caribou2Movements

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Overview

The caribou2Movements module reproduces an spatially explicit individual-based model. It simulates daily caribou movements according to 2 different movement behaviors. The movement behavior changes according to the quality of the landscape given by a raster. Landscape quality changes according to the season. There are 2 seasons. In habitat (cell) of good quality, individuals follow a random walk. In habitat (cell) of low quality, individuals follow either a biased correlated random walk (BCRW) or a foray loop (FL). All movement behaviors are habitat mediated. Movements depend of habitat quality and of paved road presence. There is an attraction to the individual's mating area during mating season. In the BCRW, individuals are attracted to the closest habitat (cell) of good quality. In the FL, individuals perform loops going away and back to their last visited habitat (cell) of good quality.

Usage

Module input objects. These objects need to be loaded first

```
library(SpaDES)

path_module <- "~/Documents/GitHub/McIntire-lab/modulesPrivate/"

downloadData("caribou2Movements", path = path_module)
load("modulesPrivate/caribou2Movements/data/inputs_caribou2Movements.RData")
```

```
# list_object<-list(unique_MA=unique_MA,
#                   rsf_summer=rsf_summer,rsf_winter=rsf_winter,
#                   distance_good_summer=distance_good_summer,distance_good_winter=distance_good_winter
#                   direction_good_summer=direction_good_summer,direction_good_winter=direction_good_wi
#                   paved_roads=paved_roads)

## Module parameters
list_param <- list(
  .plotInitialTime = NA,
   N_subpop = c(20, 20, 20),
   dates_MA = c(258, 305),
   dates_season = c(121, 320),
   scale_world = 75,
   mean_step_good = 5.97, mean_step_bad = 4.49, sd_step = 1.34, max_step = 20000,
   pCross_good = 0.17, pCross_bad = 0.17,
   sd_matingAttract = 85.95,
   move_model2 = "FL",
   sd_corr = 113.42, sd_bias = 121.53, max_bias = 20.45,
   sd_fl = 134.91, maxStep_loop = 5.68
)
```

```
path_output<-tempdir()

## Runing the module
mySim <- simInit(
  times = list(start = 0, end = 4, timeunit = "day"),
  params = list(caribou2Movements = list_param,
                .progress = list(type = "graphical", interval = 25)),
#  objects = list_object,
  modules = list("caribou2Movements"),
  paths = list(modulePath = path_module, outputPath = path_output),
  outputs = data.frame(
    objectName = c("caribou_loc", "raster_visits"),
    saveTime = 300
  )
)
#p <- profvis::profvis(out<-spades(sim = mySim, debug = FALSE)) # uncomment this to see
                                                               #  profile in a web browser
system.time(out <- spades(sim = mySim, debug = TRUE))
```

Events

Events are scheduled in the way:

- initiate the module
- plot the landscape and the initial caribou locations
- save the initial caribou locations
- start the main event: the caribou move
- plot the caribou locations*
- save the caribou locations*
- the caribou move*
- these 3 events are repeated the number of time steps
- save the final caribou locations and create the raster of the caribou visits
- write the 2 outputs files (caribou locations and raster of caribou visits) (one more time step of plot-save-move will happen but will not be recorded in the output files)

Plotting

An empty landscape based on the landscape quality is plotted at the start. Caribou locations are added on it at .plotInitialTime and then at each .plotInterval

Saving

Caribou locations x and y are recorded with the corresponding year and julian day in a dataframe. Locations are recorded at .saveInitialTime, at each .saveInterval and at the last time step.

Data dependencies

Input data

As model input, some objects and parameters are required. All rasters must be of the same size and resolution

Objects:

- "unique_MA" #list of SpatialPolygons with each item is a mating area for a subpopulation
- "rsf_summer", "rsf_winter" #rasters of habitat quality derived from a rsf, one for the summer and one for the winter
- "distance_good_summer","distance_good_winter" #rasters of distances to the closest habitat (cell) of good quality for each season
- "direction_good_summer","direction_good_winter" #rasters of directions to the closest habitat (cell) of good quality for each season
- "paved_roads" #raster of paved roads barriers

Parameters:

- ".plotInitialTime" #time to schedule first plot event. Default is 0. If NA, no plotting occurs.
- ".plotInterval" #time interval between plot events. Default is 1
- ".saveInitialTime" #time to schedule first save event. Default is 0. If NA, no saving occurs
- ".saveInterval" #time interval between save events. Default is 1
- "N_subpop" #vector of number of individuals in each subpopulation in the same order as the unique_MA
- "dates_MA" #vector with the julian dates for the beginning and the end of the mating season
- "dates_season" #vector with the julian dates for the seasons which change the movement behavior (1st date = beginning of summer, 2nd date = beginning of winter)
- "scale_world" #size of a raster cell side in meters
- "mean_step_good" #mean step length in good quality habitat (cell) in log(m)
- "mean_step_bad" #mean step length in low quality habitat (cell) in log(m)
- "sd_step" #step length standard deviation in log(m)
- "max_step" #maximum step length in m
- "pCross_good" #probability to cross a road when in good quality habitat (cell)
- "pCross_bad" #probability to cross a road when in low quality habitat (cell)
- "sd_matingAttract" #sd of the wrapped normal distribution for the mating area attraction
- "move_model2" #movement behavior in low quality habitat (cell) "BCRW" or "FL"
- "sd_corr" #sd of the wrapped normal distribution for the correlation movement
- "sd_bias" #sd of the wrapped normal distribution for the bias movement
- "max_bias" #maximum distance from a good quality habitat (cell) for the bias to occur (in km)
- "sd_fl" #sd of the wrapped normal distribution for the foray loop movement
- "maxStep_loop" #maximum number of steps in a loop for the outgoing movement

Output data

Two outputs are created and can be saved:

- "caribou_loc" #dataframe of all caribou locations saved during the saving process
- "raster_visits" #raster of the size and resolustion of the landscape quality which compiles the caribou visits after the 1st year of simulation

Links to other modules

This module could be coupled with a vegetation module transforming the landscape over time. An additional module would then be needed to transform the outputs of the vegetation model into inputs for this module.