

Package ‘bioSNR’

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Title Bioacoustic Basic Operations with Decibels and the Passive Sonar Equation

Version 1.0

Description A beginners toolbox to help those in ecology who want to deepen their understanding or utilize Bioacoustics in their work. The package has a number of utilizations from calculating frequency from waveform, performing operations in dB, and determining acoustic range of recorders. The majority of this package is based on key concepts learned from the K. Lisa Yang Center for Conservation Bioacoustics at Cornell University and their associated course: Introduction to Bioacoustics course. More information can be found within the walk through vignettes at <https://github.com/MattyD797/bioSNR/tree/main/vignettes>.

Encoding UTF-8

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Imports dplyr, ggplot2, pracma, scales, stats

Suggests rmarkdown, knitr

VignetteBuilder knitr

License GPL (>= 3)

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absorptionAir	<i>absorptionAir</i>
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Description

This function is the standard method of calculating the absorption of sound in air (ISO 9613-1).

Usage

```
absorptionAir(f, p, t, h, pr = 101.325, tr = 293.15, to = 273.16)
```

Arguments

f	The frequency of the sound source in Hz
p	The ambient atmospheric pressure in kPa
t	The ambient atmospheric temperature in C
h	The relative humidity as a percent
pr	The standard pressure at mean sea level
tr	The standard temperature in Celcius (293.15 in kelvin)
to	The triple-point isotherm temperature

Value

The sound attenuation rate in dB/m

Examples

```
#How much are Malayan tapir calls (15 kHz) absorbed in a tropical region
#(30 deg C) assuming a humidity of 80% and standard pressure (101.325)?
absorptionAir(15000, 101.325, 30, 80)
```

absorptionWater *absorptionWater*

Description

This function is a simplified method of calculating the absorption of sound in water proposed in Ainslie and McColm, 1998 and based on Francois and Garrison, 1982.

Usage

```
absorptionWater(f, pH = 8, t = 0, s = 35, z)
```

Arguments

f	The frequency of the sound source in kHz.
pH	The average acidity or pH of the water. Default is 8.
t	The average temperature of the water in Celsius. Default is 0.
s	The average salinity of the water in parts per thousand (ppt). Default is 35 ppt.
z	The depth in km.

Value

The sound attenuation rate in dB/km

Examples

```
#How much are blue whale calls (30 kHz) absorbed in a tropical region
#(30 deg C) assuming a salinity of 35 ppt, pH of 8, and a depth of 5 km?
absorptionWater(30, 8, 30, 35, 5)
```

opDB *opDB*

Description

This function either adds, subtracts or averages dB values specified in function. This is for dB values in re to power, intensity or pressure.

Usage

```
opDB(dbs, PL, op = "add")
```

Arguments

db	A vector of dB values of all the same reference.
PL	Should be 10 if dB measurements were for intensity or power and 20 if dB measurements were for pressure.
op	Default = 'add'. Can be 'add', 'sub', or 'avg' to add, subtract, or average, respectively.

Value

A single dB value

Examples

```
#Given a set of intensity values, add them.
opDB(c(100, 101, 127, 96), 10)
```

rmax	<i>Maximum Detection Range</i>
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Description

This function finds the maximum detection range of a given call.

Usage

```
rmax(sl, nl, dt, d, a = 0, xaxis = 25)
```

Arguments

sl	Source level of the signal of interest, as measured in dBs.
nl	Noise Level or background ambient noise in the recorder's local environment.
dt	Detection Threshold or the additional dBs the signal of interest must achieve above ambient noise conditions in order to be detected by the receiver.
d	Depth
a	The absorption coefficient given to you by the absorptionAir or absorptionWater formula.
xaxis	Exaggerated max distance. This gives the largest distance to evaluate in order to find the intercept of your detection threshold and propagation of the source level.

Value

The maximum detection range in meters

Examples

```
# SL= 195, NL = 82.9897, DT = 10, TR = 2500
rmax(sl=195,nl=82.9897,dt=10,d=2500*2, xaxis=1000000)
```

snell	<i>Snell's Law</i>
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Description

This function is a reformed version of Snell's law that finds reflection or refraction angle given the two mediums longitudinal wave velocities.

Usage

```
snell(ang, v1, v2)
```

Arguments

ang	The known angle of reflection or refraction
v1	The longitudinal wave velocity of medium where angle (refraction or reflection) is known given in m/s.
v2	The longitudinal wave velocity of medium where angle (refraction or reflection) is unknown given in m/s.

Value

The opposing angle of reflection or refraction, respectfully

Examples

```
# Calculate the reflection angle given the angle of a black-tailed godwit sound  
#source is 64 degrees, the speed is 1564 m/s in the first medium and 1494 m/s  
#in the second medium.  
snell(64,1564,1494)
```

soundSpeed	<i>Sound Speed</i>
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Description

This function finds the average speed of sound in water or air (c) in m/s given information on temperature, salinity, and depth.

Usage

```
soundSpeed(t, med = "air", s = NULL, z = NULL)
```

Arguments

t	The temperature in °C
med	The medium sound is traveling through
s	The salinity in parts per thousand (ppt)
z	The depth in m

Value

The speed of sound in m/s

Examples

```
#Speed of sound in 30°C water with a salinity of 2000 ppt and a depth of
# 2010 m
soundSpeed(30, "water", 2000, 2010)
```

specLv1Graph

Spectrum Level Graph and Marine Noise Level

Description

This function calculates the ambient noise level (NL; dB re. 1 microPa) in a deep-water marine environment.

Usage

```
specLv1Graph(freqBand, shipT = -1, seaState = -1, wSpeed = 0, boolR = TRUE)
```

Arguments

freqBand	The frequency band of interest
shipT	The intensity ship traffic in the area * 1 - 2 low ship traffic * 3-4-5 standard ship traffic * 6 - 7 heavy ship traffic * 8 - 9 intense ship traffic
seaState	The sea state as specified by the National Weather Service
wSpeed	The wind speed in miles per hour (mph)
boolR	Boolean of whether you want the value printed out in a string. Should be true for HW problems.

Value

The noise level (NL) in dB re. 1 microPa

Author(s)

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References

- Wenz, G. M. (1962). Acoustic ambient noise in the ocean: Spectra and sources. *The Journal of the Acoustical Society of America*, 34(12), 1936-1956.
- Urick, R. J. (1975). *Principles of underwater sound v.2*.
- Zimmer, W. M. (2011). *Passive acoustic monitoring of cetaceans*. Cambridge University Press.

Examples

```
specLvlGraph(c(28,33), ship=4,seaState = 1, wSpeed = 10, boolR = TRUE)
```

wof	<i>wavelength and frequency</i>
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Description

This function finds the length of a sound wave, known as the wavelength (m), or frequency of a sound (Hz), given the identity of the input. The speed of sound is the default in air (340 m/s). You may calculate your own value for c relative to the conditions present in your ecosystem of study via `soundSpeed()`.

Usage

```
wof(b, c = 340)
```

Arguments

- | | |
|---|--|
| b | The known wavelength (m) or frequency (Hz). |
| c | The speed of sound in m/s. As a general rule of thumb, however, c is equal to 1500 m/s in saltwater and 350 m/s in air. Note that the distinction between freshwater and saltwater is important. Sound speed is faster in saltwater than freshwater. |

Value

The unknown wavelength (m) or frequency (Hz) given the identity of input a.

Examples

```
# Given a frequency of 80 Hz in air, what is the wavelength?  
wof(80000)  
# Given a wavelength of 0.004 m in salt water, what is the frequency?  
wof(0.004, c=1500)
```

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