Potential impacts on marine mammals from offshore development in the South Pacific

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Overview

1. Why care about marine mammals?
2. Deep sea mining
3. Seismic Surveys
4. Possible management approaches
5. Concluding remarks

Why care about marine mammals?

- The Pacific is vast and is many times larger than the land area
- At least 40 species of marine mammals occupy the full extent of the EEZ
- Why focus on marine mammals?
  - Known to be sensitive to anthropogenic activities
  - Many threatened and most are protected
  - Useful ecosystem indicator species and can act as a surrogate for protection of other species
  - Iconic and have a high public profile
  - Require specific mitigation techniques

Potential effects

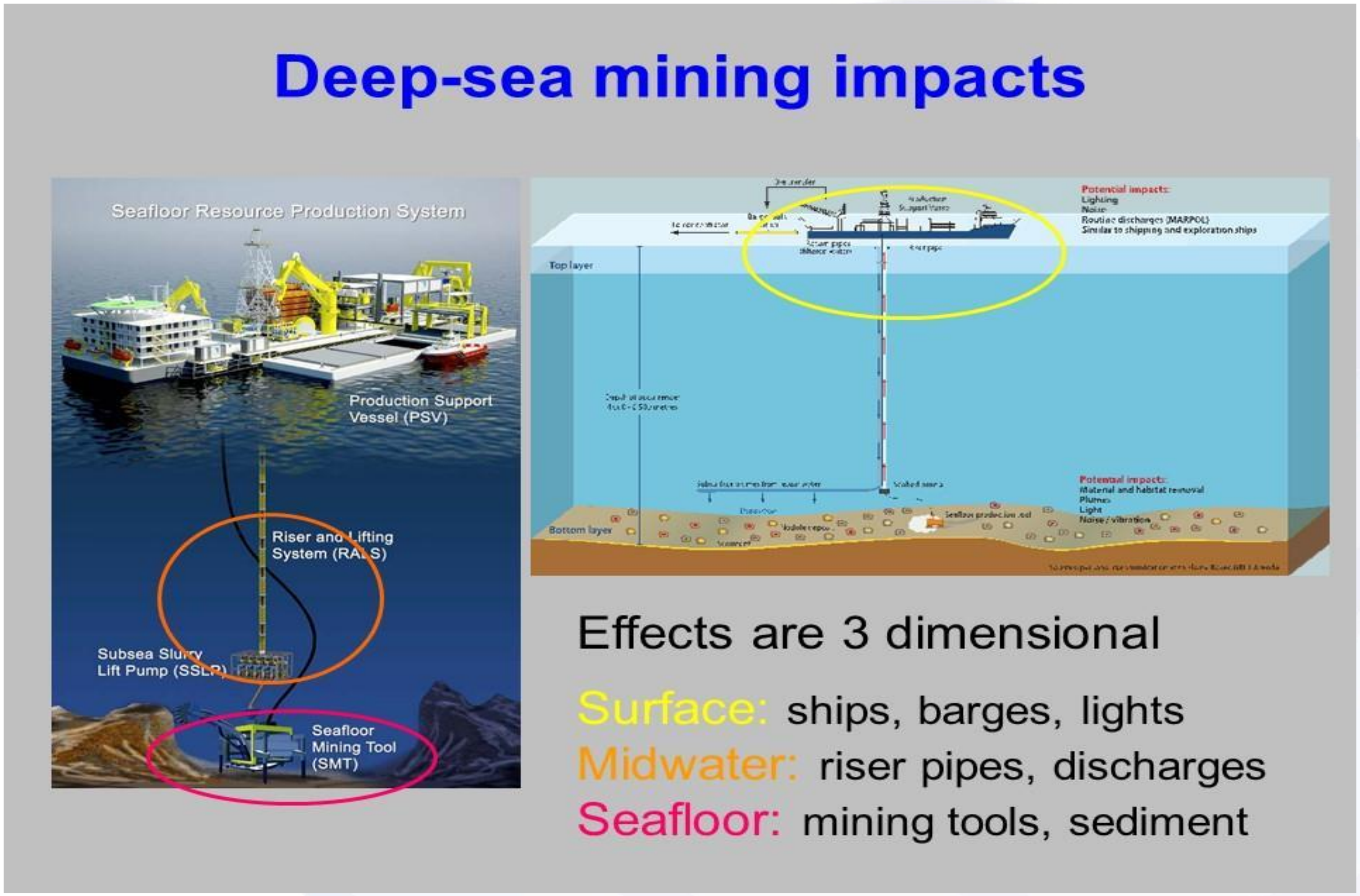
CAVEAT: Potential effects will vary considerably in their nature and extent across these groups subject to a range of factors:

- Their usage of the area (e.g. breeding, feeding, migrating)
- Importance of the mining area (e.g. are marine mammals able to undertake those activities elsewhere or not?)
- Sensitivity (e.g. can they tolerate increased sedimentation, noise, or switch prey and/or areas)
- Threat status (e.g. endangered vs. non-threatened)
- The exact nature and extent of the operation and effect (e.g. sedimentation highly localised; operational noise only a little above ambient)

DEEP SEA MINING

- There is potential for environmental impacts associated with deep sea mining
- It is a relatively new technology with considerable uncertainty regarding the potential for environmental impacts
- In most mining locations, the biological environments are often poorly understood by comparison to terrestrial environments
- Potential environmental impacts have also attracted attention from NGOs, IGOs and other stakeholders
- There are currently no recognised international best practice guidelines for minimising or mitigating environmental impacts
- Regulators, therefore, often apply the precautionary approach

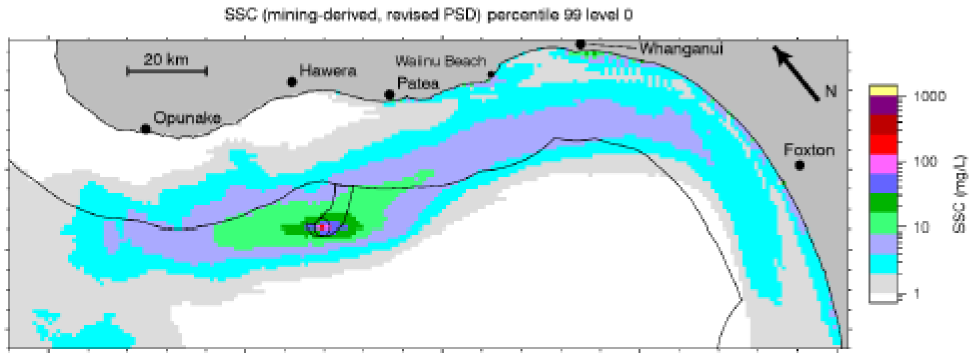
Potential environmental effects



Source Clark et al. 2014

Potential seafloor effects

- Physical destruction
- Entrainment in dredge equipment
- Sediment smothering
- Light pollution
- Toxic effects from sedimentation
- Loss and/or alteration of habitat
- Noise (i.e. from benthic operations such as pumps, sonar on crawler units)



Potential water column effects

- Sediment plume can lead to ecological effects and reduced foraging success for visual predators
- Displacement and/or mortality of species (e.g. fish)
- Seabed toxins released and can accumulate in food webs
  - Potential physiological and/or reproductive impacts
- Oxygen depletion
- Noise (i.e. from riser and discharge pipes)
- Entanglement risk (e.g. anchor lines, riser and discharge pipes & lines)

Potential surface effects

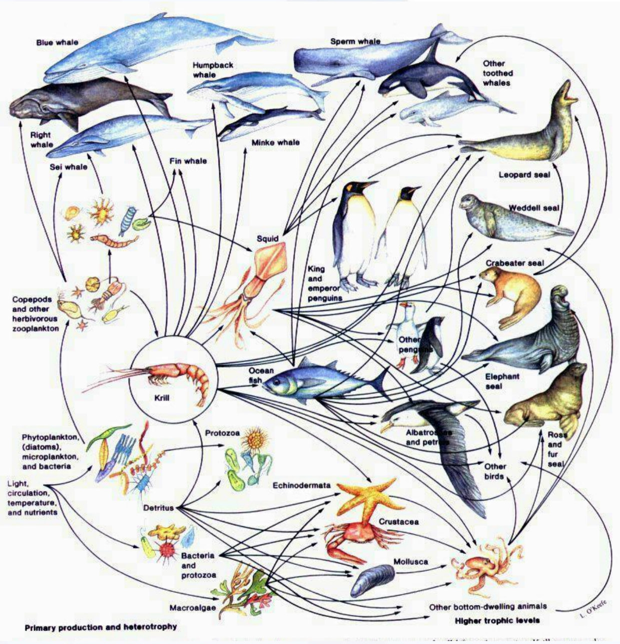
- Vessel traffic
  - potential ship strike
  - Noise (i.e. from vessels, mining machinery, pumps)
  - Displacement from area around mining operation
- Lighting effects on seabirds and turtle hatchlings

Photo Dave Paton

Photo Ros Butt

Potential ecological effects

- Covers a wide array of possible effects
- Generally due to:
  - Direct modification/destruction of sea floor habitat from actual mining activity
  - Sediment plume in water column
  - Deposition onto the sea floor
- Ecological effects
  - Displacement and/or mortality of prey
  - May lead to changes in food webs and can be indirect



Ecological effects

- In general, poorly understood and theoretical
  - Few examples of a comprehensive evaluation of effects on food webs
  - Few locations will have sufficient data to reliably estimate any potential effects
  - Most rely on generalised ecological theory
- Almost no examples of actual ecological effects from deep sea mining other than direct habitat destruction
- Risk varies considerably by operational configuration, composition and extent of sediment plume and local biodiversity
  - Generally estimated as low to medium risk

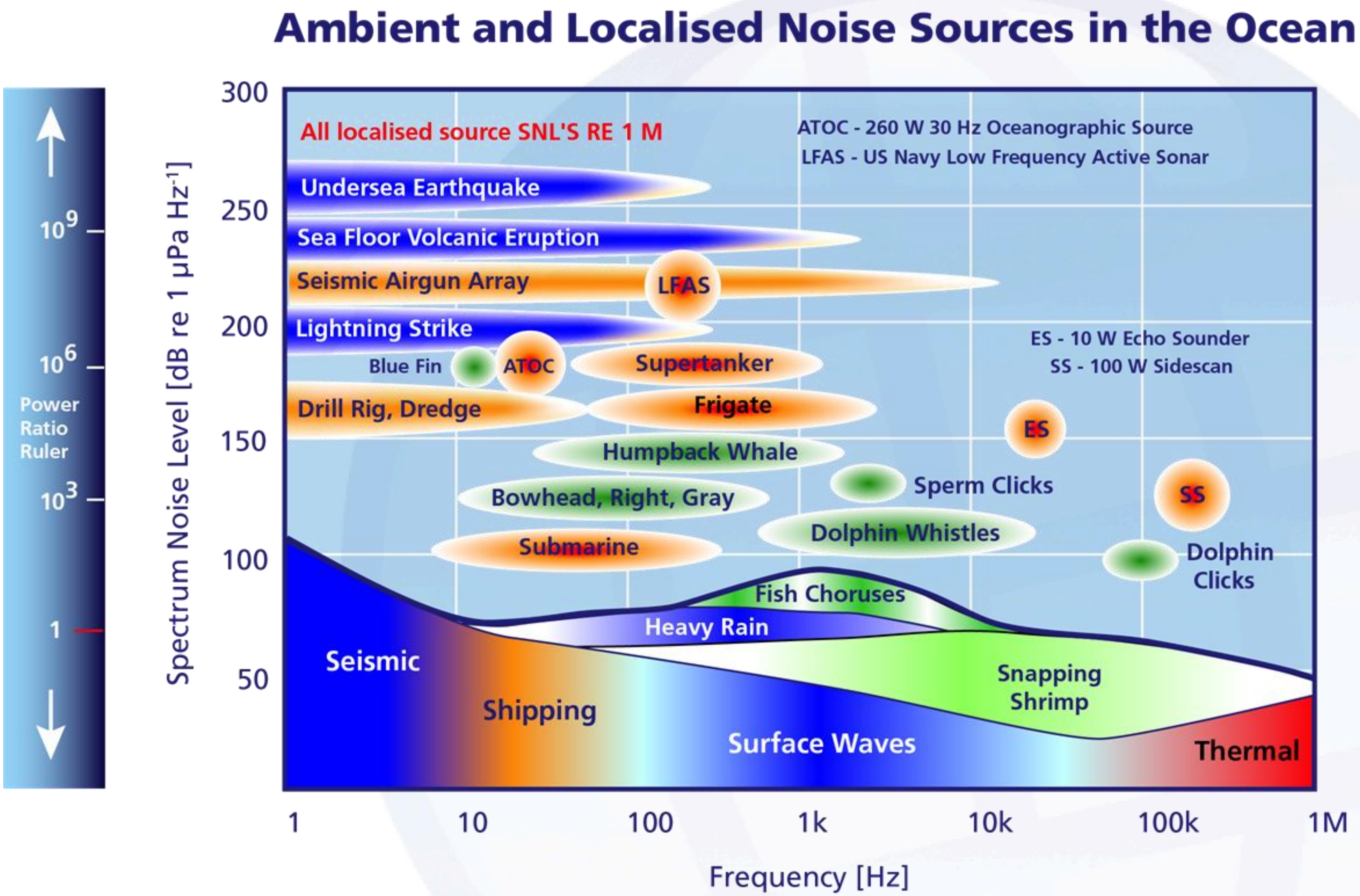
Mitigation of ecological effects

- Primary mitigation is to minimise area of mining
- Secondary, to ensure the sensitive placement of mining area to exclude or minimise areas of high biodiversity and/or productivity
- These options are not always possible depending on the location of the commercial resource being mined
- Minimising the sediment plume through ensuring discharge pipes are as close to the sea floor as possible
    - Ensuring as much sediment is discharged back onto the actual area mined and into low current areas
- Understanding the chemical composition of discharge and minimising uptake from areas with high toxic loadings

Potential noise effects

- From riser and discharge pipes, crawlers, processing and support vessels, pumps, sonar
- May lead to displacement of prey and/or megafauna
- Temporary or Permanent hearing threshold shifts
- Effects on communication, navigation and prey finding

Noise levels



Deep sea mining example

- Chatham Rock Phosphate applied for consent in NZ in 2014 with a noise level of 196 dB re 1 µPa @ 1 m
- The sound from the mining operation would be louder than 120 dB re 1 µPa (RMS) out to a distance of 29 km and creating an ensonified area of ~2,100 km^2
- 120 dB re 1 µPa RMS is the level at which many marine mammals consistently show behavioural disturbance
- The application was declined

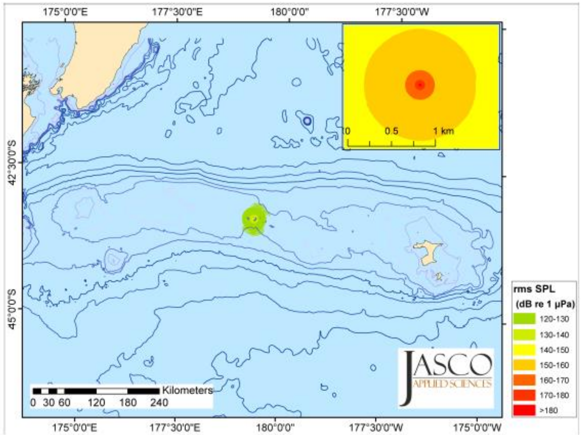


Figure 17: Maximum over depth broadband rms SPL isopleth contour map for dredge fully operational, large scale.

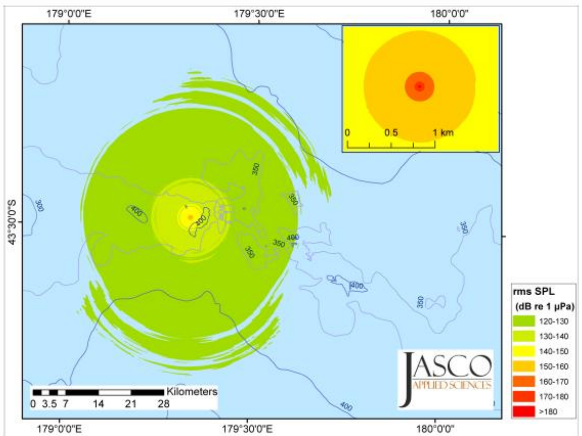


Figure 18: Maximum over depth broadband rms SPL isopleth contour map for dredge fully operational, localised

Noise effects

- Noise is generated throughout the water column:
  - Surface - processing vessel, support vessels
  - Water column - riser and discharge pipes, pumps
  - Sea floor - mining units
- Magnitude and nature of noise varies but it is primarily a function of the operational configuration
- Major noise sources include:
  - Pumps for moving material to & from the processing vessel
  - Machinery associated with processing vessel & equipment
  - Surface vessel traffic
  - Mining units – pumps, sonar, extraction tools

Noise effects

- Sound propagates extremely well in water so operational noise can travel considerable distances from the source, especially low frequency sound
- Sea bed mining can produce noise across a broad range of frequencies
  - Generally dominant frequencies below 1 kHz
- Estimated noise level of ~180-190 dB re 1 µPa at 1m
  - Varies considerably depending on operational configuration
- Noise level will be influenced by equipment used and substrate type
  - Sand generates less noise than gravel and courser materials

Noise effects

- Sound in air (e.g. above the surface) poses little risk to megafauna
- Sensitivity to noise varies significantly between species, sexes, behavioural state and even temporally
    - Different frequencies will affect species differently
- Potential effects may include:
    - Displacement of prey and/or megafauna
    - Temporary or Permanent hearing threshold shifts
    - Alteration of behaviour
    - Effects on communication, navigation and prey finding
- Risk assessed as low to medium

Mitigation of noise effects

- Best form of mitigation starts with the design and engineering of operational gear giving due consideration to noise minimisation
- Primary form of mitigation is designing equipment with lowest possible power and highest levels of sound proofing, dampening, and/or isolation from vibration
- Isolation of machinery and pumps (e.g. baffles, machinery mounts) to minimise vibrations into the water column
- Maintenance of equipment to a high standard ensures running at quietest possible levels
- Location of major machinery on the processing vessel is preferred over location in the water column as sound transmission is reduced

Mitigation of noise effects

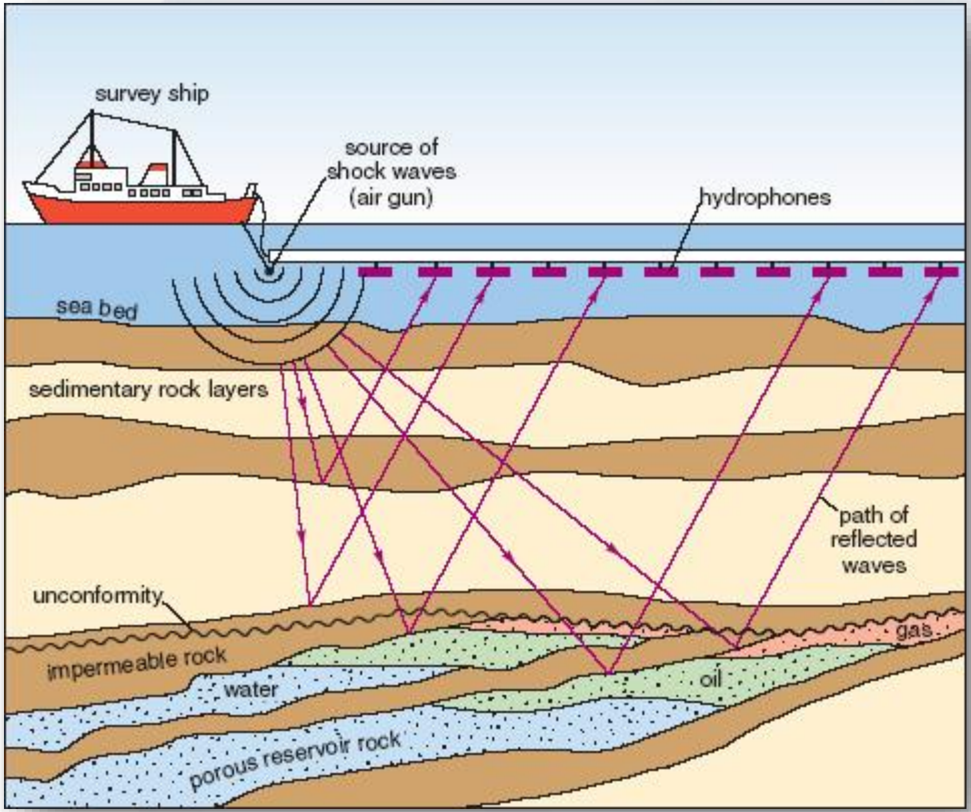
- Sonar is used to assess mining operations and for navigation
  - Should be lowest possible power and used as infrequently as possible
  - Sonar source should be closest to target as practical (e.g. located close to sea floor rather than on processing vessel)
- Depending on the exact magnitude of the noise generated best practice mitigation could be considered:
  - Soft-start of equipment
  - Visual and/or acoustic monitoring prior to start up and potentially also during operations
  - Mitigation zones applied and operation reduced in power or shut down when megafauna detected within the zones

Knowledge gaps

- Understanding of the real impacts of deep sea mining
- Understanding of the effectiveness of proposed mitigation strategies
- In most mining locations, the biological environments are often poorly understood by comparison to terrestrial environments
- Spatial and seasonal distribution and abundance of marine megafauna
  - Especially offshore in deep water environments
- Knowledge of locations that are important for core biological functions, such as marine mammal breeding, feeding and resting areas, and migration routes
- Potential impacts of deep sea mining operation, including:
  - effects of sound on behaviour (including communication, foraging, migration, reproduction and predator avoidance),
  - auditory factors that affect behaviour (including perception, sensitivity, and auditory masking),
  - the biological significance (population-level effects) of these changes including long-term cumulative effects

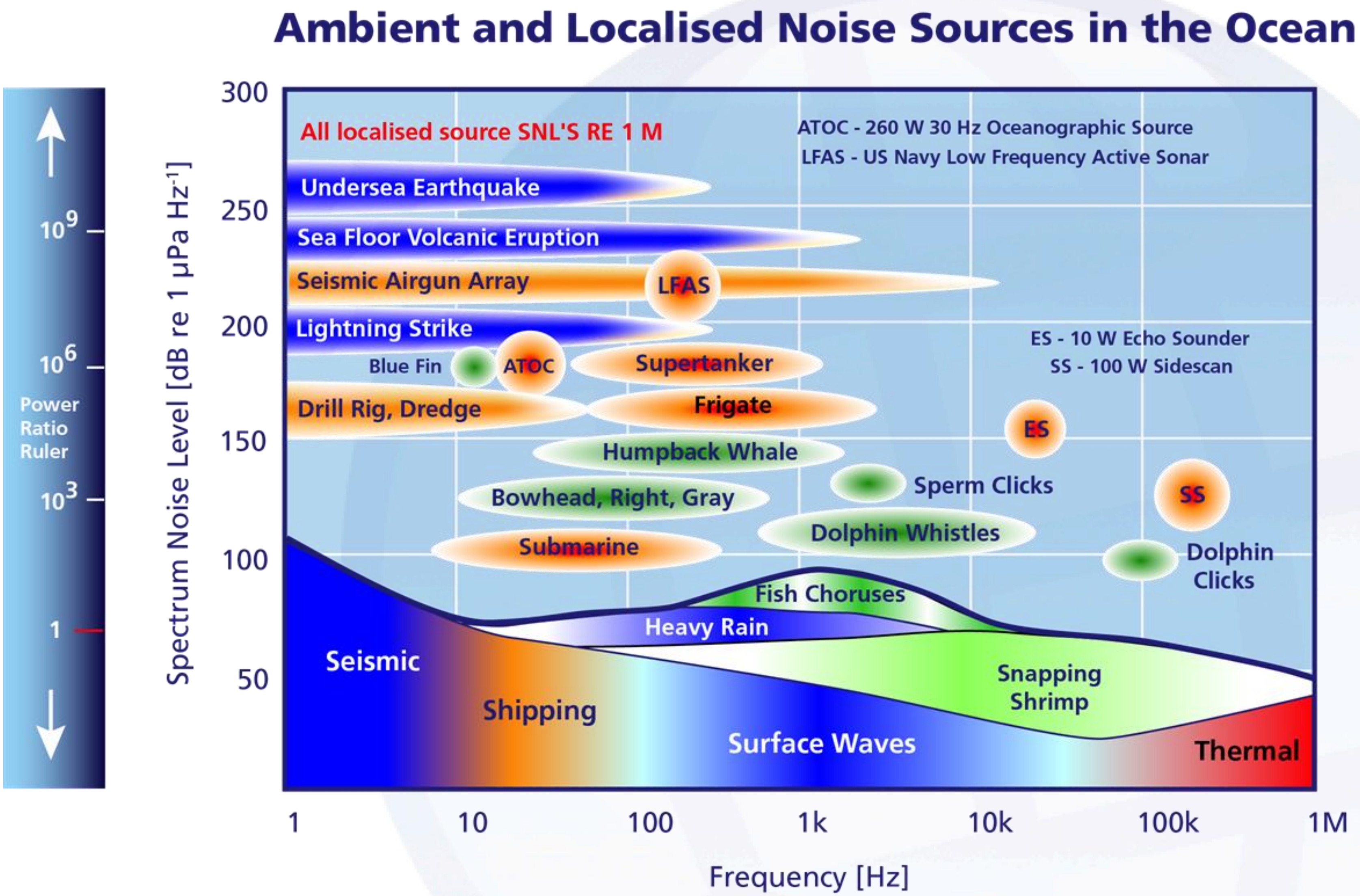
SEISMIC SURVEYS

- Studies done to gather and record patterns of induced shock wave reflections from underground layers of rock, which are used to create detailed models of the underlying geological structure



Seismic survey

Noise levels



Possible noise effects

- Primary impact is from noise which could be more than 100 times louder than Deep sea mining operations
- Physical/physiological effects
  - Temporary or permanent threshold shifts in hearing
  - Auditory damage, decompression sickness
- Behavioural disruption
  - Startle and fright, avoidance, changes in behaviour and vocalisation patterns
- Indirect effects
  - Prey displacement

Possible noise effects

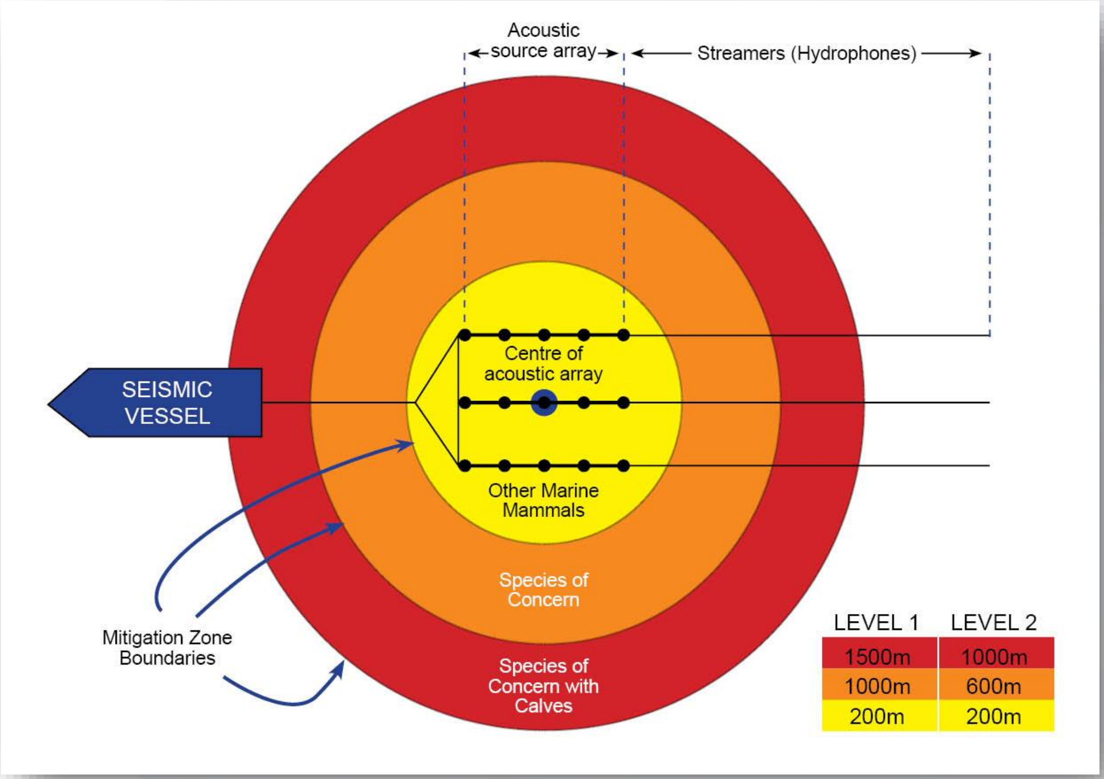
- Effects detected at ranges of tens or hundreds of kilometres
- Responses typically variable, sometimes contradictory, and their biological significance is unknown
- Unlike the effects speculated for Deep sea mining, these noise effects are well documented for some marine mammals from seismic surveys but effects vary by species, area and behavioural state so setting general rules is complicated

Mitigation

- Marine Mammal Observers (MMO)
- Passive Acoustic Monitoring (PAM)
- Soft starts
- Pre-start observations
- Mitigation zones – seismic source shut down if marine mammals enter zone
- Use of lowest possible source level to minimise the amount of noise introduced into the ocean & noise modelling to confirm level of noise and potential are of effect
- Independent observation and reporting
- Timing and location of surveys

Mitigation

- Standard mitigation distances as defined in the NZ Code
- Distances vary by species, the presence of calves, and size of seismic source

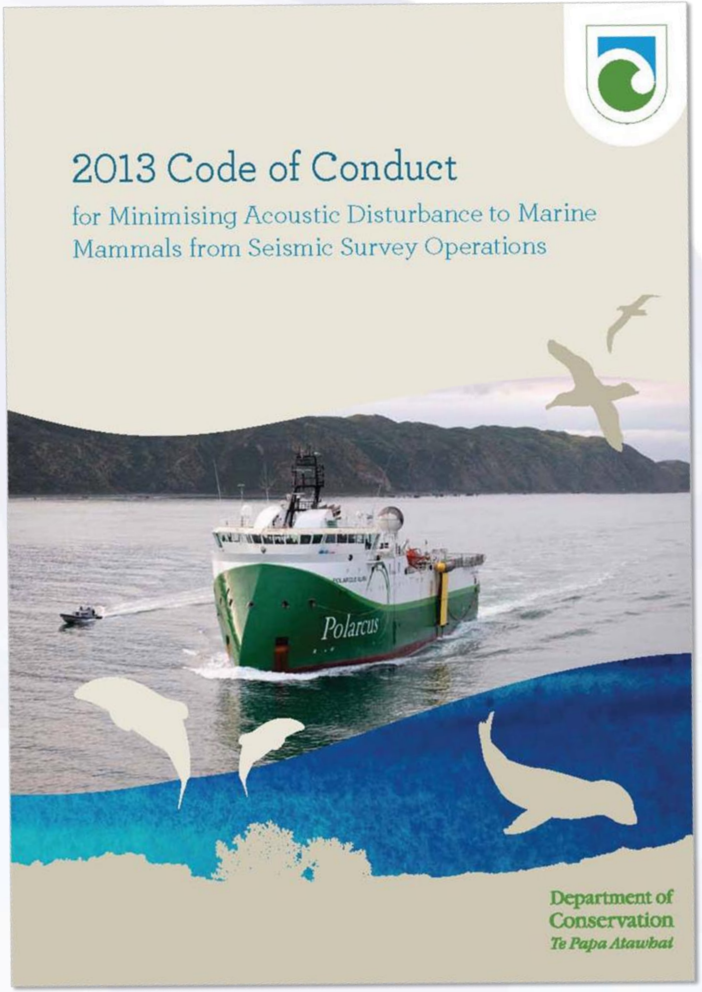


Possible management approaches

- The main would be a requirement on an operator to present a detailed Environmental Impact Assessment
- Summary of flora and fauna in the proposed area of activity including seasonality and behaviour
- Sound source & frequency levels with propagation models by distance
- Assessments of impact expected from the activity including noise and ecological impacts
- Details of proposed mitigation and details of consistency with international best practice
- Independent peer review managed by the Regulator but paid for by the operator

Seismic surveys management

- NZ Code of Conduct for minimising the impact on marine mammals from seismic surveys 2013
- Well regarded internationally with high standards of protection and mitigation
- Over the last three years in NZ, added 6% of survey time to total survey time due to mitigation action
- Presently being updated
- Other options are UK JNCC



Deep sea mining management

- No internationally recognised guidelines for Deep sea mining
- Given the relatively recent nature of Deep sea mining, impacts are poorly understood
- Standard Environmental Impact Assessments will be appropriate if done robustly but a key step is a requirement for independent peer review funded by applicants but managed by Regulators so Regulators get the information they need to review proposals
- Ongoing reporting from Operators to Regulators during operations is essential to build up a picture of possible impacts for evaluation of future applications.