavior and ecology of bottlenose dolphins, *Tursiops truncatus*. 13th Biennial Conference on the Biology of Marine Mammals, Wailea, Maui, HI.

Co-Authored Presentations:

Blawas, A.***, Coonley, K.*, Dalla Rosa, B.***, Evezich, K.***, Hermiller, B.***, Naclerio, N.***, Sequeira, D.**, Toone, T.***, Wang, J.***, Brooke, M., Mann, B. and **D.P. Nowacek**. 2017. Designing an Energy Harvesting Buoy. NC State Energy Conference, Raleigh, NC.

Tyson, R.B., Piniak, W.E.D., Domit, C., Mann, D., Hall, M., **Nowacek, D.P.,** and Fuentes, M.M. P. B. 2017. Applications for studying fine-scale behaviors of marine turtles in response to sound. Annual Symposium on Sea Turtle Biology and Conservation, Las Vegas, NV, April 14-20.

Quick, N.J., **Nowacek, D.P.** and Read, A.J. 2015. Hidden Markov Models reveal complexity in the diving behaviour of short-finned pilot whales. 21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA.

Bowers**, M.T., DeRuiter, S., Friedlaender, A.S., **Nowacek, D.P.,** Quick, N.J., Southall, B.L. 2015. Short-finned pilot whales and Risso's dolphins respond strongly and divergently to biphonic

calls of mammal-eating killer whales. 21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA.

Pallin**, L., Johnston, D.W., **Nowacek, D.P.**, Read, A.J., Robbins, J., and Friedlaender, A.S. 2015. Pregnancy rates of humpback whales along the western Antarctic Peninsula. 21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA.

Friedlaender, A.S., Heaslip, S., Johnston, D.W., Read, A.J., **Nowacek, D.P.**, Durban, J., Pallin, L., Goldbogen, J., and Gales, N., 2015. Using state-space models to compare the foraging ecology of humpback and minke whales around the Antarctic Peninsula. 21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA.

Stanistreet**, J., **Nowacek, D.P**., Hench, J., Hodge, L., Van Parijs, S., Bell, J., and Read, A.J., 2015. Do foraging beaked whales and sperm whales target the Gulf Stream frontal edge off Cape Hatteras? Using long-term passive acoustic monitoring to explore habitat associations. 21st Biennial Conference on the Biology of Marine Mammals, San Francisco, CA.

Bowers**, M.T., **Nowacek, D.P**., Howle, L.E., Murray, M.M., Rittschof, D., Shorter, K.A., and Moore, M. Sticking it to the Whales: Adhesive Attachment of Biologging Devices to Cetaceans. 2013. 20th Biennial Conference on the Biology of Marine Mammals, Dunedin, New Zealand.

Read, A.J., Bowers,** M.T., Janik, V., Quick, N.J., and **Nowacek, D.P**. 2013. Behavioral response of short-finned pilot whales to the calls of predators. 20th Biennial Conference on the Biology of Marine Mammals, Dunedin, New Zealand.

Tyson**, R. B., Friedlaender, A. S., Ware, C., Stimpert, A. K., Hazen, E., Warren, J. D., Curtice, C., and **Nowacek, D. P.** (July 2013). Do humpback whales in Antarctica feed according to optimal foraging theory? 50th Annual Meeting of the Animal Behavior Society, Boulder, Colorado.

Tyson**, R. B., Friedlaender, A. S., Stimpert, A. K., Ware, C., and **Nowacek, D. P**. June 2012. Humpback whale (*Megaptera novaeangliae*) mother and calf foraging behaviors: in synch? 49th Annual Meeting of the Animal Behavior Society, Albuquerque, New Mexico.

Tyson**, R. B., Friedlaender, A. S., Ware, C., and **Nowacek, D. P.** November 2011. In Synch? Humpback whale (*Megaptera novaeangliae*) mother and calf foraging behavior in the Western Antarctic Peninsula. 19th Biennial Conference on the Biology of Marine Mammals, Tampa, Florida.

Friedlaender, A. S., Hazen, E. L., Ware, C., Haplin, P. N., Stimpert, A. K., Tyson**, R. B., **Nowacek, D. P.** 2011. Decisions, decisions. Direct measurements of humpback whale feeding in relation to vertically-stratified prey abundance. 19th Biennial Conference on the Biology of Marine Mammals, Tampa, Florida.

Tyson**, R. B., Friedlaender, A. S., Ware, C., and **Nowacek, D. P.** March 2011. Humpback whale (*Megaptera novaeangliae*) mother and calf foraging behavior: insights from multi-sensor suction cup tags. The Fourth Science Symposium on Bio-logging. Hobart, Tasmania, Australia.

Friedlaender, A. S., Ware, C., Tyson*, R. B., and **Nowacek, D. P.** March 2011. Using multi-sensor suction cup tags to quantify the kinematics of lunge feeding in humpback whales (*Megaptera novaeangliae*) in the water around the West Antarctic Peninsula. The Fourth Science Symposium on Bio-logging. Hobart, Tasmania, Australia.

Tyson**, R.B., **Nowacek, D. P**., Arsenault, R. J., Espinasse, B., Halpin, P., Johnston, D. W., Friedlaender, A. S., Hazen, E. L., Peavey, L., Read, A. J., Revelli, E., Stimpert, A. K., Ware, C., Zhu, Y., Zhou, M. June 2010.. Foraging ecology of humpback whales (*Eubalaena glacialis*) in the Western Antarctic Peninsula. The 22nd International Coastal Society Conference, Wilmington, North Carolina.

McGregor**, A.E., Fish, F.E., **Nowacek, D.P.** Finding the window of energetic opportunity: traveling North Atlantic right whales use dive depths that avoid surface drag. Annual Meeting of the Society-for-Integrative-and-Comparative-Biology, JAN 03-07, 2010

Dobbins, P. & **D.P. Nowacek**. 2007. Azimuth localization in Pod-Track - a passive acoustic monitoring system for wild dolphins. IEEE Oceans07, Aberdeen, Scotland.

Tyson***, R.B., **Nowacek, D.P**., & P.J.O. Miller. 2006. Nonlinear dynamics in killer whale (*Orcinus orca*) vocalizations. National Conference for Undergraduate Research, Ashville, NC.

Parks, S., Searby, A., Celerier, A., **Nowacek, D.P.**, Johnson, M.P., & P.L. Tyack. 2006. Calling behavior of right whales in the Bay of Fundy: DTAG data from 1999-2005. North Atlantic Right Whale Consortium, New Bedford, MA.

Tyson***, R.B., & **D.P. Nowacek**. 2005. Nonlinear dynamics in North Atlantic right whale vocalizations. 16th Biennial Conference on the Biology of Marine Mammals, San Diego, CA.

Chapla**, M.E., **Nowacek D.P.,** Rommel, S.A., Sadler, V.M., & L.M. Witmer. 2005. Three-dimensional reconstructions of a Florida manatee (*Trichechus manatus latirostris*) head and isolated ear bone: the search for sound pathways. 16th Biennial Conference on the Biology of Marine Mammals, San Diego, CA.

Rycyk**, A.M., & **D.P. Nowacek**. 2005. Acoustic behavior of bottlenose dolphins (*Tursiops truncatus*) in the Big Bend region of Florida. 16th Biennial Conference on the Biology of Marine Mammals, San Diego, CA.

Mann, D.A., Locasio, J., **Nowacek, D.P**., & W.N. Tavolga. 2003. Spatial and temporal patterns of fish sound production in Charlotte Harbor. Charlotte Harbor Conference, Sarasota, FL.

Johnson, M.P., Tyack, P.L., Miller, P.J.O. & **D.P. Nowacek**. 2003. DTAG: A synchronous sound and orientation recording tag for wild marine mammals. Environmental Consequences of Underwater Sound, San Antonio, TX.

Gannon, D.P., Barros, N., **Nowacek, D.P.,** Read, A.J., Waples, D. & R.S. Wells. 2003. Prey detection by coastal bottlenose dolphins: testing the passive listening hypothesis. 15th Biennial Conference on the Biology of Marine Mammals, Greensboro, NC.

Nowacek, S.M., Wells, R.S., **Nowacek, D.P.,** & K.C. Buckstaff. 2002. Behavioral responses of dolphins and manatees to vessel approaches. Proceedings of the Florida Marine Mammal Health Conference, Gainesville, FL.

Mann, D.A., **Nowacek, D.P**., & W.N. Tavolga. 2002. Charlotte Harbor Acoustic Survey. Charlotte Harbor Conference, Sarasota, FL.

Nowacek, S.M., Wells, R.S., **Nowacek, D.P.,** Owen, E.C.G., Speakman, T.R. & R. Flamm. 2001. Manatee behavioral responses to vessel approaches. 14th Biennial Conference on the Biology of Marine Mammals, Vancouver, BC.

Parks, S.E., Tyack, P.L., Johnson, M.P., **Nowacek, D.P**., and N. Biassoni. 2001. Use of a digital acoustic tag to document response of North Atlantic right whales to surface active groups. 15th Annual Conference of the European Cetacean Society, Rome.

Johnson, M.P., Tyack, P.L. & **D.P. Nowacek**. 1999. A digital acoustic recording tag for measuring the response of marine mammals to sound. International Council for the Exploration of the Seas (ICES) Annual Science Conference, Stockholm

Nowacek, S.M., Wells, R.S., & **D.P. Nowacek**. 1999. The effects of boat traffic on bottlenose dolphins, *Tursiops truncatus*, in Sarasota Bay, FL. 13th Biennial Conference on the Biology of Marine Mammals, Wailea, Maui, HI.

Parks**, S.E., Tyack, P.L., **Nowacek, D.P**., & M.P. Johnson. 1999. Use of an archival recording tag to measure acoustic activity and behavior in North Atlantic right whales (*Eubalaena glacialis*). 13th Biennial Conference on the Biology of Marine Mammals, Wailea, Maui, HI.

Exhibit B
Works Cited

Blackwell, S.B., C.S. Nations, T.L. McDonald, C.R. Greene, Jr., A.M. Thode, M. Guerra, and A.M. Macrander. 2013. Effects of airgun sounds on bowhead whale calling rates in the Alaskan Beaufort Sea. *Marine Mammal Science* 29(4): E342-E365.

Blackwell, S.B., C.S. Nations, T.L. McDonald, A.M. Thode, D. Mathias, K.H. Kim, C.R. Greene, Jr., and A.M. Macrander. 2015. Effects of airgun sounds on bowhead whale calling rates: Evidence for two behavioral thresholds. *PLoS ONE* 10(6): e0125720.

Blas, J., G.R. Bortolotti, J.L. Tella, R. Baos, and T.A. Marchant. 2007. Stress response during development predicts fitness in a wild, long lived vertebrate. *Proceedings of the National Academy of Sciences* 104: 8880-8884.

Bottjer, S.W., and F. Johnson. 1997. Circuits, hormones, and learning: Vocal behavior in songbirds. *Journal of Neurobiology* 33: 602-618.

Caldwell, J., and W. Dragoset. 2000. A brief overview of seismic air-gun arrays. *The Leading Edge* 19: 898-902.

Cartwright, R., and M. Sullivan. 2009. Behavioral ontogeny in humpback whale (*Megaptera novaeangliae*) calves during their residence in Hawaiian waters. *Marine Mammal Science* 25: 659−680.

Castellote, M., C.W. Clark, and M.O. Lammers. 2012. Acoustic and behavioural changes by fin whales (*Balaenoptera physalus*) in response to shipping and airgun noise. *Biological Conservation* 147: 115-22.

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IN THE HIGH **COURT** OF **SOUTH AFRICA**
(EASTERN CAPE DIVISION, GRAHAMSTOWN)

Case No: 3941/2021

In the matter between:

SUSTAINING THE **WILD COAST NPC**	First Applicant
MASHONA WETU DLAMINI	Second Applicant
DWESA-CWEBE COMMUNAL PROPERTY ASSOCIATION	Third Applicant
NTSINDISO NONGCAVU	Fourth Applicant
SAZISE MAXWELL PEKAYO	Fifth Applicant
CAMERON THORPE	Sixth Applicant
ALL RISE **ATTORNEYS FOR CLIMATE AND** THE **ENVIRONMENT NPC**	Seventh Applicant

and

MINISTER OF MINERAL RESOURCES AND ENERGY	First Respondent
MINISTER OF ENVIRONMENT, FORESTRY AND FISHERIES	Second Respondent
SHELL EXPLORATION AND PRODUCTION SOUTH AFRICA B V	Third Respondent
IMPACT AFRICA LIMITED	Fourth Respondent
BG INTERNATIONAL LIMITED	Fifth Respondent

EXPERT AFFIDAVIT

I, the undersigned

JEAN MARY HARRIS

I .....,

do hereby make oath and say as follows:

1. I am an adult female marine scientist, and am currently the Executive Director of WILDOCEANS, the marine priogramme of the Wildlands Conservation Trust (WILDTRUST), an NGO focused on biodiversity protection and building socio-ecological resilience in Southern Africa and the western Indian Ocean.

2. The facts contained in this affidavit are within my personal knowledge, except where the context indicates otherwise, and are to the best of my belief both true and correct.

3. Together with Dr Jennifer Olbers and Dr Kendyl Wright, I have prepared the report annexed hereto marked **"JH1** ".

4. My qualifications and experience are set out in a copy of my curriculum vitae, attached to this affidavit marked **"JH2".** I respectfully submit that I am qualified by my qualifications, training and experience to express the expert opinions which are set out in the report referred to above.

5. I further confirm that the report is to the best of my knowledge and belief true and correct.

JEAN MARY HARRIS

I hereby certify that the deponent has acknowledged that she:

(a) knows and understands the contents of this affidavit;
(b) has no objection to taking the oath;
(c) considers the oath to be binding on her conscience.

Thus signed and sworn to before me, jy4'1t),,,–J c?//n 07 December 2021.

COMMISSIONER OF OATHS

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"JH1"

REPORT ON SCIENTIFIC BASIS FOR CONCERNS OF SIGNIFICANT HARM INFLICTED TO MARINE WILDLIFE BY THE SHELL SEISMIC SURVEYS ON THE WILD COAST OF SOUTH AFRICA

Harris JM, Olbers J, Wright K

6 December 2021

This report provides a summary of key findings in peer-reviewed literature on the physiological and ecological impacts of seismic survey activities on marine wildlife, with specific attention to the relevance of the information to the context of the Shell survey area, as well as with regards vulnerable and endangered species known to occur in the survey area at this time of year. Having carefully considered the available information in this regard it is our opinion that seismic surveys do cause harm to both species and the ecology, and that significant direct harm to individual animals and harm to populations of endangered species is the most likely scenario in the case of the seismic survey underway off the east coast of South Africa. Of specific concern is the impact on threatened humpback whales (at a particularly vulnerable stage for mothers and calves) in December, the impact (likely mortalities) on critically endangered (leatherback) and endangered (loggerhead) turtles (according to South African TOPS legislation) in February and March which are peak times when hatchlings are carried through the area from the iSimangaliso MPA nesting grounds. We conclude that these seismic surveys are inadvisable in December-March due to the presence of these species in the area over this time and inability of the prescribed mitigation measures preventing harm to individuals/populations. Furthermore, recent literature provides credible concern about ecosystem/food-chain impacts of seismic surveys, that may in turn have impact on fisheries the severity and localisation of which will depend on coincidences with spawning and juvenile recruitment events, and it is strongly recommended that further study on these impacts in the South African context are carried out in situ before proceeding with further seismic surveys of this nature.

Summary of Findings

- Based on peer-reviewed scientific literature, it is clear that physical damage to marine animals, including soft tissue trauma damage, embolisms, damage to organs used in balance and orientation, concussions, haemorrhaging, decompression sickness and both temporary and permanent threshold shifts to hearing ability have been directly linked to the kind and level of sound emitted during this nature of seismic surveys.
- There is plausible evidence to suggest that seismic survey activity is likely to affect the conservation status and recovery of populations of vulnerable and threatened species including (IUCN Red list species such as humpback whales), because sound and the ability to hear and interpret sound is critical for many species to reproduce (both vocalisations on breeding grounds and communications across large distances for mate detection). Therefore, it must be assumed that interference in sound perception or utilisation for communication (temporarily or permanently) had the potential to impact a species at the population level.
- Some species have been shown and documented to display physiological stress responses and behavioural changes to seismic activities, such as moving away rapidly, diving or remaining still. These responses are likely to increase their energy consumption and energy costs, reduce their time to forage, and/or affect their vulnerability to predation, thus having negative impacts on the survival of individuals {especially young or compromised animals) as well as the overall population growth and survival of a species (especially for threatened species that are already at risk of extinction).
- The impacts of seismic activities are most well studied for marine mammals, and evidence suggests that there are distinct avoidance responses such as leaving the area or ceasing to undertake everyday activities such as feeding in preferred areas. This is likely to negatively impact the "fitness" of an affected animal.

- The only existing field study in South Africa (that we have been able to find) on the impacts of seismic activities in our waters is illuminating in this regard. It presents clear evidence that the endangered, endemic African penguin avoided preferred feeding sites when a seismic survey was active nearby. This is particularly of concern for a species that is already stressed by prey depletion and the greater demand for them to forage further afield, and for which the prospect of extinction is significant.
- The phenomenon of energy-cost (from stress and avoidance behaviour) is of particular concern for some of the species expected to be encountered in the survey area in question, particularly the humpback whales (still at risk in December) together with their calves who are at risk of the airgun noise affecting their behaviour or interfering with the communication between mother and calf. Any impact on their energy reserves could impact on their condition (weight-loss and physiological condition) and affect survival of the animals during a vulnerable time (especially for lactating mothers and their calves) on their long migration to feeding grounds in Antarctica.
- In terms of physical harm (impact and damage due to collisions with the airgun array equipment towed in the water and the proximity of sound waves from the seismic survey), turtle hatchlings which are carried in the Agulhas current through the survey area from the nesting beaches of the iSimangaliso MPA, do not have the ability to avoid the arrays. Our opinion is that these animals will certainly pass through the area, not be detected by Observers and suffer extreme disturbance. The seismic survey should thus certainly not continue during February and March.
- Furthermore, the National Environmental Management: Biodiversity Act (10/2004): Threatened or Protected Marine Species Regulations (GNR.477 of 30 May 2017) may be interpreted to mean that seismic surveys constitute 'harassment' of listed species (leatherback and loggerhead turtles, which are recognised as Critically Endangered and Endangered species, as well as listed cetaceans), which is a prohibited activity, save for specified purposes which are not applicable to commercial seismic survey activities.
- Recent research (2017) has shown significant mortality in zooplankton up to 1.2 km from a seismic survey array. Zooplankton forms the base of many important food webs in the marine

environment. Depletion of zooplankton could thus have an impact on food for their predators {such as fish) as well as impact fish eggs and larvae (Ichthyoplankton) with potential local impacts on species important in fisheries. This damage to zooplankton over 1km away from the survey array raises concern that a 500m buffer for other animals that are unable to move away from the sound, particularly small ones like turtle hatchlings, is far too small to ensure that damage is not inflicted (even if they were able to evade it).

- While "Soft starts" mitigation for seismic impacts are likely to reduce the impact for highly mobile large animals, this is unlikely to be adequate for the many species that are prevalent in the area over the 5 month planned survey period that are unable to avoid the array or leave the area due to their lower mobility, such as turtle hatchlings, invertebrates, some fish species and zooplankton. Many of these species are carried relatively passively in the Agulhas current and will be swept through the area helplessly.
- The finding about observer efficiency {from a scientific monitoring study conducted during the 2018/19 and 2019/2020 seasons on the "C 1 population" humpback whales that traverse the survey grounds during their annual migration), suggests that even with trained observers up to 44% of humpback whales in an area went undetected. This casts doubt on the effectiveness and success of Marine Mammal Observer (MMO) sightings of the largest species (humpbacks) as a mitigation measure, indicating that it is most likely that whales go undetected. Furthermore, the detection rate for smaller species, such as dolphins, turtles etc. must be expected be much lower, obviating the effectiveness of visual observations to prevent harm to these species.
- It is also of concern that the efficacy of Marine Mammal Observers (MMO) is likely to be low due to the nature of the offshore marine environment in the survey area (frequent high swells and winds affecting surface visibility), putting species who are missed by MMO's and PAM operators at extreme risk, particularly at night or during adverse weather conditions.
- Furthermore, the reliance on Observers to do visual sightings to supplement the PAM monitoring during the day, as a mandated mitigation measure, necessitates that we question the acceptability of continuing with survey activities at night. If the visual observations are useful (perhaps sighting

large animals around 65% of the time) in addition to PAM, then why is it deemed acceptable to rely on PAM alone at night? It is our opinion that surveys should not occur between sunset and sunrise each day if a real attempt of maximum avoidance of humpback whales and other cetaceans is the objective of this mitigation measure.

Seismic Surveys - Impacts on Marine Animals

Despite seismic surveys having been undertaken for decades in South African waters, together with the knowledge that some impact to marine fauna does indeed occur[1], there remains very little scientific research on the effects of seismic surveys, and in addition there are no legislated guidelines for seismic surveys in South African waters (Purdon 2018). Globally, seismic surveys' environmental impacts and consequences are slightly better documented, although not uniform in results or widely accepted within all sectors. The primary mitigation measures for seismic surveys in South Africa include soft-starts, which is a gradual and systematic increase in power of the airgun array undertaken to warn and drive mobile marine species, such as cetaceans (whales, dolphins and porpoises) and turtles away from the sound source before the full-power airgun blasts begin, thus attempting to minimise the negative effects of the airgun blasting activity. Various studies contest this assumption (McCauley et al. 2000; Weilgart 2013; Dunlop et al 2016) and have revealed a growing concern for animals that are unable to avoid or out-swim the airgun arrays.

Animals use sound critical to their life cycles (Jasny et al 2005) in three ways, by actively producing sound (Tyack 1981), by listening to sounds emitted by other living organisms (Clark et al 2009; Van Opzeeland 2010), and taking cues from physical or non-living factors producing sounds, contributing to the ambient background noise, such as wind, waves, swell, bubbles, currents, turbulence, earthquakes, rainfall, ice cracking or breaking (Hildebrand 2005). Many marine animals produce sound for communication, reproduction, aggression, defence mechanisms, antagonistic interactions,

[1] https://jncc.gov.uk/our-work/marine-mammals-and-noise-mitigation: "to reduce the risk of deliberate injury to marine mammals".

courtship, group coordination, orientation, navigation, and prey identification (Hildebrand 2005). They rely on producing a sound that is heard while hearing a sound and interpreting the sound for their survival.

Various physical responses to acoustic disturbance have been documented, with physical responses including soft tissue damage (Balcom and Claridge 2001), embolisms (Dolman and Simmonds 2005), damage to organs used in balance (Andre et al 2011), concussions in penguins (Cooper 1982), haemorrhaging (Evans et al 2001) and decompression sickness (Fernandez et al 2005). Hearing impairment in the form of Temporary Threshold Shift (TTS) or Permanent Threshold Shift (PTS) has also been reported (Hildebrand 2005). Threshold shift refers to an increase in the minimum sound level required for an animal to hear a sound. A TTS is followed by successful recovery to normal hearing thresholds after a given period of time in the absence of that sound, while PTS is when the sensory hair cells in the inner ear are permanently damaged and lost making recovery impossible (Weilgart 2013).

Stress caused by disturbance is associated with a change in body chemistry (Jasny et al 2005) and can be equally disruptive as physical damage. Stress has implications on sexual maturation, inhibits growth, reproduction and general survival ability (Pickering 1992; McCormick 1999; Consten et al 2001). Perceptual effects can occur when there is an interference of sounds of interest to a specific animal but are being drowned out or masked by anthropogenic noise. The impact of this in the long term could have implications on breeding populations, thus on reproduction within a population (Erbe 2001). Many animals may have the ability to counteract this and make minor changes to their vocalisations and behaviour; however, these modifications may come at a cost in terms of energy expenditure (Tyack 2008) and are likely to reduce breeding productivity of the population. This is of particular concern for species that are threatened.

Behavioural responses to noise are dependent on various factors, such as age, sex, presence of offspring, location and an individual animals' previous encounter with a specific sound or noise.

Behavioural responses may include modification of vocal behaviour, displacement from important habitats, and other subtle responses, including increased breathing rates, change in dive duration, time spent at the surface, rapid or erratic movements (Bowles et al 1994; Lesage et al 1999; Williams et al 2002; Hastie et al 2003; Ng and Leung 2003; Aguilar de Soto et al 2006). These all with potentially high energetic costs (Williams et al 2006; Koper and Pion 2012).

Most scientific research on the impacts of seismic surveys has been conducted on cetaceans, and as a result, most mitigation measures are to protect these animals. In South Africa, this is no different. However, it is becoming more and more evident that mitigation measures are not adequate (Weilgart 2013). In the Gulf of Mexico, it was recorded that ~250 male fin whales appeared to stop singing for several weeks to months during a seismic survey. These animals resumed singing within hours or days after the survey ended (IWC 2007). The assumption is that male fin whales use vocalisations for reproduction by finding and attracting mates (Croll et al 2002); it can only be assumed that such an effect would be biologically significant (Weilgart 2013). In addition to this, a blue whale ceased calling in the presence of a seismic survey at 10 km away (Macdonald et al 1995). Conversely, a different group of blue whales appeared to have the opposite reaction. They changed their vocalisations (De Lorio et al 2010) by calling consistently more on days when the seismic surveys were actively ongoing, suggesting that seismic survey noise interfered with important signals used in their social interactions and feeding (De Lorio et al 2010).

Other reactions to seismic airguns can be subtle or hard to detect (Weilgart 2013) and it has been found that Sperm whales in the Gulf of Mexico did not appear to avoid a seismic airgun survey area but reduced their swimming effort and their tendency to reduce foraging effort (Miller et al 2009). It has also been documented that as a result of changes in behaviour, the result could be lower reproductive rates and have negative consequences for the population (Miller et al 2009). In comparison, bowhead whales showed no avoidance or change in vocalisations in the area of seismic surveys; however, their dive duration was shorter (Richardson et al 1986). In Brazil, a reduction in cetacean species diversity during 2000 and 2001 was noted with the increased occurrence of seismic

surveys in the area being implicated in the possible cause of these animals vacating the area (Parente et al 2007). In other areas, marine mammals have been recorded to avoid seismic noise by leaving an area (Castellote et al 2012; Weir 2008; Stone and Tasker 2006). The long term impacts of these changes in behaviour are unknown but potentially impact their ability to feed and/or reproduce as in some species, these life-history stages are site or habitat-specific.

McEwen and Wingfield (2003) suggested that all organisms must gather energy for growth and reproduction throughout their life cycle and that organisms must retain reserves for predictable changes such as seasons. and challenges that are less predictable such as disturbance, predation pressure, or social conflict. Often colloquially, this is referred to as the "fitness" of the animal. The accumulated cost in the balance between energy intake and demand is called the 'allostatic load', of physiological and behavioural mechanisms that enable allostasis or adaptation to these changes. McEwen and Wingfield (2003) use the word "allostasis" to signify mechanisms that allow an organism to regain equilibrium while dealing with external challenges; if energy demand is more than intake, then animals may activate a survival mode that may increase energy available, reduce energy demand, or both, to regain its energy balance. Implications on individuals and populations of this energy imbalance are unknown.

Several studies have reported negative impacts of acoustic signals from airguns on zooplankton (small, aquatic microorganisms living in the water column, including crustaceans, larvae, juvenile fish, juvenile invertebrates, eggs etc.) from more than 10m away (Kostyuchenko 1972; Kosheleva 1992; Parry *et al.* 2002) with some laboratory experiments on lobster larvae showing no impact at all (Day *et al.* 2016). However, Christian *et al.* (2003), showed retardation in some individuals in the development of snow crab eggs after being exposed to certain sound levels.

The effects of seismic noise on zooplankton were brought under the spotlight when McCauley *et al.* (2017) presented evidence from an *in situ* study which suggested that seismic surveys cause significant mortality to zooplankton populations. Zooplankton, unlike vertebrates, do not have hearing

structures (although they can sense pressure change) and their bodies are generally the same density as the surrounding water, so sudden pressure changes associated with seismic activities were presumed not to cause physical damage (Parry and Gason 2006). McCauley *et al.* (2017) disputed this and has shown zooplankton mortality at distances of up to 1.2km from the sound source.

Furthermore, the indirect effects of seismic activity on cetaceans is a concern. It is well known that the productivity and health of the oceans are under-pinned by marine plankton (Raymont 1983; Alcaraz & Calbet 2009). While forming the basis of the food webs, plankton has been implicated in links to climate change via their role in iron fertilisation and carbon sequestration through whales foraging on krill and subsequent defecation (Smetacek and Nicol 2005; Smetacek 2008; Nicol et al. 2010). In 2010, Pershing et al. suggested that over-fishing of large fish and commercial whaling had compromised the ocean's ability to store and sequester carbon, thus contributing to climate change. They indicated that populations of large baleen whales now store 9.1x106 tonnes less carbon than before commercial whaling and that protecting whales (and other large over-exploited species), would be a form of a carbon management scheme. The cascading and knock-on effects of seismic survey impacts between the upper (cetaceans) and lower reaches (plankton) of the food web, as each are being impacted are unknown. McCauley et al. (2017) noted that the ramifications of compromised larval recruitment could be massive for higher predators and for ocean health as a whole. While humpback whales do not feed in waters along the east coast of South Africa, other cetaceans such as killer whales, sperm whales and dolphins may be at risk.

South African Context

In South Africa, only a single focused study on the impact of seismic surveys has been undertaken. This study, off Gqeberha, was within the foraging area of the endangered, endemic African Penguin (*Spheniscus demersus).* Pichegru et al (2017) demonstrated that penguins avoided their preferred foraging areas during seismic surveys and foraged further from the survey vessel when in operation. Upon termination of seismic surveys, the penguins reverted to their normal behaviour (Pichegru et al (2017), a behaviour which was also observed in Gray whales *(Eschrichtius robustus)* off Sakhalin

Island in Russia (International Whaling Commission 2005). However, the long term effects on populations of this temporary retreat of the area are unknown. Furthermore, the cumulative effect of multiple, concurrent seismic surveys within the region may cause cumulative impacts.

Significant impacts on turtle species are a concern. Adult turtles may be less vulnerable to sound damage than cetaceans as the air spaces in their cochlear are smaller than those in cetaceans, making them less sensitive to sound shockwaves (Popper et al. 2014). However, while studies have shown that adult sea turtles have a moderate ability to move from an area being surveyed (Lenhardt 1994; O'Hara and Wilcox 1990), they are prone to TTS after exposure to sound within 1 km of a sound source, with signs of recovery only two weeks after injury (Lenhardt 1994). In a study undertaken on captive turtles, it was found that loggerhead turtles *(Caretta caretta)* responded to sound by swimming to the surface and remaining there or staying slightly submerged (Lenhardt 1994), as this area, regarded as a sound shadow, and is hypothesised as being where sound waves cancel each other out and the noise is at a minimum. Cummings et al (2004) disputed this saying that although near the surface, could be a place where animals take refuge, they are not in a 'zone of silence'. With an increasing exposure of sound levels, the behaviour of caged green *(Chelonia mydas)* and loggerhead (C. *Caretta)* turtles increased their swimming speed, potentially showing agitation to sound (McCauley et al 2000). Turtle behaviour is difficult to interpret (DeRuiter and Doukara 2012), given that some studies have reported that turtles do not display any signs of distress (Pendoley 1997). Globally the Leatherback turtle *(Dermoche/ys coriacea)* is vulnerable, but critically endangered in the Southwestern Indian Ocean where this subpopulation is declining (Nel 2010, 2012; Nel et al. 2013). Loggerhead *(Caretta caretta)* populations are globally vulnerable but near threatened in the southwest Indian Ocean (Lombard & Kyle 2014).

The nesting grounds of the southern African loggerhead *(Caretta caretta)* and leatherback turtle *(Derrnoche/ys* coriacea) populations are located in iSimangaliso Wetland Park, on the northern KZN coast. In the Autumn months, adult turtles are moving towards their nesting beaches but stay inshore as to avoid the north to south flowing Agulhas current. Once they have completed their laying of eggs,

they leave the shore and into the current to be carried south once again, and by late March, they will be littered along the east coast in offshore waters. However, they have a moderate ability to avoid areas with an increase of noise in the water. Mitigation measures for turtles in seismic surveys include observers, although it is unclear how an observer would be able to observe these animals at such a distance (especially as large animals such as whales are only observed 44% of the time at best). A second mitigation measure is to install turtle devices to prevent them from becoming entangled in the gear. These devices are accepted as being useful for adult turtles; however, they would not prevent hatchlings from coming into contact with the seismic gear deployed, and this is of great concern.

Each year thousands of turtle hatchlings enter the sea from their nesting grounds, with their destination being determined by the Agulhas current along the entire east and south coast. The peak hatchling period for loggerhead hatchlings is in February, with their greatest density being slightly more inshore than leatherback hatchlings, which are more offshore within the survey area, with a peak hatchling period in March. These hatchlings live out their early years on and close to the surface, only being able to dive to depths of 2-3m. Turtle hatchlings cannot swim effectively or fast enough away if in close proximity to the sound source. Furthermore, hatchlings cannot be detected by Observers.

The seismic survey thus represents a significant risk to hatchlings of these two endangered turtle species which will be carried through the survey area during January-April, with peaks in February (loggerheads) and March (leatherbacks). There is no effective mitigation measure for these as they will not be visible to MMO's, and will not be able to evade the area.

Furthermore, the National Environmental Management: Biodiversity Act (10/2004): Threatened or Protected Marine Species Regulations (GNR.477 of 30 May 2017) defines "harassing" as "behaviour or conduct that threatens, disturbs or torments a live specimen of a listed threatened or protected marine species", which may be interpreted to mean that seismic surveys constitute 'harassment', which is a prohibited activity (save for specified purposes which are not applicable to commercial

seismic survey activities) for TOPS listed species, including leatherback and loggerhead turtles, and listed cetaceans (including hump-back whales).

Effectiveness of Mitigation [Marine Mammal Observers (MMO) and Passive Acoustic Monitoring (PAM)]

During the 2018 and 2019 humpback whale *(Megaptera novaeangliae)* migration period, Wilkinson (2021) estimated the relative abundance of migrating humpback whales sighted by trainer observers from two towers located 22m apart (both observers viewing the same area), located at 70m above sea level on a dune with a horizontal vantage length of approximately 20 km. Over the observation periods during the peak of migration, it was estimated that observers from both towers missed between 41-44% of whale groups while distance offshore decreased the probability of sightings. Assuming that the best percentage sighting (56%) was achieved within 1-Skm of the observers' vantage point, then more than 40% of whales were missed. Given that this survey was done during the northward migration when mostly larger animals are present, the sighting success may be less when small calves are present as well (as would be the case in December). This begs the question of the efficacy and reliability of the mitigation method of Marine Mammal Observers (MMO), while assuming that whales (and other cetaceans) are thus regularly missed by MMOs and could be harmed.

Despite various organisations who provide MMO's on vessels having a zero tolerance policy of intimidation it is not uncommon for an MMO to complain that he/she has been subjected to coercion, harassment and intimidation. The EMPr states that: *"The MMO has the authority to stop the survey activities (including seismic shooting) in response to certain circumstances related to marine mammal risk. However, due to the cost associated with terminating activities (e.g. an entire survey line may need to be repeated), it is recommended that the decision to terminate firing be made by the operator in consideration of the MMO's advice. The MMOs must provide full reporting of all*

termination decisions (including behaviour and distance of marine mammals) in a daily close out report (Part B, p.8)". This statement is highly problematic and reinforces the concern that "A risk-averse and cautious approach, which takes into account the limits of current knowledge about the consequences of decisions and actions", a principle of the National Environmental Management Act, 107 of 1998, will not be applied in full.

Furthermore, bearing in mind the examples above, i.e. blue and fin whales ceasing to sing, the use of Passive Acoustic Monitoring {PAM) technology to detect cetaceans is baseless if cetaceans do not vocalise. As per best practice, in an effort to improve mitigation, PAM technology is complemented by visual searching over an area of 500m around the vessel by qualified Marine Mammal Observers (MMO). This technique is, however, also fatally flawed because it cannot be used at night, during rain and in sea states more than three on the Beaufort Sea State Scale. Therefore, both PAM and MMO's are insufficient to detect, with certainty, cetaceans within the surrounding survey area and these types of mitigation will only be effective for all affected species if airgun firing ceases between sunset and sunrise, and adverse weather conditions that limit visibility.

The cumulative and long-term effects of seismic survey sound is not entirely understood (Jasny et al 2005); however, it is accepted that ocean noise may have ecosystem-scale effects (Hildebrand, 2005) and the "knock-on" effects on animals, their prey and their predators will have consequences within the food chain (Koper and Pion 2012). It has been suggested that research and a critical review on mitigation measures (McCauley et al. {2017) as well as a better understanding of ecosystem-scale effects of sound (Koper and Pion 2012), especially at the lower trophic levels are imperative. Considering the ecosystem services provided by the fast-flowing Agulhas current and its associated diversity and biomass, mitigation and understanding should be a conservation imperative in South African marine waters. Up to now, there has been no effort in increasing the knowledge of the impact of these seismic surveys by industry or South African environmental departments despite them being known to have impacts on marine animals and having been undertaken in South African waters for a number of decades.

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Executive Trustee: Wildlands Conservation Trust, 2015- April 2017
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Ecological Advice Co-ordinator, Coast Region, Ezemvelo KZN Wildlife, 2002- September 2006
Regional Ecologist Marine/Scientist, Scientific Services, KZN Nature Conservation Service, 1995 - 2002
Senior Scientific Officer, Terrestrial Antarctic Biology Research Programme, Ornithology, UCT, 1991-1994

SELECTION OF RESEARCH AND MANAGEMENT EXPERIENCE

Project Leader Blue Action Fund "Oceans Alive" iSimangaliso MPA Project (2019-current): This project has 3 main objectives 1) Build knowledge of the biodiversity and socio-economics of the MPA and its communities, 2) Support effective management of the iSimangaliso MPA, and 3) Ensure benefits and improved livelihoods for rural com01unities living alongside the iSimangaliso MPA.

Directs the following WILDOCEANS projects for the Wildlands Conservation Trust (2017-current): Ocean Stewards, WhaleTime, MPA Expansion Project, Shark and Ray Conservation Project, Comoros Fish and Benthic Biodiversity Project, iSimangaliso Oceans Alive (MPA expansion, effective management and benefits to communities) Project, Blue Crew project in the Durban bay estuarine environment (plastic pollution action).

Principle Investigator and Co-ordinator for NRF-funded African Coelacanth Ecosystem Programme research projects: Biodiversity Surrogacy {2014-2017), Spatial Solutions {2016-2018) and Canyon Connections (2018-2020). Offshore biodiversity survey and sampling to test validity of modelled biozones, to refine conservation planning, and to support marine protected area expansion and the National Biodiversity Assessment (CBD).

Project leader for WWF-SA, NRF and ACEP funded project: SeaPLAN - development of a systematic conservation plan for the east coast of south Africa (2004-2012). Integrates shoreline biodiversity mapping, reef biodiversity surveys and key species and processes.

Project leader Wild lands Trust funded project: Rare and Endangered Species of the Greater St Lucia Wetland Park (2002-2005). This project aims to update the records of these species in the park and provide a management handbook. It is focussed on terrestrial and freshwater wetland species and employs a full-time researcher. This project has become entrenched and is ongoing.

Project leader for NRF funded project: KwaZulu-Natal and Transkei Indigenous knowledge of subsistence harvesters (2002-2006): Aims to document traditional knowledge and management systems of rural subsistence harvesters, compare regional differences, and integrate into current management practices.

Chairperson of Subsistence Fisheries Task Team, on behalf of Marine and Coastal Management (DEAT), managed a national programme for coast-wise identification of and consultation with subsistence fishers (1999-2000). Acted as Program manager and supervisor of 8 Regional Fieldworkers (Northern Cape, West Cape (x2), South coast, Eastern Cape (x2), KwaZulu-Natal (x2), and a National Co-ordinator and project researcher. - Project leader and finance vote-holder (ea R l mill)

Project executant (co-ordinator & researcher, and supervisor of 2 project staff) for 5-year project funded by The Green Trust, WWF-SA: The development of sustainable utilization of mussels by artisanal and subsistence gatherers along the northern KwaZulu-Natal coast - Sokhulu community alongside iSimangaliso 1995-2000.

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POST-GRADUATE STUDENT SUPERVISION:

6 MSc and 2 PhD students

PUBLICATION SUMMARY:

Papers in refereed journals:	37
Book/ book chapter	8
Reports and Popular articles	10

PUBLICATIONS AND REPORTS

Grorud-Colvert K, Sullivan-Stack J, Roberts C, Constant V, Horta e Costa B, Pike E, Kingston N, Laffoley D, Sala E, Claudet J, Friedlander A, Gill D, Lester S, Day J, Gon alves E, Ahmadia G, Rand M, VillagoA, Ban N, Gurney G, Spalding A, Bennett N, Briggs J, Morgan L, Moffitt R, Deguignet M, Pikitch E, Darling E, Jessen S, Hameed S, Di Carlo G, Guidetti P, Harris J, Torre J, Kizilkaya Z, Agardy T, Cury P, Shah N, Sack K, lingCao, Fernandez M, lubchenco J (2021) The MPA Guide: A Framework to Achieve Global Goals for the Ocean. Science. Submitted and accepted.

Obura DO, Katerere Y, Mayet M, Kaelo D, Msweli S, Mather M, Harris JM, Louis M, Kramer R, Teferi T, Samoilys M, Lewis L, Bennie A, Kumah F, Isaacs M, Nantongo P (2021) Shared earth/shared ocean - a framework to link biodiversity and people. Science. Submitted and accepted.

O'Leary, BC, Ban, NC, Fernandez, M, Friedlander, Garcia-Borboroglu P, Golbuu Y, Guidetti P, Harris J, Hawkins JP, Langlois T, McCauley DJ, Pikitch EK, Richmond RH, Roberts CM (2018} Addressing Criticisms of Large-Scale Marine Protected Areas. BioScience.

Harris JM & AT Lombard 2017. SOCIO-ECOLOGICAL RESILIENCE IN SOUTH AFRICA'S BLUE ECONOMY:THE ROLE OF MARINE PROTECTED AREAS http://www.saiia.org.za/policy-briefings/socio-ecological-resilience-in-south-africa-s-blue-economy-the-role-of-marine-protected-areas.

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Roberson L, Lagabrielle E, Lombard A, Sink K, Harris J, Grantham H, Livingstone T (2017) Pelagic bioregionalisation using open-access remote-sensing data to inform marine protected area planning in South Africa's Exclusive Economic Zone. Ocean & Coastal Management 148:214-230

Haupt P, Lombard AT, Goodman PS, Harris JM (2017) Accounting for spatiotemporal dynamics in conservation planning for coastal fish in KwaZulu-Natal. South Africa. Biological Conservation. 209:289-303

Mills M, Weeks R, Pressey B, Gleason M, Eisma-Osorio R, Lombard M, Harris JM, Killmer AB, White W, Morrison TH. (2015) Real-world progress in overcoming the challenges of adaptive spatial planning in marine protected areas. Biological Conservation 181 54-63

Vincent A and JM Harris (2014) Boundless no more - Ending illegal, unregulated and unreported fishing would bring hope to ocean wildlife. Science_346:420-421

Harris J.M., Livingstone T, Lombard AT, lagabrille E, Sink K (2011) SeaPLAN: Marine biodiversity assessment and identification of priority areas for conservation action. Technical Report. Ezemvelo KZN Wildlife. (www.kznwildlife.com)

Reaugh-Flower KE, Branch GM, Harris, JM, McQuaid, CD, Currie B, Dye A, Robertson B (2011) Scale-dependent patterns and processes of intertidal mussel recruitment around southern Africa. Marine Ecology Progress Series. 434: 101-119

Sink KJ, Harris JM and Branch GM (submitted} A rocky shore biotope classification system and its application in conservation planning on the east coast of South Africa. *Conservation Biology*

Reaugh KE, Harris JM, Branch GM (2007) Further refutation of the primary-secondary settlement hypothesis for the brown mussel Perna Perna. African Journal of Marine Science. 29(3): 545-549

Napier, V.R., G.M. Branch and J.M. Harris, 2005. Evaluating conditions for successful co-management of subsistence fisheries in KwaZulu-Natal, South Africa. *Environmental Conservation* 32: 165-177.

Sink KJ, Branch GM and Harris JM (2005) Biogeographic patterns on rocky shores in KwaZulu-Natal, south Africa: implications for conservation of biodiversity. *African Journal of Marine Science* 27(1): 76-96

Harris JM, TA Livingstone, Phadima L, Sink KA, Fasheun, T, Boyd A, Mfeka X 2015 Phakisa Initiative : fast-tracking establishment of an effective and representative network of Marine Protected Areas for South Africa. Oral presentation WIOMSA Symposium 2015

McKean S, Phadima L, Jewitt D, Mander M, Harris J.M. Assessment of the value of the ecosystem services provided by biodiversity in the province of KwaZulu-Natal. Technical report. Ezemvelo KZN Wildlife (www.kznwildlife.com)

Driver, A., K. Maze, M. Rouget, A.T. Lombard, J. Nel, J.K. Turpie, R.M. Cowling, P. Desmet, P. Goodman, J. Harris, Z. Jonas, B. Reyers, K. Sink and T. Strauss. 2005. *National Spatial Biodiversity Assessment 2004: priorities for biodiversity conservation in South Africa. Strelitzia 17.* South African National Biodiversity Institute, Pretoria. (www.sanbi.org)

Harris *et al.* 2005. Sea PLAN: a marine biodiversity conservation plan. August 2005: Brochure.

Lombard, A.T., T. Strauss, J. Harris, K. Sink, C. Attwood and L. Hutchings. 2004. *South African National Spatial Biodiversity Assessment 2004: Technical Report. Volume 4: Marine Component.* Pretoria: South African National Biodiversity Institute. (www.sanbi.org)

Harris, J.M., Branch, G.M., Clark B.M., Cockcroft, A.C., Coetzee, C., Dye, A.H., Hauck, M., Johnson, A., Kati-Kati, L., Masekio, Z., Salo, K., Sauer, W.H.H., Siqwana-Ndulo, N. and M. Sowman. 2002a. Recommendations for the management of subsistence fisheries in South Africa. *South African Journal of marine Science* 24: 503-523.

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Harris, J.M., Lawrence, L., C. Fox. & G. Hough. 2000. South African Shoreline State of Environment Indicators: Discussion document. DACST Innovation Fund programme: Towards a South African Integrated Spatial Information System (SA-ISIS): 20 pp

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on Coastal and Fisheries Co-Management. Unpublished Report: 15 pp

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Van den Berg E, Harris JM 1995 The occurrence of the plant-parasitic nematode *Rotylenchus* capensis Van den Berg & Heyns, 1974 in soils of isolated nunataks in western Dronning Maud Land, Antarctica

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Harris JM 1993 The presence, nature and role of gut microflora in aquatic invertebrates: a synthesis. Microb Ecol 25:195-231

Harris JM 1993 Relationships between invertebrate detritivores and gut bacteria in marine systems. PhD thesis, Zoology Department, University of Cape Town

Tibbles BJ, Davis CL, Harris JM, Lucas MI 1992 Estimates of bacterial productivity in marine sediments and water from a temperate saltmarsh lagoon. Microb Ecol 23:195-209

Harris JM, Seiderer U, Lucas MI 1991 Gut microflora of two saltmarsh deteritivore thalassinid prawns Upogebia africana and Callianassa kraussi. Microb Ecol 21:277-296

Fielding PJ, Harris JM, Lucas MI, Cook PA 1986 Implications for the assessment of crystalline style activity in bivalves when using the Bernfeld and Somogyi assays for reducing sugars. J Exp Mar Biol Ecol.101:269-284

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Harris, J.M. 1999. Action for subsistence fishers. SANCOR Newsletter 158:18-19

Harris, J.M. 1998. Co-management: a solution for subsistence fishing? SANCOR Newsletter 157:1

Harris JM 1997 Co-management of subsistence mussel gathering. Natal 40:4-5

Harris JM 1996 An introduction to the geology, biology and conservation of nunataks in Drenning Maud Land, Antarctica. Department of Environment Affairs and Tourism, ISBN 0-621-17325-8

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Steele WK, Balfour DA, Harris JM, Newton IP 1992 Effects of ornithogenic products on ecosystem structure and functioning in Antarctica: preliminary results 1991/92. Biotas Newsletter 7:13-16

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Book Chapters

Lombard A, Durbach I, Harris JM, Mann-Lang J, Mann B, Branch GM & Attwood C. 2019. South Africa's Tsitsikamma Marine Protected Area winners and losers. In: MARINE PROTECTED AREAS - SCIENCE, POLICY AND MANAGEMENT. Elsevier DOI: 10.1016/8978-0-08-102698-4.00013-7

Harris JM, G. M. Branch, B.M. Clark & S.C. Sibiya (2007) Redressing Access Inequities and Implementing Formal Management Systems for Marine Subsistence Fisheries in South Africa. Chapter 6. In: *Fisheries Management: Progress towards sustainability,* T.R. Mcclanahan and J.C. Castilla, eds Blackwell Publications.

Sink and J Harris, (2007) Food uses, modern. In *Encyclopedia of Tidepools and Rocky Shores* (edited by Mark W. Denny and Steven D. Gaines}. Published by University of California Press

Attwood, C.G. and J.M. Harris 2003 - Marine Protected Areas In. ed G.I. Cowan and J. Yawitch and M. Swift. Strategic innovations in biodiversity conservation. The South African experience. Department of Environmental Affairs &Tourism. pp 88 - 95.

Harris, J., G. Branch, S. Sibiya, and C. Bill. 2003. "The Sokhulu Subsistence Mussel Harvesting Project - A Case Study for Fisheries Comanagement in South Africa." In *Waves of Change. Coastal and Fisheries Co-Management in South Africa,* M. Hauck and M. Sowman, eds. (University of Cape Town Press: Cape Town).pp61-98 (358pp)

Griffiths, C.L., McQuaid, C.D., Harris, J.M. & A.H. Dye. 2000. Functional ecosystems: Rocky shores. In: Summary Marine Biodiversity Status Report for South Africa. Durham, B.D. & Pauw, J.C. (eds}. National Research Foundation, Pretoria, ISBN 1-86868-033-9, 90 pp

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Branch GM, Harris JM, Parkins C, Bustemante RH, Eekhout S 1992 Algal "gardening" by grazers: a comparison of the ecological effects of territorial fish and limpets. In: Plant-animal interactions in the marine benthos {OM John, Hawkins SJ & JH Price, eds.} Systematics Association Special Volume: 46: 405-423, Clarendon Press, Oxford

Selected Conference Presentations

Harris JM (2017) Contribution of MPAs to building ecological and social resilience. In Session: The role of MPAs in Achieving Ocean Health and Sustainable Blue Economies, 4th International Protected Areas Conference, Chile. September 2017. Invited oral presentation.

Harris JM, Lombard AT (2017) Why we need more Marine Protected Areas -tossing red-herrings off the table. South African Marine Science Symposium. July 2017. Port Elizabeth. Oral presentation.

Harris JM {2017) Marine Protected Area Expansion in South Africa. 10x20 Symposium. Ocean Conference New York, USA. June 2017. Invited oral presentation.

REFEREES

Prof AT Lombard
Research Chair: Marine Spatial Planning
Nelson Mandela University
Port Elizabeth, South Africa
Tel: 044-3431856 Email: mandylombard2@gmail.com

Prof George Branch,
Zoology Department
University of Cape Town
Rondebosch, 7700, Cape Town
Tel: 021-712 4768 Email: mbranch@mweb.co.za

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IN THE HIGH COURT OF SOUTH AFRICA
(EASTERN CAPE DIVISION, GRAHAMSTOWN)

Case No: 3941 /2021

In the matter between:

SUSTAINING THE WILD COAST NPC	First Applicant
MASHONA WETU DLAMINI	Second Applicant
DWESA-CWEBE COMMUNAL PROPERTY ASSOCIATION	Third Applicant
NTSINDISO NONGCAVU	Fourth Applicant
SAZISE MAXWELL PEKAYO	Fifth Applicant
CAMERON THORPE	Sixth Applicant
ALL RISE ATTORNEYS FOR CLIMATE AND THE ENVIRONMENT NPC	Seventh Applicant

and

MINISTER OF MINERAL RESOURCES AND ENERGY	First Respondent
MINISTER OF ENVIRONMENT, FORESTRY AND FISHERIES	Second Respondent
SHELL EXPLORATION AND PRODUCTION SOUTH AFRICA BV	Third Respondent
IMPACT AFRICA LIMITED	Fourth Respondent
BG INTERNATIONAL LIMITED	Fifth Respondent

CONFIRMATORY AFFIDAVIT

I, the undersigned

KENDYL ANDREA WRIGHT

do hereby make oath and say as follows:

1. I am an adult female marine scientist, and am currently employed as a Marine Protected Area Scientist (Marine Protected Area Expansion Project) at WILDOCEANS, the marine programme of the Wildlands Conservation Trust (WILDTRUST), an NGO focused on biodiversity protection and building socio-ecological resilience in Southern Africa and the western Indian Ocean.

2. The facts contained in this affidavit are within my personal knowledge, except where the context indicates otherwise, and are to the best of my belief both true and correct.

3. I have read the affidavit of Dr Jean Harris and confirm the contents thereof in so far as they relate to me. I confirm specifically that together with Dr Harris and Dr Jennifer Olbers I prepared the report annexed to Dr Harris' affidavit marked **"JH1".**

4. My qualifications and experience are set out in a copy of my *curriculum vitae,* attached to this affidavit marked **"KW1** ". I respectfully submit that I am qualified by my qualifications, training and experience to express the expert opinions which are set out in the report referred to above.

5. I further confirm that the report is to the best of my knowledge and belief true and correct.

KENDYL ANDREA WRIGHT

I hereby certify that the deponent has acknowledged that she:

(a) knows and understands the contents of this affidavit;
(b) has no objection to taking the oath;
(c) considers the oath to be binding on her conscience.

Thus signed and sworn to before me, at Arr,:::;uy ,y-rtoti on *bi* December 2021.

COMMISSIONER OF OATHS

NAME: "-JC0?4'SO Cele

CAPACITY: C-fc:::;i..bk=

ADDRESS: 21 Rd

AREA: Amanzimtoti

SOUTH AFRICAN POLICE
07 DEC 2021
AMANZIMTOTI
KWAZULU-NATAL

KENDYL ANDREA WRIGHT

SYNOPSIS

Kendyl is a well-rounded scientist with experience in both the academic and applied fields. She completed her master's in environmental consultancy at the University of Plymouth in 2011, before returning to South Africa. With 10 years of professional work experience including the commercial, academic, governmental, and scientific sectors, she specialises in both estuarine and offshore macrobenthlc research on the KwaZulu-Natal coastline. Kendyl has managed several different environmental projects including environmental authorizations, environmental management programme development, ecological assessments and undertaking stakeholder engagement. She has completed a PhD in macrobenthic research at the University of KwaZulu-Natal, undertaking a thesis to identify the connections between coral reefs and the adjacent sandy benthos. A competent passionate ocean enthusiast, she has experience diving (rescue diver), power boating (category C <l0m), sailing and surfing.

Personal Info

Address
13 Rockview Road

Amanzimtoti 4126

Phone
0844701932

Email
Kendyllr@gmail.com

ID Number
8707240045080

Gender
Female

Education

PhD Marine Biology	I University of KwaZulu-Natal	12020
MSc Environmental Consultancy	I University of Plymouth United Kingdom	I 2011
BSc {Honours) Marine Biology	I University of KwaZulu-Natal	I 2009
BSc Marine Biology and Geography	I University of KwaZulu-Natal	I 200s

Employment

WildOceans	I 2021 - current I Marine Protected Area Scientist
Oceanographic Research Institute	I 2018 - current I Assistant Scientist
University of KwaZulu-Natal, Westville	I 2016 - 2017 I Contractual Lecturer
Anchor Environmental	I 2014 - 2015 I Contractual Consultant
GCS Water and Environmental Consultants	I 2014 - 2015 I Contractual Consultant
WSP Environment and Energy	I 2014 - 2015 I Contractual Consultant
WSP Environment and Energy	I 2012 - 2014 I Consultant
Oceanograohic Research Institute	I 2011 I Laboratorv Assistant

KENDYL ANDREA WRIGHT

Selected Project Related Experience

Marine

2014–2019: Identification of macrozoobenthic zonation and ecosystem linkages in the iSimangaliso Wetland Park

Kendyl spent a year sampling the nearshore macrobenthos inshore of 2-Mile Reef in Sodwana Bay, KwaZulu-Natal. An area that is not well studied, she hoped to provide improved insight into biodiversity in the region. She is currently compiling two scientific papers for publication from her doctoral thesis, allowing for improved management in the region.

2016: KwaZulu-Natal Environmental Outlook Report – Marine Specialist Component

In order to align with government legislation, a specialist report assessing the current state and pressures experienced by the KZN coastal environment was compiled. Indicators to assess the impact of these pressures were outlined for monitoring purposes. The specialist report provided improved decision-making capabilities at all levels of government.

2013–2014: Richards Bay Oil Spill and Subsequent Mangrove Monitoring, Contractual Consultant.

Following a crude oil spill within Richards Bay harbour, assistance and advice were sought for the implementation of a clean-up strategy and a monitoring plan. Kendyl spent time in the field, assisting in the management of staff tasked with the clean-up. She also undertook the post-clean-up monitoring of the mangroves.

2015: Mhlanga Estuarine Assessment. KwaZulu-Natal, Contractual Consultant Anchor Environmental:.

An estuarine assessment was undertaken for a Water Use License Application to permit discharge from a Waste Water Treatment Facility. Kendyl undertook the identification of the invertebrates and compiled the specialist report.

Basic Assessment

2013 – 2014: Ecocycle Waste Solutions (Pty) Ltd, Facility Expansion, KwaZulu-Natal, Consultant:

Basic Assessment for the expansion of the current Ecocycle Health Care Risk Waste Facility including stakeholder engagement, environmental assessment and report development.

2013 –2014: Lanxess Isithebe Decommissioning, Consultant:.

Waste management license and basic assessment process application to facilitate the decommissioning and decontamination of the Lanxess, Isithebe inorganic chemical manufacturing facility.

2013 – 2014: eThekwini Municipality, Mnini Reservoir Inlet Pipeline, Consultant:.

Basic Assessment for the installation of 3 km of pipeline and associated reservoir inlet pipeline.

2012 – 2013: Transnet National Ports Authority Waste Compaction Facility, KwaZulu-Natal, Consultant:.

Basic assessment and waste management license for the construction of a hazardous galley waste handling and compaction facility within the Port of Durban.

KENDYL ANDREA WRIGHT

2011 - eThekwini Water & Sanitation, Veary Road Sewer Extension, Kingsburgh, KwaZulu-Natal. South Africa, Assistant Consultant:

Basic assessment for the proposed sewer extension in Kingsburgh, Durban. Assisting in the stakeholder engagement, environmental assessment and report development.

2011- On-going: L Toyi & Associates CC. Dukuduku Bulk Water Supply, Mtubatuba, KwaZulu-Natal, South Africa, Assistant Consultant:

Basic Assessment for the proposed construction of a water reservoir and bulk water supply pipeline in the area of Mtubatuba, KwaZulu-Natal. Assistant consultant in preparing the amended EMPr for submission to the Department of Environmental Affairs.

Environmental Impact Assessment

2013 - 2014: Proposed Pemba Port and Logistics Base, Assistant Consultant:

Scoping and EIA for the development and construction of a new Port based in Pemba, northern Mozambique.

2013 - 2014: BrightSource Kalahari Solar Energy Power Project, Assistant Consultant:

Scoping and Environmental Impact Assessment for the installation of a Solar Power Plant in Upington, Northern Cape.

2012 • 2014: Illovo Sugar South Africa (Pty) ltd, Proposed Green Boiler Project. Assistant Consultant:

Scoping and environmental impact assessment for the construction of boilers at Eston and Noodsberg to convert bagasse to energy for export to the national grid. Assistant consultant in stakeholder engagement and report writing.

Rehabilitation Plans

2011- 2013: Stefanutti Stocks (Ptyl Ltd, Umbilo Canal Rehabilitation Plan. Cato Manor, Durban, KwaZulu-Natal, South Africa, Environmental Consultant Officer:

Rehabilitation Plan for the Umbilo Canal, adjacent to the Golden Gate School in Cato Manor, Durban. Compilation of the addendum to the rehabilitation plan including the need for Dwarf Chameleon monitoring and management as well as undertaking the roe of Environmental Control Officer.

Environmental Screenings

2012 - Africa Sun Oil, Environmental Screening of a Proposed Shopping Centre, Reservoir Hills, Consultant:

Environmental Screening of the proposed new Reservoir Hills Shopping Centre based on virgin land, including the identification of potential impacts or areas of concern.

KENDYL ANDREA WRIGHT

References: *additional references on request

Dr Ursula Scharler
0844150184
scharler@ukzn.ac.za

Fiona Mackay
0829277890
fmackay@ori.org.za

IN THE HIGH COURT OF SOUTH AFRICA
(EASTERN CAPE DIVISION, GRAHAMSTOWN)

Case No: 3941/2021

In the matter between:

SUSTAINING THE WILD COAST NPC	First Applicant
MASHONA WETU DLAMINI	Second Applicant
DWESA-CWEBE COMMUNAL PROPERTY ASSOCIATION	Third Applicant
NTSINDISO NONGCAVU	Fourth Applicant
SAZISE MAXWELL PEKAYO	Fifth Applicant
CAMERON THORPE	Sixth Applicant
ALL RISE ATTORNEYS FOR CLIMATE AND THE ENVIRONMENT NPC	Seventh Applicant

and

MINISTER OF MINERAL RESOURCES AND ENERGY	First Respondent
MINISTER OF ENVIRONMENT, FORESTRY AND FISHERIES	Second Respondent
SHELL EXPLORATION AND PRODUCTION SOUTH AFRICA B V	Third Respondent
IMPACT AFRICA LIMITED	Fourth Respondent
BG INTERNATIONAL LIMITED	Fifth Respondent

CONFIRMATORY AFFIDAVIT

I, the undersigned

JENNIFER OLBERS

do hereby make oath and say as follows:

1. I am an adult female marine scientist, and am currently employed as a Senior Marine Scientist (Sharks and Rays Protection Project) at WILDOCEANS, the marine priogramme of the Wildlands Conservation Trust (WILDTRUST), an NGO focused on biodiversity protection and building socio-ecological resilience in Southern Africa and the western Indian Ocean.

2. The facts contained in this affidavit are within my personal knowledge, except where the context indicates otherwise, and are to the best of my belief both true and correct.

3. I have read the affidavit of Dr Jean Harris and confirm the contents thereof in so far as they relate to me. I confirm specifically that together with Dr Harris and Dr Kendyl Wright I prepared the report annexed to Dr Harris' affidavit marked "**JH1**".

4. My qualifications and experience are set out in a copy of my *curriculum vitae,* attached to this affidavit marked "**JO1**". I respectfully submit that I am qualified by my qualifications, training and experience to express the expert opinions which are set out in the report referred to above.

5. I further confirm that the report is to the best of my knowledge and belief true and correct.

_____

JENNIFER OLBERS

I hereby certify that the deponent has acknowledged that she:

(a) knows and understands the contents of this affidavit;
(b) has no objection to taking the oath;
(c) considers the oath to be binding on her conscience.

Thus signed and sworn to before me, at on **December 2021**.

_____

COMMISSIONER OF OATHS

NAME:

CAPACITY:

ADDRESS:

AREA:

Jennifer Olbers

Marine Scientist

Info

PHONE
084 406 5907

EMAIL
jfromtheb@live.co.za

ADDRESS
Bluff, Durban

WEBSITES
ResearchGate
https://www.researchgate.net/profile/Jennifer_Olbers

LinkedIn
https://www.linkedin.com/in/jennifer-olbers-82307587/

SKILLS

- Class IV Commercial Diver (2004).
- SAMSA Skipper - Category C [Surf Launch] (2017)
- SAMSA Short Range VHF Radio Operators Certificate (2017)
- IMO[1] STCW[2] Basic (in progress; awaiting the end of lockdown)
- First aid - Level 3 (in-date).
- Quantum GIS (2015)

Profile

I am a dedicated and enthusiastic marine scientist with a keen interest in marine biodiversity. I have a proven knowledge of essential scientific skills and technical experience, including data collection, data analysis, as well as worthy presentation and report writing skills. This resume validates my excellent work ethic and personal attributes, including sound organizing and planning skills, together with the ability to work both independently or in a team.

Education

PhD (Zoology) - 2016
University of Cape Town, South Africa.
Taxonomy, biodiversity and biogeography of the brittle stars (Echinodermata: Ophiuroidea) of South Africa.

MSc (Biological Sciences) - 2006
University of KwaZulu-Natal, Oceanographic Research Institute.
Zonation of the benthic communities on Aliwal Shoal, KZN, South Africa.

BSc Hons (Marine Ecology) - 2003
University of Natal, Durban.
Age, growth and stock assessment of Otolithes ruber from KwaZulu-Natal, South Africa.

BSc degree (Natural and Environmental Sciences) - 2002
Rand Afrikaans University.

Higher Certificate in Environmental Law and Liabilities for the Regulated Community - 2019
University of South Africa.

Employment History

Wildlands Conservation Trust - Marine Conservation Scientist - August 2020 - Present
Provide scientific oversight on a Shark and Ray Protection Project, funded by the Shark Conservation Fund.

Ezemvelo KZN Wildlife - Marine Ecologist - 2007 - 2020.
Provide ecological advice and decision support to conservation managers on priority biodiversity information needs in KZN. Develop and implement biological monitoring programmes for several marine ecosystems and resources. Contribute to policy development, guidelines and legislation tackling marine biodiversity conservation concerns. Provide training to field staff on aspects of marine protected areas, threatened and protected species and marine resources. Liaise with external organisations on issues relating to marine research and the marine environment.

[1] IMO (International Maritime Organisation)
[2] Standards of Training, Certification and Watchkeeping

Oceanographic Research Institute - Research Assistant - 2006.
Sort, process and identify benthic samples, including data capture and maintain a benthic reference collection database.

Oceanographic Research Institute - MSc Fellowship - 2004 - 2005.
In addition to completing an MSc, maintain the ORI research aquarium, capture data for the east coast reef survey project and assist with oyster, crayfish and mud prawn surveys.

IUCN Shark Specialist Group - Workshop assistant
Batoid Workshop - September 2003.
Sub-Equatorial Africa Workshop - September 2004.
General and administrative assistance for the duration of the workshop, and aid in documenting elasmobranches for IUCN red data list criteria.

Publications

2020 Dames, V., Bernard, A., Floros, C., Mann, B., Speed, C., Maggs, J., Laing, S., Meekan, M., **Olbers, J.M.** 2020. Zonation and reef size significantly influence fish population structure in an established marine protected area, iSimangaliso Wetland Park, South Africa. *Ocean and Coastal Management*, 185: 105040

2019 **Olbers, J.M.,** Griffiths, C.L., O'Hara, T.D. & Samyn, Y. 2019. Field guide to the brittle and basket stars (Echinodermata: Ophiuroidea) of South Africa. *Abc Taxa* 19: 1-346.

2018 Atkinson L.J, Mah C., Filander Z., **Olbers J.** and Thandar A. 2018. Phylum Echinodermata In: Atkinson L.J. and Sink K.J. (eds) *Field Guide to the Offshore Marine Invertebrates of South Africa*, Malachite Marketing and Media, Pretoria, pp. 393-476. DOI: 10.15493/SAEON.

2015 **Olbers, J.M.,** Samyn, Y. and Griffiths, C.L. 2015. New or notable records of brittle stars (Ophiuroidea: Echinodermata) from South Africa. *African Natural History* 11:83-116.

2014 **Olbers, J.M.**, Rowe, F.W.E., Griffiths, C.L. and Samyn, Y. 2014. The rediscovery of a collection of echinoderms including two holotypes in the Durban Natural Science Museum, South Africa. *Novitates*: 36: 1-13.

2013 Smit, A.J., Roberts, M., Anderson, R.J., Du Fois, F., Dudley, S.F.J., Bornman, T.G., **Olbers, J.M.** and Bolton, J.J. 2013. A coastal Seawater Temperature dataset for biogeographical studies: Large biases between in-situ and remotely-sensed datasets around the coast of South Africa. *PLoS ONE*, 8(12): e81944. Doi: 10.1371/journal.pone.0081944.

2013 Okanishi, M, **Olbers, J.M.** and Fujita, T. 2013. A taxonomic review of the genus *Asteromorpha* Lütken (Echinodermata: Ophiuroidea: Euryalidae). *The Raffles Bulletin* 61(2): 461-480.

2012 **Olbers, J.M.** and Samyn, Y. 2012. The *Ophiocoma* species (Ophiurida: Ophiocomidae) of South Africa. *Western Indian Ocean Journal of Marine Science*, 10(2): 137-154.

2009 **Olbers, J.M.**, Celliers, L. and Schleyer, M.H. 2009. Zonation of benthic communities on the subtropical Aliwal Shoal, Durban, KwaZulu-Natal, South Africa. *African Zoology* 44(1): 8-23.

2007 **Olbers, J.M.** and Fennessy, S.T. 2007. A retrospective assessment of the stock status of *Otolithes ruber* (Pisces: Sciaenidae) as bycatch on prawn trawlers from KwaZulu-Natal, South Africa. *African Journal of Marine Science*, 29(2): 247-252.

2005 **Brash, J.M.** and Fennessy, S.T. 2005. Age and growth of *Otolithes ruber* of KwaZulu-Natal, South Africa. *Western Indian Ocean Journal of Marine Science*, 4(1): 21-28.

References

Dr Camilla Floros
TRAFFIC
✉ Camilla.floros@gmail.com
☎ 082 893 6919

Mr Santosh Bachoo
Ezemvelo KZN Wildlife
✉ santosh.bachoo@kznwildlife.com
☎ 083 783 9612

Dr François Lampen
SAAMBR (uShaka Sea World)
✉ flampen@seaworld.org.za
☎ 031 328 8231

IN THE HIGH COURT OF SOUTH AFRICA

(EASTERN CAPE DIVISION, GRAHAMSTOWN)

Case No: 3941/2021

In the matter between:

SUSTAINING THE WILD COAST AND OTHERS — Applicants

and

MINISTER OF MINERAL RESOURCES AND ENERGY AND OTHERS — Respondents

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SUPPORTING AFFIDAVIT

I, the undersigned,

LYNTON FRANCOIS BURGER
South African ID: 6402025094089

do hereby make oath and say:

1 I am an adult male ocean impact investment specialist with 30 years professional experience in environmental and sustainability management.

2 The contents of this affidavit are to the best of my knowledge true and correct. Unless I indicate otherwise, or the contrary appears from the context, they are within my personal knowledge and belief.

3 My CV is attached marked LB1. I confirm that it is accurate.

4 I coordinated a group of South Africa's most distinguished marine experts in drafting an open letter to President Ramaphosa, Minister Mantashe, and Minister Creecy regarding the proposed seismic surveys off the South African coastline.

5 This open letter was signed by the following 24 experts:

5.1 Emeritus Professor George Branch - Dept. of Biological Sciences, University of Cape Town {UCT)

5.2 Dr Jean Harris - Executive Director, WildOceans, Durban

5.3 Dr Larry Oellennann - CEO, South African Association for Marine Biological Research (SAAMBR)

5.4 Professor Kenneth Findlay - Research Chair: Oceans Economy, Centre for Sustainable Oceans, Cape Peninsula University of Technology

5.5 Professor Isabelle Ansorge - Head of Dept. Oceanography, UCT

5.6 Dr Judy Mann - Conservation Strategist, South African Association for Marine Biological Research (SAAMBR)

5.7 Professor William Froneman - Acting Director: SARCHi Chair: Marine Ecology - Rhodes University

5.8 Dr Eis Vermeulen • Research Manager, Mammal Research Institute Whale Unit, University of Pretoria

5.9 Emeritus Professor Jan Glazewski - Institute of Marine and Environmental Law, UCT

5.10 Professor Merle Sowman • Dept. Environmental and Geographical Science, UCT

5.11 Adjunct Professor Lorien Pichegru • Acting Director, Institute for Coastal and Marine Research Institute, Nelson Mandela University

5.12 Assoc. Professor Niall Vine - Department of Zoology & Entomology, University of Fort Hare

5.13 Professor Astrid Jarre - SA Research Chair in Marine Ecology and Fisheries, Dept. of Biological Sciences, UCT

5.14 Professor Lorien Pichegru - Director: Institute for Coastal and Marine Research, Nelson Mandela University

5.15 Dr Bruce Mann . Senior Scientist, Oceanographic Research Institute

5.16 Dr Sean Porter. Coral reef scientist, SAAMBR

5.17 Dr Gwenith Penry - Cetacean scientist, Institute for Coastal and Marine Research, Nelson Mandela University

5.18 Emeritus Professor Christopher McQuaid - Marine Biology, Rhodes University

5.19 Professor Amanda Lombard - NRF SARChI Chair: Marine Spatial Planning, Nelson Mandela University

5.20 Professor Rachel Wynberg - SARChi Chair: Environmental and Social Dimensions of the Bio-economy, Dept. Environmental and Geographical Science, UCT

5.21 Dr Simon Elwen - Cetacean and acoustic scientist, Director: Sea Search Research & Conservation, and Hons Assoc. Stellenbosch University

5.22 Assoc. Professor AJ Smit - Dept. of Biodiversity and Conservation Biology, University of Western Cape

5.23 Professor Mike Bruton - Honorary Research Associate, South African Institute for Aquatic Biodiversity, Makhanda

5.24 Dr Tess Gridley - Director: Sea Search Research & Conservation, and Honorary Associate Stellenbosch University

6 I can personally affirm that each of these distinguished experts signed off on the open letter, and that there is an email communications trail attesting to this, including the amendment dated 06 December 2021.

7 I attach a copy of the open letter - which was updated by the signatories on 06 December 2021 to amend a legal statement - hereto marked LB2.

8 I have personally reviewed Shell's 2013 EMPr compiled by Environmental Management Resources (ERM) and this firm's subsequent 2020 Environmental Compliance Audit. I attach my assessment of these documents hereto marked LB3.

LYNTON FRANCOIS BURGER

The Deponent has acknowledged to me that she knows and understands the contents of this affidavit, which affidavit was signed and sworn to or before me at Muizenberg on this 6th day of December 2021 the regulations contained in Government Notice No. R12 s of 21 Jul 1972 been complied with.

SUID-AFRIKAANSE POLISIEDIENS
COMMUNITY SERVICE CENTRE
MUIZENBERG
06 DEC 2021
SOUTH AFRICAN POLICE SERVICE

(HANDTEKENING) KOMMISSARIS VAN EDE
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SCHOOL ST, MUIZENBERG
BESIGHEIDSADRES (STRAATADRES)
BUSINESS ADDRESS (STREET ADDRESS)
Captain

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Emal: l)'nton@tyntooburger.com
Website: www.lyntonburger.com W www.venture-ilth.fund
Mobile: +27 665828395
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Dateolbi'th: 2 February 1964
Natlonuty: South African and Australian
SAID: 6402025094089
Languages: English, Afrikaans

PROFILE

Lynton Is• pro/essloNJ ocean Impact Investor and m,rine conseMtlooos,. drowing on Ihlny ye.,,· co,por.1te comuh,ng. advl>o,y •nd .ademc: research oxperlence. Lynton·s svength lies in i . breadth and depth of experience whilst wo,lung at a high level. globdy >nd a a o u dc,cipl,nes. Lynton is driven to - the best outcomes for inveslot> and Investees - illway, with the future ol the world's oceans as •n underiylrc driver.

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S December 2021
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Dea, President Ramaphosa. Honowablc Ministers

South Africa's marine «:osystems, and the c.....i communiiy's suswnable blue ....-ies, thll depend on their health, are being lhrulmed by the deployment of offsllotc seismic SLU\eying.

Seismic 1urveying. which employs large amys of air guns that produce hfiih amplitude. low frequency pulses. (of over 200dB re l µpa11 l m) every ten seconds, 24 hows a day and fo, months on end- over extensive areas of ocean, is fundamenlally damagu,g to marine ecosys1cms. There is a growina body of cvidmce pointing to the imm<diale and long-term, and largely unmilipble, nega1ive impacu (includina in<pan.ble h.vm) of this invasive method on marine creatures, from luge (including acoustically .sensitive whales and dolphins) to small (c.g, plankton, upon which all ocean lrophlc systems depend), that make up our valuable marine ecosystems, and upon which our coast.al communities and cconotnics depend. fwthcrmore, balhymelric sonar „„CYSoften wociatcd with scwnic surveys have been ideotifitd to resu.lt in further acoustic impacts..

We poinl out that much of this evidence, and a growing global Opposition to this method of swvcying (it has been ,topped in some counlly's Exclusive Economic Zones (EEZ)), has only come lD ligl>t !1ls! lhe granting of eurrcnt permits. notwith.nanding their questionable legal sttcus. for cumple. lhc Environmental Managemen1 Pros,amme (EMPr), whi<h underpins the lfllLMg of the penmit for Sll<ll 0.1 lD eotomenc,c ..,,,eying off tJe Transkci Coast (one of our riches! and lllOSl sensitive su.1chcs of our COlSl, wilh four Marine Prolltct<d Areas (MPAs)) was comple1ed over eigl>l years aao in June 2013 for Impact Afric>. We note that lhe subsequent 2020 Environmental Compliance Audit was completed by the same firm as the EM Pr (i.e. lacks full indcpe:ndence). by consultants with no formal marine biological training. and who did not take any new marine ecological and social impact cvidencc lh10 aa:ooni. o r particular concern is the inadequacy of the proposed mitigation measures givm the M l scale 11ftl range or potmtial impacu to rmrinc life and coa.ual communities arising fiom more recent studies. For example. the acoustic buffers proposed around. MPAs: and the avoidance of times and places when sensitive species are most likely to experience lhc impacts, are very likely to be inadequate - given whnt we now know. Both repons are therefore out of dillC and lack validity.

From l l e p point of view, we submit thll !he,, is an underlying deficiency in. andpoc,ntial eonOicu v.;lh, the current Environmentt.l Impac1 Regul:u.ions enacted under the National f.nvironmenla.l Ma:nagemfflt Act (NEMA) with respt(t to seismic SW'Ycying. In our le.uned opinion all seismic: surveys should be subjecled 10 full Environmental Impact Assessments (ElAs). Secondly, the precautionary principle, enshrined in NEMA principle, Soction 2(4X1Xvii) in the following terms: "that a ri6k.averse and cautious approach is applied, v.+tich takes i n t o - lhe limilS o f = • knowledge abou1 the cooscqu<1IC<$ of decisions w ! actions", is lcgally applicible in !his case. We point 0Dl thal 2(1)ofNEMA s,;puw,sthaL "Jbc principlgs g o u t in !his section aDPIY 1hroughou11bc RfPYbljc to the actions of all o r g w of state that mav sipnificantly affect the -" (Our underlining).

Finally, we would like 10 higl>ligbl thal the approval o(lhcse surveys clearly contradicu South Afiica•s ogreemtnt at the COP26 in Odober this year, 10 move away fiom h energy lowotds renewebtes..

tn lhe ligh1 of the above. we, lhe undersigned leading South African marine scientists, marine legal and coastal zone management exe rts, are imploring 1he South African Government to:

1, Hall all planned seismic surveys (including 1he survey thal commenced on 1 December) until South Africa h a clear policy position on oil and gas exploration that is aligned wilh iiS climate change commitmenc.s; and,
2. If I above aJlows (or any funher exploration, then:
    a. Review and harmonise environmental legislation as ii pertains *to* seismic surveys, and if the current legislati\le framework is maintained to then enact legislation that requires for EMPrs to be current and based on the most recent available scientific information;
    b. Establish appropriaJc regulations to account for more adequate miligation of acoustic impacts to species and systems in the marine environment:
    c. Re\liew the One Environment System that allows the Minister of Mineral Resources and Energy to authorise environmental applkations for seismic surveys;
    d. Review and consider the use of alternaJe, less hannful, survey 1ech.nolog.ies (e.g. marine ..,,ibrcoscis).
3. Commission a Sttalegic &wironrncntal Assessment of aJl cunenl and futwe seismic SUlYeys for the South African EEZ. 10 dctennine key environmental and social constraints and sensitivities to inform a and b above.

Yours sincerely,

Emeritu.s Pr-o(cssor Jaa Glazewski • Institute of Marine and Environmental Law, UCT
Dt Jean Hanis• Eic.ewtivc Dimc:1or, WildOeeans
Professor Loricn PicbfVll - Oire,ctor. hmirure for Qmtal and Marine Research, Nelson Mandell Univeniry
Professor Keaoclb F'mdlay - Research Qair: Oceans Economy, Cemrc for Sustainable Oc.cans. Cape Peninsula UniVfflity ofTe<lLJlology
ProfC$$0r Jsabcllc Ansorie - Head of Dept. Oceanography, UCT
Professor WiU.tllm Fr'oneman • Acting Director: SARCHi Chair: Marine Ec.ology • Rh Univcniry
E ui1us Pro(t.Uor Gtorcc Btu1ch - Dept. of Biological Sciences, University of Cape Town (UC'O
Dr Larry Odlerma11n - CEO, Soofih African Association for Marine Biologica.1 Research (SAAMBR)
Dr J/1dy Mana -COnSCMtion Str.1,1egist, SAAMBR
Dr Els Vermeutea • Research Manager, Mammal Rcs.careb Institute Whale Unit. Univers.ity orPrc1oria
Prorwor Merle Sowman • Dept. Environmental and GcographieaJ Science. UCT
As.loc. Profes,or NdU Viae • Department of Zoology&. Entomology, University orFon: Hare
ProfC$.5or As-lrid Jure- Re:search Chair in Marine &:ology and Fisheries, Dept. of Biological Sciences, UCT
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Enicritus Prore.uor CbrisCopber McQaaJd- Marine Biology, Rhodes Univusil)'
Professor Amnda LoB1bard-NRF SARCh.I Chair: Marine Spatial Planning. Nelson Mandela University
Professor Rachel Wyabu& • SARChi Chair: Environmental and SociaJ Dimensions of lbe Bio-economy, Dept. Environmental and Geographical Science, u c r
Dr Simon Elwcn • Cew:eati a,coustic scientist. Director: Sea Search RC$UlCh & Conservation,, and Hons Assoc. Stellenbosch University
Assoc. Proreuor AJ Smll - Dept. ofBiodiv(l"Sity and Conservation Biology, University of Wcst«n Cape
Professor Lore«• Feris - Environmenlal Law, UCT
Profe.ssor Mike Bna ton . Honorary Resurch Associate, South African Institute. for Aquatic Biodiversity, Malchanda
Dr Tess Gridley - DirtetOf: Sea Searth. Research & ConseMJion. and Hons Assoc. Stellenbosch Uni11ersiy

Re: Transk,j Algoa E,cploration Right
An Assessment of ERM's 2013 EMPr and 2020 Environmental Compliance Audit

Compiled by Lymon Francois Burger
MSc (lchthyology - Rhodes lkwfflity). MBA (UCT)

S December 2021

Wamintee and Disdainer:

- I am the f'"-'1ding Managing Director of ERM Southern Africa and draw on 30 years· envrom,ental management corporate suruinability and research e><perience on four c011tinents. My 0 / is attached. Whilst I no longer worl< in the environment.11 management field (I now worl< in the ocean impact and sustainable in-.estment field where I get to examine such reports on behalf of investoo), I am professionally fam iar with the drafting and review of. and level of e,q,ertise req\ired for, documents of this nature;
- I submit that this opinion. based on publicly available information and after consultation *with* leading marine experts in South Africa. is freely given to accompany the court interdict being brought to the High Court of South Africa - Case 394112021 • by Sustainng the Wild Coast NPL & Others (Appficants).
- I hereby declare that it is my opinion and miie alone, and that I have received no benefrt. monetary *or* otherwise, from compiling it
- I do 1121 yj,e my consent *for* this opinion to be shared outside of this court. *or* for any purpose other than as a submission to the Judge in the above matter.

Assessment:

The May 2020 Environmerital Comp6ance Aucit (hereafter referred to as the "Audit') completed by ERM concluded (page I):
"Fuidings of lhe EMPr review indicate rhat perooo,t mirigolion ond rnanogm,ent tapic:s ore ,n one wilh lhe current tffliroomerltol legis/owo r e q u i = re/ew,nt indusuy standards and intemal/Onol best p,oa,ce. In hg/lt of above ieg,slorion, ERM ore therefore of lhe opinion that lhe s contomd in rhe EMPr suff,dently provide for the <midonco. management and mirigotion of k y porenriol efflironmer,tol unpoas idenu{ied and no r&ammendorion for updace of lhe EMPr ,s considffed necesso,y. •

I cannot in any way, agree with this conclusion.

The following points are presen!ed to "4)port this view:

1. The original EMPr, released in June 2013, is out of date. and the 2020 Audit does not address this funclamental shortcoming. It is not inrustry best practice for consultants or proponents to stand by a report which is 8 years old. especially when the underlying scientific knowledge and relevant legislation and policy around the world has advanced/changed to sue!, an extent that it places in serious doubt the conclusions of the coosultants - see point 2. PUblic consultation with interested and all'ected parties (I&APs). which was alreacly limited (as a full EIA was not conducted), is also dated and no longer valid;
2. Neither report adequately considers the mounting peer-reviewed scieritific studies and govemmerit reviews that are exposing the full impacts - many studies and e><pert reviews quote irreparable damage • to marine organisms and ecosystems from seismic testing. The Audit also makes no mention of the fact that a growing number of govemmerits around the YlOrld have, as a result of this scientific concern. outlawed this practice. The fact that many of these studies and reviews have been published post the 2013 EMPr further invalidates ERM's Audit conclus,on I attach a ltSt of example references, and I refer to the O p e n Letter compiled by South Afnca's 24 most senior marine scient,sts · which has beer, submitted to the Ce<rt by the Applicants • in support or th,s poinc

k.k

3. Based on publicly available information, the authors of the repotts are, in my opinion, inadequately qualified. I have perused the Unkedin promes of the autho<s of both reports and none or them have any listed professionaJ marine science or marine envimnmental training. It appears that both reports have been compiled by consultants with land-based mining and/or generalist emironmental impact experience. The p<ima,y author of the 2020 Aud€ report is a junior-level consultant with ERM Southern Africa;
4. The EMPr mitigation measures are. in my professional opinion. weak and inadequate as a management tool when one considers the full extent of ecologkal impacts that we are now beginning to understand (see point 2). They focus on an incomplete list of actual/potential negative impacts and they are heavy reliant on "so called independent" onboard observers. Practically, these ;.mior-level observers have n o • € onboard a highly sophisticated su-vey vessel where seismic testing is being conducted 24-hours a day and to cost and time sensitive corporate agendas. Their ability to detect cetaceans (scanning a vast and ever-changing 360 seascape with human eyes and binocuars) is severely Um€ed to fleeting surface shows (blows and fins). And there is effectively oo mitigation d...-ing night-time surveying - i.e. 50% of the time (the EMPr glosses over this), But most importantly, the full impacts to ecosystem components like plankton. which occur as vast undetected biomass and which are the very ooldli n g blocks of ocean ecosystems, as well as to the extensive unseen benthk reefs that the survey vessel passes over - c,,,er a vast area of ocean, srnply cannot be moMored or mitigated by at sea observers. and are not adequately addressed by either of the reports. Notably. the EMPr relies on old research that only plankton within 10 metres will be affected by ..;smic surveys. A more recent study by McCauley et al (see references) reveals that zooplankton more than Ikm away are impacted, with high death rates n,corded among larval knll;
5. Pethaps the most material shortcoming of the 2020 Aud€ - as a comphance tool -€that € does not address the potential legal compliance conflicts and legislative framework questions that have arisen post the 2013 EMPr - as alluced to in the expert's Open Lener.

The 2013 EMPr and subsequent 2020 fmironmental Cotrf>liance Aud€ therefore do not. in my professional opinion, represent a current and valid assessment of the fjU erMronmental impacts of seismic surveying off 1he Wild Coast of South Mica

Signed:
Lynton Francois Burger

lly

LB
R.k.

Re: Transkei Algoa E,cploration Right
All Assessment of ERM's 2013 EMPr and 2020 E:wiromiental Compliance Aucit - L)'ntOn Francois Burg,,,-

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R.k.

IN THE **HIGH COURT OF SOUTH AFRICA**
(EASTERN CAPE DIVISION, GRAHAMSTOWN)

Case No: 3941/2021

In the matter between:

SU_STAINING THE **WILD COAST NPC**	First Applicant
MASHONA WETU DLAMINI	Second Applicant
DWESA-CWEBE COMMUNAL PROPERTY ASSOCIATION	Third Applicant
NTSINDISO NONGCAVU	Fourth Applicant
SAZISE MAXWELL PEKAYO	Fifth Applicant
CAMERON THORPE	Sixth Applicant
ALL RISE ATTORNEYS FOR **CLIMATE AND** THE **ENVIRONMENT NPC**	Seventh Applicant

and

MINISTER OF MINERAL RESOURCES AND ENERGY	First Respondent
MINISTER OF ENVIRONMENT, FORESTRY AND FISHERIES	Second Respondent
SHELL EXPLORATION AND PRODUCTION SOUTH AFRICA B V	Third Respondent
IMPACT AFRICA LIMITED	Fourth Respordent
BG INTERNATIONAL LIMITED	Fifth Respondent

CONFIRMATORY AFFIDAVIT

I, the undersigned

MICHAEL NOEL BRUTON

MB

do hereby make oath and say as follows:

1. I am an adult male aquatic marine scientist, a retired Professor of Ichthyology, and currently a Director of Mike Bruton Imagineering.

2. The facts contained in this affidavit are within my personal knowledge, except where the context indicates otherwise, and are to the best of my belief both true and correct.

3. I was requested by the Applicants to provide an expert opinion on the presence of the coelacanth *(Latimeria chalumnae)* within the area impacted by the Third to Fifth Respondents' seismic survey activities.

4. I hold BSc (Hons), MSc and PhD degrees from Rhodes University as well as a Doctor of Science *honoris causae* from Rhodes University. My fields of research include ichthyology, aquatic biology and ecology, fish life histories, aquatic conservation, indigenous knowledge systems and environmental education.

5. My qualifications and experience are set out in a copy of my *curriculum vitae,* attached to this affidavit marked **"MB(".**

6. A list of some of my own publications relating to the coelacanth are attached to this affidavit marked **"MB2".**

MB

MK

7. I respectfully submit that I am qualified by my qualifications, training and experience to express the expert opinions which are set out in the report referred to above.

Presence of coelacanth in east coast waters of South Africa

8. The first live coelacanth known to science, which was named *Latimeria chalumnae,* was trawled off the Chalumna River between the depths of 72 and 100 rr\'etres on 22 December 1938.

9. Since then coelacanths have also been caught (mainly by traditional fishermen), and recorded by scientists, off the Comoros, Mozambique, Tanzania, Kenya and Madagascar, and a different living species, *Latimeria menadoensis,* has been found off Indonesia.

10. In 1989 I published an article (Bruton M.N. 1989. Does the coelacanth occur in the Eastern Cape? *Eastern Cape Naturalist* 33(3): 5-13) in which I concluded, based on available evidence, that the coelacanth does occur off the Eastern Cape coast, including the Wild Coast.

11. In May 1991, in collaboration with Professor Hans Fricke of the Max Planck Institute in Germany, we carried out a series of dives to a depth of 400 metres in the *Jago* research submersible to search for coelacanths off the East London and Port Elizabeth coasts. We did not find coelacanths (which does not necessarily mean that they do not occur there) but we did see wreckfish, *Polyprion americanus.* In the 1986 edition of the authoritative 'Smiths' Sea

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Fishes' book P. *americanus* is recorded from South African waters at depths from 40 to 300 metres.

12. In October 2000 a colony of coelacanths was discovered at a depth of 104 metres by amateur mixed-gas divers off the iSimangaliso Wetland Park in northern Zululand. This population has been well-studied and numbers over 26 individuals.

'13. On 22 November 2019 mixed-gas dil/ers found a live coelacanth at a depth of 69 metres off Pumula on the south coast of KwaZulu-Natal, about 350 km south of the ISimangaliso population. This discovery suggests that coelacanths may occur in suitable habitats between northern Zululand and East l::ondon, including the Wild Coast, but research submersible and mixed-gas dives to search for coelacanths have not as yet been carried out along this stretch of coast, including the Wild Coast, due to the treacherous nature of this coast and a lack of research funding.

14. Based on my own experience and available evidence, I confirm that the wreckfish, *Polyprion americanus,* do s occur off the Wild Coast in suitable habitats and that the coelacanth is likely to occur there as live specimens have been caught or seen on either side of the Wild Coast off Pumula and East London.

15. The known depth preferences of coelacanths range from less than 100 metres to 800 metres, and they probably occur even deeper in suitable habitats, but research dives in human-operated and remote-operated research

submersibles have not as yet been carried out deeper than 400 metres off South Africa or 800 metres off the Comoros.

16. As the swim bladders of coelacanths are filled with fat and not gas, and therefore do not create a density discontinuity in their bodies, they are less susceptible to the effects of water pressure at great depths, or at changing depths, compared to fishes with gas-filled swim bladders. Furthermore, coelacanths hunt at night using non-visual sensors (mainly electro-sensitive organs) so the lack of light at great depths is not a deterrent to them. They may therefore occur at depths greater than 800 metres if suitable habitats and prey species are present.

•The iconic status of the coelacanth

17. The first discovery of a coelacanth in 1938 is still regarded as one of the greatest biological discoveries of the twentieth century. The subsequent description of Latimeria chalumnae by Professor JLB Smith of then-Rhodes University College attracted international attention to South African science and resulted, six years later, in the establishment by the CSIR of the Department of Ichthyology at Rhodes University College. This Department eventually became the JLB Smith Institute of Ichthyology and then the South African Institute for Aquatic Biodiversity (SAIAB) in Makhanda, a world famous research institute. The Department of Ichthyology & Fisheries Science that I subsequently founded at Rhodes University arose directly from the Ichthyology Institute. The discovery of the coelacanth off South Africa

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therefore played a very important role in the development of ichthyology in South Africa and Africa.

18. The coelacanth is an iconic fish as it is a 'living fossil' that has provided a unique window into the past. It belongs to an ancient group of fishes whose fossil record stretches back over 400 million years, more than 150 million years longer than that of the dinosaurs, yet it survived all the five great extinction events including the Cretaceous Extinction Event 65 million years ago that killed off all the large non-flying dinosaurs.

19. Furthermore, the coelacanth was close to that important evolutionary step when backboned animals first left the sea and ventured onto land about 320 million years ago.

20. The coelacanth is a predator of fishes that sits at the top of the food pyramid and is therefore vulnerable to changes in the availability of prey lower down the food pyramid.

21. Coelacanths are large fish, reaching 100 kg and two metres in females.

22. Their breeding strategy is very advanced in that they produce a small number of large eggs (the largest eggs of any fish) and have an incubation period of 60 months (five years), more than twice as long as that of any other animal (African elephant: 22 months). Coelacanth young hatch inside the mother (this live-bearing mode of breeding occurs in only about 5% of fishes) and are large at birth (ea 500 grams, 33 cm). The females therefore make a very large

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parental investment in each of a few young. The loss of one pregnant female would therefore have a very negative effect on the population size.

23. Coelacanths are slow growing and reach an age of over 100 years, longer than that of almost all other fish except some polar sharks and other polar fishes. They only reach sexual maturity at an age of about 25 years so any coelacanth killed before that age has not had an opportunity to breed.

24. Many other superlatives are associated with the coelacanth, which emphasize its extreme conservation value: they have the lowest haemoglobin count in their blood of any vertebrate animal; they have the lowest resting oxygen consumption rate of any fish and the slowest known metabolic rate of any vertebrate animal, they are the only living animal that can lift their upper jaws and lower their lower jaws (to produce a wide gape while ambushing prey), they have a unique combination of morphological and physiological characteristics of sharks, bony fish and even four-legged animals, they have a unique three-lobed tail fin that is not found in any other fish, they unusually have eight fins, they have a unique sculling swimming action, and each fish has a unique pattern of white spots on its body which allows them to be individually identified. In addition, coelacanths have a rich cultural history, i.e. the extent to which they have been represented in poems, literature, language, films, sculptures, paintings and crafts, and on postage stamps and money.

25. Coelacanths do not occur in large numbers but they are social fish in that hey congregate in groups in caves and under rock overhangs during the day,

which would make them more vulnerable. They hunt at night using non-visual senses including electro-reception.

26. The only population estimate that has been made for L. chalumnae is that about 500 adults occur off Grand Corhoro island in the Comoros. No accurate estimate has been made of the number of coelacanths off our east coast but it is likely to be in the hundreds judging from observations and counts made elsewhere.

27. In South African law, the coelacanth is listed as Critically Endangered in terms of the "List of marine species that are threatened or protected, restricted activities that are prohibited and exemption from restriction" (GN 476 of 30 May 2017).

Potential implications of the seismic activity

28. Given the scarcity of the coelacanth and the difficulty of research involving the coelacanth, there is little, if anything, known about the potential impacts of seismic activities on this species.

29. However, given the long gestation period I have referred to above, and their late sexual maturity, the loss of any one coelacanth individual is likely to have a significant detrimental effect on their population as a whole, and particularly to the population occurring in the east coast waters of South Africa.

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IV//<

MICHAEL BRUTON

I hereby certify that the deponent has acknowledged that he:

(a) knows and understands the contents of this affidavit;
(b) has no objection to taking the oath;
(c) considers the oath to be binding on his conscience.

Thus signed and sworn to before me, at Rondebosch on 07 December 2021.

COMMISSIONER OF OATHS

NAME:

CAPACITY:

ADDRESS:

AREA:

SUID-AFRIKAANSE POLISIEDIENS
STASIEBEVELVOERDER
2021 -12- 07
STATION COMMANDER
RONDEBOSCH, K.P/C.P.
SOUTH AFRICAN POLICE SERVICE

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Abbreviated currfculum vitae

Retired Professor Mike Bruton MSc, PhD, DSc, FRSSAfr

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1. **Full names:** Michael Noel Bruton

2. **Date and place of birth:** 30th November 1946, in East London, South Africa.

3. **Citizenship:** South Africa.

4. **Permanent residential address:** 22 Forth Road, Rondebosch 7700, Cape Town, South Africa.

5. **Family:** Married to Carolynn, with two sons (Craig and Ryan) and a daughter (Tracey).

6. **Hobbies:** Hiking, diving, kayaking, public speaking, reading, writing, travel, photography, astronomy, cycling and golf.

7. **Special scientific interests:** History of science, South African and African inventions, technological innovation, nature of creativity, science and technology education, coelacanth research, and con rvation of biodiversity.

8. **Formal qualifications:** BSc (Hons) (1969, with distinction); Master of Science (1972, with distinction); Doctor of Philosophy (1976), Rhodes University, Grahamstown/Makhanda, South Africa; Doctor of Science *honoris causae* (2012), Rhodes University, South Africa.

9. **Main research fields:** Initially, ichthyology, aquatic biology and ecology, fish life historie . aquatic conservation, indigenous knowledge systems and environmental education. More recently, psychology of learning, nature of creativity, structure and function of the brain, history and development of museums and science centres, history and role of science and technology, history of Islamic contributions to science and technology, technological innovation, and African innovations.

10. **Awards:** *Fellow of the Linnean Society of London* (1979); *Fellow of the Royal Society of South Africa* (1984); Jaycees *'Outstanding Young South African'* Award (1985); *British Association for the Advancement of Science* Captain Scott Medal (1986); *Chevalier dans l'Ordre des Pa/mes Academique* from the Government of France (2001); *Lifetime Achievement Award,* National Science and Technology Forum, South Africa (2001); Emeritus Professor, University of Cape Town, South Africa (2004-present); Honorary doctorate, Rhodes University, South Africa (2012); Marloth Medal of the Royal Society of South Africa for contributions to science and science education over lifetime (NovembE 2020).

11. **Employer:** Currently self-employed as a science education consultant and science centre/science museum designer and developer based in Cape Town.

12. **Job description:** Director of Mike Bruton Imagineering, Cape Town

    - Scientific research and knowledge management

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- Consultancy services in the fields of science centre and museum conceptualization, design, project management and development; development of cost: benefit analyses and business plans for science centres and museums; conceptualization, design and development of indoor and outdoor exhibitions; development of exhibition content, and presentation using different media.
- Training of science centre and museum personnel in science centre management and development.
- Conceptualization and development of new exhibitions and displays in science centres and museums. ;
- Conceptualization and development of new science centres and museums.
- Popular science lectures in the fields of environmental conservation, creativity, brain structure and function, efficiency of learning, and the evolution and future of science centres and science awareness programmes.
- Development of science and technology teaching aids (books, teacher's and learner's kits, activity sheets, science shows, science demonstrations, science theatre, science festivals, science weeks).
- Writing popular science books, including biographies of famous South African §nd African scientists.

13. Prior experience:

- Originally trained as a marine and freshwater biologist and ecologist.
- Studied and conducted research in southern and central Africa, western Europe, Middle East, North America and south-east Asia.
- Achieved top research rating by National Research Foundation in South Africa in chosen fields of research (aquatic ecology, invasion ecology, ichthyology)
- Internationally recognized expert on African fish and fisheries, and especially on the coelacanth
- Published over 120 peer-reviewed scientific papers and authored, co-authored and edited 29 scientific b oks on aquatic biology, ichthyology, South African and African inventions and, ·elated topics
- Published five books targeted at children on marine and freshwater biology
- Published over 600 popular science and technology articles in magazines, newspapers and newsletters worldwide.
- Lectured under- and post-graduate students at universities and museums in South Africa, Malawi, Botswana, England, Wales, Scotland, France, Belgium, Netherlands, Malaysia, Thailand, USA, Canada, Australia, New Zealand and Saudi Arabia.
- pupervised the studies of over 40 post-graduate students in aquatic sciences at the Masters and Doctoral levels.
- Acted as external examiner for Masters and Doctoral degree studies from African, European, Australian and American universities.
- Served on numerous national and international scientific research committees, including the Scientific and Technical Review Panel of the International Ramsar Wetland Convention, and IUCN, VWWF, SSC and other international committees.
- International consultant on marine research, conservation and mariculture projects.
- Published book entitled 'Great S9uth African Inventions' through Cambridge University Press. Developed a travelling exhibition, and made many public presentations, on the same topic.

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- Have in press a book on African innovation entitled 'Harambee: The Spirit of Innovation in Africa' with the Human Sciences Research Council, which will be published in October 2021.
- Directly involved in the establishment of several field research stations, museums, aquaria and science centres in southern Africa, including the Lake ibaya Research Station, KwaZulu-Natal; JLB Smith Institute of Ichthyology (now the South African Institute for Aquatic Biodiversity), Grahamstown; Department of Ichthyology & Fisheries Science, Rhodes University, Grahamstown; Two Oceans Aquarium, Cape Town; MTN Sciencentre, Cape Town; Old Mutual-MTN Sciencentre, Umhlanga; Sci-Bono Discovery Centre, Johannesburg; Knysna Angling Museum, Knysna; Museum of Science and Technology in Islam, King Abdullah University of Science and Technology, Thuwal, Saudi Arabia.
- Appointed as a consultant through MTE Studios to launch the new Bahrain Science Centre in Isa Town, Bahrain, and acted as director of this science centre from February 2012 until April 2015.
- Appointed as Curator of the Trail's End Bicycle Museum in Grabouw.

14. Previous positions held:

- Officer-in-Charge, Lake Sibaya Research Station, KwaZulu-Natal, South Africa.
- Visiting Research Fellow, British Museum (Natural History), London, England.
- Professor and Founding Head, Department of Ichthyology & Fisheries Science, Rhodes University, Grahamstown, South Africa.
- Director, JLB Smith Institute of Ichthyology, Rhodes University, Grahamstown, South Africa.
- Founder, Knysna Angling Museum, Knysna, South Africa.
- I=ducation Director, Two Oceans Aquarium, Cape Town, South Africa.
- Founder-Director, MTN Sciencentre, Cape Town, South Africa. During my tenure as Director the MTN Sciencentre thrived, receiving over 120 000 visitors per year, and taking the lead as one of the most influential non-formal science education facilities in South Africa. During this time the MTN Sciencentre was effectively the agent of the Department of Science and Technology for their science awareness programmes in the Western and Northern Cape.
- Founder, Old Mutual-MTN Sciencentre, Umhlanga, near Durban, KwaZulu-Natal, South Africa.
- Conceotualized, designed, researched and developed content for nine traveling exhibitions from the MTN Sciencentre, Cape Town, including exhibitions on scientific discoverie and inventions, science of sport, and the educational value of games.
- Through MTE Studios, conducted research for a series of iconic interactive displays in the Ibn Battuta Mall, Dubai, on great Islamic inventions
- Through MTE Studios, conducted research and prepared signage for a major international traveling exhibition entitled 'Sultans of Science'
- Through MTE Studios, conducted research and prepared signage for a modern interactive exhibition on the Pebble Bed Modular Reactor (PBMR) and on nuclear energy.
- Consultant responsible for developing the business plan for the Sci-Bono biscovery Centre, Johannesburg, South Africa
- Consultant responsible for developing the business plan for the UDDI Discovery Centre, Uitenhage, South Africa.

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- President, Southern African Association of Science and Technology Centres (SAASTEC, 2001-2003); member of the Board of Directors of SAASTEC (2001- present).
- Member of the International Programme Committee of the Science Centre World Congress (2001-2004, 2007 2011)
- Chairman of the Local Organizing t:ommittee, and of the International Programme Committee, of the Sixth Science Centre World Congress, Cape Town (2007-2011)
- Board of Directors, MTN Sciencentre (now Cape Town Science Centre), Cape Town (2007- present)
- Member of numerous national and international science centre development committees and commissions of enquiry.
- Participated in science festivals, science centre conferences and workshops in 19 countries on five continents.
- Active participant in Science Centre World Congresses held in Calcutta (1999), Canberra (2002), Rio de Janeiro (2005) and Toronto (2008). Chair of the local and international organizing committees for the 6th Science Centre World Congress, which was held in Cape Town in September 2011 and attended by 430 people from 67 countries.
- Continued active involvement in the development of science centres and museums in southern Africa and the Middle East.
- Acted as *in-situ* advisor to the director of the Museum of Science & Technology in Islam at the King Abdullah University of Science & Technology in Thuwal, Saudi Arabia.
- Cu ration of displays for the first Bicycle Museum in Africa, in Grabouw, Western Cape.

15. **Membership of boards and committeeS'.** Board of the Cape Town Science Centre (since 1996); Honorary Research Associate, South African Institute for Aquatic Biodiversity (since 2016); Council of the Royal Society of South Africa (since 2019); Chairman of the Advisory Committee of *SciFest Africa,* the National Science Festival (since 2018); Senior Vice-President of The Owl Club, a cultural society in Cape Town established in 1894.

16. **Relevant experience:** I have been involved in a number of scientific research, science education, museum and science centre projects from initial conceptualization through design, development, implementation, launch and operation. These include:
    - Lake Sibaya Research Station, Zululand, South Africa
    - JLB Smith Institute of Ichthyology (now South African Institute for Aquatic Biodiversity), Grahamstown, South Africa
    - Department of Ichthyology and Fisheries Science, Rhodes University, Grahamstown, South Africa
    - Knysna Angling Museum, Knysna, South Africa
    - MTN Sciencentre (now Cape Town Science Centre), Cape Town, South Africa
    - Old Mutual-MTN Sciencentre, Umhlanga, KwaZulu-Natal, South Africa
    - Sci-Bono Discovery Centre, Johannesburg, South Africa
    - Museum of Science and Technology in Islam, Thuwal, Saudi Arabia
    - Bahrain Science Centre, Isa Town, Bahrain
    - Trail's End Bicycle Museum, Grabouw, Western Cape (curator)

    In most of these projects my tasks have included the following:

    - Brief development

- D velopment of the mission, goals, scope, theme, story line and take-home messages of the institution
- Development of the 'personality traits' of the institution
- Development of cost: benefit analyses and business plans
- Conducting SWOT analyses
- Contributions to the concept design of exhibition galleries and exhibitions
- Content development for exhibitions and displays
- Liaison with statutory authorities
- Preparation of fund-raising proposals
- Selection and co-ordination of professional teams and consultants
- Development and monitoring of work schedules
- Appointment of staff and volunteers
- Design review
- Design development review
- Chairing steering committee meetings
- Reporting to sponsors and other stakeholders
- Display curation
- Staff and volunteer training
- Development of public relations, marketing and media relations campaigns
- Development of outreach programmes
- Development of partnerships and collaborative programmes
- International liaison.

16. Contact details: Professor Mike Bruton, Mike Bruton Imagineering, Cape Town. Tel: 021 685 6925; Cell: 083 212 7609; Email: mikefishesbruton@gmail.com; website: www.mikebruton.co.za.

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38. Cooke, A., M.N. Bruton & M. Ravolololoharinjara. 2020. Coelacanth discoveries in Madagascar, with recommendations for research and conservation. South African Journal of Science (in press).

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IN THE HIGH COURT OF SOUTH AFRICA

(EASTERN CAPE DIVISION, GRAHAMSTOWN)

Case No: 3941/2021

In the matter between:

SUSTAINING THE WILD COAST AND OTHERS Applicants

and

MINISTER OF MINERAL RESOURCES AND ENERGY AND OTHERS Respondents

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SUPPORTING AFFIDAVIT

I, the undersigned,

ALEXANDER WINKLER

do hereby make oath and say:

1 I am an adult male at the Centre of Marine Science at the University of the Algarve Faro, Portugal.

2 The contents of this affidavit are to the best of my knowledge true and correct. Unless I indicate otherwise, or the contrary appears from the context, they are within my personal knowledge and belief.

3 My CV is attached marked **AW1.** I confirm that it is accurate.

4 I have personally reviewed Shell's EMPr. I attach my assessment of the EMPr, and, in particular, the developments in the research that have come since, hereto marked **AW2.**

ALEXANDER WINKLEF

The Deponent has acknowledged to me that she knows and understands the contents of this affidavit, which affidavit was signed and sworn to or before me at 18 Hamilton Avenue, Craighall Park, Johannesburg on this 6th day of December 2021 the regulations contained in Government Notice No. R1258 of 21 July 1972, having been complied with.

Nathan Mallinson
15 Biermann Avenue
Rosebank
Commissioner of Oaths Ex Officio
Practising attorney
Republic of South Africa

EXPERT OPINION

Introduction

1 In December 2021, Shell plans to start conducting a seismic survey to explore for oil and gas reserves along the east coast of South Africa as part of Transkei and Algoa Exploration Areas.

2 In light of the nature of these surveys and in response to the EMPr published in 2013 which was composed by Impact Africa I hereby offer my expert opinion on the likely effects and proposed mitigatory actions suggested by the EMPr.

3 The current EMPr investigates the likely effects of proposed survey on both important fishery species and the likely direct and indirect effects on the fisheries that operate in the region.

4 I hereby provide my expert opinion on the potential effects on the region's fish fauna. I do not only comment on species that are of importance to the fishing industry, but also about those that are important to the ecosystems functions as a whole. Any human effect on the ecosystem is likely to have unseen indirect effects on the entire ecosystem, causing subtle and slow trophic cascades that may only reveal themselves decades later.

5 Furthermore I note that there is a wealth of knowledge including at least two systematic peer reviewed articles on the effects of seismic surveys on fish that were published in Carroll et al. (2017) and Slabbekoorn et al. (2019) well after the publication of the EMPr in 2013.

6 I will also highlight new findings that have recently been reported by van der Knaap et al (2021) which have been possible due to technological advances in fish biotelemetry that have accurately been able to assess the direct behavioural effects on adult fish in the wild before, during and after seismic surveys. These advances in technology are only recently allowing us to understand the effects of these surveys on fish in a natural setting. Biotelemetry techniques involve the attachment of either data transmitters or archival loggers that record a variety of environmental parameters as well as fish movement and accelerometery information. Similar to athletes wearing smart watches or us using our cell phones to count of steps and calculate the amount of energy we use within a given day.

Expertise

7 I am a well published inshore fisheries expert with expertise in fish behaviour and life-history assessment. I currently hold a professional position as a junior researcher at the Centre of Marine Science at the University of the Algarve Faro, Portugal. My current positions include being a honorary research associate at the Department of Ichthyology and Fisheries Science, Rhodes University. I am a group member of the IUCN's Snapper, Seabream, Grunt Specialist Group.

Documents considered

8 The following documents were considered in drafting this opinion:

8.1 Impact Africa, Environmental Management Programme (EMPr), Transkei and Algoa exploration areas. June 2013.

8.2 Regulations gazetted under the Disaster Management Act, post the 16 April 2020 amendment;

8.3 Standard Operating Procedures published by the Minerals Council, dated 23 March 2020;

8.4 Standard Operating Procedures published by the Minerals Council, dated 9 April 2020; (this document refers to a 25 March 2020 SOP, but that document was not provided, it possibly means the 23 March 2020 SOP above)

8.5 10-Point Action Plan published by the Minerals Council, undated;

8.6 Minister of Mineral's remarks document, dated 25 March 2020;

8.7 Minister of Mineral's remarks document, dated 16 April 2020; and

8.8 Chief Inspector of Mining's Guiding Principles on Prevention and Management of Covid-19 in SAMI, dated 26 March 2020.

Disclaimer

9 The opinion is written in my personal capacity and is not necessarily the opinion of the organisations I am affiliated to. I reserve the right to amend, supplement, substitute, or vary my opinion if provided with further information or records.

Shortfalls found in the EM Pr

1O The EM Pr was conducted in 2013. Following the publication of this report at least two in-depth scientific reviews on the effects of seismic surveys on fish have been published that were not included in the report.

11 In my opinion a seminal fisheries study published by van der Knaap et al. (2021) in the Journal Current Biology (Impact factor > 10), highlights the direct behavioural effects of seismic surveys on the rhythmic behavioural patterns of cod in the North Sea was not included in this EMPr.

12 For example, the EMPr (see section 6.2, impacts on fish) states that "information on feeding success of fish (or larger predators) in association with seismic survey noise is lacking". I agree that maybe in 2013 this was lacking but the above-mentioned study directly links the effects of seismic surveys on the rhythmic diurnal foraging behaviour of cod in the North Atlantic. Reductions in foraging behaviour may leave less energy available to the fish to perform tasks that utilise considerable amounts of excess energy such as reproduction, growth or migrations.

13 At least two fish species (shallow-water hake and spiney dogfish) found within the survey area have been found to show rhythmic diurnal foraging behaviour (Pillar and Brange 1995, Juby et al. 2021) such as that exhibited by cod in the North Sea and therefore it is quite likely the effects of the survey would be similar.

14 Furthermore, the EMPr states that the "The ecological significance of such effects is therefore expected to be low, except in cases where they influence reproductive activity." While there is little evidence of direct effects on reproduction if the survey indirectly effects fish diurnal foraging patterns there is a likely effect on fish energy budgets and therefore the amount of energy fish can allocate to reproduction. I would therefore argue that indirectly the effects of the surveys would affect the reproductive processes of fish that perform rhythmic foraging behavioural patterns.

15 The EMPr provides little capacity in identifying the fish species of conservation concern (at risk of population declines or extinction) found within the proposed survey area, this is however not surprising given the most recent and in-depth South African National Biodiversity assessment was published in 2018. Unfortunately, 13 % of South Africa's linefish fish species are threatened with extinction and most are found along the East Coast. Of these fish more than 30% of the endemic seabream species are threatened and a further 27% are Near Threatened. Iconic endemic seabreams such as Seventy-Four *(Polysteganus undulosus* - Critically Endangered) (the same status as Black Rhinos), Red Steenbras *(Petrus rupestris* - Endangered) and Dageraad (*Chrysoblephus cristiceps* - Critically Endangered) have not yet recovered since the linefish 'State of Emergency' declared in 2000 (SANBI 2019). Both the Transkei and Algoa bay are thought to be population strongholds for both the juveniles and the adults of all three of the above-mentioned species (Parker et al. 2016).

16 In the absence of evidence that this survey will not directly or indirectly effect these species, the precautionary approach on species of such dire conservation concern is imperative if we are to conserve them into the future.

17 Furthermore, this area is known globally as the birthplace of the Coelacanth, when Courtney Latimer made the discovery of the ancient fish in East London on 23 December 1938, after an inshore trawler caught the fish off the Chalumnae river. The discovery of this ancient fish thought to be extinct, placed South Africa in the history books and stimulated ichthyological research within the country. While few Coelacanths have been found in this area again, a self-sustaining population exists in Isimangaliso but sightings have been made as far south as Pumula, an area close to proposed survey sight. Given the slow and lethargic nature of this charismatic species

there is no doubt that if they do inhabit the deep reefs of the Transkei they will be directly or indirectly affected by the survey.

Conclusions

18 There are some severe shortfalls in the EMPr that are a consequence of updated literature, technological advances and a growing global concern around the subtle indirect effects of noise pollution on marine ecosystems (Duarte et al. 2021). Given this new body of information I would suggest to the best of my knowledge that the effects of the survey will at least have lasting indirect energy budget effects on the Transkei and Algoa Bay's marine fish fauna which will probably affect processes such as reproduction and migration of certain species.

References

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Duarte, C.M., Chapuis, L., Collin, S.P., Costa, D.P., Devassy, RP., Eguiluz, V.M., Erbe, C., Gordon, T.A., Halpern, B.S., Harding, H.R. and Havlik, M.N., 2021. The soundscape of the Anthropocene ocean. *Science,* 371(6529).

Juby, R., Bernard, A.T.F. and Gatz, A , 2021. Day/night patterns of habitat use by dogfish sharks (Squalidae) at photic and subphotic warm-temperate reefs: evidence for diel movements and size-and sex-segregation. *African Journal of Marine Science,* 43(3), pp.325-336.

Parker, D., Winker, H., Attwood, C.G. and Kerwath, S.E., 2016. Dark times for dageraad Chrysoblephus cristiceps: evidence for stock collapse. *African Journal of Marine Science,* 38(3), pp.341-349.

Pillar, S. C., & Barange, M. (1995). Diel feeding periodicity, daily ration and vertical migration of juvenile Cape hake off the w st coast of South Africa. Journal of Fish Biology, 47(5), 753-768

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Slabbekoorn, H., Dalen, J., de Haan, D., Winter, H.V., Radford, C., Ainslie, M.A., Heaney, K.D., van Kooten, T., Thomas, L. and Harwood, J., 2019. Population-level consequences of seismic surveys on fishes: An interdisciplinary challenge. *Fish and Fisheries,* 20(4), pp.653-685.

van der Knaap, I., Reubens, J., Thomas, L., Ainslie, M.A., Winter, H.V., Hubert, J., Martin, B. and Slabbekoorn, H., 2021. Effects of a seismic survey on movement of free-ranging Atlantic cod. *Current Biology,* 31(7), pp.1555-1562.

Regards,

Dr Alexander Claus Winkler

Signed on 06/12/2020 at 18 Hamilton Avenue, Craighall Park, Johannesburg.

Curriculum **Vitae**

Alexander Claus Winkler

Personal Details

Date of Birth: 03-08-1988
Gender: Male
ID: 8808035080082
Nationality: South African / German
Languages: English (fluent), Afrikaans (conversational), Portuguese (conversational)
Cell Phone: (+27) 76717 9223
Email: alexwinkrsa@gmail.com
@alexwinkrsa

Education

BSc (PhD), Fisheries Science, 2018. Degree by thesis: Using a multi-method approach to understand the movement patterns and the associated environmental correlates of an iconic West African recreational fish **(Graduated) (Rhodes University)** available at:
http://vital.seals.ac.za:8080/vital/access/manager/Repository/vital:30597?site_name=GlobalView&query=winkler&sort=ss_dateNormalized+desc%2Csort_ss_title+asc&queryType=vitalDismax

BSc (Masters), Fisheries Science, 2014. Degree by thesis: Aspects of the biology of an inshore Sparid fish *Diplodus cervinus* (Lowe 1841) *off* the southern coast of Angola. **(Graduated with distinction) (Rhodes University)** available at:
http://vital.seals.ac.za:8080/vital/access/manager/Repository/vital:5361?site_name=GlobalView&exact=sm_creator%3A%22Winkler%2C+Alexander+Claus%22&sort=sort_ss_title%2F

BSc (Honours), Ichthyology and fisheries science, 2010. Degree by coursework and thesis: The effect of a dietary kelp additive and protein level on abalone *Haliotis midae* (Linnaeus) growth and canning yield. **(Graduated with distinction) (Rhodes University).**

BSc, majoring in Ichthyology and Fisheries Science and Botany, 2009. **(Graduated with distinction in Ichthyology and Fisheries Science) (Rhodes University).**

Achievements and Awards

African Coelacanth Ecosystem Project (ACEP) Postdoctoral Fellow Award - 2019
NRF Knowledge, Interchange and Collaboration (KIC) Travel Award - 2017
4th International Conference on Fish Telemetry Student Travel Award - 2017
Rhodes University Vice Chancellors Award for Community Engagement - 2017
Margaret Smith bursary - 2016
NRF - DAAD in country PhD Scholarship 2013 to 2015
NRF - DAAD in country MSc Scholarship 2011 and 2012
Rhodes University Fishing Club President - 2011
Rhodes University Full Academic Colours - 2010
Rhodes University Dean's List for Academic Merit - 2010
Rhodes University Fishing Club Chairman - 2010

Other Qualifications and Courses (all certificates or licences available on request)

Class IV Commercial Scuba Diving Supervisor- obtained at the RDU at the University of Cape Town 2018
Class IV Commercial Scuba Diver - obtained at the RDU at the University of Cape Town 2013
Category C Commercial Skippers Licence (vessel< 9m, 40 NM off-shore restriction)- issued by the South African Maritime Safety Association (SAMSA)

Curriculum Vitae

Veterinary proficiency certificate to implant transmitters and take blood samples from fish
Pre-Sea Safety Course - SAMSA
Code 08 Drivers Licence (light motor vehicle)
Level 3 First Aid - NOSA Port Elizabeth (2019)
Rescue Level Scuba Diver - PADI

Professional Positions

Centro de Ciences do Mar (CCMAR) Junior Researcher (Current) - Junior researcher working on the multidisciplinary BECORV project which aims to understand the movement biology of the meagre *(Argyrosomus regius)* in southern Portugal using acoustic and satellite telemetry as well as population genetics. Contact: David Abecasis - dabecassis@ualg.pt

GCRF One Ocean Hub Co-investigator (Current) - Co-investigator working on the sustainable fisheries component of a large multinational project lead by Strathclyde University aiming to transform our response to the urgent challenges facing our ocean in developing nations: Contact - oneocean-hub@strath.ac.uk

IUCN Snapper Sea bream and Grunt species survival group member (invited-Current) - A member of the conservation assessment group due to my specialist nowledge on sparid fish taxonomy and conservation biology. Contact: Barry Russell - Barry.Russell@magnt.net.au

Rhodes University Honorary Research Associate (Current)- Honorary research associate through the department of Ichthyology and Fisheries Science at Rhodes University. Contact: Clifford Jones - c.jones@ru.ac.za

African Coelacanth Ecosystem Project (ACEP) Postdoctoral Fellow (01/01/2019 - 30/12/2019)- Independent postdoctoral researcher based at Rhodes University working on a variety of projects relating to the understanding of how climate change and exploitation effect fish physiology and activity patterns with projects based in South Africa, Namibia and Angola. Contact person: Warren Potts - w.potts@ru.ac.za

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Work Related Experience

Ocean Tracking Network (OTN) Data and Equipment Management (2013 - 2019) - Responsible for the management of all acoustic telemetry data and equipment collected and used on two OTN projects in southern Angola and South Africa - a.childs@ru.ac.za

Rhodes University Recreational Fisheries Research Group Associated Scientist (2013 - current) - Participated as an associated research scientist in the formulation and collection of recreational fisheries data during various shore and boat-based fishing tournaments. - w.potts@ru.ac.za

Conference and Workshop Coordinator (2015 & 2019) - Coordinated the running and planning of an otolith preparation and ageing workshop as well as the 5th SAMLS Symposium (see www.samls5.com) in 2015 and 2019 respectively. Contact person: Warren Potts - w.potts@ru.ac.za

Commercial Diving Supervisor and Diver (Class IV) (2013 - 2019) - Contractual work for the South African Institute of Aquatic Biodiversity (SAIAB), South African Environmental Observation Node (SAEON) and Aquatic Ecosystem Services (AES) either servicing off-shore moorings or conducting benthic habitat assessments, > 100 diving hours logged, supervisors completed in 2018. Contact person: Russell Chalmers - pieter.truter@uct.co.za

Scientific manuscript reviewer (2013 - current) - The African Journal of Marine Science, Cahiers de Biologie Marine, Journal of Fish Biology and marine and freshwater research - https:l/publons.com/researcher/1305690/alexander-claus-winkler/

Grants

Curriculum Vitae

GCRF One Ocean Hub (2019 - 2024) - Co-investigator and collaborator on writing the sustainable fisheries component of the successful One Ocean Hub proposal (GCRF £ 20 million). Contact person: Warren Potts -w.potts@ru.ac.za

NRF South Africa/Namibia Bilateral grant (2017 - 2019) - Conceptualising and co-writing of the successful proposal to conduct thermal physiology work on fish being affected by a climate change induced hybridisation event occurring in Namibian coastal waters (NRF R 1.2 million). Contact person: Warren Potts - w.potts@ru.ac.za

NRF African Coelacanth Ecosystem Programme grant (2018 - 2020) - Conceptualising and co-writing of the successful proposal to conduct fish energetic studies on the effects of exploitation and climate change on a resident reef fish species using advanced acoustic telemetry techniques (NRF R 2 million). Contact person: Warren Potts - w.potts@ru.ac.za

Rhodes University Research Council Grant (2020 & 2021) - Principle investigator: *Working with, not against recreational ski-boat anglers,* research funding to conduct community engagement and fish health evaluations with recreational ski-boat in Port Elizabeth (US$ 1000 PA). Contact person: Amber Childs - a.childs@ru.ac.za

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Publication Record (published, chronological order) https://orcid.org/0000-0001-7864-8243

1. **Winkler, A.C.,** Butler, E.C., Mann, B., Attwood C., and Potts, W.M., 2021. The emergence of marine recreational drone fishing: regional trends and emerging concerns. *Ambio.* Available Online.
2. van der Walt, K A , Potts, W.M., Porri, F., **Winkler, A.C.,** Duncan, M.I., Skeeles, M.R., James, N.C., 2021. Marine heatwaves exceed the cardiac thermal limits of adult sparid fish *(Diplodus capensis,* Smith 1884). *Frontiers in Marine Science. 8,* 801.
3. Butler, E.C., Childs, A.R., Milner, M.V., Farthing, M.W., Duncan, M.I., **Winkler, A.C.** and Potts, W.M., 2021. Do contemporary age-growth models overlook life-history complexities in protandrous fishes? A case study on the large protandrous polynemid, the giant African threadfin *Polydactylus quadrifilis. Fisheries Research, 233,* p.105770.
4. Potts, W.M., Attwood, C.G., Cowley, P.O., Childs, A.R., **Winkler, A.C.,** Duncan, M.I., Murray, T.S., Mann, B.Q. and Mann-Lang, J.B., 2020. Editorial overview: recommendations for the promotion of a resilient linefishery in the Anthropocene. *African Journal of Marine Science,* 42(3), pp.255-267.
5. Pringle, B A , Childs, A.R., Butler, E.C., **Winkler, A.C.,** Duncan, M.I., Tela, C. and Potts, W.M., 2020. Time-course of the physiological-stress response in bronze bream *Pachymetopon grande* following a simulated catch-and-release angling event. *African Journal of Marine Science,* pp.1-6.
6. Skeeles, M.R., **Winkler, A.C.,** Duncan, M.I., James, N.C., van der Walt, K.A. and Potts, W.M., 2020. The use of internal heart rate loggers in determining cardiac breakpoints of fish. *Journal of Thermal Biology,* p.102524.
7. Muller, C., Childs, A.R., Duncan, M.I., Skeeles, M.R., James, N.C., van der Walt, K A , **Winkler, A.C.** and Potts, W.M., 2020. Implantation, orientation and validation of a commercially produced heart-rate logger for use in a perciform teleost fish. *Conservation Physiology,* 8(1), p.coaa035.
8. **Winkler, A.C.,** Mannheim, S., Childs, A.R., Santos, C., de Beer, C., Smale, M.J. and Potts, W.M., 2019. A snapshot assessment of the diet of Cape fur seals *Arctocephalus pusil/us pusil/us* at Ilha dos Tigres, Angola. *African Journal of Marine Science, 41(4),* pp.443-447.
9. **Winkler, A.C.,** Duncan M1. Farthing M., Potts W.M, (2019) Sectioned or whole otoliths? A global review of hard structure preparation techniques used in ageing sparid fishes. *Reviews in Fish Biology and Fisheries.* 29: 605-611
10. Potts, W.M., Parkinson, M., Sauer, W., Santos, C., **Winkler, A.C.,** Childs A.R. (2018). Testing the validity of catch rate and conventional tagging information for understanding fish migration

patterns using acoustic telemetry data. Canadian Journal of Fisheries and Aquatic Science (OTN special edition). 75 (12): 2364-2374. doi: 10.1139/cjfas-2017-0428

11. Arkert, N.K., Childs, A.R., Parkinson, M.C., **Winkler, A.C.,** Butler, E.C., Manneheim, S., Potts, W.M., (2018). Evaluating the effects of catch-and-re/ease angling on Cape stumpnose *(Rhabdosargus ho/ubi)* in a South African Estuary. *African Journal of Marine Science.* 40 (3): 235-244. doi: 10.2989/1814232X.2018.1494041
12. Butler, E.C., Childs, A.R., **Winkler, A.C.,** Potts, W.M. (2018). Evidence for protandry in *Polydactylus quadrifilis* in the Kwanza Estuary, Angola, and its implications for local fisheries. *Environmental Biology of Fishes,* 101 (2), 301 - 313. doi: 10.1007/s10641-017-0699-6
13. Gwilliam, M.P.*, **Winkler, A.C.*,** Potts, W.M., Sauer, W.H.H., Shaw, P.W., McKeown, N.J. (2018). Integrated genetic and morphological data eco-evolutionary divergence of Angolan and South African populations of *Dip/odus hottentotus. Journal of Fish Biology.* 92: 1163-1176. doi:10.1111/jfb.13582. *Joint authors
14. Farthing, M., **Winkler, A.C.,** Anderson, K., Kerwath, S., Potts, W.M., Wilke, C. (2018). The age and growth of hottentot *(Pachymetapon blochii)* before and after the South African line fish state of emergency in 2000. *African Journal of Marine Science.* 40(2): 187:196. doi: 10.2989/1814232X.2018.14 75302
15. Manneheim, S.L., Childs, A.R., Butler E.C., **Winkler, A.C.,** Parkinson, M.C., Farthing, M.W., Zwieg, T., Mccord, M., Drobniewska, N., Potts, W.M. (2018). Working with not against recreational anglers: evaluating a pro-environmental behaviour strategy for improving catch-and-release behaviour. *Fisheries Research.* 206: 44-56. doi: 10.1016/j.fishres.2018.04.016
16. **Winkler, A. C.,** Santos, C. V., Potts, W. M. (2014). Diagnosing the sexual pattern of *Diplodus cervinus hottentotus* (Pisces: Sparidae) from southern Angola. *African Journal of Marine Science,* 36(4), 505-512. doi: 10.2989/1814232X.2014.969771
17. **Winkler, A. C.,** Santos, C. V., Potts, W. M. (2014). Ontogenetic and seasonal shifts in the diet of *Diplodus cervinus hottentotus* (Pisces: Sparidae) in southern Angola. *African Journal of Marine Science,* 36(3), 323-330. doi: 10.2989/1814232X.2014.951392
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Conferences

Winkler A.C., Potts, W.M., Mann B.Q., Attwood C.A., Matuge D. (2020). Should we be worrying about marine recreational drone-fishing? Oral presentation. 6111 *International Marine Conservation Congress (IMCC),* Kiel, Germany. (online).

Winkler A.C., Arkert N.K., Bernard A.T.F., Butler E.C., Bova C.S., Childs A.R., Farthing M.W., Hewett K., Mannheim S., Mullins R., Potts W.M. (2019). Working with, not against, recreational anglers: two case studies on changing angler behaviour through engagement, education, rules changes and incentives. *Southern African Marine Linefish Symposium.* Mpekweni, South Africa.

Winkler A.C., Childs, A.R., Parkinson, M.C., Henriques R., Skeeles M., Santos, C., Potts, W.M., (2019) The importance of understanding intraspecific behavioural variation in migratory fishes and its impact on the adaptability of these fishes to climate change. Oral presentation, *3rd Species On the Move,* Skukuza, Kruger National Park, South Africa.

Winkler A.C., Parkinson, M.C., Childs, A.R., Santos, C., Potts, W.M., (2017) Acoustic telemetry reveals behavioural complexity in the leerfish *(Lichia amia* Teleostei: Carangidae) in southern Angola. Oral presentation, *4th International Conference on Fish Telemetry,* Cairns, Australia.

Winkler A.C., Parkinson, M.C., Childs, A.R., Santos, C., Potts, W.M., (2017) Acoustic telemetry reveals behavioural complexity in the leerfish *(Lichia amia* Teleostei: Carangidae) in southern Angola. Oral presentation, *South African Marine Science Symposium,* Port Elizabeth, South Africa.

Winkler A.C., Parkinson, M.C., Childs, A.R., Sauer, W.H.H, Roberts, M. Potts, W.M., (2016) Using acoustic telemetry to understand the intraspecific variation in the thermal range of *Lichia amia* in southern Angola. Poster presentation, *Bengue/a Symposium,* Cape Town, South Africa.

Workshops

Hidden Markov models for animal movement and other ecological data, 7th March 2016, Ocean Research, Mossel Bay, South Africa.

Movement ecology workshop, 5th February 2015, Nelson Mandela Metropolitan University, Port Elizabeth, South Africa.

South Africa - Namibia Joint Science and Technology Research Collaboration successful applicant launching workshop, 8-10 March 2017, Windhoek, Namibia

GCRF One Ocean, proposal writing workshop, 29 March - 1 April 2018, Glasgow, Scotland.

WIOMSA - Marine Organism Response to Climate Change Effects - Adaption or Extinction? 8 - 10 October 2018, Mombasa, Kenya

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Supervision, Teaching and engagement

Graduate students:

2016 - 2020 graduated, Edward Butler, Rhodes University, (PhD, supervisors: W. Potts and A. Childs)

2018 - 2020 graduated, Micheal Skeeles, Rhodes University, (MSc, supervisors: W. Potts and A. Childs) *Awarded a PhD scholarship to pursue a PhD at Deakin University, Australia

2019 - 2021, graduated, Brett Pringle, Rhodes University, (MSc, supervisors: W. Potts and A. Childs)

2013 - present, Honours students, Rhodes University, University of Fort Hare I have supervised and co-supervised various honours students working on smaller research projects primarily on fish life history, physiology and the effects of catch and release angling

Lecturing

2020, Commonwealth of Learning, Massive Online Course for Development, Understanding the Blue Economy, Fisheries. Lectured the fisheries section of the MOOC, pre-recorded lecture series - Kelly@unisey.ac.sc

2019, Lectured honours year Ichthyology students at Rhodes University on the current and potential effects of climate change on marine fish population - p.britz@ru.ac.za

2016 - 2017, Lectured honours year Zoology students at the University of Fort Hare on how to conduct and analyses fish life history studies in the context of how fish life histories have evolved. Contact person: Niall Vine - NVine@ufh.ac.za

2013 - 2018, Lectured second year undergraduate Ichthyology students at Rhodes University on how to conduct and analyses fish life history studies - p.britz@ru.ac.za

Engagement

United Nations World Oceans Week webinar co-organiser; Breaking Laws on the Sea, https:ljwww.youtube.com/watch?v=tOmP-7hZ08U

Breaking Laws on the Sea II - review global supply chains, external market incentives, and customary practices and pose the question "is localised enforcement is targeted at the right actors?

Curriculum Vitae

https://www.youtube.corn/watch?v=8uC4203R2wl&t=2s

References

Prof Warren Potts: Professor of Ichthyology, DIFS, Rhodes University
Relationship: MSc and PhD supervisor
Tel: +27 (0)46 603 8415, Email: w.potts@ru.ac.za

Dr Amber Childs: Lecturer, DIFS, Rhodes University
Relationship: PhD co-supervisor
Tel: +27 (46) 603 8317, Email: a.childs@ru.ac.za

Dr Rhett Bennet: Shark and ray conservation officer (WIO), Wildlife Conservation Society
Relationship: Collaborator
Tel: +27 084 329 9272, Email: rbennet@wcs.org

IN THE HIGH COURT OF SOUTH AFRICA
(EASTERN CAPE DIVISION, GRAHAMSTOWN)

Case No: 3941/2021

In the matter between:

SUSTAINING THE WILD COAST NPC	First Applicant
MASHONA WETU DLAMINI	Second Applicant
DWESA-CWEBE COMMUNAL PROPERTY ASSOCIATION	Third Applicant
NTSINDISO NONGCAVU	Fourth Applicant
SAZISE MAXWELL PEKAYO	Fifth Applicant
CAMERON THORPE	Sixth Applicant
ALL RISE ATTORNEYS FOR CLIMATE AND THE ENVIRONMENT NPC	Seventh Applicant

and

MINISTER OF MINERAL RESOURCES AND ENERGY	First Respondent
MINISTER OF ENVIRONMENT, FORESTRY AND FISHERIES	Second Respondent
SHELL EXPLORATION AND PRODUCTION SOUTH AFRICA B V	Third Respondent
IMPACT AFRICA LIMITED	Fourth Respondent
BG INTERNATIONAL LIMITED	Fifth Respondent

CONFIRMATORY AFFIDAVIT

I, the undersigned

DAVID WILLIAM RUSSELL

do hereby make oath and say as follows:

1. I am an adult male fisheries consultant in Namibia. I have worked in this capacity for a wide range of government, non-governmental and private organisations. Between 2013 and 2017, I assisted the Namibian Albacore Tuna Sector in liaising between the Namibian Government through the Inter-Ministerial Seismic Taskforce, and later the commercial oil exploration sector, known as the Namibian Petroleum Operators Association.

2. The facts contained in this affidavit are within my personal knowledge, except where the context indicates otherwise, and are to the best of my belief both true and correct.

3. I confirm that the report annexed hereto marked "**DWR1**" is to the best of my knowledge and belief true and correct.

4. I further confirm that my qualifications and experience are set out in a copy of my *curriculum vitae,* attached to this affidavit marked "**DWR2**". I respectfully submit that I am qualified by my qualifications, training and experience to express the expert opinions which are set out in the report referred to above.

_____

WILLIAM DAVID RUSSELL

I hereby certify that the deponent has acknowledged that she:

(a) knows and understands the contents of this affidavit;
(b) has no objection to taking the oath;
(c) considers the oath to be binding on her conscience.

Thus signed and sworn to before me, at on **December 2021**.

_____

COMMISSIONER OF OATHS

NAME:

CAPACITY:

ADDRESS:

AREA:

Statement made on request by Wilmien Wicomb, lawyer representing small-scale fishers in South Africa, by William David Russell, via email from Swakopmund, Namibia, on 6 December 2021.

To whom it may concern:

I have been requested to make a statement, to which I have agreed of my own free will, regarding my professional experience relating to Shell Oil's presence and work ethic specifically with regards to Environmental Impact Assessment (EIA) compliance, in Namibia. I state on good conscience as follows:

I am a fisheries consultant in Namibia, and have worked in this capacity for a wide range of governmental, non-governmental and private organizations, both locally and internationally, and both from within Namibia and based abroad. From 2013, through to 2017 I assisted, on a part-time, needs-basis, the Namibian Albacore Tuna Sector in liaising between the Namibian Government through the Inter-Ministerial Seismic Taskforce, and later the commercial oil exploration sector, known as the Namibian Petroleum Operators Association (NAMPOA) including Shell Oil Exploration, Namibia. My assistance and interest have always been to ensure sustainability of Namibia's fish and marine species, as well as the commercial fisheries sector. (I have simultaneously been assisting the Confederation of Namibian Fishing Associations on various, similar concerns).

Our Namibian experience in the albacore tuna fishing industry was briefly as follows:

- There is a requirement in Namibia that key economic activities with potential impact on the environment, whether on land, or sea, can only be approved after submission of proper Environmental Impact Assessment (EIA) studies.

  In recent years under the Environmental Management Act, Shell Oil Exploration Namibia would have had to submit an EIA before getting the go-ahead for any seismic surveillance activity. From memory, Shell Oil Exploration Namibia, in the period immediately preceding the gazetting of the Environmental Management Act, acted under the spirit of the to be gazetted Act, by undertaking an EIA for a seismic survey, even though at the time it was not required under the Mining Act.

- Another element of Shell's presence in Namibia that has been very positive, was its open and mutually beneficial consultations with the fishing industry.

  I can testify that current Shell Exploration Namibia Manager, Mr Dennis Zekveld, has liaised initially with the albacore tuna fishing sector based in Luderitz, and later through myself, which I relayed back to the fishing sector. This contact established with the fisheries sector became a communication link that had a vital positive impact on the way the seismic survey was designed. Meaning, Shell Oil Exploration Namibia asked the fishing industry to raise their genuine concerns, and then took on board those concerns to design the seismic survey in such a way as to minimise the impact on the fishery.

- It has to be noted that in the period from 2012, onwards to around 2017, seismic exploration activity close to the Namibian albacore tuna grounds in the South of Namibia increased significantly, with an equivalent downturn in tuna catches. Fish in the locality of the albacore tuna grounds in Southern Namibia, mostly migrated away when seismic surveys in the area were underway. Due to seismic

surveys needing to occur while seas are calm in the summer months, this conflicted with the migratory tuna season over the same period. Shell Oil Exploration Namibia was able to diminish this impact through consulting with the albacore tuna fishing sector, and then designing its seismic survey accordingly.

- The sudden drop in catches around 2012 and the years that followed while seismic exploration activity was intense, had a devastating economic impact on the albacore tuna industry based in Luderitz. Many seasonal fishermen lost their jobs in the tuna sector during this period.

  Although it is hard to provide direct evidence that tuna migration and catch losses were caused by seismic surveys (research of this magnitude is very expensive), the circumstantial evidence was there. For this reason, the Namibian fisheries sector continues to urge for a precautionary approach as the ethical and responsible strategy. The fisheries sector appreciates the initiation and continuation of dialogue with Shell Oil Exploration Namibia, including Shell's sincere positive response to try and mitigate risks and potential impacts of seismic sound chasing the fish away.

Southern Africa shares a valuable natural resource in migratory albacore tuna, and from Namibia's side we would consider it an unwise decision if South Africa relied on the apparently less accountable Environmental Management Programme of 2013 to guide its seismic activities, especially since a requirement for EIAs for seismic surveys was introduced in South Africa in 2014, for companies to comply with. Shell, being a major international oil company with corporate social responsibilities, would do well to apply its positive Namibian experience in South Africa too, to undertake an EIA related to potential seismic impacts, including positively communicating with the small-scale fishers, whose meager livelihood could be significantly negatively impacted if the fish run away due to seismic survey noise, in an effort to mitigate against this risk.

I hope this helps to clarify.

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