CGG Regia MSS

NOPSEMA observations made post-OMR#2 Meeting#2 – 15 July 2025

The following document summarises NOPSEMA's observations regarding the Regia MSS EP and approaches proposed in OMR#2 Meeting#2 on 15 July 2025, in relation to:

1. General NOPSEMA observations on overarching key issues and the potential acceptability of the proposed activity
2. CGG proposal to reduce source and re-model with a different modelling provider
3. Consideration of received levels less than 140 dB and other contextual factors
4. CGG proposal to use coastal observers and assess response severity in SRWs within the reproduction BIA to inform mitigation
5. CGG's proposed whale detection methods (acoustic and visual)
6. Residual uncertainty regarding impacts to little penguins (particulalrly during chick provisioning during the proposed Sept – Dec survey window.

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1. Overarching issues and the potential acceptability of the activity

- **Acceptability** – Most impacts from the proposed activity are likely to be manageable to ALARP and acceptable levels. Impacts that are potentially unacceptable include:
    - Impacts to SRWs, primarily utilisation of the reproduction HCTS (including reproduction behaviours, and migration of females and calves into/out of the reproduction HCTS) are potentially unacceptable and potentially inconsistent with the recovery plan. There are high levels of uncertainty.
    - Impacts to PBWs still require CGG to demonstrate comprehensive and effective detection and mitigation in order for the activity o be acceptable and consistent with the CMP.
    - To a lesser degree, impacts to little penguins require further consideration to demonstrate if impacts will be acceptable.
- **Timing of activity** – Hierarchy of control should prioritise avoidance where there is potential for disturbance from activities in or adjacent to the BIAs
    - CGG have demonstrated they have given equal weighting to BW foraging and SRW reproduction despite SRW reproduction being a more sensitive life stage and affording a higher level of protection through designation as HCTS.
    - Regia MSS avoids periods of peak numbers of BWs (Jan – Feb) and SRWs (Jul-Aug), but still overlaps months where they may still occur in significant numbers (when RPs require consideration of individuals [any whale"]).
    - SRW Recovery Plan: Migration April-October, Reproduction May-September.
    - Rule out Apr-June due to potential overlap with SRW arrival into reproduction BIA and early calving and nursing (May-June)?

    - Avoid Sept, adaptive commencement criteria to ensure departure of SRWs in Oct, acquire Oct-Dec.
    - PBWs may not arrive in Otway/Bonney Upwelling until Dec or later.
    - Penguins – Potential issue for Sept-Dec window. Can this issue be addressed?
- **Detection** – If survey timing changed, the criticality of the ADM component of whale detection is potentially reduced, however, CGG would still need to demonstrate effective detection and mitigation for BWs in the foraging BIA in order to be consistent with the CMP, so the ADM and improvements to visual detection options are still important.

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2. Reduce source size and re-model

Background:

- Due to impact assessment and control measures for BW and SRW being based upon TTS ranges predicted with animat modelling, a reasonable assessment of changes as a result of updates to NMFS thresholds and weighting function parameters is needed. **This has not currently been done.** SLR study (App B7c) has revealed a number of issues:
    - Compared NMFS 2024 spreadsheet tool with JASCO model, but not comparable (simplistic transmission loss calculation vs sophisticated propagation models).
    - Did not consider NMFS 2024 updates unless there was a change to a threshold. Therefore have not considered
    - NMFS spreadsheet tools (which use a single frequency 'weighting factor adjustment') may not adequately consider changes in the LFC weighting function.
- CGG explaine don 15/07/2025 that they have spoken with JASCO, who aren't prepared to provide a technical note and revised modelling is needed. JASCO has a lead in time to start of 9 weeks.
- CGG has indicated that due to time and cost, CGG is looking to proceed with SLR undertaking revised propagation and animat modelling.
- Modelling will consider a quieter 2,610 cui source and quieter technology to see if it will make a material difference to source and received sound levels compared with the current 2,820 cui source. If no material reduction, modelling may be undertaken for the 2,820 cui source, but with the NMFS (2024) updates applied.

NOPSEMA observations and comments:

- JASCO models have been applied extensively and NOPSEMA is familiar with them. Deemed reasonably accurate and reliable on the basis they have been validated with field measurements in numerous locations around the world, including in Australia.
- JASCO animat model, and the various parameters and assumptions that underpin it, have also been through extensive review on a number of EPs since circa. 2019. The methods are fundamental to our acceptance of the results in impact assessments.
- NOPSEMA is less familiar with SLRs models or their capabilities. Unclear if SLR have the same sound propagation and animat modelling capabilities.
- **In the meeting, NOPSEMA communicated to CGG that the SLR model reports, including details of the models, methods, parameters and assumptions would need to be submitted with the EP and would come under scrutiny.**

- Could SLR or JASCO undertake a more simplistic source and propagation model to compare the source sizes without having to proceed with full, detailed propagation and animat modelling?

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3. SRW Reproduction – Received sound levels <140 dB

Background:

- CGG originally assess behavioural disturbance to the 160 dB threshold, but failed no appropriately acknowledge and address uncertainties and limitations.
- Following OMR#1, CGG provided some consideration of levels to 140 dB (based on Wood et al [2012]) and some contextual factors.
- No consideration of potential disturbance at lower levels, or appropriate acknowledgement of remaining uncertainty and contextual factors.

NOPSEMA observations and comments:

- By not considering levels lower than 140 dB, the EP hasn't adequately captured hasn't adequately captured all impacts and risks, and is not able to demonstrate if the activity will be consistent with the recovery plan.
- NOPSEMA is not prescribing 120 dB or saying it is the only relevant consideration. Other contextual factors and typical ambient noise levels are also relevant to the assessment.
- <u>BUT</u> CGG is applying probabilistic behavioural functions, so 120 dB does warrant consideration (as per Wood et al. 2012 cited in the EP, and others).
- EP references studies with avoidance responses at 110 – 130 dB in <u>migrating</u> bowhead and gray whales (Richardson et al. 1999, Manly et al. 2007, Malme et al. 1984).
- Darias-O'Hara et al. (2025) - The probability distribution of behavioural response thresholds for LF cetaceans to seismic (including SRWs) is 139 dB median (50 %ile) and goes lower, noting variability and that mother-calf pairs are more likely to elicit more adverse and quicker responses. This reference was provided to CGG following the 15/7 meeting.
- Can CGG provide any scientific evidence that received levels of >120/140 dB won't disturb SRW reproduction and prevent utilisation of the HCTS (and the single primary established calving ground for the SE population)?
- **Other context and uncertainties (some still to communicate to CGG)** – EP provides some contextual assessment, but is not recognising:
  - <u>Species:</u> No studies undertaken into the effects of seismic on right whales. Uncertainty.
  - <u>Behavioural state / life stage:</u> No studies undertaken into the effects of seismic on reproductive behaviours or on calving grounds. Reproduction is most sensitive and vulnerable life stage. Stress responses may not be evident from a visual response. Vulnerability and uncertainty.
  - <u>Population / recovery rate:</u> Low population. Uncertain recovery rate. Low number of calving females each year. Primary calving area for SE population. Vulnerability and uncertainty.
  - <u>Sound type / familiarity</u>: Unfamiliar. Different from natural sounds. Different from shipping sounds (e.g. see Nowacek [2004] re right whales, and Castellote et al. [2012] Fin whales abandoned Alboran basin in the Mediterranean during a 10-day

seismic survey but not in response to shipping noise; these references have been provided to CGG following the 15/7 meeting). Uncertainty re response to seismic sound characteristics.

- Exposure duration: Potentially weeks of exposure during May-June, or Sept-early Oct. Repeated exposures, “sustained” exposure? Not clear from EP.
- Ambient / existing noise:
  - The EP provides median levels offshore of 93 and 97 dB (Woodside), and 104.5 dB (Beach Energy) in OA in proximity to shipping lanes. Mean level in OA is 118.9 dB (Beach Energy). Levels not provided in EP for inshore areas (i.e. in the reproduction HCTS), but ‘nearshore’ ambient levels in other EPs have been given as ~90 – 110 dB.
  - NOPSEMA notes that there will be occasional increases during periods of inclement weather and rough seas, but these are typically short-term (days), whales will be familiar with them, and such natural events include other environmental cues (currents, water temp) that the whales will be familiar with. The EP notes maximum ambient levels of ~158 dB, but does not acknowledge this exposure context.
  - The EP references Nielsen et al (2019) to suggest that mothers and calves seek out shallow waters with the sound of breaking waves to help mask their calls from predators, however, the EP does not provide relevant ambient sound levels:
  - From Nielsen et al (2019) https://doi.org/10.1242/jeb.190728:
    - *Mother-calf calls may be crucial for maintaining contact and facilitate reunion in the case of separation.*
    - *Mother calf vocalisations were recorded at low rates of <10 calls h−1 (1 call per dive) and at low received levels between 123±8 and 134±10 dB re. 1 µPa RMS depending on call type* (NOPSEMA notes that these levels are often less than 140 dB and sometimes at/approaching/less than 120 dB).
    - *The ambient noise level was estimated in calm seas to be 103±11 dB re. 1 µPa RMS in the frequency band overlapping the frequency band of mother–calf calls. At such ambient noise levels, the differences between the ambient noise levels and the recorded southern right whale call amplitudes were on average 30 and 20 dB, for harmonic and non-harmonic calls, respectively.*
    - The study was undertaken at Flinders Bay, near Augusta in WA (Southern Ocean) – Would these ambient levels and differences be comparable to ambient levels in embayments in the Otway region? They are potentially more relevant than ambient measurements for oil and gas, which are usually measured further offshore.

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4. CGG proposal to use coastal observers to monitor response during SRW reproduction behaviours and inform mitigation

Background:

- CGG propose monitoring using coastal observers and monitoring to evaluate SRW response severity as per Southall et al. (2021) severity scale.
- CGG suggest the selected received sound level (i.e. threshold) applied in the EP is less critical if they actually monitor the response and applying mitigation, but NOPSEMA noted to CGG during the meeting of 15/7 that the levels wee still important for identifying the area where impacts could occur for impact assessment and for identifying and where observations need to be undertaken.
- CGG propose severity levels 5 – 9 to trigger mitigation.
- EP is currently unclear on the months when observations would be undertaken and the mitigation that would be triggered.

Pros:

- If undertaken correctly, monitoring could provide a world first behavioural response study that looks at potential whale response levels to seismic during reproduction behaviours.
- A well-executed behavioural response study would be consistent with NOPSEMA Research Strategy research topics:
    - '*Blue whales and southern right whales: Better understanding, and where possible quantifying, behavioural responses to underwater noise and implications for foraging, feeding, fitness and breeding success in the context of EPBC Act species recovery requirements (e.g. Actions relevant to underwater noise management set out in in-force EPBC Act species conservation management documentation)*'.
    - '*The effect of anthropogenic noise on whale physiology and behaviour to inform the management needed to avoid whale injury and displacement from biologically important areas*.'
- A well-executed behavioural response study would be consistent with Recovery plan action A5.5: '*Quantify risks of anthropogenic underwater noise to southern right whales, including studies aimed to measure physiological effects, behavioural disturbance, and changes to acoustic communication (e.g., masking of vocalisations) to whales'.*

General Concerns/Issues:

- Potential for unacceptable impacts and impacts inconsistent with a recovery plan if cannot be undertaken with complete confidence. Still need to consider recovery plan requirements in relation to impacts to any whale (*individuals*).
- Approach is representative of a behavioural response study or controlled field exposure experiment - Risky doing this as a means to inform mitigation in real-time during an activity.
- May require research permit and animal ethics permits from State government agency and/or research organisation – Needs to be confirmed.
- High detection rates are essential, however:
    - Visual observations will be from a limited number of coastal locations. Only possible to get good observation if close to viewing location. SRWs may be in other locations. Nighttime observations unlikely or night vision "trials" cannot be relied upon to be effective.
    - Low vocalisation rates and levels – Limited potential for acoustic detection using ADM unless acoustic recording devices or acoustic tags used within the reproduction HCTS.

- Are Southall et al. 2021 severity levels 5 – 9 appropriate for triggering mitigation, or might lower-level response severities have implications for individuals? Don't know until data analysed.
- Stress responses may not be evident from a visual response.
- Southall et al. (2021) developed the approaches to be applied to behavioural response studies, not as a mechanism for making rapid decisions and implementing mitigation.
- Southall et al. (2021) notes that many behavioural response studies involve known and controlled exposures.
- Behavioural response studies have never before attempted on reproduction behaviours / calves in nursery grounds.
- Papers acknowledge that there is limited information on disturbance to calves / reproduction due to obvious ethical and logistical challenges e.g. Darias-O'Hara et al. (2025).
- Other behavioural response studies have been undertaken during migration and foraging, where there is greater potential for animals to compensate energetically for disturbances than during reproductive behavioural states.
- Difficulty immediately assigning a response severity level to visual detections and acoustic detections for the purpose of informing mitigation – May not be possible.
- Other behavioural response studies involve extensive detection and monitoring methods, and extensive post-data collection analyses of the multiple lines of data (see below).

Examples of other behavioural response studies:

- Other behavioural response studies have used a combination of detection measures and multiple lines of data to analyse and assess response, e.g.:
  - **Richardson et al. (1999) – Bowhead whales, migrating real seismic surveys over 3 months** – boat-based observations and daily aerial surveys.
  - **Blackwell et al. (2013, 2015) – Bowhead whales, migration, real seismic surveys over 3 months** – 40x directional acoustic recorders. Study only evaluated vocalisations, so these aren't a suitable proxy.
  - **Gailey et al. (2016, 2022) – Gray whales, feeding, real seismic surveys over 3-4 months** – Visual observations and theodolite tracking by 5 teams from 8 shore-based locations and visual observations from offshore vessels. Monitored movements, behaviour state, and respiration patterns. 40x acoustic recorders. Analysis and modelling of variables, benthic habitat, prey availability and responses. Standard shut-down mitigation protocols were implemented.
  - **Dunlop et al. (2015, 2016, 2017) – humpback whales, migration, controlled airgun exposures** – Shore based observations and theodolite tracking, dedicated boat-based observations, acoustic monitoring.
  - **Miller et al. (2012)** – Archival acoustic tags and visual observations.
- Response severity is not determined immediately, but are determined from extensive analyses of the various data streams.

What would NOPSEMA expect to see to be reasonably satisfied:

- High-detection rates and high levels of confidence
- Reliable interpretation of behavioural response severity scale for real-time, real-world observations – unlikely in mitigation timeframes as may require extended analysis of multiple lines of evidence.

- Involvement and oversight by independent scientific researchers with familiarity with Southall et al (2021) methods, species and exposure types.
- **Is this realistic / achievable?**

Also consider if research or monitoring to inform mitigation may meet new definition of "Explore". Based on recent legal advice this seems unlikely but may need to be confirmed.

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5. Whale detection methods (acoustic and visual)

<u>OMR letter point 2.3(1) – Acoustic detection – ADM</u>

- EP makes a case for multiple detection methods, including ADM, and the 15km detection range is presented.
- As noted in previous OMR, noting the sensitivity of the area in / adjacent to where the Regia MSS will be acquired and noting the area that needs to be covered, ADM provides additional detection potential and situational awareness.
    - EP does not commit to ADM (subject to trial).
    - ADM is not yet demonstrated to be effective.
    - Regardless, there are devices (moored / glider / drifter) used elsewhere in the world to detect similar species, similar ambient noise profiles and in the presence of seismic / pile driving that are already demonstrated to be effective.
- Regardless of which system CGG could eventually use, the EP should set minimum levels of performance that need to be met or exceed (including detection range, detection rate, decision making factors that CGG will consider when designing the final number and location of deployments.
- If not going to do ADM, what will CGG do?

<u>OMR letter point 2.3 (2) – Visual and acoustic detection</u>

- Need to demonstrate with a high degree of confidence that CGG can detect SRW/BW over the given distances from the source and ASA, such that the proposed controls to manage impacts to an acceptable level can be implemented effectively.
- Currently, while CGG's detection strategy includes a range of options, it does not demonstrate this.
- Both acoustic and visual methods need to be effective (collectively and independently).
- May not need to provide 100% coverage, but methods collectively need to provide a good degree of confidence in detecting BW /SRW.
- Current methods:
    - ~5km for MFO from survey vessel
    - Spotter vessel - ~5km (scouting/sentry protocols 15-23 km ahead). Good, but there is still a significant area that will not be observed visually.
    - Towed PAM (<10km detection range) – Potentially very low detection rates, based on most recent survey in Otway.
    - Only committing to one aerial survey prior to the survey, opportunities for increased situational awareness and visual observations form addition aerial surveys.
    - Trials of other technology (drones, satellite, infra-red) encouraged, but cannot be relied upon).

- Third party sightings (industry, research bodies) - Good, but no set agreement or framework in place so unclear how effective (timely) this may be. Opportunistic.
- Coastal observers and integration of other shore-based sightings. Good for SRW in reproduction area, but what about offshore?
- **Aerial prior to survey, but only commit to prior to start-up? Limited benefit for more surveys?**
- **Other support vessels?**

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6. Residual uncertainty regarding impacts to little penguins

NOPSEMA considerations:

- Survey ~17 km from LJPI and 20 – 30 km from a number of other smaller coastal colonies, shoreward of the survey.
- Little penguins are listed Marine, not Threatened, but part of the CMA.
- Single biological population across SE Australia.
- EPBC Act Significant Impact guidelines 1.1 significant impact criteria for CMA includes '*have a substantial adverse effect on a population of a marine species or cetacean including its life cycle (for example, breeding, feeding, migration behaviour, life expectancy) and spatial distribution*' (not reflected in EP). Guidelines aren't clear what constitutes a 'population' in this case.
- Would this be our only consideration in relation to 'serious or irreversible harm' and scientific uncertainty in relation to the precautionary principle?
- Limited science available on impacts to penguins
- One study found response to 120 dB in captive tank exposures. CGG has acknowledged this mapped 120 dB (otariid weighted) isopleth to R = ~78 km. CGG note unlikely to be representative of disturbance in wild / open ocean environment, which is reasonable, but still uncertain at what levels / distances that disturbance may alter penguin foraging.
- Pichegru et al. (2017) found 2D seismic resulted in changes to foraging distribution from 60 – 100 km. Significantly further than Otway colonies.
- CGG have assessed impacts to prey fish species (sardines) - ~10 km, which may be reasonably representative for most changes to abundance and distribution. EP notes from Pichegru et al. (2017), no significant changes detected to sardine distribution.
- CGG have provided further information, to explain that penguins have some flexibility in foraging and can compensate for this energetically.
- **Still unclear if they can tolerate / compensate to the extent needed given the proximity to colonies.**

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NOPSEMA messaging for CGG

1. **Opening messaging:**
   - EP has been through RFFWI and into 2nd OMR. NOPSEMA intends to make a decision on the EP next round.
   - NOPSEMA not yet reasonably satisfied that the EP demonstrates that impacts and risks will be managed to acceptable levels.

- NOPSEMA has had opportunity to consider CGG's proposed approaches from meeting of 15 July.
- We have high level feedback which may be in CGG's best interests to consider – Likely path of least risk and increased chance for acceptance.
- Our advice is not the only path available to CGG and would be subject to CGG articulating its position within the permissioning document.
- Allow opportunity for CGG to provide update.

2. **Information discussed in meeting of 15 July 2025:**
    - Assessment of behavioural impacts to SRW reproduction and HCTS utilisation (received sound levels, context, uncertainty).
    - CGG propose to use coastal observers to ascertain behavioural response by SRWs and inform mitigation.
    - CGG propose to consider quieter source and undertake new sound propagation and Animat modelling using SLR.
3. **NOPSEMA advice on a potential path forward:**
    - Not yet provided evidence that gives confidence that levels of performance will be achieved in relation to uncertainties regarding received sound levels (e.g. 120 dB) and context (e.g. behavioural state, sound type, exposure duration, ambient noise).
    - NOPSEMA has significant concerns regarding CGG's proposed approach to monitoring SRWs and making decisions based on observed responses to inform mitigation:
        - Approach is risky / has high levels of uncertainty - Potential for unacceptable impacts and impacts inconsistent with a recovery plan if cannot be undertaken with complete confidence.
        - Behavioural response studies have never before been attempted on reproduction behaviours / calves in nursery grounds due to acknowledged ethical and logistical challenges. Previously only ever undertaken on migrating/foraging animals.
        - High confidence and levels of detection across the potentially affected area of disturbance are required, and may not be achievable.
        - The Southall et al. (2021) approach and severity scale are not intended for rapid, real-time decision-making.
        - How do CGG proposes to make clear observations and rapid judgments against the severity scale descriptors that can reliably inform mitigation?
        - How do CGG propose to address the qualitative indicators of change from a baseline state in a repeatable and non-biased way?
        - Studies typically require multiple lines of evidence and extensive analysis before assigning severity ratings.
    - Suggest primary focus for CGG should be to revisit the hierarchy of controls and consider avoidance of times of year when SRWs will be present and undertaking behaviours (as suggested in the recovery plan).
        - CGG included information on timing – equal level of protection for BWs and SRWs, but SRW reproduction requires higher level of protection.
        - Apr-June window would require detection and survey cessation measures, noting the arrival of SRWs in the reproduction HCTS is typically in May.
        - CGG should consider avoiding September and applying detection and adaptive commencement criteria to ensure departure of SRWs prior to commencement of the survey, then acquire Oct-Dec.

        - Still requires robust detection and mitigation for potential arrival of PBWs in the foraging BIA.
    - Stress again that new source and new modelling with a different contractor and models will be subject to renewed scrutiny at this late stage in the assessment process.
4. **Re-articulate:** Our advice is not the only path available to CGG and would be subject to CGG articulating its position within the permissioning document

HOLD: Items for more in-depth discussion in separate meeting, if requested:

- OMR letter item 2.1 – Whale detection strategy (not yet discussed with CGG).
- Possible further clarification re little penguin assessment.

Attachment - Southall *et al*. (2021) behavioural response severity scale

Table 3. Behavioral response severity scale for discrete exposures of free-ranging marine mammals

Response score	Behavioral changes affecting survival	Behavioral changes affecting feeding	Behavioral changes affecting reproduction
0	No response detected with methods sufficient to identify responses relevant to survival	No response detected with methods sufficient to identify responses relevant to feeding	No response detected with methods sufficient to identify responses relevant to reproduction
1	Identifiable change in behavior indicating vigilance response: • Orientation • Interruption of resting behavior • Listening: Delay in vocal behavior/locomotion/ breathing • Detectable change in diving behavior • Minor deviation from typical migratory pathway	Detectable interruption of foraging behavior	Detectable interruption of advertisement and courtship behavior
2	Sustained or multiple vigilance responses		
3	• Individual investigation of potential threat • Recruitment of orienting behavior • Increase in contact or alarm calls to initiate social cohesion • Individual startle response	Behavioral state changes from foraging to other behavior	Behavioral state changes from advertisement and courtship to other behavior
4	• Prolonged silencing or other cryptic behavior to avoid detection • Defensive bradycardia or stillness • Increased interval between surfacing bouts • Reduction in variance of heading • Change in group cohesion • Brief/minor changes in vocal rates or signal characteristics—potentially related to higher auditory masking potential	• Non-foraging state longer than typical • Detectable elevation in energy expenditure (e.g., increase in dynamic acceleration, respiration rate, locomotion, speed) • Brief/minor changes in vocal rates or signal characteristics—potentially related to higher auditory masking potential	• Non-reproductive (advertisement and courtship) state longer than typical • Brief/minor changes in vocal rates or signal characteristics—potentially related to higher auditory masking potential
5	• Onset of avoidance behavior (e.g., heading away and/or increasing range from source) • Recruitment of defensive social behaviors (e.g., rafting, marguerite, vocal threats) • Increase in mother–offspring cohesion (including acoustic signaling and/or mother herding offspring)	• Reduction of foraging success less than typical daily intake requirement (during exposure period) • Detectable change in nursing behavior	
6	• Repeated startle response; abrupt agonistic behaviors (e.g., head thrusting, mouth gaping) • Individual aggressive behavior (e.g., jaw clapping, gnashing teeth, abrupt directed [rush/ ramming] movement potentially directed at conspecifics) • Sustained avoidance behavior (e.g., heading away and/or increasing range from source) • Separation of females; dependent offspring exceeding baseline • Group aggressive behavior (e.g., mobbing) • Sustained changes in vocal rates or signal characteristics—potentially related to higher auditory masking potential	• Reduction of foraging success exceeding typical daily intake requirement (potentially extending beyond exposure period) • Energy expenditure exceeds nominal daily baseline • Sustained disruption of nursing behavior • Sustained changes in vocal rates or signal characteristics—potentially related to higher auditory masking potential	• Reduction of advertisement and courtship behaviors potentially sufficient to reduce reproductive success • Disruption of parental attendance behavior • Sustained changes in vocal rates or signal characteristics—potentially related to higher auditory masking potential

7	• Separation of females and dependent offspring sustained for long enough to compromise reunion • Clear anti-predator response (e.g., severe and/or sustained avoidance or aggressive behavior) • Displacement to area of increased predation risk • Failure of vocal mechanisms to compensate for noise (e.g., silencing affects group cohesion/defense)	• Reduction of foraging success sufficient to compromise health and/or reproduction • Failure of vocal mechanisms to compensate for noise (e.g., cessation of acoustically mediated foraging)	• Interruption of breeding behavior • Failure of vocal mechanisms to compensate for noise (e.g., cessation of acoustic advertisement displays)
8	• Disruption of group social structure (e.g., breaking pair bonds/alliances, altering dominance structure) • Prolonged/significant separation of females and dependent offspring with disruption of acoustic reunion mechanisms	• Prolonged displacement to suboptimal foraging habitat • Disruption of group social structure (cooperative feeding groups with specialized knowledge or division of labor)	• Disruption of breeding behavior sufficient to compromise reproductive success (e.g., repeated interruption of mating, disrupting male–female association) • Disruption of group social structure (e.g., breaking pair bonds/alliances, altering dominance structure)
9	Risk that behavioral response leads to serious injury or mortality (predation, outright panic, flight, stampede, stranding, mother–offspring separation)	Disruption of energetic balance sufficient to result in morbidity or mortality	Failure to successfully reproduce during breeding season