Bear Home Ranges from GPS Tracks

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1. Aims

- animal home range (Burt 1943): "[the] *area traversed by an individual in its normal activities of food gathering, mating,* [...]"
- grizzly bears are considered an endangered species in Alberta, Canada (# < 700)
- home range determination of grizzly bears enables wildlife managers and researchers to spatially focus on issues related to protection & conservation, but raises certain questions:

➡ How do different home range estimators perform for grizzly bear movement data from GPS collars?

➡ What poses problems for the estimators when considering geographical and ecological context?

2. Home Range Estimators

- developed originally for point-based observation data e.g. sightings or VHF telemetry
- data from GPS collars are different:
  - (i) number of points (1000s vs. 50-150 pts)
  - (ii) sampling intervall (⟶ auto-correlation?)
  - (iii) additional temporal information stored (⟶ tracks & velocity)

Point-based	⟷	Track-based
Kernel Density Est.		Line-Buffer
Convex Hull (MCP)		Brownian Bridge
LOcal COnvex Hull		*new developments*

3. Grizzly Bear Life

Grizzly bears
- omnivor
- roam widely
- not territorial
- males have larger home ranges
- home range size is influenced by population density
- they avoid certain environments that provide no food: snow, rocks, glaciers, ...

➡

Expectation of GPS data/home ranges
- point distribution with multiple centres
- large areas covered (500-1000 km²)
- patches connected by corridors
- few GPS points on glaciers, and few tracks that cross mountain ridges
- GPS points around edge of lakes (not in)

grizzly bear - ursus arctos horribilis (photo: US Gov.)

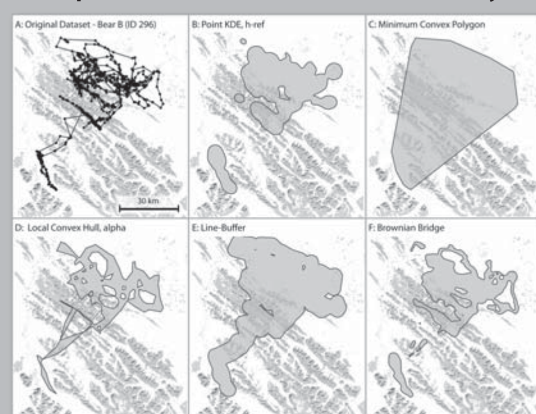
4. Estimator Comparison

Data
- GPS collar data from 20 bears, for one year, April-Nov.
- ca. 1...6 locations per day
- male vs. female bears
- living in Rocky Mountains vs. Alberta Foothills
- landcover data from Foothills Research Institute

Methods Implemented & Tested
- Point-based Kernel Density (KDE) - variants: h_ref, ad-hoc, LSCV
- Local Convex Hull (LoCoH) - variants: r, k, a
- Minimum Convex Polygon (MCP)
- Line-Buffer
- Brownian Bridge

Implementation
- implemented with free desktop GIS OpenJUMP
- raster functions from Sextante Toolbox
- Brownian Bridge ported from R - adehabitat module

Selected Graphical Results for one 'Mountain' Grizzly



Home ranges for Brownian Bridge and point-KDE (h_ref) are retrieved for the 95% utilization probability. Grey background represents non-vegetated areas, e.g. steep mountain slopes.

5. Outcome

Major Results
- MCP doesn't work well for patch-based (concave) home ranges
- KDE (with h_ref) is fast and reliable, no big difference among kernels
- Brownian Bridge results 'look' best, but problems with corridors*

Problems with Estimators
- KDE- param. estimation with LSCV failed for all 20 datasets (large # pts.)
- point-based estimators don't model corridors between patches well
- home ranges cover areas that are not really used by the animal (ridges)
- estim. don't take context into account (e.g. elevation/habitat constraints)

Recommendations
- MCP only useful if home range is known to be convex
- advantage of KDE & Brownian Bridge are resulting density grids, so contours for different probabilities of utilization can be generated, hence:
- use KDE if no time information is available
- use Brownian Bridge* when time is recorded and utilization probability grids are needed, otherwise use Line-buffer

* we noticed additional problems with Brownian Bridges with respect to numeric instabilities, and for the calculation of core areas (using methods by Harris et al. 1990, Seaman and Powell 1990)

GEOIDE

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