Guidelines for prediction and evaluation of acoustic impact on underwater fauna

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INTRODUCTION

- In recent years, noise pollution has been recognized as the biggest threat to cetaceans.
- Chilean west coast extends for 6400 kilometers of the Pacific Ocean.
- This coast has 51 species of marine mammals, 36% of the world's diversity, including subjects of three groups: Whales, otters and pinnipeds (seals and sea lions).
- Many marine mammals rely on sound for their basic needs: Food, Communication, Protection, Reproduction and Navigation.
- One of the biggest concerns is the background noise
- Considering the great length of Chilean coast and the lack of any legal protection law in Chile, this topic is considered of high interest.

NOISE SOURCES – NATURAL

- **Ambient noise have several components**: turbulent pressure fluctuations, surface agitation (wind dependent), marine life, seismic activities.
- **Spectral Range**: Waves or Wind (100 Hz to 50 KHz), Volcanic activities (Below 100 Hz), Rain, snow and hails (100 to 500 Hz)
- **Duration**: Short duration, repetitive, a variety types of sound (cries, moans, grunts, chirps, etc.)
- **Three orders for marines mammals**: Cetacea (many species in Chile), sirenia and carnivore.

NOISE SOURCES – ANTROPOGENIC

- **Commercial navigation**: The greatest contribution of acoustic energy (5 to 5000 Hz) - Propeller, drive motor and the water flow under the boat.
- **Sonar**: Creates acoustic energy and listen (below 20 KHz).
- **Seismic exploration**: Analyze the composition of the seabed, as well as being the main technique for locating oil reserves and natural gas - It generates high sound pressure levels, at low frequency and short duration.
- **Exploration and production of gas**: Mainly associated with drilling activities - Historically the biggest source of acoustic activity of surface water (<200m) -In recent years these activities are moving to deep water (up to 3000 m).
- **Industrial activities and construction**: Dredging – Drilling - Pile driving – Blasting.

UNDERWATER SOUND PROPAGATION

- The ocean is an extremely complex medium due its inhomogeneous nature.
- The main effect of propagation is to decrease the signal amplitude, by geometrical spreading and absorption.
- There are other underwater phenomena and additional variables that can influence the underwater acoustic propagation.

EFFECTS OF NOISE ON MARINE FAUNA

- Threats on marine life can include physiological and behavioral effects.
- The powerful noise can cause rupture or hemorrhage on ear, body parts.
- Also high levels of noise can trigger hearing loss, and interfere with the echolocation abilities.
- In the *Islote Lobería* of *Cobquecura*, Chile, has been observed that sea lions (*Otaria flavescens*) cease vocalization in the presence of fireworks during New Year celebrations.
- Disturbance can force whales to dive deeply, causing decompression sickness on rising.
- Most of this studies are short-term behavioral observations, and a few-long term studies have been conducted.
- Marine mammals are very adaptable and tolerant to noise, but the limits of this tolerance are unidentified.
- The effects of masking important sounds, such as predators, and the adaptability to adjust the frequency or strength of their signals, are mainly unknown.

REGULATION APPROACHES

- **(A) Noise source selection**: Minimum power source must be used or foundation alternative techniques.
- **(B) Location and timing:** Spatial or temporal Vedas.
- **(C) Operational procedures**: (C1) Soft start/ramp: gradual increase to full power. (C2) Using vibrating ramming instead of pile driving.
- **(D) Mitigation measures**: Bubble screens. Almost all European countries require bubble curtains.
- **(E) Mitigation procedures**: (E1) Safety Zones / (E2) Marine Mammal Observers / (E3) Study before the start of operations/ (E4) Low Power and Off: If animals entering the areas. The operations have to switch to low power or off / (E5) Passive acoustic monitoring (PAM). In addition to the MMO, the PAM is recommended for operations in low visibility conditions.