INTERACTIONS BETWEEN SHARKS, CABLES AND INDUSTRY: STATUS OF CURRENT RESEARCH

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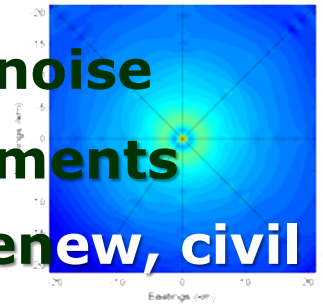
New Zealand Petroleum Conference 2017
21 - 23 March, New Plymouth

Auckland 21-23 March 2017

OSC™ OCEAN SCIENCE CONSULTING NZ ASIA-PACIFIC

Who are we & what we do?

- 14th year, family-owned
- NZ, Scotland, & Greek-based
- Independent industrial scientists
- Specialise mainly in marine mammals
- ROV analysis & underwater noise
- MMO, PAM, & impact assessments
- Seis, drill, decom, dredge, renew, civil eng, defence, etc.
- Subject to release from NDA
- Invest >80% profits into R&D
- Publish in peer-reviewed journals
- MMO & PAM Handbook (iwi training)

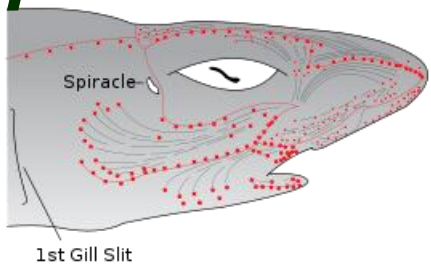


Talk outline

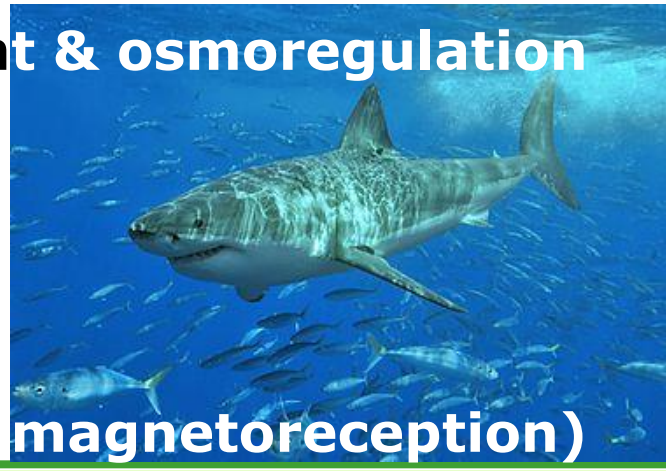
- Introduction
  - Shark electrosensory system
  - Electromagnetic fields (EMF) around bottom cables
- Current research on bottom cables
  - Overview
  - NZ lab study
- Implications of current research
  - For EIAs
  - Mitigating potential impacts
- Implications for seismic streamers?
- Further reading

Introduction: shark electrosensory system

- Elasmobranchs: collectively sharks & rays – not chimaeras
- Passive electrosensory system – *Ampullae de Lorenzini*
  - Jelly-filled pores
  - Contain sensors that respond to electric potential
  - Between internal reference & external stimulus

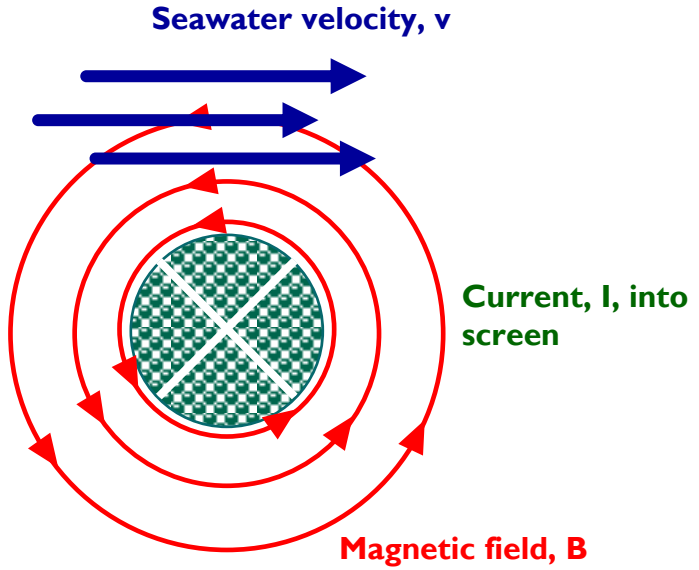


- Detect very weak electric fields
  - 1 nV cm^{-1} (1 V = 1000,000,000 nV)
  - Natural electric fields induced through muscle movement & osmoregulation
- Used to detect and pinpoint
  - Prey
  - Predators
  - Conspecifics
  - Possibly plays role in long-distance navigation (might be magnetoreception)



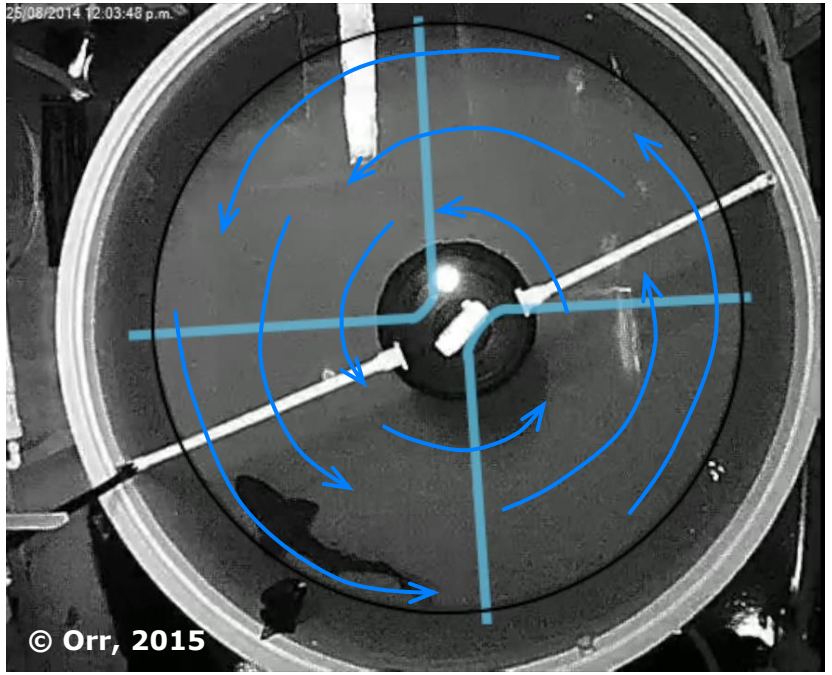
Introduction: EMFs around submarine cables

- **Electromagnetic fields (EMFs) – Faraday's law of induction**
  - Electric current running through a cable
  - Generates a magnetic field around cable
  - Electrically-conductive seawater flows through magnetic field
  - Induces a weak electric field (of interest to sharks)
- **General insulation around cables does not impede magnetic fields**
- **Potential impacts on sharks?**
  - EMFs within shark detection range
  - Sharks known to bite cables - including fibre optic cables



Current research: Overview

- Electrosense shark research started in 1970s
- Numerous calls for research investigating impacts of power cable EMFs
- Difficult to investigate: 2 studies so far
- COWRIE field study (Gill *et al*, 2009)
  - Three species
  - Inconclusive due to design flaws
- NZ lab study (Orr, 2016)
  - NZ carpet sharks (*Cephaloscyllium isabellum*)
  - Replicated EMFs around 198 A Direct Current (DC) and 50 Hz 75 A Alternating Current (AC) cables



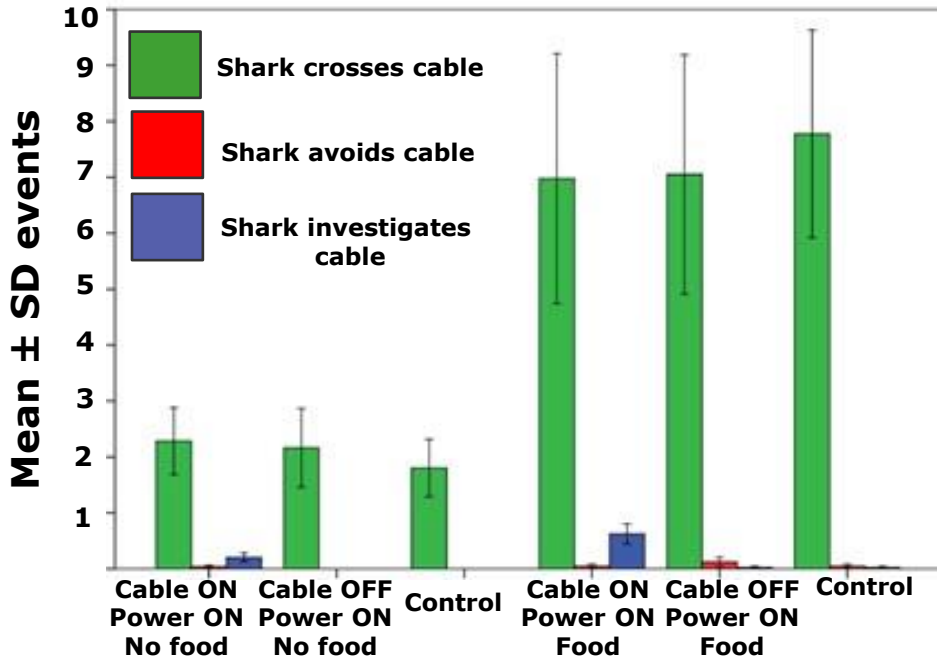
Results: NZ lab study (Orr 2016)

Main findings

- AC cables: no effect
- DC cables: small effect
- Sharks investigated cables more when fed
- After a while – no effect (habituation)

Caveats to this research

- Lab study: specific cable configs & conditions
- Only 1 adult shark species tested



Conclusions

- No impact *on NZ carpet sharks* from submarine power cables *in these configurations*
- More research on other species, cable specs & juveniles required

Implications for EIAs?

- **Further research required**
  - Other cable specifications & conditions
  - Other shark species
  - Other life stages
- **AC cables unlikely to have impact**
  - But undersea cables often use DC
  - Lower TL over long distances, cost effective
- **DC cables may have an impact**
  - Adults *vs* juveniles
  - Habituation
  - Effect *vs* impact
- **All we can do is ….acknowledge *possible* effects of EMFs**

Implications: how do we protect submarine cables?

- Fibre optic? – no info, needs trials
- Shielding? – No info, needs trials
- Bury cables – very effective
- Not practical for short term OBC
- Avoid nursery areas & feeding grounds (unlikely)
- Fund JIP programs
- Field trials, field trials, field trials…

Sharks & Cables

Consequences for seismic streamers?

- **Pelagic (open sea) not benthic (bottom) sharks**
  - Blue shark, Mako shark, white shark
  - >15 m rely on smell
  - < 15 m rely on sight
  - Hear LF noise
  - Lateral line – sense vibration
  - Using different senses – sight & vibration to detect and…
  - Close range – exploratory bite
- **Attracted by streamer induced water turbulence & noise**
  - Rather than short range electrosense of EMFs
- **Mitigation?**
  - Magnets on towed equipment – Claes Borreson & Nils Lunde - patentented
  - Over stimulate ampullae de Lorenzini causing sharks to retreat
  - That’s it folks, if we want to solve the problem, we’re going to have to invest $$$

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