Present and future population dynamics of grey wolves in Washington State

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Members of the modeling team

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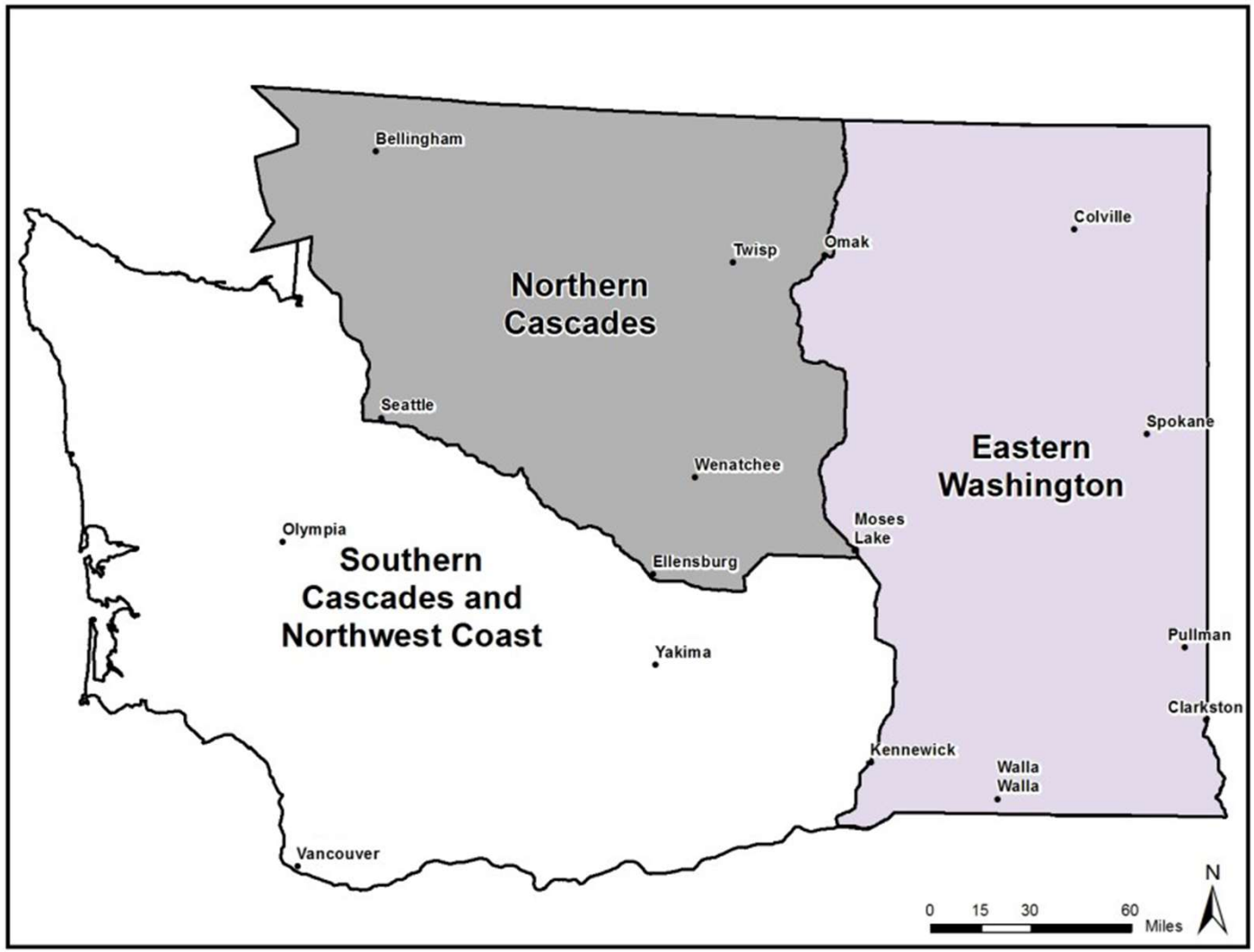
- Ben Maletzke
  - WDFW Wolf Specialist
- Sarah Converse
  - Unit Leader, USGS Washington Cooperative Fish and Wildlife Research Unit
  - Associate Professor, UW
- Beth Gardner
  - Associate Professor, UW

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

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


Bellingham
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Seattle
Spokane
Eastern
Washington
Wenatchee
Moses
Lake
Olympia
Southern
Cascades and
Northwest Coast
Ellensburg
Pullman
Yakima
Clarkston
Kennewick
Walla
Walla
Vancouver
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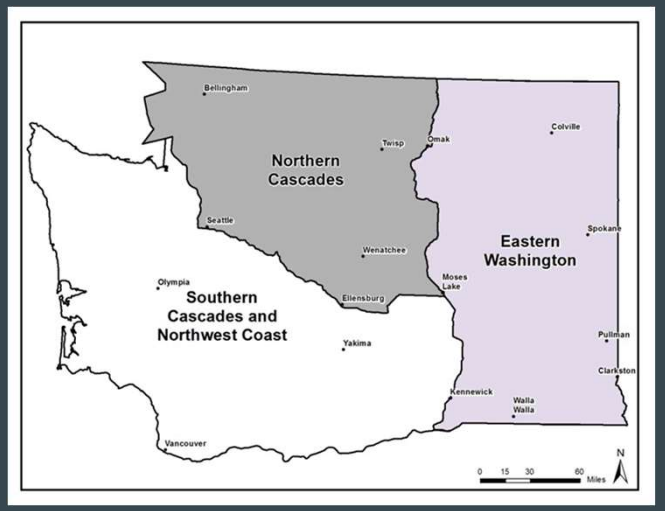
Miles

WDFW

Recovery goals from 2011 plan (Wiles et al. 2011)

- Delisting: 4+ breeding pairs (BPs) in each Recovery Region (RR) & 3 additional BPs anywhere in WA for 3 consecutive years
  - Alternative: 4+ BPs/RR & 6 additional BPs anywhere in WA *for a single year*
- Threatened: 2 BPs/RR for 3 consecutive years
- Sensitive: 4 BPs/RR for 3 consecutive years



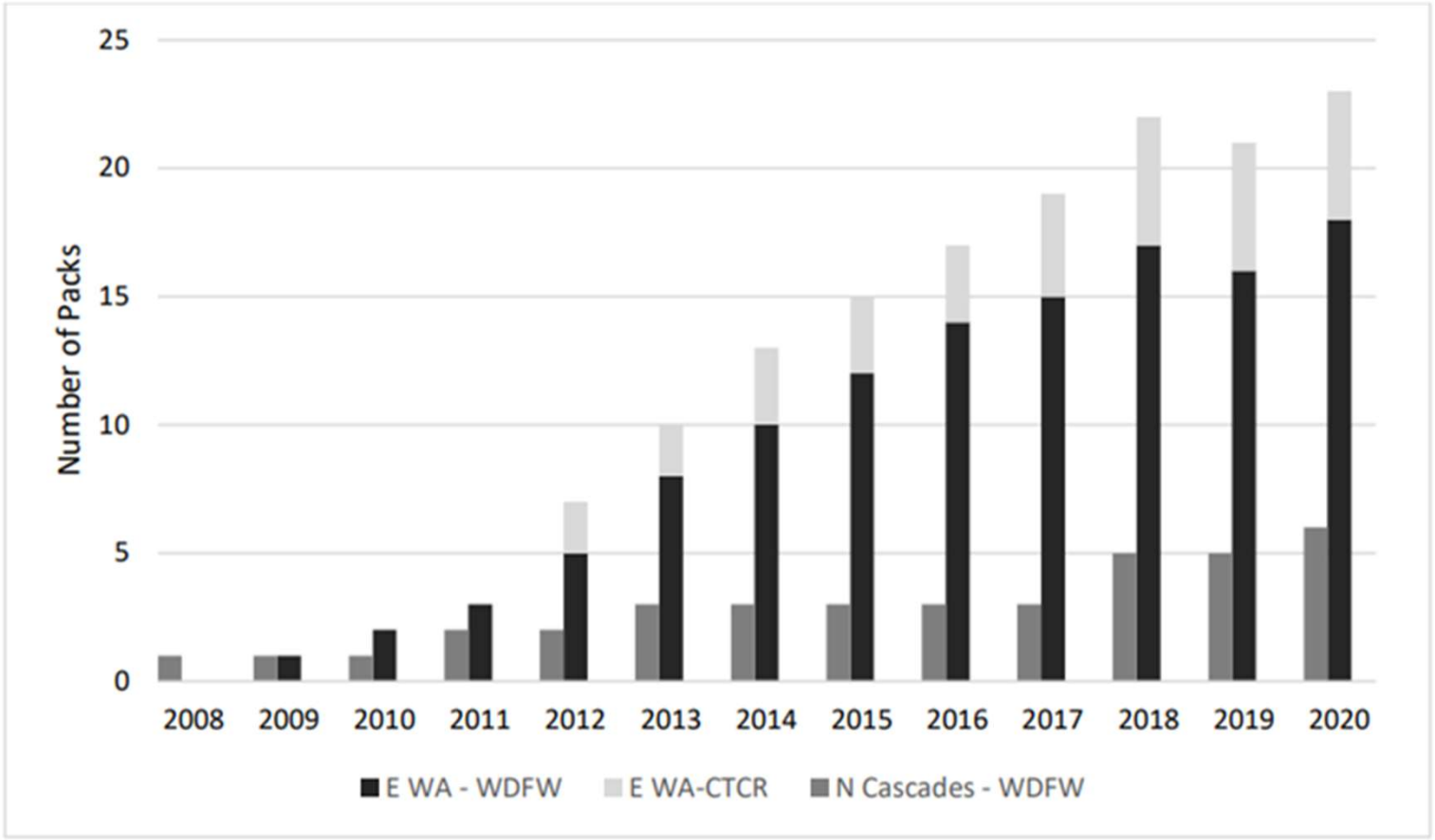


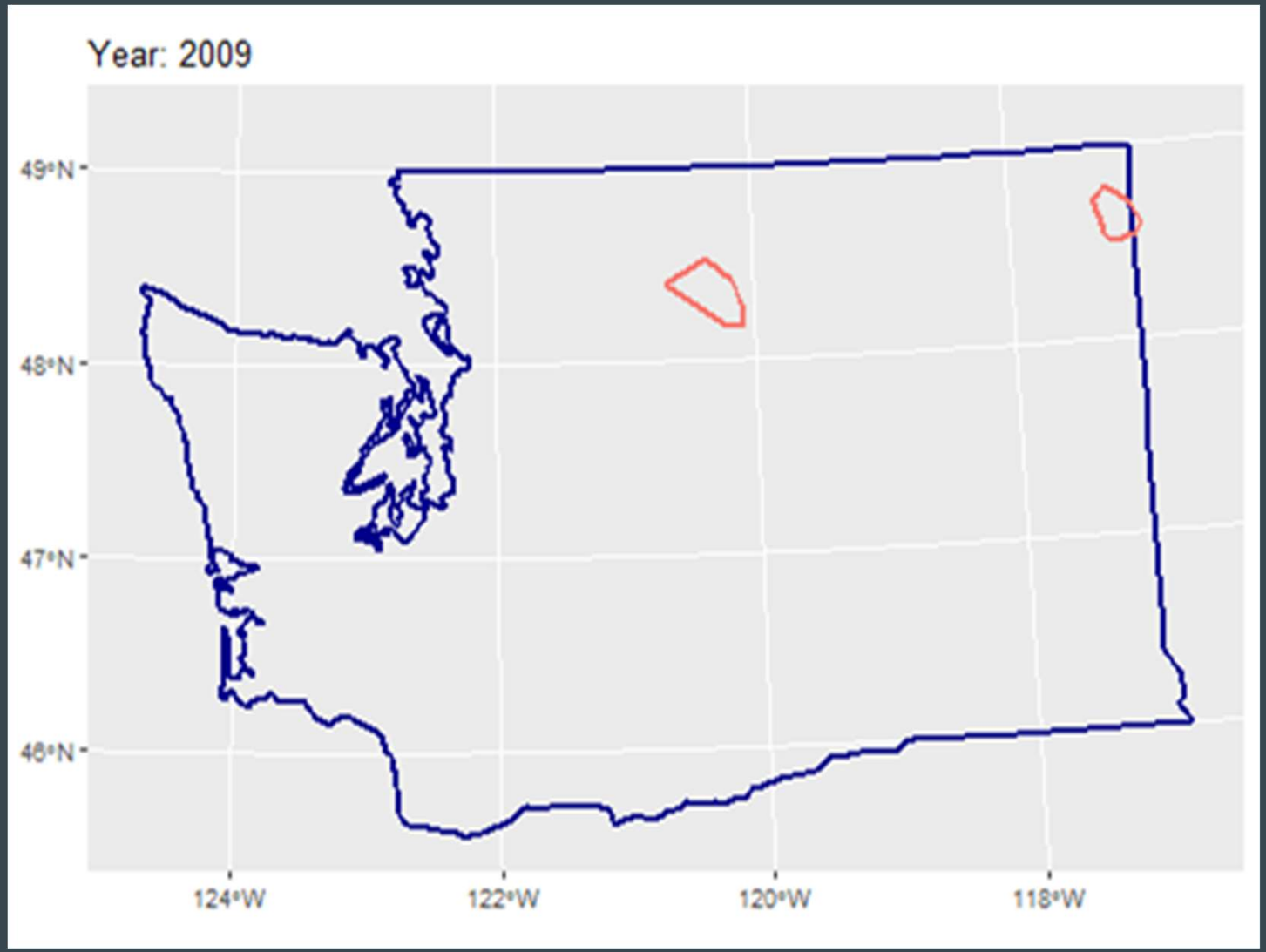
Figure 4. Minimum known number of packs by recovery region in Washington, 2008 – 2020. Wolf packs counted by Washington Department of Fish and Wildlife (WDFW), the Spokane Tribe, and Confederated Tribes of the Colville Reservation (CTCR) are displayed separately. There are no known packs in the Southern Cascades and Northwest Coast recovery region.

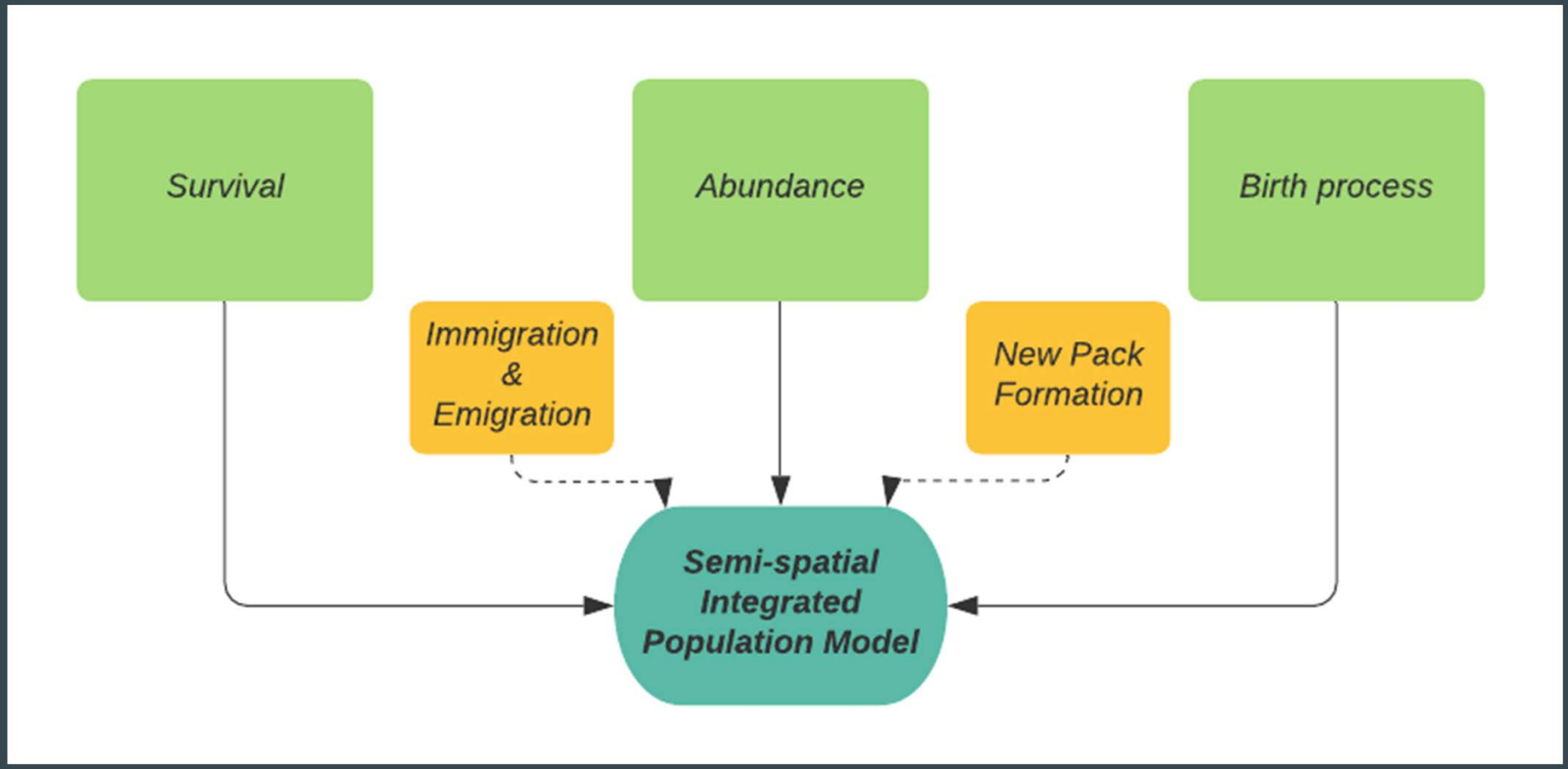
WDFW 2020

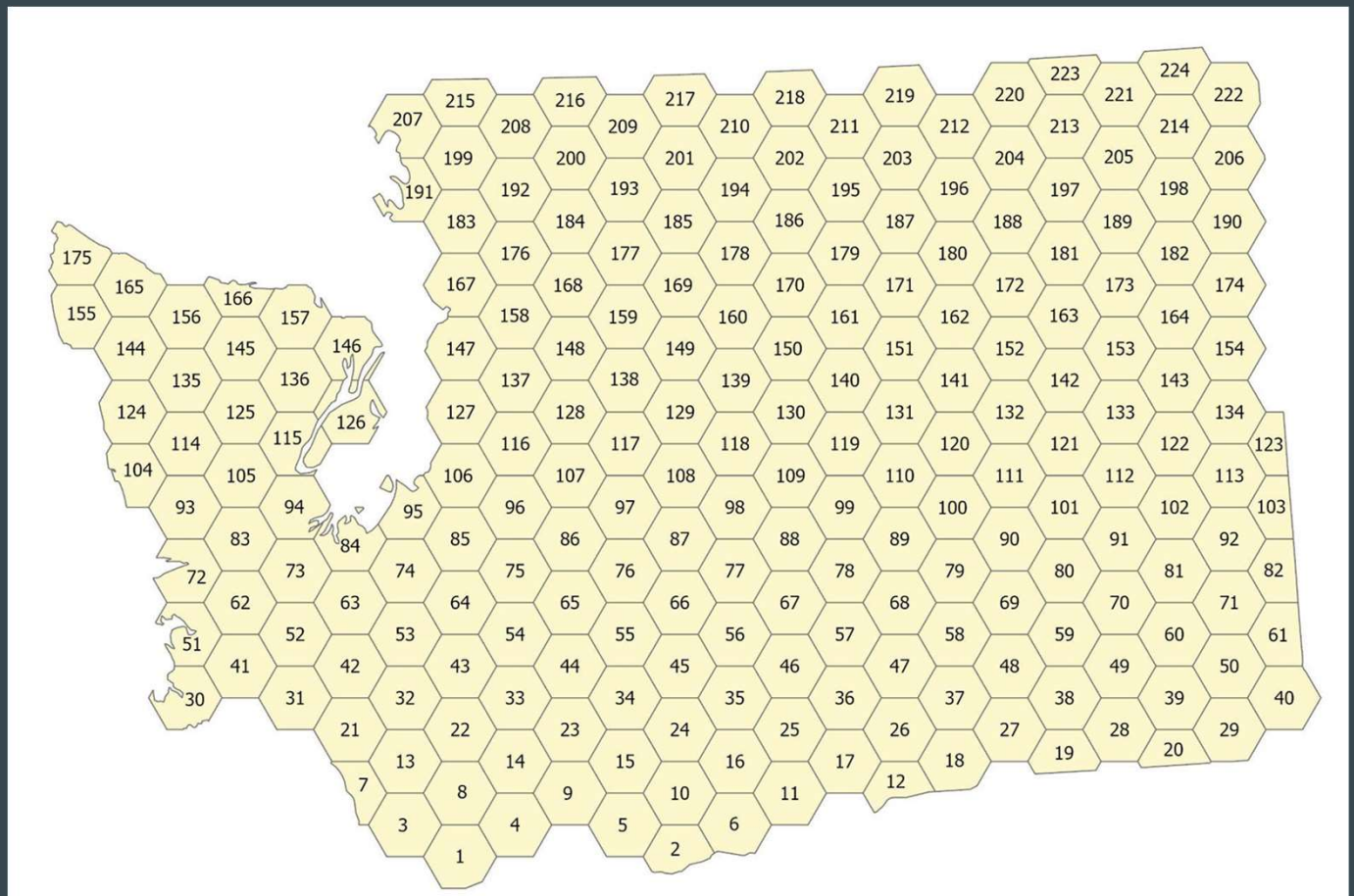
What were our project goals?

- Estimate demographic rates for wolves in Washington
  - Connect them to a spatial, territory-level colonization process
- Develop simulation scenarios for wolf management strategies
- Assess biological status at present and future time points

Sarah Bassing


Year: 2009
49°N
48°N
47°N
46°N
124°W
122°W
120°W
118°W


Survival
Abundance
Birth process
Immigration & Emigration
New Pack Formation
Semi-spatial Integrated Population Model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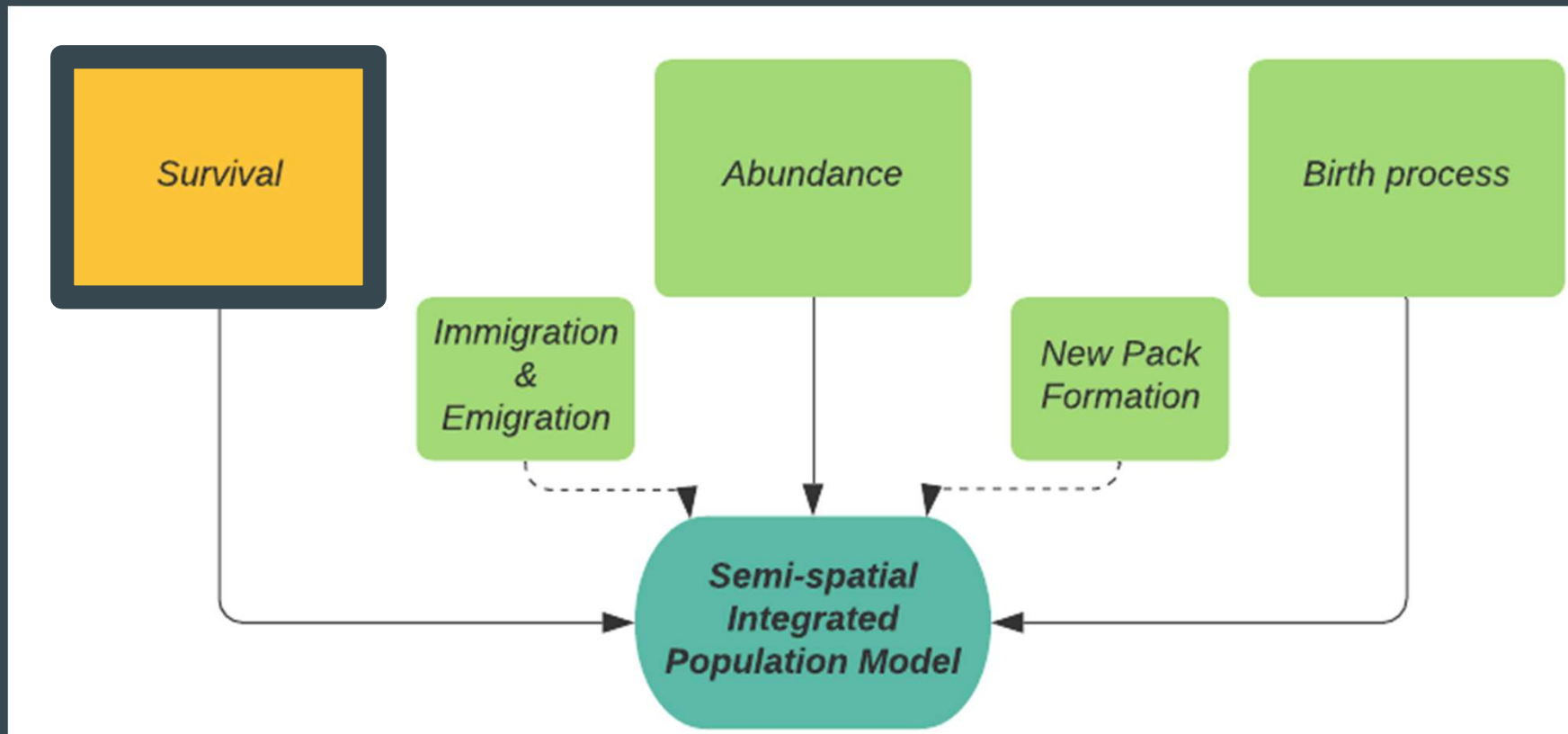
What data did we use in our model?


Survival
Abundance
Birth process
Immigration & Emigration
New Pack Formation
Semi-spatial Integrated Population Model

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

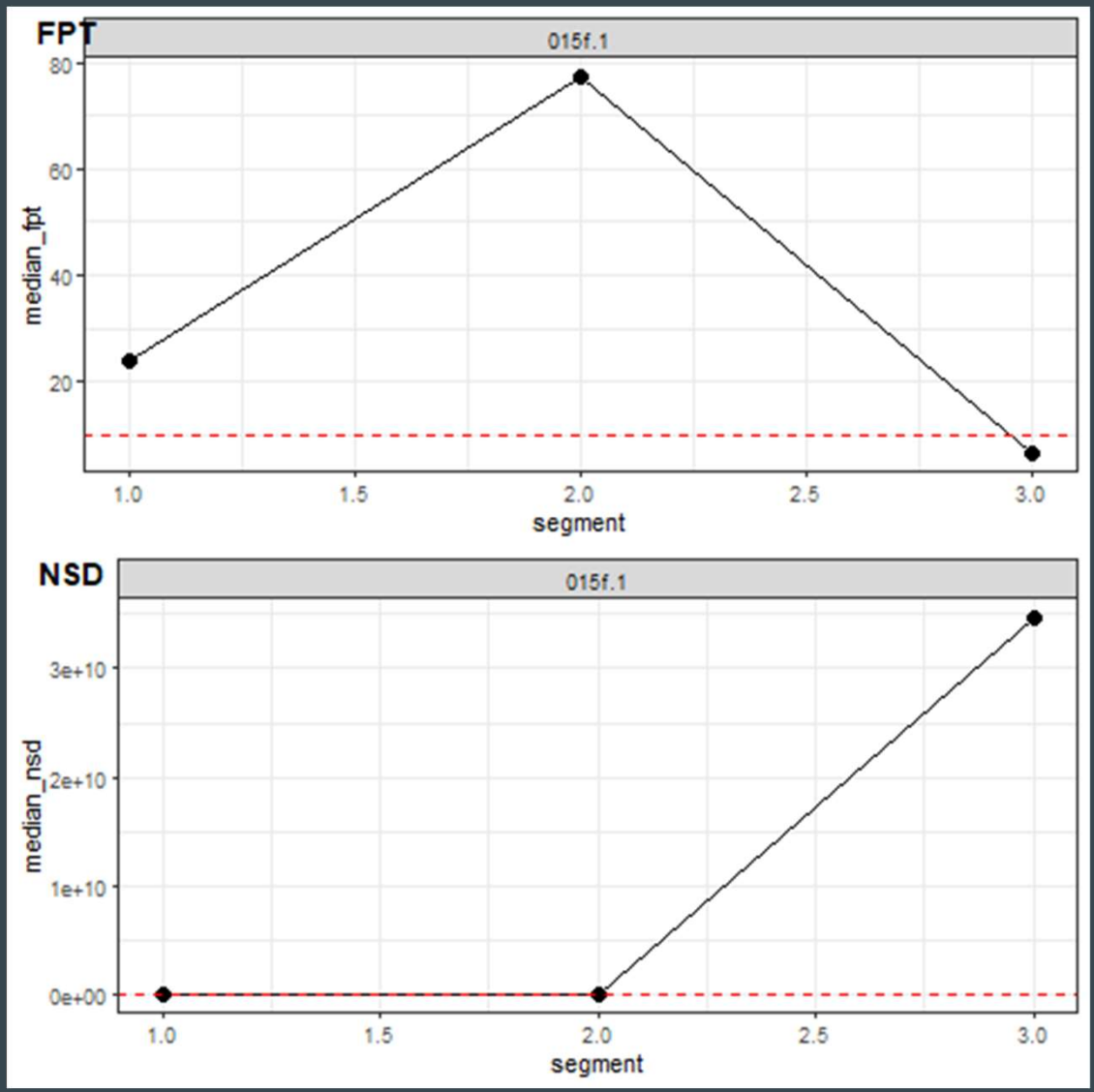
WDFW

Survival model states

- Our survival model has four states, and wolves can transition between these states

  1 = alive, not in movement state, in WA
  2 = alive, in movement state, in WA
  3 = alive, in movement state, out of WA
  4 = dead

15f


FPT
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1e+10
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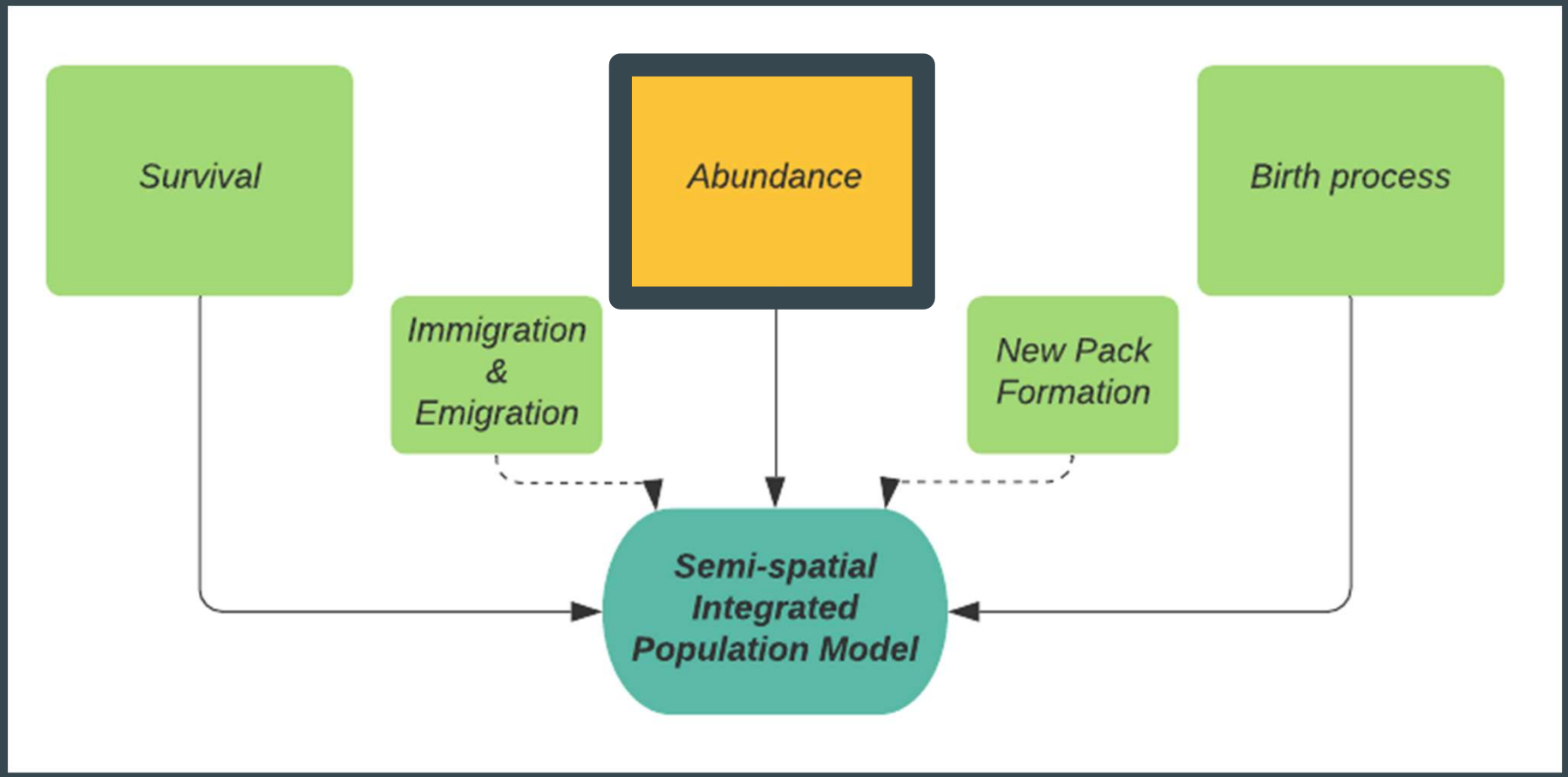
segment

As we had insufficient information on the probability of wolves stopping movement, we combined Washington data with data from the scientific literature to estimate this parameter


Survival
Abundance
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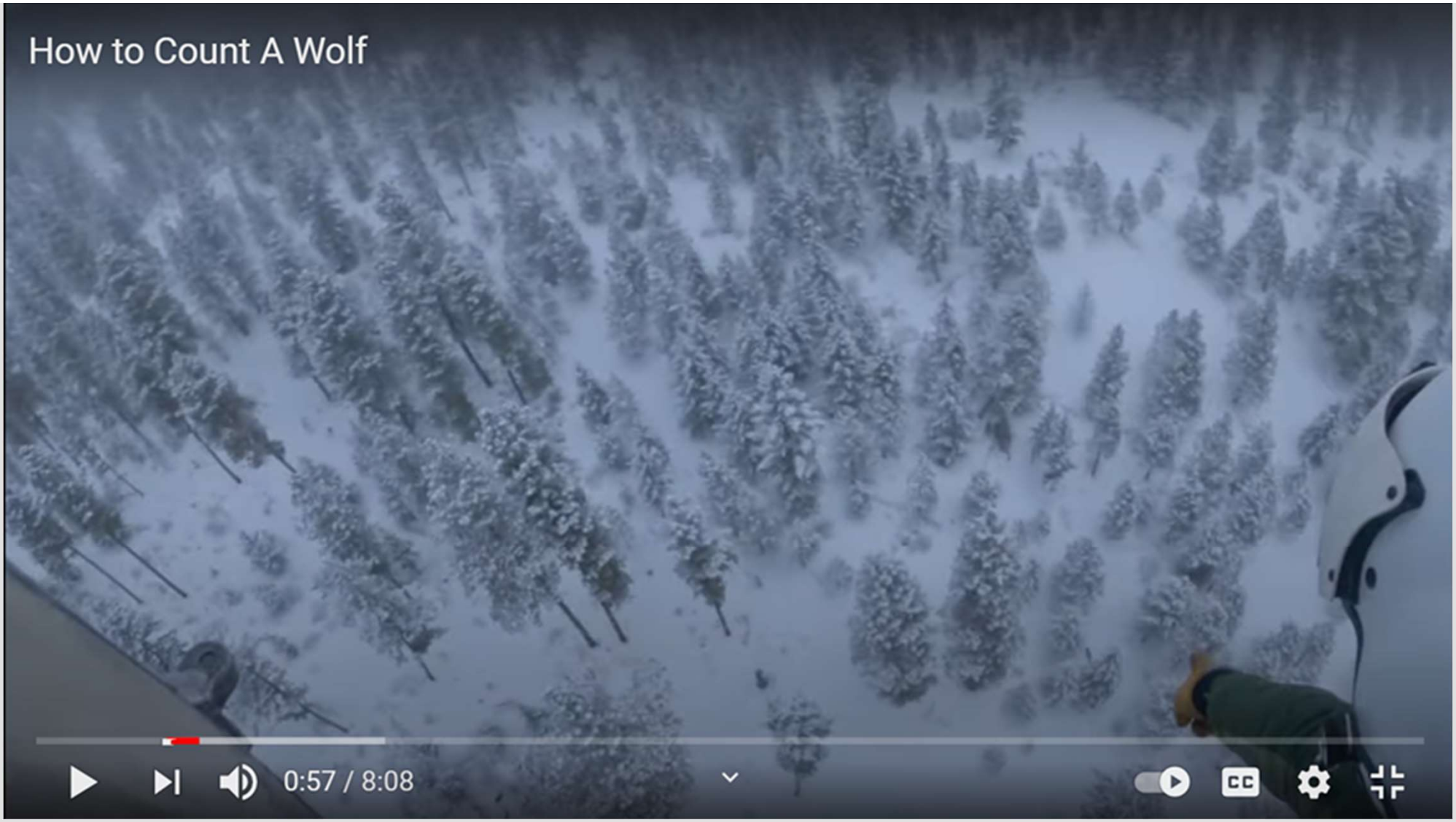
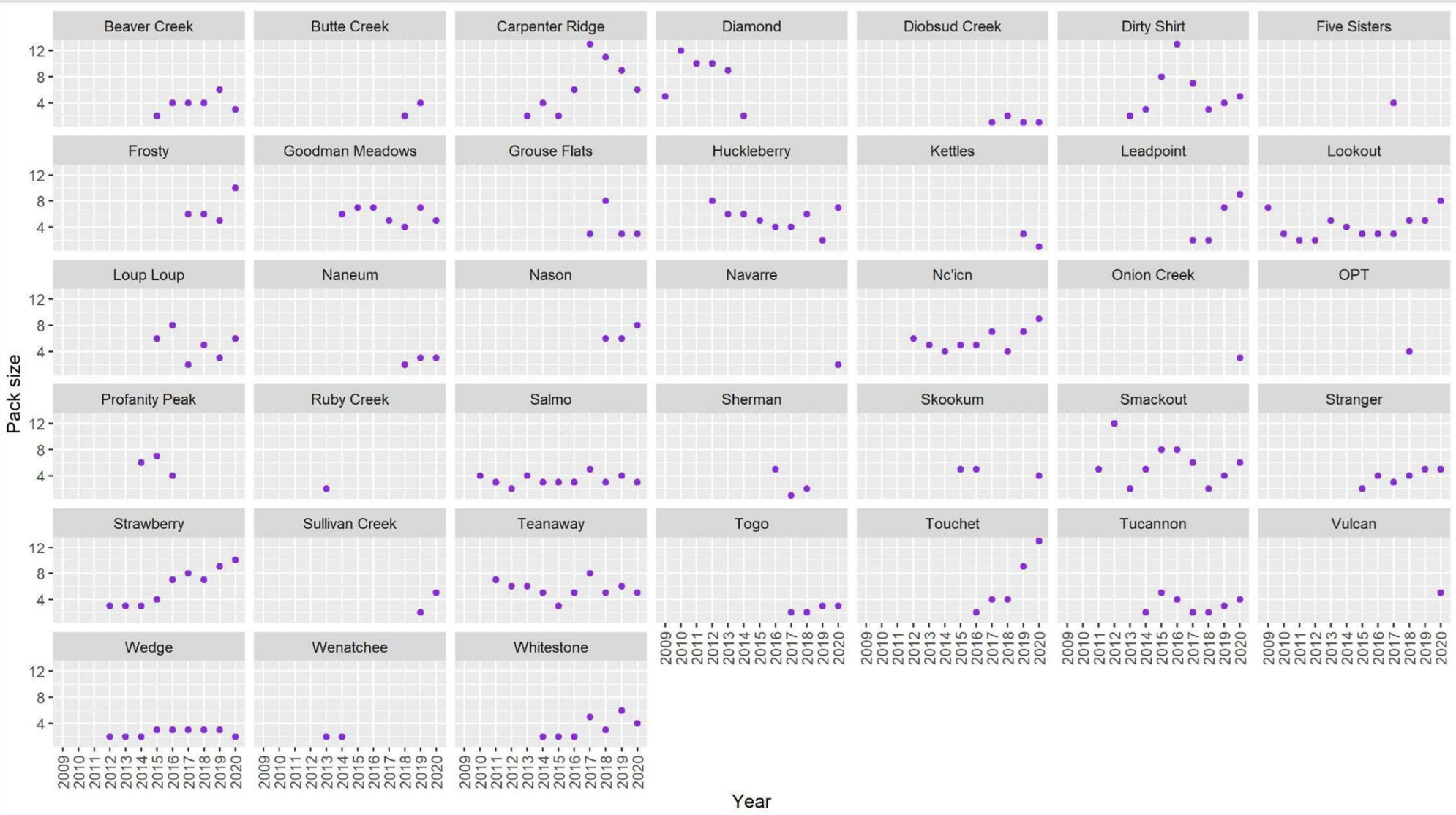
For abundance, we are using data from winter aerial surveys by WDFW (2009-2020)



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


Beaver Creek
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Carpenter Ridge
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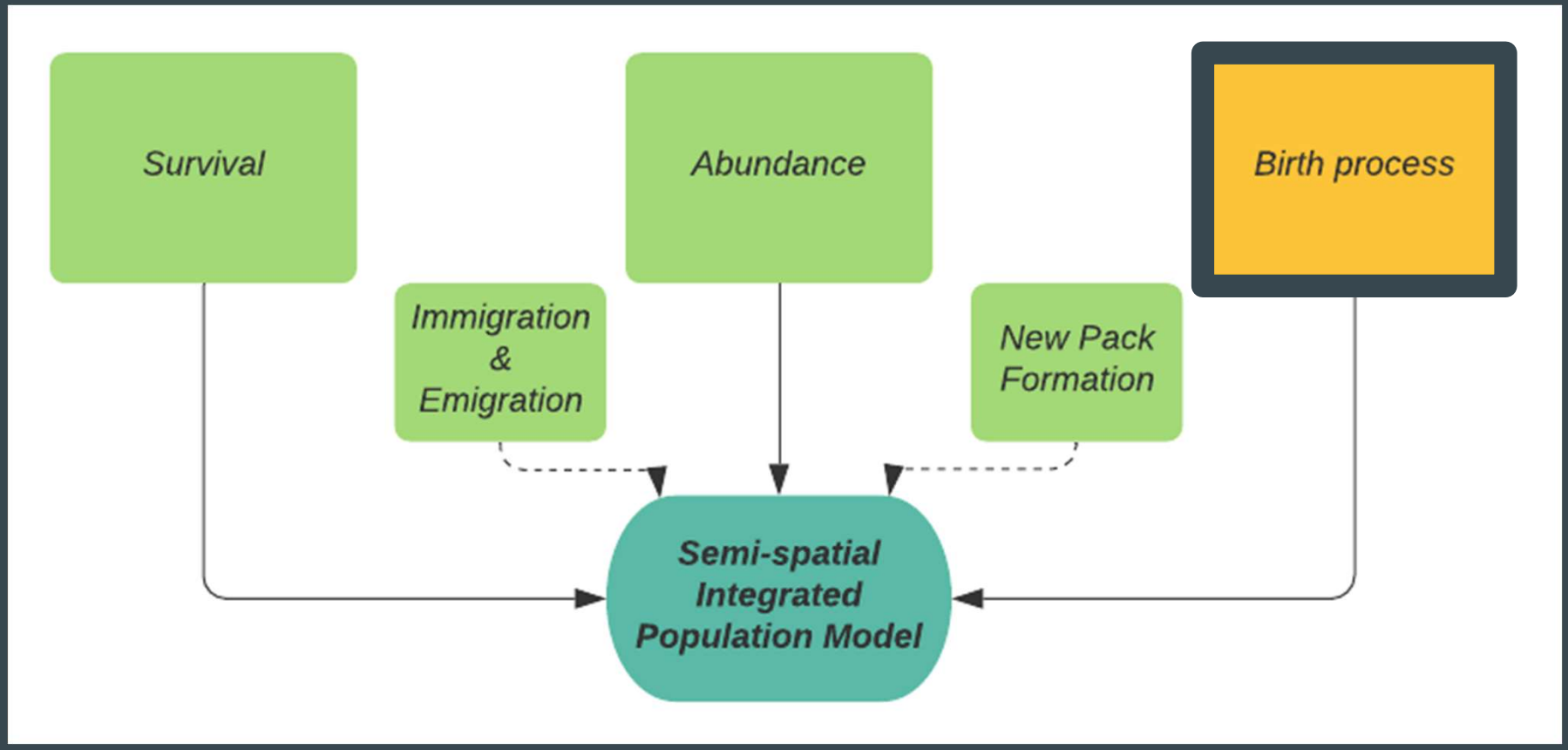
Dirty Shirt
Five Sisters
Frosty
Goodman Meadows
Grouse Flats
Huckleberry
Kettles
Leadpoint
Lookout
Loup Loup
Naneum
Nason
Navarre
Nc'icn
Onion Creek
OPT
Profanity Peak
Ruby Creek
Salmo
Sherman
Skookum
Smackout
Stranger
Strawberry
Sullivan Creek
Teanaway
Togo
Touchet
Tucannon
Vulcan
Wedge
Wenatchee
Whitestone
Pack size
Year


Survival
Abundance
Birth process
Immigration & Emigration
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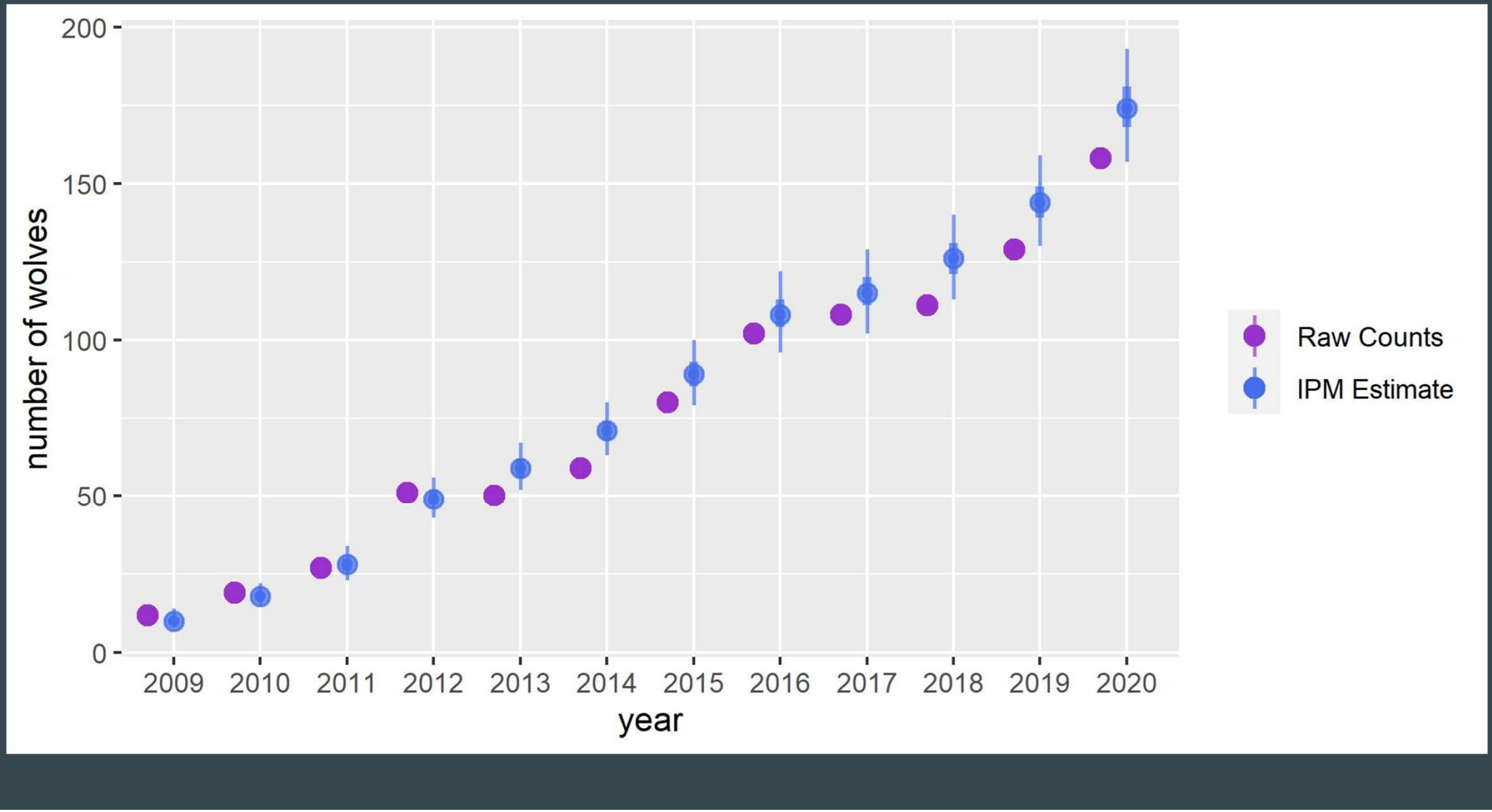
Semi-spatial Integrated Population Model

Pup counts are from end of year; encompass 48 pack-years from 17 packs 2009-2014


200
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number of wolves
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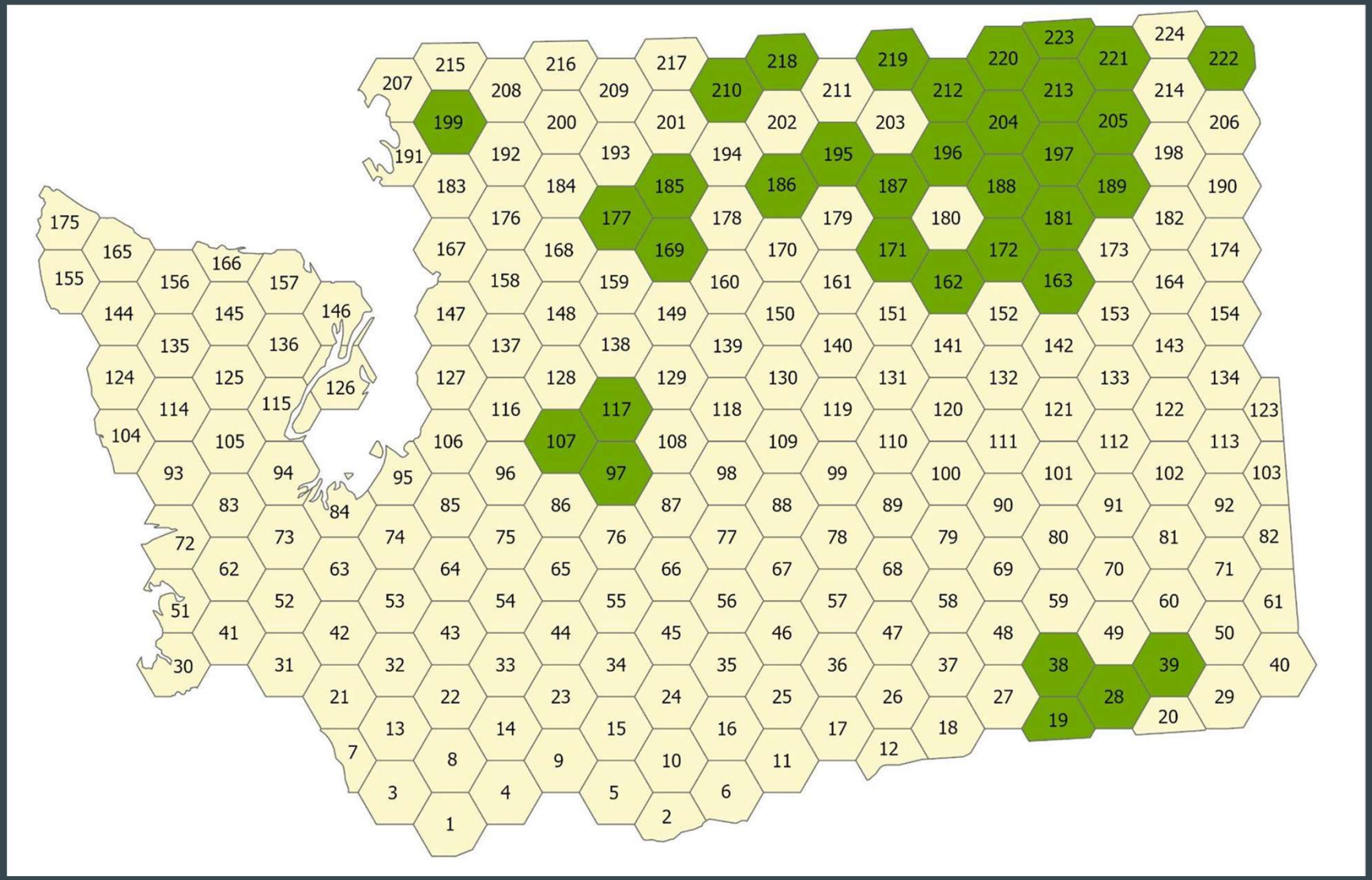
Raw Counts
IPM Estimate

Moving onto the projection model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What are the 15 scenarios?

1. **Baseline** - annual removal rate ~0.035, w immig ⇦	9. **Disease** - mortality rate 0.75, 50% compensatory
2. **Increased removals** - annual removal rate ~0.085 ⇦	10. **Harvest** - 6-mo rate 0.025, additive, starting 2025
3. **No out of state immigration** ⇦	11. **Harvest** - 6-mo rate 0.025, 50% compensatory ⇦
4. **Disease** - mortality rate 0.25 in 12/22 & 6/23, additive	12. **Harvest** - 6-mo rate 0.05, additive ⇦
5. **Disease** - mortality rate 0.25, 50% compensatory ⇦	13. **Harvest** - 6-mo rate 0.05, 50% compensatory
6. **Disease** - mortality rate 0.50, additive	14. **Translocation** - 8 individuals to Mt St Helens, 2025 ⇦
7. **Disease** - mortality rate 0.50, 50% compensatory	15. **Translocation** - 8 individuals to Olympic, 2025 ⇦
8. **Disease** - mortality rate 0.75, additive ⇦	

Model outputs for each scenario

- Total population size & number of occupied sites each year
  - State and Recovery Region level
- Probability of 2+ adults by site at years 1, 10, 20, 30, 40, 50
- Geometric mean of lambda
- Probability of plan recovery at any point in 50 years
- Probability of plan recovery for each year 1-20
- Probability of extinction at year 50

For this wolf, in a given territory, it can....

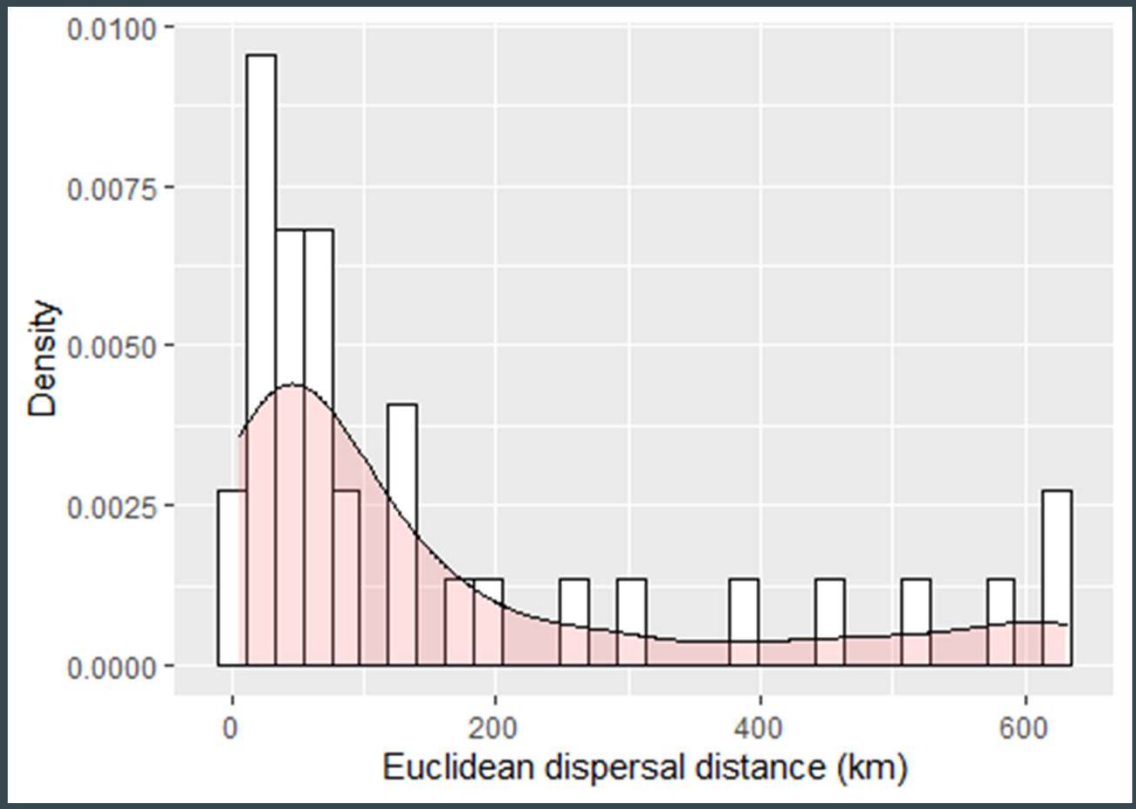
t = 1

- die
- live
  - enter movement phase & leave state
  - enter movement phase & stay in-state "movers"
    - continue moving "movers"
    - stop moving "settlers"
  - stay in territory "stayers"

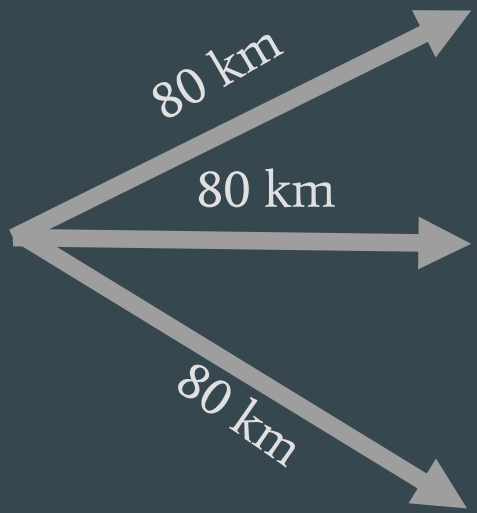
t = 2

Each settler wolf will draw a dispersal distance

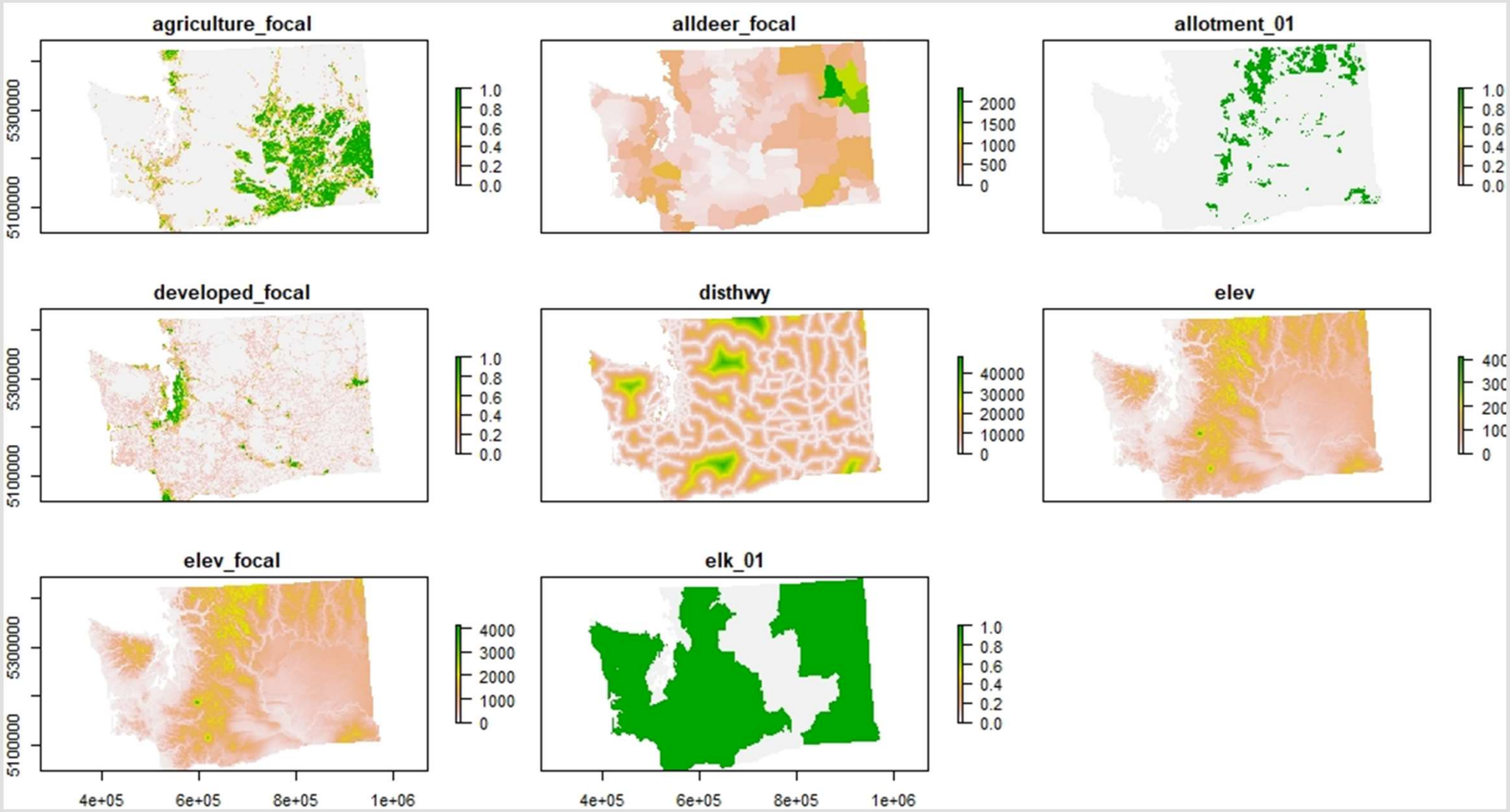
~



And will choose a territory at that distance based on an underlying probability



We determined suitability at the state level using GPS collar data and 12+ statewide covariates


agriculture_focal
alldeer_focal
allotment_01
developed_focal
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elk_01
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6e+05
8e+05
1e+06
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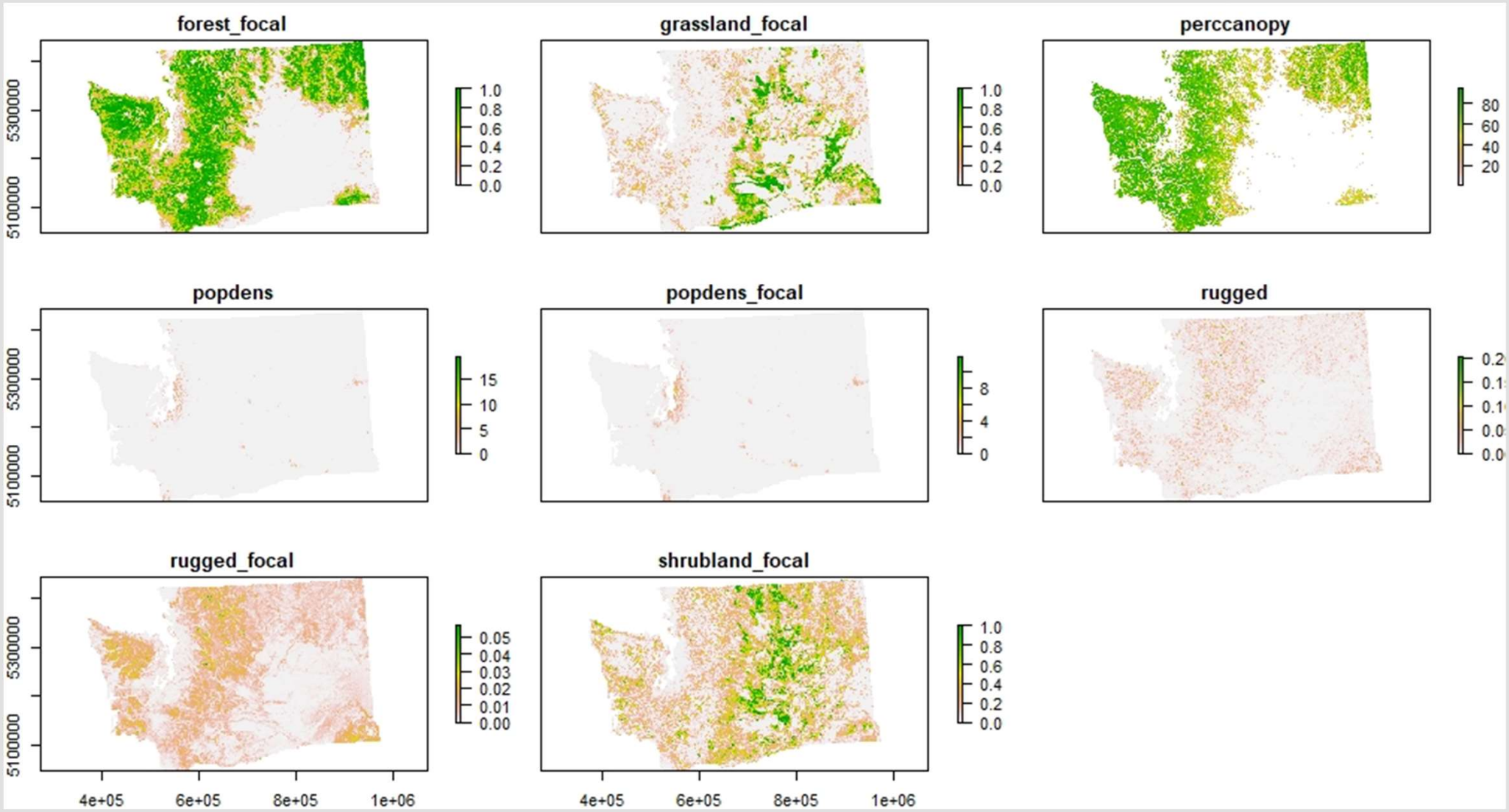
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rugged_focal
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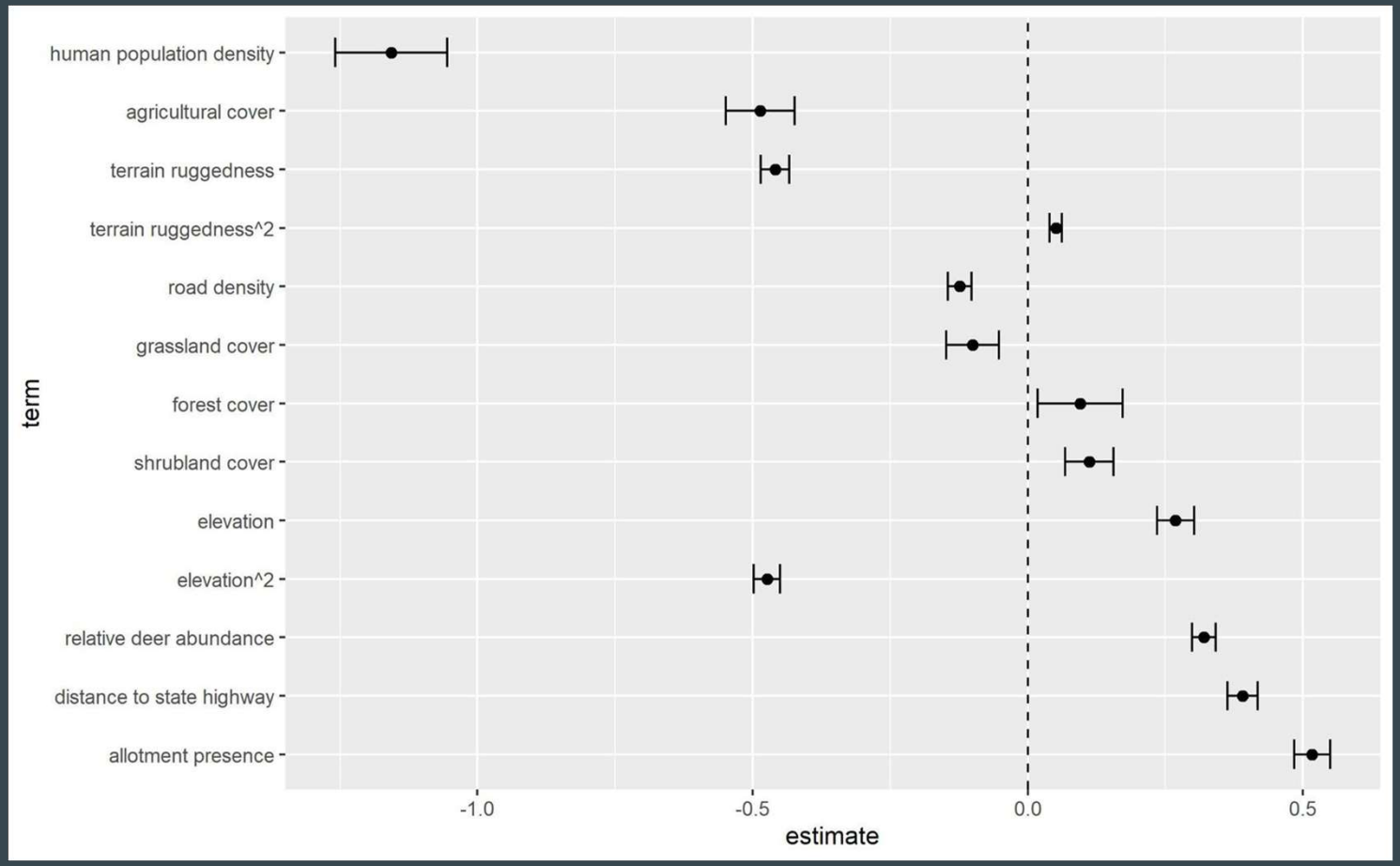
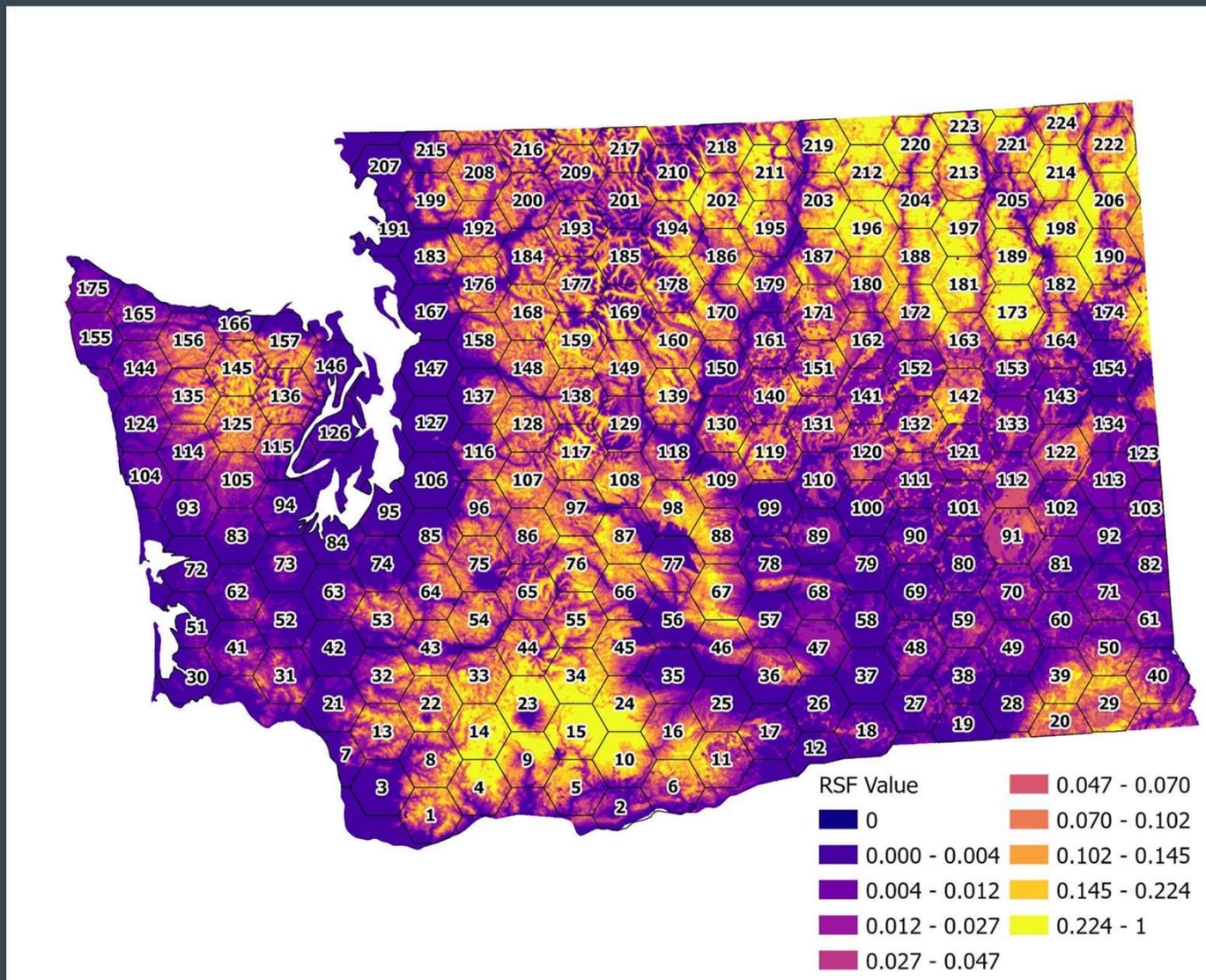
Building a statewide resistance surface

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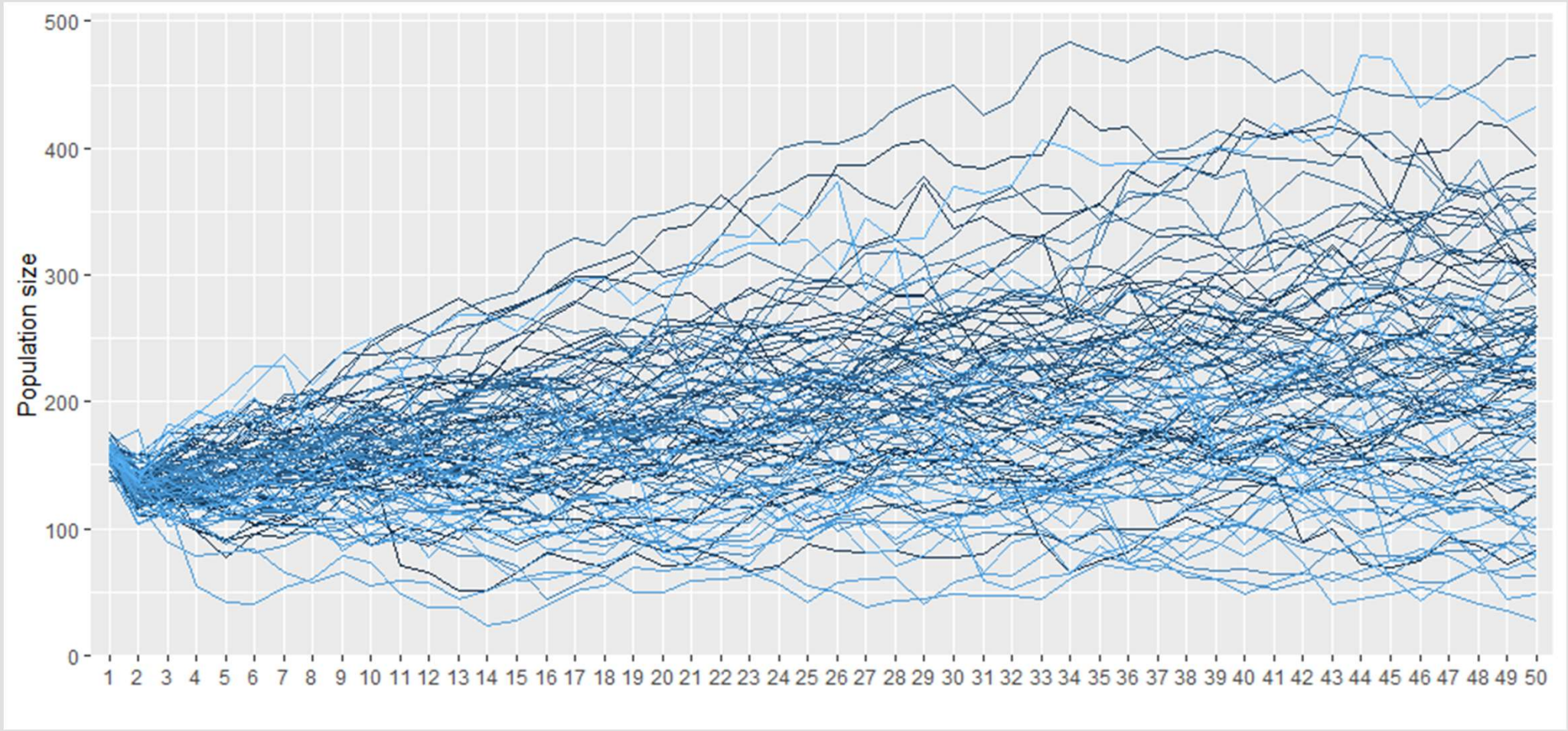
0.012 - 0.027
0.027 - 0.047
0.047 - 0.070
0.070 - 0.102
0.102 - 0.145
0.145 - 0.224
0.224 - 1


Population size
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300
200
100
0
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Management and model uncertainty scenarios

Management scenario 1: Harvest

- Starting in 2025
- 5%, 10% annually across all age classes
  - Additive and 50% compensatory variations

Management scenario 2: Translocation

- Happening in 2025
- Locations = Mount St. Helens Elk Herd Area & Olympic Peninsula
- Number of individuals per scenario = 8 total
  - 4 individuals removed from two packs in E Wash (2 24+ mo olds, 2 pups)
  - Move them to most suitable sites

Management scenario 3: Increase removals

- Removals are a rate (removals/N/yr)
  - first: will continue at current rate in E Wash
  - next: 30% removed every four years in E Wash→ annual 8.5%
    - Removed at pack level
    - Currently only in E Washington

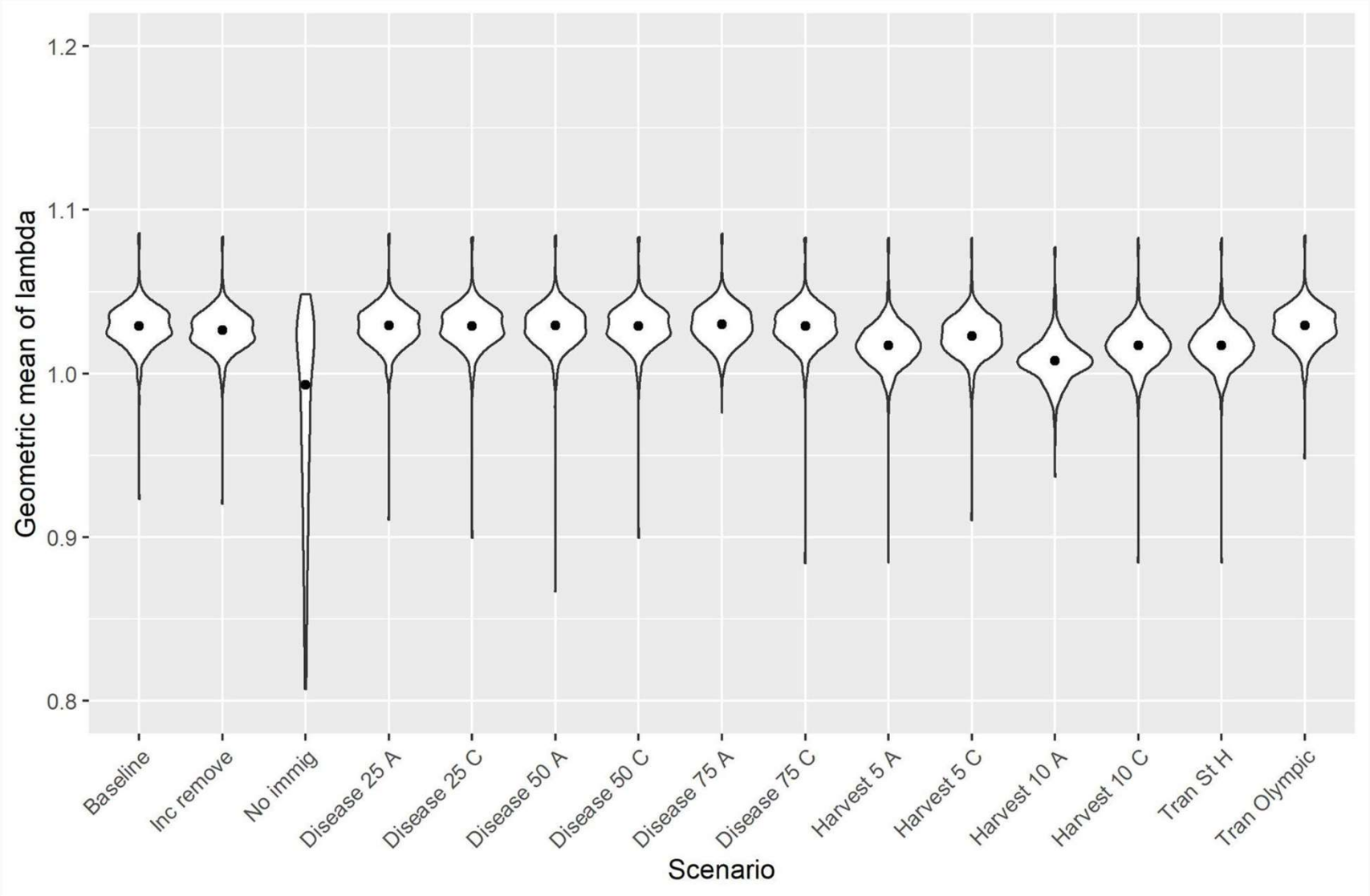
Model uncertainty

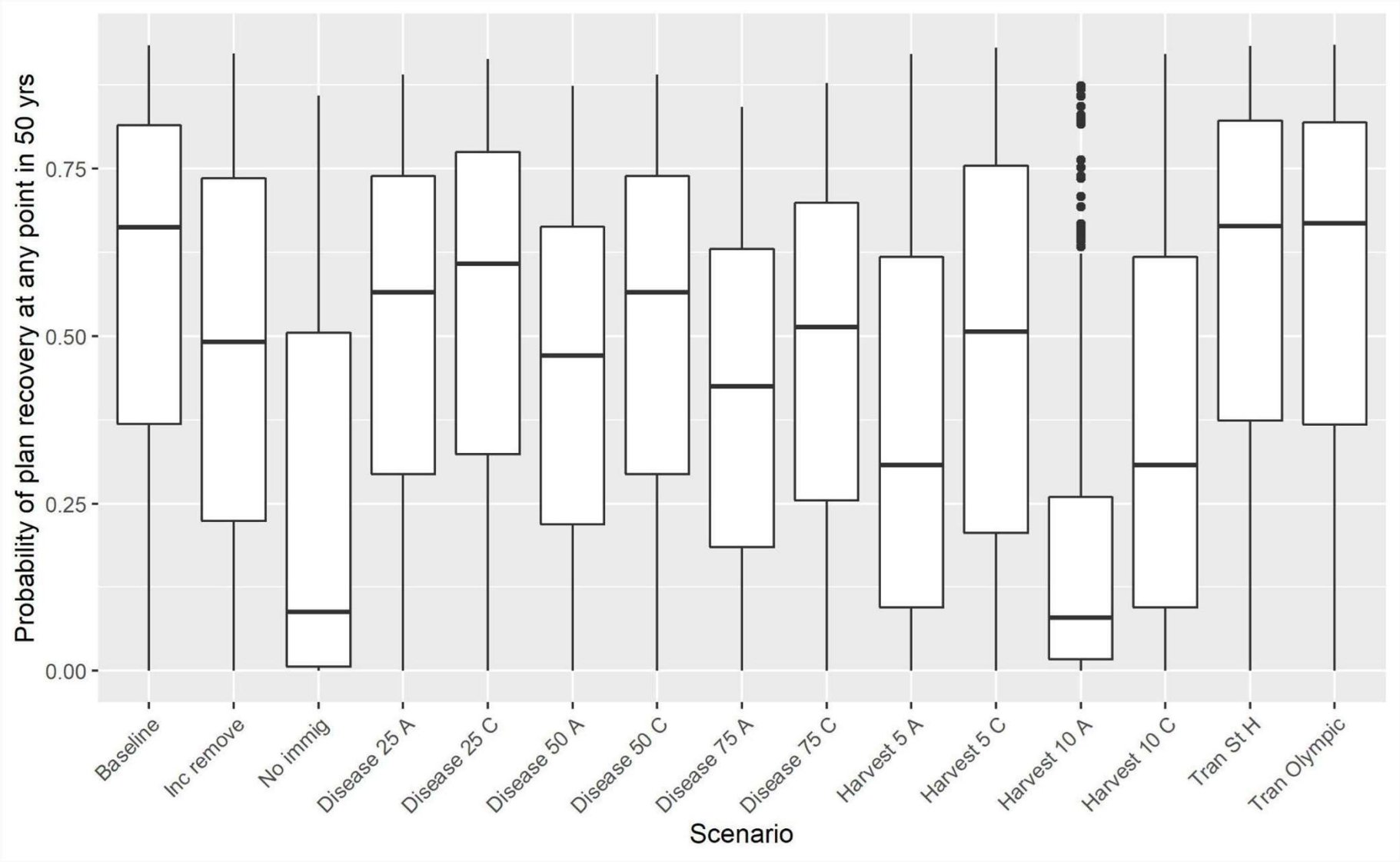
Model uncertainty 1: Disease outbreak

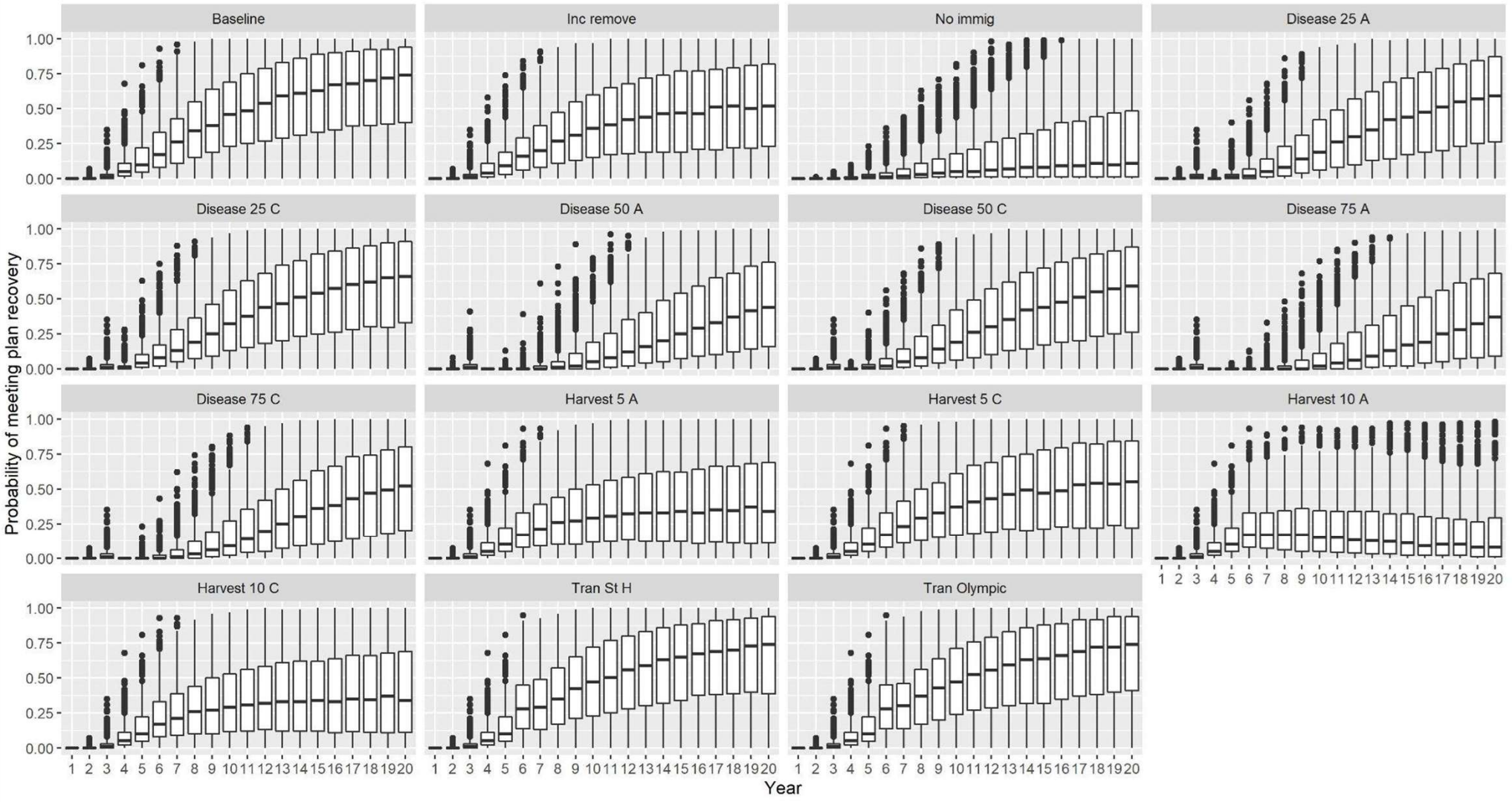
- Happens over two consecutive 6-mo periods
- Loss of 25%, 50%, or 75% of entire population
  - Additive & 50% compensatory variations

Model uncertainty 2: Immigration

- Forcing out of state immigration $\rightarrow 0$


Geometric mean of lambda
1.2
1.1
1.0
0.9
0.8
Baseline
Inc remove
No immig
Disease 25 A
Disease 25 C
Disease 50 A
Disease 50 C
Disease 75 A
Disease 75 C
Harvest 5 A
Harvest 5 C
Harvest 10 A
Harvest 10 C
Tran St H
Tran Olympic
Scenario


Probability of plan recovery at any point in 50 yrs
0.00
0.25
0.50
0.75
Baseline
Inc remove
No immig
Disease 25 A
Disease 25 C
Disease 50 A
Disease 50 C
Disease 75 A
Disease 75 C
Harvest 5 A
Harvest 5 C
Harvest 10 A
Harvest 10 C
Tran St H
Tran Olympic
Scenario


Baseline
Inc remove
No immig
Disease 25 A
Disease 25 C
Disease 50 A
Disease 50 C
Disease 75 A
Disease 75 C
Harvest 5 A
Harvest 5 C
Harvest 10 A
Harvest 10 C
Tran St H
Tran Olympic
Probability of meeting plan recovery
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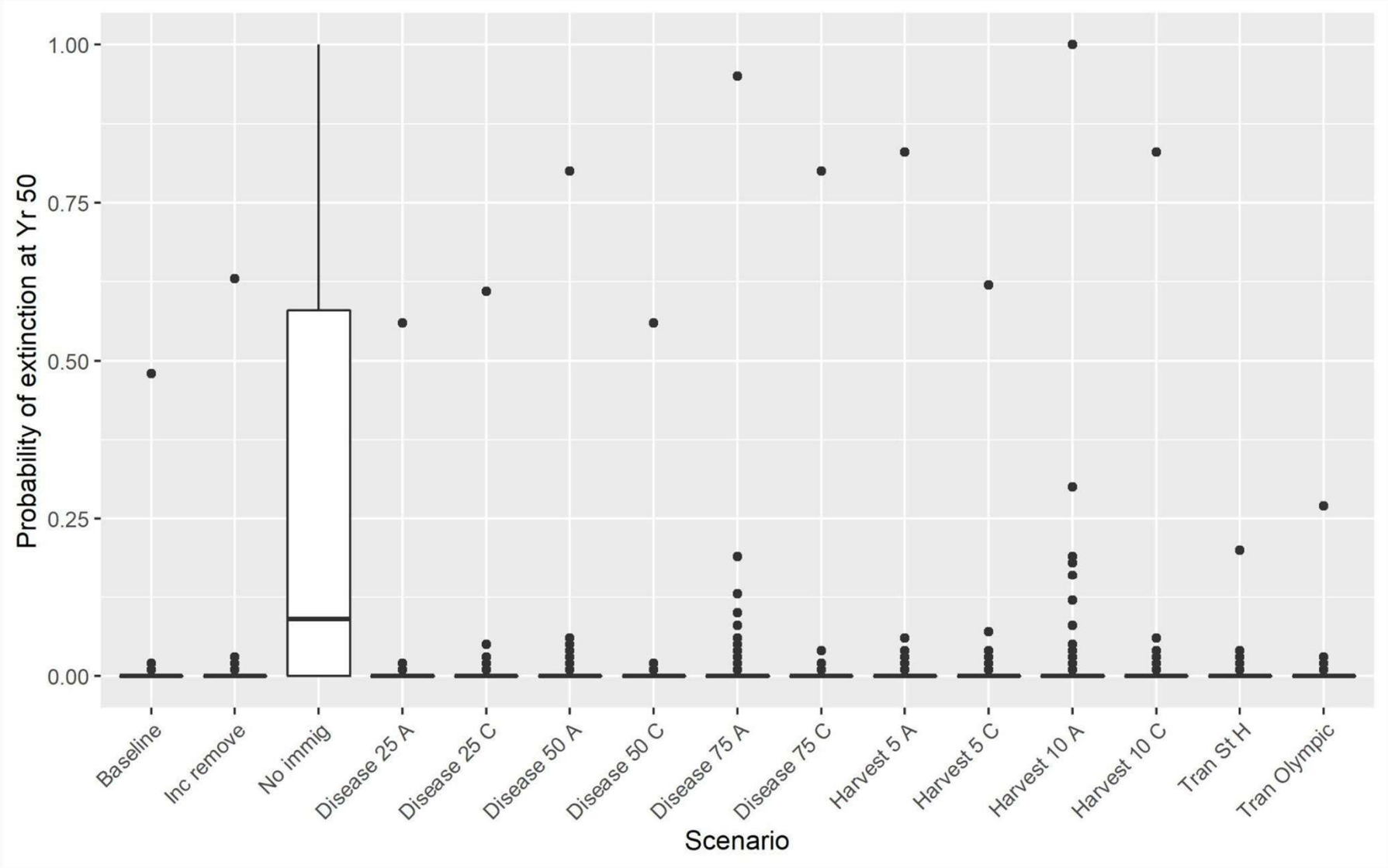
0.25
0.50
0.75
1.00
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Year


Probability of extinction at Yr 50
1.00
0.75
0.50
0.25
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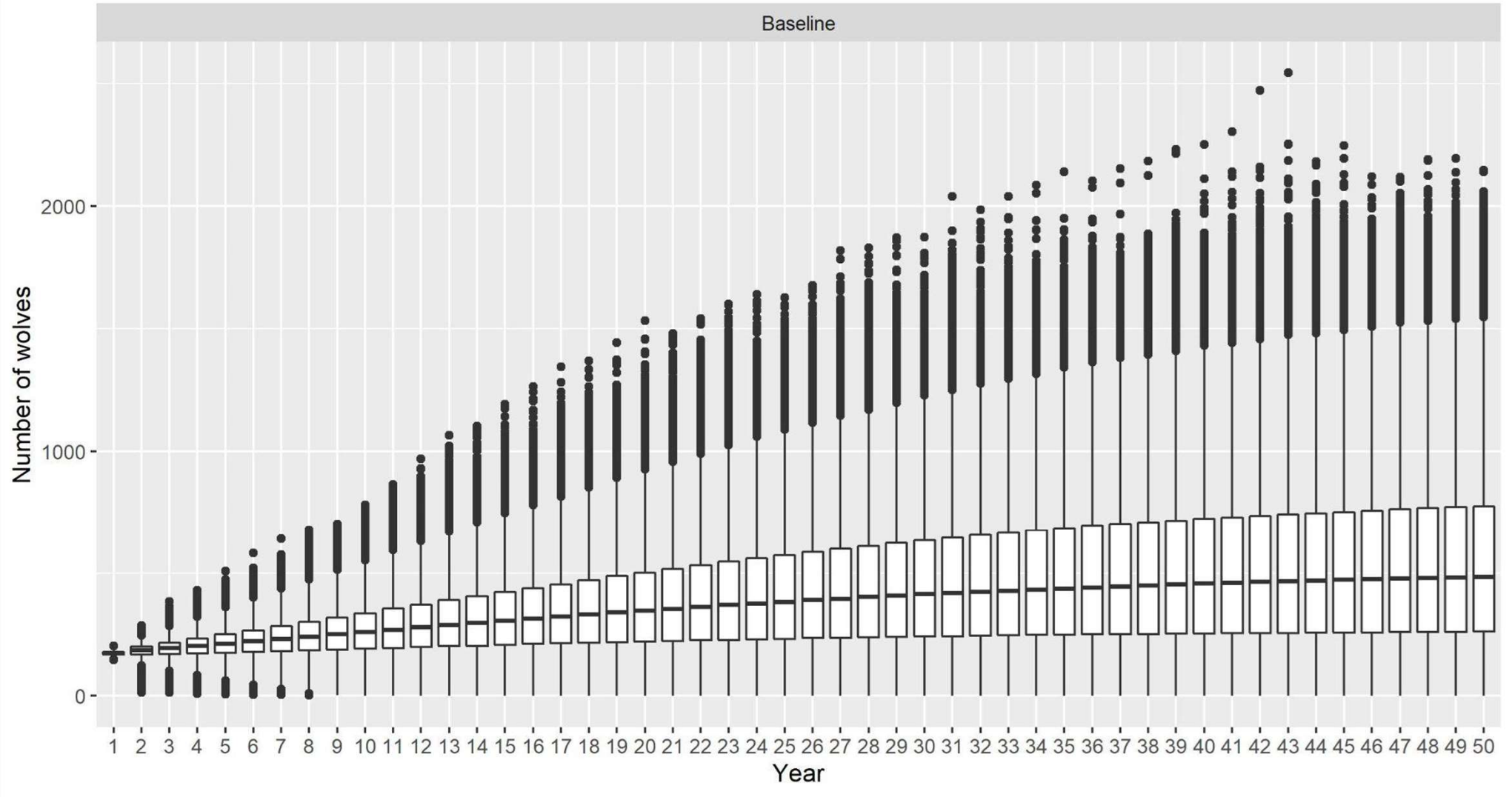
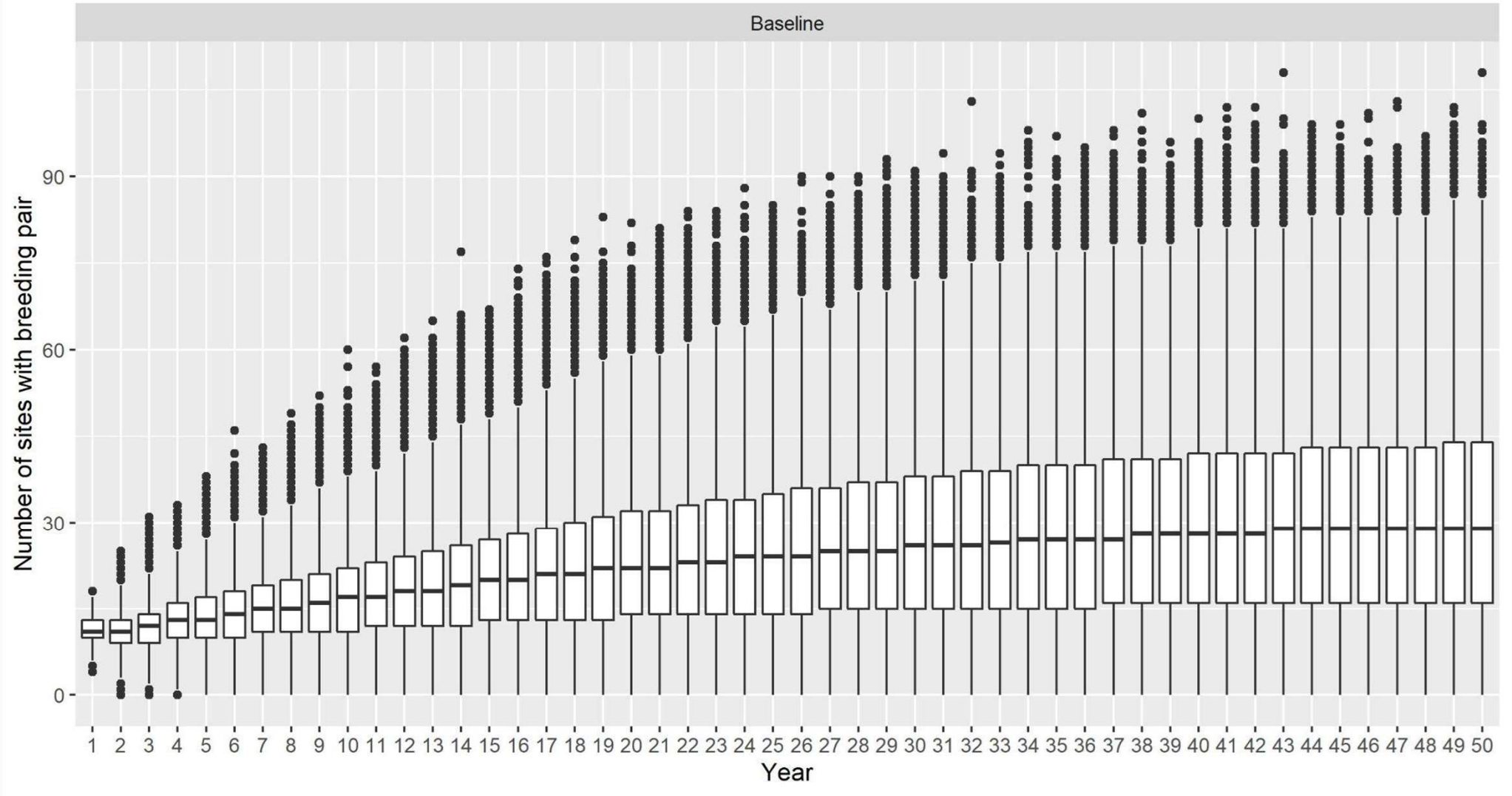
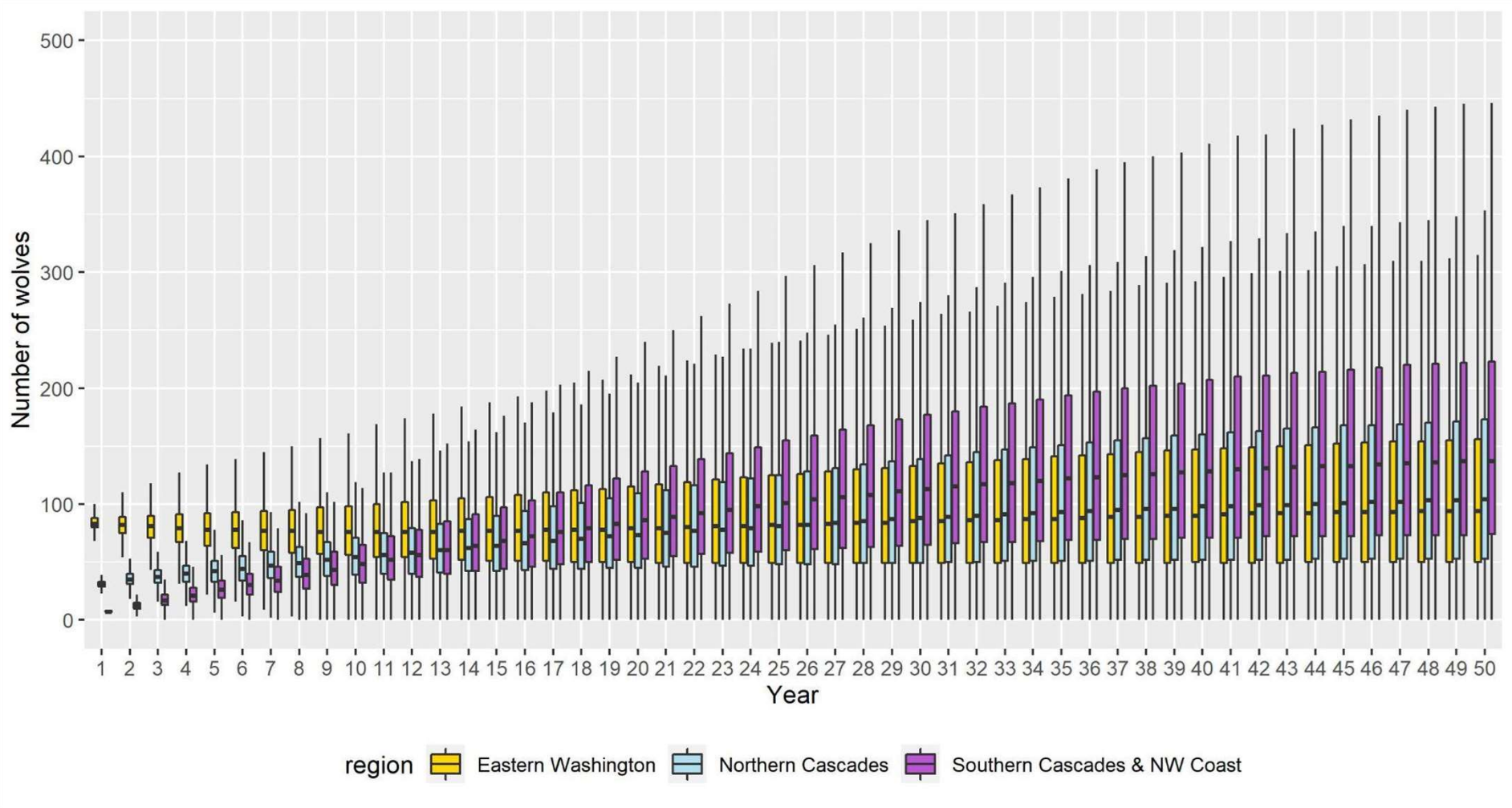
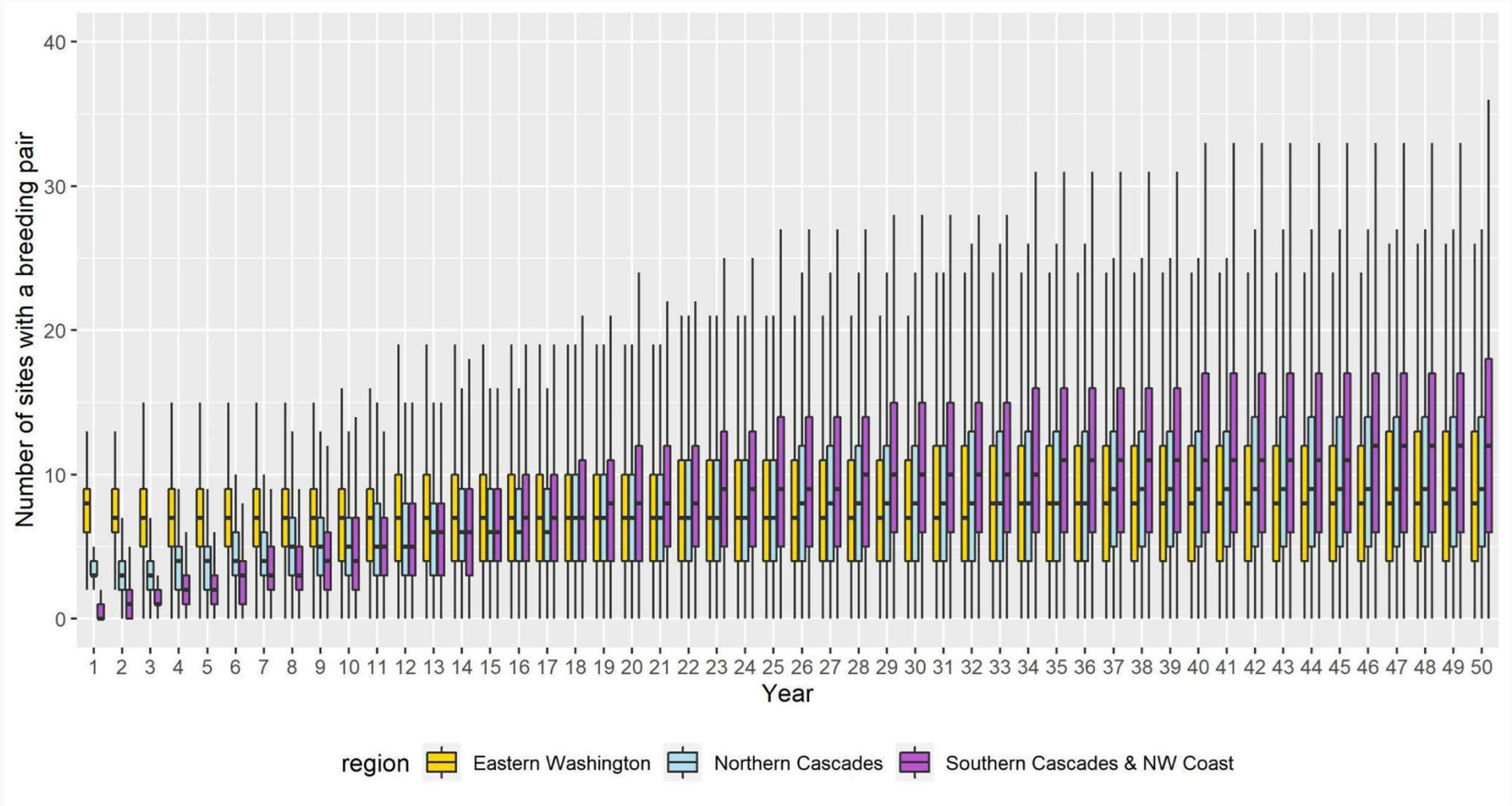
Baseline
Inc remove
No immig
Disease 25 A
Disease 25 C
Disease 50 A
Disease 50 C
Disease 75 A
Disease 75 C
Harvest 5 A
Harvest 5 C
Harvest 10 A
Harvest 10 C
Tran St H
Tran Olympic
Scenario


Baseline
Number of wolves
0
1000
2000
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
Year

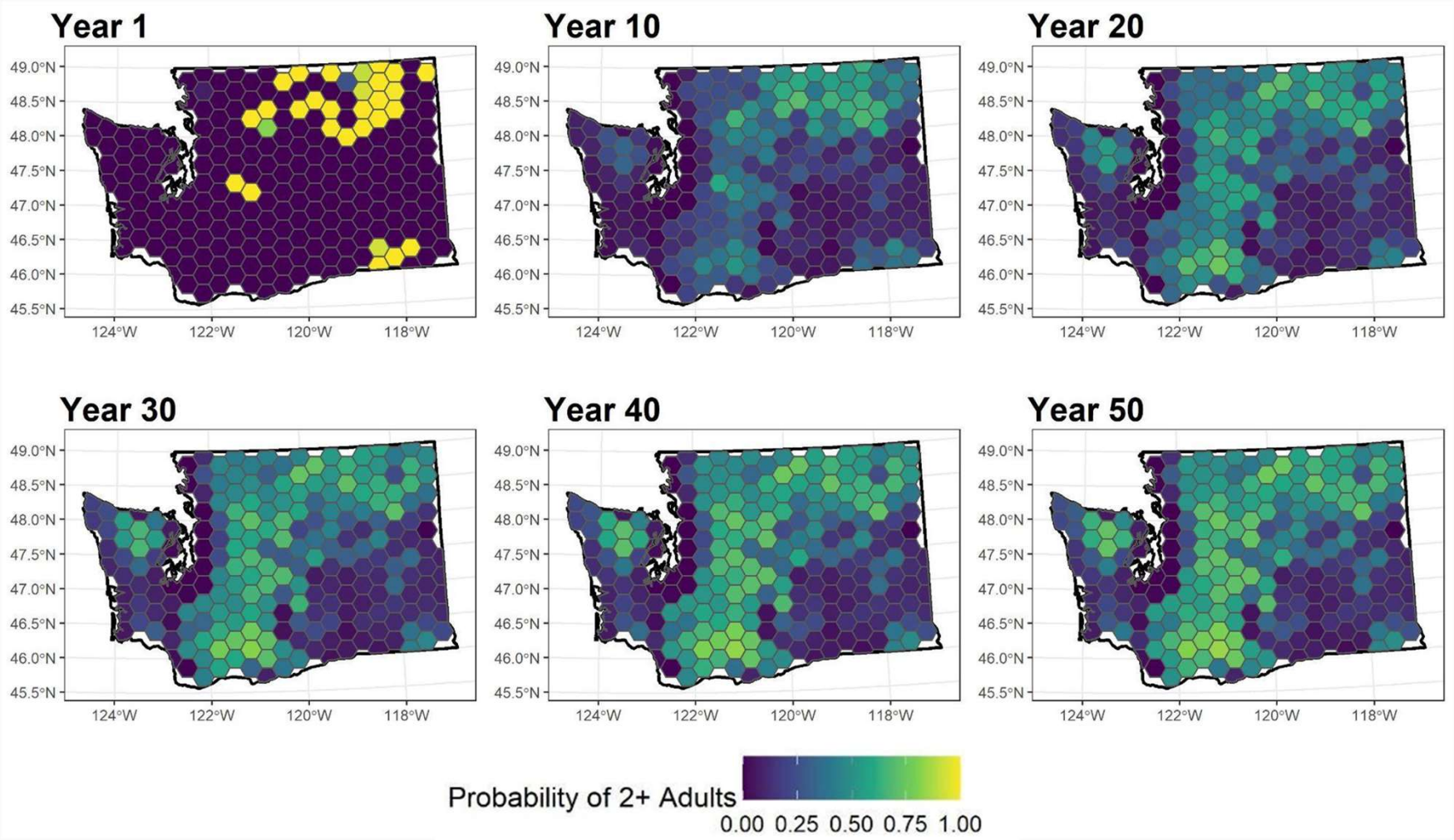

Baseline
Number of sites with breeding pair
0
30
60
90
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
Year


Number of wolves
500
400
300
200
100
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
Year
region
Eastern Washington
Northern Cascades
Southern Cascades & NW Coast

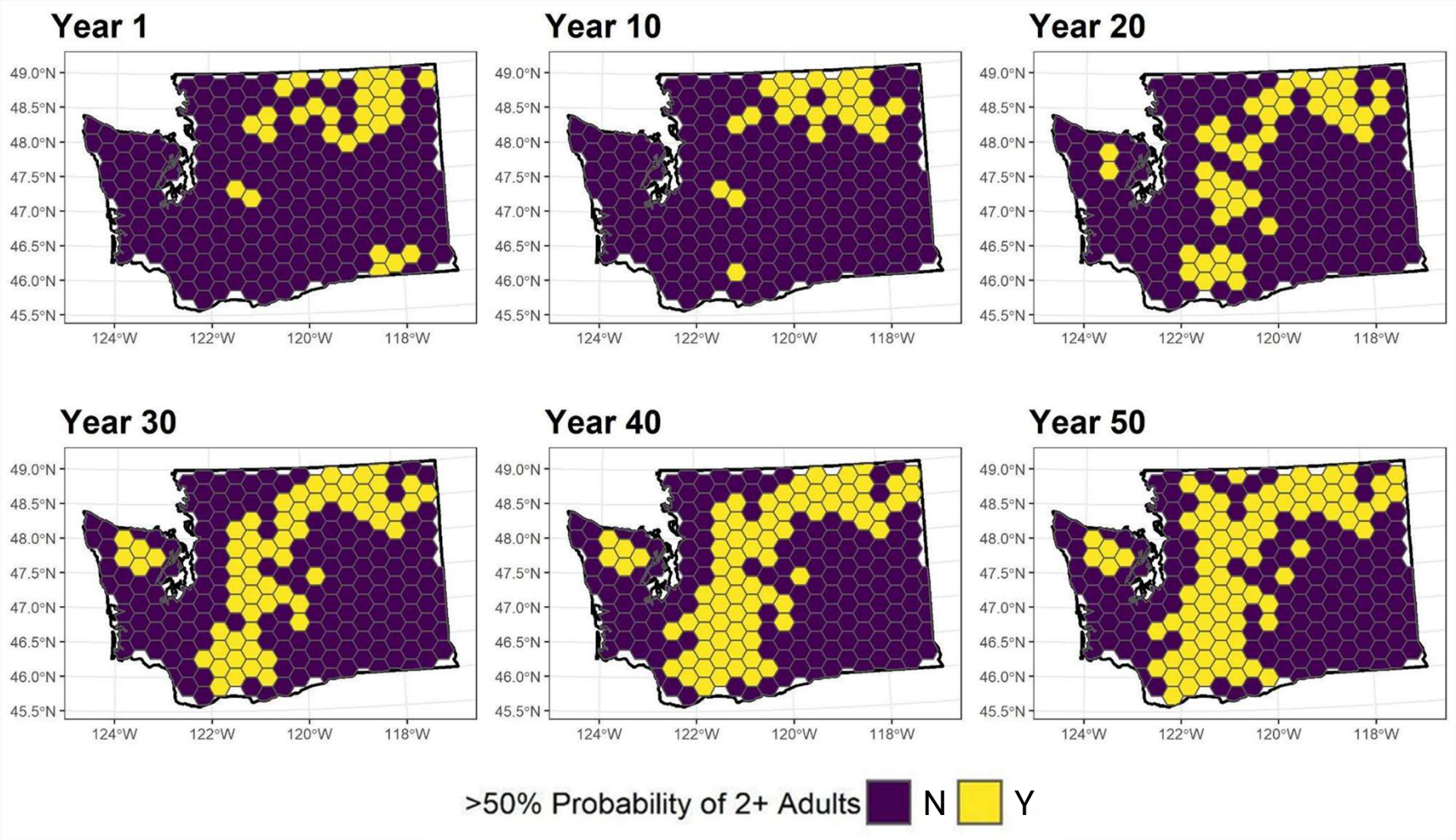
Baseline


Number of sites with a breeding pair
0
10
20
30
40
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
Year
region
Eastern Washington
Northern Cascades
Southern Cascades & NW Coast

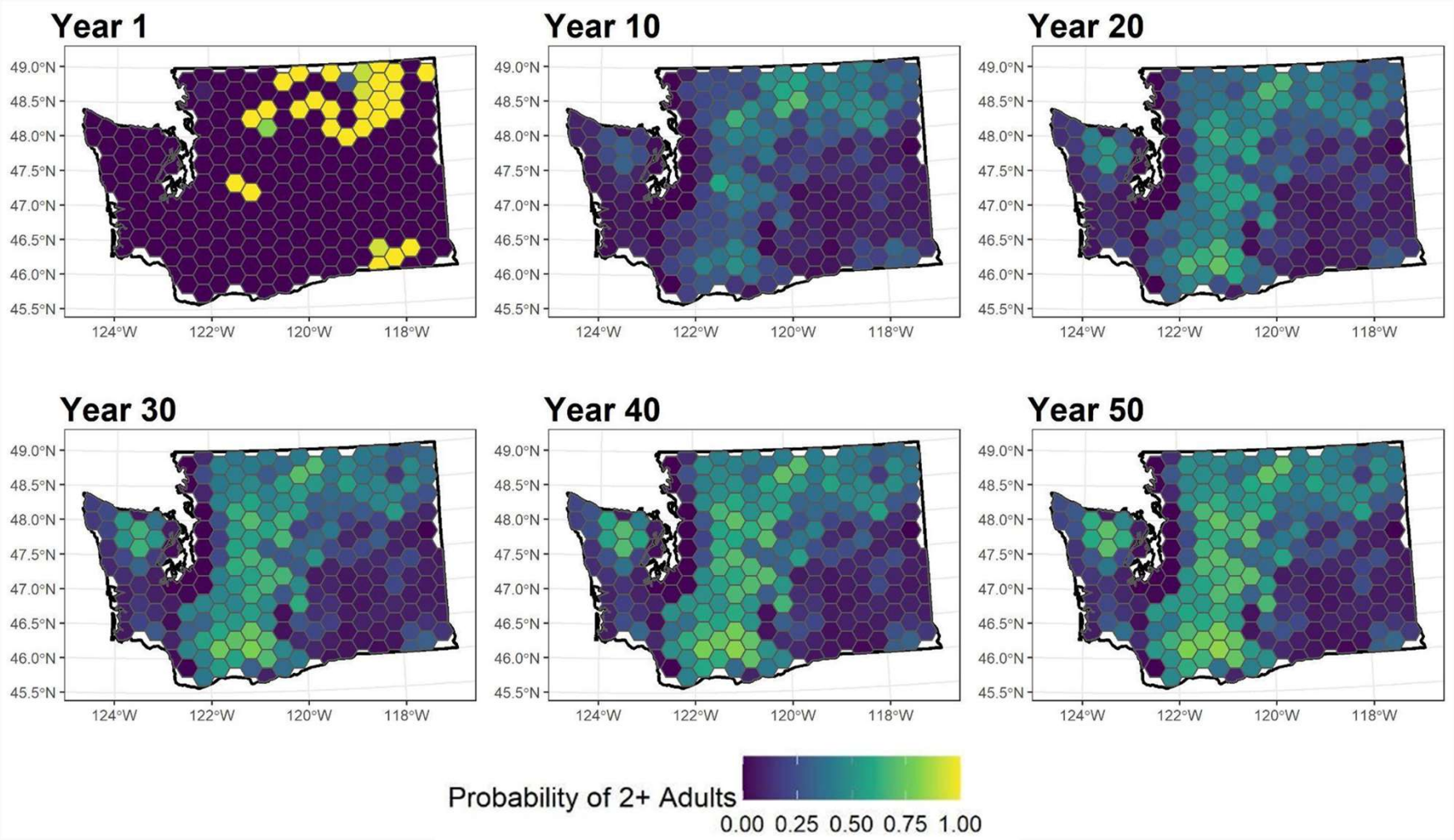
Baseline


Year 1
Year 10
Year 20
Year 30
Year 40
Year 50
49.0°N
48.5°N
48.0°N
47.5°N
47.0°N
46.5°N
46.0°N
45.5°N
124°W
122°W
120°W
118°W
Probability of 2+ Adults
0.00 0.25 0.50 0.75 1.00

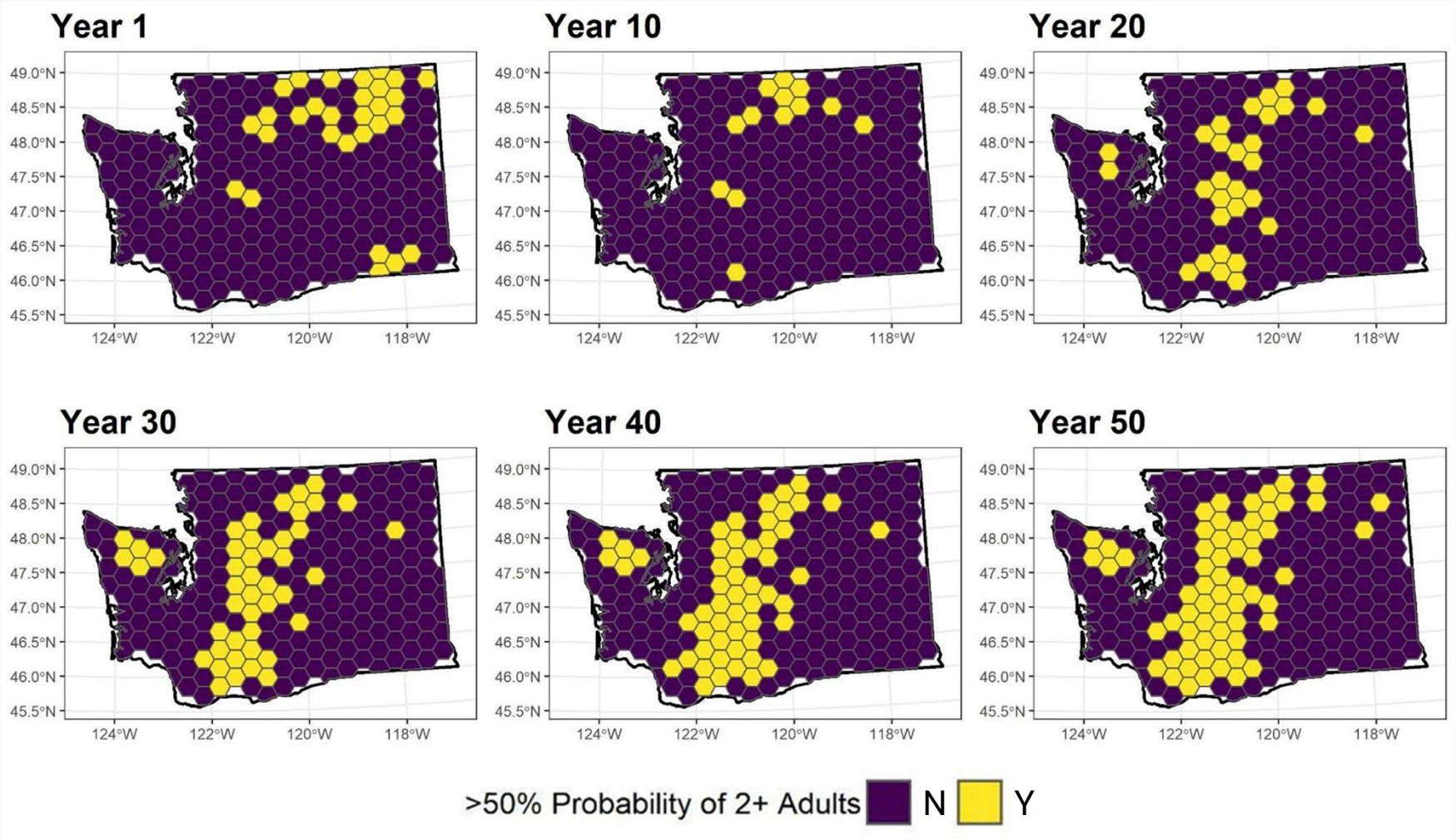
Baseline


Year 1
Year 10
Year 20
Year 30
Year 40
Year 50
49.0°N
48.5°N
48.0°N
47.5°N
47.0°N
46.5°N
46.0°N
45.5°N
124°W
122°W
120°W
118°W
>50% Probability of 2+ Adults
N
Y

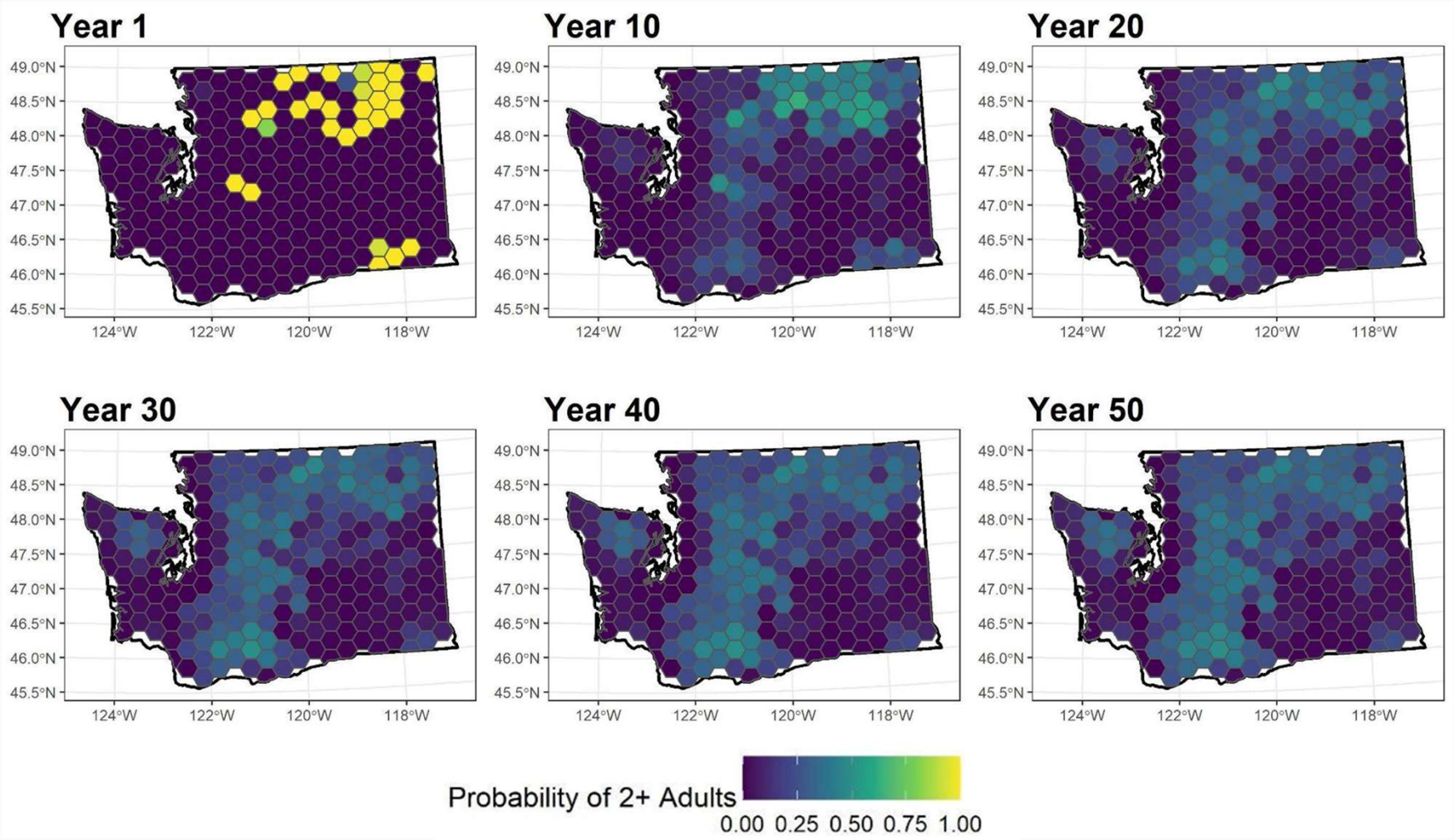
Baseline



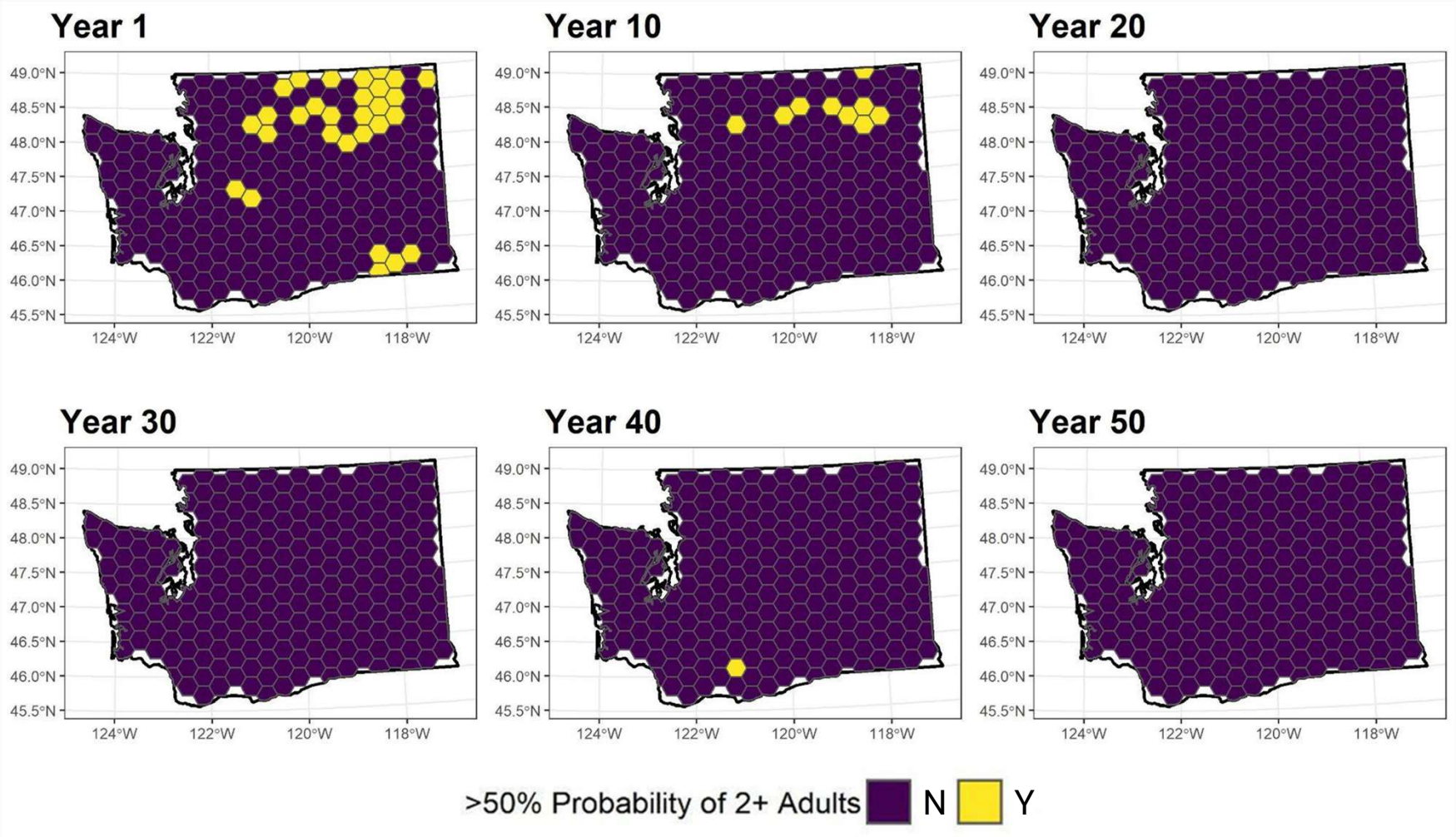
Increased removals



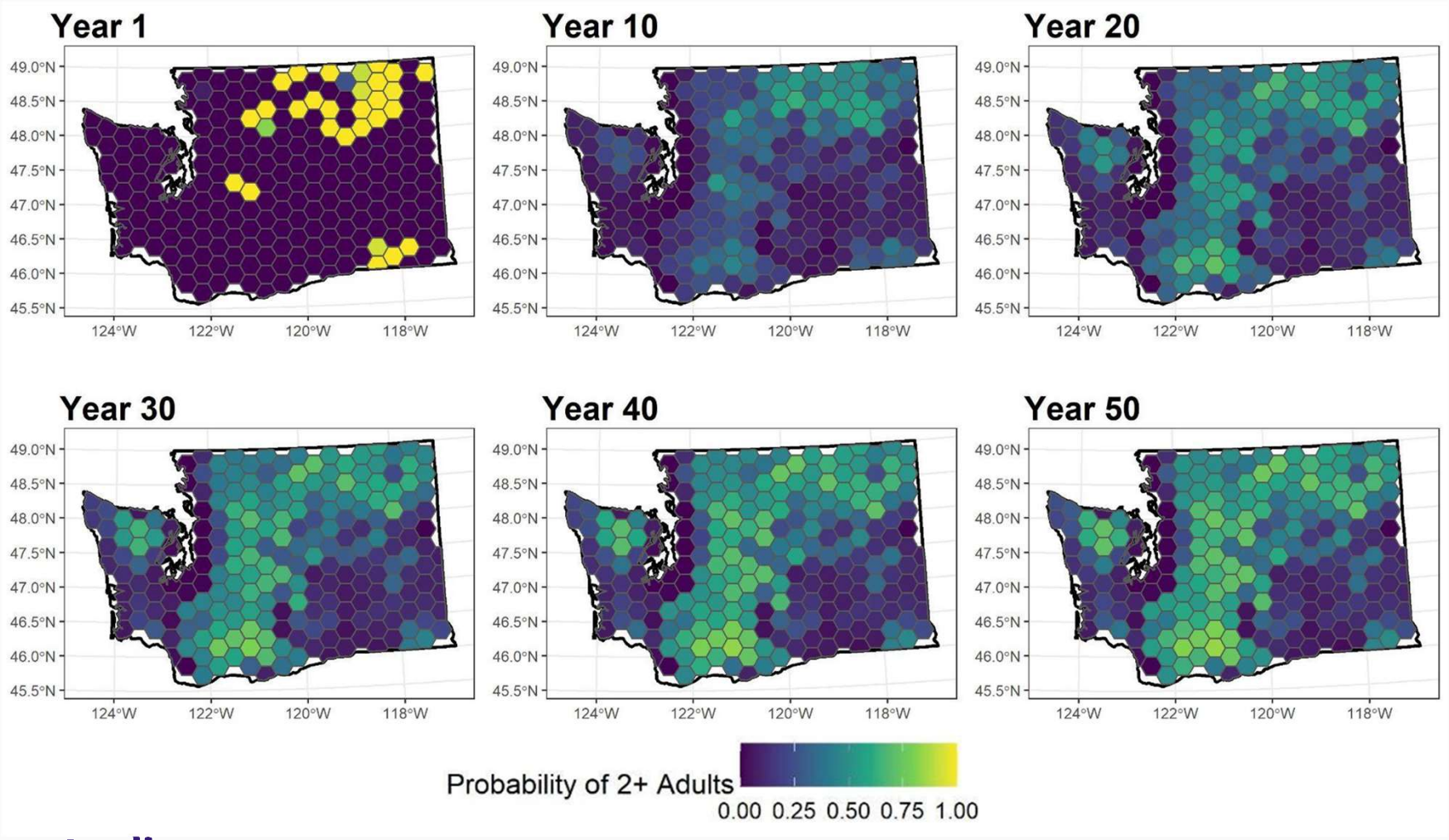
Increased removals



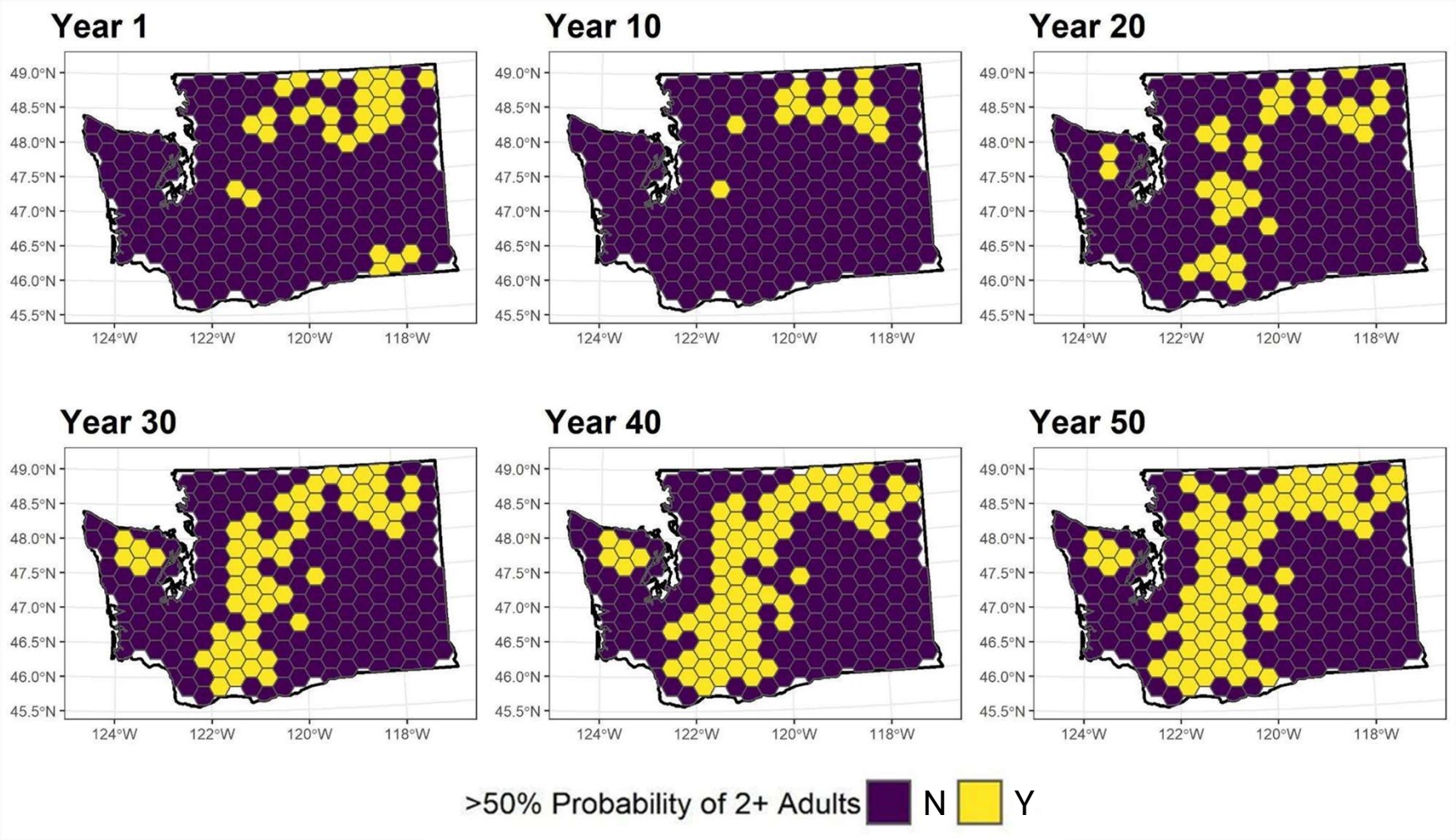
No immigration



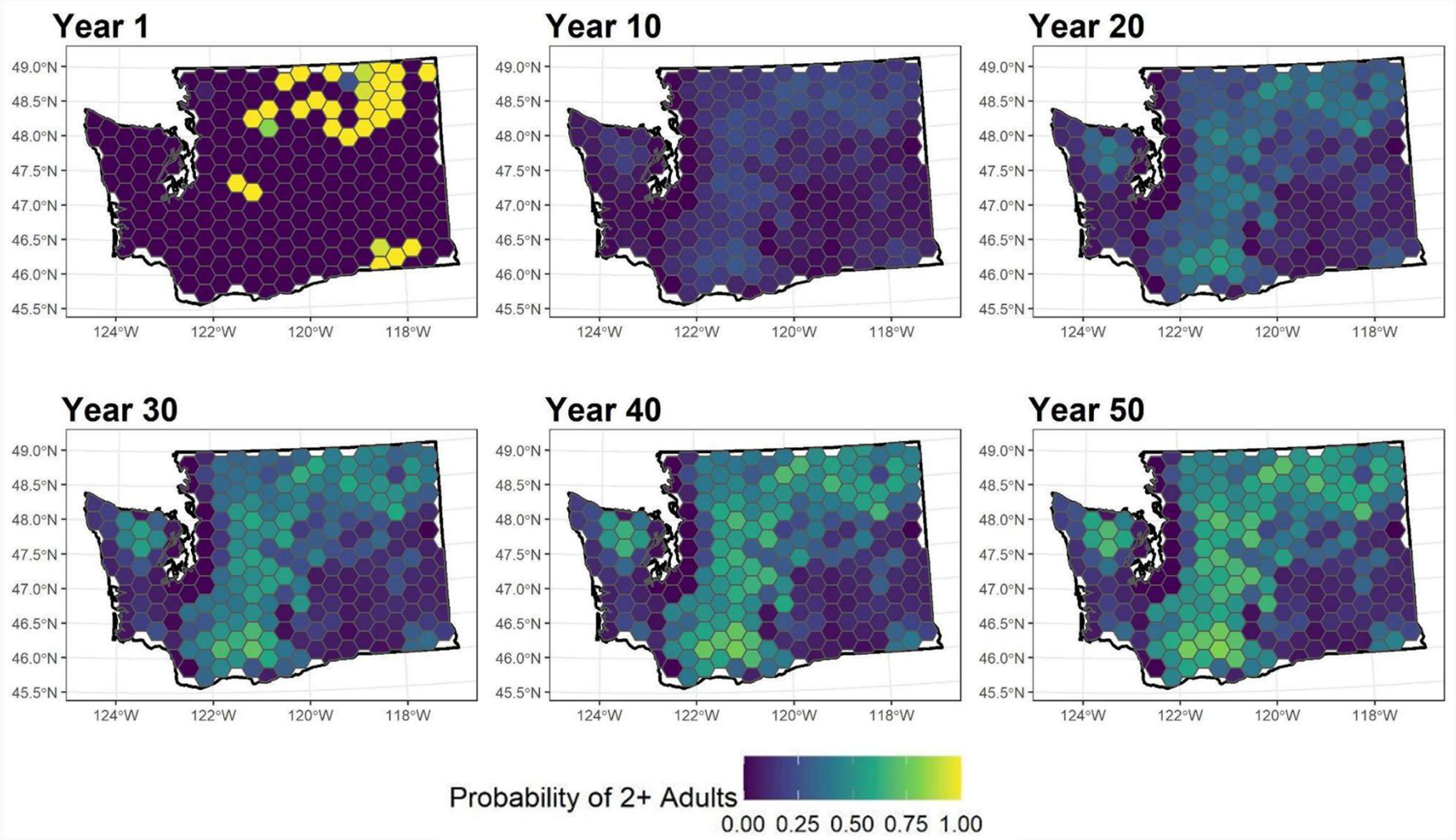
No immigration



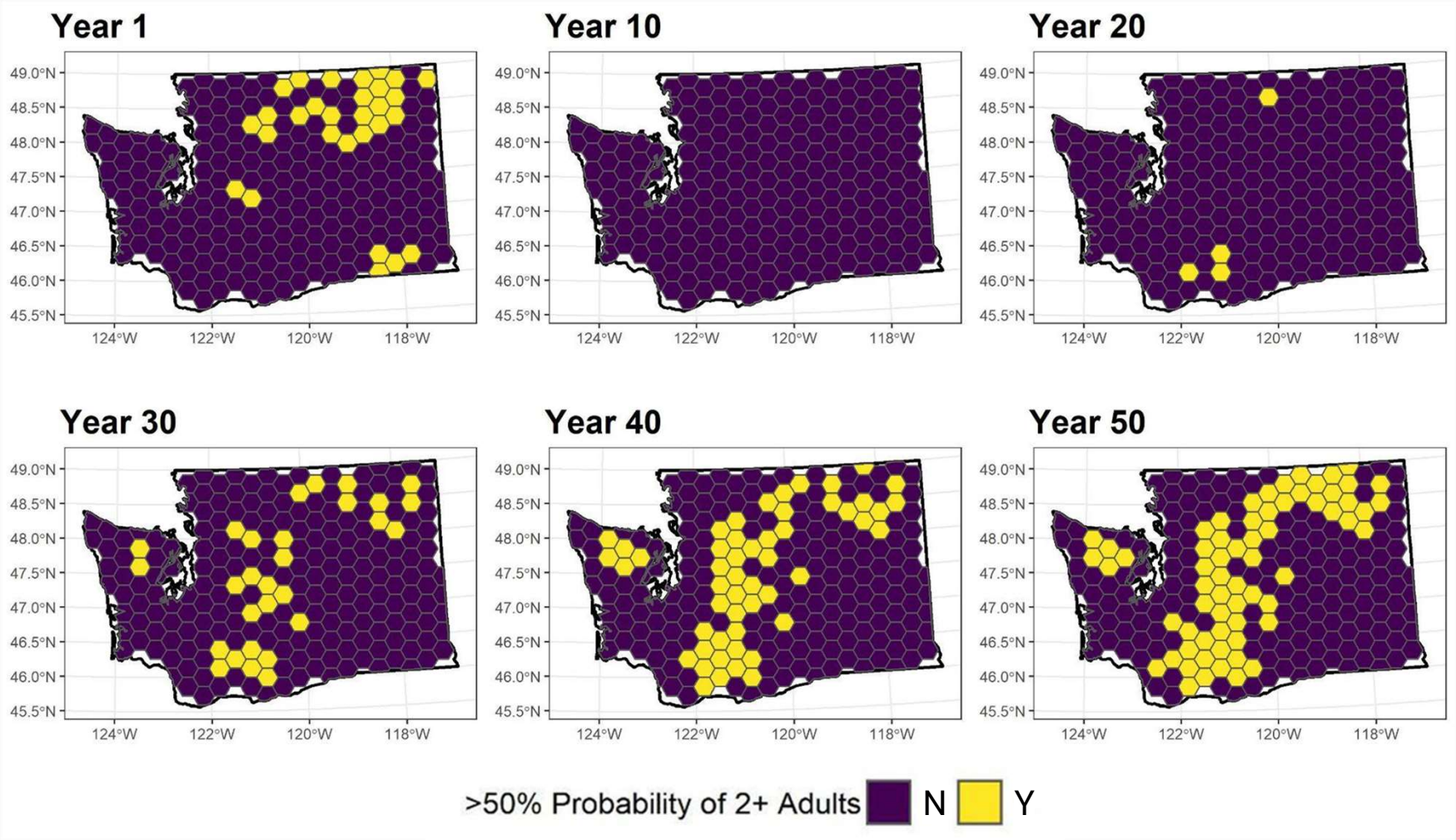
25% loss to disease, compens



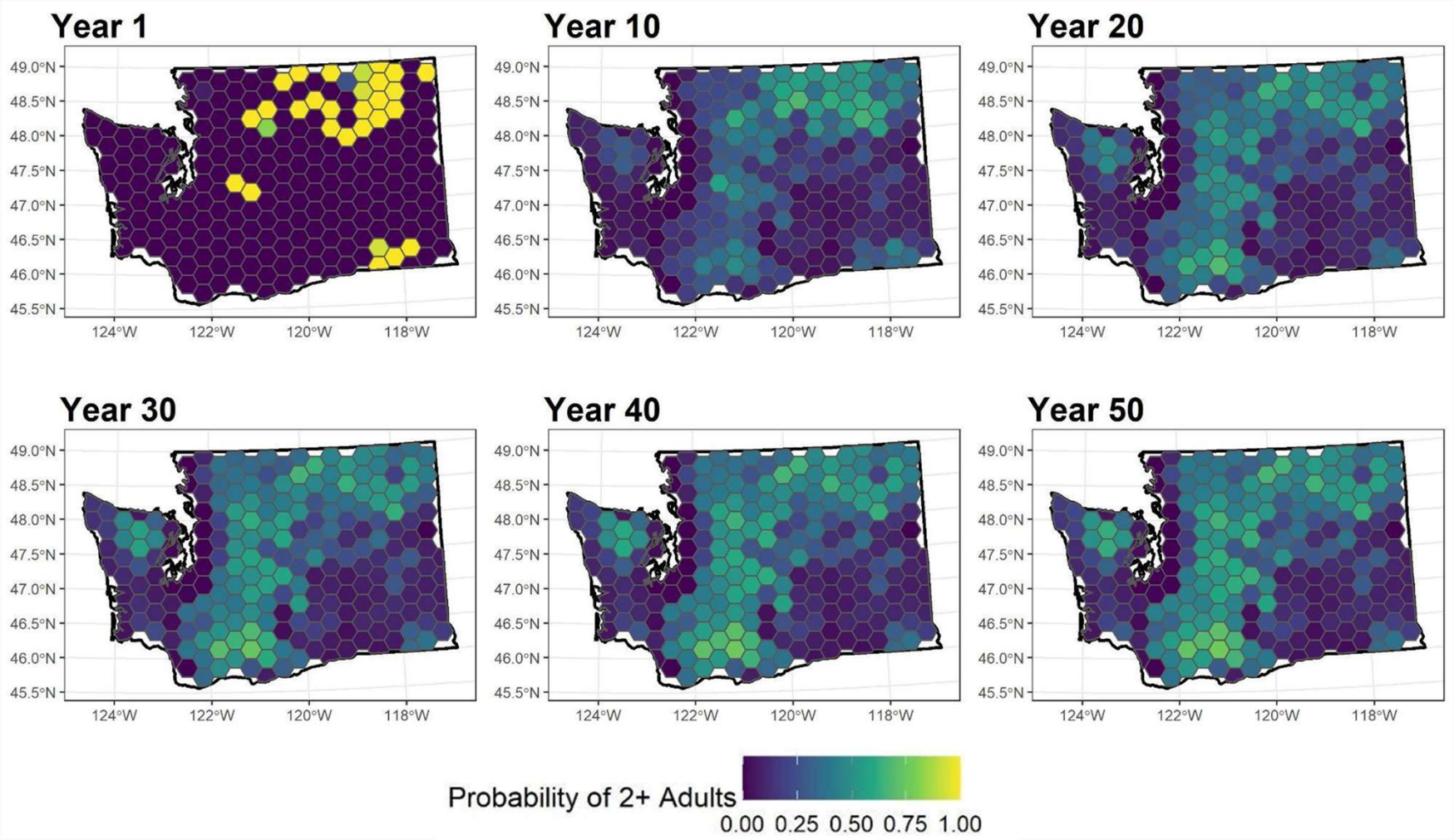
25% loss to disease, compens



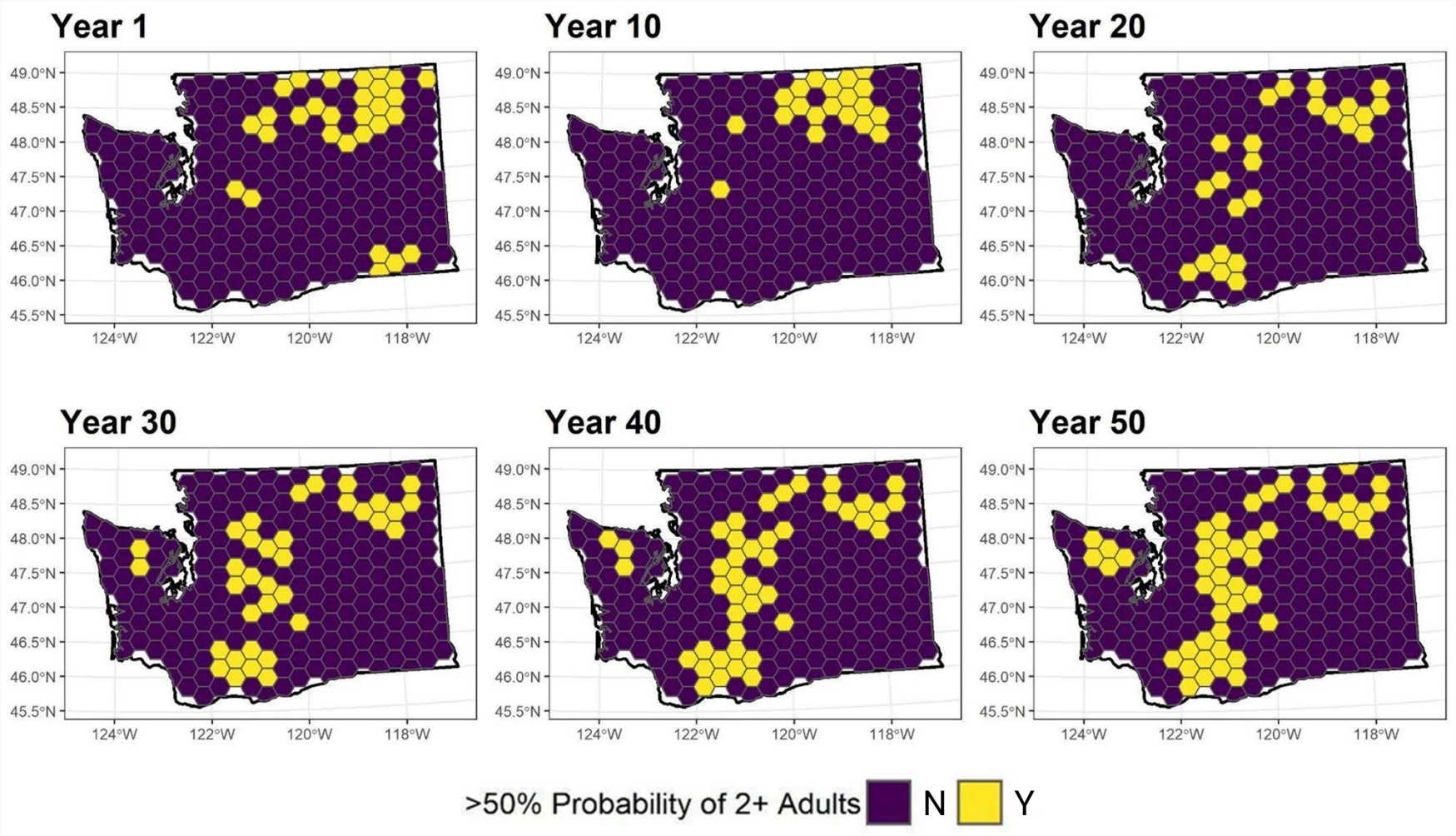
75% loss to disease, additive



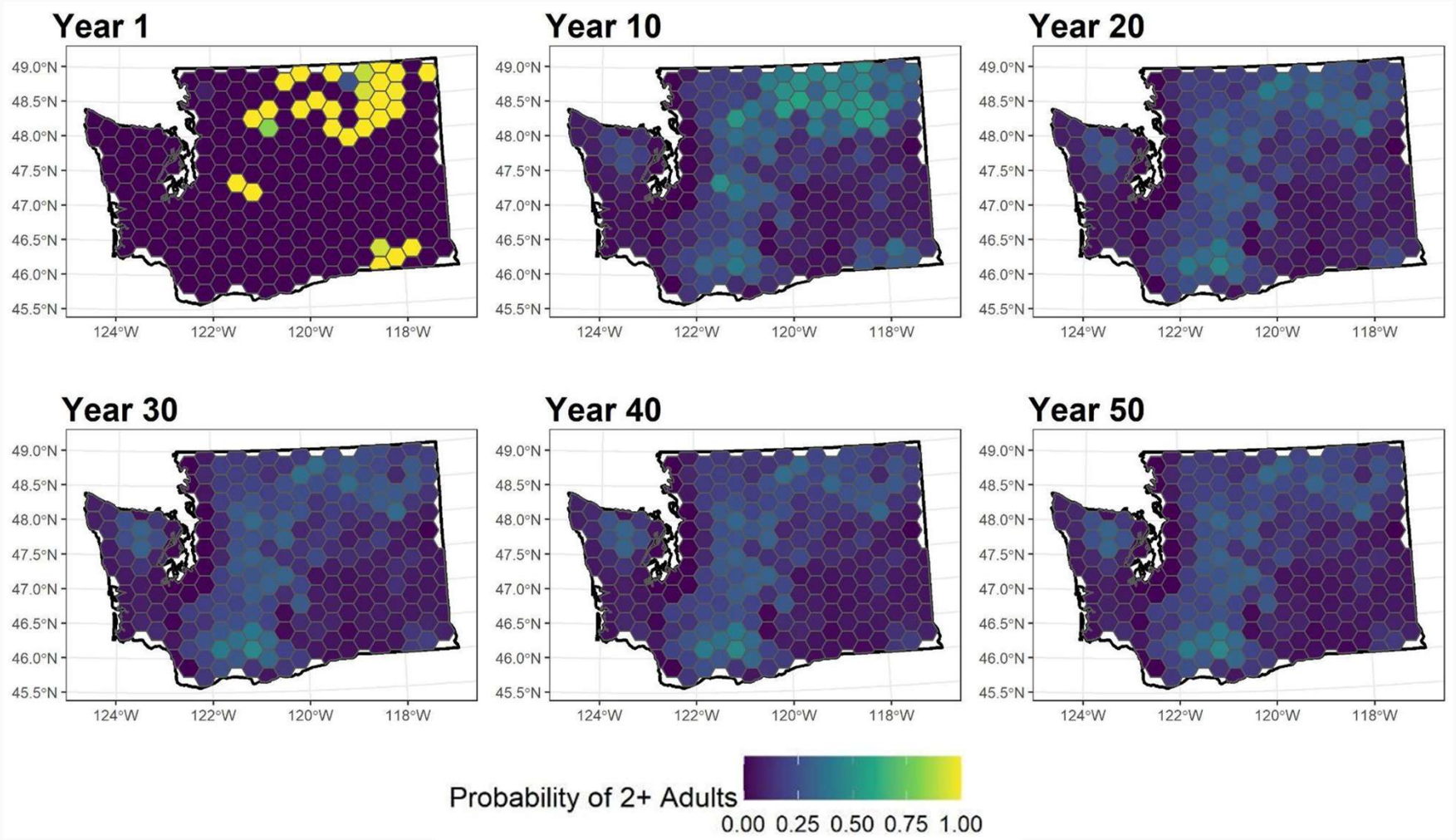
75% loss to disease, additive



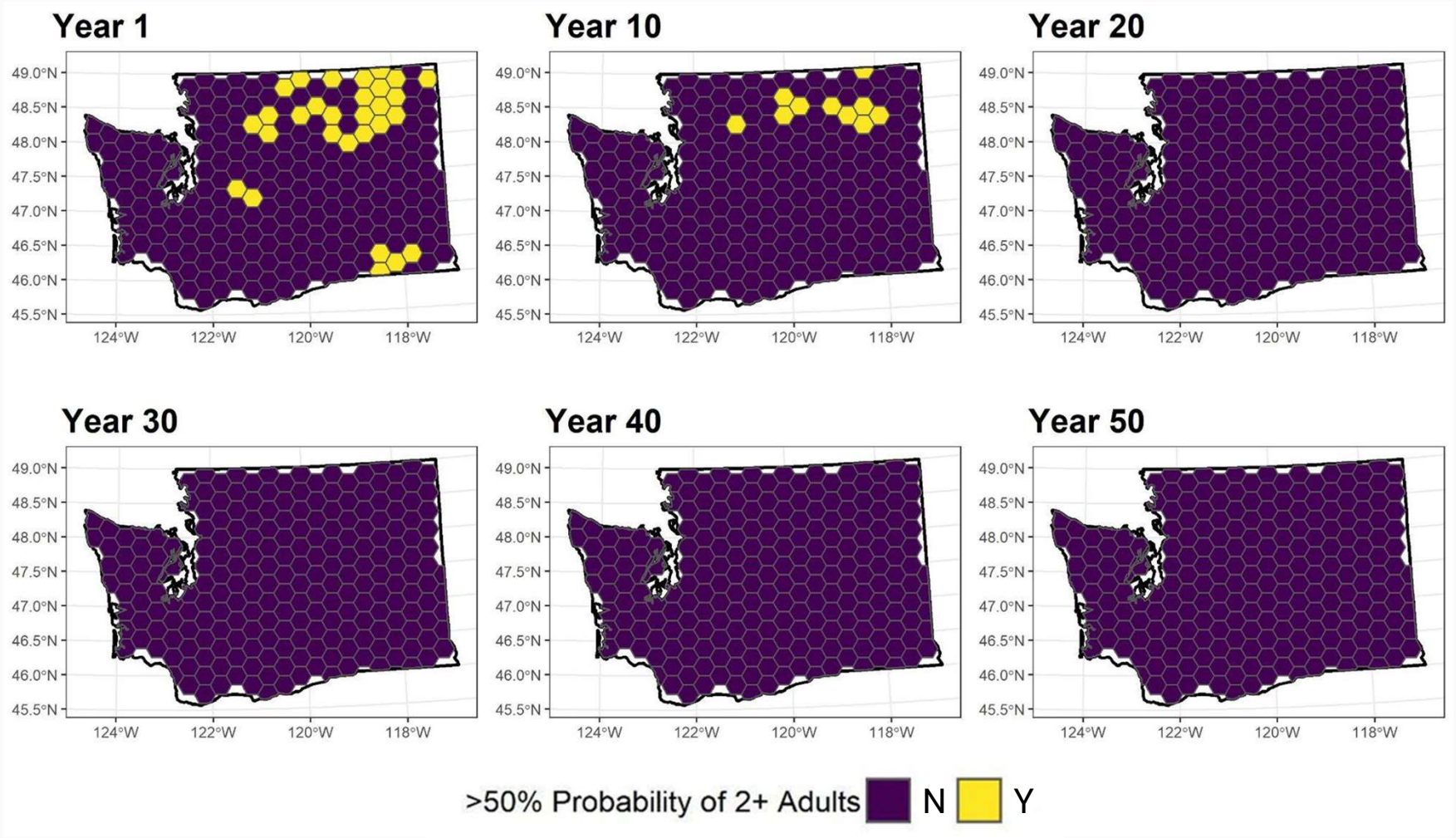
2.5% 6-mo harvest, compens



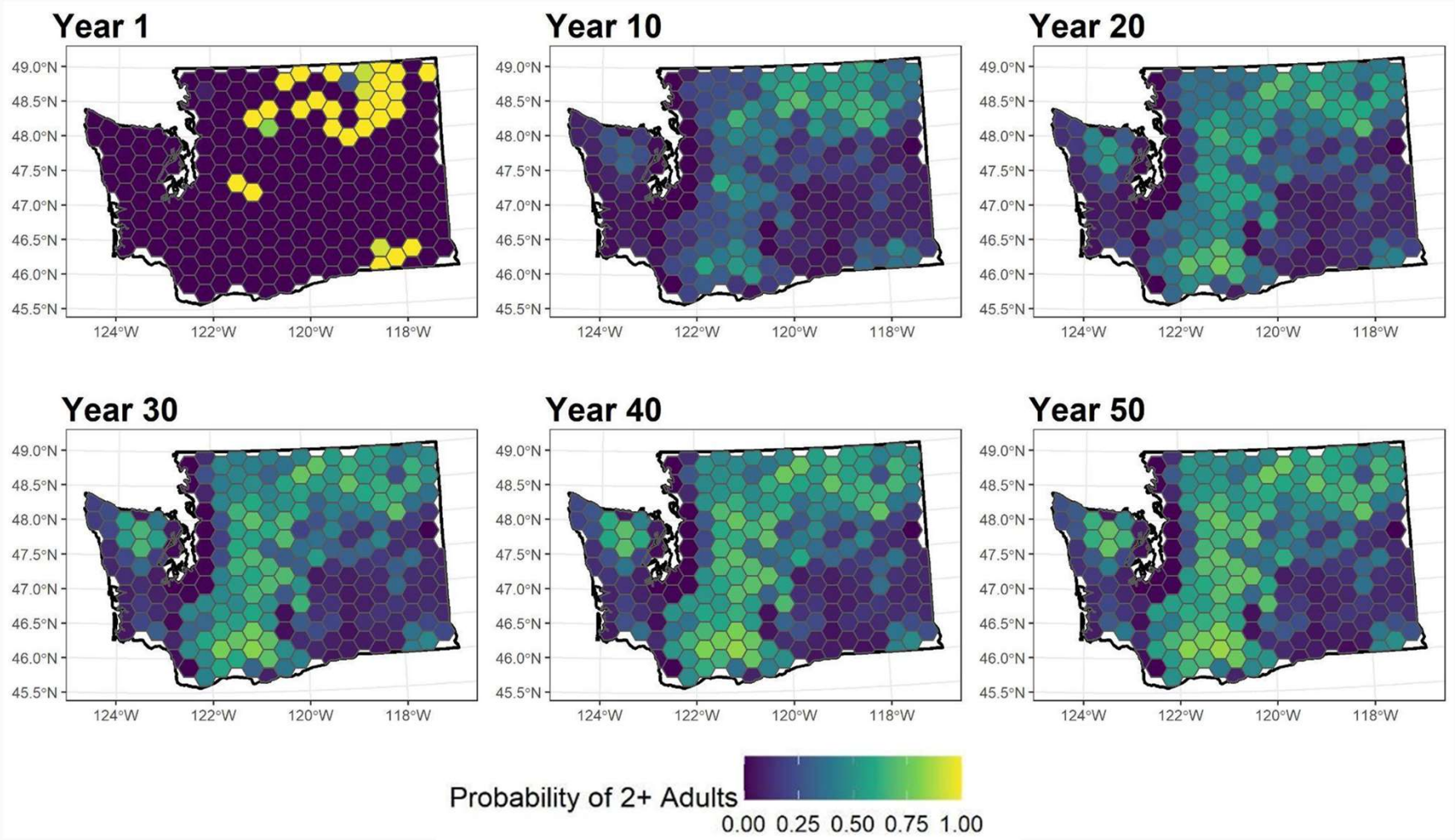
2.5% 6-mo harvest, compens



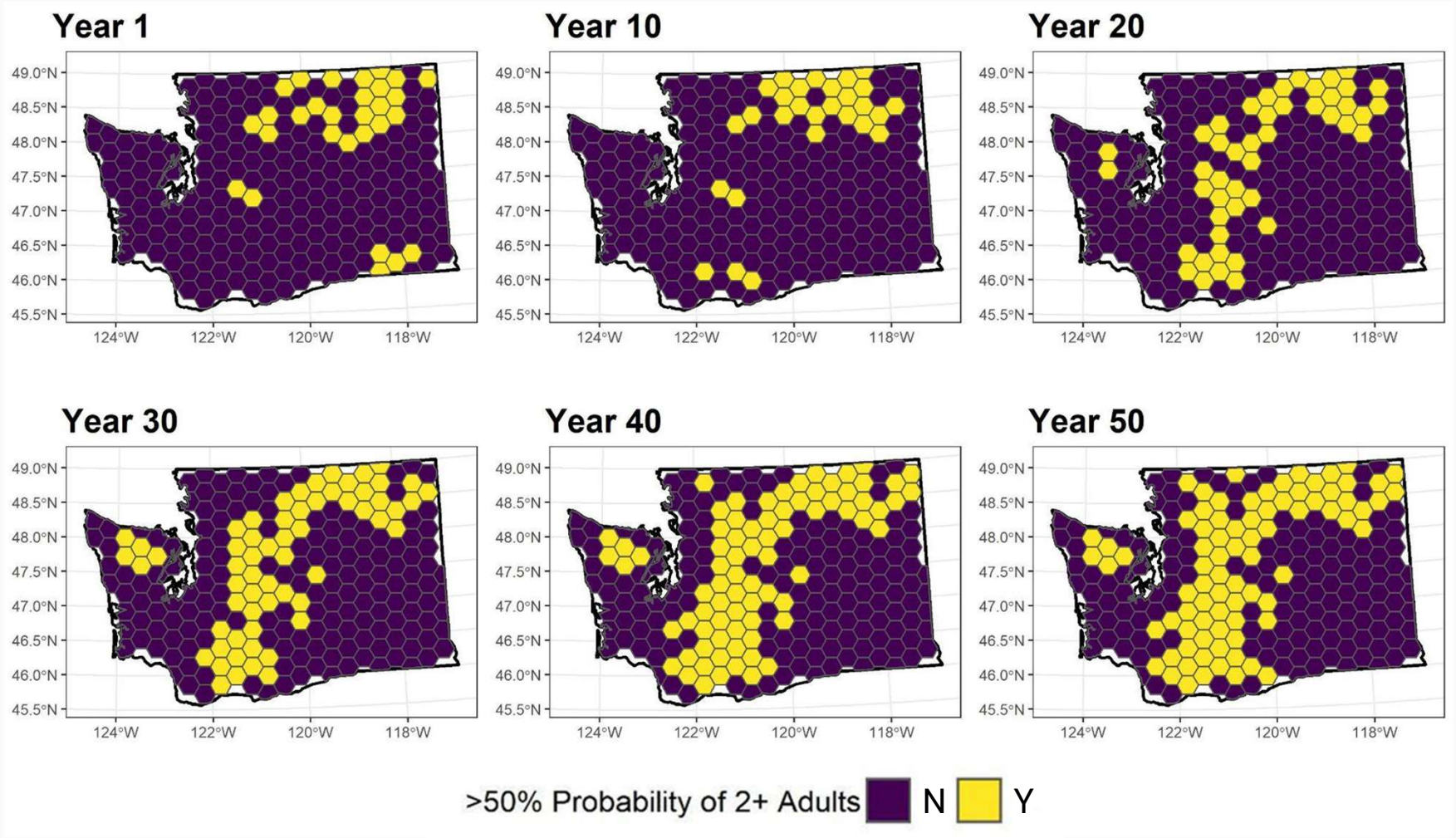
5% 6-mo harvest, additive



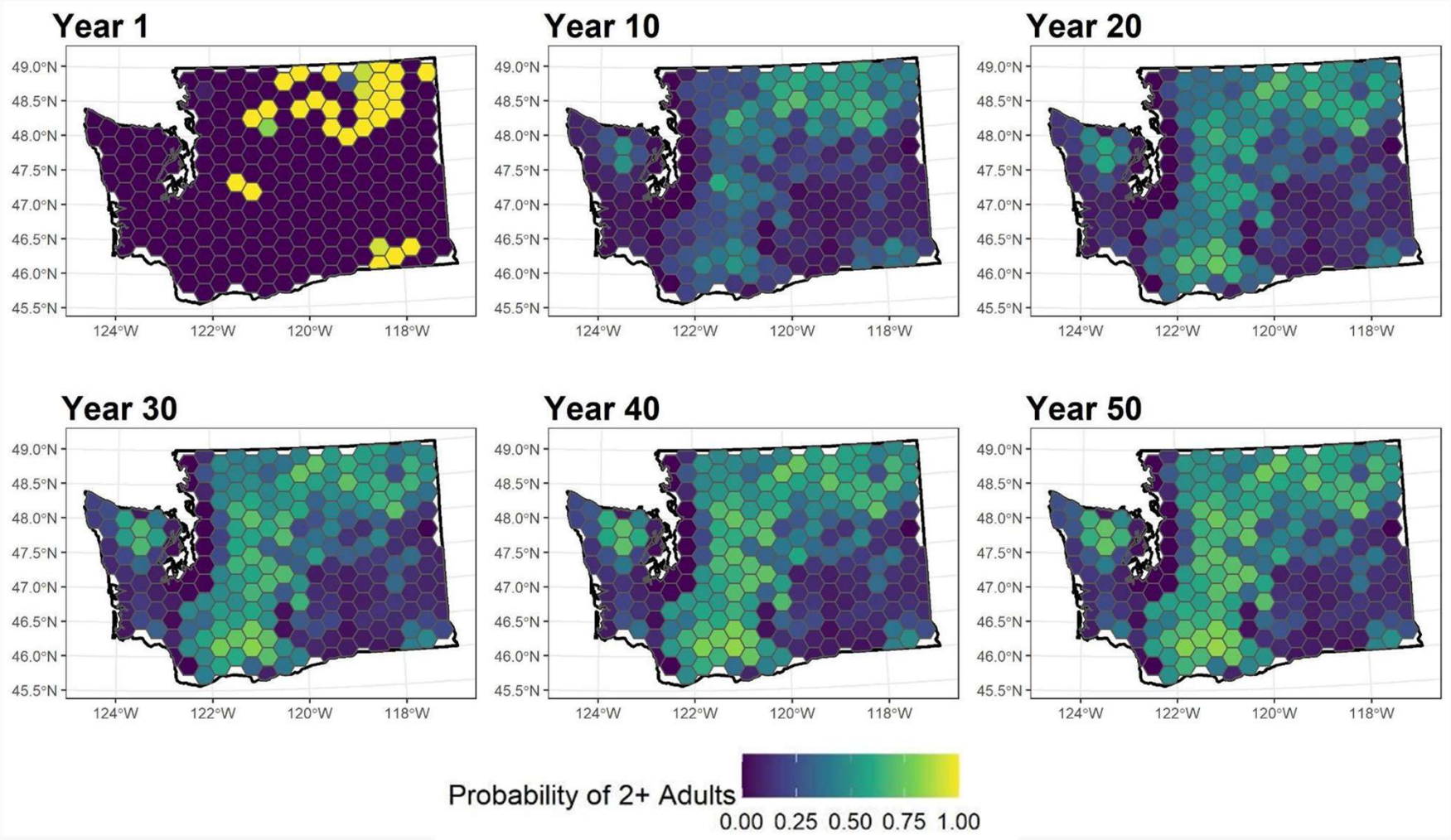
5% 6-mo harvest, additive



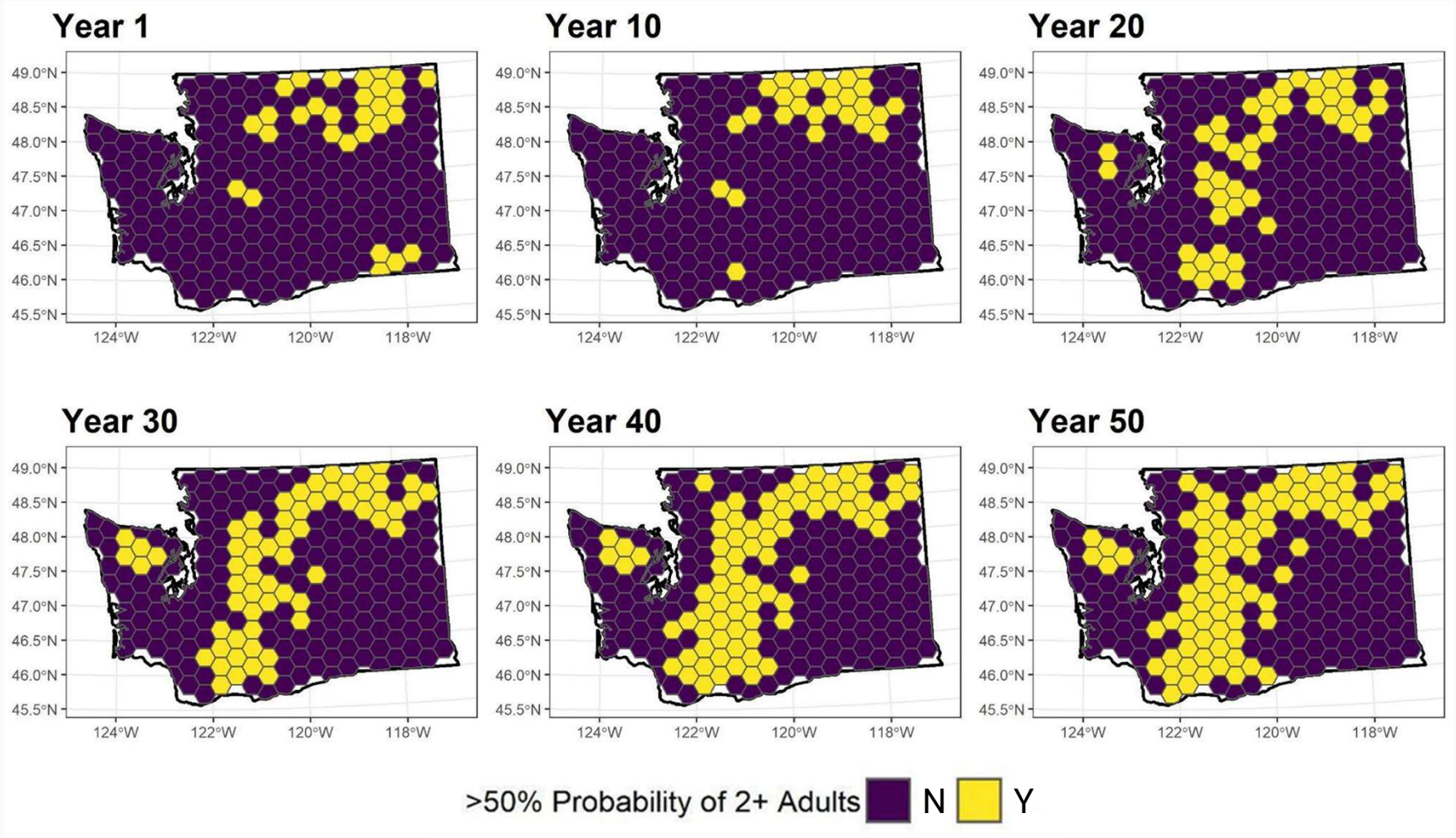
Translocation to Mt. St. Helens



Translocation to Mt. St. Helens



Translocation to Olympic



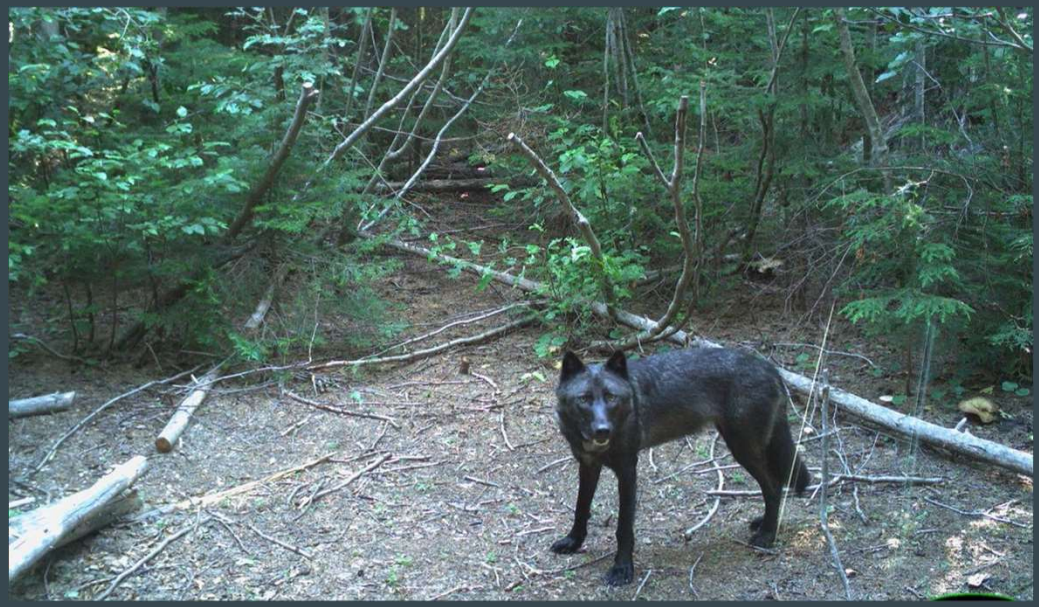
Translocation to Olympic

We can say with confidence that the wolf population is growing.
Predicting movement is difficult, but our models suggest wolves will get to the Southern Cascades, and to the Peninsula too

Cessation of out of state immigration and high additive harvest had the highest impacts on future wolf population abundance

Summary points

- Our model was able to predict current and future wolf population dynamics by combining multiple data streams
    - Modeling the movement process was the trickiest part of this operation
- Baseline and other scenarios should help guide wolf management into the future



Sarah Bassing

Thank you. We welcome your questions.