The ultimate driver of birth timing in grizzly bears: synchronized cues or an energetic tradeoff ?

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Credit: MFWP

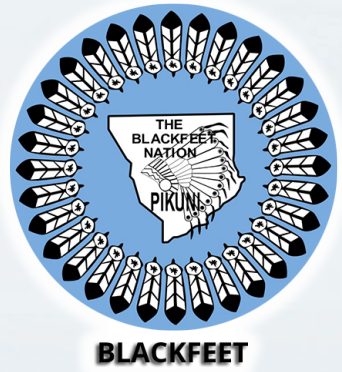
Many thanks!!

To the state, federal, and tribal agencies supporting work
& all the field staff of that contributed to decades of data collection for this study





















Grizzly bears display distinct seasonality of births in winter

- Seasonal timing evolved due to ancestral traits common to ursids*
  - Delayed implantation
  - Highly altricial young
  - Obligate maternal denning

- For species in the Ursinae subfamily, maternal denning = hibernation denning*

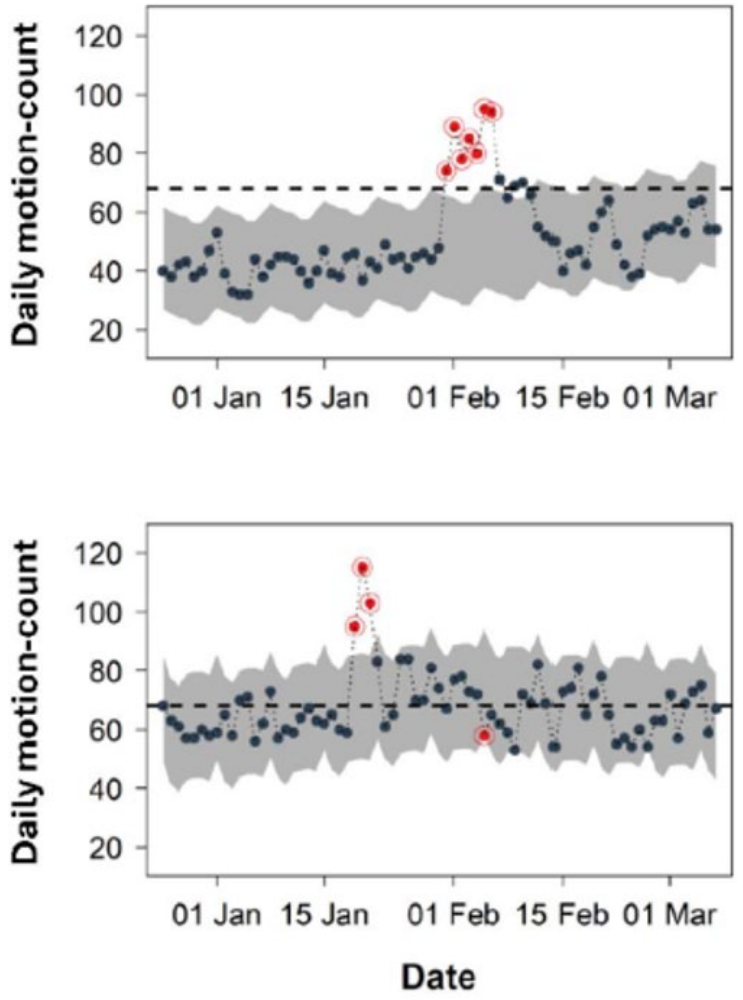
- Hibernation can last 4 to 8 months
  - No explanation for precise timing within denning period


Credit: MFWP

*Spady et al. (2007) Mammal Review 37: 21–51, Fowler et al. (2021) Mammal Review 51: 465–481.

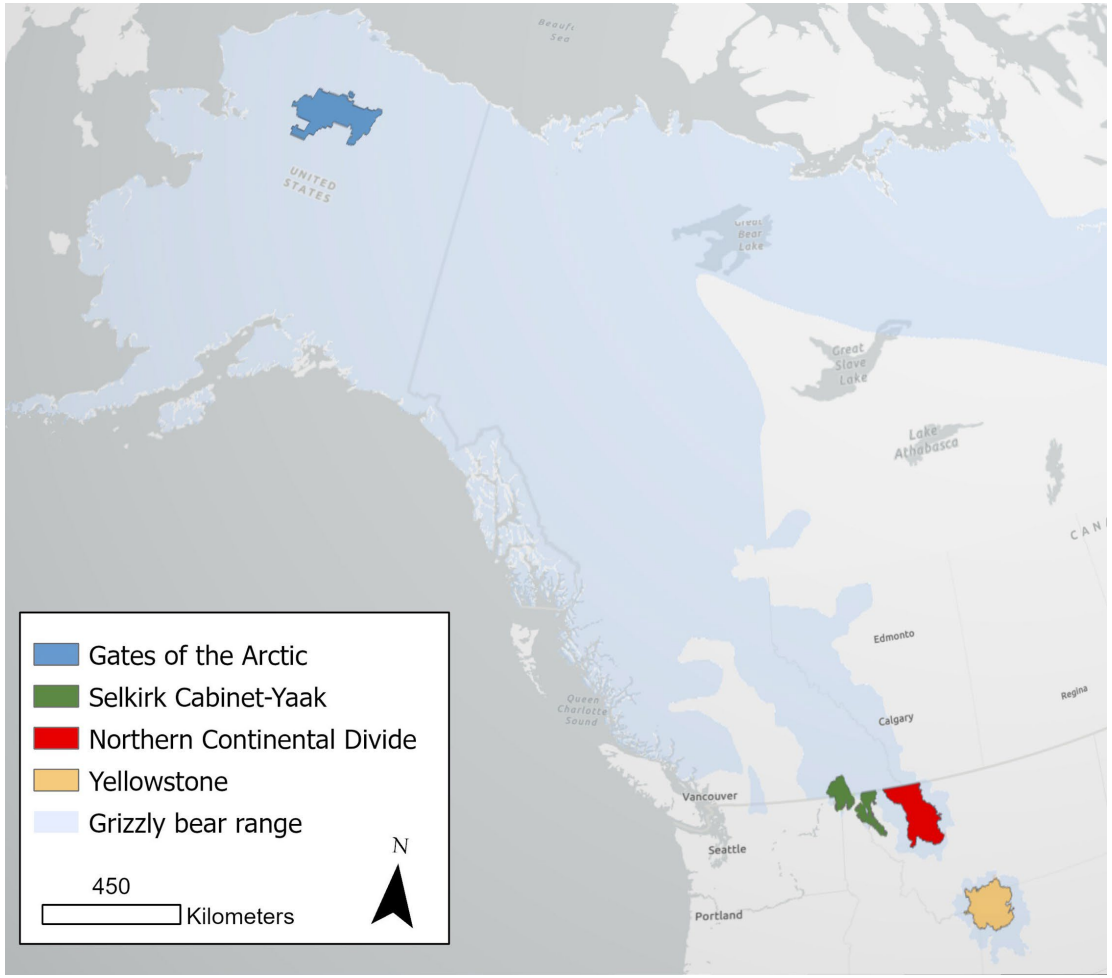
Tested hypotheses for birth timing based on predicted birth events

Identified parturition events from activity data using anomaly detection

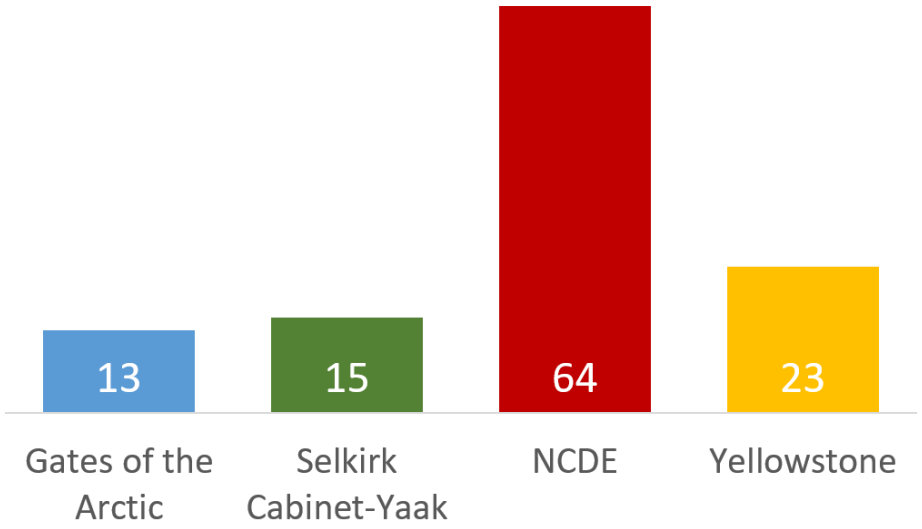


*Roberts et al. (2026) Ursus 37:e10.

4 interior North American populations at varying latitudes

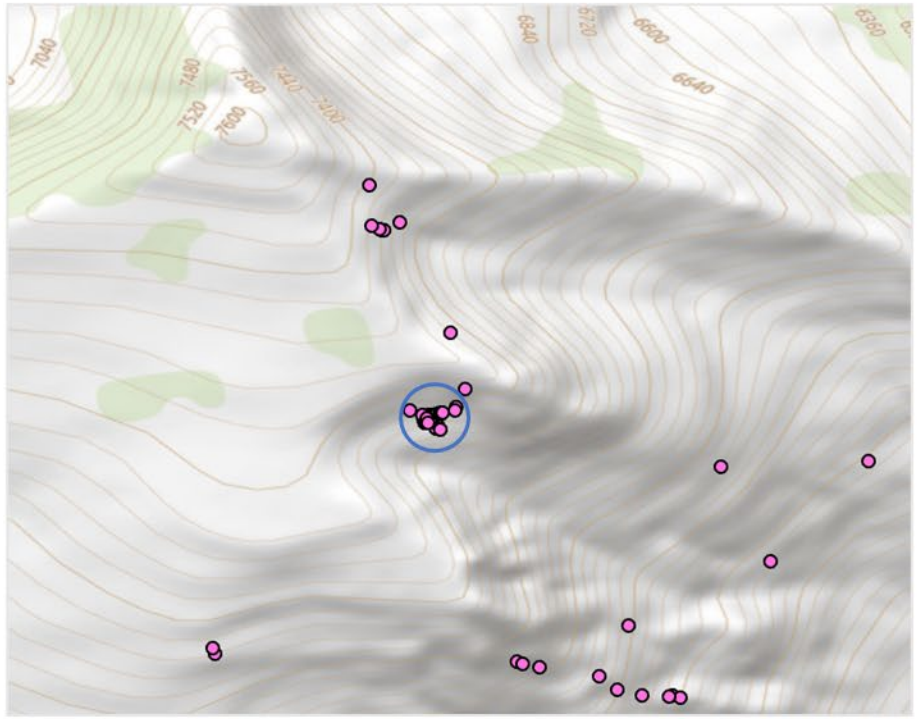


n = 115 predicted parturient females

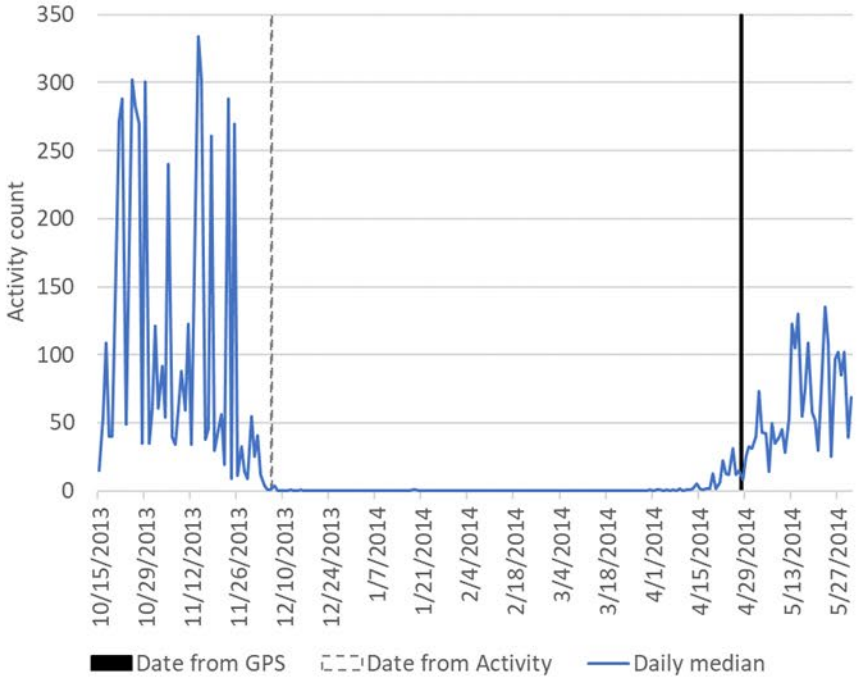


Estimated den entry and exit dates

GPS / VHF data

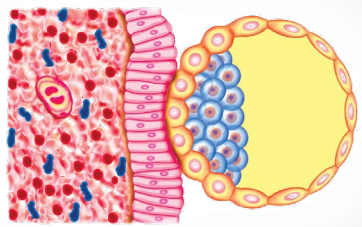


Activity data

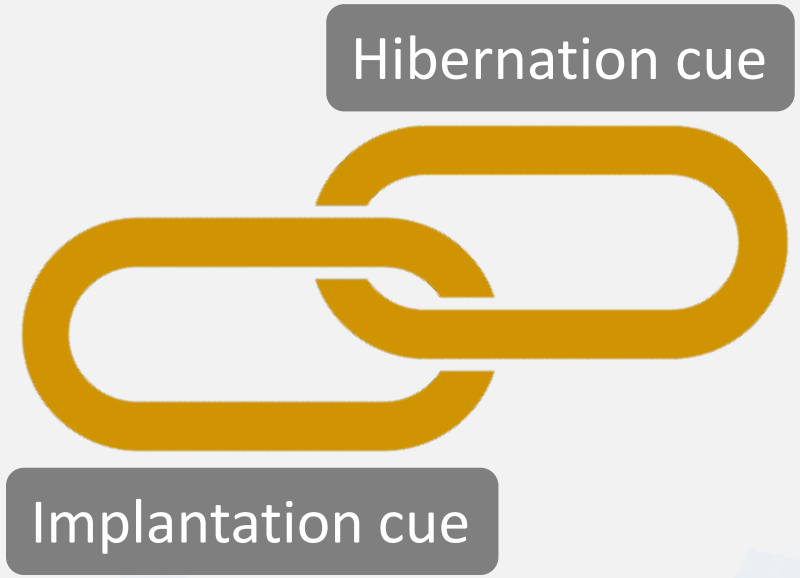


Synchronized cue hypothesis

Parturition timing is governed by the timing of den entry because of proximate cues linking implantation with the onset of hibernation



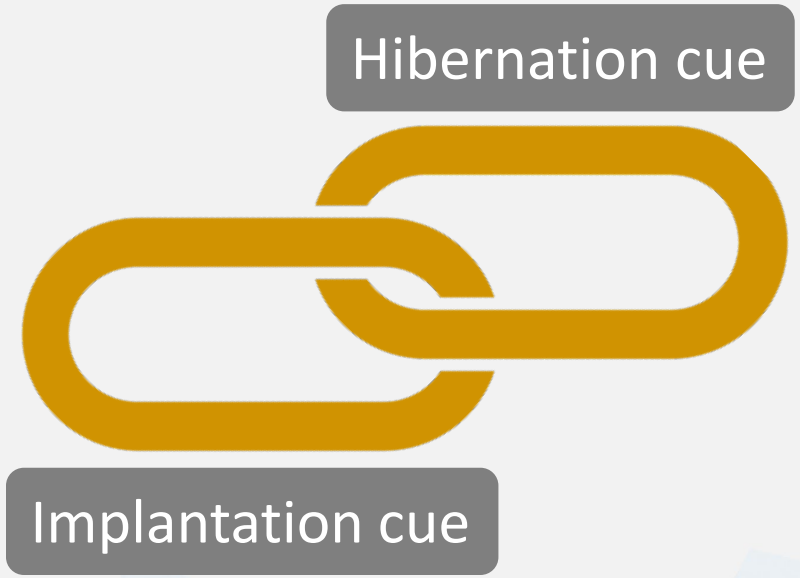
Synchronized cue hypothesis



- Long-held idea that females may forgo implantation if fat stores inadequate*
- Supported by frequent observations that females in poor condition fail to produce cubs
- Ideally, evolution might favor a strategy to discontinue pregnancy when body fat is at its maximum

*Rogers (1976) NA Wildlife and Natural Resources Conference 41: 431–438, Bunnell and Tait (1981) Dynamics of Large Mammal Populations, Robbins et al. (2012) Journal of Mammalogy 93: 540–546

Synchronized cue hypothesis



- Frequent observations that pregnant females enter den earlier than other sex-age classes
- In captivity, pregnant black bears stopped feeding to den, but other females denned only when food was removed*
- Start of gestation may be a driver for sending pregnant females to their dens^

*Mesa Cruz (2018) Dissertation Virginia Tech University
^Hissa et al. (1997) Annales Zoologici Fennici 34: 267–287, Tsubota et al. (1990) International Bear Conference 8: 125–128.

Energetic tradeoff hypothesis

Parturition timing is ultimately timed
in relation to spring green-up and den exit
to optimize the allocation of stored energy



Energetic tradeoff hypothesis

Protect long-term fitness of mother

Later birth

Minimize lactation time



Credit: MFWP

López-Alfaro et al. (2013) Ecological Modelling 270: 1–10

Energetic tradeoff hypothesis

Increase survival of current litter



Earlier birth

Maximize cub developmental time



Gardner et al. (2014) Ursus 25: 121–138

Energetic tradeoff hypothesis

Increase survival of current litter



Earlier birth

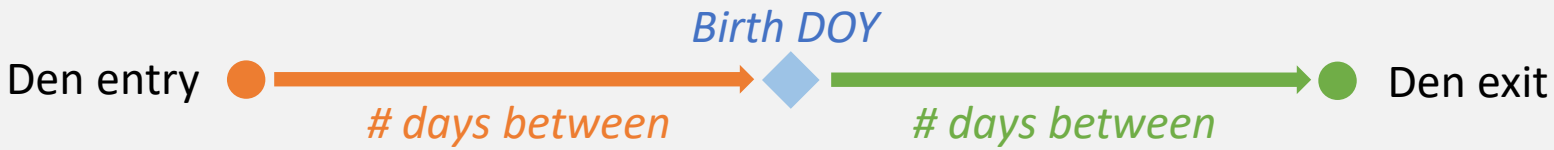
Later birth

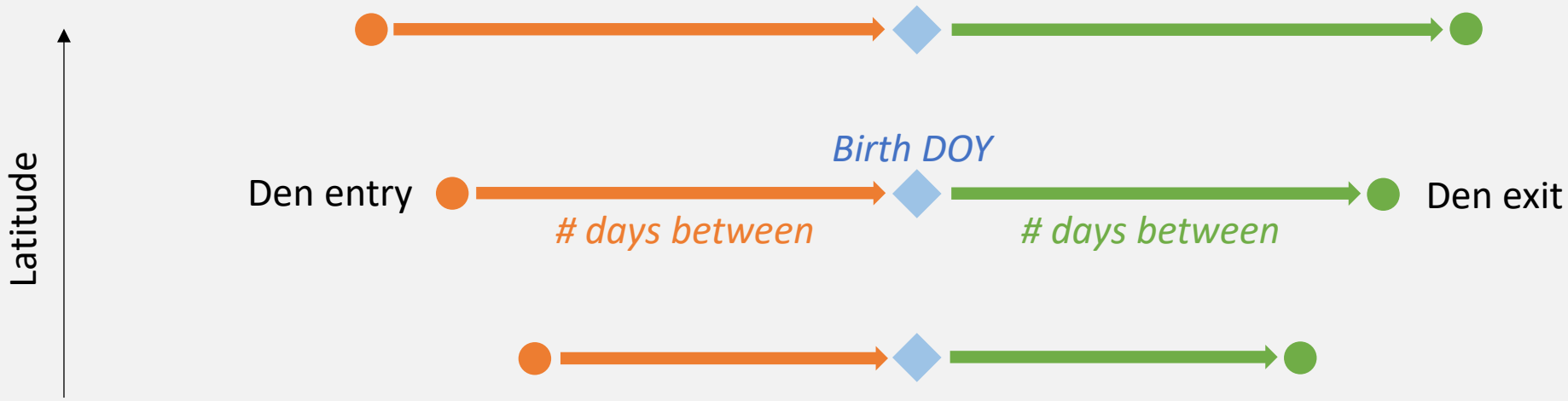
Maximize cub developmental time

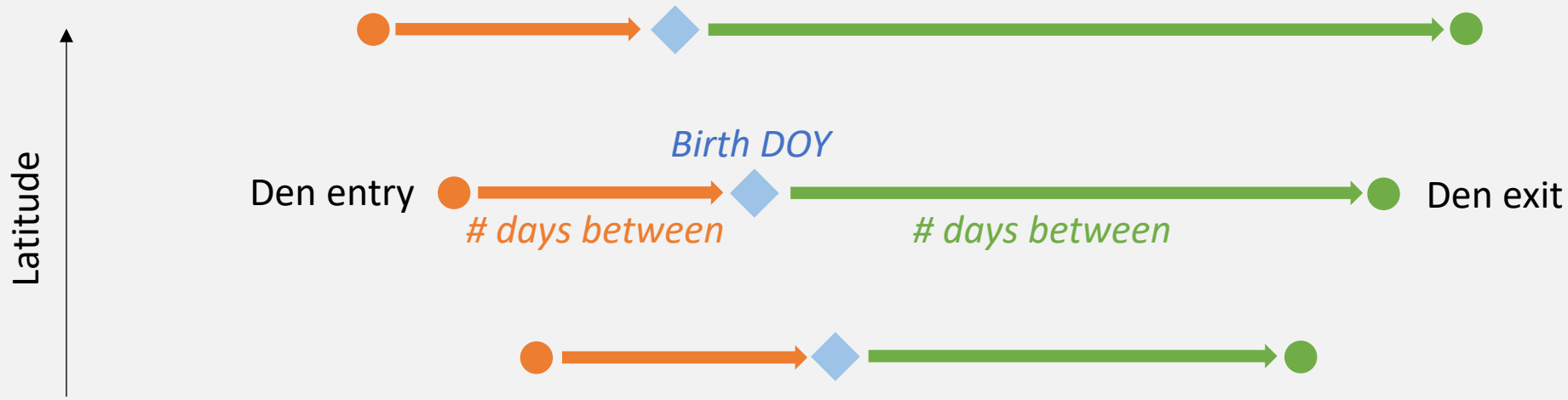
Minimize lactation time

Protect long-term fitness of mother

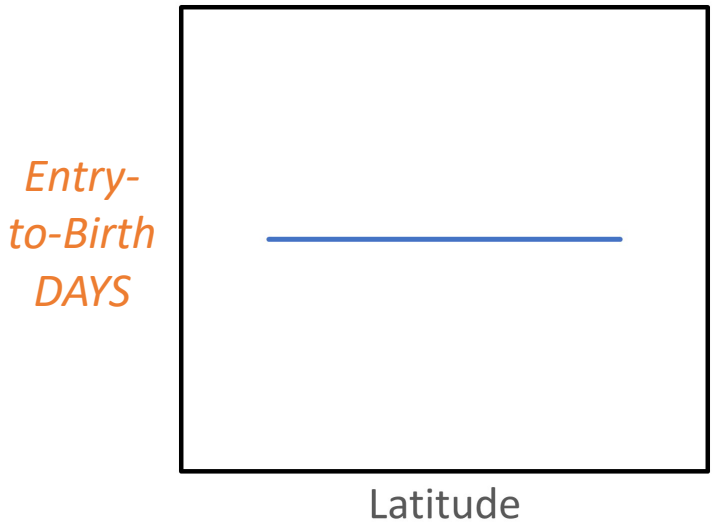


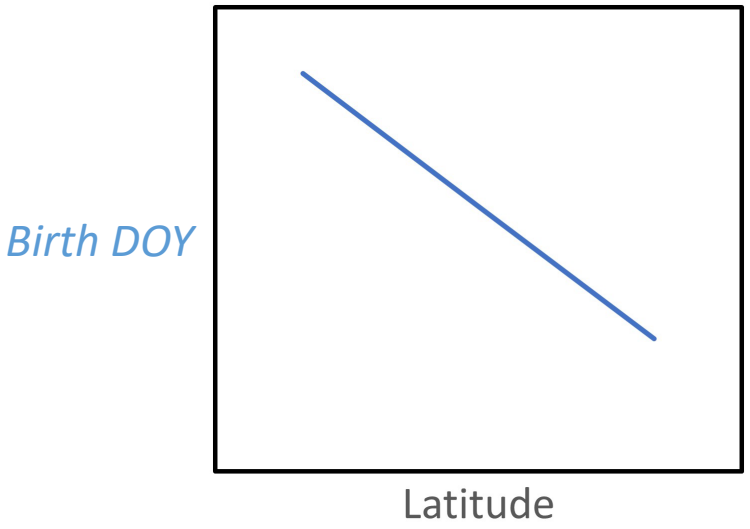

Birth DOY
Den entry
Den exit
days between
days between

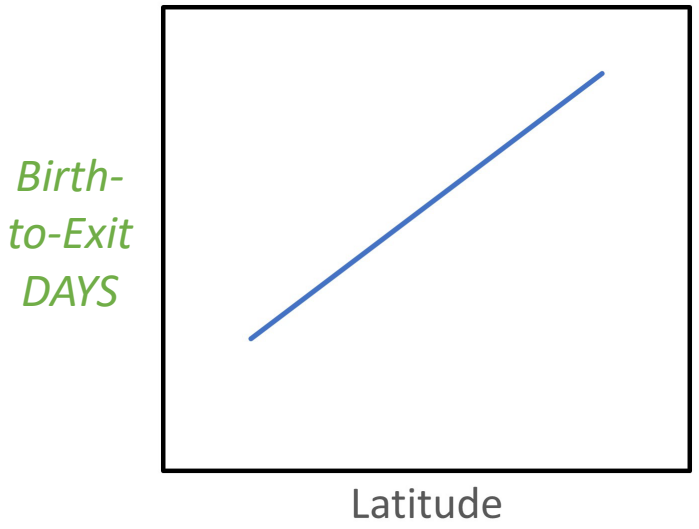

Latitude
Birth DOY
Den entry
Den exit
days between
days between

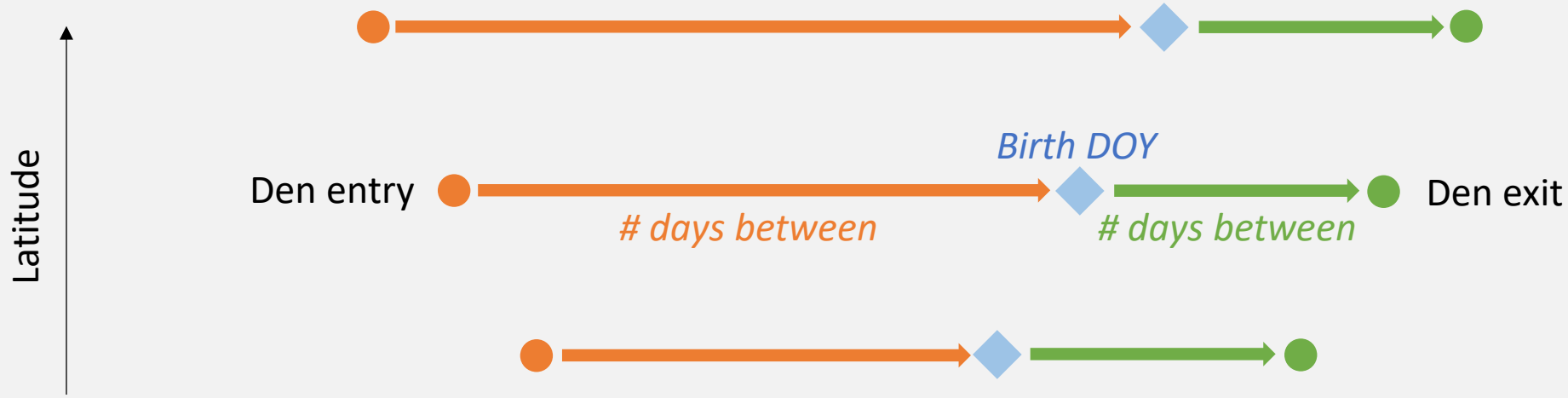


Predictions for synchronized cue hypothesis

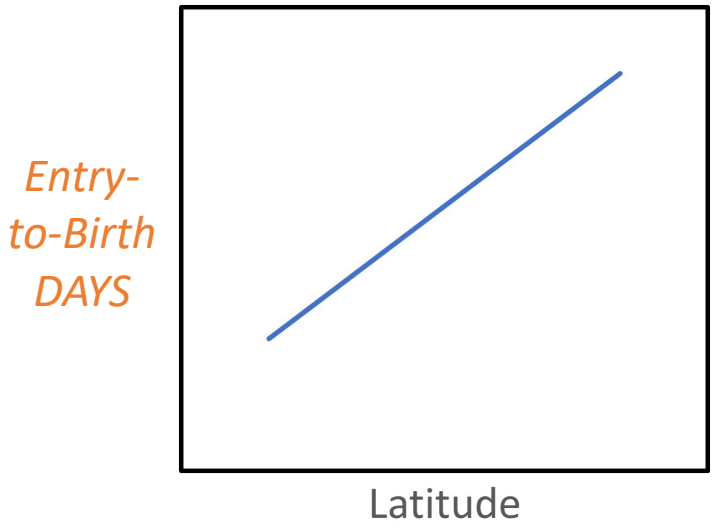


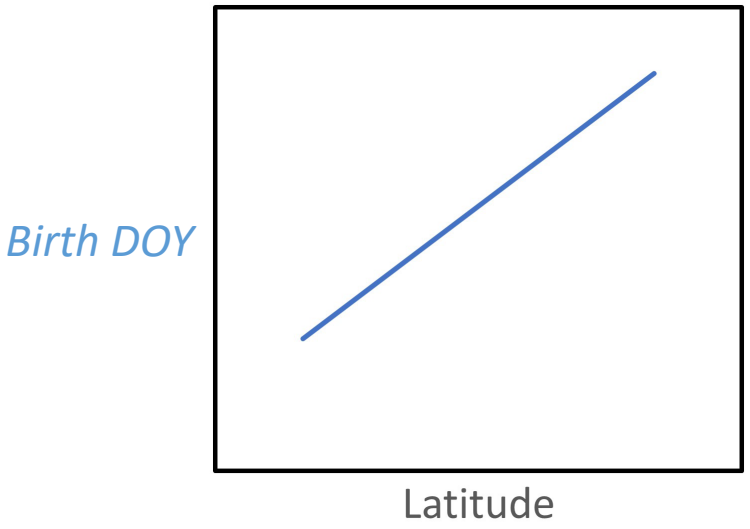


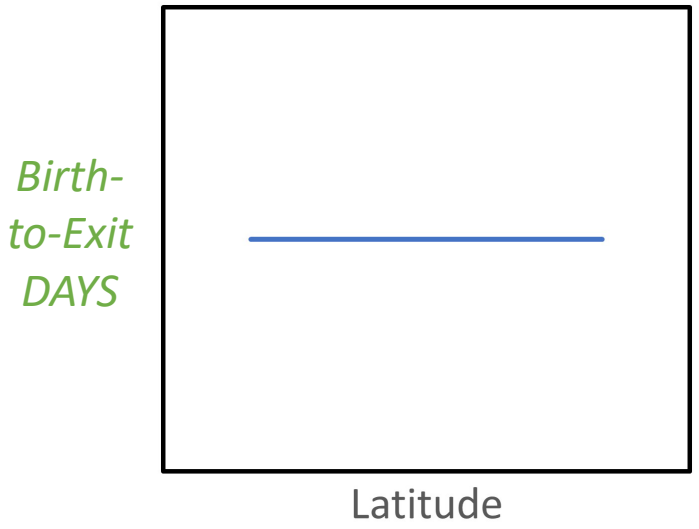




Predictions for energetic tradeoff hypothesis



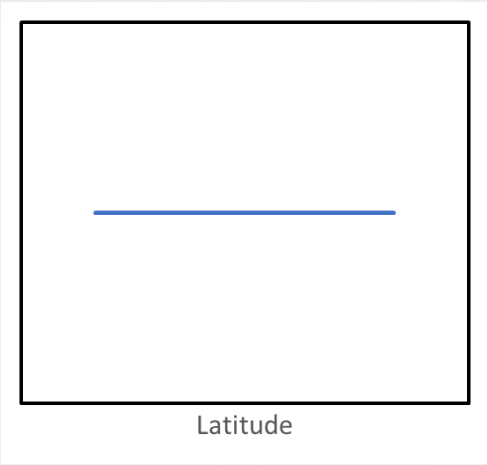




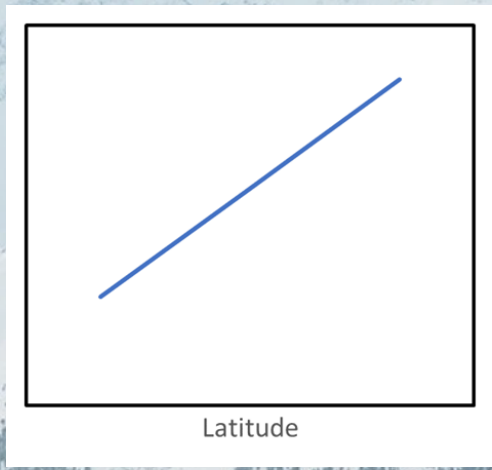
General Linear Models

- Responses: *Birth DOY*, *Entry-to-Birth DAYS*, *Birth-to-Exit DAYS*
- Covariate: Latitude
- Factor: Female observation status
  - Successful = observed with cubs after den exit (n = 66)
  - Unsuccessful = predicted parturient, but observed without cubs after den exit (n = 25)
  - Unknown = predicted parturient, but never observed (n = 23)

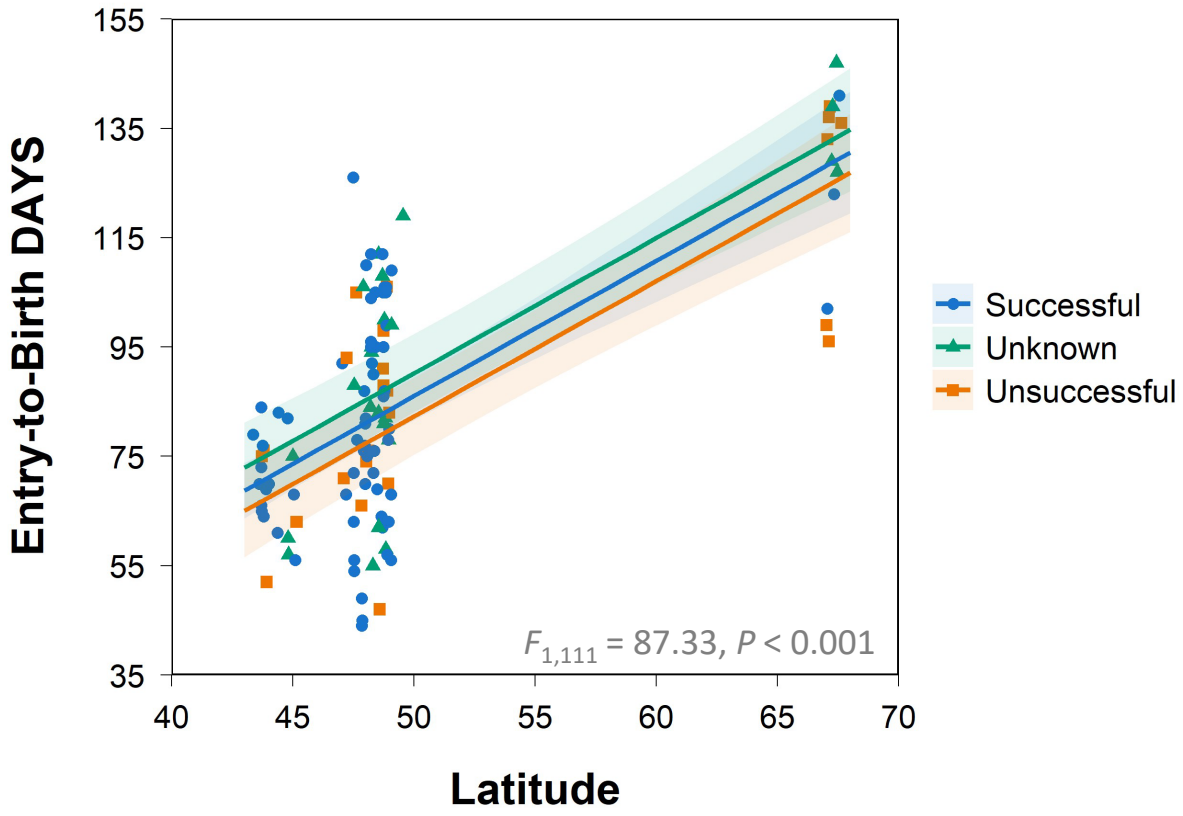
Synchronized cue hypothesis



Energetic tradeoff hypothesis



Entry-to-Birth DAYS



Costello et al. (2026) Ecology and Evolution 16:e72914.

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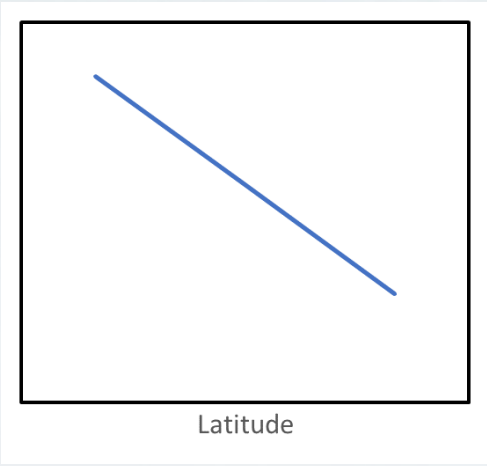

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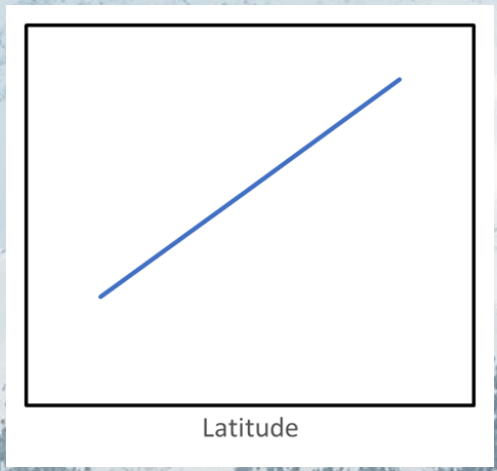
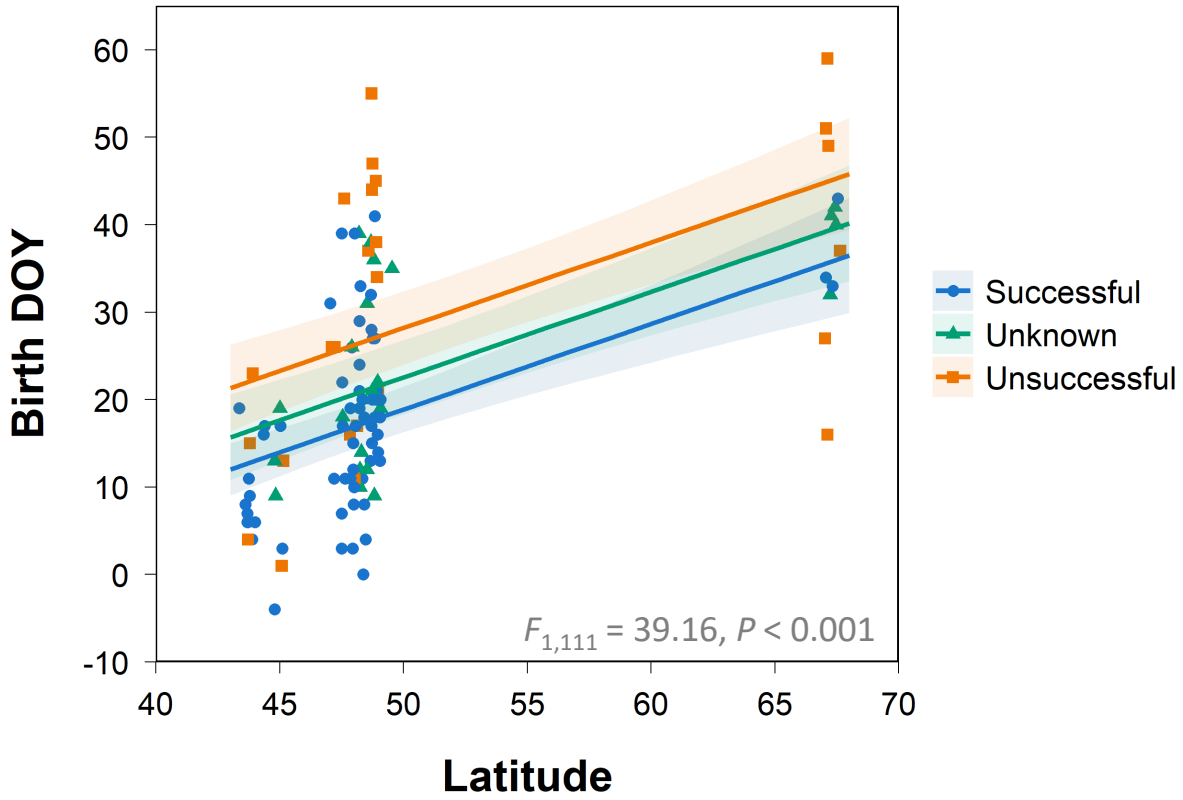


Birth DOY



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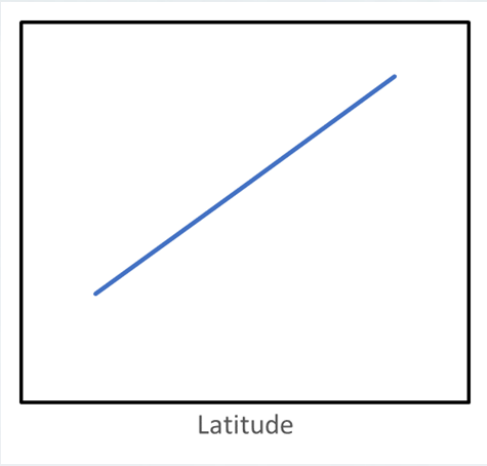

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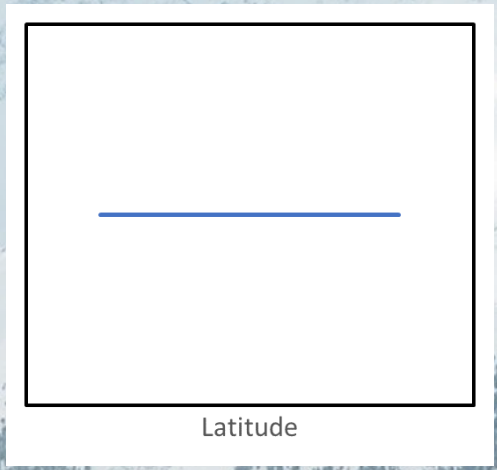
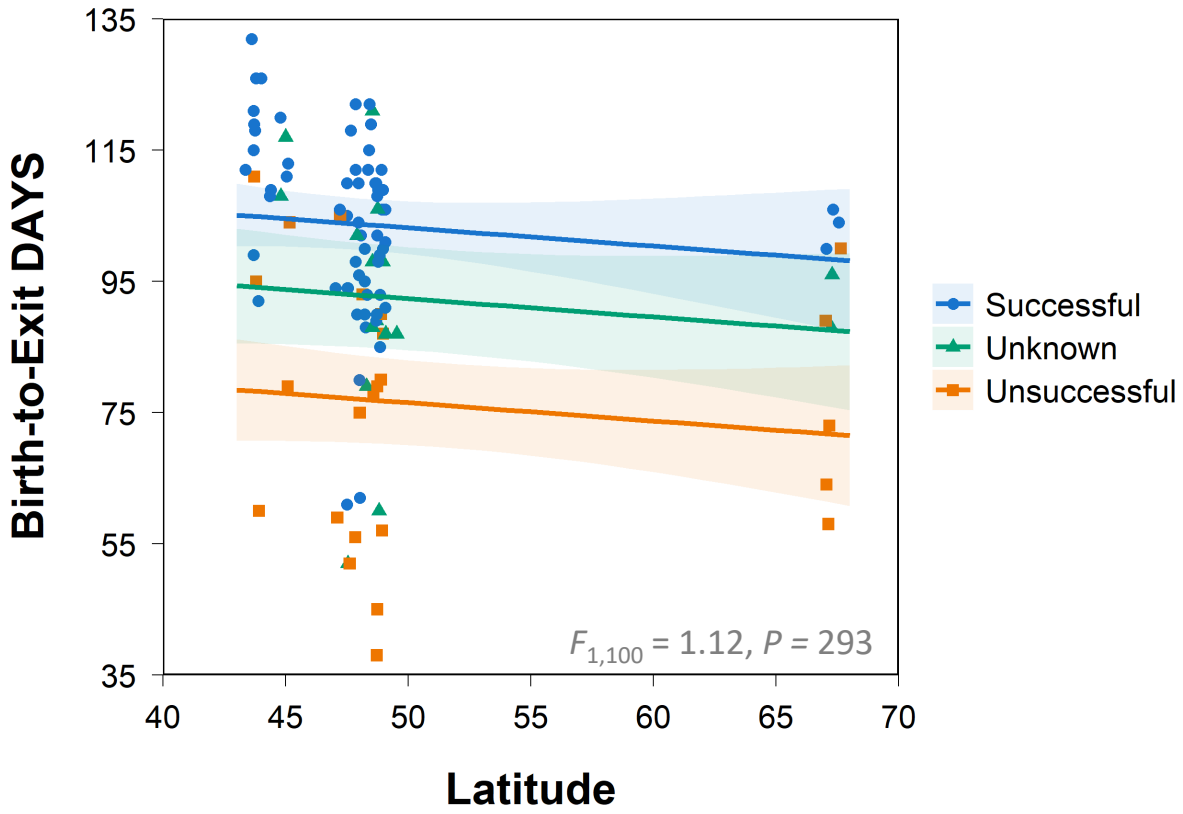


Birth-to-Exit DAYS



Costello et al. (2026) Ecology and Evolution 16:e72914.

No evidence in support of synchronized cue hypothesis

- Implantation independent from onset of hibernation
- Assuming a 56-day gestation:
  - 5% occurred before week of den entry (up to 7 days before)
  - 7% occurred within week of den entry
  - 88% occurred after week of den entry (up to 91 days after)
- Observed earlier denning by pregnant females not explained by start of gestation



Costello et al. (2026) Ecology and Evolution 16:e72914.

Evidence supports the energetic tradeoff hypothesis

High variation in parturition dates

- Optimal birth timing likely **constrained** by the stochastic nature of spring conditions
- Optimal birth dates associated with average conditions
- Realized den exit dates may vary by actual conditions
  - *Birth DOY* (range = 63 days, SD = 13.2 days) less variable than *Birth-to-Exit DAYS* (range = 94 days, SD = 20.0 days)



Costello et al. (2026) Ecology and Evolution 16:e72914.

Evidence supports the energetic tradeoff hypothesis

High variation in parturition dates

- Population-level optimal birth timing is likely **modified** by individual maternal body condition
- Good-condition females shift births earlier, poor-condition females shift birth later
  - Mean *Birth DOY* was 9 days earlier for successful females than for unsuccessful females ($P < 0.001$)
  - Mean *Birth-to-Exit DAYS* was 103 days for successful females, but 77 days for unsuccessful females ($P < 0.001$)
  - Some later-born litters survived



Costello et al. (2026) Ecology and Evolution 16:e72914.

Energetic tradeoff hypothesis supported by previous studies

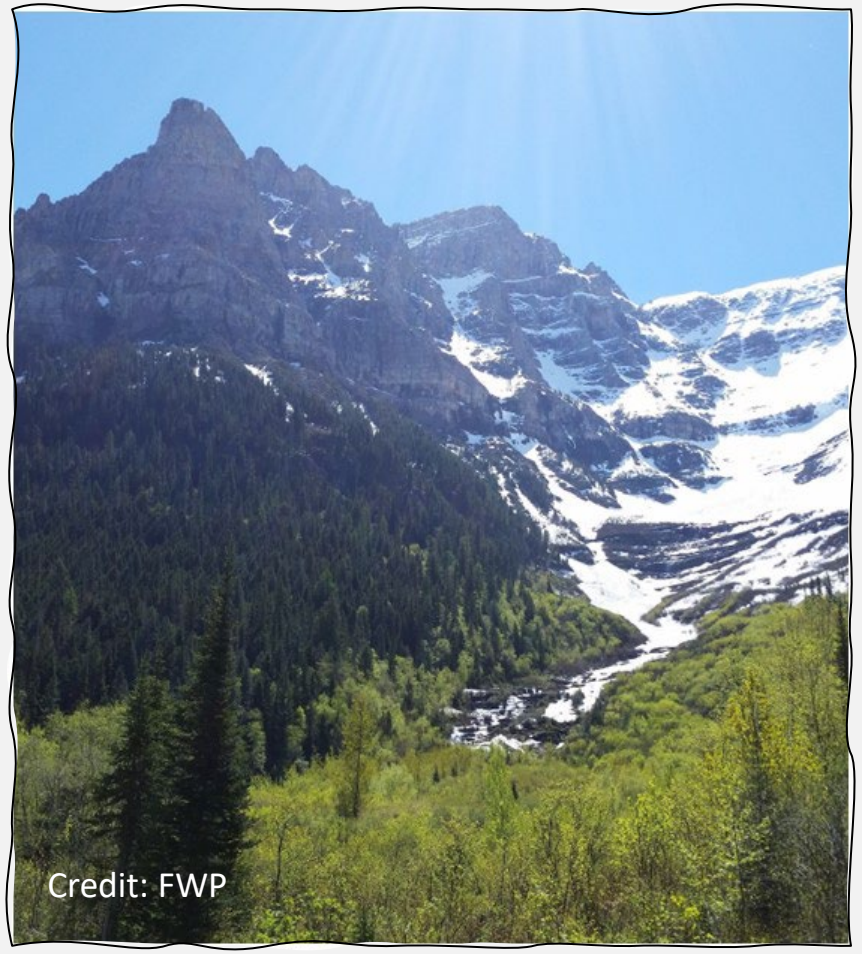

Credit: IGBST

- Earlier births by older or larger females*
- Later births at higher latitudes^
- Lactation costs were viewed as a constraint on **some females**
  - Our hypothesis expands the lactation vs. cub development energetic tradeoff to explain birth timing for **all females**

*Bridges et al. (2011) Ursus 22: 1–8, Robbins et al. (2012) Journal of Mammalogy 93: 540–546, Mesa Cruz (2018) Dissertation Virginia Tech University
^Lemière et al. (2022) Frontiers in Ecology and Evolution 10: 1045331

Management Considerations

- Climate change
  - Our results suggest a mismatch between birth timing and den exit* is unlikely
- Density-dependence
  - Later births may be an indirect mechanism explaining reduced cub survival rates, where food competition is elevated


Credit: FWP

*Pigeon et al. (2016) Behavioral Ecology and Sociobiology 70: 1745–1754, González-Bernardo et al. (2020) Ecology and Evolution 10: 6844–6862, Lemière et al. (2022) Frontiers in Ecology and Evolution 10: 1045331


Costello et al. (2026) An energetic tradeoff best explains parturition timing in grizzly bears. Ecology and Evolution 16:e72914.
Credit: Montana Fish, Wildlife & Parks

Questions?

The ultimate driver of birth timing in grizzly bears: synchronized cues or an energetic tradeoff ?

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