Constructing a modeling tool for wolf status review in WA

July 2021 Update

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Our goal is to use rigorous quantitative science to assess the status of wolf populations in Washington

MODEL STRUCTURE AND RESULTS ARE NOT FINAL

Importantly, the work we are describing here is still in progress, so we value your insights and suggestions

MODEL STRUCTURE AND RESULTS ARE NOT FINAL

A reminder of who we are…

- Lisanne Petracca
  - Postdoctoral Scientist
- Ben Maletzke
  - WDFW Wolf Specialist
- Sarah Converse
  - Unit Leader, USGS Washington Cooperative Fish and Wildlife Research Unit
  - Associate Professor, UW
- Beth Gardner
  - Associate Professor, UW

Photos: http://oyezroslyn.com/, https://environment.uw.edu/, https://fish.uw.edu/

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What are our project goals?

- Estimate demographic rates for wolves in Washington
    - Survival, recruitment, dispersal
- Connect these demographic rates to a spatial, territory-level colonization process
- Develop simulation scenarios to account for wolf management strategies
- Use current conditions and simulated scenarios to assess biological status at present and future time points

Sarah Bassing

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What will modeling results include?

- A model that captures the present population dynamics and space use of WA wolves while considering uncertainty
- For future time points:
    - Probability of persistence
    - Probability of quasi-extinction
    - Predicted abundance and distribution
- Expected time to meet existing downlisting and delisting criteria
- Measures of uncertainty around each of these quantities

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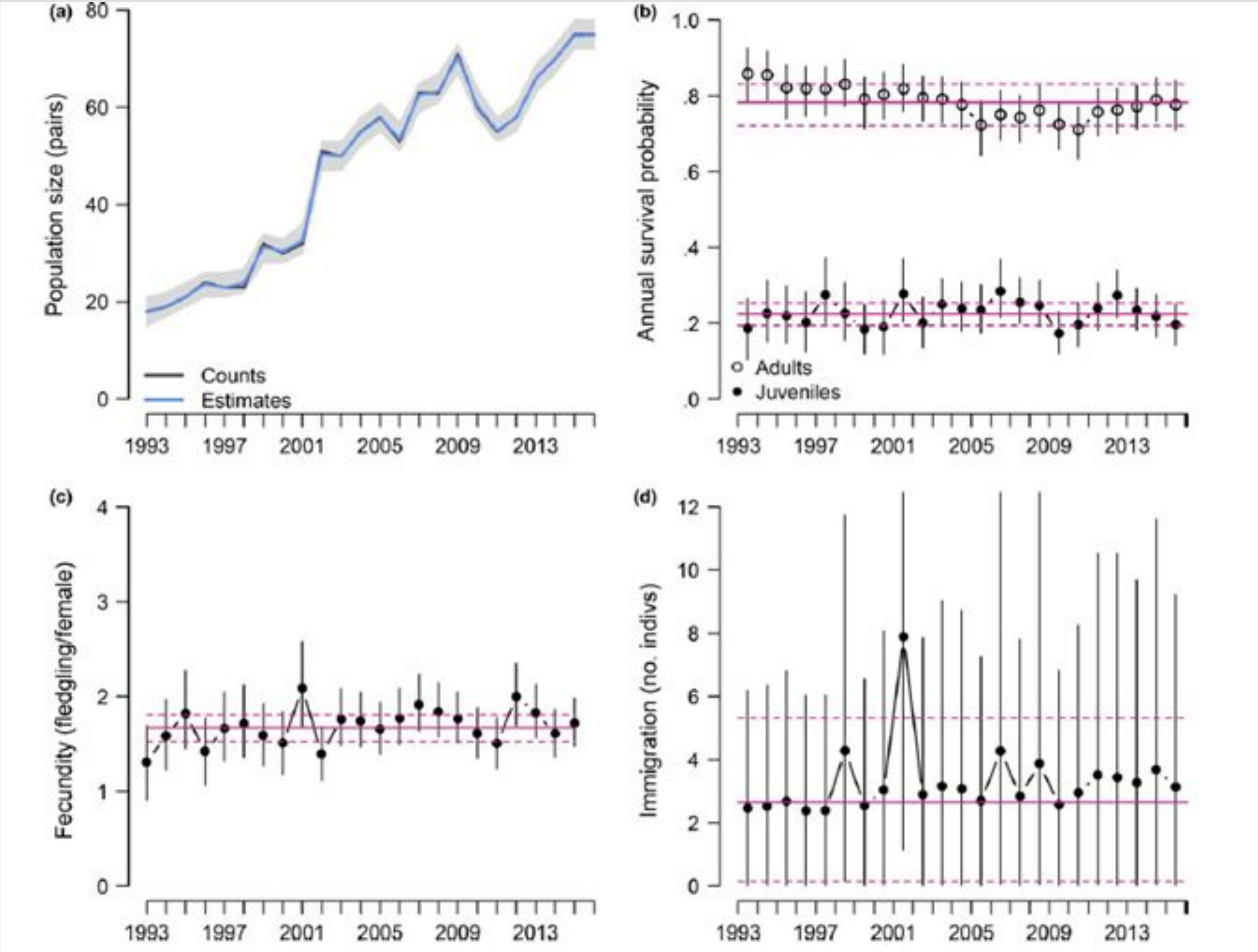
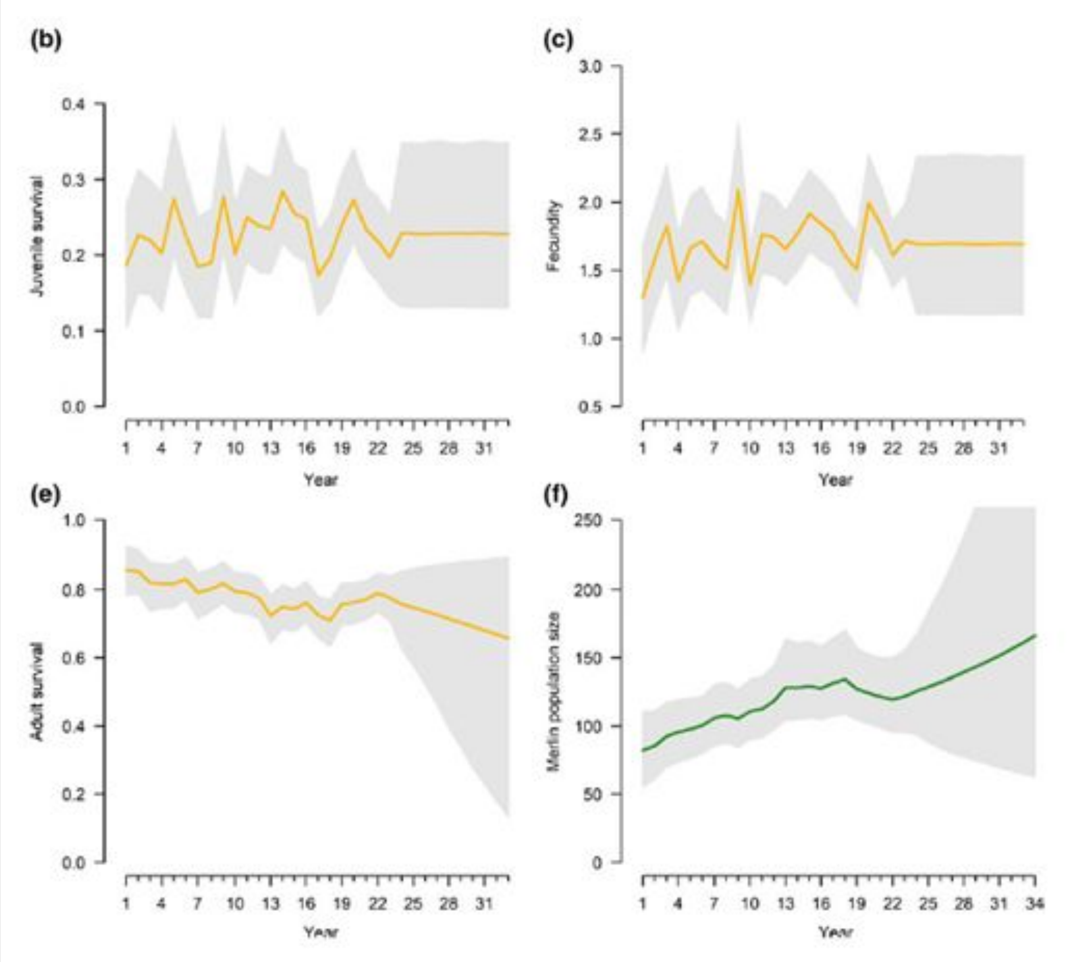


Example of population parameters that can be estimated from an IPM, using an example from Great Lakes piping plovers (Saunders et al. 2018)

MODEL STRUCTURE AND RESULTS ARE NOT FINAL

Example of projecting population parameters at **future** time points using an IPM (Saunders et al. 2018)



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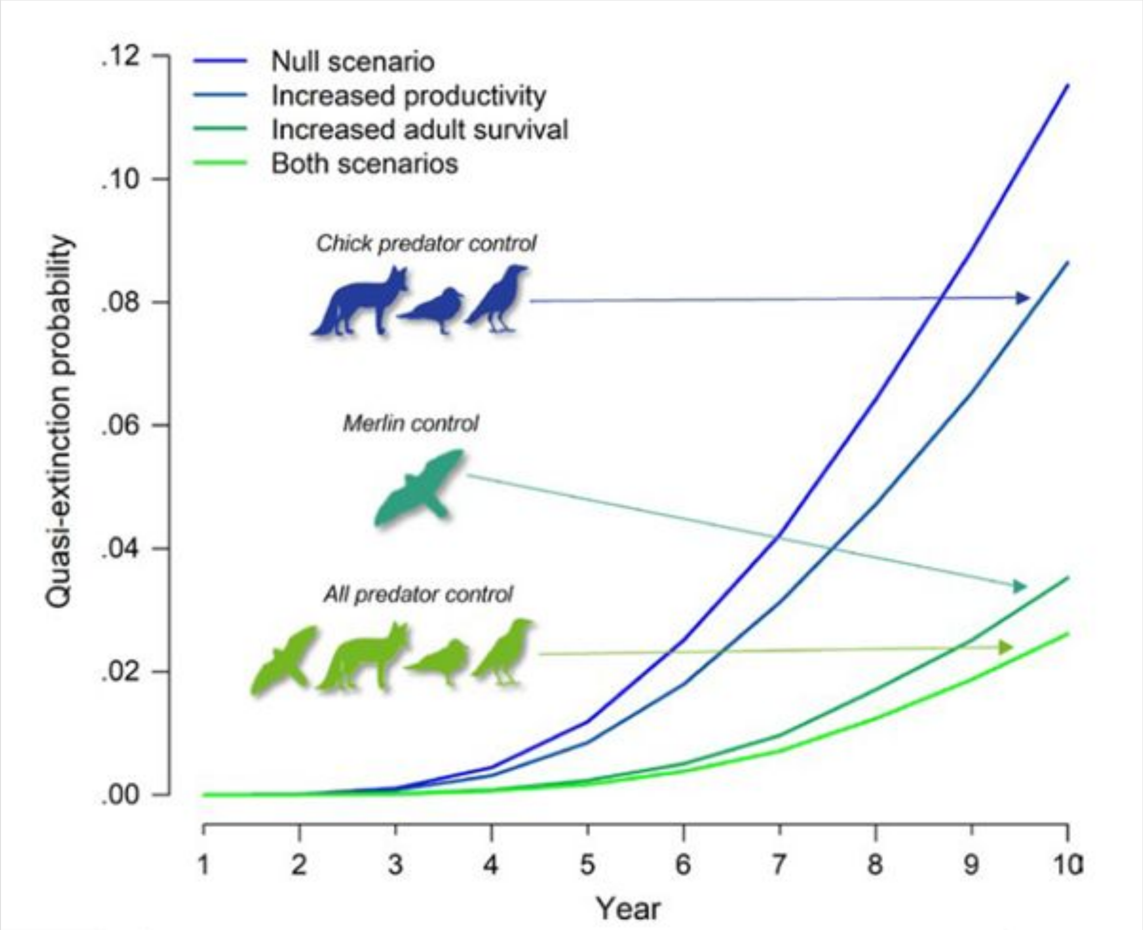

Example of using various management scenarios to estimate quasi-extinction probability (Saunders et al. 2018)

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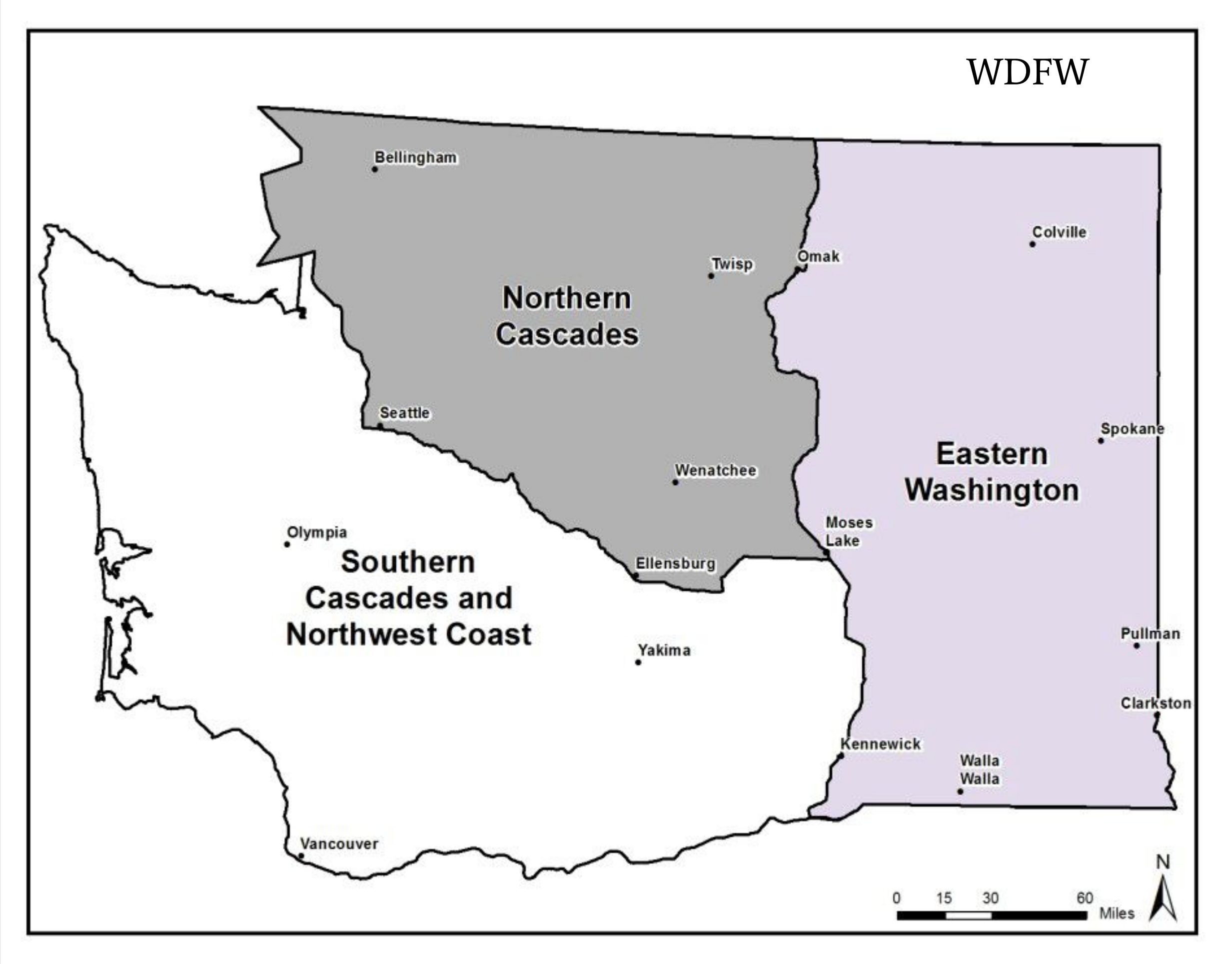

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What was our proposed project timeline?

- June to September 2020
  - *Project scoping and data compilation*
- September 2020 - January 2021
  - *Model development*
- February to March 2021
  - *Scenario dev't and implementation*
- April to July 2021
  - *Draft report complete, revision w/ WDFW*
- August 2021
  - *Submission of final report and model code*

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State of progress

- June to September 2020
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Our statistical approach

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- Use of an *integrated population model*
  - Allows the use of multiple datasets in a single model framework
    - Increases precision & is a more efficient use of data than analyzing datasets independently
- Use of Bayesian framework allows for correct propagation of uncertainty in model parameters
- By giving this model a spatial component, we can integrate dispersal behaviors and colonization of new areas

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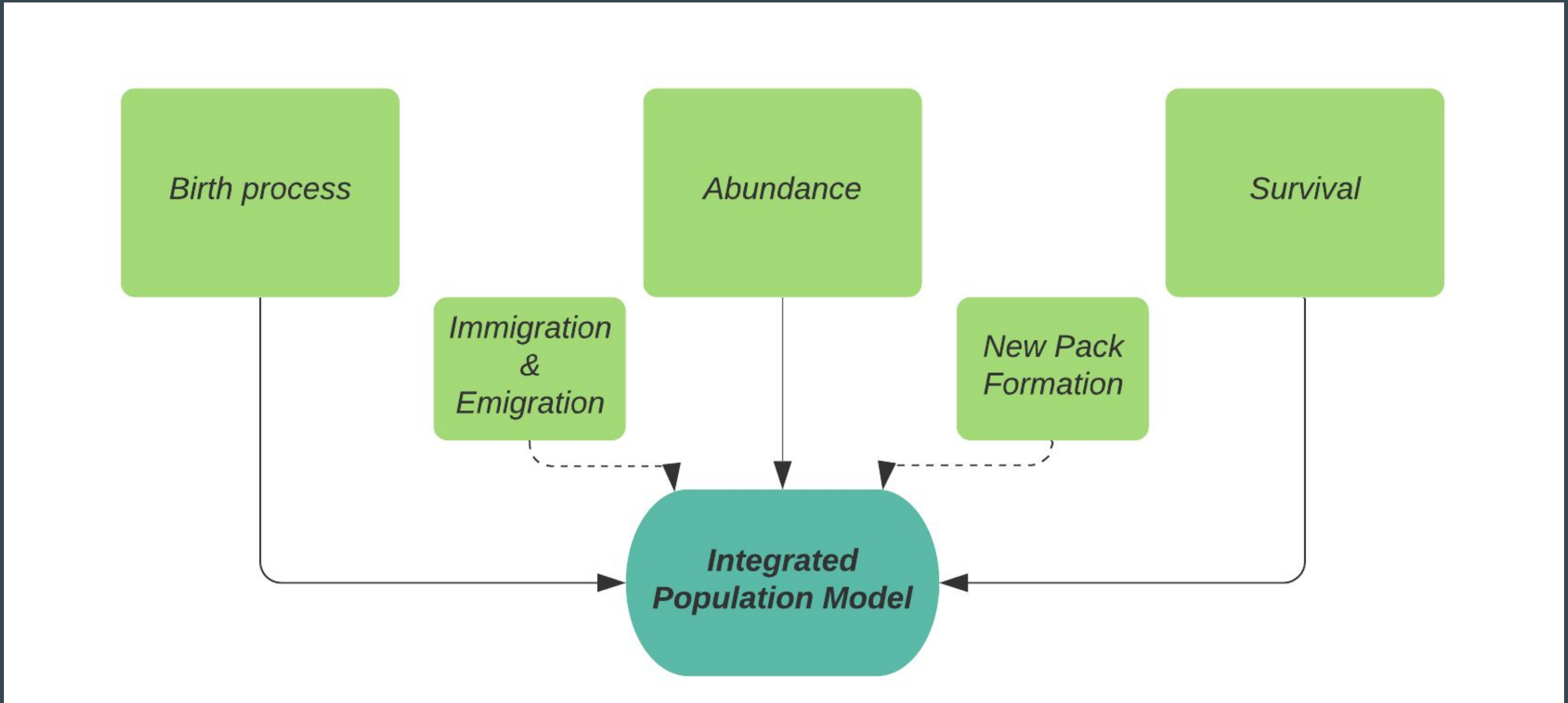
What are the demographic model components?



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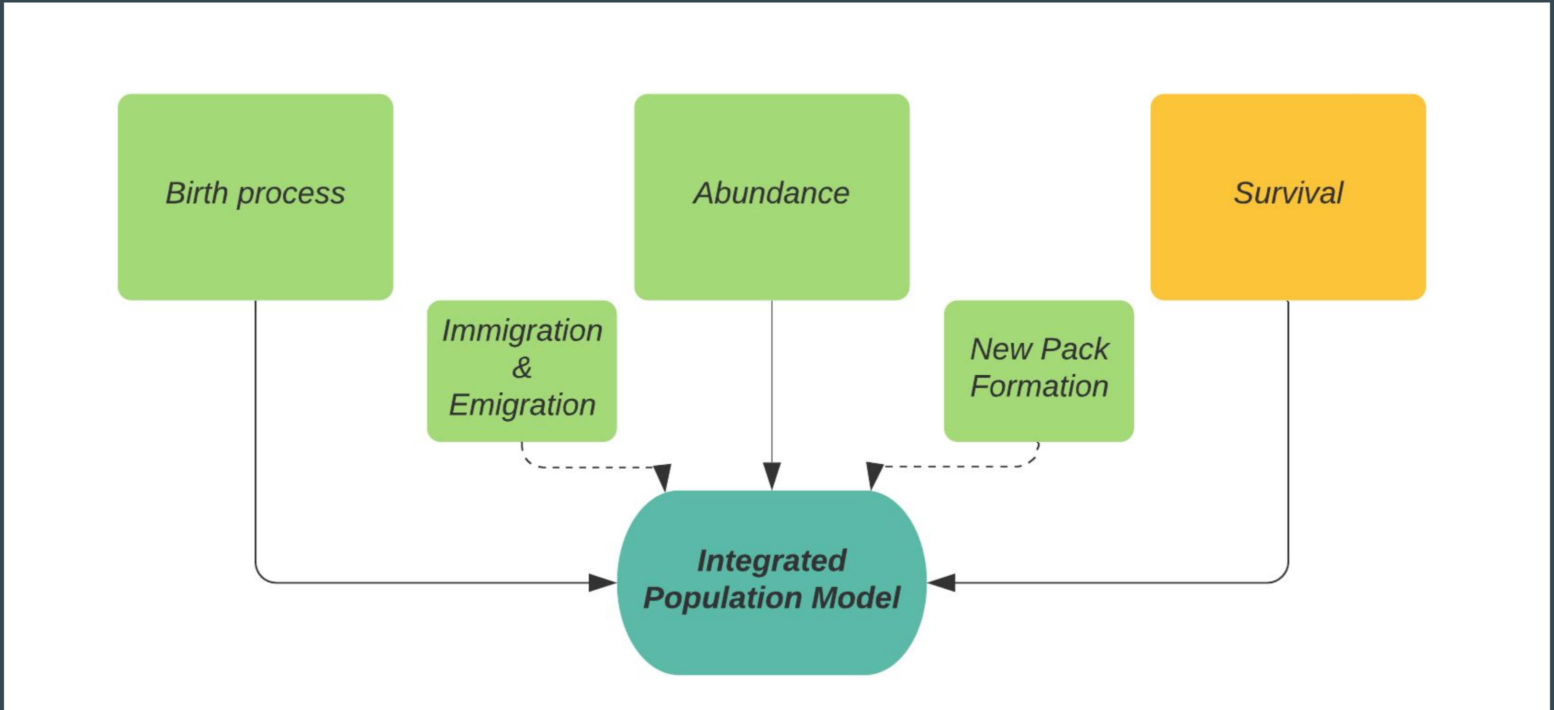
Let’s start with the survival component



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For the survival part of our model, we used GPS collar data from 81 wolves

We used a known fate survival model, with fixed effects of month and age class, and random effect of year and individual wolf

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Age classes were:
7-23 mos
24-35 mos
36-47 mos
48+ mos

Wolves were censored if they left the state or were removed by WDFW due to livestock depredations

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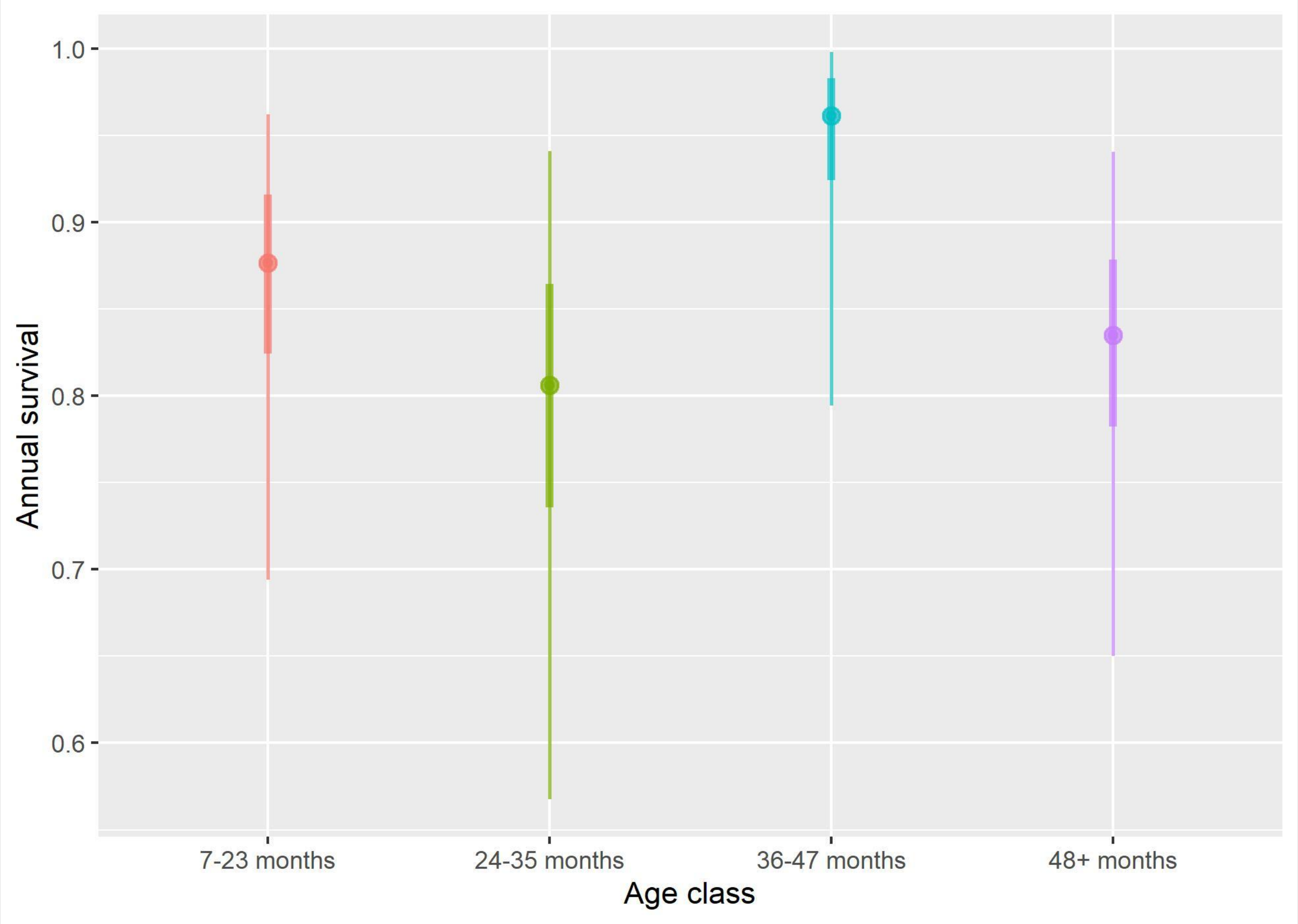

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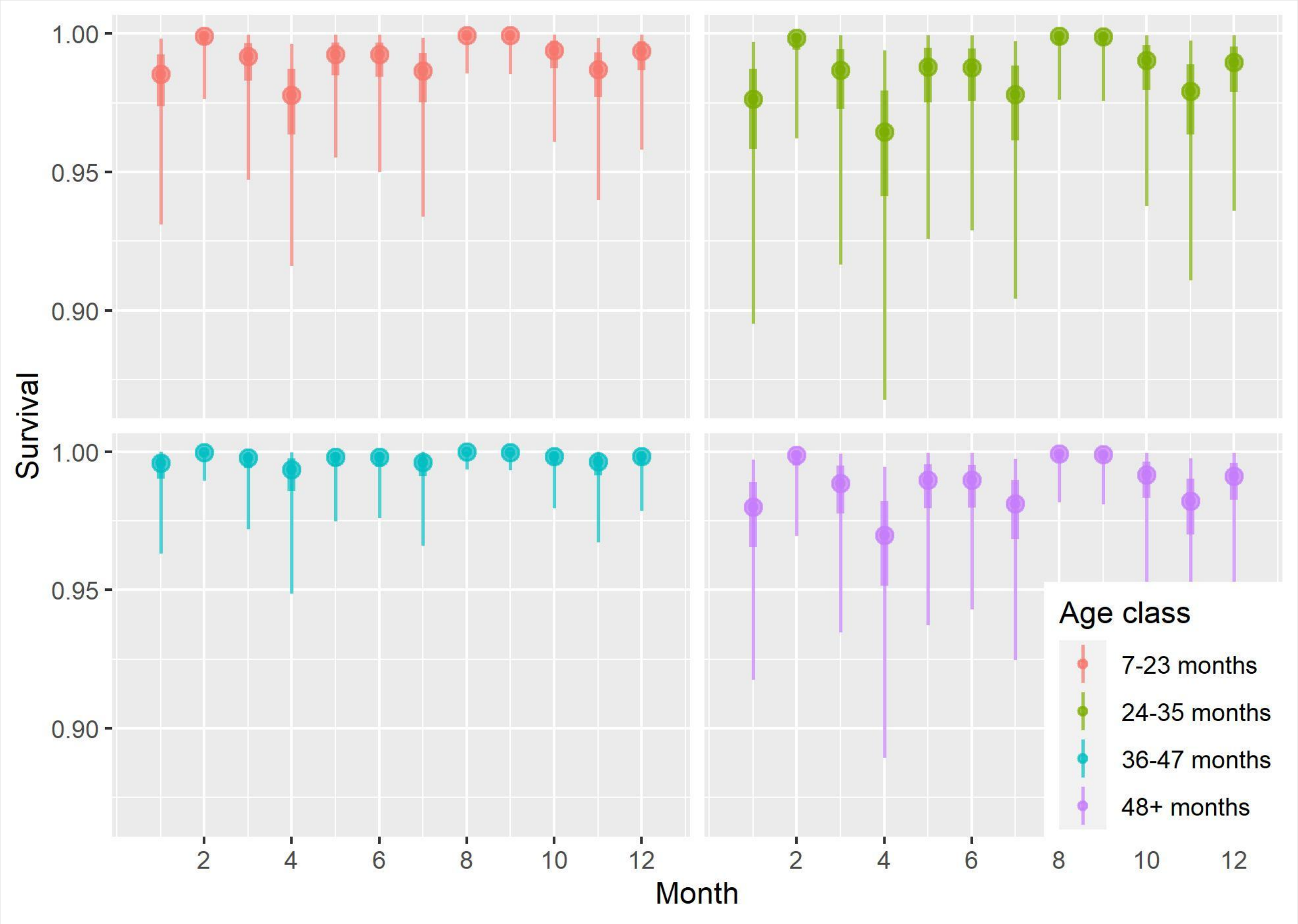

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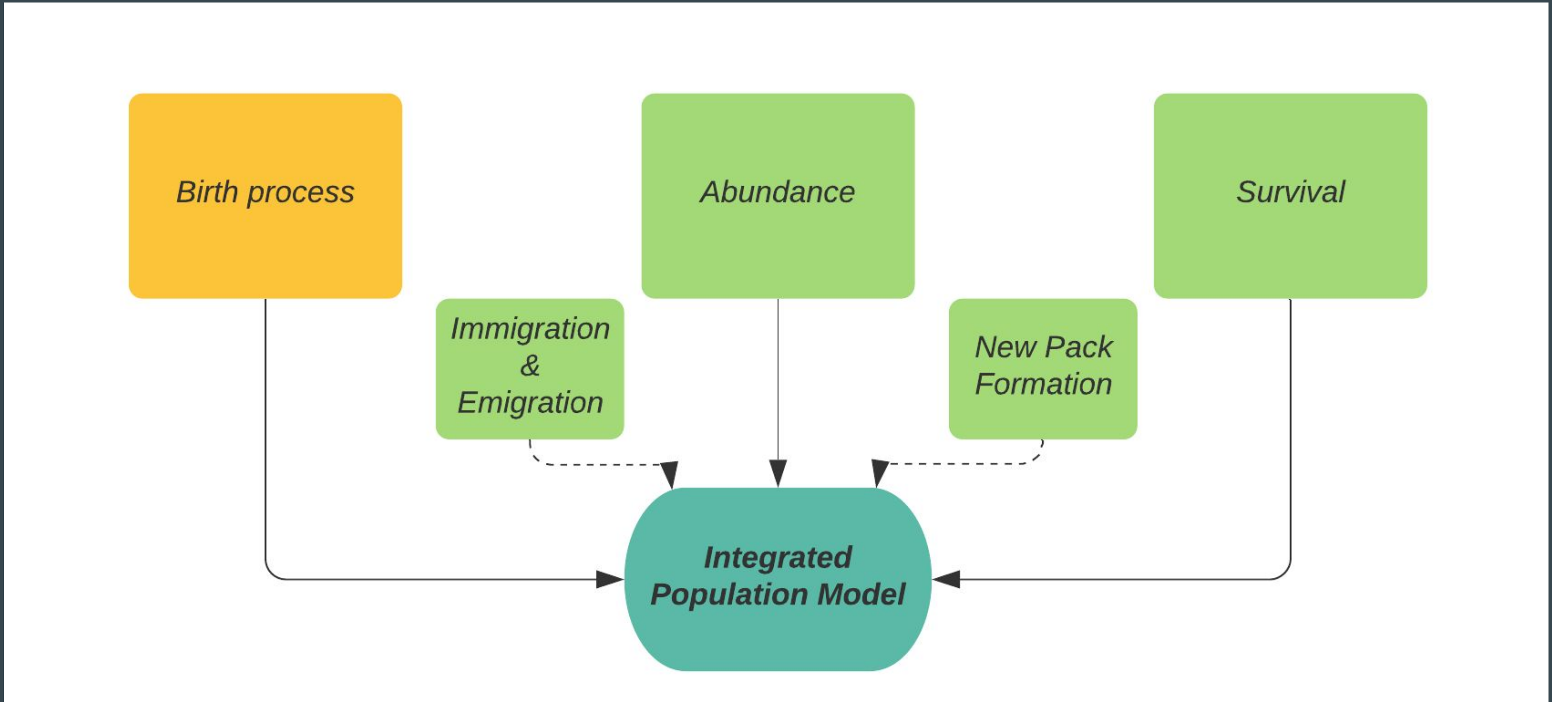
Now let's move on to the birth process



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There are two sources of data on reproduction

- WDFW pup counts from end of year 2009-2014

- Photos/videos of pups from camera traps placed opportunistically by WDFW staff in the summer trapping season

Spokane Tribal Wildlife Program (Savanah Walker)

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The end of year counts encompass 48 pack-years for 17 packs from 2009-2014

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The camera traps encompass 37 pack-years for 20 packs from largely summer 2013-2020

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End of year pup count data

- We hired a gifted undergraduate, Tam Ta, to sort through 177,548 separate images and videos of wolves captured by WDFW
  - This also included photo/video sent to WDFW from verified sources
  - As well as some photo/video from Sarah Bassing, Ph.D. candidate at UW-SEFS

WDFW

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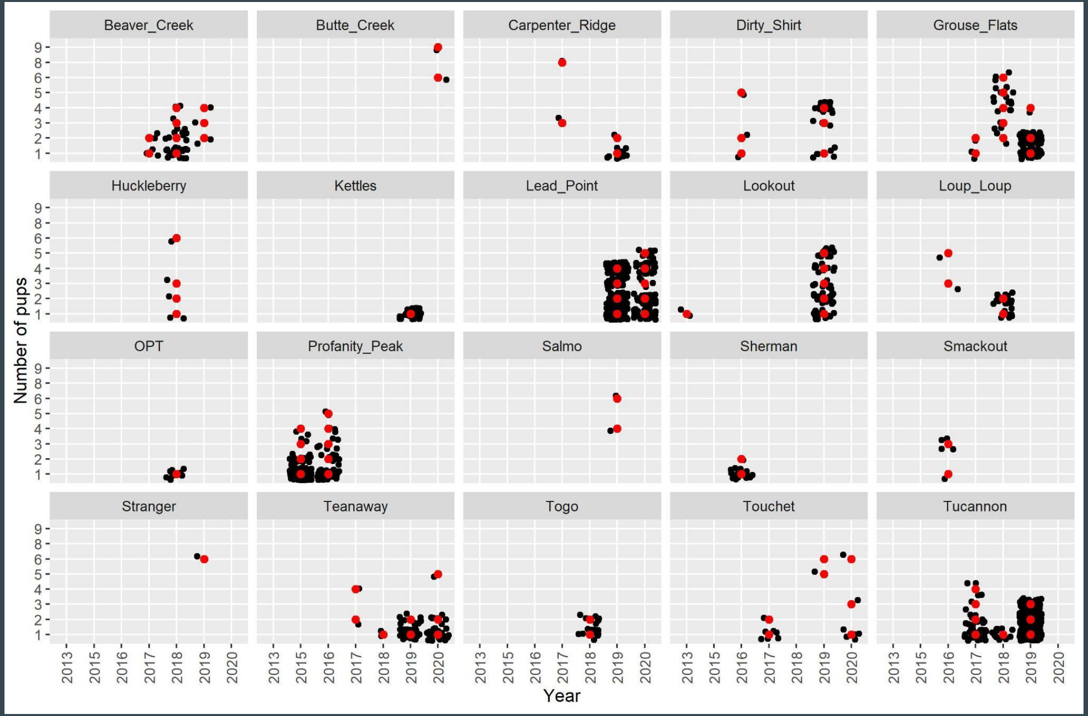
Overview of data from camera traps

- 7450 images of wolves
- 1572 images of pups
  - When we reduce to independent photos (those separated by 30 minutes at the same camera station), this number reduces to 220



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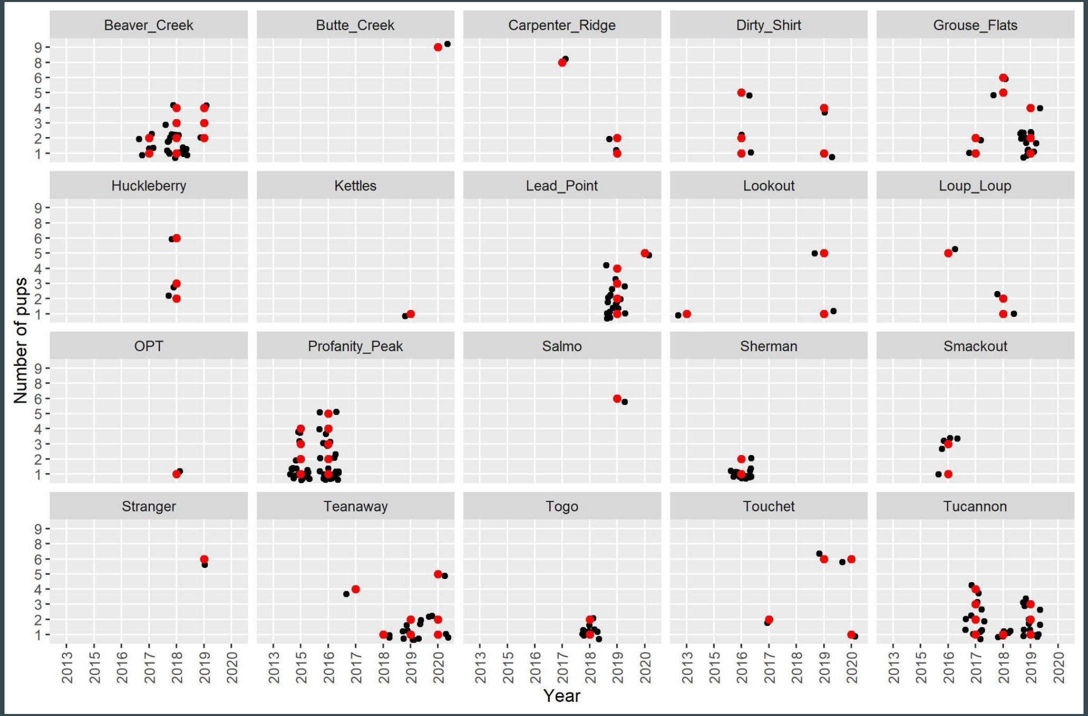

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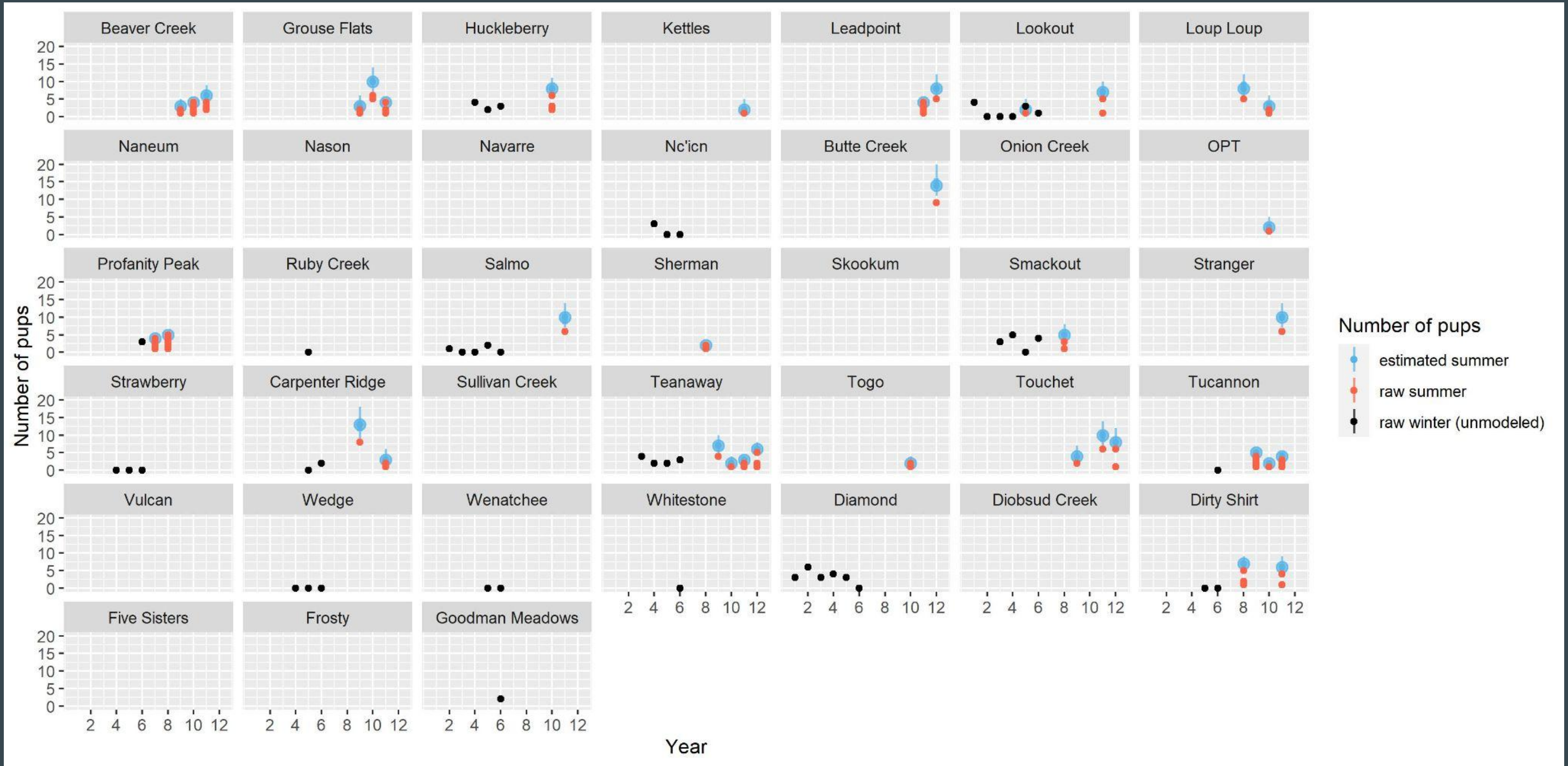
At one point, we tried modeling the summer data only, leaving the winter counts as fixed…



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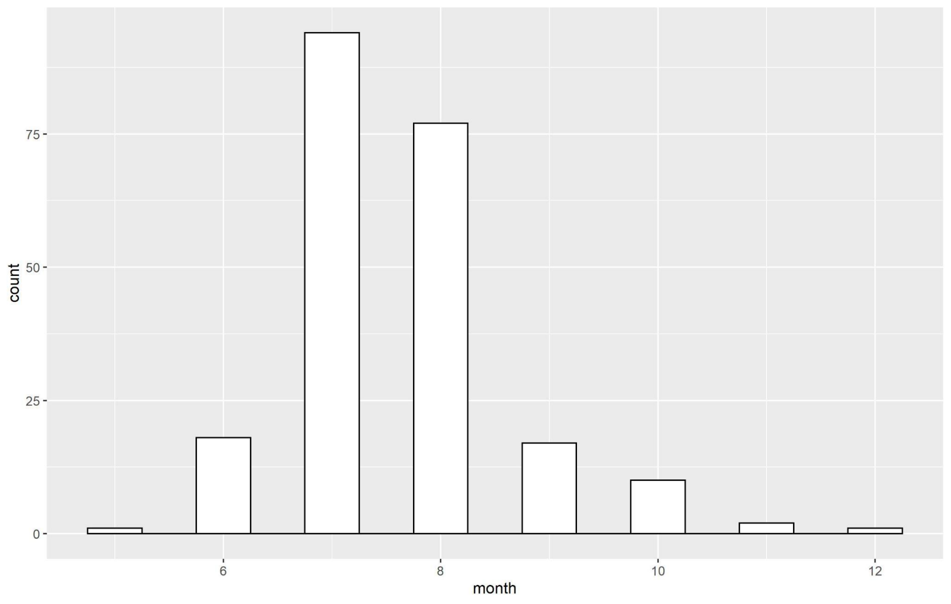
We are moving forward with end of year counts for now



- The camera trap data are useful, but they are largely from July/August and we have no survival data to inform how many pups will survive to December
- The end of year data will align with the end of year pack count data (on abundance component)

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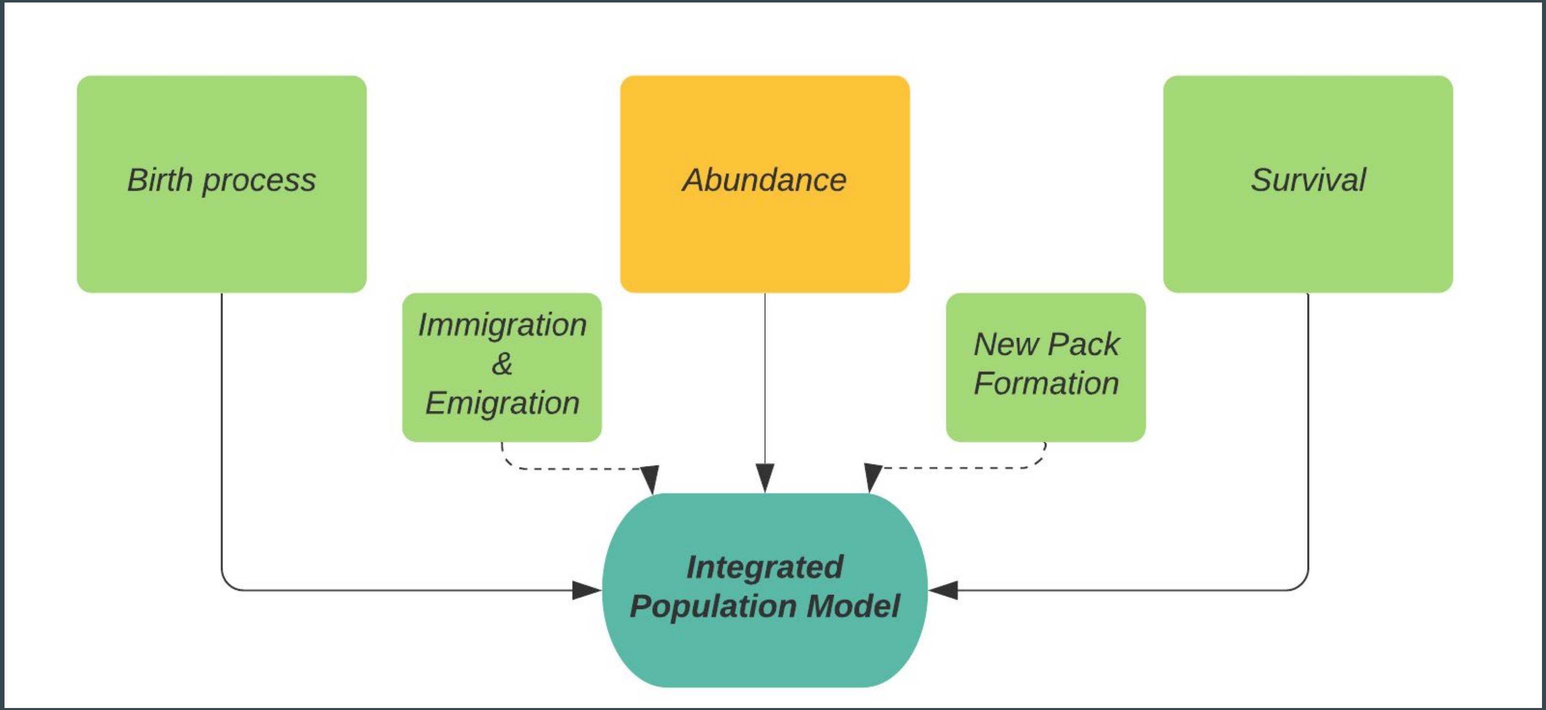
Now let’s move on to abundance



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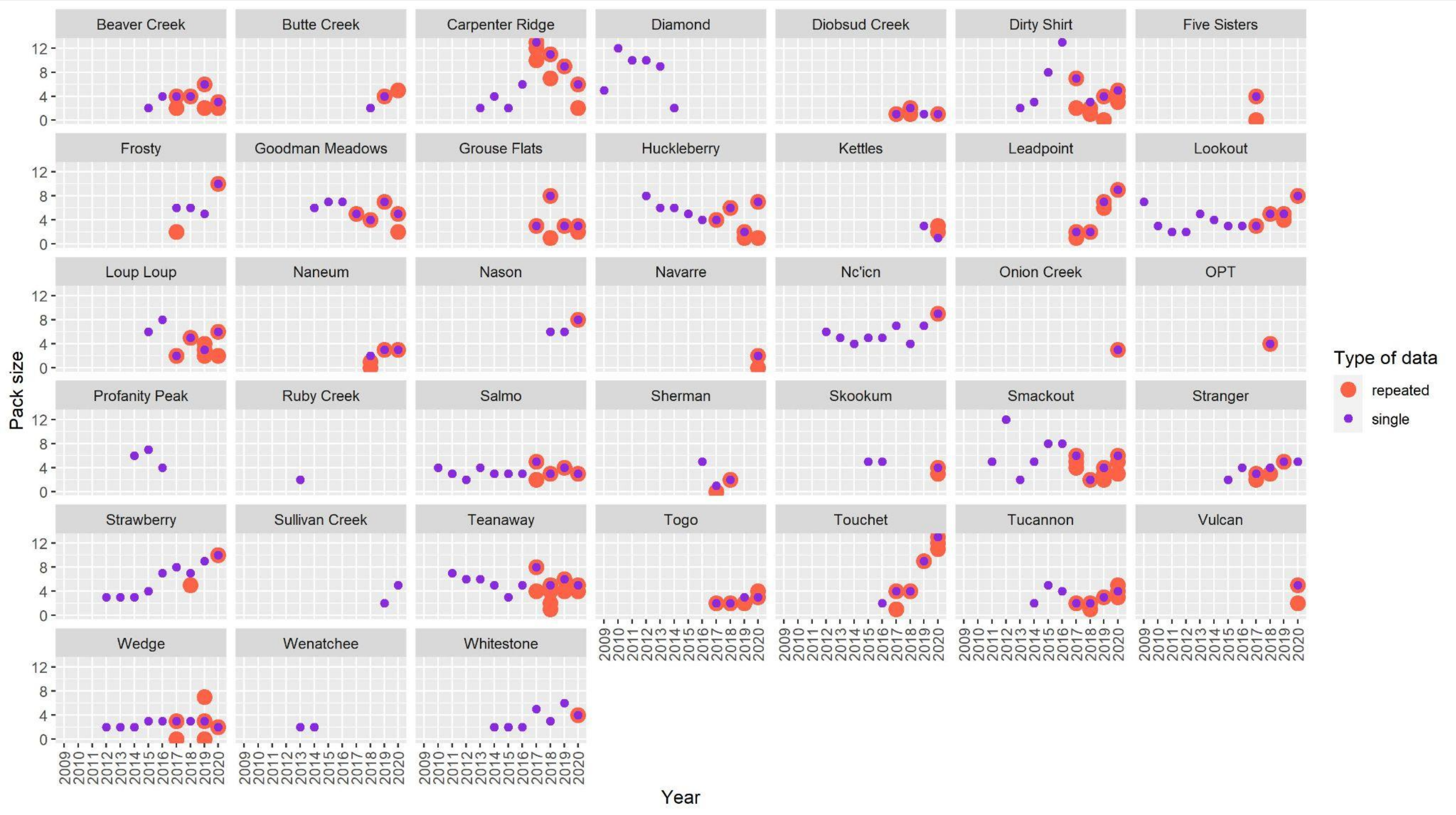
For abundance, we will be using data from winter aerial surveys by WDFW (2009-2020)

MODEL STRUCTURE AND RESULTS ARE NOT FINAL

Benjamin Drummond and Sara Joy Steele, “How to Count A Wolf”

The pack counts encompass overall counts from pre-2014 and repeated counts from 2017-2020 across 38 packs

MODEL STRUCTURE AND RESULTS ARE NOT FINAL



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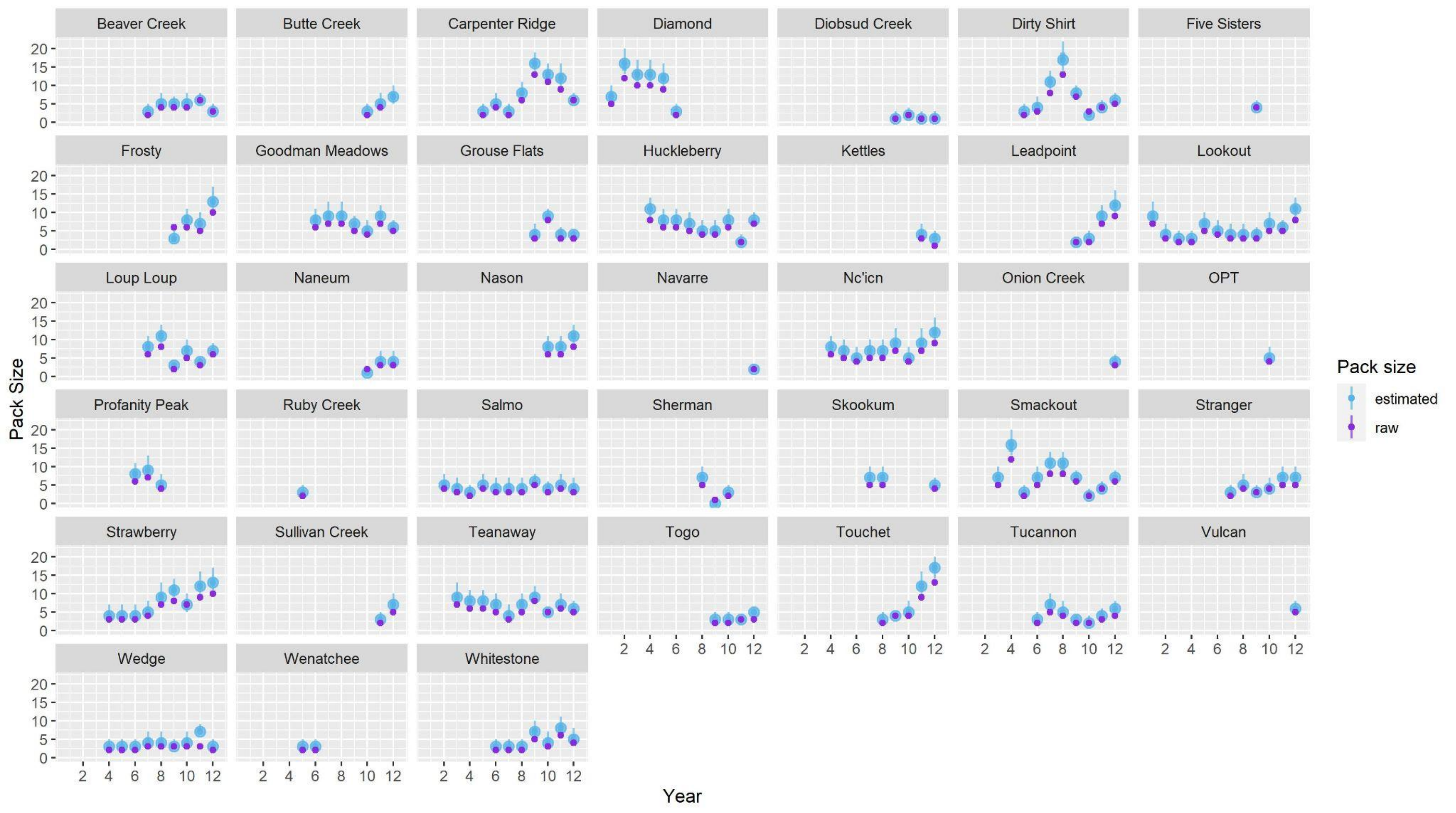

MODEL STRUCTURE AND RESULTS ARE NOT FINAL

The IPM will integrate these processes of survival, birth, and abundance into a single model and estimate desired parameters

How will these parameters fit together?

- $Ntot_{terr,t} = N_{1,terr,t} + N_{2,terr,t} + N_{3,terr,t}$
- $N.immig_{terr,t}$ (latent) is included within each age class
- $N_{1:3,terr,1}$ ~ stable age distribution
- Beyond the first time step
  - $N_{1,terr,t} \sim f_{terr,t}$
  - $N_{age,terr,t} \sim survival_{age-1,t-1}$ and $N_{age-1,terr,t-1}$
- End of year pack count ~ detection probability and $Ntot_{terr,t}$
- $f_{terr,t}$ is number of 7-mo pups
  - $f_{terr,t}$ ~ pup.avg * yes/no (at least two reproductive individuals?)
- **Survival (phi)** is estimated from our survival model

MODEL STRUCTURE AND RESULTS ARE NOT FINAL

Importantly, we are now no longer working at the level of what we know as “pack.” Rather, we are working at the level of hypothetical pack territory

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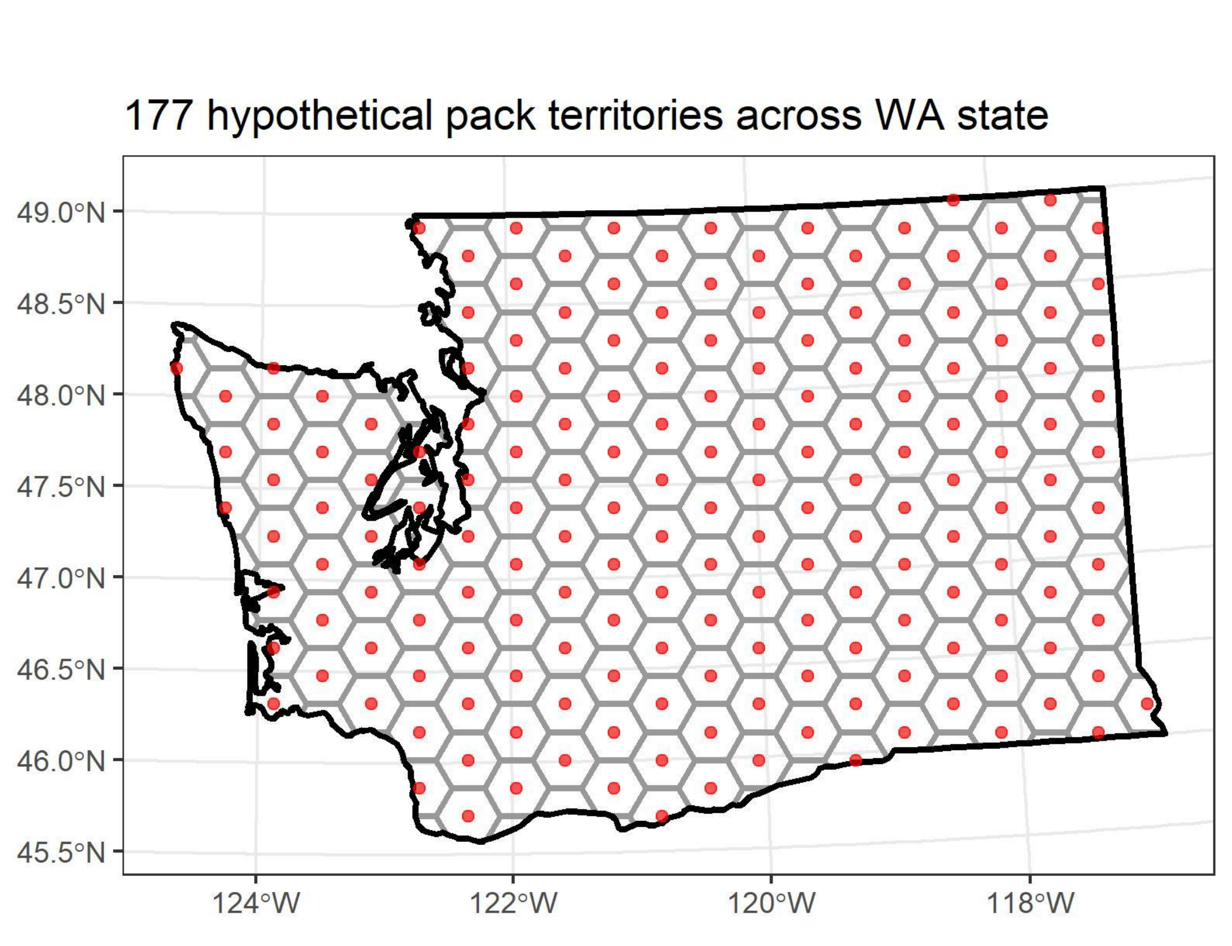
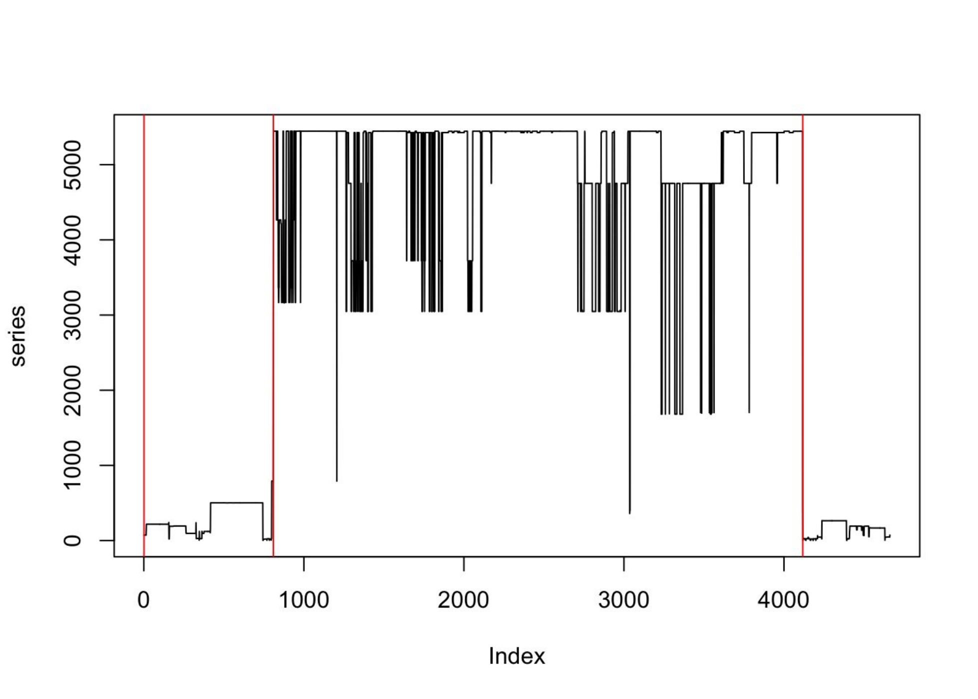


MODEL STRUCTURE AND RESULTS ARE NOT FINAL

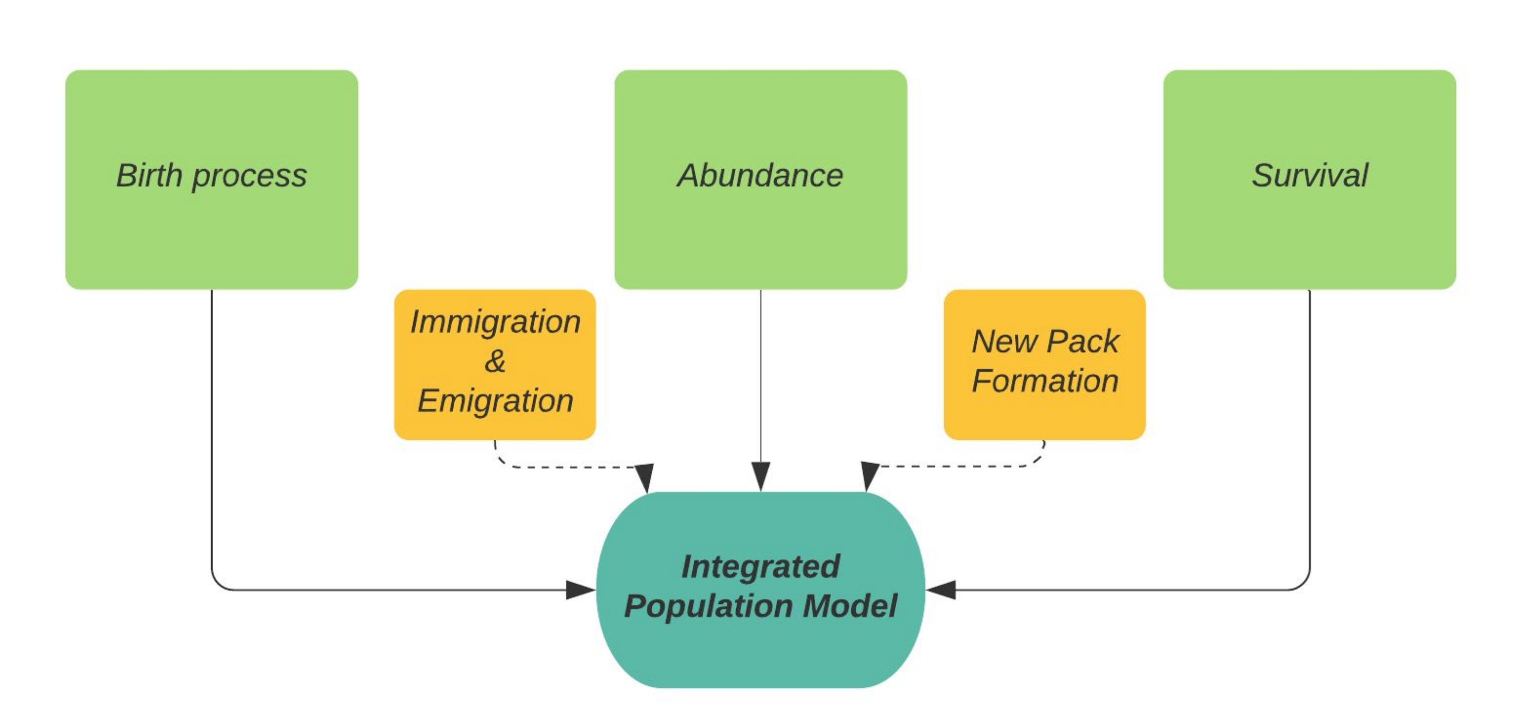
Size of hypothetical territories is ~1000 km^2

- Analysis of 81 pack-years of data
  - Home range analysis considered multiple wolves from same pack
  - Dispersal points removed via segmentation method using First Passage Time



MODEL STRUCTURE AND RESULTS ARE NOT FINAL

Now we've arrived at the spatial component



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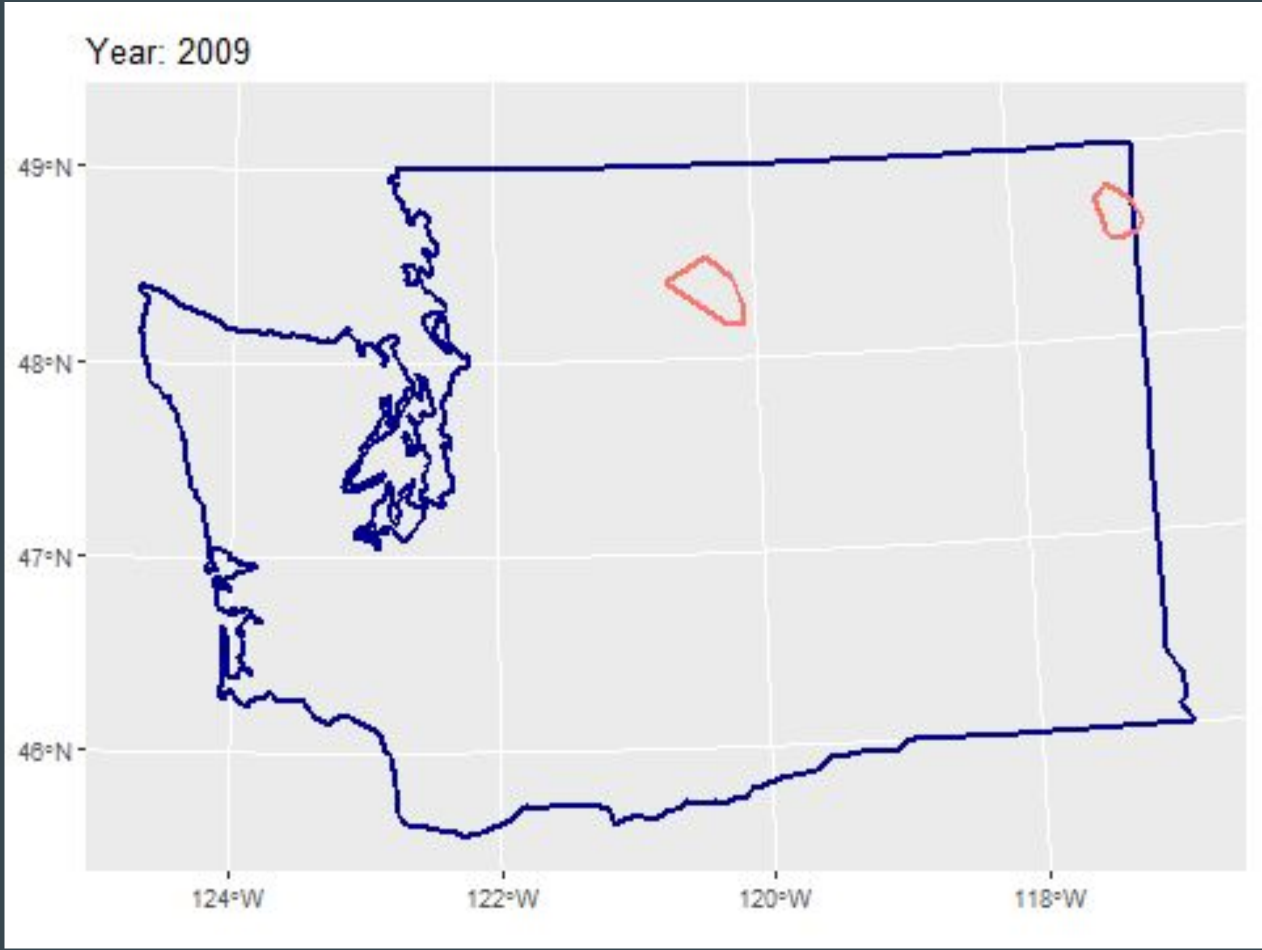


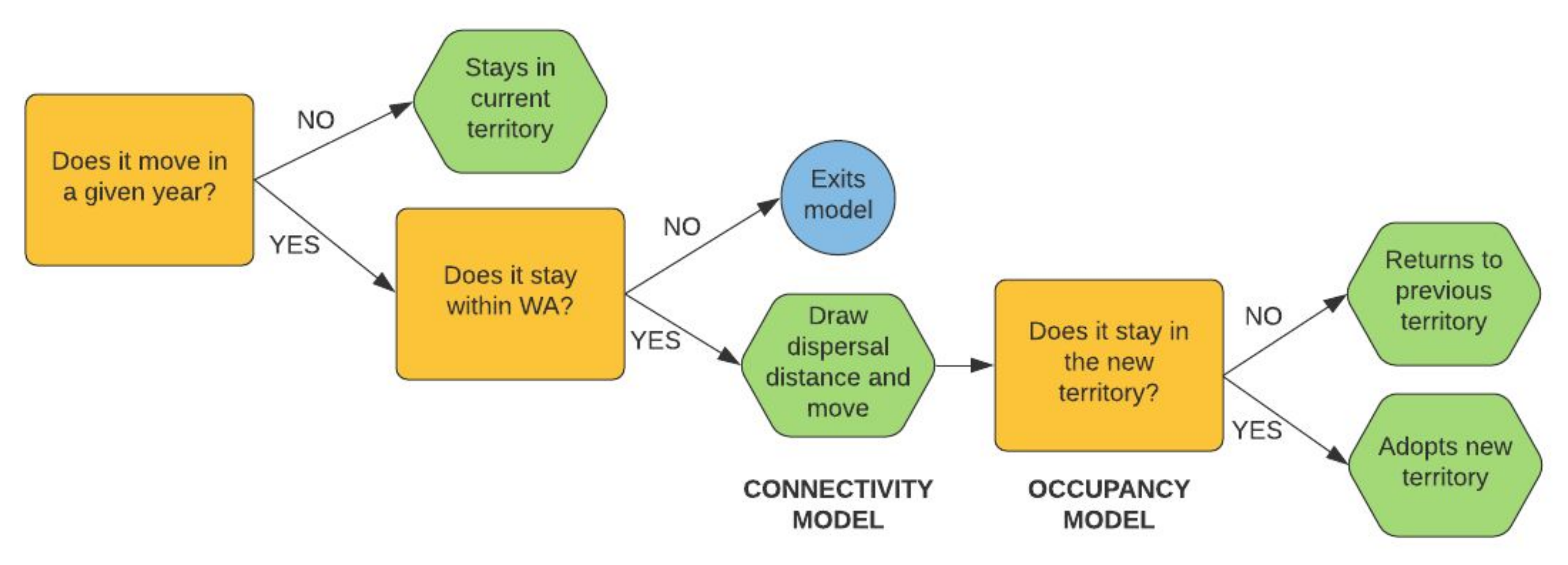
MODEL STRUCTURE AND RESULTS ARE NOT FINAL

We plan to decompose the emigration process into two parts:
(1) leaving the state, and
(2) dispersing to another territory within WA

MODEL STRUCTURE AND RESULTS ARE NOT FINAL

We plan to decompose the immigration process into two parts:
(1) coming from out of state (latent) and
(2) dispersing from another territory within WA

MODEL STRUCTURE AND RESULTS ARE NOT FINAL



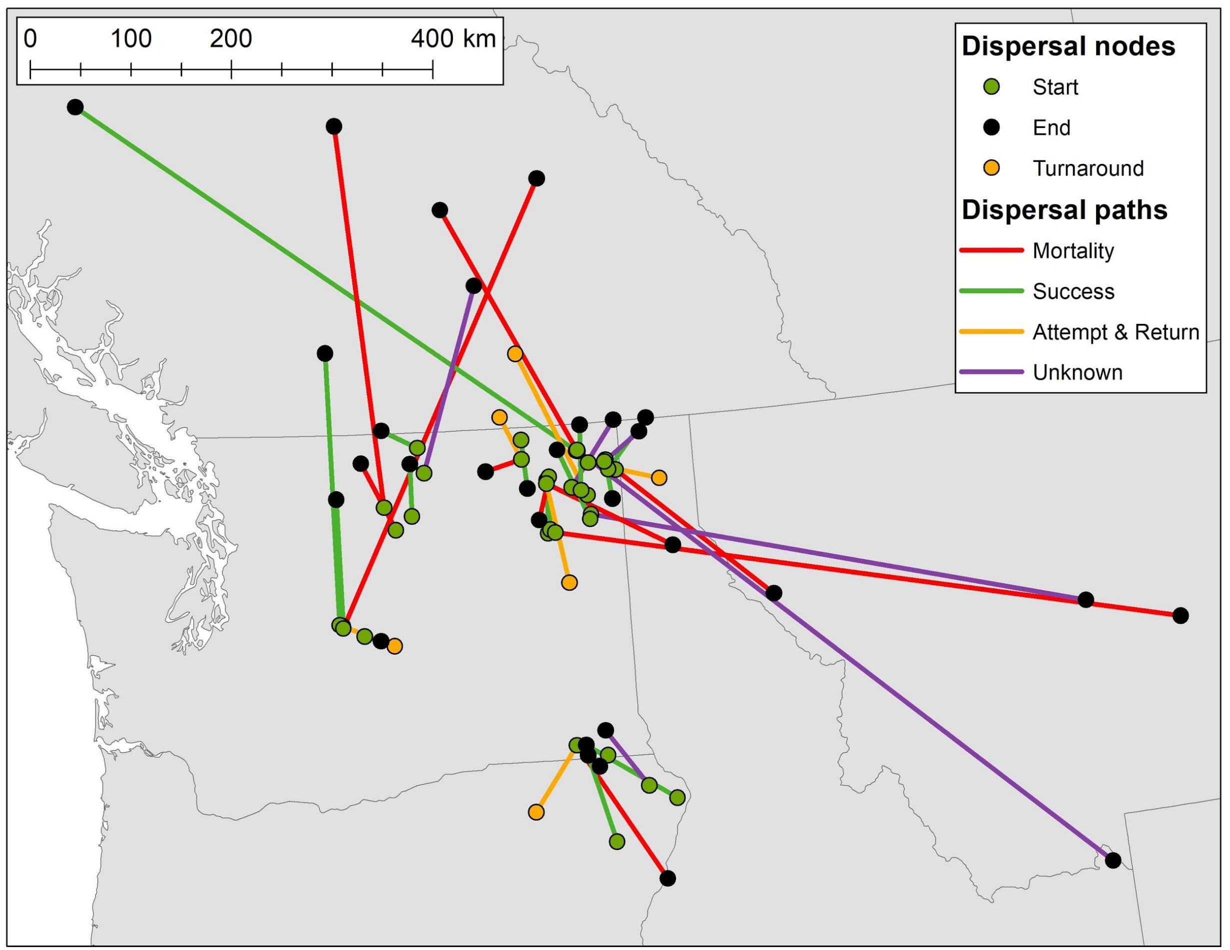
MODEL STRUCTURE AND RESULTS ARE NOT FINAL

In any given year, some animals will move based on two underlying rates

$e0 \sim \text{bin}(\text{prob}_{\text{leaving.state},}\ \#\ \text{wolf-months})$

$eS \sim \text{bin}(\text{prob}_{\text{moving.instate},}\ \#\ \text{wolf-months})$

MODEL STRUCTURE AND RESULTS ARE NOT FINAL



38 events

- 16 successes
- 10 mortalities before territory establishment
- 6 unknowns
- 6 turnarounds

MODEL STRUCTURE AND RESULTS ARE NOT FINAL

Those that move within the state will draw a dispersal distance

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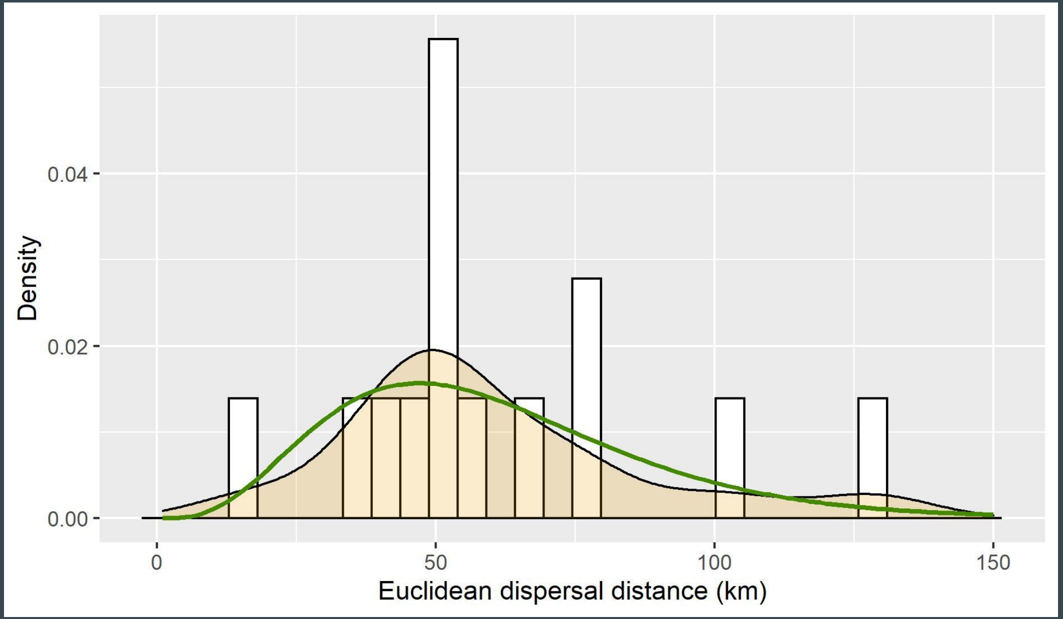
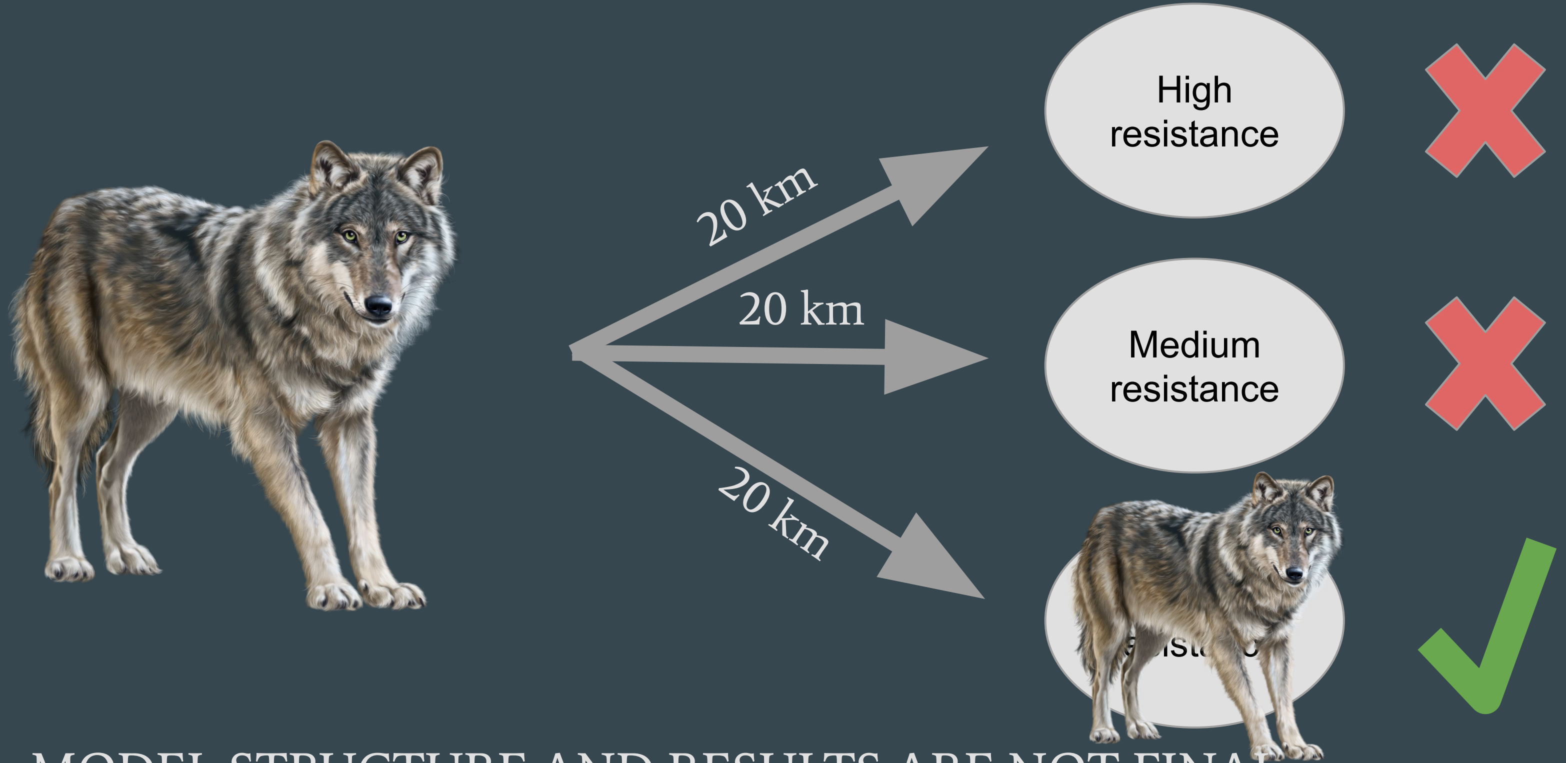


MODEL STRUCTURE AND RESULTS ARE NOT FINAL

And will move to the territory at that distance with lowest movement resistance



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Once there, does it stay or return to its former territory?

Probability of staying $\sim$ ψ

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The least cost path analysis was implemented in program UNICOR using a resistance surface

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This resistance surface was an inverted resource selection function at the second order

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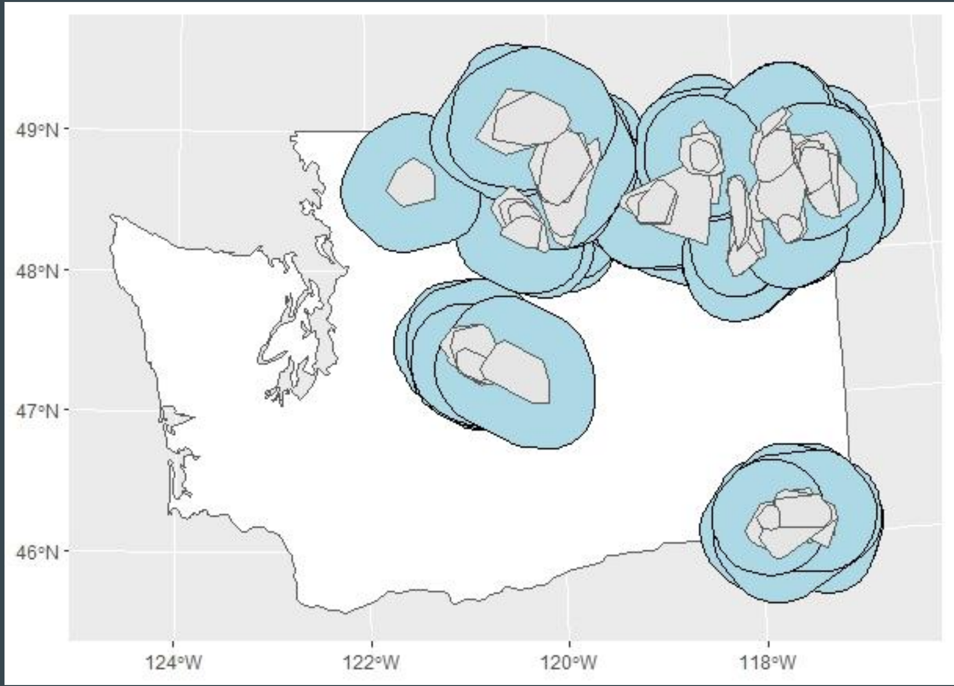
This analysis was at the level of where wolves were placing home ranges within the state

- We used telemetry data to establish home ranges, and sampled randomly within "used" and "available"
    - 20:1 A:U ratio
- "Available" == existing MCPs and average HR diameter around those existing MCPs



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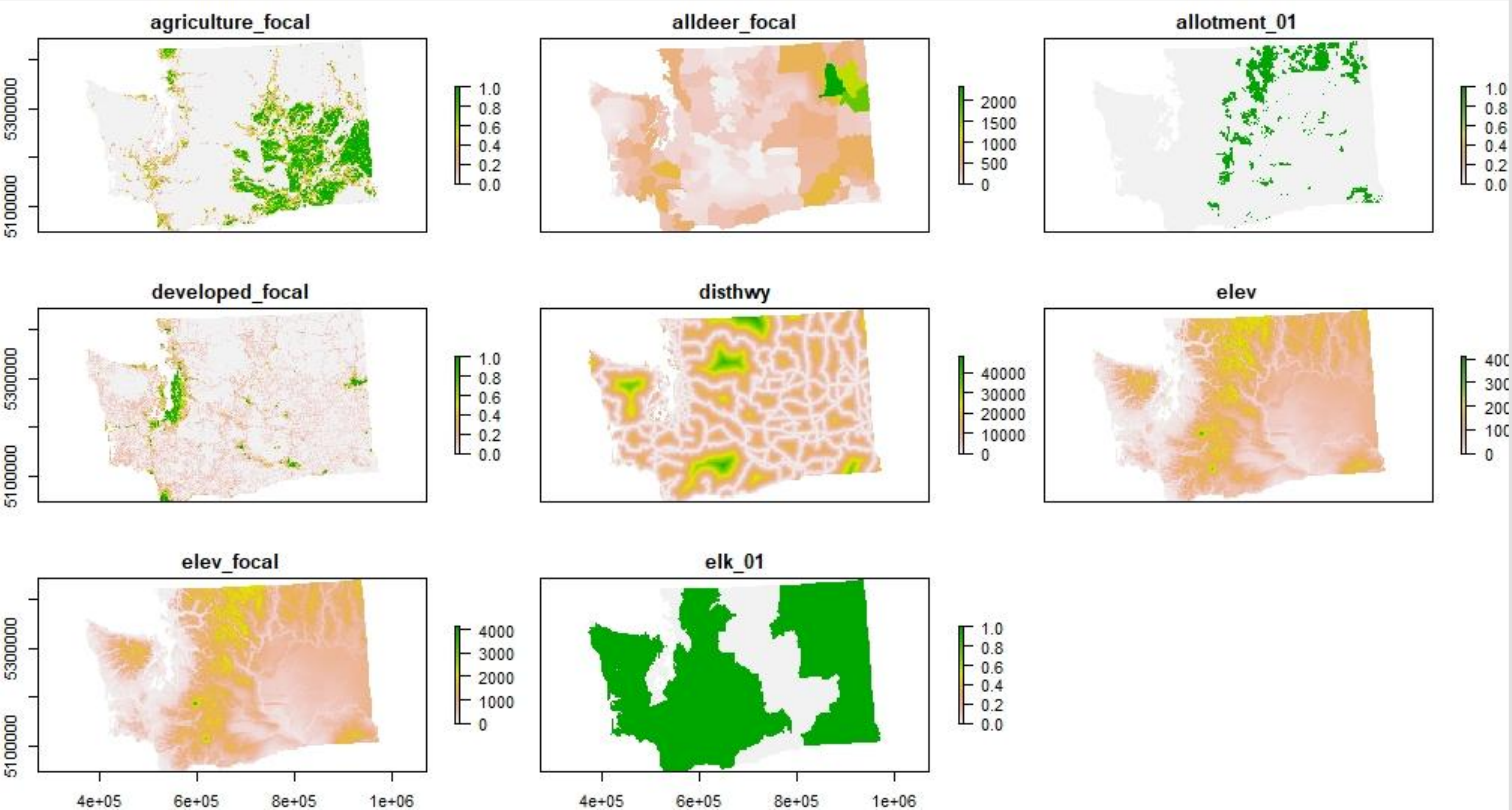

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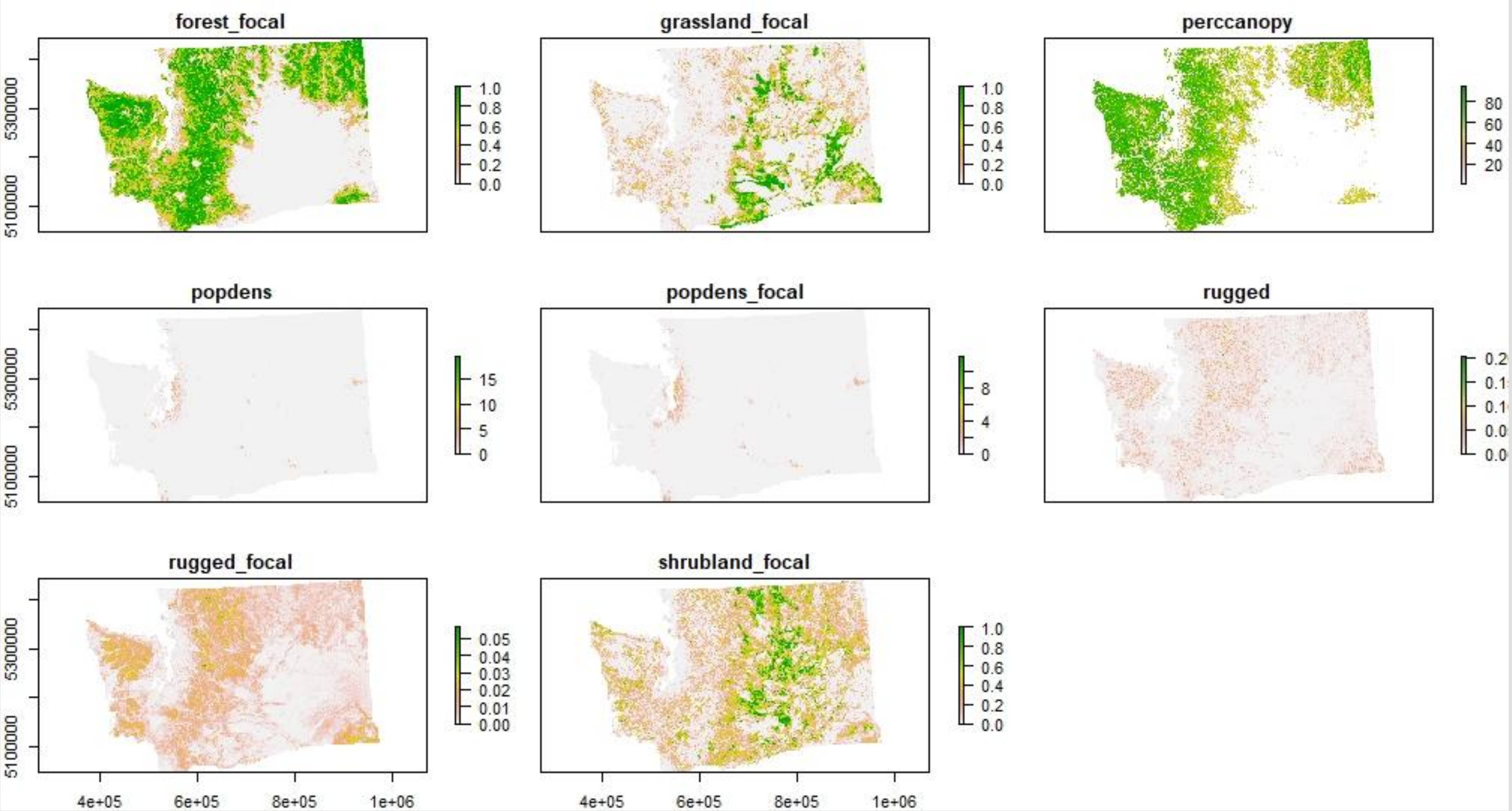

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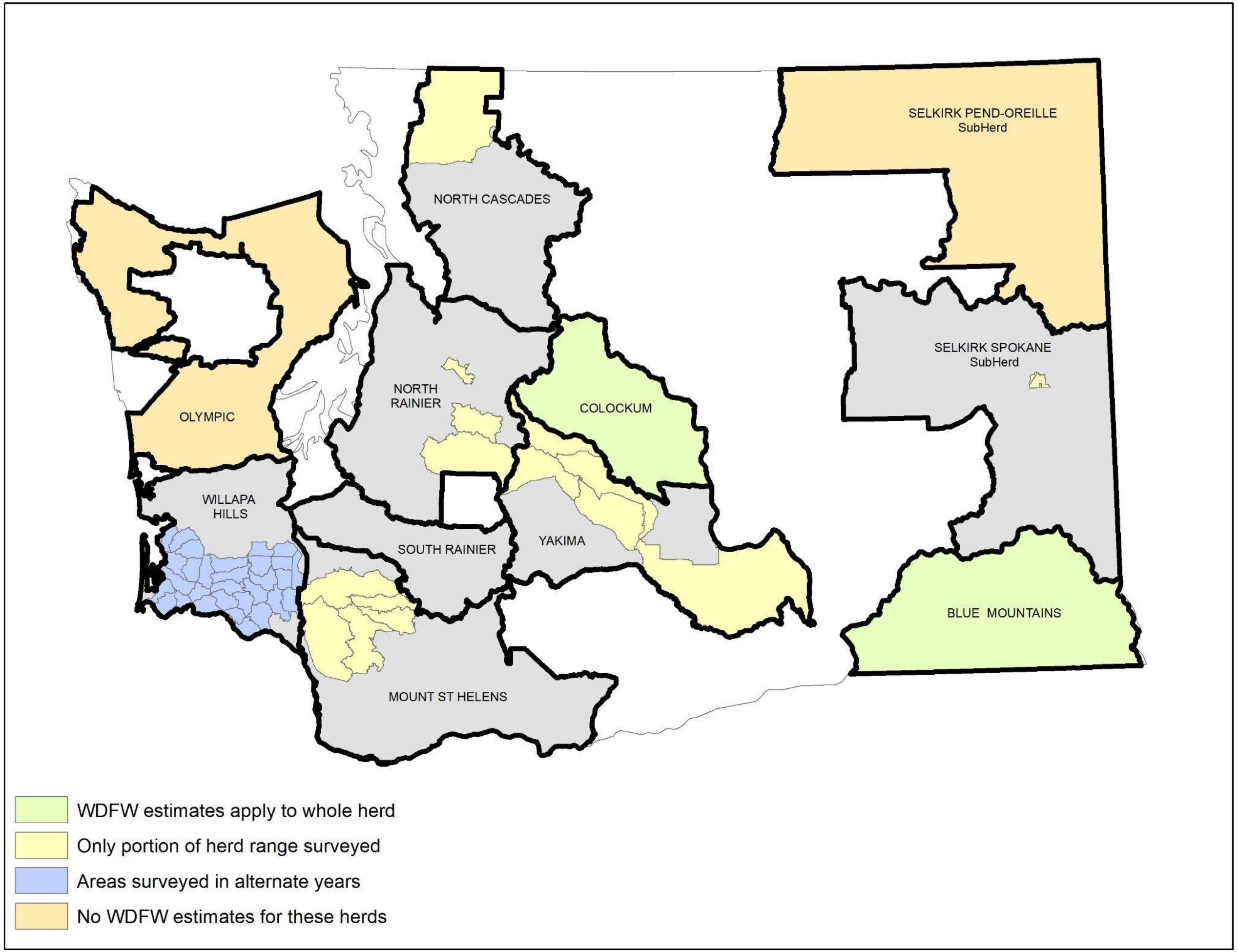

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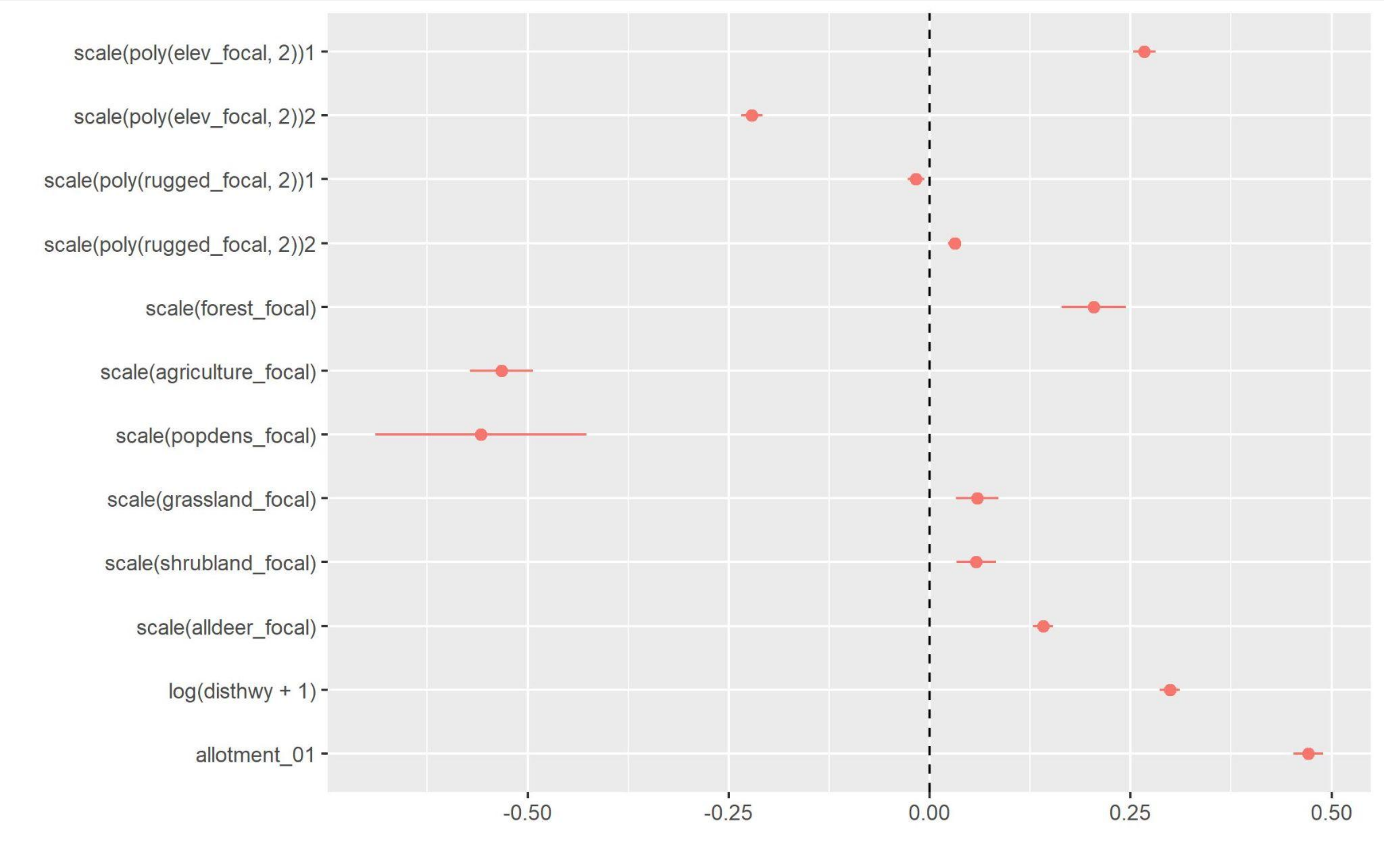

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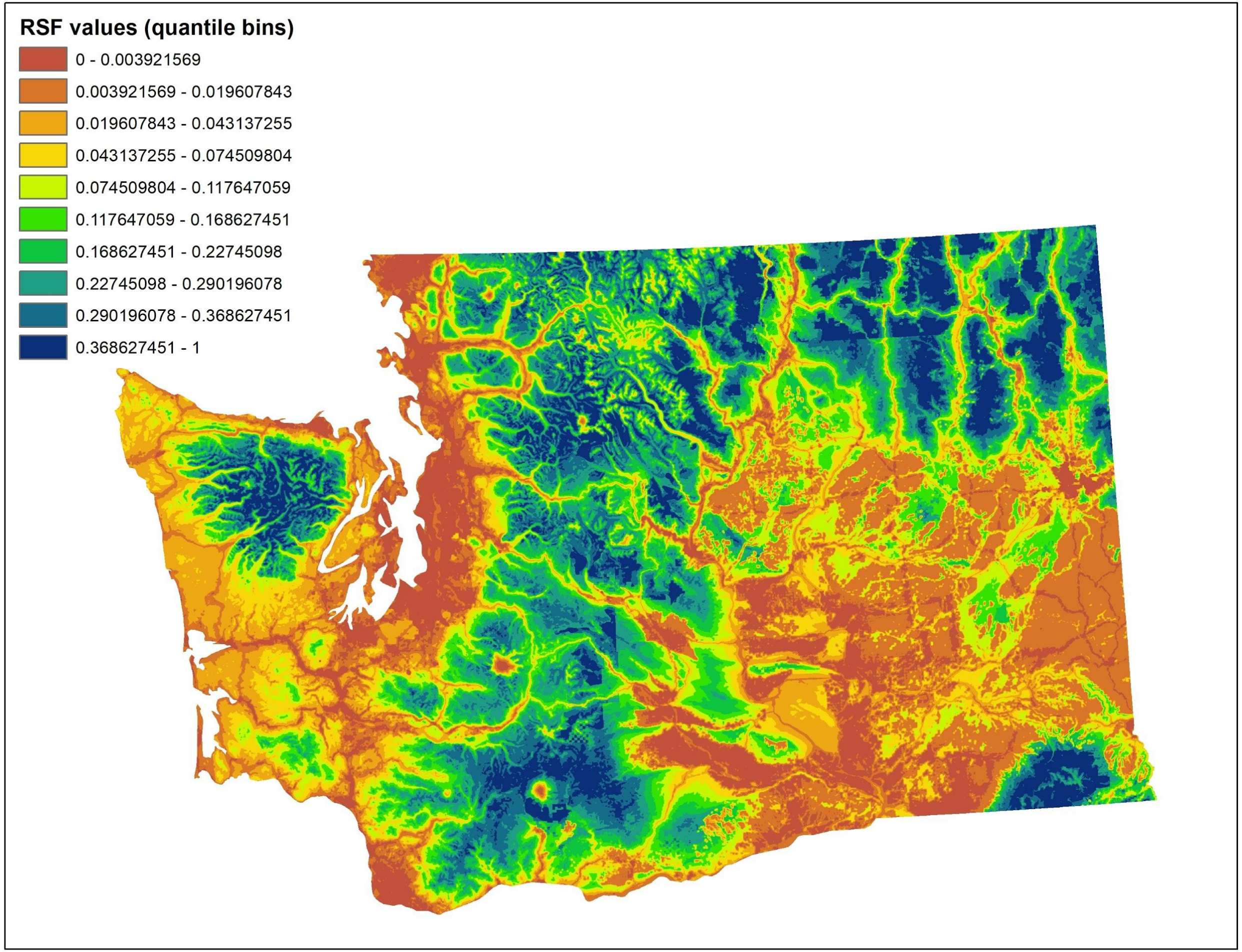


MODEL STRUCTURE AND RESULTS ARE NOT FINAL

UNICOR calculated the single shortest path from each territory centroid to all others

But once it’s there, does it stay or return? This is based on an occupancy analysis at the territory level

The data for this model came from randomly-placed camera traps across the state of Washington

Robert Long, Woodland Park Zoo

Robert Long

Sarah Bassing, UW & PPP

Sarah Bassing

Lisa Shipley, WSU

WSU

Dan Thornton, WSU

WSU

Jeff Manning, WSU

WSU

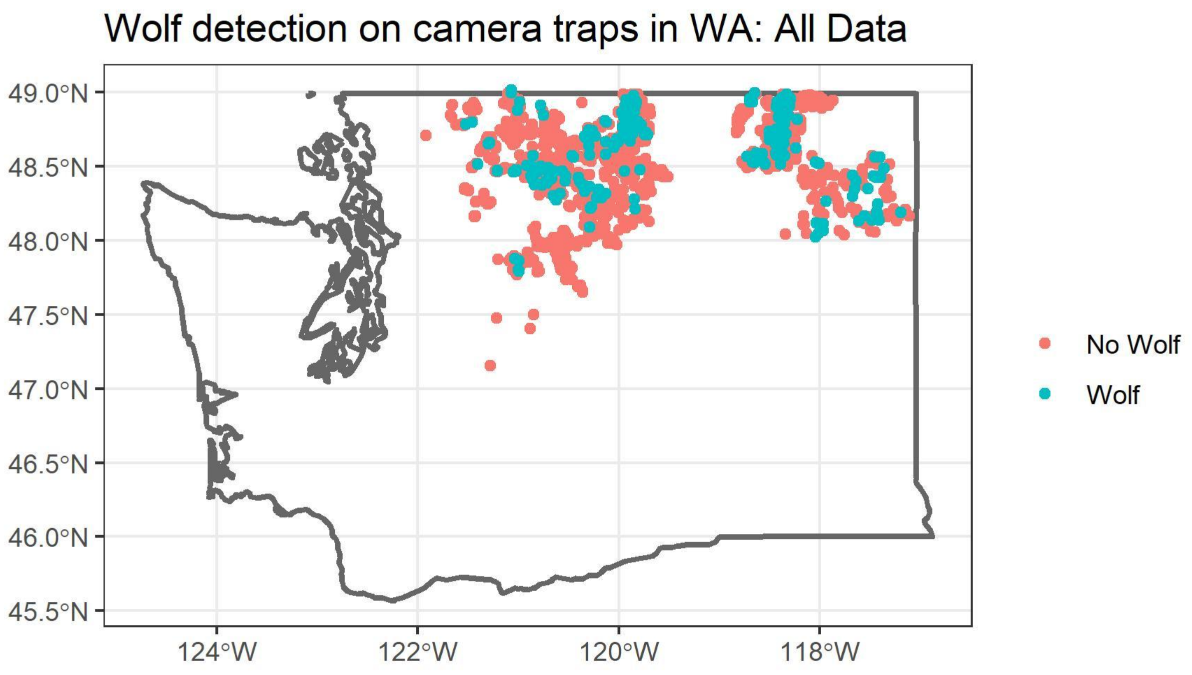
Jason Ransom, NPS

Jason Ransom

Of 1616 total cameras, 207 have a wolf record

2321 photos of wolves total

495 photos when separated by 30 mins



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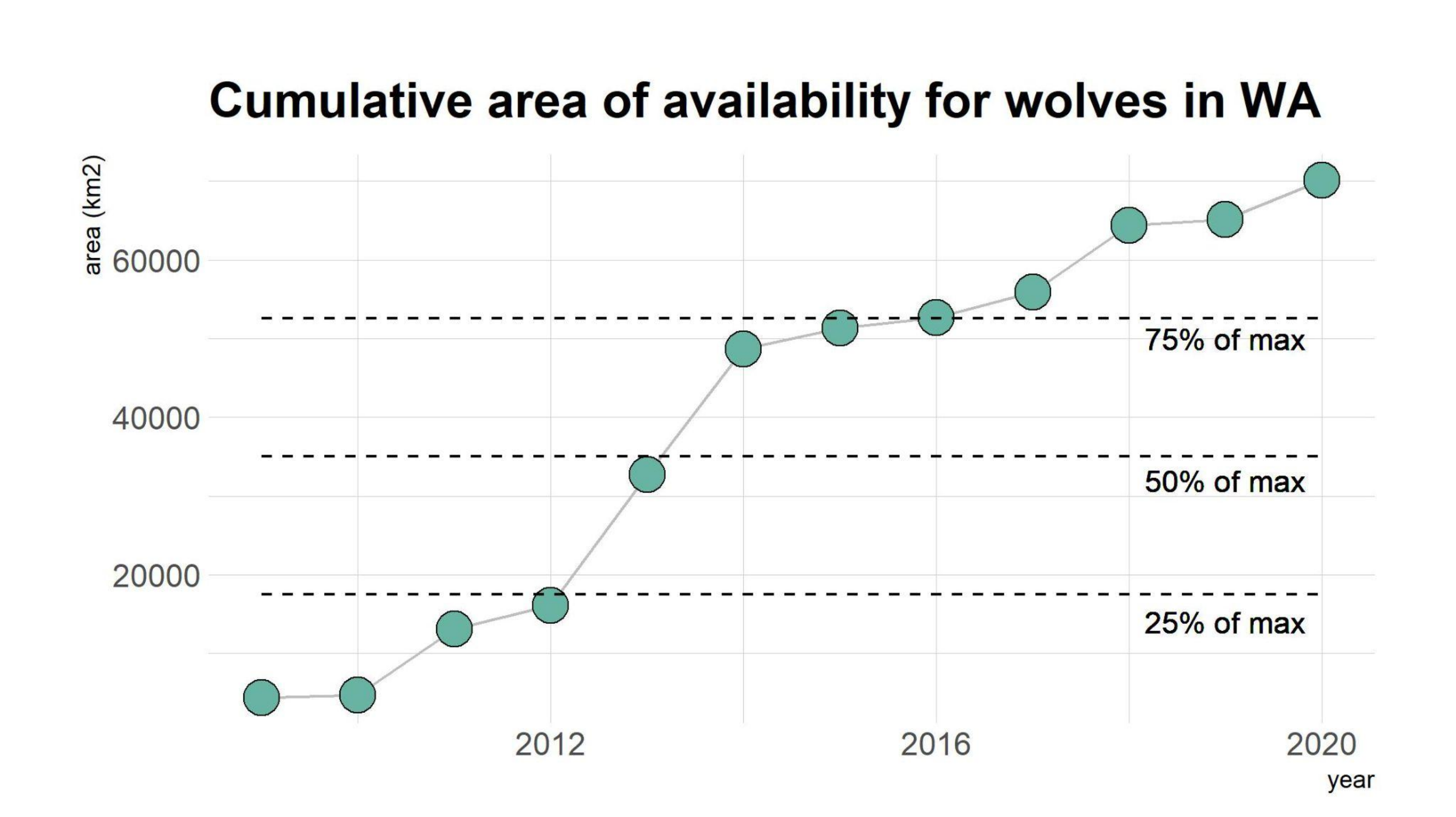


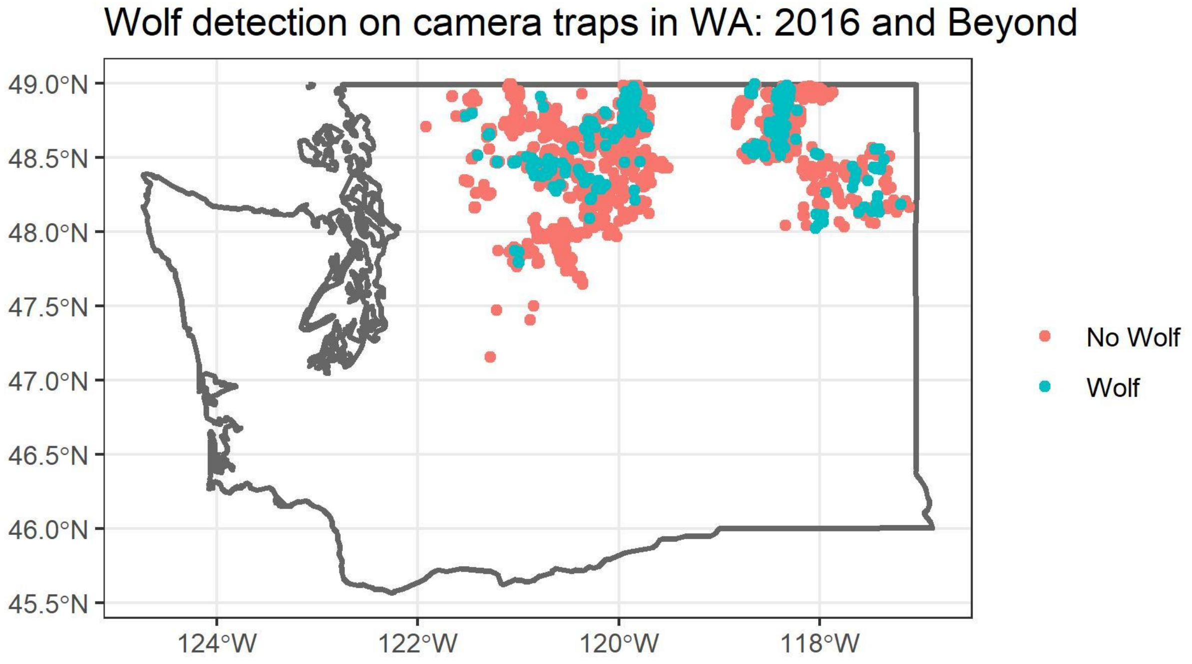
MODEL STRUCTURE AND RESULTS ARE NOT FINAL

When we reduce to cameras set up in 2016 and beyond...

1616 → 1383 cameras

207 → 197 cameras with wolf

495 → 485 photos separated by 30 mins



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In our occupancy model, whether a wolf was recorded at a camera trap was a function of detection and occupancy

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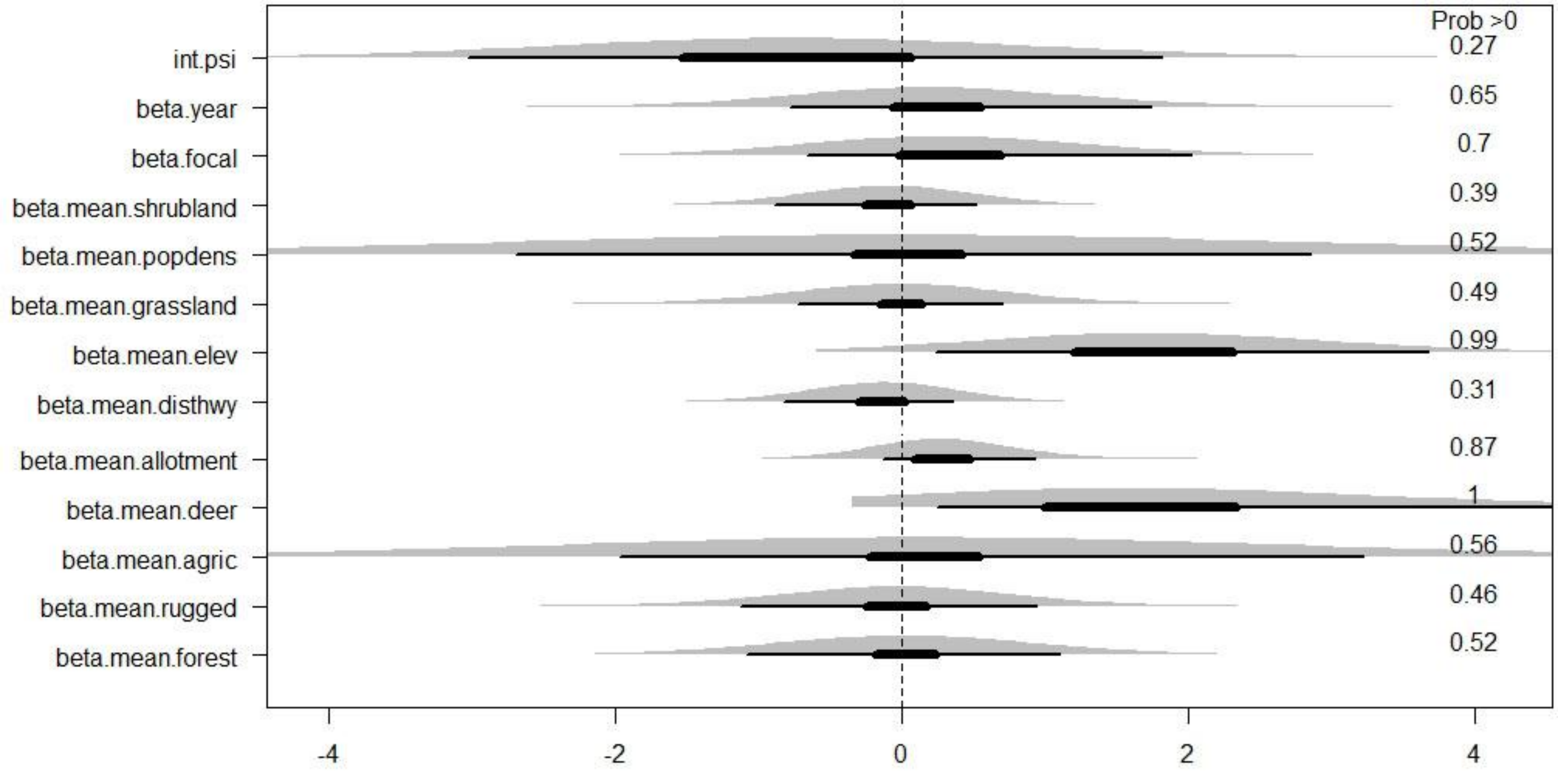

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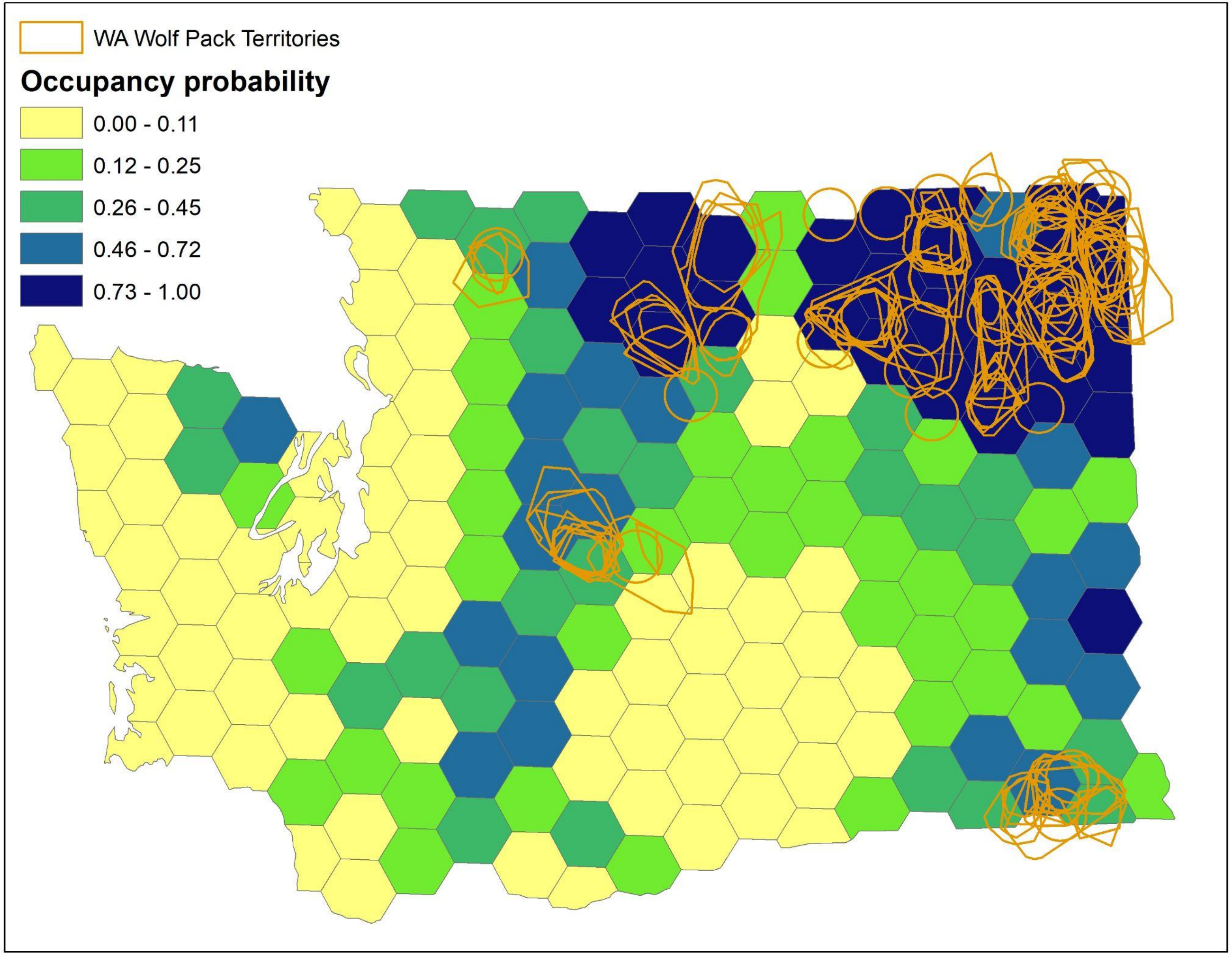

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Next steps: Part 1

- Finalize the non-spatial IPM components
    - The model is running, but we have to work out some small technical details
- Allow movement of individuals in/out of packs given dispersal rate, territory chosen, and whether it stays
- Predict to future time steps

WDFW

MODEL STRUCTURE AND RESULTS ARE NOT FINAL

Next steps: Part 2

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- Work with WDFW and Wolf Commission to test management scenarios
  - Agency removal is targetable component
  - Can increase or decrease survival, immigration, fecundity, etc.
- Use model predictions to assess wolf population status

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Thank you. We welcome your questions.