Spatial-temporal dynamics of grizzly bear movement
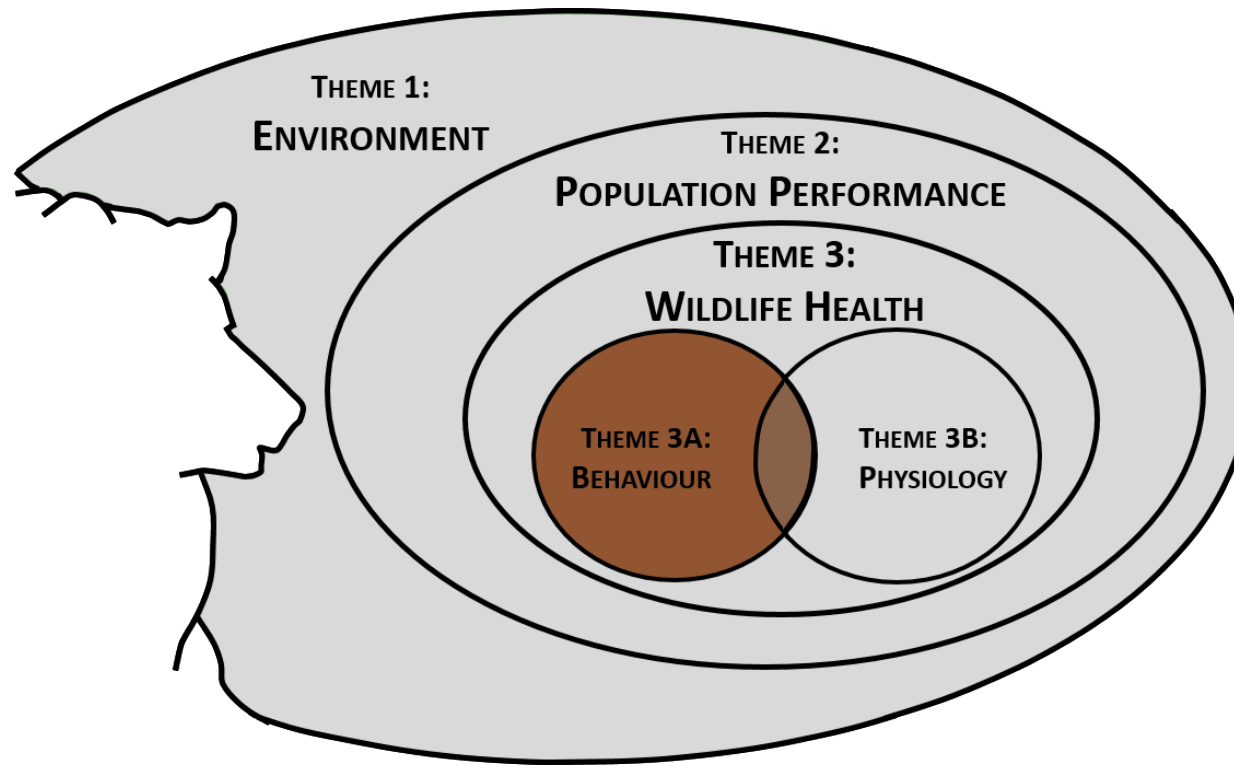
presented by

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Research question

Q3A.1 Can grizzly bear responses to disturbance, as represented by movement and health, be modeled to allow probabilistic prediction of future movement associated with changes in landscape disturbance and habitat fragmentation?
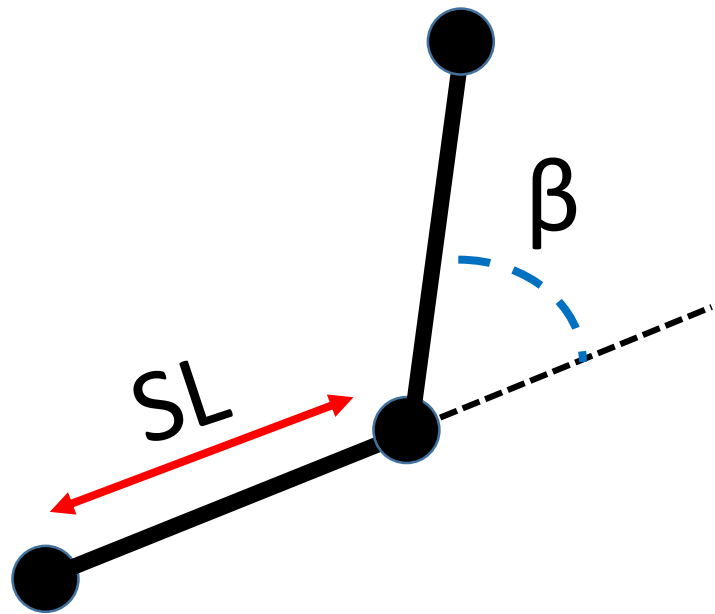
Movement

- Link individuals/populations/landscape
- Variation in space and time at multiple scales
- Shifts in movement parameters/behaviours?
  - Time: 2001 – 2014
  - Management areas

- 121 individuals, 97 with multiple captures (n = 218)
- ~400 000 locations

Conservation Areas
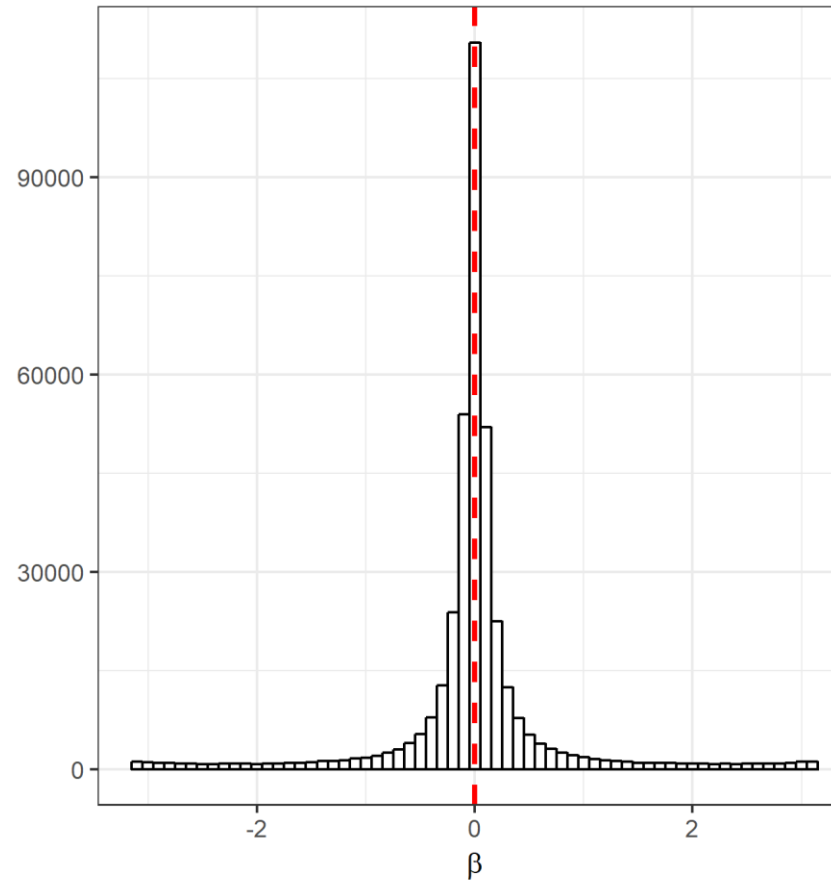- Core
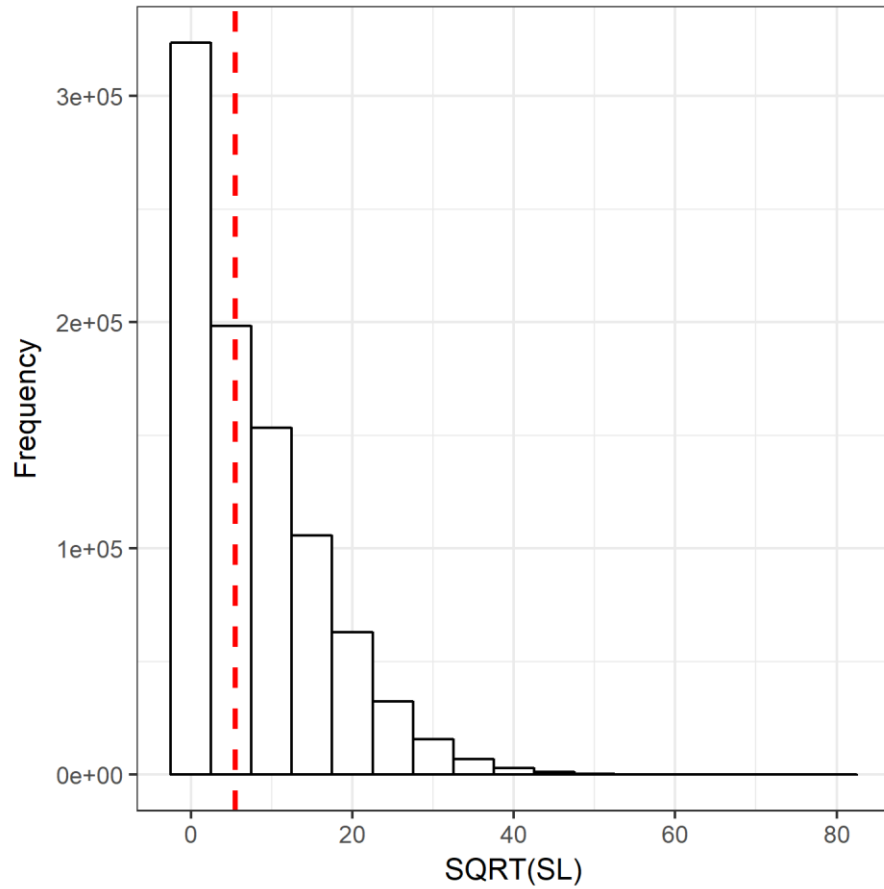- BMU
- Parks
- Secondary
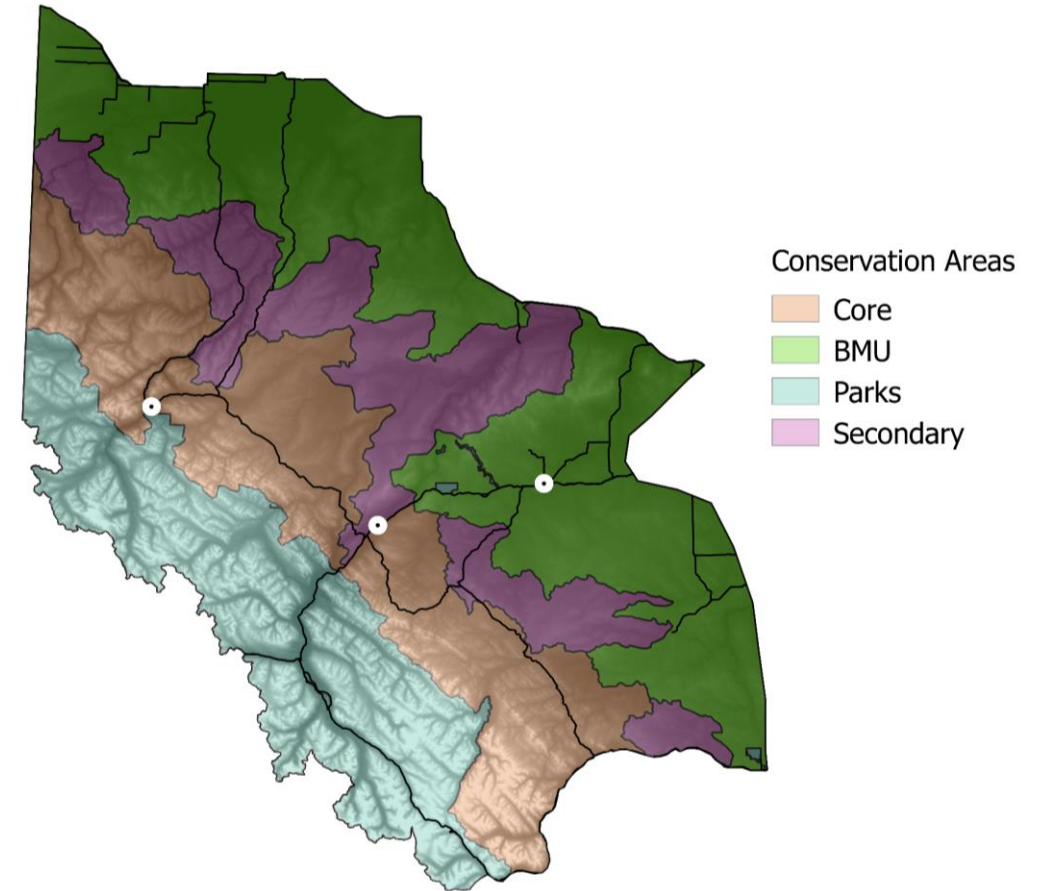
Source: Nielsen et al. (2009)

Movement parameters
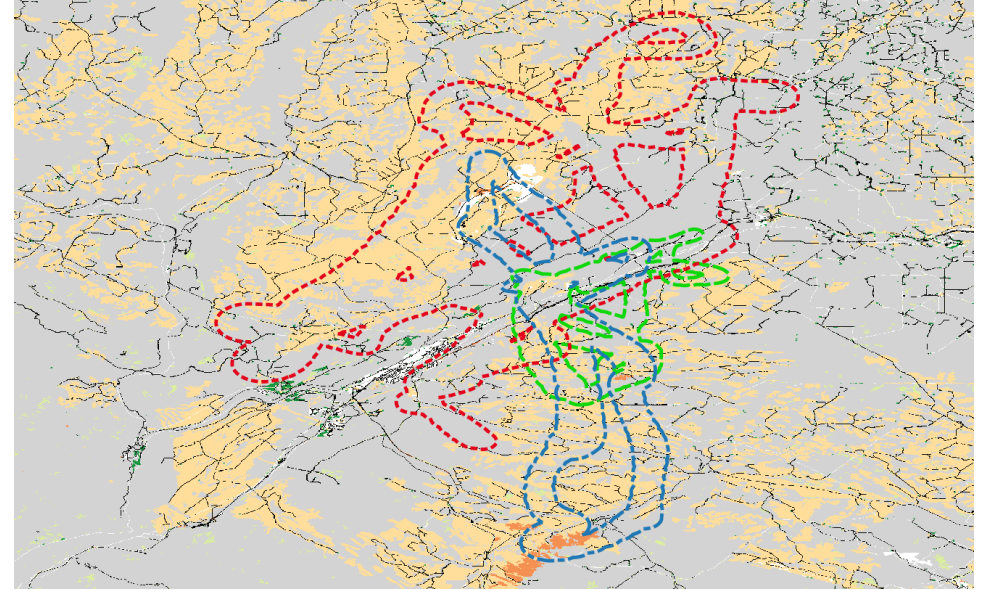
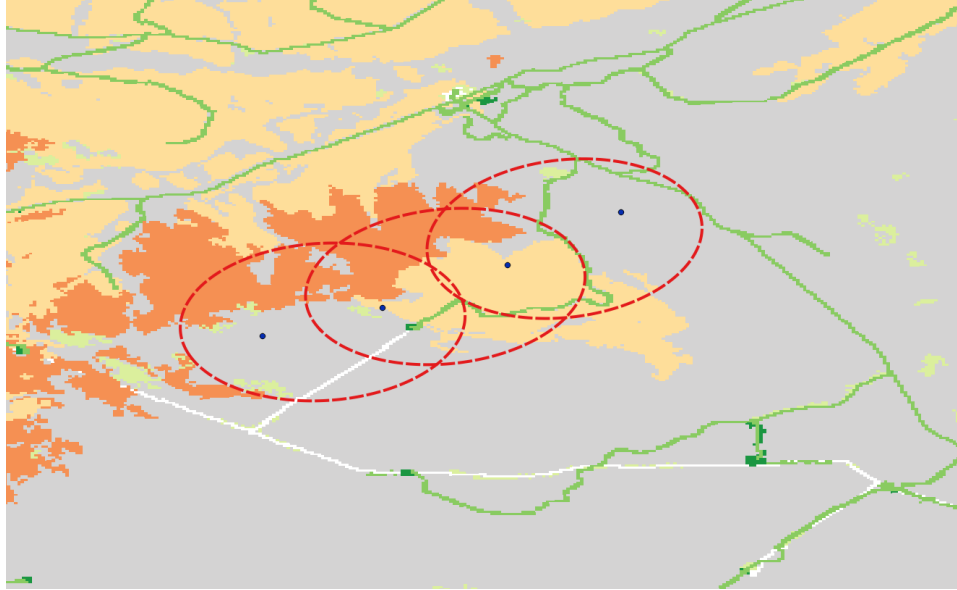SL = Step Lengths
β = Turning Angles

Movement parameters

Space use

Variables

1. External

- Disturbance (IRSS)
  - Roads, harvest, well-sites, mines, infrastructure, and fires
- Food (ACE Lab)
  - Seasonal food availability (vegetation/meat)
- Topography
- Vegetation indices (NDVI & DHI)
- Land cover

2. Internal

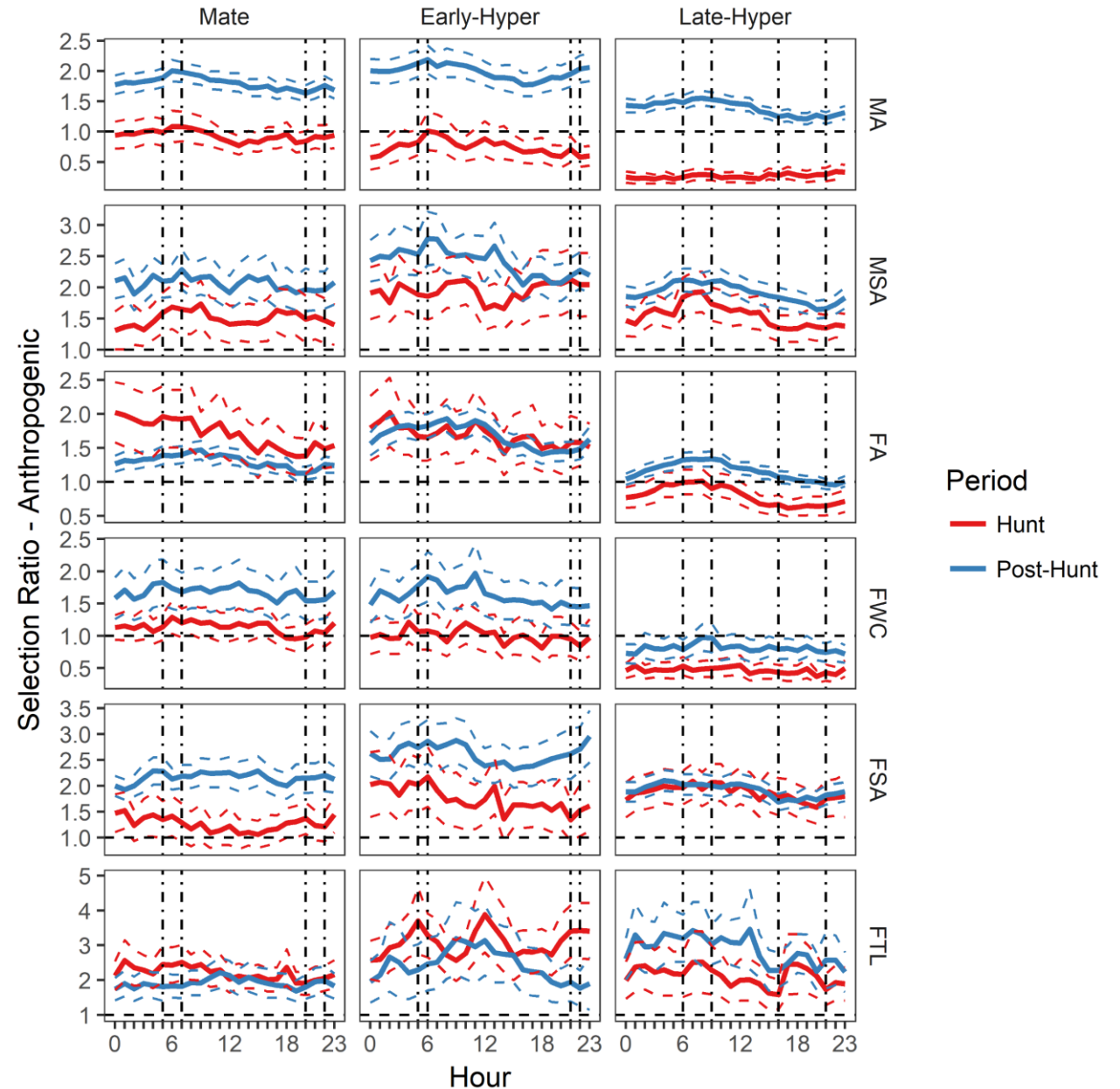- Cohort (Gender x Age; Mortalities)

3. Space

- Conservation areas

4. Time

- Hourly, seasonal
- Inter-annual
  - Time since hunt

Selection ratio

- Ratio of hourly disturbance f and the seasonal disturbance f

- SR < 1: select less than available
- SR > 1: select greater than available

# General modelling approach

- Multilevel Bayesian framework (STAN)
    - Group-level intercepts by bear
- Response
    - Movement parameters (rates; space use)
- Multiple combinations of variables
    - Time (diel; seasonal; inter-annual) + Space (CA's) + Disturbance (SR's; Density) + Food + Landscape Productivity (veg indices) + Topography
      + Land cover + Internal factors (cohort)
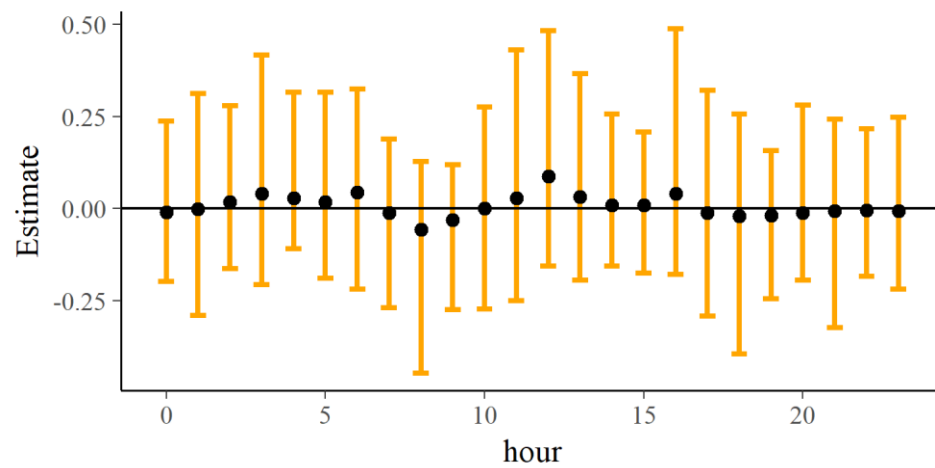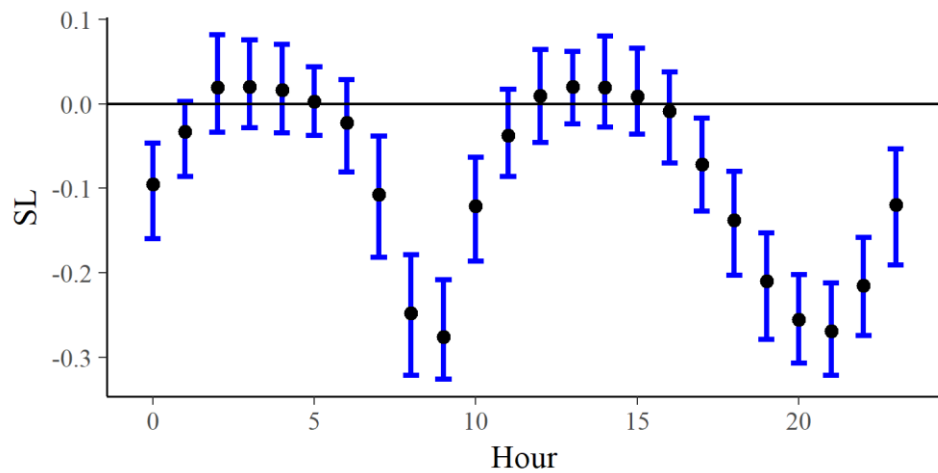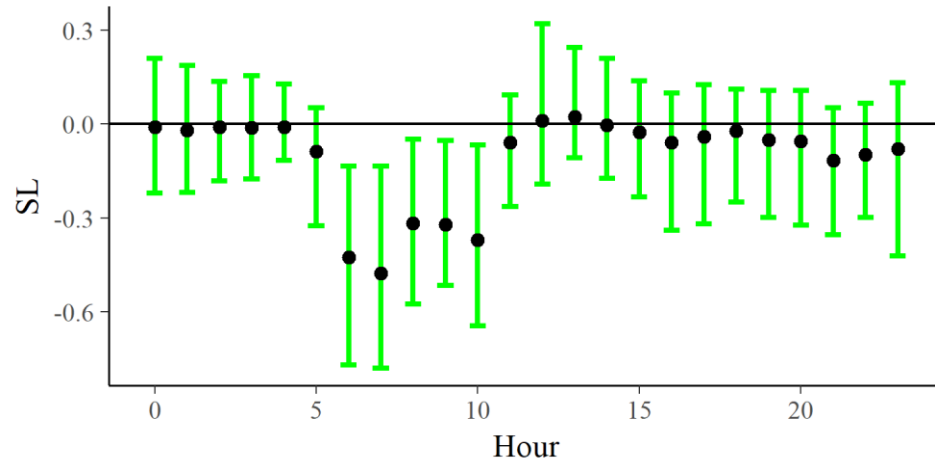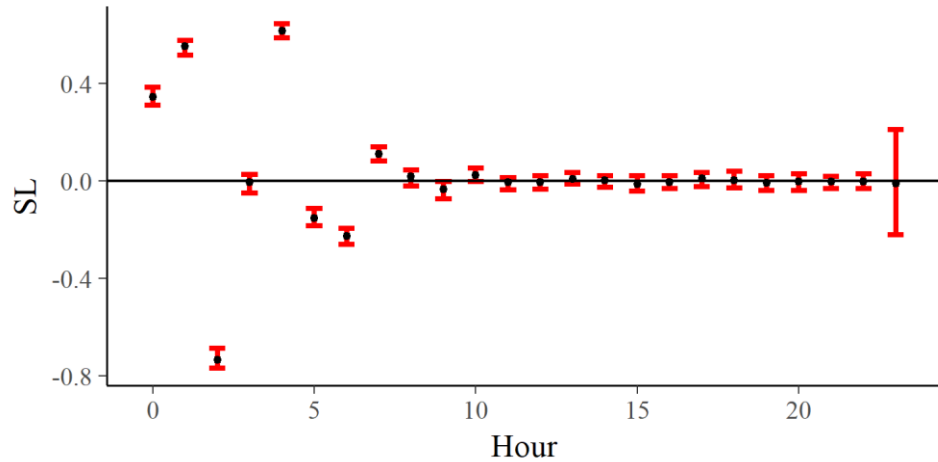- Compare using WAIC

Results

Hourly movements (ΔWAIC = 319.85)

- Time of day (TOD)
- Cohort
- SR: Road, Harvest, Wells
- Density: Road, Harvest, Wells
- Food
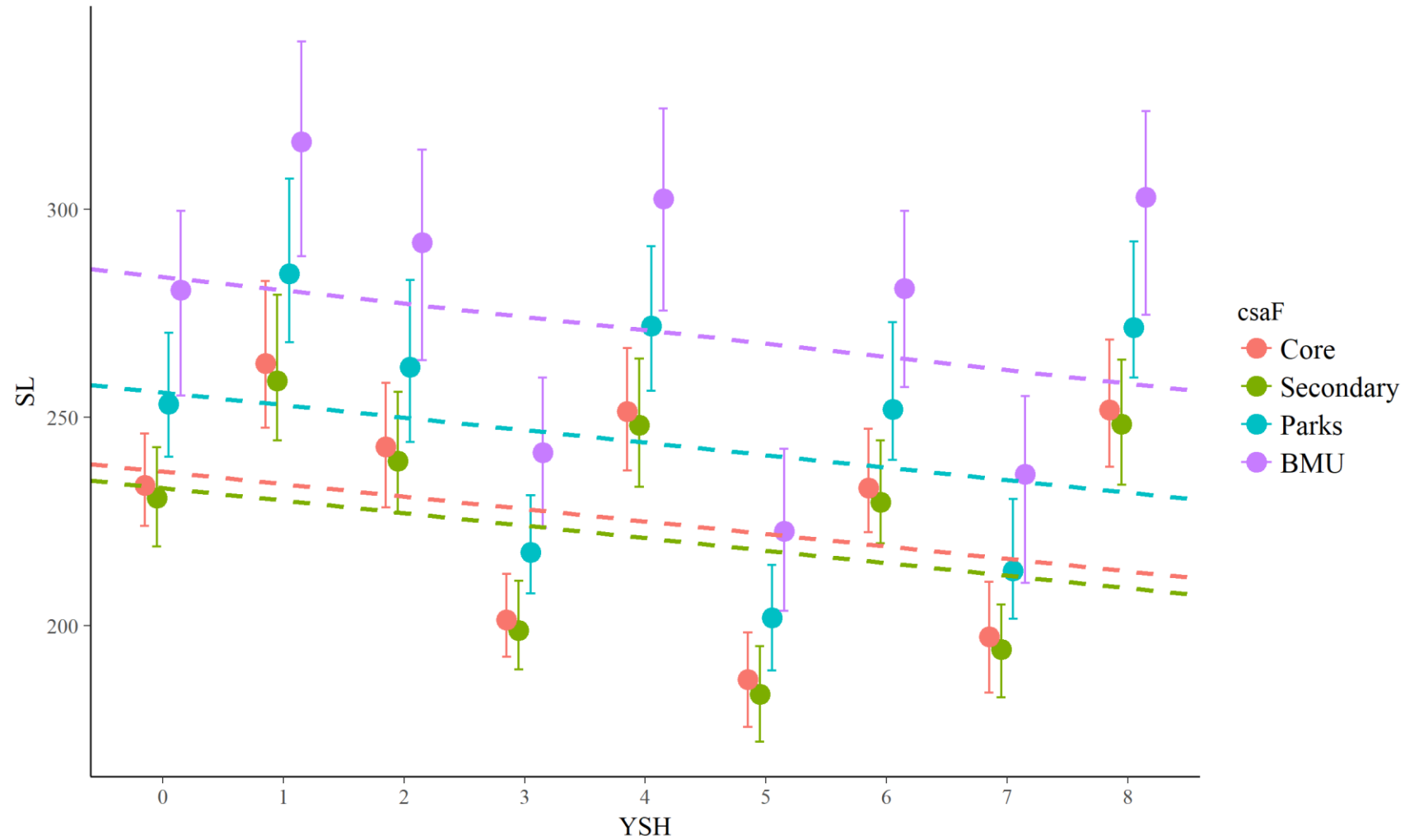- Conservation areas
- Years since hunt
- TOD * SR * Density

Hourly movements
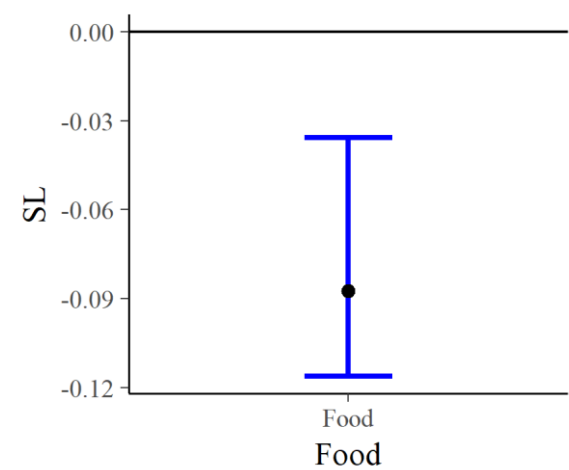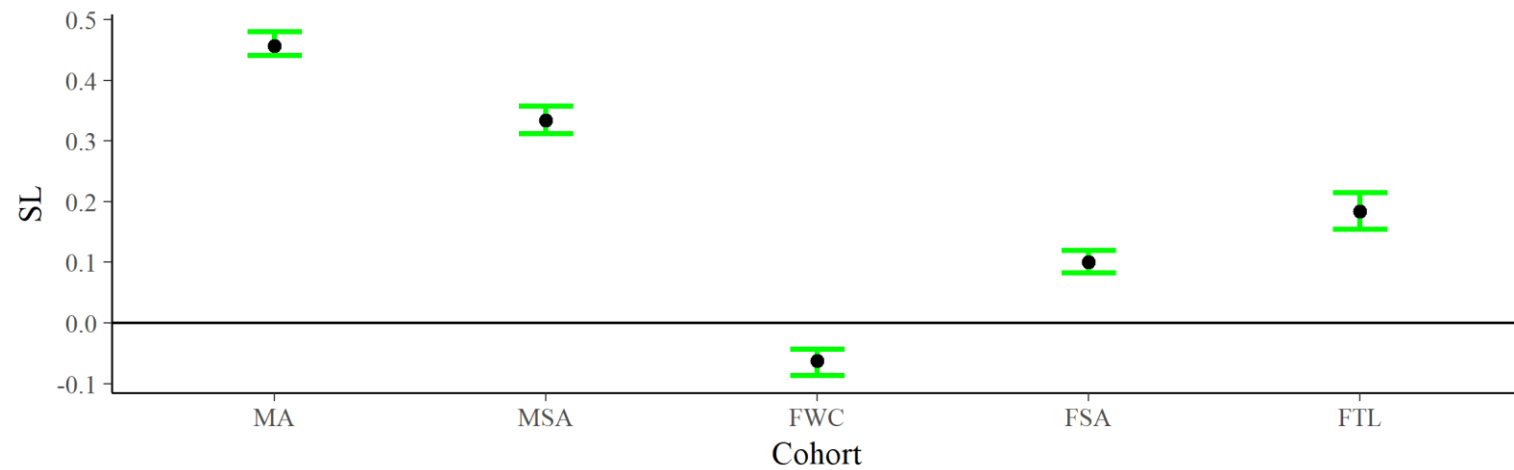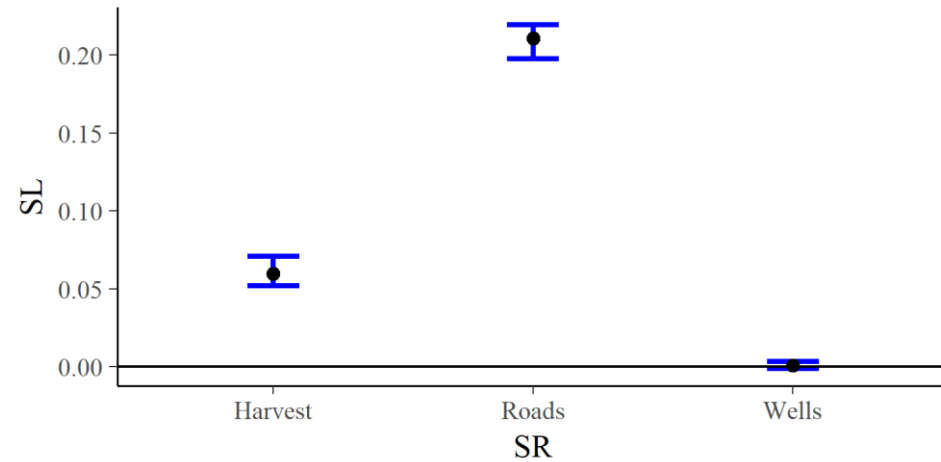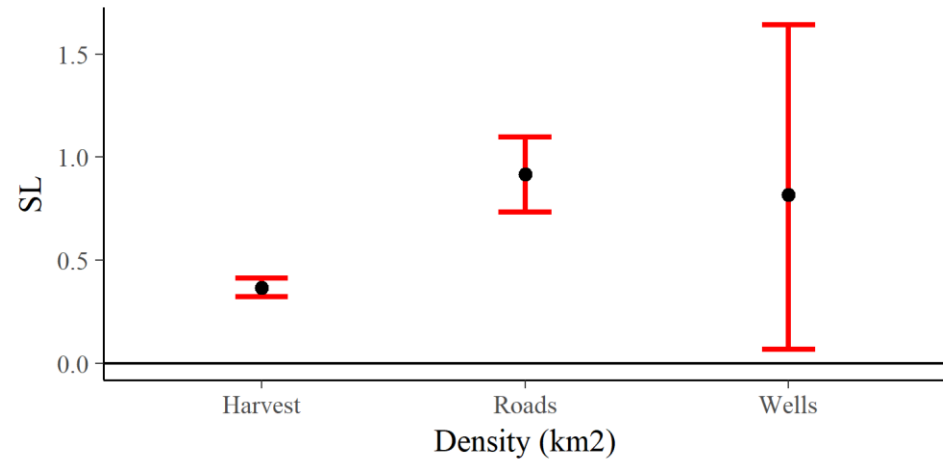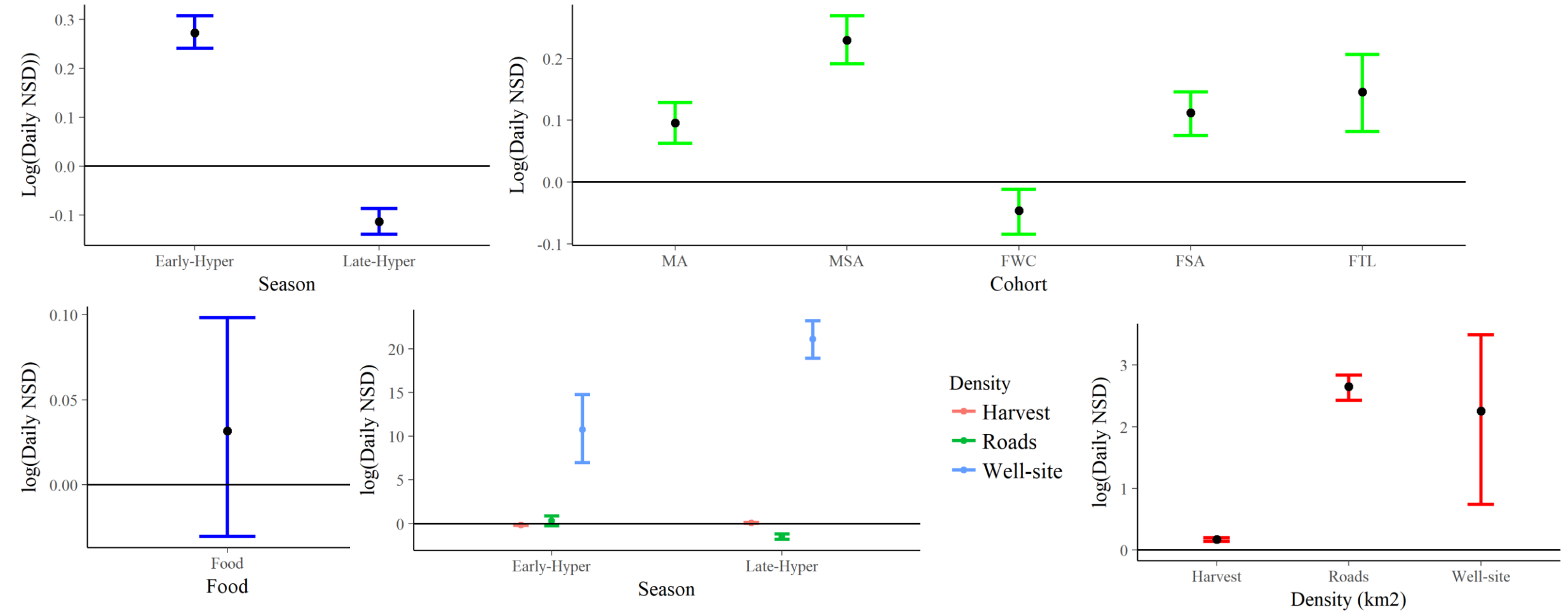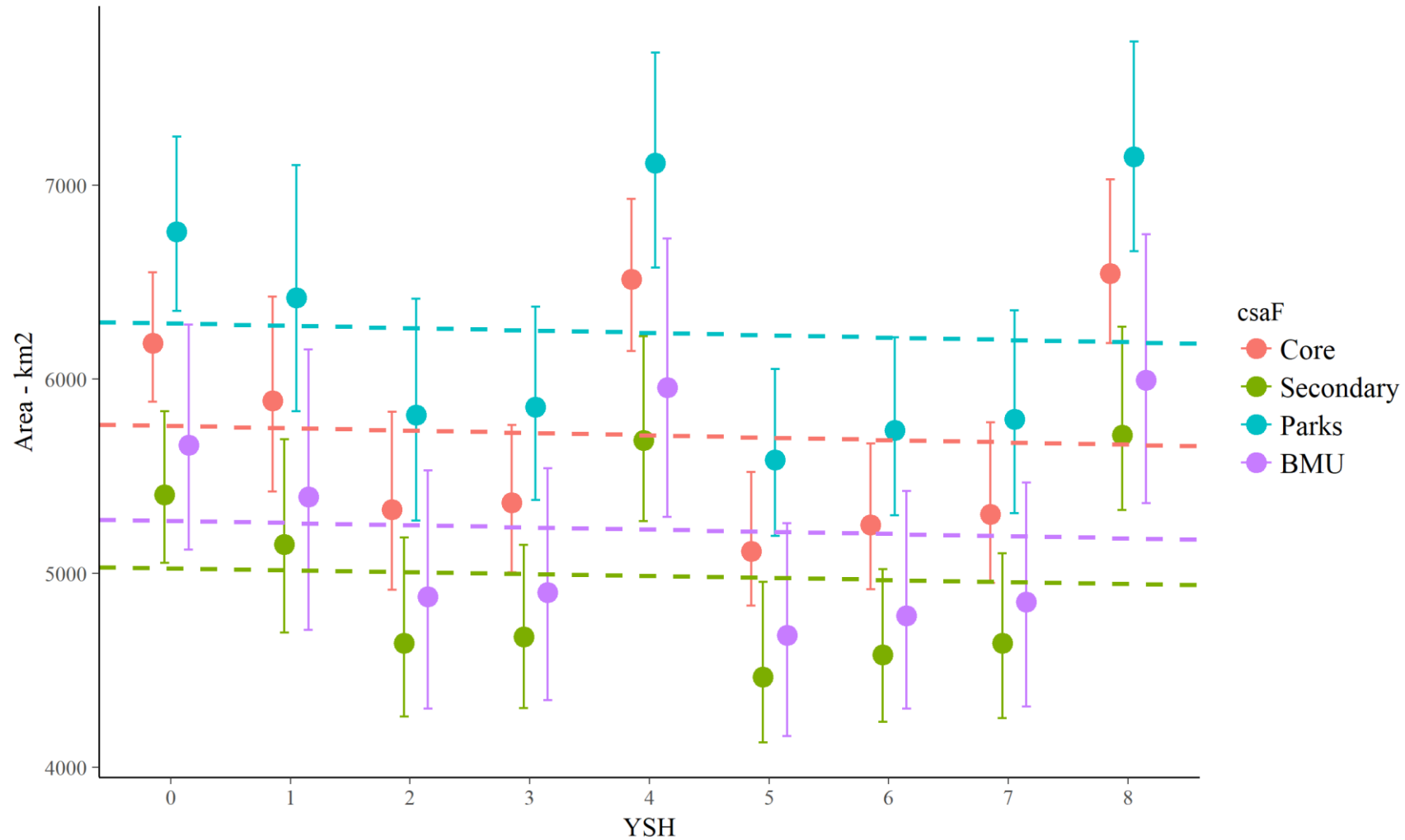
Hourly movements

Hourly movements

Results

Daily movements (ΔWAIC = 21913)

- Season
- Cohort
- Density: Road, Harvest, Wells
- Food
- Conservation areas
- Years since hunt
- Season * Density

Daily movements

Daily movements
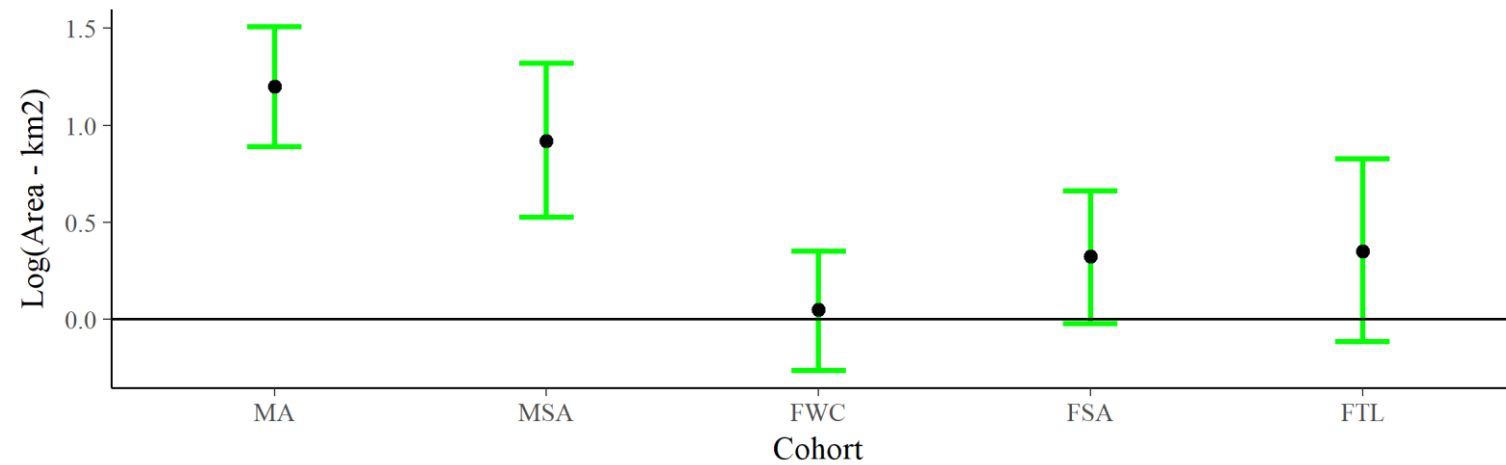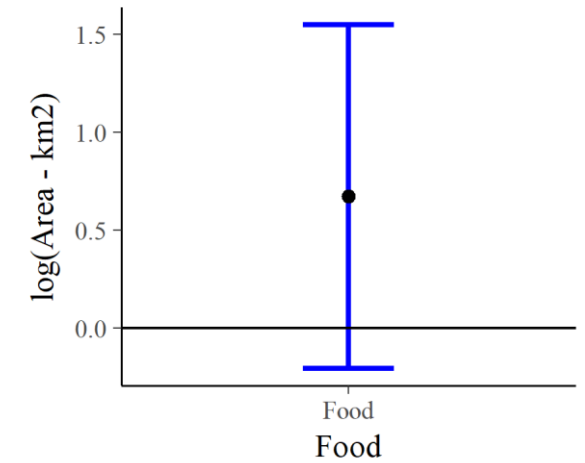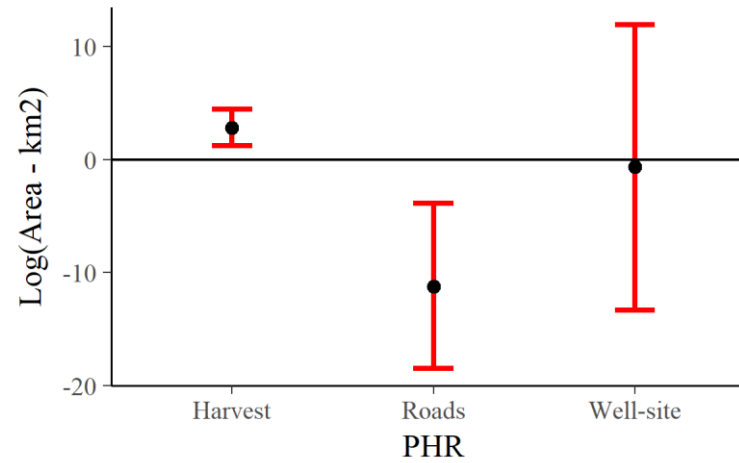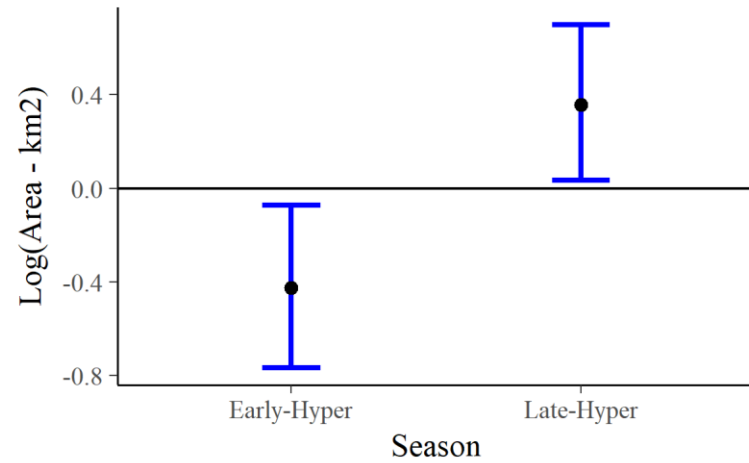
Results
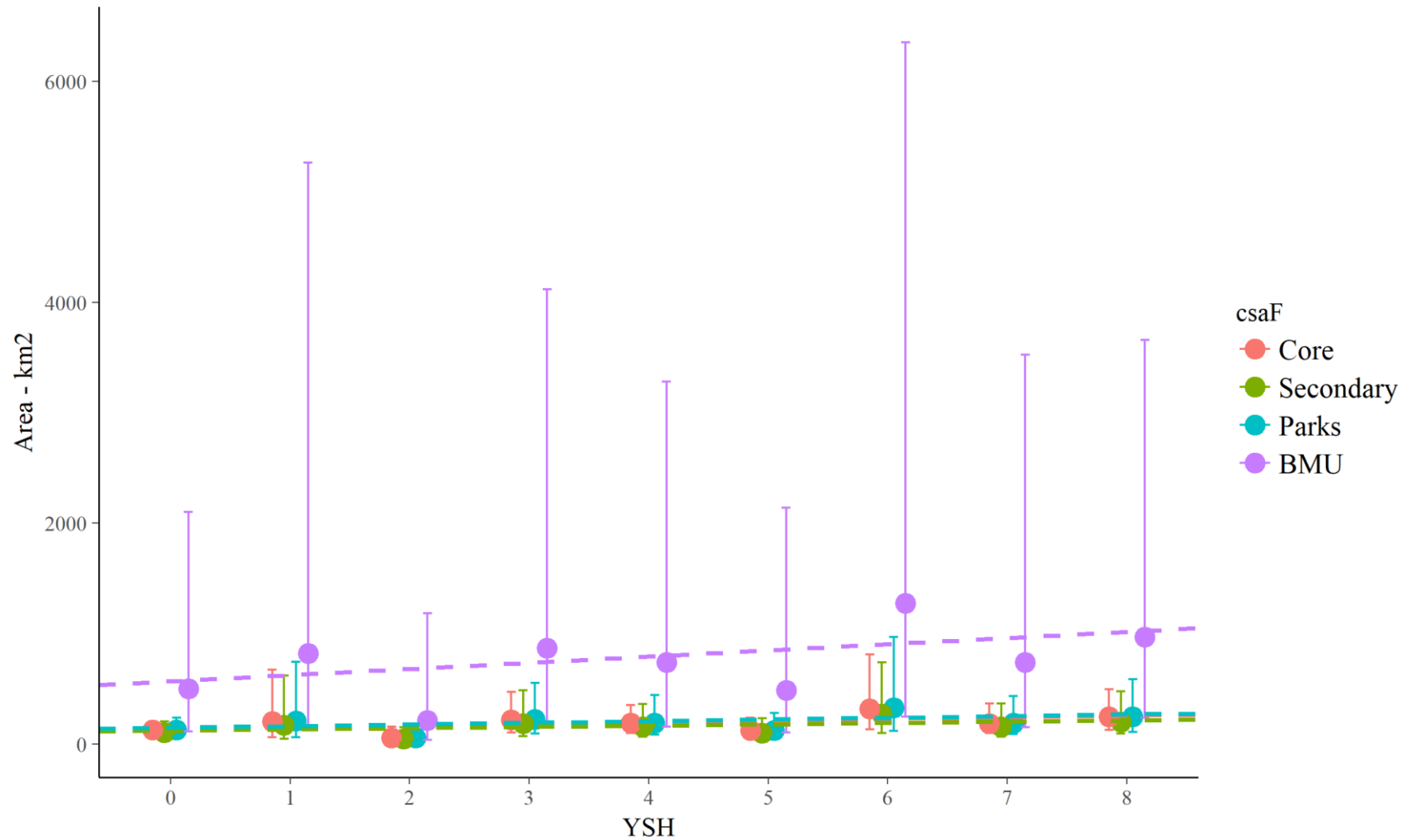
Seasonal movements (ΔWAIC = 62.77)

- Season
- Cohort
- Proportion home range: harvest, roads, well-sites
- Food
- Conservation areas
- Years since hunt
- Season * PHR

Seasonal movements

Seasonal movements

Summary

- Evidence that movement rates have changed over space and time
    - Dependent on temporal scale
    - Decreasing hourly/daily and increasing seasonal
    - Core area generally lowest movement rates (food, security?)
- Hourly scale dependent on density and "strength" of selection
    - High density * high selection = greater movement rates
    - Increasing hourly SRs represent "novel" habitat compared to HR
    - Link to mortality well established
    - Energetic requirements
- Daily distance travelled / seasonal range size more dependent on density rather than selection

Next steps

- Hourly, daily, and seasonal models easily used for prediction of movement rates / space use
- Ideally, want to predict the probability of space use and movement
  - Chapter 3: Third order selection over time and linkages among areas using movement probability (step selection function).
- Do bears in poorer condition exhibit "risky" behaviour?
  - Chapter 4: Behavioural path segmentation (HMM) combined with BCI data
  - Could predict changes in body condition using new energetic food landscape models.