Literature to emulate

* Grimm et al 2020
  + A good review of the ODD protocol
  + “Overview, Design concepts, and Details”
* EDA-based ABM simulations (Butts et al 2022)
  + Deer example of EDA in ABM
  + Uses ODD
* abmAnimalMovement (Marshall and Duthie 2022)
  + “External influences are implemented via matrices describing landscape characteristics (e.g., shelter quality, foraging resources, movement ease), and predefined points describing shelter sites and points the animal aims to avoid.”
  + Incorporates behavioral states (foraging, resting, exploring)
  + Allows for diel cycles, with transition matrices changing over time
  + “In addition to the predefined attraction to shelter sites, the abmAnimalMovement package allows for a more dynamic attraction to areas of high resource quality.”
  + Separates movement scales: “destination” versus “local” preferences; this means that while they could head towards an area of high appeal, they may travel through low-quality areas to get there
* SiMRiv (Quaglietta and Porto 2019, Quaglietta et al 2019)
  + “We are aware of no tools allowing simulating spatially-explicit multistate Markovian movements constrained to linear features or conditioned by landscape heterogeneity, which hinders movement ecology research in linear/dendritic (e.g. river networks) and heterogeneous landscapes.”
  + “allowing continuous-space mechanistic spatially-explicit simulation of multistate Markovian individual movements incorporating landscape bias on local behavior.”
  + “it avoids unrealistic assumptions, such as animal omniscience and planned final destination, generally found in the least cost path (LCP) modelling approach”
  + Con: doesn’t seem to have any features that would attract animals (e.g. artificial waterholes); how would I change the resistance layer over time?

Other packages/software

* HexSim (Schumaker and Brookes 2018)
  + Seems to be more about long-term range shifts and population dynamics
  + GUI so I don’t know how much I’ll be able to edit
  + Transforms linear features into hex boundaries and this is a key feature of our system, seems like an afterthought here?
* abmR Gochanour et al 2023)

**Patterns and Metrics**

See Butts et al 2022 for a more detailed look at this EDA approach for creating an ABM.

|  |  |  |  |
| --- | --- | --- | --- |
| **Pattern** | **Scale** | **Features** | **Metric** |
| Elephant movements trace along fences and channel along omiramba | Spatial | Fences &  omiramba and om |  |
| Pinch points across roads and at rivers | Spatial | Roads and rivers |  |
| Habitual/repeated movement to and from water sources, especially artificial waterholes | Spatial and Temporal | Natural & artificial waterholes |  |
| Deflection/permeability differences by sex and boundary type (fence [and fence type], road, river) | Spatial | Fence, road, river | Encounter and crossing rates should be similar to those found in Naidoo et al 2022 (see table below) |
| Bulls cross fences more often in the wet season (?) and animals move away from water sources in the wet season (expansion contraction) | Temporal | fences |  |
| Elephant attraction to some areas with higher quality resources? | Spatial and Temporal? | Landcover type? |  |

**Feature permeability** (Naidoo et al 2022)

Percentage of crossings @ 1km encounter threshold

(should we use 25km instead? What is the utility of a larger threshold if we are controlling the movements?)

|  |  |  |  |
| --- | --- | --- | --- |
|  | **River** | **Road** | **Fence** |
| **Female** | 10.1 | 15.3 | 0 |
| **Male** | 14.5 | 25.8 | 3.5 |

**Spatial data**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Description** | **Source** | **Res** | **Extent** | **Type** | **Status** |
| Elevation (DEM) and slope (calculated) | USGS SRTM ([link](https://earthexplorer.usgs.gov/)) | 30m | KAZA | Raster | Obtained, reprojected, and mosaicked on ArcGIS; slope calculated in ArcGIS |
| Human settlements | ESA World Settlement Footprint 2019 (Sentinel-1 and -2) ([link](https://geoservice.dlr.de/web/maps/eoc:wsf2019)) | 10m | Africa | Raster | Obtained |
| Landcover | WWF (link? What dataset did these come from?) | 10m | Africa | Raster | Obtained |
| Ephemeral surface water | Schaffer-Smith et al 2022 (Sentinel-2) ([link](https://doi.org/10.4211/hs.6f5b34803dc247e890925d7f26b04a3b)) | 10m | Khaudum | Raster | Obtained for Khaudum |
|  |  |  |  |  |  |
| Fences | Robin... where did he get these? | NA | KAZA | Vector | Obtained |
| Roads | OpenStreetMap (Angela) (see metadata file) | NA | KAZA | Vector | Obtained |
| Rivers | Digitized by Robin from various sources ([link](http://gaia.geosci.unc.edu/rivers/)) (see metadata file) | NA | KAZA | Vector | Obtained |