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

Parasound
- parametric echosounder to obtain structure of sedimentary environments (e.g. multi-beam sonar system to Hydrosweep)
- Application:
  a) determine location and thickness of sediment layer for paleo-oceanographic 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) TTS of PTS is defined through dual criterion:
     i) max SPL<sub>ps</sub> = 224dB re 1 µPa
     ii) max SEL = 10 log (195dB re 1 µPa x 1 µPa/s) non pulsed
     iii) max SEL = 185dB re 1 µPa/s pulsed
- Apply to Scientific Sonars in Antarctic
    a) calculated the critical SPL at which single ping could cause TTS:
       crit. SPL<sub>ps</sub> = Max SEL – 10 log (τ)
      HS: (τ) ≤ 60ms → crit. SPL<sub>ps</sub> = 203 dB re 1 µPa
      PS: (τ) ≤ 22ms → crit. SPL<sub>ps</sub> = 212 dB re 1 µPa
- figures below show corresponding critical contours
- c) critical volume is related to volume displaced

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 dose
  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

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

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.

References

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.

Sperm whales clicks lack evidence of response to Hydrosweep signals.