

Fundamentals of Underwater Sound Webinar Outline

Dr. Joe Warren

School of Marine and Atmospheric Sciences at Stony Brook University

I. Background Information

- A. Sounds are variations in pressure
- B. Sound amplitudes vary widely so are typically measured in deciBels
- C. Common ways to visualize a sound
 - 1. Waveform (pressure vs time)
 - 2. Spectrum (energy vs frequency)
 - 3. Spectrogram (energy vs frequency vs time)

DOSITS Links for part I

Science > How do you characterize sounds?

<https://dosits.org/science/sound/characterize-sounds/>

Science > Amplitude

<https://dosits.org/science/sound/characterize-sounds/intensity/>

Science > Introduction to Decibels

<https://dosits.org/science/advanced-topics/introduction-to-decibels/>

Science > How are sounds viewed and analyzed?

<https://dosits.org/science/measurement/how-are-sounds-viewed-and-analyzed/>

Strongly recommend watching/reading Dr. Tracianne Neilsen's DOSITS webinar from 2 June 2020 which covers these topics in greater detail. <https://dosits.org/decision-makers/webinar-series/2020-webinar-series/fundamentals/>

II. Underwater Sound Creation

A. Sources

- 1. Geophony - natural geological or physical processes create sounds
- 2. Biophony - organisms create sounds
- 3. Anthrophony - human-created sounds

B. Types of sounds

- 1. Broadband sounds - typically short in duration, energy at broad range of frequencies
- 2. Narrowband sounds - typically longer in duration, energy at a single or narrow range of frequencies
- 3. "Low" and "High" frequency sounds
- 4. Amplitude - loud vs soft

5. Repetition - continuous or intermittent

C. Soundscape - the collection of sounds in a particular area or site AS PERCEIVED BY A LISTENER

DOSITS Links for Part II

Audio Gallery > Other Natural Sounds

<https://dosits.org/galleries/audio-gallery/other-natural-sounds/>

People > How is sound used to study undersea earthquakes?

<https://dosits.org/people-and-sound/examine-the-earth/earthquakes/>

Animals > How do marine mammals produce sounds?

<https://dosits.org/animals/sound-production/how-do-marine-mammals-produce-sounds/>

Animals > How do fish produce sounds?

<https://dosits.org/animals/sound-production/how-do-fish-produce-sounds/>

Animals > How do marine invertebrates produce sounds?

<https://dosits.org/animals/sound-production/how-do-marine-invertebrates-produce-sounds/>

Animals > Effects > Anthropogenic Sound Sources

<https://dosits.org/animals/effects-of-sound/anthropogenic-sources/>

Audio Gallery > Anthropogenic Sounds

<https://dosits.org/galleries/audio-gallery/anthropogenic-sounds/>

Science > What are Soundscapes?

<https://dosits.org/science/sounds-in-the-sea/what-are-soundscapes/>

III. Sound Transmission

A. Sound travels from a source to a receiver

1. Sounds become quieter the further you are from the receiver

a. Geometric spreading

b. Absorption

2. Sounds can reflect or scatter

a. Density and soundspeed contrasts are important

3. Sounds can refract or "bend" as they travel

a. Creates the SOFAR channel allowing sounds to travel great distances

b. Environmental conditions can produce situations where sounds don't always get quieter with distance !

DOSITS Links for Part III

Science > Sound Spreading

<https://dosits.org/science/movement/why-does-sound-get-weaker-as-it-travels/sound-spreading/>

Science > Sound Absorption

<https://dosits.org/science/movement/why-does-sound-get-weaker-as-it-travels/sound-absorption/>

Science > Reflection

<https://dosits.org/science/movement/how-does-sound-move/reflection/>

Science > Scattering

<https://dosits.org/science/movement/how-does-sound-move/scattering/>

Science > How fast does sound travel?

<https://dosits.org/science/movement/how-fast-does-sound-travel/>

Science > Refraction

<https://dosits.org/science/movement/how-does-sound-move/refraction/>

Science > How does sound travel long distances? The SOFAR Channel

<https://dosits.org/science/movement/sofar-channel/>

Next month's DOSITS seminar by Dr. Aaron Thode will likely discuss how scientists use physics and math to make very accurate predictions about sound transmission.

IV. Passive and active acoustics

A. Passive acoustics "listens" to an environment's soundscape

1. Silent animals can not be detected
2. Some sounds indicate specific behaviors

B. Active acoustics transmits a sound, then listens to echoes which contain information about the environment

1. Navigation and vessel safety
2. Geophysical exploration
3. Fisheries and biological monitoring
4. National Security (vessel detection)

DOSITS Links Part IV

Technology Gallery > Real-time Passive Acoustic Sensors

<https://dosits.org/galleries/technology-gallery/observing-and-monitoring-marine-animals/real-time-passive-acoustic-sensors/>

Animals > Use of Sound

<https://dosits.org/animals/use-of-sound/>

People > Navigation

<https://dosits.org/people-and-sound/navigation/>

People > How is sound used to map the seafloor?

<https://dosits.org/people-and-sound/examine-the-earth/map-the-sea-floor/>

People > How is sound used to explore for oil and gas?

<https://dosits.org/people-and-sound/examine-the-earth/how-is-sound-used-to-explore-for-oil-and-gas/>

People > How is sound used to study marine mammal distribution?

<https://dosits.org/people-and-sound/investigate-marine-animals/how-is-sound-used-to-study-marine-mammal-distribution/>

People > How is sound used to study the distribution of marine fishes?

<https://dosits.org/people-and-sound/investigate-marine-animals/how-is-sound-used-to-study-the-distribution-of-marine-fishes/>

People > How is sound used to find submarines?

<https://dosits.org/people-and-sound/national-defense/how-is-sound-used-to-find-submarines/>

V. Sound scattering

A. Echo sounder was invented to measure depth below ships or distances from obstacles

B. Fisherman realized other parts of the ocean scattered sound

C. Echograms can show what goes on in the interior of the ocean

D. Two examples of applied active acoustics

1. How many fish could a bubble-netting humpback whale catch ?

2. Is a school of sardines in the Philippines more valuable as food or as a tourist attraction ?

DOSITS Links Part V

Technology Gallery > Echosounder

<https://dosits.org/galleries/technology-gallery/observing-the-sea-floor/echosounder/>

Technology gallery > Multibeam Echosounder

<https://dosits.org/galleries/technology-gallery/observing-the-sea-floor/multibeam-echosounder/>

Technology Gallery > Side Scan sonar

<https://dosits.org/galleries/technology-gallery/observing-the-sea-floor/side-scan-sonar/>

Animals > Marine mammal feeding

<https://dosits.org/animals/use-of-sound/marine-mammals-feeding/>

Relevant past and future DOSITS webinars for more information on:

Fundamentals of Sound:

<https://dosits.org/decision-makers/webinar-series/2020-webinar-series/fundamentals/>

<https://dosits.org/decision-makers/webinar-series/webinar-archive-2015-16/webinar-archive-science-of-sound/>

Geophony: <https://dosits.org/decision-makers/webinar-series/webinars-2019/seismic-sources/>

Anthrophony:

<https://dosits.org/decision-makers/webinar-series/webinars-2019/pile-turbine/>

<https://dosits.org/decision-makers/webinar-series/webinars-2019/commercial-vessel/>

<https://dosits.org/decision-makers/webinar-series/webinars-2019/echo-sonar/>

Biophony:

<https://dosits.org/decision-makers/webinar-series/webinars-2018/sound-production-reception-fishes/>

<https://dosits.org/decision-makers/webinar-series/webinar-archive-2015-16/webinar-archive-marine-animal-sound-production-and-reception/>

Passive Acoustics:

<https://dosits.org/decision-makers/webinar-series/2021-webinar-series/webinar-passive-acoustic/>

<https://dosits.org/decision-makers/webinar-series/2020-webinar-series/passive-acoustics-data/>

Active acoustics:

<https://dosits.org/decision-makers/webinar-series/webinars-2019/echo-sonar/>