Detecting occurrence and timing of grizzly bear parturition based on anomalies in accelerometer data

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Acknowledgements:
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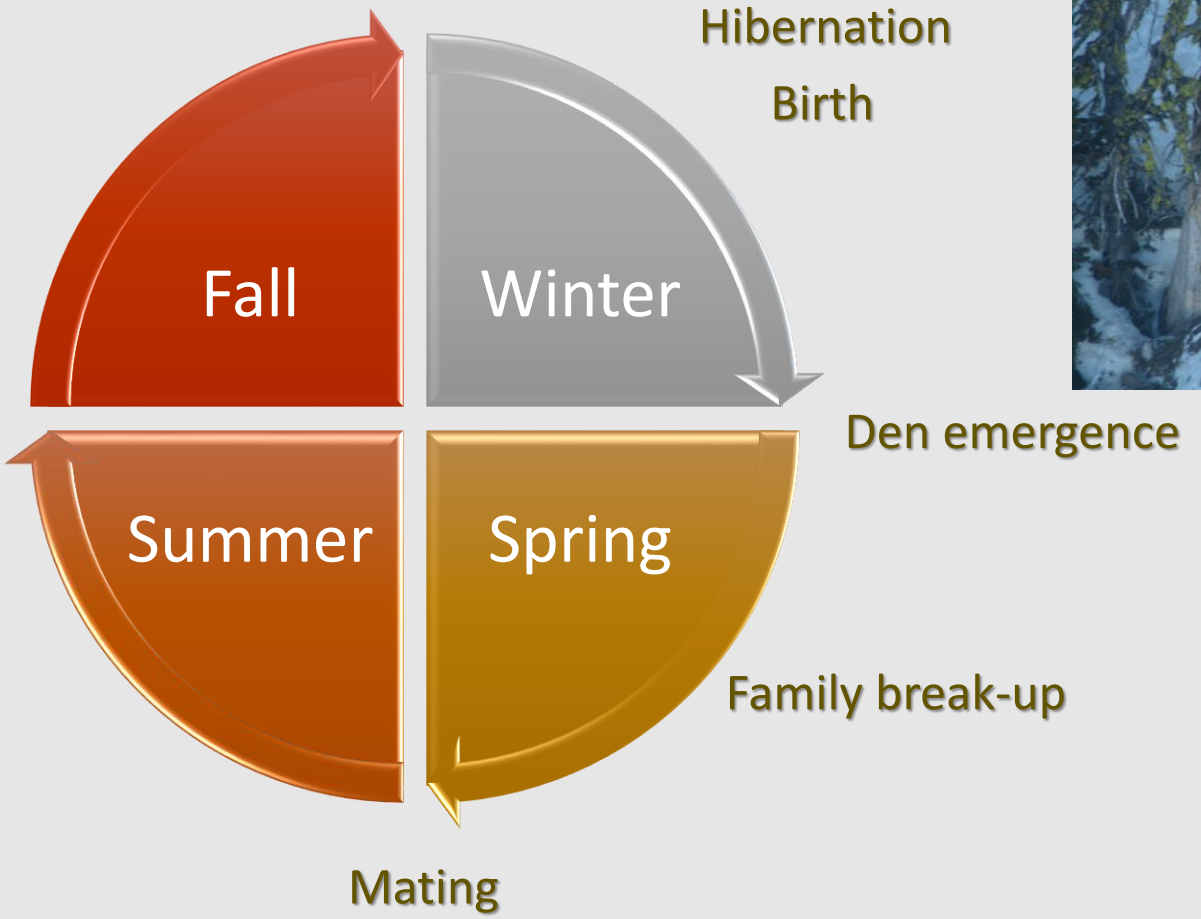
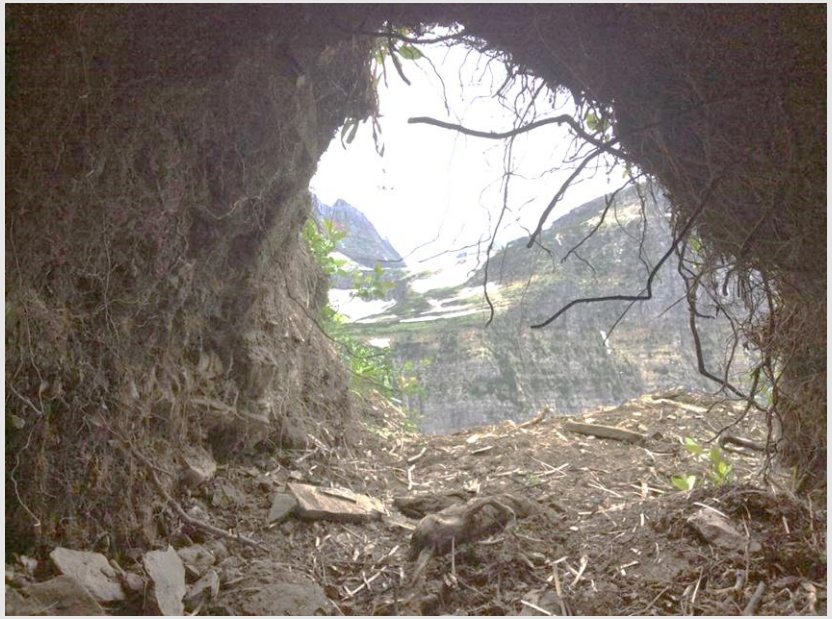
Photo Credit: MFWP

Annual cycle influenced by hibernation





Denning duration is 4 to 6 months

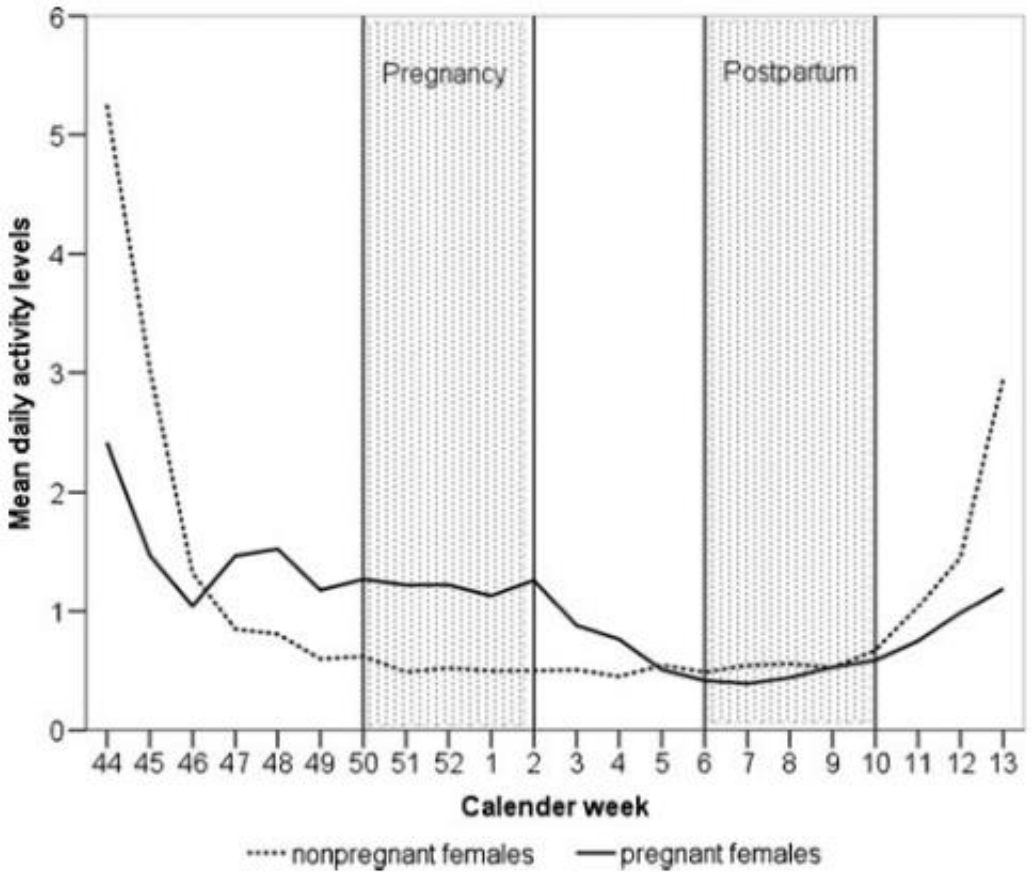


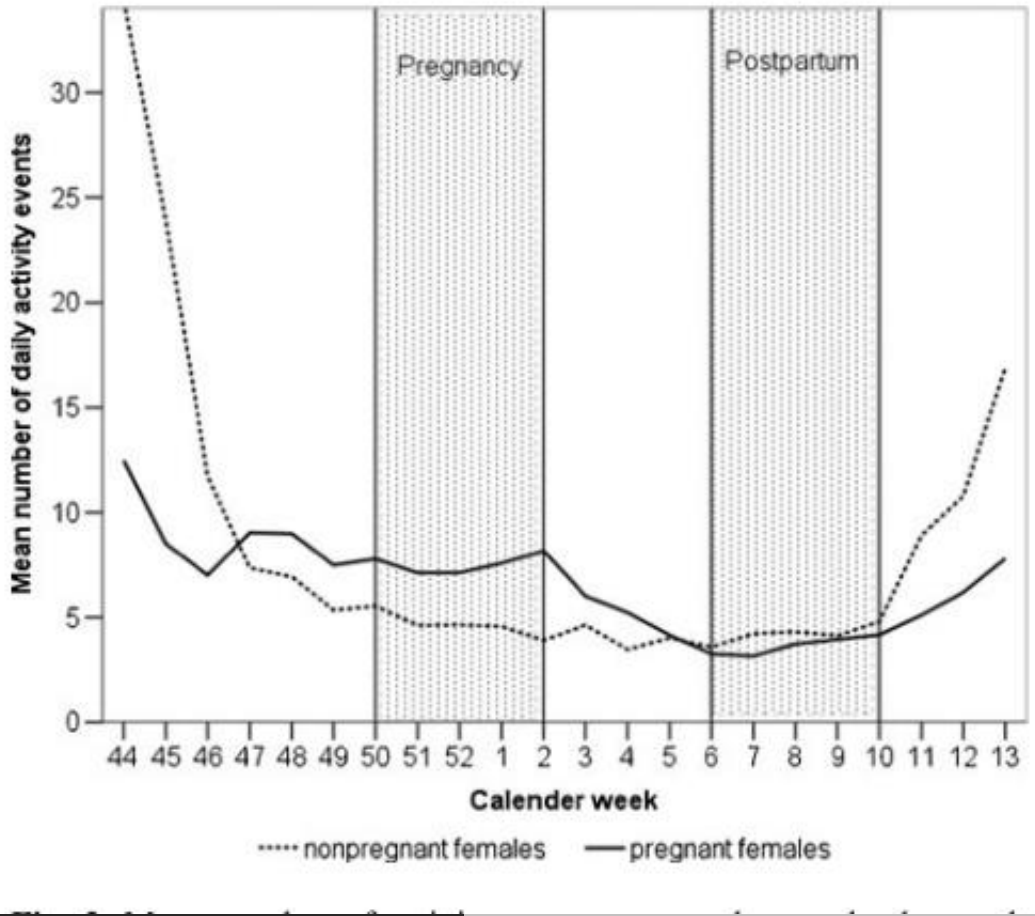
- Most bears enter dens during November
- Extremes examples of September and late December
- Females typically enter dens earlier than males

- Most bears emerge from dens during April
- Extreme examples of January and late May
- Males typically emerge earlier than females



Detection of pregnancy in a hibernator based on activity data (Friebe et al. 2013)





Validation of mercury tip-switch and accelerometer activity sensors for identifying resting and active behavior in bears (Ware et al. 2015)

- Accelerometer did a better job at detecting resting and “active” behaviors.
- Resting behavior was laying, sitting, or standing all other behavior was considered “active”.

Data time-scale (min)	Resting definition (%)	Accelerometer values for resting behaviors	Accelerometer values for active behaviors	Accuracy of classifying resting behaviors (%)	Accuracy of classifying active behaviors (%)	Overall accuracy of classification (%)	Cut-off used
1	100	≤9	>9	94.3	86.6	93.2	0.8
5	80	≤41	>41	94.5	92.8	94.3	0.8
5	100	≤33	>33	93.6	89.9	92.9	0.8
10	80	≤73	>73	93.8	92.2	93.5	0.8
10	100	≤51	>51	92.1	89.4	91.4	0.8
15	80	≤96	>96	93.9	92.9	93.7	0.8
15	100	≤63	>63	90.6	92.2	91.1	0.8
30	80	≤185	>185	92.3	95.9	93.2	0.8
30	100	≤108	>108	90.0	92.4	91.5	0.7
60	80	≤355	>355	92.1	92.3	92.2	0.8
60	100	≤127	>127	91.3	93.2	92.2	0.7

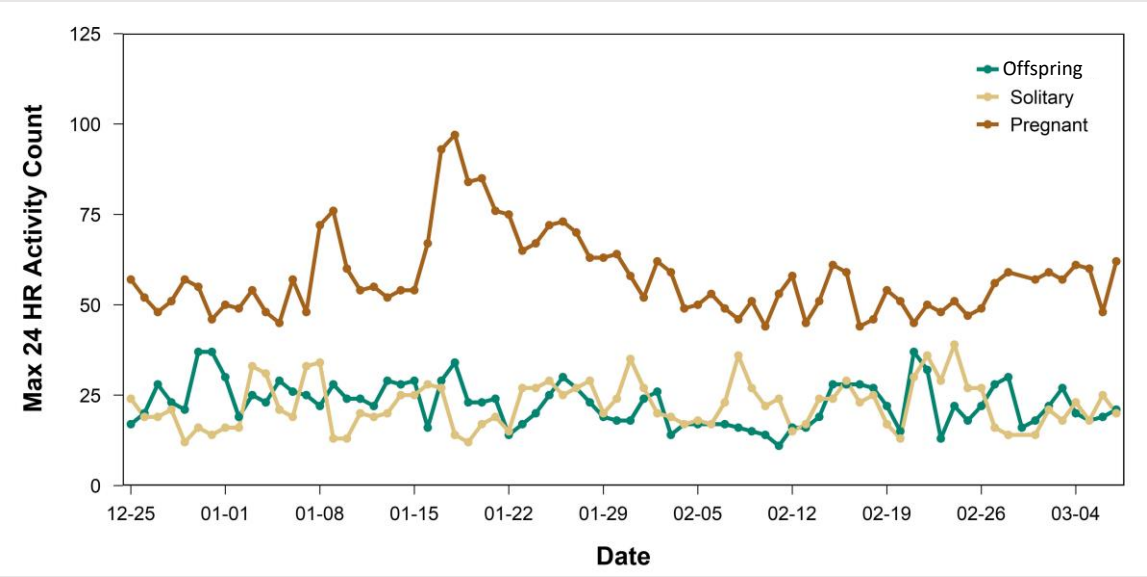
Washington State University Captive Bears

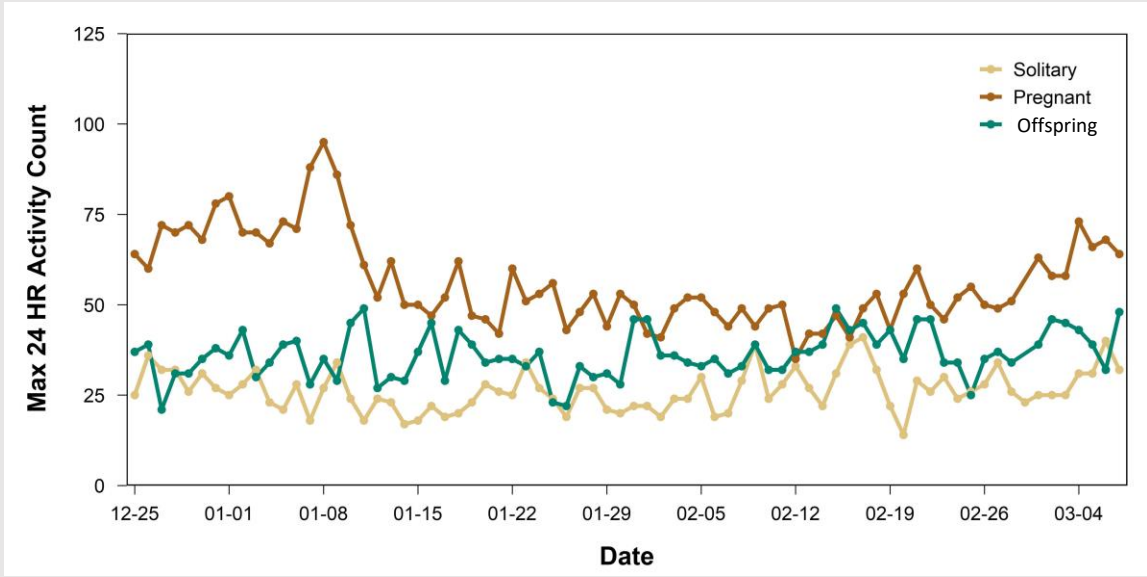
- Maternal condition determine birth date and growth of newborn bear cubs (Robbins et al. 2012)
  - Behavior associated with birth included prolonged licking of the vulva and surrounding area by the female in a sitting, upright posture.
  - Using sound of bawling cub
  - Followed by lateral recumbency of the mother for lactation.
  - Birth dates ranged from January 3rd – 20th. (6 captive females)



Photo Credit: WSU

Female Activity Data during Hibernation



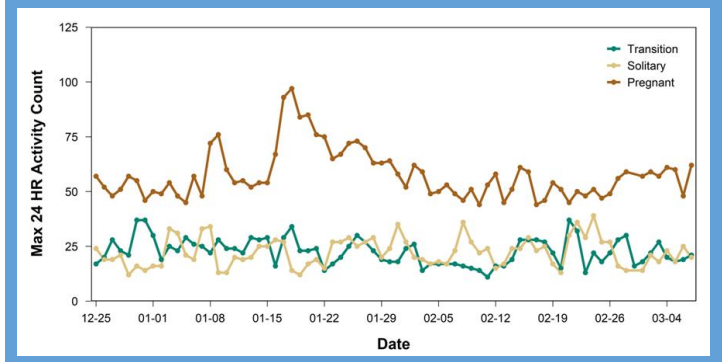


Male Activity Data during Hibernation



Photo Credit: Google

Objectives of this study



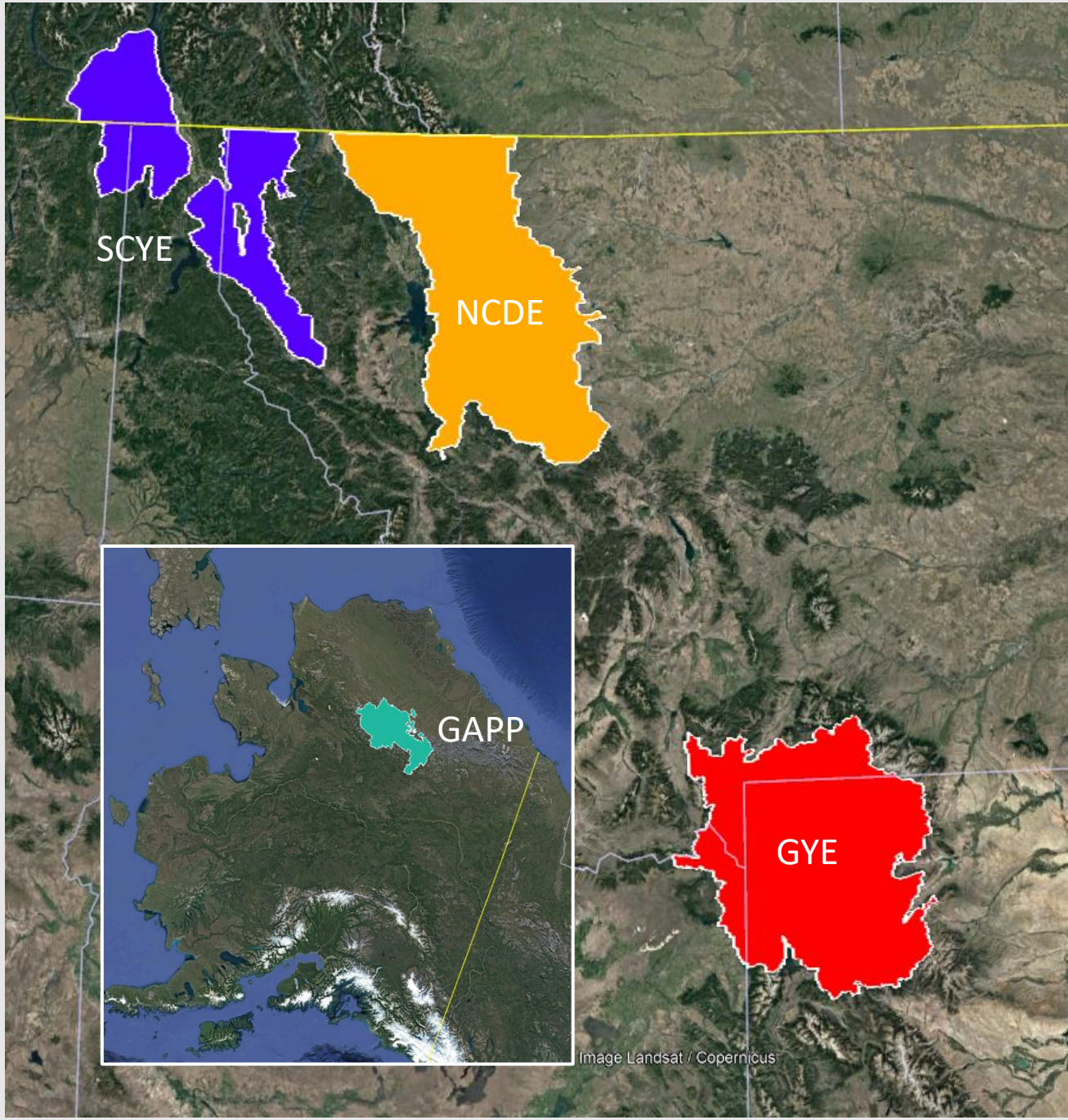
Create a model that could detect parturition event using activity data

Predict parturition in all study areas

Data Acquisition

Northern Continental Divide Ecosystem

- 148 Denning Events from 104 Individuals
- 2009-2022
- Age range: 1-36 ($\bar{x}$ = 11)



Data Acquisition

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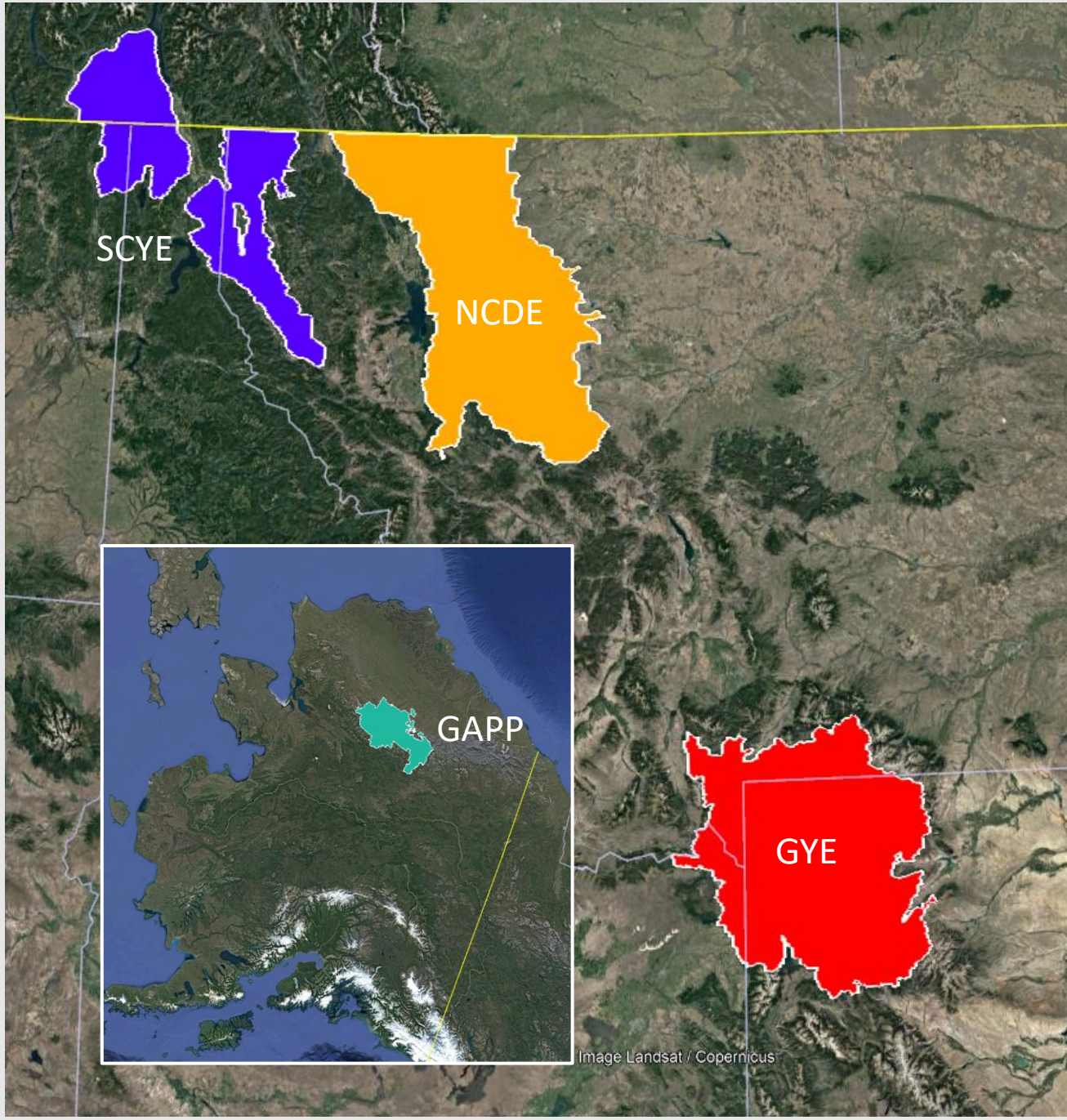
Greater Yellowstone Ecosystem

- 58 Denning Events from 38 Individuals
- 2013-2022
- Age range: 3-22 ($\bar{x}$ = 9)

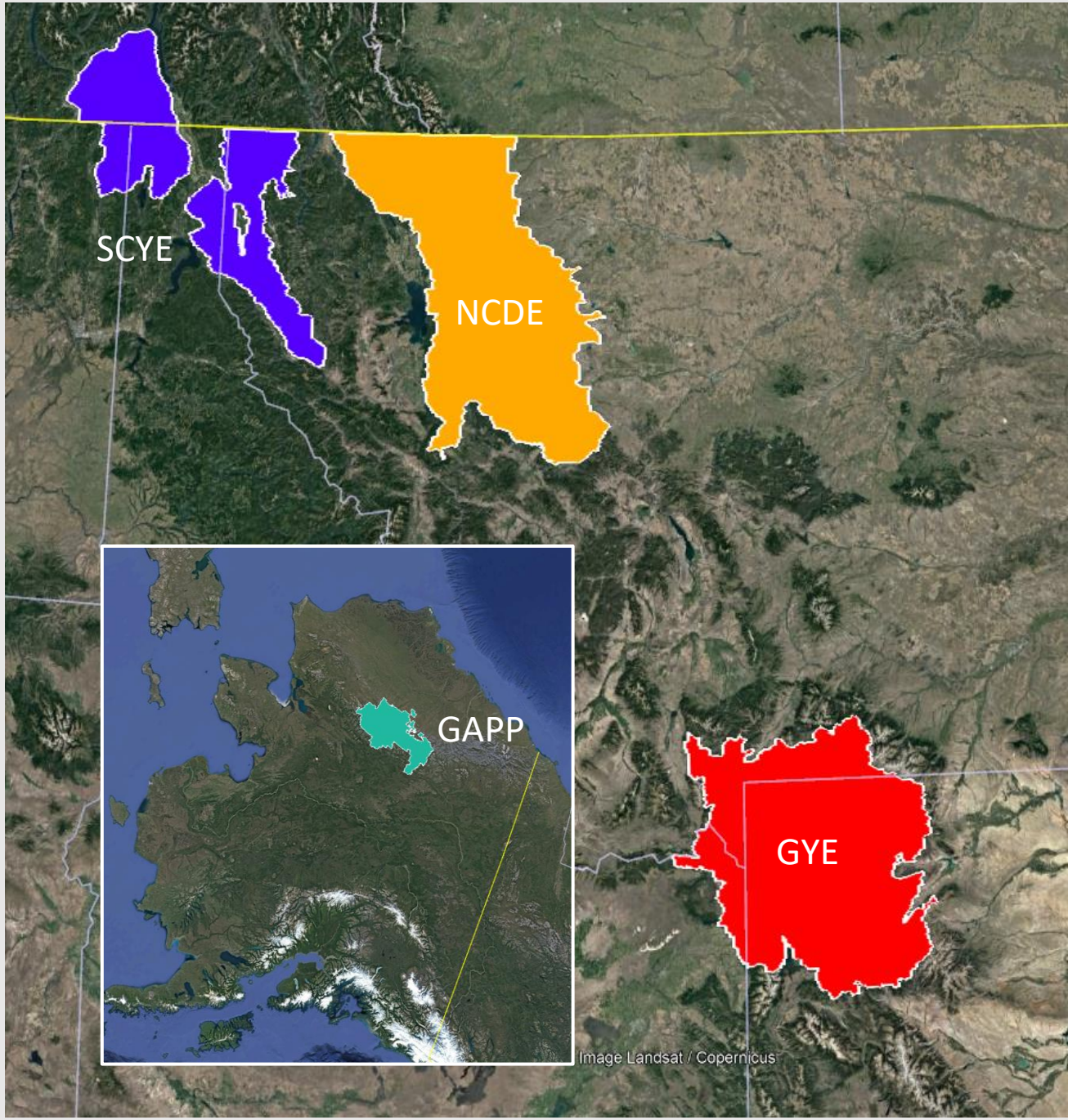


Data Acquisition

Northern Continental Divide Ecosystem
- 148 Denning Events from 104 Individuals
- 2009-2022
- Age range: 1-36 ($\bar{x}$ = 11)

Greater Yellowstone Ecosystem
- 41 Denning Events from 20 Individuals
- 2013-2022
- Age range: 3-22 ($\bar{x}$ = 9)

Selkirk Cabinet-Yaak Ecosystem
- 55 Denning Events from 27 Individuals
- 2011-2022
- Age range: 2-26 ($\bar{x}$ = 10)



Data Acquisition

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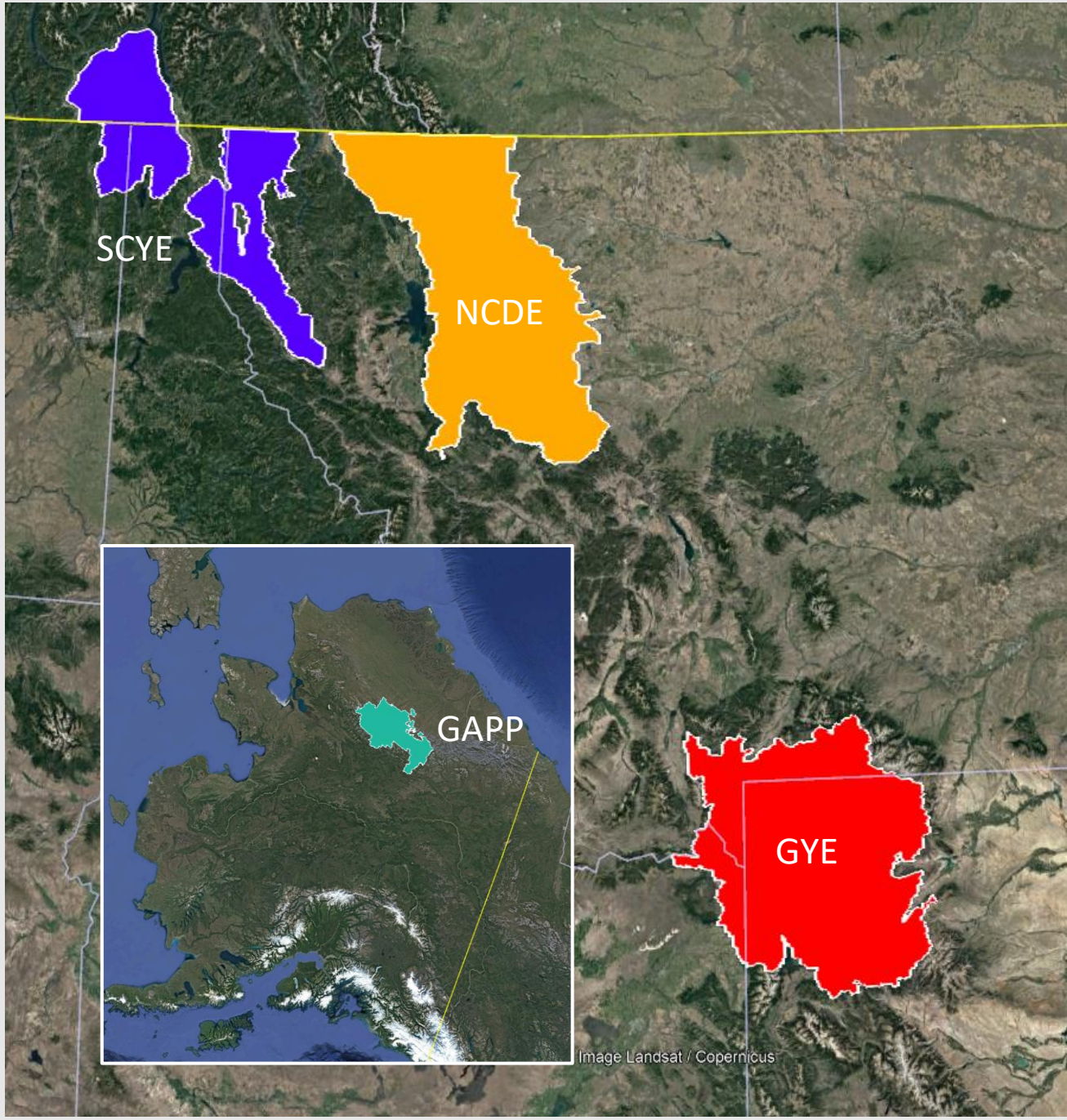
Selkirk Cabinet-Yaak Ecosystem
- 55 Denning Events from 27 Individuals
- 2011-2022
- Age range: 2-26 ($\bar{x}$ = 10)

Gates of the Arctic Park and Preserve
- 55 Denning Events from 25 Individuals
- 2014-2017
- Age range: 6-28 ($\bar{x}$ = 14)



Observed Status

Based on age at den emergence and/or reproductive status after den emergence.

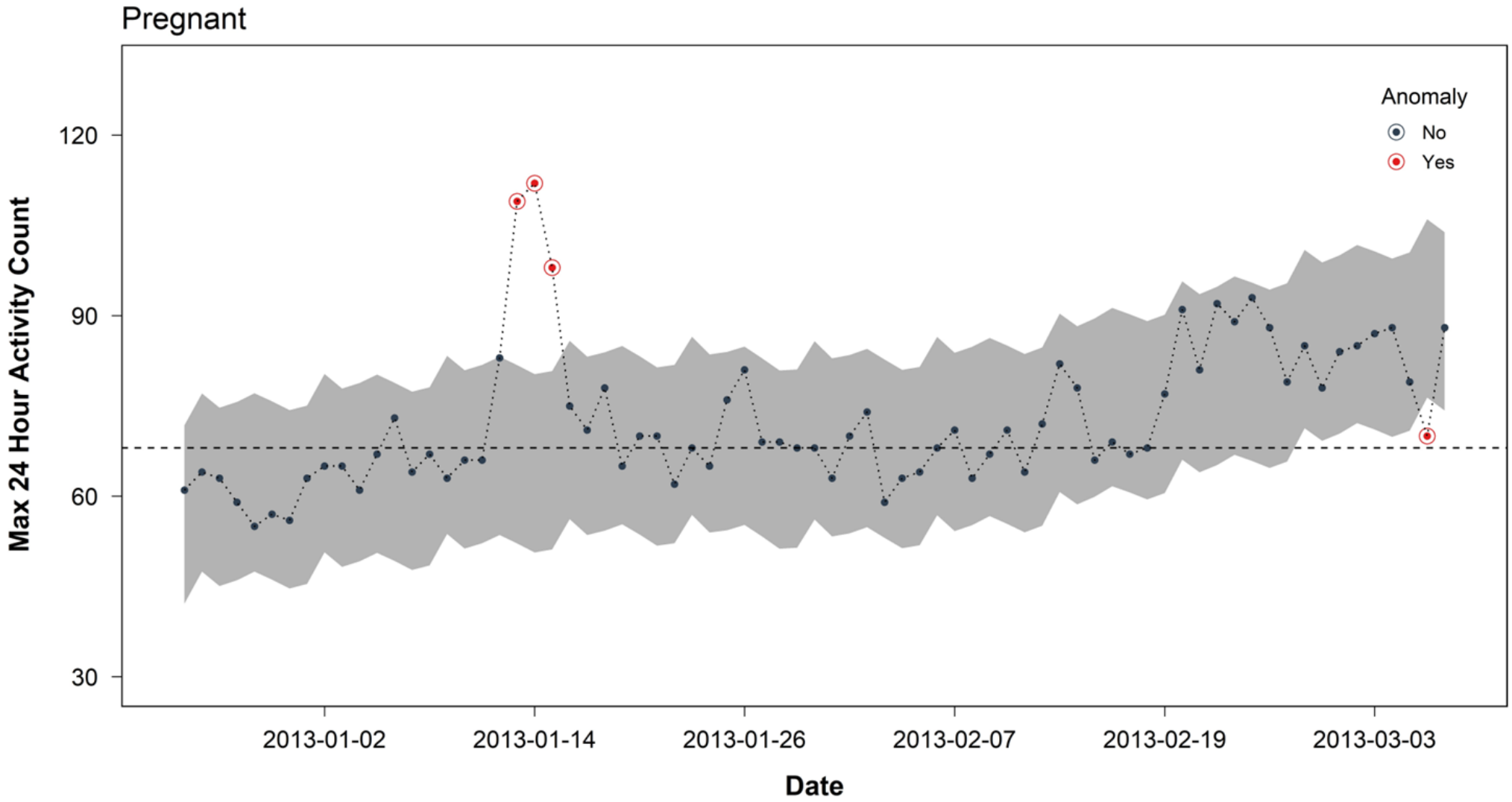
- Subadult ≤3 years old
  - The youngest observed age of first litter was 4 across all study areas.
- Pregnant
  - Observed with cubs of the year after emergence
- Female with Offspring
  - Observed with cub or yearling offspring before entry or yearling or 2-year-old offspring after emergence
- Solitary
  - Adults observed alone before entry and after emergence
- Unknown
  - Adults not observed before entry or after emergence

New Method to detect parturition using activity data

- Selected a sample Known Pregnant Females from the NCDE
  - 22 Denning Events from 18 Known pregnant females (2012-2017)
  - Age range: 4-24 ($\bar{x}$ = 12)
- Each activity count reading >0 = 1 (Active)
- 24 Hour running window of the max activity
- Dates range from December 25th to March 7th
  - Detecting Parturition in January and February
- R-Package Anomaly



Anomaly Results



Anomaly Results

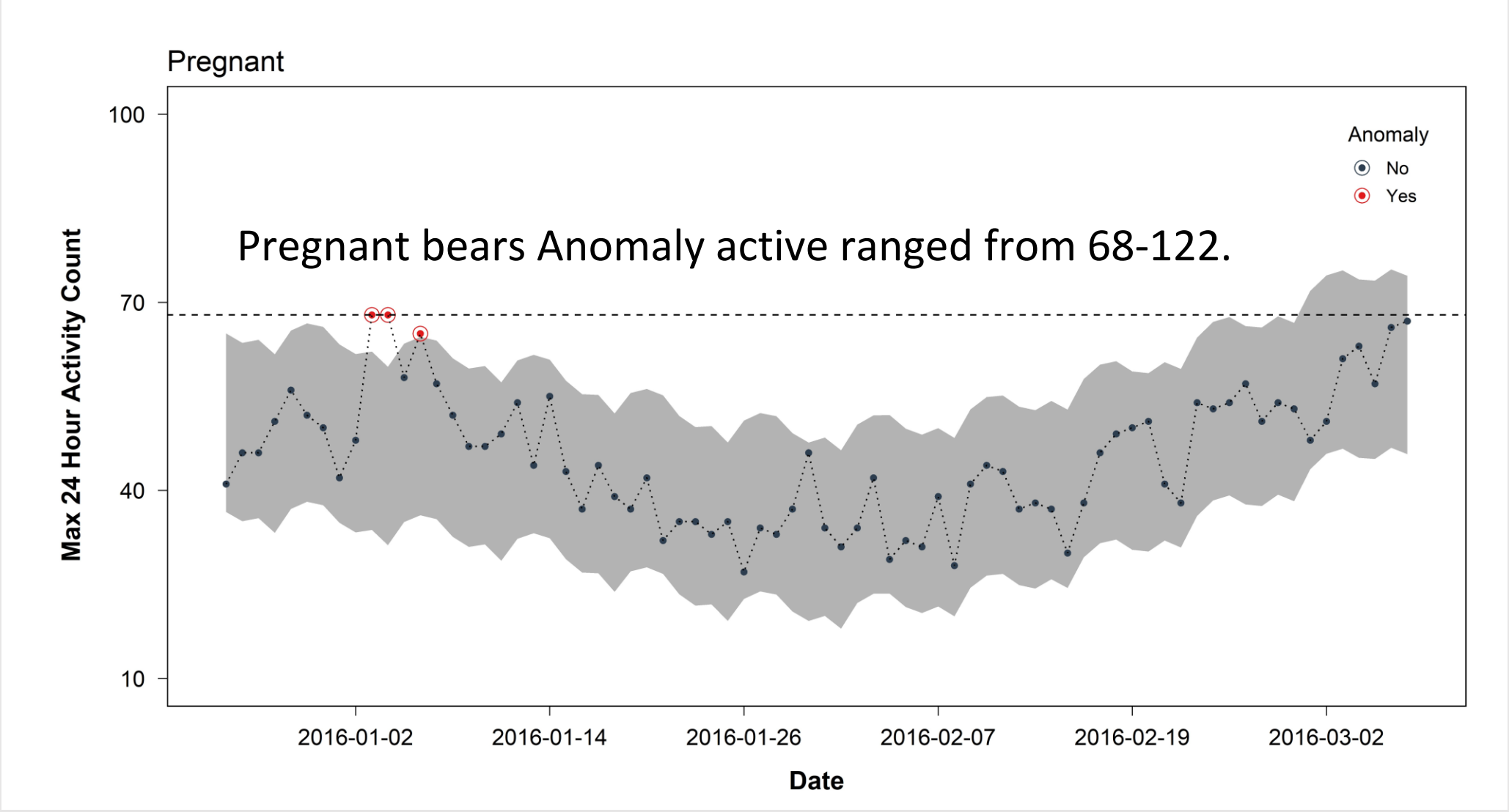




Photo Credit: MFWP

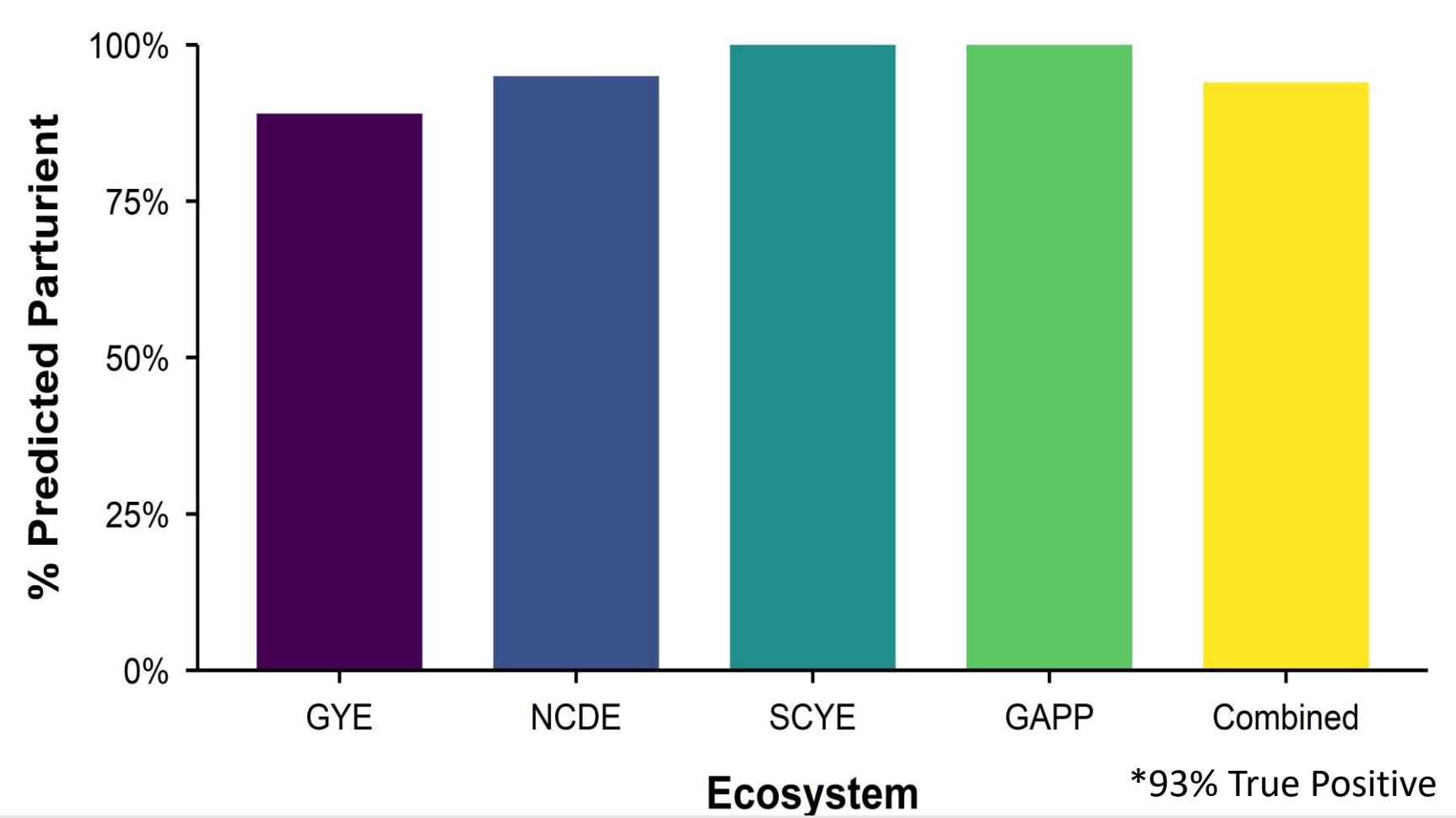
Predict Parturition

- All remaining data was run blindly

- Pregnant → Detect Anomaly
- Female with Offspring → No Anomaly
- Subadults → No Anomaly
- Solitary and Unknown

Detect Anomaly No Anomaly

Pregnant Category

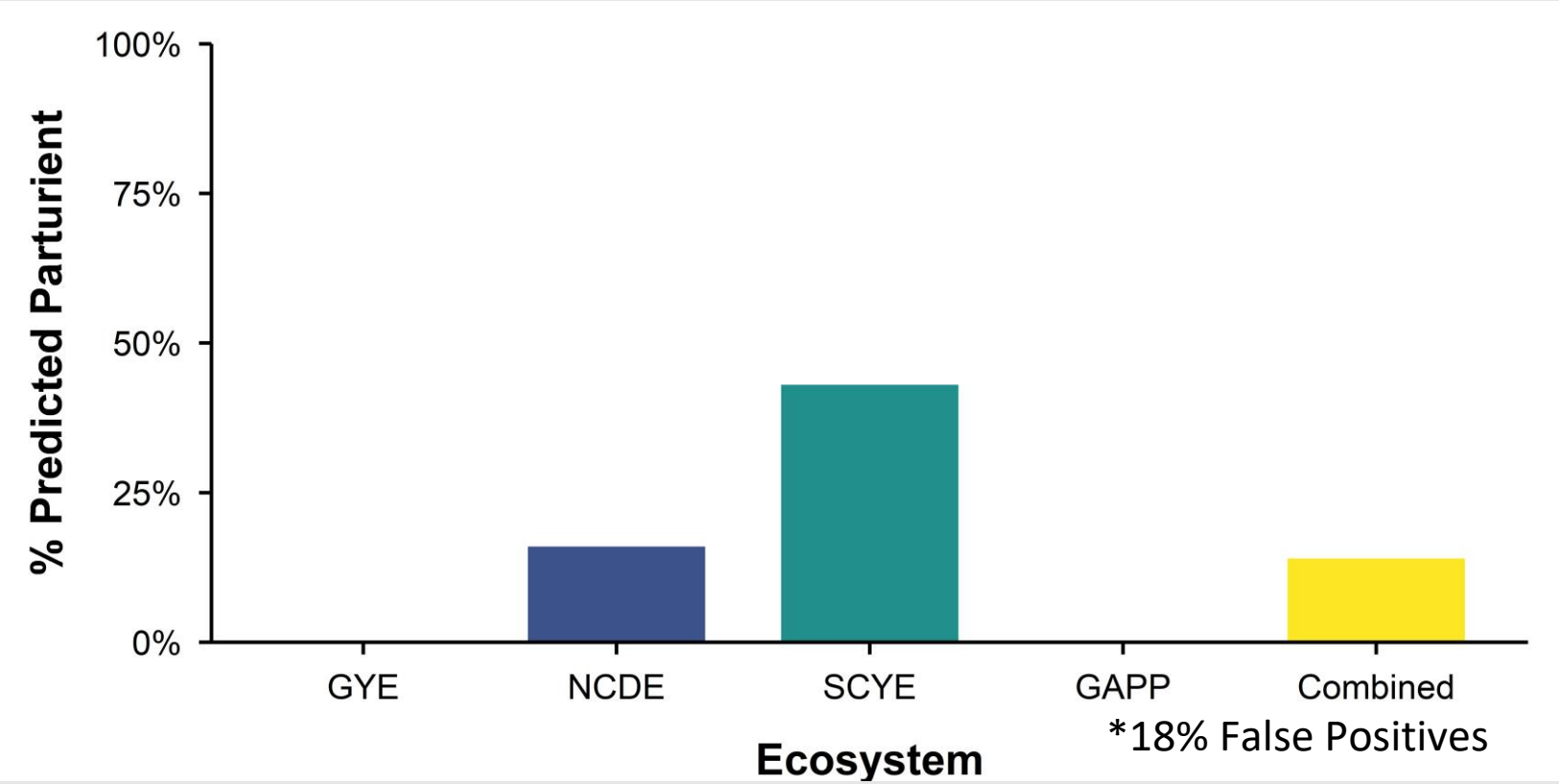


*93% True Positive



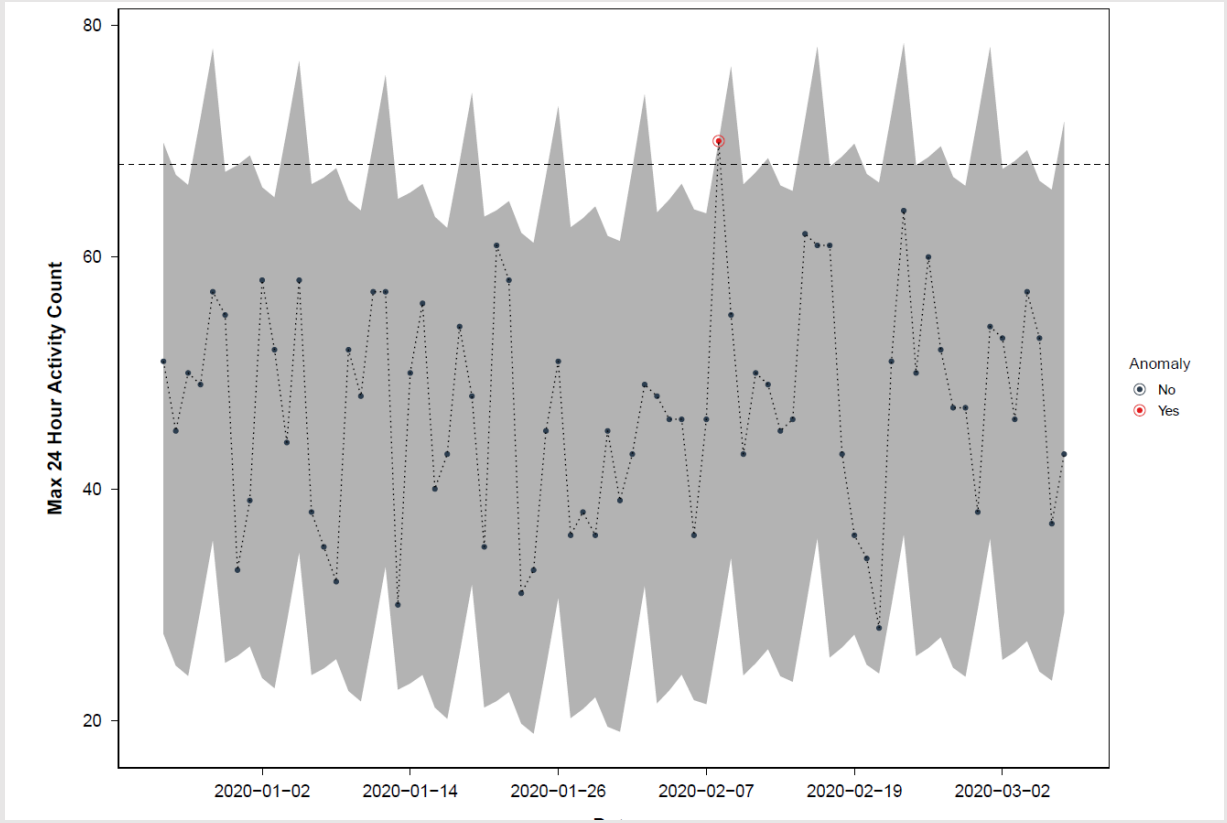
Photo Credit: MFWP

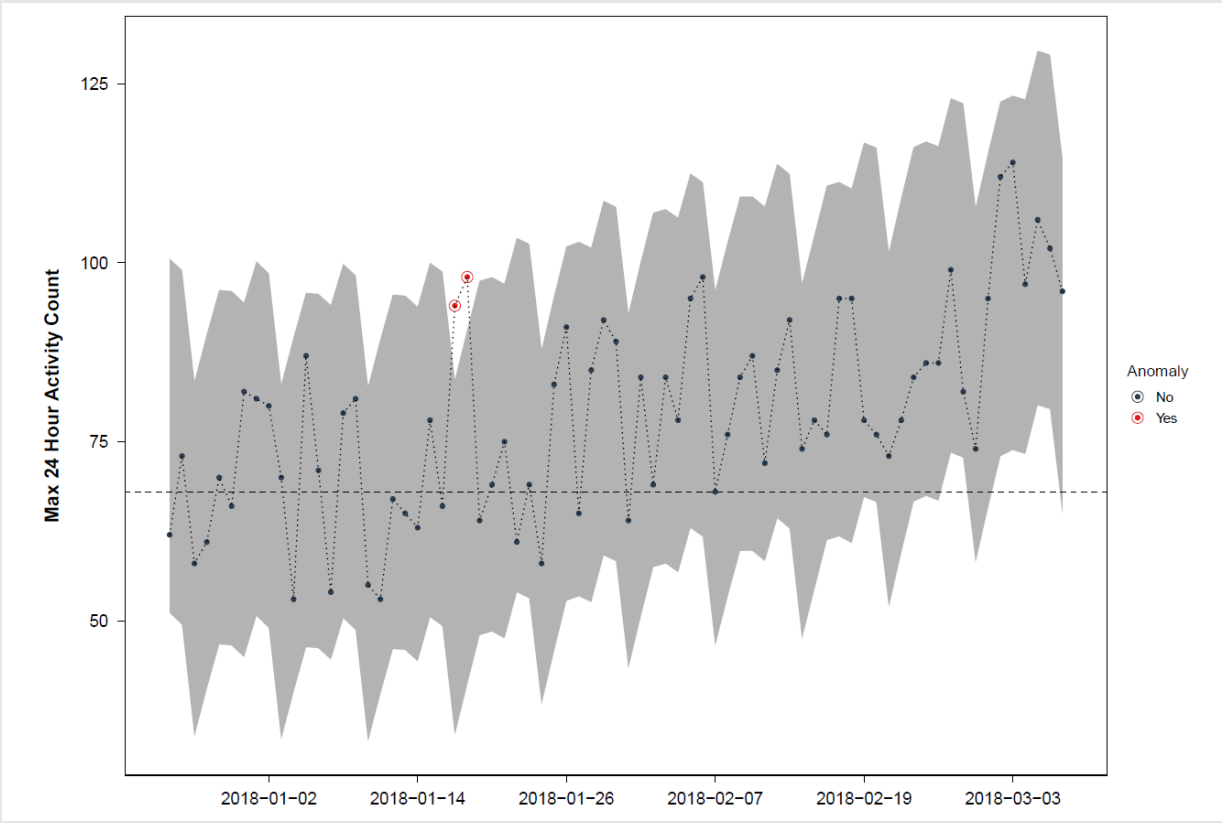
Female with Offspring Category





Anomaly Results





Subadult Category

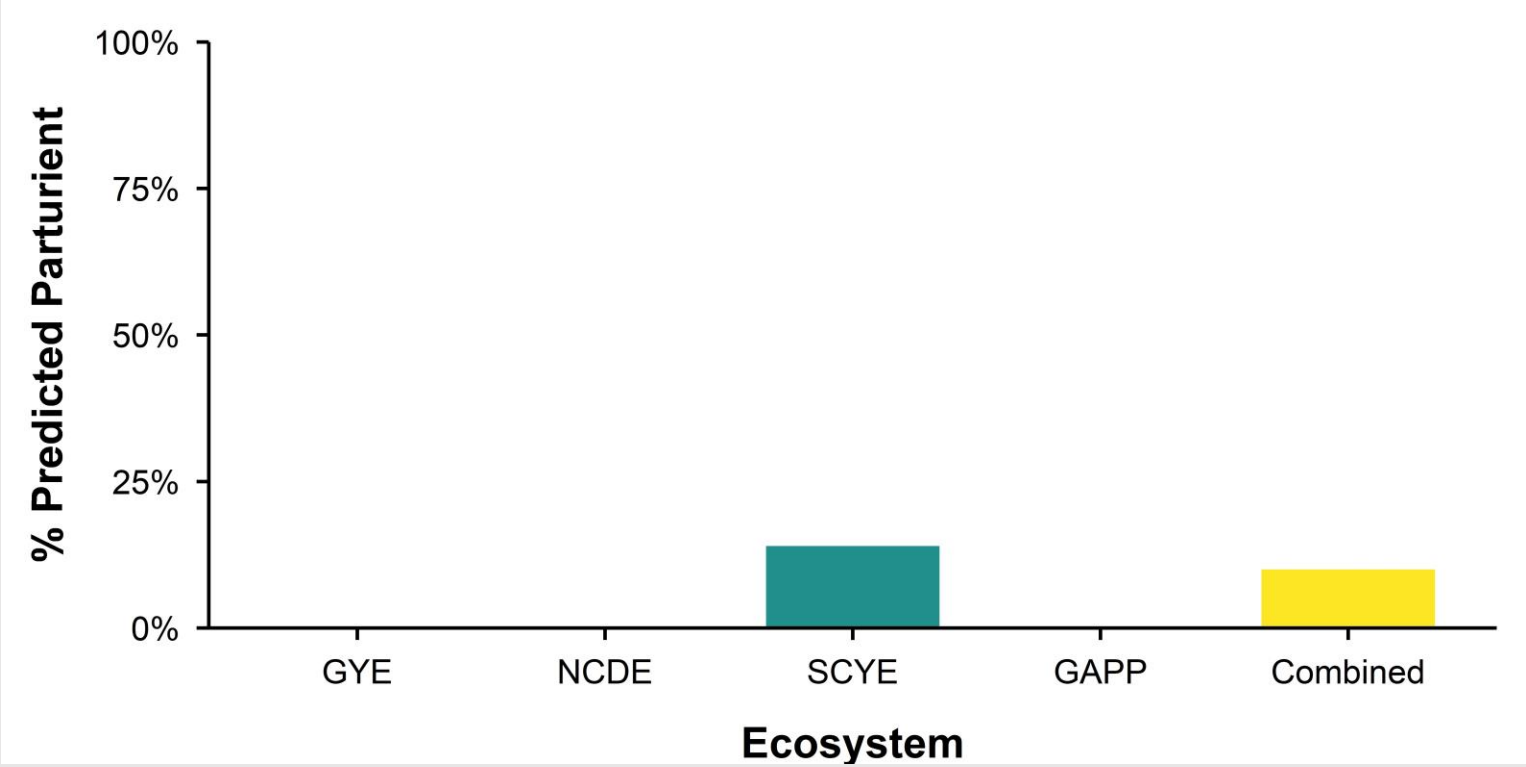



Photo Credit: MFWP

Solitary Category

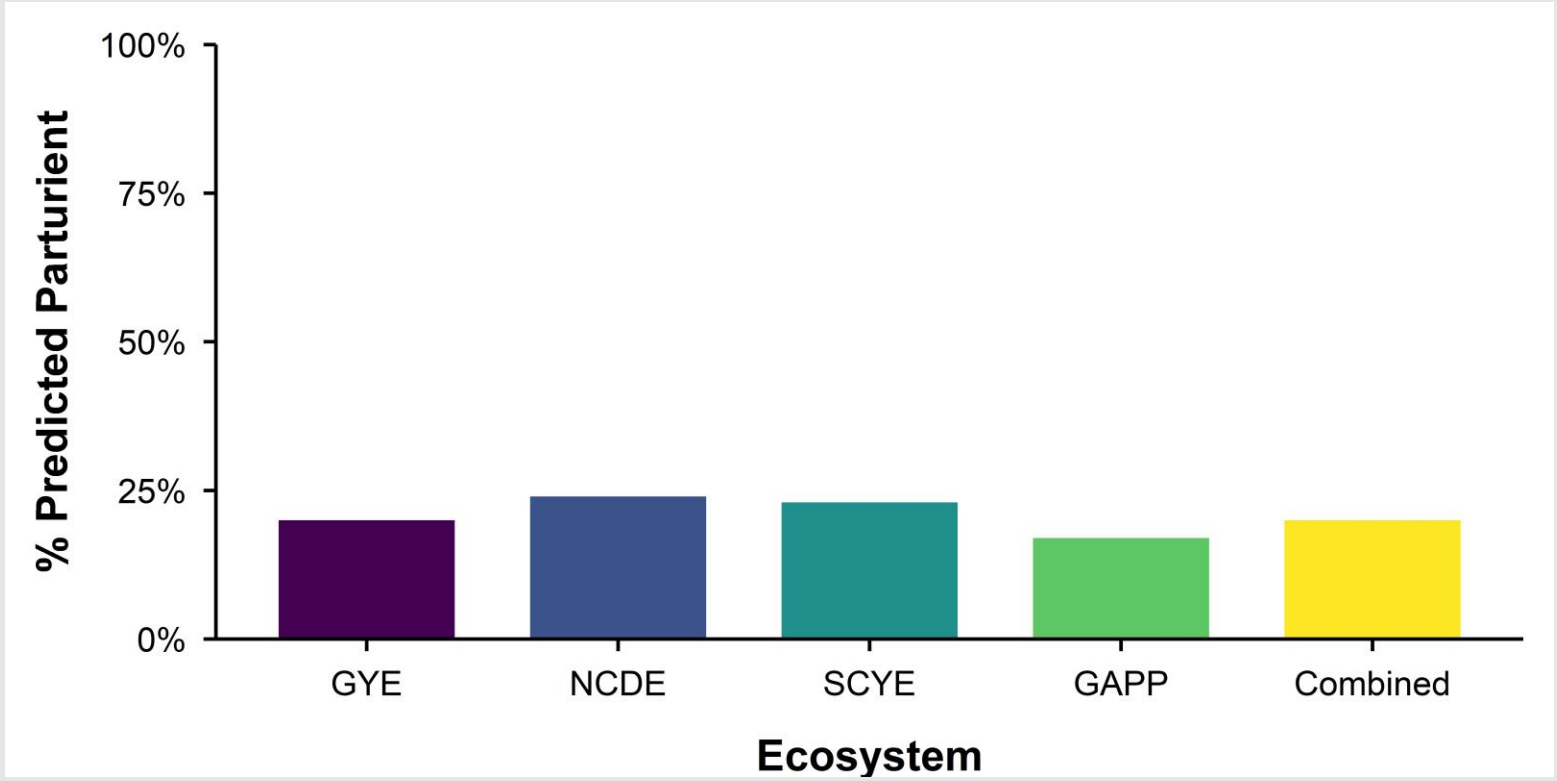
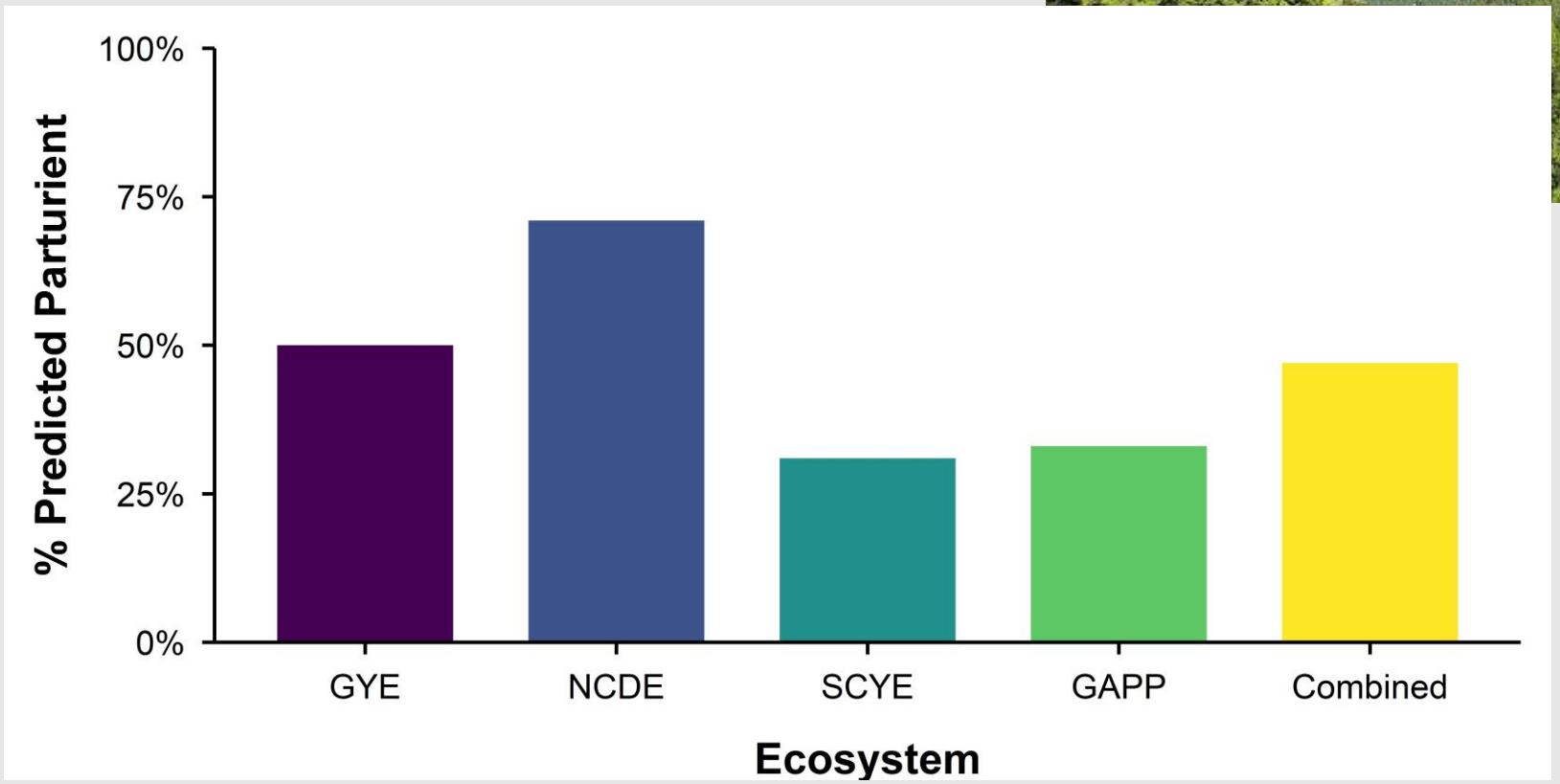


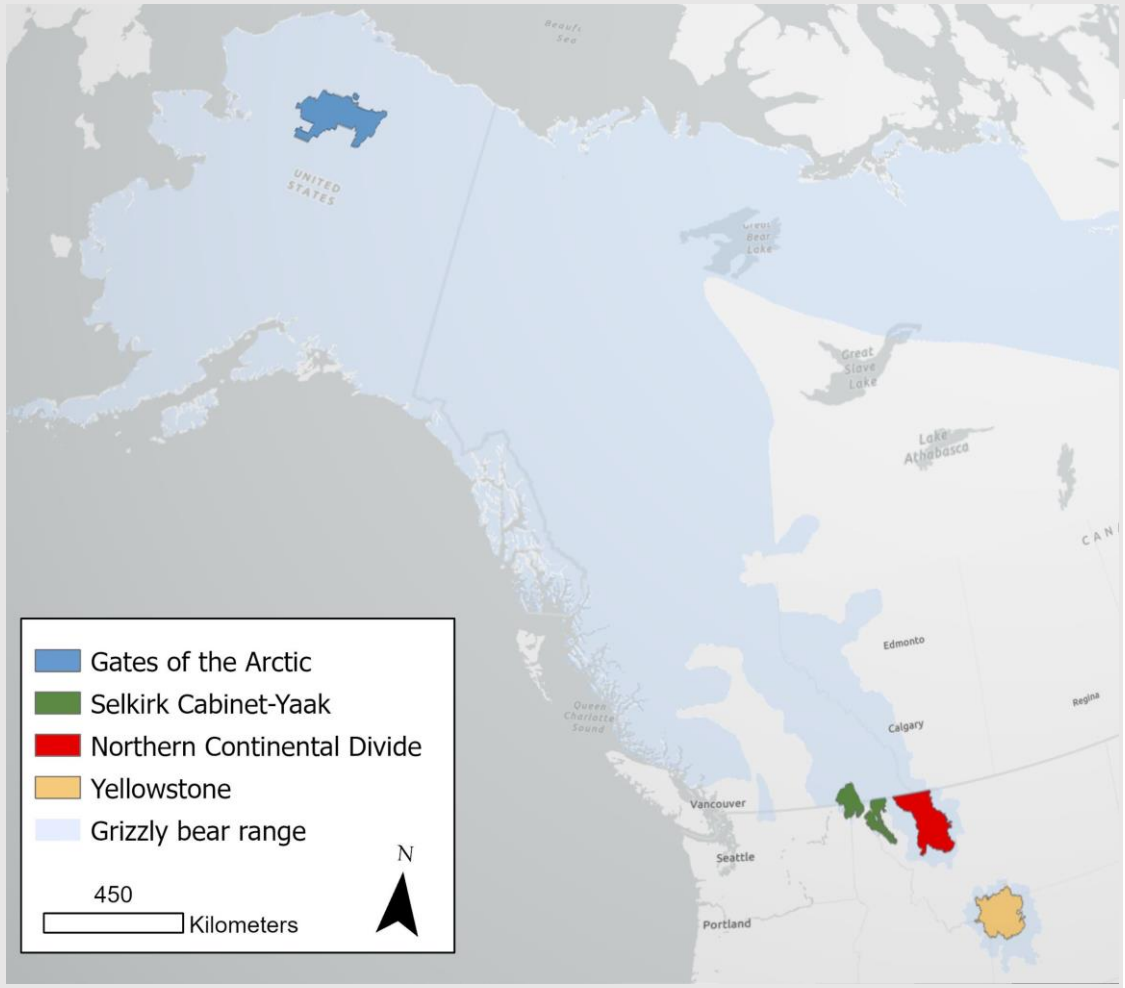

Photo Credit: MFWP

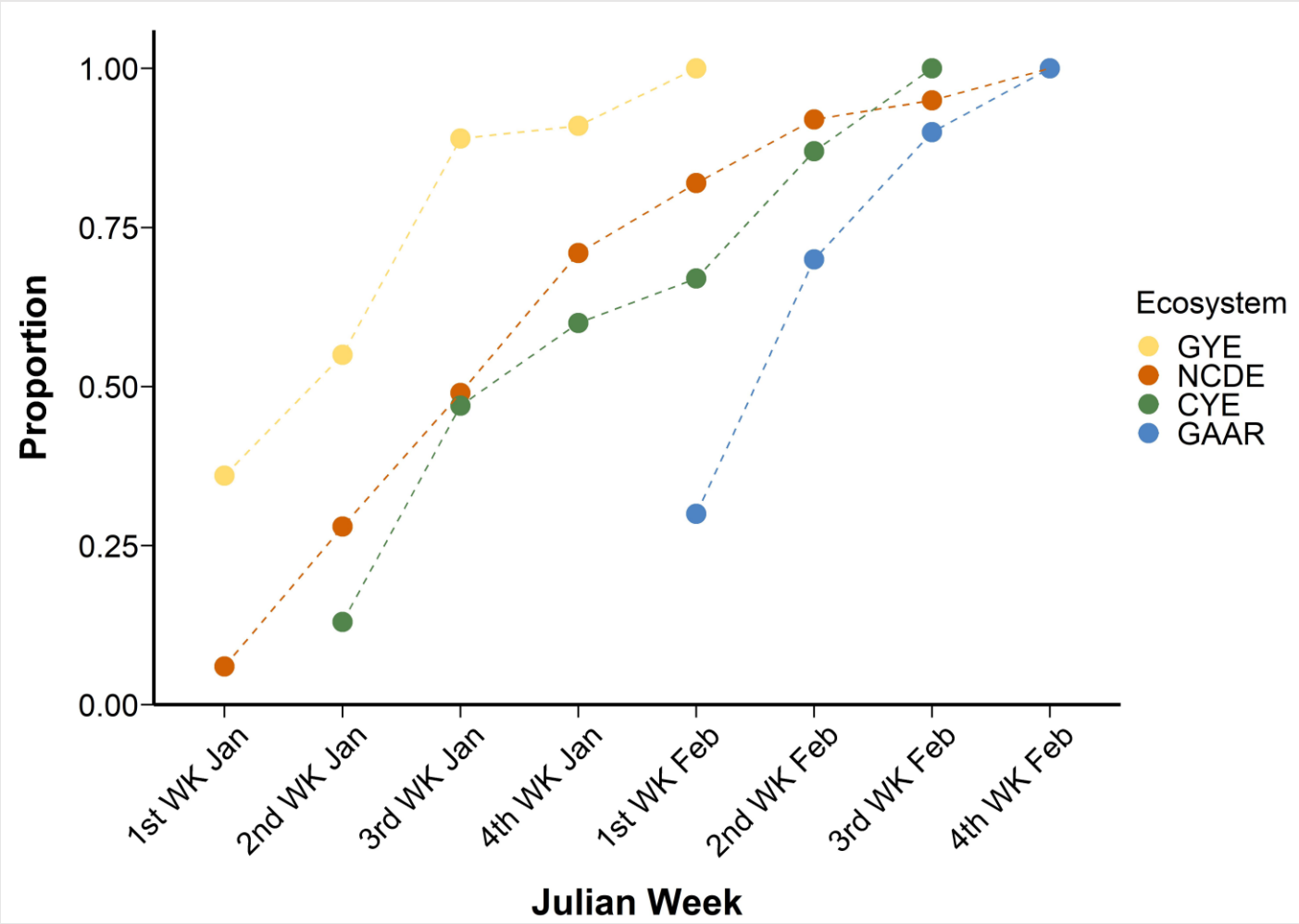
Unknown Status Category





Latitude Difference





Applications

- Population Vital Rates
- Cub loss in Den
- Can we detect the litter size?
- Split Parturition
- Physiological and Energetic Questions


Photo Credit: R. Mace


Photo Credit: MFWP

Questions???

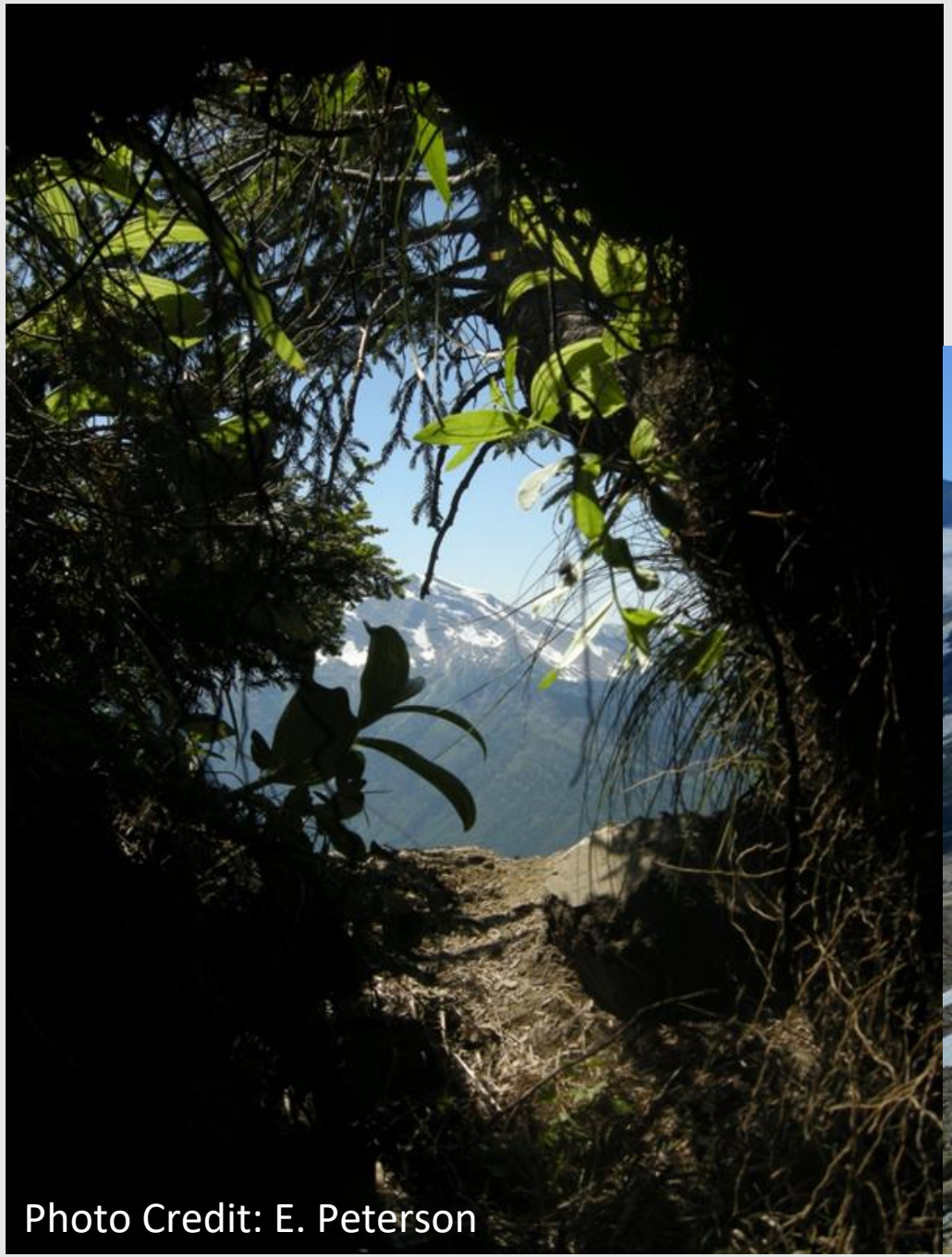


Photo Credit: E. Peterson



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