Evaluation of the Final Environmental Impact Assessment Report

Multi-commodity Prospecting Activities in Marine Concessions 11A, 12A, 13A, 11B, 12B and 13B, West Coast, South Africa

Impacts to Marine Resources

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Context

This report analyzes the Final Environmental Impact Assessment (EIA) Report: Multi-commodity Prospecting Activities in Marine Concessions 11A, 12A, 13A, 11B, 12B and 13B, West Coast, South Africa with emphasis on its associated Marine Ecology Impact Assessment (MEIA; Appendix C1) with an aim to reflect on six specific aspects (see points 1-6 below) that investigate whether marine impacts were adequately addressed in response to the Biodiversity Law Centre's request to ELAW to provide expert scientific and technical input. In summary, we find major deficiencies in the scope of the assessment, inadequate mitigation measures proposed, and critical technical inaccuracies in defining the project's footprint, the scale and intensity of impacts.

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Dr. Melissa Garren joined ELAW in 2021, bringing over 20 years of experience working at the intersection of ocean and coastal environmental issues that impact communities spanning disciplines, including engineering, water quality, microbiology and biotechnology, disease, aquaculture/fisheries, and social issues. She earned a doctorate and master's in marine biology from Scripps Institution of Oceanography and a bachelor's in molecular biology from Yale University. She completed a postdoctoral fellowship at MIT in the Department of Civil and Environmental Engineering.

1: Assessment of impacts to the Olifants Estuary

The EIA (including the associated expert reports) completely fails to assess potential impacts to the Olifants Estuary from transport of pollution (inclusive of suspended marine sediment or noise pollution) from prospecting activities. In fact, failing to include any estuary impact assessment is especially concerning because two estuaries are found in the concession areas: the Sout River estuary is located in Concession 11a and the Olifants estuary is in Concession 12a. The documents provide some key context from the literature about how important the estuary is from a fisheries nursery perspective for high-value linefish species and notes that the estuary spends 6 months of the year in a marine-dominated state.[1]

[1] Appendix C1, section 4.3.3.3 Estuaries, pages 88-89: "*Predominantly open estuaries and estuarine lagoons are particularly important for recruitment for some inshore linefish species and are the most vulnerable to marine pollution events as they receive tidal inflows almost constantly….Under modern conditions of low flows and reduced*

The EIA provides maps (on pgs. 48-49) showing that the Olifants Estuary is classified as Endangered habitat and sections of this fall within the boundaries of the concessions they intend to prospect (see Figs 4-6 and 4-7 copied below). The EIA also states that the prospecting will only avoid sensitive areas when it's practical from the project proponents perspective without any indication of how practicality would be assessed.[2] This leads the reader to believe that the project proponents will not avoid the sensitive habitat at the Olifants river mouth and its estuary if they believe resources of value to them may be found there. Notably, failing to adhere to internationally accepted good practice for EIAs, the documents do not contain any quantitative modeling to provide projections of how sediments may be transported into sensitive habitats due to the proposed prospecting activities. The impact was assessed to be low, but with no defensible methodology or data-informed basis provided for how that conclusion was drawn. All of the responses documented in Appendix B2 that the project proponents provided to stakeholders said that concerns regarding impacts were addressed by expert reports that concluded no meaningful impact was expected; however, not one of those expert reports provides a technically sound demonstration of how such conclusions were drawn. There are no expert reports from an oceanographer or pollution transport specialist to assess the currents, transport dynamics, or vulnerability of sensitive habitats, such as the Olifants Estuary, to impacts from the proposed project sampling. And there appears to be a complete absence of credible methodology behind the assertions made by the EIA and Appendices regarding the categories assigned for levels of impacts throughout the documents.

On what basis could the EIA possibly have concluded that the Olifants Estuary, which it reports is dominated by influence from marine waters for half of the year, would not be impacted negatively by the intense sampling plan proposed? There was absolutely no sampling or modeling done to support such an assertion, and the information that the EIA itself provides (i.e. that the estuary is marine-dominated for large parts of the year), are in contradiction to that conclusion. The EIA (see excerpt highlighted on pg. 96 below) simply claims that the marine-dominated habitat is unlikely to receive suspended sediments from sampling without any evidence provided whatsoever to support such a claim. There is no evidence provided in Annex C1 or C2 either. It appears to be a completely unsupported and unsubstantiated claim, upon which rests a huge portion of the project proponents' confidence that the endangered habitat will not be negatively affected.

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winter flood peaks, the ***Olifants River estuary experiences a marine-dominated state for about six months of the year (November to April)*** *with salinities of 5 ppt throughout the water column penetrating some 20 km upstream….. The Olifants River estuary supports a large salt marsh habitat with a combined area of inter- and supratidal habitat of 1,010 ha. The invertebrate community of the Olifants River estuary is characterised by high abundance relative to other South African estuaries, and comparatively high species diversity for the west coast. As many as 38 fish species have been recorded in the estuary, of which 18 can be regarded as being either partially or completely estuarine dependent.* ***The estuary also serves as an important nursery area for many highly-valued linefish species including white steenbras, west coast steenbras, silver kob, and elf. For many of these the stocks are overexploited or have collapsed emphasising the importance of the estuary in maintaining the range and stock integrity of these species*** *along the west coast.*" (**emphasis** added)

[2] EIA pg.11: "**Where practicable**, the bulk sampling sites will be selected to avoid sensitive environments such as marine areas of conservation importance and heritage features." (**emphasis** added)

The unconsolidated sediments in the sampling target areas comprise primarily medium to fine sands, with a minimal silt and clay fraction. The suspended sediment plumes generated through discharge of fine tailings during drill sampling will be localised to within a few 100 m of the sampling vessel and as they will be ephemeral, negative effects of increased suspended sediment concentrations on marine communities are highly unlikely as biota would be well adapted to naturally high suspended sediment concentrations. Even the highest concentrations in the immediate discharge are unlikely to reach concentrations that would have lethal effects on marine fauna or inhibit primary productivity of phytoplankton or nearshore algae. Similarly, due to their highly localised and ephemeral nature, any suspended plumes generated in the southern portion of Concession 12A and 12B and in proximity to the mouth of the Olifants River, are highly unlikely to penetrate the river mouth and influence the estuary, even during summer months when the waters of the estuary are clear and marine-dominated. In the unlikely event that plumes enter the estuary, suspended sediment concentrations are unlikely to reach levels that would have lethal or sub-lethal effects on marine biota.

The biochemical impact of reduced water quality through increased turbidity is assessed as ***insignificant.*** No mitigation is possible (or necessary) (Table 6-9).

Table 6-9: Significance of the disturbance of marine fauna due to increased turbidity and reduced light penetration

	Extent	Intensity	Duration	Consequence	Probability	Significance	Status	Confidence
Without mitigation	Local 1	Low 1	Short 1	**Very Low** **3**	Improbable	**INSIGNIFICANT**	– ve	High
Essential mitigation measures: None.								

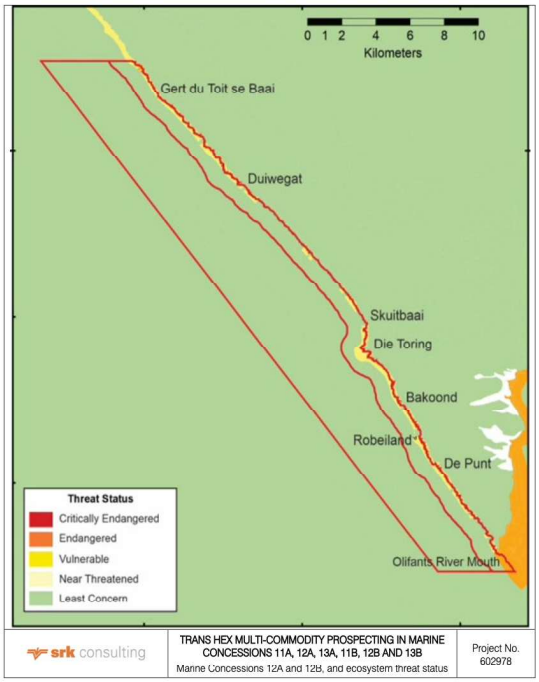

Figure 4-6: Marine Concessions 12A and 12B, and ecosystem threat status

Source: (Pisces Environmental Services, 2024)

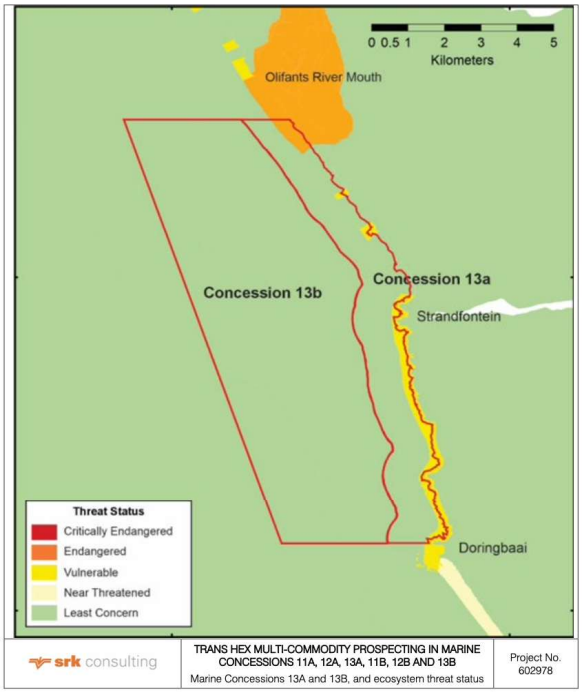

Figure 4-7: Marine Concessions 13A and 13B, and ecosystem threat status (right)

Source: (Pisces Environmental Services, 2024)

Furthermore, Appendix C1, section 4.2.8 Turbidity, appears to be the only section in which any quantification of sediment suspension or background levels of suspended particulates are provided, and none of the information comes from field sampling, as would be expected from an EIA process for a project of this scale. Aggregiously, not only is there a complete absence of primary data, but the literature upon which the authors rely is extremely old by professional standards in the field with most of the citations coming from the 1980's and 90's. The most

recent document referenced in that section is > 20 years old (from 2003), and it emphasizes the point that anthropogenic induced turbidity increases are a global threat to biodiversity[3]– again, the EIA is contradicting its own assertion that this project will be low-impact.

2: Assessment of impacts on marine biodiversity

The EIA does not adequately address biodiversity or the ecosystem processes that sustain it. "Resilience" is the critical ability of an ecosystem (and the services it provides) to respond to disturbance by absorbing the impacts such that it can withstand disturbance or recover quickly from disturbances. This ability to resist and recover from disturbances is a fundamental feature of any natural ecosystem that allows communities dependent on natural resources to sustain themselves in the face of natural disasters (such as hurricanes or floods). When man-derived disturbances are added to an ecosystem's natural stress load, the ecosystem's ability to absorb and recover from natural disturbance can be dramatically or catastrophically affected. The ecosystem can change dramatically from its traditional state to some alternative, stable state that may not support the environmental services originally provided.[4,5]

A classic example of this phenomenon occurred in the Caribbean coral reefs of Jamaica in the early 1980s, when a series of natural disasters, beginning with Hurricane Allen in 1980, combined with chronic overfishing and long-term nutrient pollution to create a dramatic shift from a healthy coral-dominated system to an alternate steady state algae-dominated system. In this case, the reefs appeared to be doing well and functioning until a hurricane hit and nothing recovered as it normally did because local stressors (in this case, mainly pollution and overfishing) had eliminated their ability to do so. And now, > 40 years later, and only after major changes in local management practices, communities are finally starting to see reef recovery.[6,7] This example underscores the important messages in the restoration literature that advocates for the incorporation of a more complex set of ecological factors and interactions (trophic interactions, disease, substrate processes, etc.) in any attempted restoration effort, as well as instituting long-term monitoring to assess restoration success.[8,9]

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[3] Appendix C1 pg. 29: "*there has been a **worldwide increase of water turbidity and sediment load in coastal areas as a consequence of anthropogenic activities**. These include dredging associated with the construction of harbours and coastal installations, beach replenishment, accelerated runoff of eroded soils as a result of deforestation or poor agricultural practices, and **discharges from terrestrial, coastal and marine mining operations** (Airoldi **2003**). Such increase of sediment loads **has been recognised as a major threat to marine biodiversity** at a global scale (UNEP 1995).*" (**emphasis** added)

[4] Sasaki, T., Furukawa, T., Iwasaki, Y., Hedge, M., & Mori, A. S. (2015). Perspectives for ecosystem management based on ecosystem resilience and ecological thresholds against multiple and stochastic disturbances. Ecological Indicators, 57, 395-408.

[5] Knowlton, N. (1992). Thresholds and multiple stable states in coral reef community dynamics. American Zoologist, 32(6), 674-682.

[6] Lason, C., November 4, 2019. Restoring Jamaica's lost coral reefs, The Guardian. https://www.theguardian.com/environment/2019/nov/04/restoring-jamaicas-lost-coral-reefs-photo-essay

[7] Knowlton, N., & Jackson, J.B.C. (2008). Shifting baselines, local impacts, and global change on coral reefs. PLoS Biology, 6(2), e54

[8] Freeman, L. A., Corbett, D. R., Fitzgerald, A. M., Lemley, D. A., Quigg, A., & Steppe, C. N. (2019). Impacts of urbanization and development on estuarine ecosystems and water quality. Estuaries and Coasts, 42, 1821-1838.

[9] https://www.mangrovealliance.org/wp-content/uploads/2023/10/Executive-Summary_Best-Practice-Guidelines-for-Mangrove-Restoration_v4.pdf

The U.S. National Research Council (2013) highlights that "*increasing resilience can reduce the risk of the system crossing critical thresholds and undergoing harmful regime change ... The resilience of the system can play an important role in maintaining the conditions that will sustain the provision of environmental services that contribute to human well-being.*" [10]

In addition, the resilience of environmental services provided by coastal marine ecosystems is less researched and understood than terrestrial ecosystems, and thus it is not possible to reasonably predict the period of time during which environmental services will be absent. This is particularly important in the context of climate change, as communities will rely more on the ability of the natural ecosystem to recover from the increased frequency of disturbances that are anticipated to accompany this planet's changing climate (i.e., the Anthropocene era that is upon us, see quote below) and that resilience is severely affected by additional human-induced local disturbances.[11] Appendix C1 (pg. 89) specifically highlights the high annual economic value of South Africa's estuaries with respect to ecosystem services as a nursery[12], and the research article cited (Turpie et al. 2017) also provides strong valuations of additional services such as flood protection.[13]

Best practices require that ecosystem services be explicitly considered and treated with the same respect and rigor as biodiversity itself. Perhaps the most relevant standard for these proposed surveys is the International Finance Corporation (IFC) *Performance Standard 6: Biodiversity conservation and sustainable management of living natural resources*.[14] This standard explicitly requires that ecosystem services be considered. The introduction of the standard states:

> "Performance Standard 6 recognizes that protecting and conserving biodiversity, maintaining ecosystem services, and sustainably managing living natural resources are fundamental to sustainable development. The requirements set out in this Performance Standard have been guided by the Convention on Biological Diversity, which defines biodiversity as 'the variability among living organisms from all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species, and of ecosystems.'...
>
> Ecosystem services valued by humans are often underpinned by biodiversity. Impacts on biodiversity can therefore often adversely affect the delivery of ecosystem services." (emphasis added).

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[10] Committee on the Effects of the Deepwater Horizon Mississippi Canyon-252 Oil Spill on Ecosystem Services in the Gulf of Mexico; National Research Council (2013) An Ecosystem Services Approach to Assessing the Impacts of the Deepwater Horizon Oil Spill in the Gulf of Mexico. National Academies Press. Chapter 3.

[11] Woodhead, A. J., Hicks, C.C., Norström, A. V., Williams, G. J., & Graham, N. A. (2019). Coral reef ecosystem services in the Anthropocene. Functional Ecology, 33(6), 1023-1034.

[12] Appendix C1 (pg. 89): "*Turpie et al. (2017) estimated the contribution of the estuarine nursery function as R960 million in 2018 terms (equivalent to over R1 billion in 2020) to the South African economy*"

[13] Turpie, J. K., Forsythe, K. J., Knowles, A., Blignaut, J., & Letley, G. (2017). Mapping and valuation of South Africa's ecosystem services: A local perspective. Ecosystem services, 27, 179-192.

[14] IFC World Bank Group, January 1, 2012. Performance Standard 6 Biodiversity Conservation and Sustainable Management of Living Natural Resources
https://www.ifc.org/content/dam/ifc/doc/2010/2012-ifc-performance-standard-6-en.pdf

With respect to benthic communities, the Marine Ecology Impact Assessment (MEIA; i.e., Appendix C1) identifies reef communities containing sponges, bryozoans, sea fans, soft corals, hydroids and other attached organisms, yet it does not evaluate how much sediment would actually settle onto these organisms or whether deposition would exceed their ability to clear sediment. Although the MEIA maps Vulnerable Marine Ecosystem habitat, it does not overlay predicted sediment plumes onto those habitats to determine whether reefs containing sensitive organisms would actually be affected. The report concludes that sediment impacts will be of low significance but does not present any hydrodynamic or sediment transport modelling predicting the horizontal extent of sediment plumes, suspended sediment concentrations, rates of deposition, thickness of deposited sediment, or duration of burial.

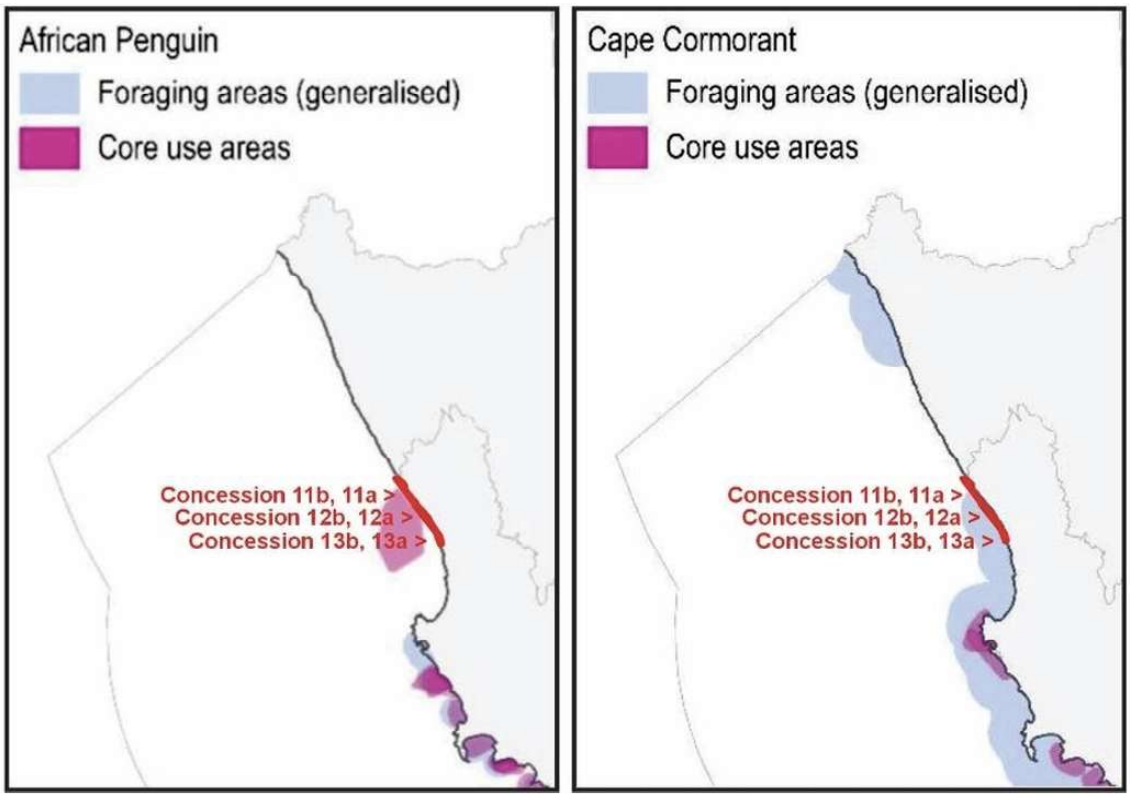
3: Evaluation of condition 4, which bans geophysical surveys between June and November to avoid disturbing baleen whales, to adequately prevent harm

Condition 4 of the Environmental Authorization (EA) is specific to migratory cetaceans: "*No Geophysical surveys are to be conducted from June to November to avoid the potential disturbance of the movement of migratory cetaceans (Particularly Baleen whales)*." By requiring a ban on geophysical surveys to protect whales, it's clear the regulatory agency deems the surveys to be disruptive and harmful to migrating baleen whales, despite the severely underestimated "insignificance" finding put forward in the EIA. Page 64 of the Marine Ecology Impact Assessment (MEIA) states, "... the blue whale is considered 'Critically Endangered', the sei whale is 'Endangered' and the fin and sperm whales are considered 'Vulnerable' (IUCN Red Data list Categories)." Table 4-9 shows the seasonality of baleen whales, in the broader project area, including these highly vulnerable species. While condition 4 of the EA would prevent impacts to whales from June to November, it's clear that all of these species are present in the area throughout the year, and some highly vulnerable species have high (H) abundance outside of the June-November time frame.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Bryde's Inshore	L	L	L	L	L	L	L	L	L	L	L	L
Bryde's Offshore	**H**	**H**	**H**	L	L	L	L	L	L	L	L	L
Sei	L	L	L	L	**H**	**H**	L	**H**	**H**	**H**	L	L
Fin	M	M	M	**H**	**H**	**H**	M	**H**	**H**	**H**	M	M
Blue	L	L	L	L	L	**H**	**H**	**H**	L	M	L	L
Minke	M	M	M	**H**	**H**	**H**	M	**H**	**H**	**H**	M	M
Humpback	M	M	L	L	L	**H**	**H**	M	M	L	M	**H**
Southern Right	**H**	M	L	**L**	L	**H**	**H**	**H**	**M**	**M**	**H**	**H**
Pygmy right	**H**	**H**	**H**	M	L	L	L	L	L	L	M	M

Condition 4 does not address non-cetaceans sensitive receptors in the area even though there are many in the area. We note conflicting and incorrect statements on page 30 in the MEIA: "The biological communities consist of many hundreds of species, often displaying considerable temporal and spatial variability (even at small scales). No rare or endangered species have been recorded (Awad et al. 2002)." This is clearly incorrect based on the information above and on pages 43-44 and 53-54 that report Endangered and Critically Endangered shark and fish species

occur in the area. The assessment also notes three species of sea turtle, all of which have Endangered or Critically Endangered status, occur in the area. And at least two Endangered bird species, Cape Cormorant and African Penguin, are reported in the direct project area, as shown the excerpt below from Figure 4-27, and stated on page 59 of the MEIA: "Concessions 11a, 12a, 13a and 11b, 12b and 13b lie within the aggregate core home ranges of African Penguins."



A Cape fur seal breeding colony is located in Concession 12a, and non-breeding colonies and haul-out sites occur throughout the additional concessions. The MEIA states on page 79 these non-breeding sites, "All have important conservation value since they are largely undisturbed at present." This section also illustrates the vulnerability of Cape fur seals to declines in pelagic fish populations, which is described to have likely caused a massive mortality event in 2021.

Condition 4 of the EA would only prevent impacts to these species from June to November, leaving them vulnerable and potentially heavily impacted the rest of the year.

4: Evaluation of conditions 3, 5 and 2, which aim to protect marine fauna from the impacts of noise

The mitigation measures required by the EA to protect marine fauna from the impacts of noise (conditions 3, 5, and 2) are not based on best practices and unlikely to be effective. Condition 2 only requires "a" Marine Mammal Observer (MMO). One person would not be sufficient to provide adequate surveillance continuously during operations, which is why, well known best practices require a sufficient number of trained observers to cover round-the-clock operations

with reasonable work hours and breaks to keep their eyes fresh.[15] Condition 3 is especially problematic: "*Terminate sampling/survey if any marine mammals exhibit affected behaviour within 500m of the survey vessel or equipment & resume only after the marine mammals/penguin has vacated the area*" (emphasis added). This means the surveys can continue unless a MMO deems an animal to be exhibiting affected behavior. A 500-m clearance or exclusion zone, in which no sensitive species can be present during operations, is considered standard practice and would therefore be considered the minimum radius that should be used for protection of marine fauna. The United States establishes two different sizes of exclusion zones for seismic surveys depending on species present, with a 1.5-km exclusion zone required for beaked whales, sperm whales, and baleen whales. The same guidance also requires a buffer zone around 500-m exclusion zones where monitoring should also occur, which effectively acts as an extension of the 500-m exclusion zone out to 1,000 m, as described below:

> "7. Exclusion zone means the area to be monitored for possible shutdown in order to reduce or eliminate the potential for injury of protected species. Two exclusion zones are defined, depending on the species and context. For beaked whales, *Kogia spp*., sperm whales, and baleen whales, the exclusion zone encompasses the area at and below the sea surface out to a radius of 1.5 kilometers from the edges of the airgun array (0–1,500 meters). For all other protected species, the exclusion zone encompasses the area at and below the sea surface out to a radius of 500 meters from the edges of the airgun array (0–500 meters).
> "8. Buffer zone means an area beyond the exclusion zone to be monitored for the presence of protected species that may enter the exclusion zone. During pre-clearance monitoring (i.e., before ramp-up begins), the buffer zone also acts as an extension of the exclusion zone in that observations of marine mammals and sea turtles within the buffer zone would also prevent airgun operations from beginning (i.e. ramp-up). The buffer zone is not applicable for contexts that require an exclusion zone beyond 500 meters. The buffer zone encompasses the area at and below the sea surface from the edge of the 0–500 meter exclusion zone, out to a radius of 1000 meters from the edges of the airgun array (500–1,000 meters)"[16]

Furthermore, page 99 of EIA (page 112 of the Marine Ecology Impact Assessment) states the use of a 15-minute pre-survey scan will be used, when best practice is a minimum of 30 minutes,[17] and there is no description of the survey area that should be monitored. The MEIA describes the mitigation measures as guidelines from the Joint Nature Conservation Committee (JNCC, 2017), that have been "*revised to be more applicable to the southern African situation*" (page 112), but there is no explanation of why revision was deemed necessary or what factors were considered.

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[15] E.g., 50 CFR Part 217, Subpart S - Taking Marine Mammals Incidental to Geophysical Survey Activities in the Gulf of Mexico. https://www.ecfr.gov/current/title-50/chapter-II/subchapter-C/part-217/subpart-S

[16] Appendix A: Seismic Survey Mitigation and Protected Species Observer Protocols https://repository.library.noaa.gov/view/noaa/23738/noaa_23738_DS2.pdf

[17] E.g., 50 CFR Part 217, Subpart S - Taking Marine Mammals Incidental to Geophysical Survey Activities in the Gulf of Mexico. https://www.ecfr.gov/current/title-50/chapter-II/subchapter-C/part-217/subpart-S;
Joint Nature Conservation Committee (JNCC) (2017). JNCC guidelines for minimising the risk of injury to marine mammals from geophysical surveys. August 2017. 28pp. https://data.jncc.gov.uk/data/e2a46de5-43d4-43f0-b296-c62134397ce4/jncc-guidelines-seismicsurvey-aug2017-web.pdf

Conclusion 5 requires a 20-minute soft start, which is consistent with best practices; however, it fails to require gradually increasing sound levels over the 20-minute period, which is an essential element of a soft start.

5: Evaluation of condition 7 and the realistic footprint of the prospecting activities

The Terms of Reference for the Marine Ecology Impact Assessment (MEIA) limits the assessment to "*a literature review of existing information on the regional and local marine ecology and draw on previous surveys undertaken in the area in order to describe the marine ecology of the study area*" (page 1). It's unclear whether the Terms of Reference were created and approved during the EIA scoping phase, but they do not follow best practices which would include conducting field surveys to determine the location of different habitats and species in the area. As such, the baseline information that is provided in the EIA suggests the location of rocky outcrops and other sensitive habitats is not entirely known, therefore it's unclear how the project proponent could effectively avoid these areas. In addition to information gaps, the baseline information that is included in the EIA and MEIA contains many inconsistencies. For example, Section 4.1.1 Bathymetry on page 17 states that detailed bathymetry data are only available for two concessions: Concessions 11b and Concession 13b, both of which show a substantial coverage of rocky seabed – see Figure 4-1A of Concession 11b below.

> "The majority of concession 11b is characterised by outcropping rocky seabed intersected by large and deep, west-southwest facing, drainage gullies and channels filled with unconsolidated sediments. Portions of concession 13b are characterised by outcropping rocky seabed intersected by large and deep, southwest facing, drainage gullies and channels filled with unconsolidated sediments."

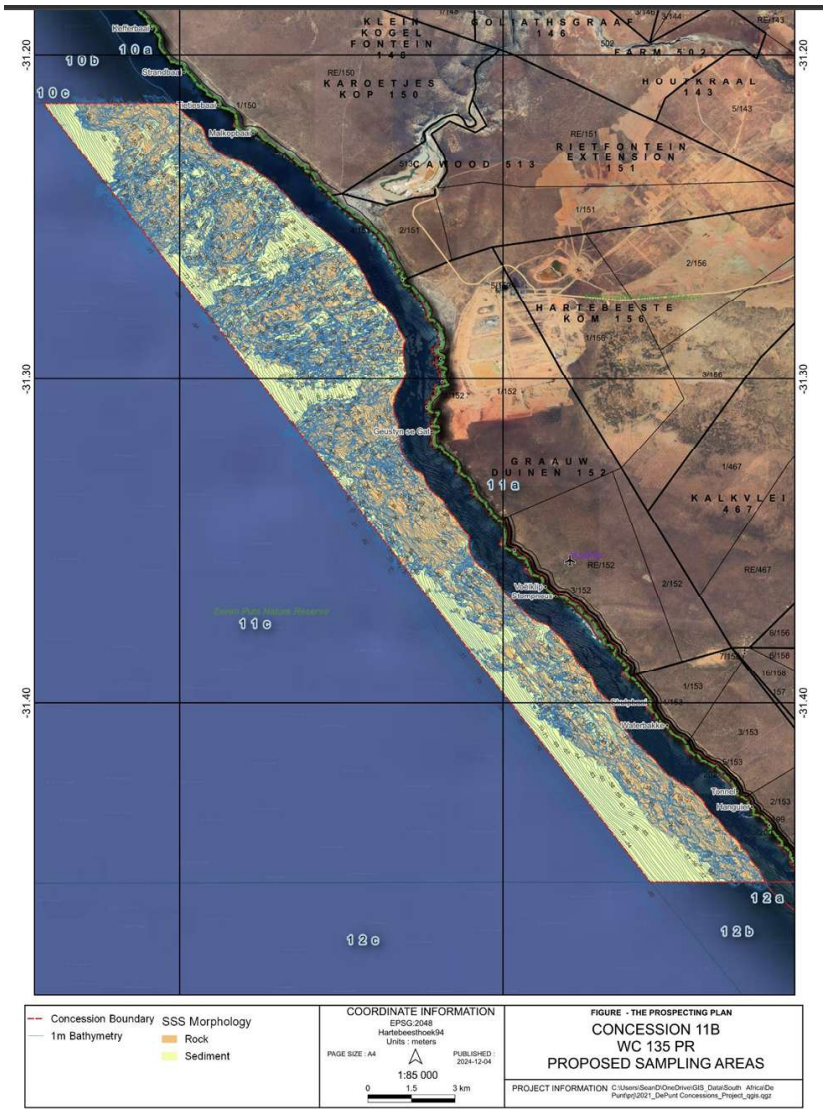

Figure 4-1A: Regional bathymetry and seabed features of SASA Concession 11b

This means that the EIA does not effectively provide a bathymetry baseline for the remaining four concessions, but even so it states, "*Concession 12b is likely to reflect similar bathymetry and seabed features as seen in Concessions 11b and 13b.*" This information conflicts with later statements and figures that describe concession 11b and 13b as Southern Benguela Sandy Shelves – see Figure 4-2A for example:

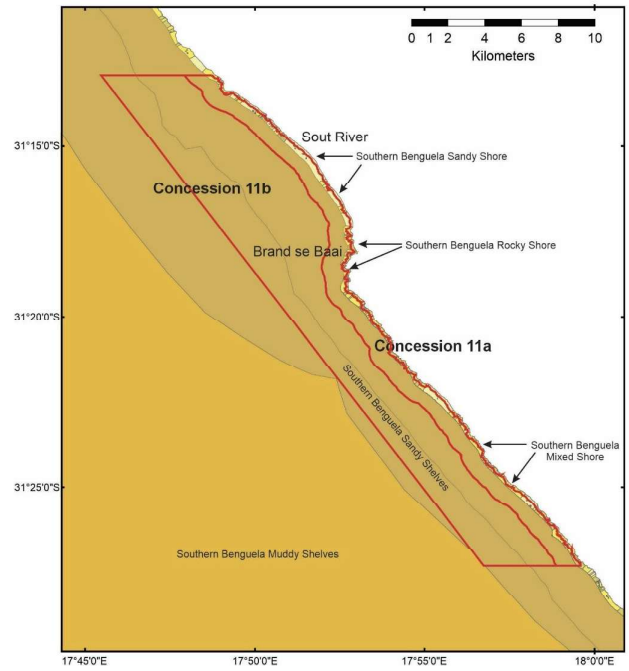

Figure 4-2A: Concession 11a and 11b (red polygons) in relation to the distribution of seabed substratum types along the West Coast (adapted from Sink *et al.* 2019).

The MEIA also mischaracterizes the ecosystem threat status of the inner and mid-shelf area as as Least Concern when the maps included in the document show the concessions span areas of Vulnerable and Near Threatened status – see figure 4-8A for example:

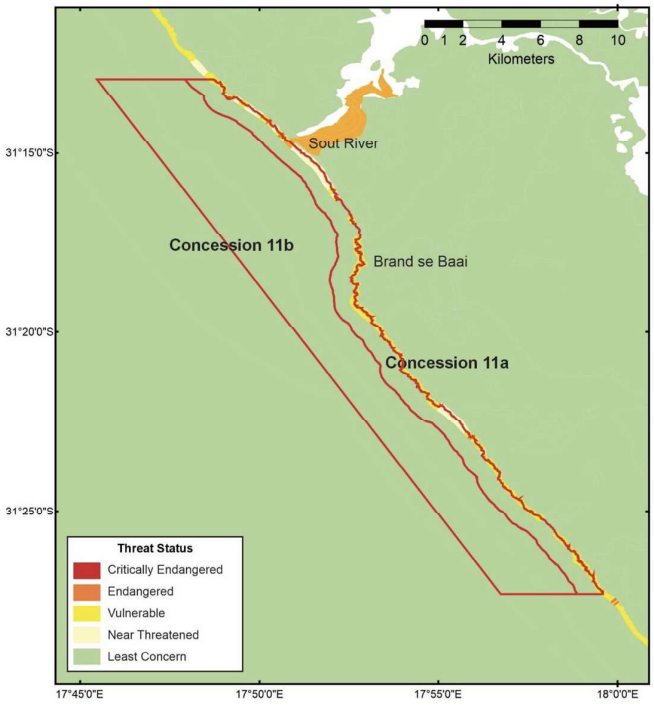

Figure 4-8A: Concession 11a and 11b (red polygons) in relation to the ecosystem threat status for coastal and offshore ecosystem types on the South African West Coast (adapted from Sink et al. 2019).

6: Assessment of the footprint with respect to marine fauna

With respect to noise, the EIA and Marine Ecology Impact Assessment (MEIA) do not adequately assess the impacts of the underwater noise that would be generated from the mining activities and instead rely on two noise dispersion studies: one study was undertaken in a proposed oil drilling project in Block 3B/4B, which is located 250 km offshore and in much deeper waters (with depths up to 2,500 m (SLR Consulting 2023)), and a very old second study that was conducted in 1996 to examine the effects of vessel-based diamond mining on marine mammals (Findlay 1996). There are many reasons why these studies may not provide results that are representative of the proposed project. In short, the distance underwater noise can travel is affected by project and site-specific characteristics such as the sound source, the frequency of the sound, water depth, density, temperature, salinity, pressure, and local propagation features.[18] As such, professional and impartial site-specific modelling is necessary for the project area to provide decision-makers with credible, science-based estimates of the expected impact area and sound pressure levels that would be experienced by marine life. The inclusion of a site-specific ambient noise baseline and a specialized sound propagation study is considered best practice for an EIA and should follow recommended guidelines and the best available science.[19,20] Additionally, it is critical that any assessment of a project's sound sources and their potential impact on marine fauna consider cumulative and aggregate effects of different types of sources.[21]

Notwithstanding the questionable use of the cited studies, it is unclear how the effects of high frequency sonars on marine fauna would be considered "localised" and "medium intensity" (MEIA, page 111) based on their results. The SLR study reports noise levels exceeding thresholds that cause permanent auditory damage in sensitive high-frequency marine mammals as far as 70 m from the sound source and temporary injury as far as 150 m from the source.[22] The Finlay study reports elevated noise levels extending 20 km from the sound source[23]. The impact

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[18] Geoff Prideaux & Margi Prideaux (2016) Environmental impact assessment guidelines for offshore petroleum exploration seismic surveys, Impact Assessment and Project Appraisal, 34:1, 33-43, DOI: 10.1080/14615517.2015.1096038. https://www.tandfonline.com/doi/full/10.1080/14615517.2015.1096038

[19] Faulkner, R. C., Farcas, A., & Merchant, N. D. (2018). Guiding principles for assessing the impact of underwater noise. Journal of Applied Ecology, 55(6), 2531-2536. DOI:10.1111/1365-2664.13161 https://ueaeprints.uea.ac.uk/id/eprint/79238/1/Published_Version.pdf

[20] Farcas, A., Thompson, P. M., & Merchant, N. D. (2016). Underwater noise modelling for environmental impact assessment. Environmental Impact Assessment Review, 57, 114-122. https://www.sciencedirect.com/science/article/pii/S0195925515300202

[21] Hawkins, A. D., & Popper, A. N. (2016). Developing sound exposure criteria for fishes. In The effects of noise on aquatic life II (pp. 431-439). New York, NY: Springer New York.

[22] SLR Consulting Canada (2023). Proposed Offshore Exploration Drilling Campaign in Block 3B/4B. Underwater Sound Transmission Loss Modelling. Prepared for EIMS. October 2023. 87pp. "A recent sound modelling study undertaken in Block 3B/4B offshore of Concessions 11a, 12a, 13a, and 11b, 12b and 13b identified that only in the case of the most sensitive very-high-frequency cetaceans were the zones of recoverable injury (temporary threshold shifts - TTS) expected at <150 m from the source, with auditory damage (PTS) occurring at a range of <70 m from the source along the cross-track direction (SLR Consulting Canada 2023). For the other marine mammal hearing groups and turtles TTS and PTS onset occurred at <25 m and <5 m, respectively."

[23] Findlay, K.P. (1996). The impact of diamond mining noise on marine mammal fauna off southern Namibia. Specialist Study #10. In: Environmental Impact Report. Environmental Evaluation Unit (ed.) Impacts of deep sea diamond mining, in the Atlantic 1 Mining Licence Area in Namibia, on the natural systems of the marine environment. No. 11-96158, University of Cape Town. Report to De Beers Marine (Pty) Ltd. pp. 370 "In a study

rating is further downgraded from VERY LOW to INSIGNIFICANT with mitigation, but the proposed mitigation measures in the EIA and the required measures stated in the EA are not likely to work as intended (see comments in Q3 and Q4 above).

Sediment plumes (turbidity)

The Marine Ecology Impact Assessment (MEIA) recognizes the significant threat that turbidity can have on biodiversity on page 29:

> "Although natural turbidity of seawater is a global phenomenon, there has been a worldwide increase of water turbidity and sediment load in coastal areas as a consequence of anthropogenic activities. These include dredging associated with the construction of harbours and coastal installations, beach replenishment, accelerated runoff of eroded soils as a result of deforestation or poor agricultural practices, and discharges from terrestrial, coastal and marine mining operations (Airoldi 2003). Such increase of sediment loads has been recognised as a major threat to marine biodiversity at a global scale (UNEP 1995). "

The Fisheries Impact Assessment (FIA) and MEIA provide thorough (and nearly identical) descriptions of the types of turbidity plumes (surface, dynamic, and transitional) that can be generated from mining and drilling operations, as well as their potential impacts. The MEIA cites published studies on pages 117 in which the size of sediment plumes ranged from 700 – 5,500 m in length and 700 – 3,500 m in width, and extending to a maximum depth of "~70 m", and yet the EIA documents claims (without any underlying data) that sediment plumes will be localized, ephemeral, and unlikely or unexpected to have significant impacts. For example,

Page 118 of the MEIA:

> "... kelp beds along the coastline of concession 11a, 12a and 13a are unlikely to be affected by the turbidity plumes generated during sampling in concessions 11b, 12b and 13b. Similarly, the depths of the proposed sampling areas lie beyond those at which kelp is likely to occur on adjacent reefs and no shading of these canopy forming macrophytes by sampling-related turbidity plumes is expected." (emphasis added)

Page 118 - 119 of the MEIA:

> "The plumes will be localised to within a few 100 m of the sampling vessel and as they will be ephemeral, negative effects of increased suspended sediment concentrations on marine communities are highly unlikely… Even the highest concentrations in the immediate discharge are unlikely to reach concentrations that would have lethal effects on marine fauna…. " (emphasis added)

The EIA claims fish larvae and eggs are not likely to be impacted by turbidity because spawning occurs offshore and away from the proposed sampling areas- for example, page 118 of the MEIA states:

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evaluating the potential effects of vessel-based diamond mining on the marine mammals community off the southern African West Coast, Findlay (1996) concluded that the significance of the impact is likely to be minimal based on the assumption that the radius of elevated noise level would be restricted to ~20 km around the mining vessel."

> "The development of invertebrate and fish eggs and/or larvae may be impaired through high sediment loading, but as the major spawning areas are all located on the continental shelf, south of the concession areas, any potential effects of turbid water plumes generated during tailings disposal on phytoplankton and ichthyoplankton production, fish migration routes and spawning areas, or on benthic and demersal species in the area would be negligible." (emphasis added)

This reasoning ignores the lifecycle of pelagic fish and hake, which requires nursery areas in the nearshore, bays, and estuaries. Page 29 of the FIA states:

> "Along the South African coastline, seasonally variable and often strong currents have led many fish species to develop reproductive patterns that increase the chances of their eggs and larvae reaching suitable nursery grounds along the coast. Settlement of larvae occurs in the inshore areas, in particular the bays that are used as nurseries, from October to March." (emphasis added)

Figure 3.11 in the FIA shows high abundances of anchovies recruiting to the coast where the project is located (north from Doring Bay, Doringbaai), although the map does not include or note the locations of the concession areas in relation to these densities.

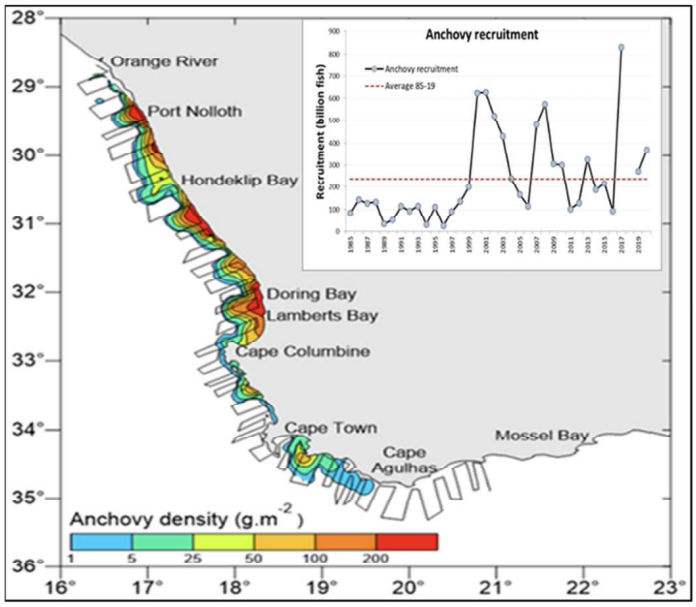

Figure 3.11: Recruitment survey results (May 2020) for anchovy and recruitment trend (inset). The red dotted line is the running average level of recruitment since 1985 and is used as one of the stock status indicators (information and figure provided by J. Coetzee and D. Merkel of DFFE).

Additionally, this claim of "negligible" impacts to offshore spawning grounds is inconsistent with statements made on page 89 that indicate sediment plumes would in fact be dispersed offshore or shoreward:

> "Relative to the location of the nursery areas, the sediment plumes generated during benthic sampling would be predominantly dispersed northwards and offshore of the nursery areas. However, wind has been shown to be a significant influencer of sediment plume dispersal (Geyer et al. 2004; Fernandes et al. 2021). Given the prevailing wind conditions within the concession area, the sediment plume may move shoreward and towards sensitive nursery areas."

These kinds of inconsistent and unfounded statements underscore the need for a rigorous sediment dispersion modeling analysis so that decision makers have sufficient, accurate, and science-based information to fully understand the potential impacts of the proposed activities. Project specific analyses are especially important because, as the MEIA and FIA documents note, the development and movement of sediment plumes is influenced by many factors, such as wind, waves, currents, outflow velocity of tailings discharged from the vessel, water density, density of the plume, sand and silt composition, etc.

Furthermore, cumulative impacts from chronic exposure to turbidity plumes is not considered in the EIA. While the FIA states, "*the sampling is not contiguous and therefore there will be a delay in time whilst the seabed tool is transferred to the new sampling site before additional sediment is released overboard with the next sample*", it fails to identify how far apart the samples would be taken or recognize the potential impacts of repeated exposure to elevated sediment concentrations.

Unsubstantiated impact ratings

Section 6.1.4 Impact Rating Methodology does not include any citations for the methodology used to rate impacts and best summarizes the process as being "*based on specialists' expertise, SRK's professional judgement and desk-top analysis.*" (page 89). Similarly, the judgement used to determine the probability, duration, reversibility and confidence is entirely subjective and not based in any scientific reasoning. For example, the entire description of how the probability of an impact was determined is one sentence on page 90: "*Once the consequence was derived, the probability of the impact occurring was considered, using the probability classifications presented in the table below.*", with no explanation of how they might determine the percent chance of an impact occurring, or how they would differentiate between a <40% chance and a 40% - 70% chance, for example.

Table 6-3: Probability classification

Probability *– the likelihood of the impact occurring*	
Improbable	< 40% chance of occurring
Possible	40% - 70% chance of occurring
Probable	> 70% - 90% chance of occurring
Definite	> 90% chance of occurring

Dramatic underestimate of the scope and scale of disturbance

Even more glaring, however, is how the EIA severely undercalculates the area of disturbance. Page 94-95 states, "*A maximum of 2 230 vibracore samples, 625 grab samples and 1 650 drill samples will be taken disturbing a maximum total (extremely small) area of ~0.011 km2 (1.1ha).*" (emphasis added)

This description doesn't account for the actual footprint of the equipment or the impacts that extend beyond the sampling sites. The Marine Ecology Impact Assessment provides a more detailed explanation of the methods and dimensions of the equipment, but it still underestimates the impact area. For example, the number of drill samples and maximum drilling disturbance area per concession is provided in Table 2-3 (included below). Based on the description from page 10 it appears the area of disturbance is calculated using the diameter of the drill bit (2.5 m), such that for Year 1 each concession would have a disturbance of 0.05 hectares/100 samples = 0.0005 hectares, or 5 m^2 per sample. However, page 10 also states, "*The drill frame structure has a base of 6.5 x 6.5 m, stands 23 m high and weighs 147 tons*". Therefore the direct disturbance from the drilling equipment for each drill sample would actually be 42.25 m^2 (6.5 m x 6.5 m), which when multiplied by 100 samples equates to a disturbance area of 4,225 m^2, or 0.4225 hectares–over eight times the area reported for each concession in Year 1 in the EIA.

Table 2-3: Number of drill samples and maximum drilling disturbance area per Marine Concession.

Marine Concession	Number of samples	Maximum anticipated area of disturbance	Duration
11A	0	None	N/A
12A	0	None	N/A
13A	0	None	N/A
11B	Year 1: 100 Year 2: 150 Year 3: 200 Year 4: 100 **Total: 550**	Year 1: 0.05 hectares Year 2: 0.075 hectares Year 3: 0.1 hectares Year 4: 0.05 hectares **Total: 0.275 hectares**	Year 1: 6 days Year 2: 7 days Year 3: 8 days Year 4: 6 days **Total: 27 days**
12B	Year 1: 100 Year 2: 150 Year 3: 200 Year 4: 100 **Total: 550**	Year 1: 0.05 hectares Year 2: 0.075 hectares Year 3: 0.1 hectares Year 4: 0.05 hectares **Total: 0.275 hectares**	Year 1: 6 days Year 2: 7 days Year 3: 8 days Year 4: 6 days **Total: 27 days**
13B	Year 1: 100 Year 2: 150 Year 3: 200 Year 4: 100 **Total: 550**	Year 1: 0.05 hectares Year 2: 0.075 hectares Year 3: 0.1 hectares Year 4: 0.15 hectares **Total: 0.275 hectares**	Year 1: 6 days Year 2: 7 days Year 3: 8 days Year 4: 6 days **Total: 27 days**

It's important to note that even this calculation is an underestimate of the actual disturbance area of the drilling activities. Page 10 of the EIA states, "*The sediments are fluidised with strong water jets and airlifted to the support vessel where they are treated in the onboard mineral recovery plant. All oversized and undersized tailings are discharged back to the sea in situ.*" There is no estimate of the amount of drill tailings that will be discharged to the sea, nor is there any analysis of where they would fall and settle on the seafloor. The EIA notes, "*The drill bit can penetrate sediments up to 12 m depth above the bedrock or clay footwall*", so each sample could produce up to 507 m^3 (4,225 m^2 x 12 m) of tailings. There is also no information on the type of lubricants or drilling fluids that would be used or their toxicity levels. Furthermore, noise and

vibrations from the drilling activity, as well as turbidity plumes, would extend and cause disturbance across a much greater area than the footprint of the drilling equipment.

While the EIA includes assessments of the impact of turbidity plumes and discharged tailings, it includes no data or citations to support the reported impact ratings nor does it provide any quantitative modeling to support their ratings. For example, 6.2.2.5 Potential Impact ME5: Alteration of Benthic Habitats by Re-Deposition of Tailings During Drill Sampling is rated as "Very Low" based entirely on what appear to be assumptions, e.g.:

> "In the case of unconsolidated habitats, the impacts would be of low intensity but highly localised extending only a few 10s of metres from the sampling footprint, and short-term as recolonisation from adjacent areas or upward migration through deposited sediments would occur rapidly."

The assessment provides no analysis of how the local currents and waves would disperse the tailings, where they would settle, or how "few 10s of metres" was calculated. The biological baseline lacks sufficient information to know what organisms would be smothered by the discharged tailings or if there are surrounding populations that could recolonize the impacted area, and no data are provided on typical recolonization rates to support the claim of rapid recovery.

The EIA also incorrectly claims in this section that no mitigation is possible. Mitigation measures that are typically used for drilling operations, include ROV surveys of drill sites to ensure no sensitive species or communities are present at the site or in the areas that sediment plumes are estimated to spread and disposing of drill tailings on land.

Melissa S. Garren

Education

Post-Doctoral Fellowship, Environmental Engineering, MIT (2014); under Prof. Roman Stocker

Ph.D. Marine Biology, Scripps Institution of Oceanography (2011); Advisor: Prof. Farooq Azam

M.S. Marine Biology, Scripps Institution of Oceanography, UCSD (2008)

B.S. Molecular Biology, Yale University (2003)

Languages

Native speaker: English
Professionally competent: French and Spanish

Professional Experience

Marine Scientist 2021-present. Environmental Law Alliance Worldwide. (remote)

Principal & Founder 2020-present. Working Ocean Strategies. (Monterey, CA)

Board Member 2020-present. California Marine Sanctuary Foundation (Monterey, CA)

Center for Blue Economy Advisory Council Member 2019-present. Middlebury's Institute for International Studies, Center for the Blue Economy Advisory Council. (Monterey, CA)

Adjunct Research Faculty 2015-present. California State University Monterey Bay (Seaside, CA)

Review Editor 2015-present. Frontiers in Marine Science

COO & Chief Scientist 2017-2020. Pelagic Data Systems (San Francisco, CA)

Chief Scientific Officer 2014-2017. Pelagic Data Systems (San Francisco, CA)

Postdoctoral Researcher 2011-2014. Environmental Engineering, Massachusetts Institute of Technology with Prof. Roman Stocker (Cambridge, MA)

Workshop Organizer 2013. Marine Spatial Planning: From Policy to Practice (Woods Hole, MA)

Workshop Facilitator 2013. Water Diplomacy Workshop, MIT and Tufts Universities, Cambridge, MA

Symposium Host 2011. 2nd International Marine Conservation Congress (Victoria, Canada) "Can Innovative Entrepreneurship Save Seafood and the Seas?"

Graduate Researcher 2006-2011. Prof. Farooq Azam, Marine Microbial Ecology, Scripps Institution of Oceanography (San Diego, CA)

Program Coordinator 2008-2011. Scripps Community Outreach Program for Education (SCOPE), Scripps Institution of Oceanography (San Diego, CA)

Research Specialist 2010. Coral Reef Microbial Ecology, The Nature Conservancy and The

Kohala Center (Kona, Hawai'i)

Research Associate 2005-2006. Assay Development, Ambit Biosciences Inc. (San Diego, CA)

Marine Scientist 2004-2005. Gandoca-Manzanillo Wildlife Refuge (Manzanillo, Costa Rica)

Lab Manager 2003-2004. Prof. Jeff Powell, Conservation Genetics, Yale University (New Haven, CT)

Research Fellow 2002. Prof. Nancy Knowlton, Coral Ecology, Smithsonian Tropical Research Institute (Bocas del Toro, Panama)

Research Assistant 2001. Prof. Allen Nicholas, Genetics, The Curie Institute (Paris, France)

Research Intern 2000. Prof. James Harvey, Marine Vertebrate Ecology, Moss Landing Marine Lab (Moss Landing, CA)

Professional Working Groups

2021-present Environmental Law Alliance Worldwide (ELAW) Marine Working Group

2020-2021 Ocean Vision's Ocean-Based Carbon Dioxide Removal Working Group (Steering committee member)

2012-2017 NSF Research Coordination Network: Evaluating the Impacts of a Changing Ocean on Management and Ecology of Infectious Marine Disease.

2012 National Center for Ecological Analysis and Synthesis (NCEAS): Coral Reef Preservation

2006-2009 World Bank/ Global Environment Facility: Coral Reef Targeted Research Working Group on Coral Disease

Selected Presentations (of >200)

Roundtable Session Moderator (2024) ""Blue Economy and Its Impacts on Small-Scale Fisheries: Moving Towards Just and Equitable Ocean Use and Protection" World Fisheries Congress, Seattle, WA, USA. Hosted 8 speakers from 3 different continents from ELAW's Marine Working Group.

M. Garren (2023) "Opportunities for Services Providers to Engage with EM Program Development in Tuna-RFMOs". Pew Workshop: Electronic Monitoring Service Providers for RFMO Engagement**,** Aberdeen, Scotland

M. Garren (2023) "Consideraciones para innovar y escalar la tecnología en la pesca". Marea Digital (a workshop on technology in small scale fisheries), La Paz, Mexico. Invited speaker.

M. Garren (2022) "The Current Landscape of Electronic Monitoring Globally". Global Electronic Monitoring Symposium, Honolulu, Hawaii. Invited plenary speaker.

M. Garren (2021) Duke Law's Fishing for Data Podcast: Episode 3 Electronic Monitoring and the Magnuson-Stevens Act. Invited guest expert.

M. Garren & A. Brett (2021) Net Gains Alliance Seminar Series: "Supporting Innovation & Technology Compatible Fisheries Management Frameworks in the US". Virtual. Invited speaker.

M. Garren (2020) United Nations World Ocean Day: "Blue Economy and Private Sector Impact". United Nations Headquarters, NY (shifted to virtual for COVID-19). Invited speaker.

M. Garren (2020) Sustainability Seminar Series: "The Triple Bottom Line in Ocean and Coastal Sustainability". Middlebury Institute of International Studies, Monterey CA. Invited speaker

M. Garren (2019) Board meeting for BlueBelt Initiative on fisheries management & cooperation among the African States bordering the Atlantic Ocean (ATLAFCO; currently 22 member nations). Delivered a 2-hour workshop on fisheries management tools at the invitation of the Moroccan government. Casablanca, Morocco. Invited expert

M. Garren (2019) WorldFish Food for Thought Seminar Series: "Using Sunlight and Cellular Networks to Bring New Management Tools to Small Scale Fisheries". WorldFish Headquarters, Penang, Malaysia. Invited speaker

M. Garren (2018) Panel hosted by Indonesian IUU Task Force (#115): "Policy Implementation of Combatting Illegal, Unreported, and Unregulated Fishing". Our Ocean Conference, Bali, Indonesia. Invited speaker (1 of 3 speakers on panel)

M. Garren (2018) "Registro de las rutas de las embarcaciones menores en Alto Golfo". Foro Economico de Pesca y Acuacultura, Mexico City, Mexico. Invited speaker

M. Garren (2018) "Technology in support of robust fisheries management and reduced ghost gear". Sustainable Seafood Summit, Barcelona, Spain. Invited speaker

M. Garren (2018) Invited workshop contributor and speaker as a technical expert for the United Nations Food and Agriculture Organization. FAO's General Fisheries Commission for the Mediterranean VMS and related control system workshop, Beirut, Lebanon. Invited expert/ speaker

M. Garren (2017) Smithsonian's Earth Optimism Summit. Washington, DC. Invited speaker https://www.youtube.com/watch?v=kC_5Z26nL3s

M. Garren (2016) Plenary Speaker for the Italian Society for Ecology. Milan, Italy. Invited speaker

M. Garren (2015) Senate Briefing on Technology for Small Scale Fishery Management. Washington, DC

M. Garren (2015) Plenary Panel Speaker at the Sustainable Seafood Summit. Valleta, Malta.

M. Garren (2015) "Bacterial Behaviors Shed Light on Ecosystem Function". Woods Hole Oceanographic Institution, Woods Hole, MA. Invited seminar

M. Garren (2014) "The Sea We Rarely See: Connecting Microscale Processes to Ecosystem Function". Monterey Bay Aquarium Research Institute, Monterey, CA. Invited seminar

M. Garren (2012) "The Sea We've Hardly Seen". TEDx Monterey Event. Invited oral presentation. (http://www.ted.com/talks/melissa_garren_the_sea_we_ve_hardly_seen.html)

M. Garren (2012) "Linking Microscale Bacterial Behaviors to Large-scale Ecosystem Function". Sustainability Seminar, Cornell University, Ithaca, NY. Invited departmental seminar.

M. Garren (2012) "Diving into the Unseen: Live Coral-Bacteria Interactions". Climate Change Cluster Seminar, University of Technology Sydney, Sydney, Australia. Invited departmental seminar.

M. Garren, L. Raymundo, J. Guest, C.D. Harvell and F. Azam (2010) "Dynamic Interactions among Coral-Associated Bacteria in Response to Fish Farm Effluent Exposure". American Society of Limnology and Oceanography Meeting, Portland, OR. Oral presentation.

M. Garren (2009) “Mariculture in a Changing Environment”. Scripps Environmental Advocates, La Jolla, CA. Invited oral presentation.

M. Garren, S. Smriga and F. Azam (2008) “Gradients of Coastal Fish Farm Effluents and Their Effect on Coral Reef Microbes”. 12th International Symposium on Microbial Ecology, Cairns, Australia. Poster presentation.

M. Garren (2006) “Una perspectiva sobre el manejo integrado de una area protegida marinocostero”. University of Costa Rica, San Jose, Costa Rica. Invited departmental seminar.

M. Garren, A. Caccone, N. Knowlton (2004) “Patterns of Association between Symbiodinium and Members of the Montastraea annularis Species Complex in the Bocas del Toro Archipelago, Panama”. 10th International Coral Reef Symposium, Okinawa, Japan. Poster presentation.

Selected Publications (of >35)

M. Garren, M. Michelin, V. Maharaj (2024) Technical Source Document on the Governance of Electronic Monitoring (EM) Systems for Industrial Tuna Fisheries. *Developed by the World Wildlife Fund Inc. (WWF-US) under the FAO Common Oceans Program.* [Full PDF and Summary toolkit available]

M. Chernaik, J. Chamberlin, M. Garren, R. Howard, M. Lu, F. Salinas, G. Wendling, B. Yednock (2024) How to Evaluate Environmental Impact Assessments for Oil and Gas Projects. *Environmental Law Alliance Worldwide (ELAW)* ISBN#: 979-8-218-48856-7 [Full PDF]

R. Moss-Christian, B. Hanchard, J.T. Mudge, M. Garren, M. Michelin, M. Zimring, C. Heberer (2022) Final Draft Forum Fisheries Agency Electronic Monitoring Standards, Specifications, and Procedures. Adopted as interim guidelines by the FFA on May 12, 2022.

M. Garren, F. Lewis, L. Sanchez, D. Spina, A. Brett (2021) How Performance Standards Could Support Innovation and Technology Compatible Fisheries Management Frameworks in the U.S. *Marine Policy* *https://doi.org/10.1016/j.marpol.2021.104631* [Executive Summaries available in Spanish and English]

S. Haukebo, S. Poon, C. Cusack, M. Garren, J. Kenyon-Benson, E. Schindler, B. Tate (2021) SmartPass: An innovative approach to measure fishing effort using smart cameras and machine learning. https://www.edf.org/sites/default/files/content/EDFSmartPass-whitepaper.pdf

R. Vega Thurber, L.D. Mydlarz, M. Brandt, C.D. Harvell, E. Weil, L. Raymundo, B.L. Willis, S. Langevin, A.M. Tracy, R. Littman, K.M. Kemp, P. Dawkins, K.C. Prager, M. Garren, J. Lamb (2020) Deciphering coral disease dynamics: integrating host, microbiome, and the changing environment. *Frontiers in Ecology and Evolution*, 8

D.C. Claar, J. McDevitt-Irwin, M. Garren, R. Vega-Thurber, R. Gates, J. Baum (2020) Increased diversity and concordant shifts in community structure of coral-associated *Symbiodiniaceae* and bacteria subjected to chronic human disturbance. *Molecular Ecology*

J. McDevitt-Irwin, M. Garren, R. McMinds, R. Vega-Thurber, J. Baum (2019) Variable interaction outcomes of local disturbance and El Niño-induced heat stress on coral microbiome alpha and beta diversity. *Coral Reefs* DOI: 10.1007/s00338-019-01779-8

J. McDevitt-Irwin, J. Baum, M. Garren, R. Vega-Thurber (2017) Responses of Coral-Associated Bacterial Communities to Local and Global Stressors. *Frontiers in Marine Science* DOI:10.3389/ fmars.2017.00262

M. Garren (2016) Microbial ecology: Algae feed a shift on coral reefs. *Nature Microbiology* DOI:10.1038/nmicrobiol.2016.61

M. Garren, K. Son, J. Tout, J. Seymour, R. Stocker (2016) Temperature-induced behavioral switches in a bacterial marine pathogen. *International Society for Microbial Ecology Journal* doi:10.1038/ ismej.2015.216

M. Groner, R. Breyta, A. Dobson, C. S. Friedman, M. Garren, F. Gulland, J. Maynard, E. Weil, S. Wyllie-Echeverria, C.D. Harvell (2015) Emergency Response for Marine Diseases. *Science* 347:1210

J. Maynard, R. van Hooidonk, C. M. Eakin, M. Puotinen, S. F. Heron, M. Garren, J. Lamb, G. Williams, E. Weil, B. Willis, C.D. Harvell (2015) Climate projections of conditions that increase coral disease susceptibility and pathogen virulence. *Nature Climate Change* DOI: 10.1038/ nclimate2625

M. Garren, K. Son, J.B. Raina, R. Rusconi, O. Shapiro, D. Bourne, J. Seymour, R. Stocker. (2014) Pathogen uses dimethylsulfoniopropionate as a cue to target heat-stressed corals. *International Society for Microbial Ecology Journal* 8: 999–1007

O. Shapiro, V. Fernandez, M. Garren, J. Guasto, F. Debaillon-Vesque, E. Kramarski-Winter, A. Vardi, R. Stocker (2014) Ciliary currents enhance mass transport in reef-building corals. *Proceedings of the National Academy of Sciences* doi: 10.1073/pnas.1323094111

M. Garren and F. Azam (2012) Corals shed bacteria as a potential mechanism of resilience to organic matter enrichment. *International Society for Microbial Ecology Journal* 6: 1159-1165

M. Garren, L. Raymundo, J. Guest, C.D. Harvell and F. Azam (2009) Resilience of coral-associated bacterial communities exposed to fish farm effluent. *PLoS One* doi:10.1371/journal.pone.0007319

M. Garren, J. Myers, C. Arney (2009) Rebalancing human-influenced ecosystems. *The Journal of Undergraduate Mathematics and Its Applications* 30: 100-107

M. Garren, S. Smriga and F. Azam (2008) Gradients of coastal fish farm effluents and their effect on coral reef microbes. *Environmental Microbiology* 10: 2299-2312.

M. Garren, S.M. Walsh, A. Caccone, N. Knowlton (2006) Patterns of association between *Symbiodinium* and the *Montastraea annularis* species complex on spatial scales from within colonies to between geographic regions. *Coral Reefs* DOI:10.1007/s00338-006-0146-1

Grants & Awards

2020 Net Gains Alliance Grant for "Building a Model Regulatory Framework for Fisheries Management that Supports Technology and Innovation"

2020 Finalist Ocean Award for Innovation (https:// www.boatinternational.com/luxury-yacht-events/ocean-awards/ocean-awards-finalists--39691/ frame-4)

2019 Foundation Grant: Augmenting National Scale Food Security through Sustainable Fisheries ($1.2M program)

2019 Conscious Company World-Changing Woman (https://twitter.com/consciouscomag/status/1084132966933110784)

2019 CGIAR Big Data for Agriculture Inspire Challenge Awardee for Scale-Up (second award)

2018 National Geographic Society Marine Protection Prize (https://www.nationalgeographic.org/newsroom/national-geographic-society-announces-winners-of-competition-to-combat-illegalfishing/)

2018 SeaWeb's Seafood Champion for Innovation (http://www.seafoodchampions.org/2018seafood-champion-awards/2018-innovation-finalists/pelagic-data-systems-2/; http://www.pelagicdata.com/2018-seafood-champion)

2018 CGIAR Big Data for Agriculture Inspire Challenge Winner (http://blog.worldfishcenter.org/2018/10/big-data-proposal-wins-2018-inspire-challenge/)

2016 Schmidt Marine Technology Partners Grant to PDS

2013 Journal of Limnology and Oceanography Prize for Best Talk by a Junior Scientist

2012 Costerton Award from International Society for Microbial Ecology for "research that best evolves new theories in microbial ecology and wider interdisciplinary significance"

2012 Policy Traineeship from the Robert & Patricia Switzer Foundation

2010 Switzer Environmental Leadership Fellowship

2010 American Society of Limnology and Oceanography Student Travel Grant

2010 Travel Grant to "Ethics and Ecological Risk Assessment Symposium" hosted by University of Minnesota's Risk Assessment for Introduced Species and Genotypes IGERT program.

2009 IGERT/NSF Internship Grant

2008 IGERT/NSF Mini-Grant

2008 Zobell Fellowship

2006 National Science Foundation Graduate Research Fellowship (NSF GRFP)

2006 Integrative Graduate Education and Research Traineeship from National Science Foundation (IGERT)

2004 PADI Aware Foundation Mini-Grant

2003 Yale's Ellsworth Memorial Prize for "most distinguished thesis of the graduating class"

2003 Yale University Dean's Research Fellowship

2002 Thoreau Environmental Research Fellowship

Reviews

2007-present Aquaculture, Aquatic Sciences, Coral Reefs*, Disease of Aquatic Organisms*, Environmental Chemistry, Environmental Microbiology*, Frontiers in Marine Science*, International Society of Microbial Ecology Journal*, Journal of Marine Science and Engineering, mBio, Marine Ecology, Molecular Ecology, PLoS ONE*, Nature Reviews Microbiology, Proceedings of The Royal Society B*, The French National Research Agency (ANR), The National Geographic Society*, National Fish and Wildlife Foundation* (NFWF), National Science Foundation* (NSF), World Bank (* indicates multiple reviews)

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EDUCATION

Doctor of Philosophy, Environmental and Evolutionary Biology: 2013
University of Louisiana, Lafayette, LA
Dissertation: Population genetic structure and natural selection in blue crabs, *Callinectes sapidus*.

Master of Science, Coastal Marine and Wetland Studies: 2005
Coastal Carolina University, Conway, SC
Thesis: Habitat utilization by multiple shark species in a southeastern salt marsh estuary.

Bachelor of Arts, Environmental Studies: 1998
University of Oregon, Eugene, OR
Minors in Biology and Planning, Public Policy, and Management
Oregon Institute of Marine Biology, Charleston, OR (Spring 1998)
University of Copenhagen, Copenhagen, DK (Fall 1997)

CURRENT POSITION (2017 - present)

Reserve Manager, South Slough National Estuarine Research Reserve
Oversee day-to-day operations and management of a 7,000-acre coastal protected area under the supervision of the Director of Oregon Department of State Lands and at the direction of the Governor-appointed Reserve Management Commission. Duties include:

- **Human Resources Management –** supervision and support for 19 permanent employees and additional grant-supported temporary staff and interns.
- **Land and Facilities Management –** oversee operation and management of reserve including a public visitor center, trails, research lab, and support facilities.
- **Grants, Finance and Contracts Administration –** prepare budget requests, grant proposals, reports, and contracts to support personnel, operations, facility improvement projects, land acquisitions, and research, education, and stewardship projects.
- **Project Development and Implementation –** lead multiple teams in long range and short-term strategic planning and the development, implementation, and evaluation of research, education, and stewardship projects tied to coastal management.
- **State and Federal Policy –** implementation of state and federal policies, statutes, and rules related to the Reserve and in coordination with the National Oceanic and Atmospheric Administration's oversight of the National Estuarine Research Reserve System; also propose and contribute to necessary state rulemaking and legislative concepts.
- **Collaborative Partnerships –** develop and maintain constructive partnerships with relevant state and federal agencies, tribal governments, non-profits, and universities through the creation and maintenance of formal cooperative agreements.

RESEARCH EXPERIENCE

Lead Scientist/Research Coordinator, South Slough National Estuarine Research Reserve (2014-2018)
Courtesy Faculty Member, University of Oregon, Oregon Institute of Marine Biology
Coordinated research and monitoring activities for South Slough Reserve, including work with visiting researchers and students. Projects included native oyster restoration, fish and invertebrate diversity surveys, eelgrass community assessments and mapping, ecology of invasive species, and the application of environment DNA for estuarine monitoring. Guided strategic planning and direction of the science team comprised of five research professionals and additional interns and temporary staff.

Postdoctoral Research Scientist, University of Louisiana (2013-2014)
Designed and implemented a molecular genetics investigation as part of a collaborative project with Tulane University and the Louisiana Universities Marine Consortium to study the effects of the Deepwater Horizon oil spill on blue crab populations in Louisiana. Duties included the experimental design of a laboratory oil exposure experiment, data collection, molecular work, and the development of genetic markers from Next Generation Sequencing data.

Doctoral Fellow, Graduate Research Assistant, University of Louisiana (2007-2013)
Designed and carried out a population genetics study on blue crabs in the Gulf of Mexico and along the Atlantic Coast of the US. Duties included experimental design, development of a field-based sampling program, specimen collection in Louisiana, and coordination of a multi-state sampling effort. Laboratory duties included the development of genetic markers and collection of genetic data by sequencing and genotyping of single nucleotide polymorphisms (SNPs).

Graduate Research Assistant, Coastal Carolina University (2003-2005)
Designed and implemented a field-based investigation of habitat use of sharks and rays in a salt marsh estuary in South Carolina. Recruited, trained and coordinated more than 50 volunteers and one full-time research assistant. Additional responsibilities included experimental design, coordination of boat use, maintenance of sampling equipment, data collection and database management, data analysis, and presentation of results in professional documents and presentations.

TEACHING AND OUTREACH EXPERIENCE

Lab Coordinator, University of Louisiana (2013)
Genetics and Evolution Lab, Bio 234 (1 semester)

Graduate Teaching Assistant, University of Louisiana (2007-2013)
Genetics and Evolution Lab, Bio 234 (4 semesters)
Molecular and Cellular Engineering Lab, Bio 454 (1 semester)
Introductory Biology Lab, Bio 112 (2 semesters)

Graduate Teaching Assistant, Coastal Carolina University (2003-2005)
Field Studies in Shark Biology in Bimini, Bahamas, Bio 473 (1 semester)
Principles of Ecology Lab, Bio 370 (2 semesters)
Introductory Biology Lab, Bio 121-122 (2 semesters)

Youth Programs Coordinator, North Cascades Institute (2005-2007)
Coordinated all aspects of a residential science-based and natural history education program for students (grades 4-12) in North Cascades National Park. Designed and developed field science-based education curriculum, with emphasis on forest and aquatic ecology, environmental awareness, and natural history of the North Cascades. Supervised, trained, and mentored graduate students in residence from the Master's of Education program through Western Washington University. Hired, trained and supervised seasonal educators and naturalists. Coordinated first-aid and safety training of staff and implemented safety policy framework. Oversaw all aspects of residential family education programs at the North Cascades Environmental Learning Center during the summer months, including recruitment, hiring, and training of staff, budget management, and on-the-ground program facilitation and education.

Continuing Education Instructor, Coastal Carolina University (2005)
Taught classes in beach ecology, marine invertebrates, and sea turtle biology to the local community.

BOARD SERVICE AND ADVISORY EXPERIENCE

Bureau of Land Management, Western Oregon Resources Advisory Committee (2022 to present)
Representative for Public Land Management for Recreation

National Estuarine Research Reserve Association Board of Directors (2017 to present)
Executive Committee, Member at Large since 2022

Pacific Marine and Estuarine Fish Habitat Partnership Steering Committee (2020 to present)
Governance Committee, Chair-elect since 2023

Elakha Alliance Advisory Council (2020 to present)

Partnership for Coastal Watersheds Steering Committee (2014 to present)

Coos Watershed Association Board of Directors (2017 – 2022)
Vice President, 2019 to 2020. President, 2020 to 2021.

PROFESSIONAL PUBLICATIONS

Thomas, M.D., J.B. Schram, Z.F. Clark-Henry, **B.K. Yednock**, A.L. Shanks, A.W.E. Galloway. 2020. Juvenile Dungeness crabs (*Metacarcinus magister*) selectively integrate and modify the fatty acids of their experimental diets. Philosophical Transactions of the Royal Society B 375, no. 1804 (2020): 20200038.

Whalen, M.A., R.D Whippo, … **B.K. Yednock**, *et al*. 2020. Climate drives the geography of marine consumption by changing predator communities. Proceedings of the National Academy of Sciences, 117(45), 28160-28166.

Yamada, S.B., C. Lundeberg, T. Weldon, J. A. Prickett, A. Randall, **B. Yednock**, C. Geierman, C. Williams. 2016. Status of the European Green Crab, *Carcinus maenas*, in Oregon and Washington Estuaries in 2016. Technical Report.

Wasson, K., C. Zabin, J. Bible, S. Briley, E. Ceballos, A. Chang, B. Cheng, A. Deck, T. Grosholz, A. Helms, M. Latta, **B. Yednock**, D. Zacherl, M. Ferner. 2015. A guide to Olympia oyster restoration and conservation: environmental conditions and sites that support sustainable populations. Elkhorn Slough National Estuarine Research Reserve, pp.42.

Yednock, B.K., T.J. Sullivan, J.E. Neigel. 2015. De novo assembly of a transcriptome from juvenile blue crabs (*Callinectes sapidus*) following exposure to surrogate Macondo crude oil. BMC Genomics 16:521.

Prada, C., M.B. DeBiasse, J.E. Neigel, **B.K. Yednock**, J.L. Stake, Z.H. Forsman, I.B. Baums, and M.E. Hellberg. 2014. Genetic species delineation among branching Caribbean Porites corals. Coral Reefs:1-12.

Yednock, B.K. and J.E. Neigel. 2014. Detecting selection in the blue crab, *Callinectes sapidus*, using DNA sequence data from multiple nuclear protein-coding genes. PLoS ONE 9: e99081.

Yednock, B.K. and J.E. Neigel. 2014. An investigation of genetic population structure in blue crabs, *Callinectes sapidus*, using nuclear gene sequences. Marine Biology: 161, 871-886.

Yednock, B.K. and J.E. Neigel. 2011. Rethinking mechanisms that shape marine decapod population structure. In: Held C. et al. (Ed.) Phylogeography and population genetics in Crustacea. Crustacean Issues 19: 57-73.

Abel, D.C., R.F. Young, J.A. Garwood, M.J. Travaline, **B.K. Yednock.** 2007. Survey of the shark fauna in two South Carolina estuaries and the impact of salinity structure. In: McCandless, C. et al. (Ed.) Shark nursery grounds of the Gulf of Mexico and the east coast waters of the United States, American Fisheries Society Symposium 50:109-124.

Sawicki, J., **B.K. Yednock**, R. Bender. 1998. Coos Bay salinity intrusion study: the effects of deepening the channel on striped bass (*Marone saxatilis*) and other fish populations. 1998 Annual Report. Oregon Department of Fish and Wildlife, Contract Number: E969600027.

Megan Egler

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Education

2024 **Ph.D. Natural Resources, University of Vermont**
Rubenstein School of Environment & Natural Resources

2020 **Graduate Certificate in Ecological Economics, University of Vermont**
Rubenstein School of Environment & Natural Resources

2015 **M.Sc. Food, Agriculture and Resource Economics, University of Guelph**
Dept. Food Agriculture & Resource Economics

2012 **B.Sc. Environmental and Conservation Sciences, University of Alberta**
Dept. Resource Economics and Environmental Sociology
Major: Environmental Economics and Policy

Research Appointments

2024 - **Postdoctoral Fellow, Institute for Integrated Energy Systems**
School of Public Administrations, University of Victoria
- Research on public perceptions of energy transition within rural and medium-sized communities in Western Canada and the effective and inclusive design of policies advancing both climate and justice goals.

2018-2024 **Graduate Fellow, Gund Institute for Environment**
University of Vermont
- Dissertation research around narrative, power and energy transitions within fossil fuel producing regions

2023-2024 **Research Assistant, NSF Navigating the New Arctic: Sustainable Transitions through Arctic Redevelopment**
University of Vermont
- Qualitative interviews with Northern Alaskan communities and government officials around Arctic mine closures and redevelopment in Alaska, USA.

2021-2023 **Contract Researcher, Parkland Institute**
University of Alberta
- Research publication and public facing report in partnership with Oxfam Canada on the equity dimensions of environmental liabilities in the Canadian fossil fuel industry. Responded to media inquiries and engaged with journalists regarding key research results and policy implications.
- Research publication in partnership with Environmental Defence Canada on climate change and environmental liabilities in the Canadian fossil fuel industry.

2023 **Research Consultant, David Suzuki Foundation**
- Research in preparation for public comment on Ksi Lisims Liquid Natural Gas (LNG) Project in British Columbia, Canada.

2021-2022 **Junior Consultant, United Nations Research Institute for Social Development**
- Quantitative assistance on the UNRISD Flagship Report 2022 on Inequalities and a New Eco-Social Contract.

2021 **Research Assistant, Ecozoic Policy Project**
University of Vermont
- Policy research and strategic communication on just transitions and job guarantees in the United States and Vermont.

2018 **Research Volunteer, Nicaragüense para las Mujeres Productora**

CUSO International
- Participatory Action Research for the design of a pricing observatory and agricultural value chain development.

2017-2018 **Value Chain Analyst, Association of Producers and Exporters of Nicaragua**
CUSO International
- Project lead for a pro-poor value chain assessment of coconut production in South Caribbean Coast Autonomous Region of Nicaragua.

2013-2015 **Graduate Researcher, Dept. of Food Agriculture and Resource Economics**
University of Guelph
- Econometric modeling of food aid program efficacy in sub-Saharan Africa.

2013 **Development Intern, Fundación PROINPA**
Sustainable agricultural research and development
- Statistical Analyst for a project developing mycorrhizal seed treatments for small-scale farming in the Andean high lands.

2012 **Research Assistant, Dept. of Resource Economics and Environmental Sociology**
University of Alberta
- Evaluation of US trade policy and its effect on the survival of trade relationships with developing country partners.

Select Teaching Appointments

Spring, 2025 **Instructor and course design, Coastal Climate Challenge, Experiential learning**
The Coast Climate Solutions Leaders graduate training program, University of Victoria

Spring 2022 **Co-Instructor and course design, Community Development Economics**
Dept. Community Development Economics, University of Vermont

Fall 2020 **Co-Instructor, Human Ecology and Health in the Arctic**
Rubenstein School of Environment and Natural Resources, University of Vermont

Community & Academic Service

Leadership

2023- Director of Research, Canadian Society for Ecological Economics
2022-2023 Board Member, International Society for Ecological Economics

Community Organizing

2019 - 2024 Organizer, DegrowBTV in Burlington, Vermont
- Partnered with various community organizations to coordinate mutual aid efforts, organized and facilitated public education, community arts and visioning events

2016 Team lead, Drapen I Havet (Drop in the Ocean)
- Responsible for food distribution and children's activities in Souda Migrant Camp, Chios, Greece.

Professional Affiliations

Institute for Integrated Energy Systems, Accelerating Community Energy Transformation
UNRISD Network of Collaborating Researchers
UN Harmony with Nature Knowledge Network
Leadership for the Ecozoic
Petrocultures Research Group
Canadian Society for Ecological Economics

Select Publications

in review **Egler, M.,** Morse, C. 'Power, narrative, and the oil and gas worker: Meaning making and the maintenance of extractive subjectivities', i*n review at Antipode.*

2024 **Egler, M.,** Barbieri, L.'Prefiguring energy futures: hybrid energy initiatives and just

transitions in fossil fuel regions'. *Energy Research & Social Science*, 118, 103830.

2024 Farley, J., Melgar, R., Burke, M., Danielsen, J., **Egler, M**., et. al. 'Rethinking Ecosystem Services from the Anthropocene to the Ecozoic: Nature's Benefits to the Biotic Community'. *Ecosystem Services*, 67, 101624.

2021 **Egler, M.** 'Not Well Spent: A review of $1-billion federal funding to clean up Alberta's inactive oil and gas wells'. Parkland Institute and Oxfam Canada. Edmonton, Canada.

2020 Bliss, S., & **Egler, M**. 'Ecological Economics Beyond Markets'. *Ecological Economics*, 178, 106806.

2020 Koliba, C., **Egler, M.,** Posner, S. Governing for sustainable development: rethinking governance and ecological economics. In Sustainable Wellbeing Futures: A Research and Action Agenda for Ecological Economics. Costanza, R., Erickson, J. Farley, J., Kubiszewski. Edward Elgar Publishing Limited.

Selected Presentations

2025 'Energy capital, discursive power and the shaping of energy futures.' Invited seminar for the **New Energy Series at The Arthur L. Irving Institute for Energy & Society, Dartmouth**

2025 'The divided politics of energy transition and support for climate-justice policies in Western Canada's small and medium communities.' **Canadian Economics Association Annual Conference**

2024 'Realizing the clean energy transition: Large-scale surveys of citizen perceptions of energy transition technologies and policies in small and medium communities of Western Canada.' Presentation for the **Environmental Politics and Governance Network Survey Workshop**

2022 'Ecological Economics and the Rights of Nature.' Invited panelist to the **Eleventh Interactive Dialogue of the General Assembly on Harmony with Nature**

2021 **'**Not well spent: A review of $1-billion federal funding to clean up Alberta's inactive oil and gas wells.,' Invited panelist to the **Publish What You Pay US/Canada Webinar**

2021 'Informing the energy transition: Deep dive into methane emissions and reserve disclosures.' Invited panelist to the **The Big Cleanup: How Canadians are Paying to Reclaim Polluters' Wells Webinar**

Professional Training and Workshops

2024 Workshop on Surveys, Survey Experiments, and Field Experiments, The Environmental Politics and Governance Network

2024 The Arthur L. Irving Institute for Energy & Society New Energy Summit, Dartmouth

2020 Decolonial and Non-Hierarchical Research Methods Workshop, San Cristobal de las Casas, Mexico

Technical skills

Programming & Statistical Computing: Python • R • Excel • SPSS • Gephi

Qualitative data analysis: NVivo

Languages: English (Native), Spanish (Intermediate), French (A1)