Olaf Boebel, Horst Bornemann, Elke Burkhardt and Christoph Ruholl

Risk Assessment of Hydrosweep Fan-Beam and Parasound Sediment Echosounders.

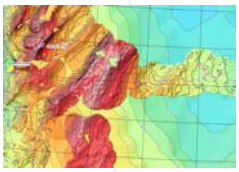
Hydrosweep

- **multi-beam sonar system to map sea-floor topo-graphy at high resolution.**

- **Application:**

a) identify and map sites of environmental importance (e.g. cold water coral reefs, sea mounts)
b) locate suitable sites for oceanographic, geophysical, or biological studies (e.g. deep water passages, ice-berg grounding)
c) develop navigational charts, for commercial navies, tourism and sovereignty

Schematic of Hydrosweep multi-beam sonar



Discrepancy between currently best available Arctic chart (smooth contour lines) - and Hydrosweep survey (wiggly contour lines) near 83°N, 3°W. Contour lines every 100m.

Parasound

- **parametric echosounder to obtain structure of upper sediment layers beneath sea-floor.**

- **Application:**

a) determine location and thickness of sediment layer for coring sites for paleooceanographic and sedimentological studies
b) map sediment distribution for paleo-oceanographic and paleo-biodiversity studies.

Immediate direct damage:

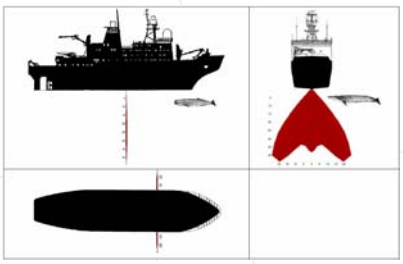
- **energy of sound causes direct damage of tissue (auditory or other)**

- **Critical elements:**

a) TTS is used as conservative proxy for any immediate direct damage
b) onset of TTS is defined through dual criterion:
i) max SPL_{PP}: 224dB re 1 µPa
ii) max SEL: 195dB re 1 µPa²s(W) non pulsed
185dB re 1 µPa²s(W) pulsed

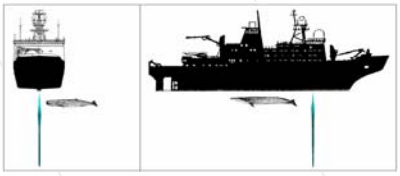
- **Apply to Scientific Sonars in Antarctic**

a) calculated the critical SPL at which single ping could cause TTS:
crit. SPL_{rms} = Max SEL – 10 log (τ)
HS: (τ) ≤ 60ms → crit. SPL_{rms} ≈ 203 dB re 1 µPa
PS: (τ) ≤ 22ms → crit. SPL_{rms} ≈ 212 dB re 1 µPa
b) figures below show corresponding critical contours
c) critical volume is related to volume displaced



Hydrosweep:
43 m depth
46 m athwart
1 m fore-and-aft

relative risk:
1.2 % the risk of a collision.

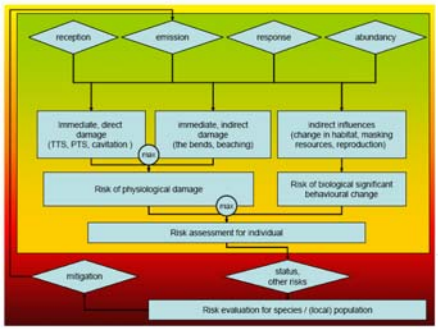


Parasound:
47 m depth
2 m athwart
1 m fore-and-aft

relative risk
about 0.6% the risk of a collision

Concept

- **4 critical factors**
- **3 possible impact scenarios**
- **combined risks by "max" criterion**
- **conservative estimates throughout**



Immediate indirect damage:

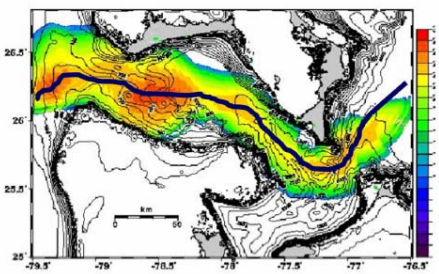
- **self damaging behavioural response (fast/prolonged surfacing) induced by sound emission, as e.g. proposed for Bahamas' strandings (2000).**

- **Critical elements:**

a) nitrogen super saturation
b) large ensonified volume
c) high dosis
d) no escape routes

- **Apply to Scientific Sonars in Antarctic**

a) baleen whales and orcas: super-saturation unlikely; sperm and beaked whales: super-saturation possible
b) small ensonified volume (< 0.25% TMFS)
c) small dose due to small ensonified volume and small duty cycle (< 0.01 % of TMFS)
d) open ocean conditions: escape routes in any direction



Dosis of SPL > 160dB for naval mid-frequency sonar (Bahamas stranding) vs. a fictional Hydrosweep track.

Table 1: Comparision of emission characteristics of tactical midfrequency sonar AN-SQS 53C Details take from Joint Interim Report zur Bahama-Strandung) with scientific echosounders Hydrosweep DS2 and Parasound DS2. „Volume" indicates the volume area room enfonified with more than/with higer sound pressure levels than 160 dB, „Dosis" indicates the volume weighted with Duty Cycle

	Takt. Mid-Freq. Sonar AN SQS 53C	Atlas Hydrographic **Hydrosweep** DS-2 fan-beam echosounder	Atlas Hydrographic **Parasound** DS-2 sediment echosounders
pulse length	1500 ms	60 ms	max. 22ms
repetition rate	24 s	15 s	8.300 ms (8,3s)
Duty cycle	6.3%	0.4 %	0,3 %
frequency	2 – 8 kHz	15.5 kHz	18 &22 kHz
Extension of 160 dB contour	Ø ca.68 km (obere 200 m) Ø ca.20 km (unterhalb 200 m)	3458 m (T) x 189 m (X-beam) x 2818 m (A-beam)	max. 05 x1,2 x 3,6 km
volume	820000·10⁶ m³	2300·10⁶ m³	652·10⁶ m³
dose	52000·10⁶ m³	1·10⁶ m³	2·10⁶ m³

Conclusion

- **Immediate direct damage is less than 2% of the risk of a collision between the animal and the ship (steaming ship at 10 kn); not to be excluded when ship on station.**

- **Immediate indirect damage is unlikely due to technical, bathymetric and biological differences**

- **Indirect influences are insignificant.**

- **Code of conduct can mitigates this remaining risk when ship on station:**

shut down of sonars when whales approach the ship within the critical TTS area + safety radius.

- **Overall: uses of scientific echosounders in Antarctica does pose not risk at population level – even for endangered species.**

Indirect influences:

- **sound emission results in a risk of biologically significant behavioural response, i.e. have an effect on growth and/or reproduction and/or survival**

- **Critical elements:**

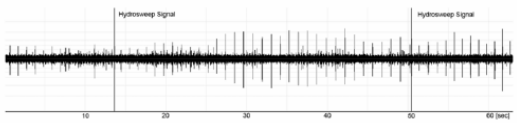
a) migration – neither path length nor duration should be increased into the upper quartile
b) feeding – area of interest index should not be critically reduced
c) breeding – pool of potential male mates should not be reduced by more than 25%
d) lactation – nutrition from lactation should not reduced to less than the lower quartile of normal

- **Apply to Scientific Sonars in Antarctic**

a,b,d) transient nature of exposure due to linear cruise track: exposure for "less than 24 hours / only once" during entire season
c) not applicable in Antarctica

- **Uncertainties**

knowledge of normal behavior for many species is still lacking



Sperm whales clicks lack evidence of response to Hydrospeep signals.

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Alfred-Wegener-Institut
für Polar- und Meeresforschung
in der Helmholtz-Gemeinschaft

www.awi-bremerhaven.de

Forschungsstelle Potsdam
Telegrafenberg A 43
14473 Potsdam

www.awi-potsdam.de