RHIFA EPS application - accompanying code

TAST operation

Individual vessels

This code calculate the maximum total duration of TAST trials in a 24 hour period as well as the actual duration of noise emitted according 0.8% duty cycle for a single vessel.

```
boats = 1 # calculation for individual vessel
stops = round(425/59) # mean number of stops per boat per day taken from Whyte et al.
↪  2020 (425 total stops, 59 vessel days at sea)
duration = 10 # maximim duration of a tast trial
duty_cycle = 0.008 # 0.8% duty cycle

timeperday = boats*stops*duration # total minutes of TAST trial per day (NB: stops
↪  alternate between TAST and control)
percentperday = timeperday/(24*60) # percentage of day that TAST trial occurs
noisetime = timeperday*duty_cycle # time in minutes the TAST will emit noise

print(paste("TAST deployment time per day:", timeperday, "mins"))
```

```
[1] "TAST deployment time per day: 70 mins"
```

```
print(paste("Playback time per day (as proportion):", round(percentperday, 2)))
```

```
[1] "Playback time per day (as proportion): 0.05"
```

```
print(paste("Playback time per day:", noisetime, "mins"))
```

```
[1] "Playback time per day: 0.56 mins"
```

Overall fishery

This code calculate the maximum total duration of TAST trials in a 24 hour period as well as the actual duration of noise emitted according 0.8% duty cycle for the whole fishery.

Five devices will be available for use with one per vessel.

```
boats = 5 # maxmimum no. boats with tast device on any day
stops = round(425/59) # mean number of stops per boat per day taken from Whyte et al.
↪  2020 (425 total stops, 59 vessel days at sea)
duration = 10 # maximim duration of a tast trial
duty_cycle = 0.008 # 0.8% duty cycle

timeperday = boats*stops*duration # total minutes of TAST trial per day (NB: stops
↪  alternate between TAST and control)
```

```r
percentperday = timeperday/(24*60) # percentage of day that TAST trial occurs
noisetime = timeperday*duty_cycle # time in minutes the TASTs will emit noise

print(paste("TAST deployment time per day:", timeperday, "mins"))
```

```
[1] "TAST deployment time per day: 350 mins"
```

```r
print(paste("Playback time per day (as proportion):", round(percentperday, 2)))
```

```
[1] "Playback time per day (as proportion): 0.24"
```

```r
print(paste("Playback time per day:", noisetime, "mins"))
```

```
[1] "Playback time per day: 2.8 mins"
```

Disturbance and injury distances

Using the distance thresholds for PTS from the "2024 User Spreadsheet Tool" that accompanies NMFS (National Marine Fisheries Service) (2024) for **non-impulsive stationary intermittent noise**.

```r
# PTS thresholds for non-inpulsive stationary intermittent noise
lf_pts = 197 # cumulative SEL for PTS in LF cetaceans
hf_pts = 201 # cumulative SEL for PTS in HF cetaceans
vhf_pts = 181 # cumulative SEL for PTS in VHF cetaceans

# distance threshold for PTS calculated using NOAA spreadsheet tool
lf_dist = 0.5
hf_dist = 0.1
vhf_dist = 0.1
```

Calculate the disturbance threshold using the RL of 160 dB NMFS (National Marine Fisheries Service) (2024).

```r
disturbance = 160 # flat RL for behavioural disturbance
sl = 176 # TAST source level
transmission_loss = 18.3 # transmission loss at 1 kHz

disturbance_distance <- 10^((sl-disturbance)/transmission_loss)

print(paste("Disturbance distance threshold for all cetacteans:",
↪  round(disturbance_distance, 1), "m"))
```

```
[1] "Disturbance distance threshold for all cetacteans: 7.5 m"
```

```r
# join all into a table
tast_distances <- data.frame(type = c("LF_PTS","HF_PTS","VHF_PTS","disturbance"),
                             cumSEL_threshold = c(lf_pts,hf_pts,vhf_pts,disturbance),
                             distance = c(lf_dist, hf_dist, vhf_dist,
                                          round(disturbance_distance,1)))

print("SEL (dB) and distance (m) thresholds for PTS and disturbance of cetaceans:");
↪  print(tast_distances)
```

```
[1] "SEL (dB) and distance (m) thresholds for PTS and disturbance of cetaceans:"
```

	type	cumSEL_threshold	distance
1	LF_PTS	197	0.5
2	HF_PTS	201	0.1
3	VHF_PTS	181	0.1
4	disturbance	160	7.5

Number of disturbed cetaceans

Surface area and species density from Gilles et al. (2023).

If available, densities for the relevant block were used from SCANS IV. In some cases these weren't available. For the white-sided dolphin, the mean density of the two adjacent areas was used. For bottlenose dolphins and minke whales, density from SCANS III was used, increased by 10% to conservatively account for any increase. For sperm whales, the total density across the full SCANS area was used (likely a very conservative over-estimate). For common dolphins, as no density estimate (for either common dolphins or unidentified dolphins) was included for the relevant block in either SCANS III or IV, the minimum density of all other delphinids was used as a conservative estimate with the assumption that common dolphin density is likely below this if they were not detected in the surveys. Similarly, minke whale density was set to that of humpback whales, and killer whale density was set to that of sperm whales.

```r
# harbour porpoise
hp = 0.179 # scans IV

# bottlenose dolphin
bnd = 0.019*1.1 # scans III + 10% to account for possible increase

# Risso's dolphin
rd = 0.0042 # scans IV

# white-beaked dolphin
wbd = 0.0346 # scans IV

# white-sided dolphin
wsd = mean(c(0.0029, 0.0087)) # mean of adjacent areas CS-J and NS-E

# common dolphin
cd = min(bnd, rd, wbd, wsd) # assumed to be <= min. density of other dolphin spp.

# minke whale
mw = 0.0095*1.1 # scans III + 10% to account for possible increase

# sperm whale
sw = 0.001 # from total in scans IV

# humpback whale
hbw = mw # assumed to be <= minke whales

# killer whale
kw = sw # assumed to be <= sperm whales
```

```r
# create dataframe with species, hearing group, area of density estimate, density
injury_estimate <- data.frame(
  species = c("hp","bnd","rd","wbd","wsd","cd","mw","sw","hbw","kw"),
  group = c("VHF","HF","HF","HF","HF","HF","LF","HF","LF","HF"),
```

```
  density = c(hp, bnd, rd, wbd, wsd, cd, mw, sw, hbw, kw))

injury_estimate <- injury_estimate |>
  mutate(PTS_m = case_when(group == "VHF" ~
                  tast_distances$distance[tast_distances$type == "VHF_PTS"],
                         group == "HF" ~
                  tast_distances$distance[tast_distances$type == "HF_PTS"],
                         group == "LF" ~
                  tast_distances$distance[tast_distances$type == "LF_PTS"]),
         disturbance_m = tast_distances$distance[tast_distances$type ==
         ↪  "disturbance"])

injury_estimate <- injury_estimate |>
  mutate(PTS_km = PTS_m/1000,
         disturbance_km = disturbance_m/1000,
         PTS_area_km2 = pi*(PTS_km^2),
         disturbance_area_km2 = pi*(disturbance_km^2),
         PTS_estimate = density*PTS_area_km2,
         disturbance_estimate = density*disturbance_area_km2)

print("Estimated number of cetaceans experiencing PTS or disturbance in the proposed
↪  area:"); print(injury_estimate |>
        dplyr::select(c(species, PTS_estimate, disturbance_estimate)) |>
        mutate(PTS_estimate = round(PTS_estimate, 11),
               disturbance_estimate = round(disturbance_estimate, 7)))
```

```
[1] "Estimated number of cetaceans experiencing PTS or disturbance in the proposed area:"
```

	species	PTS_estimate	disturbance_estimate
1	hp	5.62e-09	3.16e-05
2	bnd	6.60e-10	3.70e-06
3	rd	1.30e-10	7.00e-07
4	wbd	1.09e-09	6.10e-06
5	wsd	1.80e-10	1.00e-06
6	cd	1.30e-10	7.00e-07
7	mw	8.21e-09	1.80e-06
8	sw	3.00e-11	2.00e-07
9	hbw	8.21e-09	1.80e-06
10	kw	3.00e-11	2.00e-07

Gilles, A, M Authier, Ramirez-Martinez, H Araujo, A Blanchard, J Carlstrom, C Eira, et al. 2023. "Estimates of Cetacean Abundance in European Atlantic Waters in Summer 2022 from the SCANS-IV Aerial and Shipboard Surveys." https://doi.org/10.1016/B978-0-12-819053-1.00015-6.

NMFS (National Marine Fisheries Service). 2024. "Update to Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing (Version 3.0)."