Soundscape Ecology at Sea

Agency and research initiatives

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Naval MFA (Mid Frequency Active) Sonar

Injuries, deaths — rare
apparently in unusual circumstances

Naval MFA Sonar

Behavioral effects — wide area (10-70 miles)
Avoidance, Foraging disruptions?

Thousands of animals hear sonar when in use
Research underway to determine extent of behavioral changes

Scientific and regulatory attention largely driven by concerns about effects of anthropogenic noise on marine life

See http://aeinews.org/?s=d-tags

http://aeinews.org/archives/category/ocean/sonar
Seismic surveys
Behavioral effects — chronic in oil/gas regions:
100 +/- ships worldwide

“Make a few whales cross the street”

Yet:
Mid-Atlantic Ridge, survey sounds dominant (from Canada, South America)

Current:
Resistance to renewed oil/gas exploration along eastern seaboard

See http://aeinews.org/archives/category/ocean/seismic-surveys

Global shipping
Chronic exposure — nearly ubiquitous

Greatly reduced communication space

Figure 4. Estimated reduction in baleen whale communication range from (left) prior to the advent of commercial shipping to (right) the expected ranges of today. Figure courtesy of C. W. Clark, Cornell University.

http://aeinews.org/archives/626

Global shipping
Shipping in Stellwagen Bank reduces the area in which whales can hear and be heard:

• Right whales: 84%
• Fin whales: 33%

http://aeinews.org/?s=stellwagen
Energetic costs of reduced foraging

Many studies find reduced foraging in whales near sonar, seismic, and ships.

Energy budget study in PacNW:
Overall energy expenditures are only negligibly increased in the presence of boats (2-3% increase)

Total energy taken in was reduced by more than 25% because of lost/disrupted foraging time

Beyond behavioral . . . Chronic stress?

Is a subset of the population more noise-sensitive? ...and if so, being disproportionately affected by repeated exposures to chronic noise sources?

Are animals moving a moderate distance, out of harmful or “annoying” range? ...while experiencing elevated stress levels even as they engage in normal activities?

Gradually dawning awareness

We’ve altered the soundscape of the oceans
The acoustic environment is permeated by human noise

Ocean soundscape ecology

Mostly at stage of understanding the extent of human noise

More apt to chart ambient noise levels Rather than advanced metrics like % time audible or noise-free intervals

So far, either annual averages or spot-checks Not much seasonal variability info
**Ocean soundscape ecology**

**NOAA Ocean Noise Mapping**

- Darker areas 10-20dB over natural ambient
- Worst areas up to 60dB over natural ambient

Modeled from shipping data

- Mapped for several frequencies and water depths
- Some limited ground-truthing (so far, within 5-10dB)

See [http://cetsound.noaa.gov](http://cetsound.noaa.gov)

**Ocean soundscape ecology**

Several research teams:

- “soundscapes” / “acoustic ecology”
- “acoustic quality” of habitats

Fig. 2. (Color online) (a) Cumulative sound exposure level from vessel traffic from Jan to Dec 2008. (b) Areas where the estimated annual average sound pressure level (SPL) exceeded the EU Marine Strategy Framework Directive of 100 dB (SPL) in 1/3-octave bands centered on 63 or 125 Hz.


**Ocean soundscape ecology**

Current communication space on BC coast

**Ocean soundscape ecology**

Variations in soundscape of North Atlantic

http://aeinews.org/archives/2226
http://www.st.nmfs.noaa.gov/cetsound/

http://aeinews.org/archives/2520

No AEI summary yet…see reference on slide
Ocean soundscape ecology

Seismic survey sounds in remote polar Atlantic

Increases to ambient:

- Airguns: 5-10 dB, up to 20 dB
- Stormy winter waves: up to 10 dB
- Calls of 1000’s of whales: up to 10 dB

Klink et al., Seasonal presence of cetaceans and ambient noise levels in polar waters of the North Atlantic. J. Acoust. Soc. Am. 132 (3), September 2012

Automated detection

Risso’s dolphin

Short-beaked common dolphin

Striped dolphin

OceanSoundscape.com (2009; no longer online)

Ocean soundscape ecology

Sound budgets

Tanker “New England”
Fin whale song (20 Hz)
Gadoid pulses + Right whale Upcalls (50-300 Hz)

Denise Risch, Northeast Fisheries Science Center. 2007 data, Stellwagen Bank National Marine Sanctuary

Ocean soundscape ecology

Sound budgets — seasonal

No AEI summary yet...see reference on slide

Ocean soundscape ecology
Real-time acoustic monitoring

LIDO: Listening to the Deep Ocean Environment
Real-time listening and initial classification
Data archiving

http://aeinews.org/archives/1763

Ocean soundscape ecology
Ocean observatories (some with acoustic sensors)

US Ocean Observatories Initiative (OOI)
Papa, Pioneer, Endurance, more

Ocean Networks Canada
NEPTUNE (regionally linked with US sites)
VENUS (BC), Arctic

http://www.oceannetworks.ca
http://oceanobservatories.org

Ocean soundscape ecology
Ocean observatories (some with acoustic sensors)

On tap: acoustic monitoring from autonomous gliders

http://aeinews.org/archives/826 (section in AEI report)
http://aeinews.org/?s=gliders
Ocean soundscape ecology
Goal: Identifying areas of relative natural quiet

Ocean soundscape ecology
Goal: Managing (reducing?) anthropogenic noise in the sea

Ship noise reduction
NOAA > Int’l Maritime Organization
US Chamber of Shipping
Loudest 10-15% of ships in each class creating 40-80% of ship noise?

NOAA Sanctuaries/MPAs
Increasing interest in sound
Still shy from speaking of “wilderness”

Environmental assessments
Noise footprint routinely assessed
Navy / oil and gas exploration
offshore wind / tidal, wave energy

Ocean soundscape ecology
Goal: expanding the use of acoustics

Move beyond:
• Monitoring for specific species
• Focus on average noise levels
• Identifying local geophony/biophony/anthrophony

Expand into:
• Assessing species composition & habitat health
• Individual animal responses to soundscape and changes
• Better modeling of noise outside of monitored areas

Ocean soundscape ecology
Links to learn more

AEInews.org: sound-related environmental news, science
Peruse main page, or poke around in categories and do searches

See categories list on each page, eg:
ocean / shipping / seismic surveys
Create searches, eg:
IMO+shipping / “communication+space” / navy+sonar

Good post on acoustic tagging of whales (including links to related articles)
http://aeinews.org/archives/2531

Excellent ocean noise presentation from NOAA’s Leila Hatch:
http://aeinews.org/archives/2585
https://vimeo.com/94543099
Considerations for Marine Species
Reduced foraging in response to moderate noise

Boats and foraging
Tour boats disrupt foraging common dolphins:
Proportion of time spent foraging dropped by 28%
(from 35% to 25% of the time)
Length of each foraging period dropped by 40%
(from 10 minutes to 6 minutes)
Time until return to foraging increased 56%
(from 9 minutes to 14 minutes)
21% decrease in foraging activity observed in
orcas when boats are within 400m
(from 76% to 60% of the time)

20% decrease in foraging likely among sperm whales
SWSS overall conclusion
No tagged whales made a deep foraging dive closer than
4km from active seismic array

Several studies show indications of whales lingering
on surface near active arrays
Pilot whales: moved to be 1.2km from survey vessel then
“exhibited a behavior best described as milling.”
Humpback whales: increase in number of whales seen within
visual observing range (i.e. close to vessel) when airguns are active


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Caroline Weir. Overt Responses of Humpback Whales (Megaptera novaeangliae), Sperm Whales (Physeter macrocephalus), and Atlantic Spotted Dolphins (Stellena frontalis) to Seismic Exploration off Angola. Aquatic Mammals 2008, 34 (1), 71-83.