

# Interagency Grizzly Bear Study Team 2021 Status Recap & Integrated Population Models



*Photo: Jake Davis*

# Study Team Members

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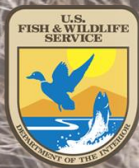
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**Kate Wilmot (NPS)**



# Recap: GYE 2021 population status update

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## Population

- 16–km distance criteria used to estimate unique females with cubs in Demographic Monitoring Area:  $\text{Chao2}_{\text{GAM}} = 84$
- Population estimate (DMA) = 1,069

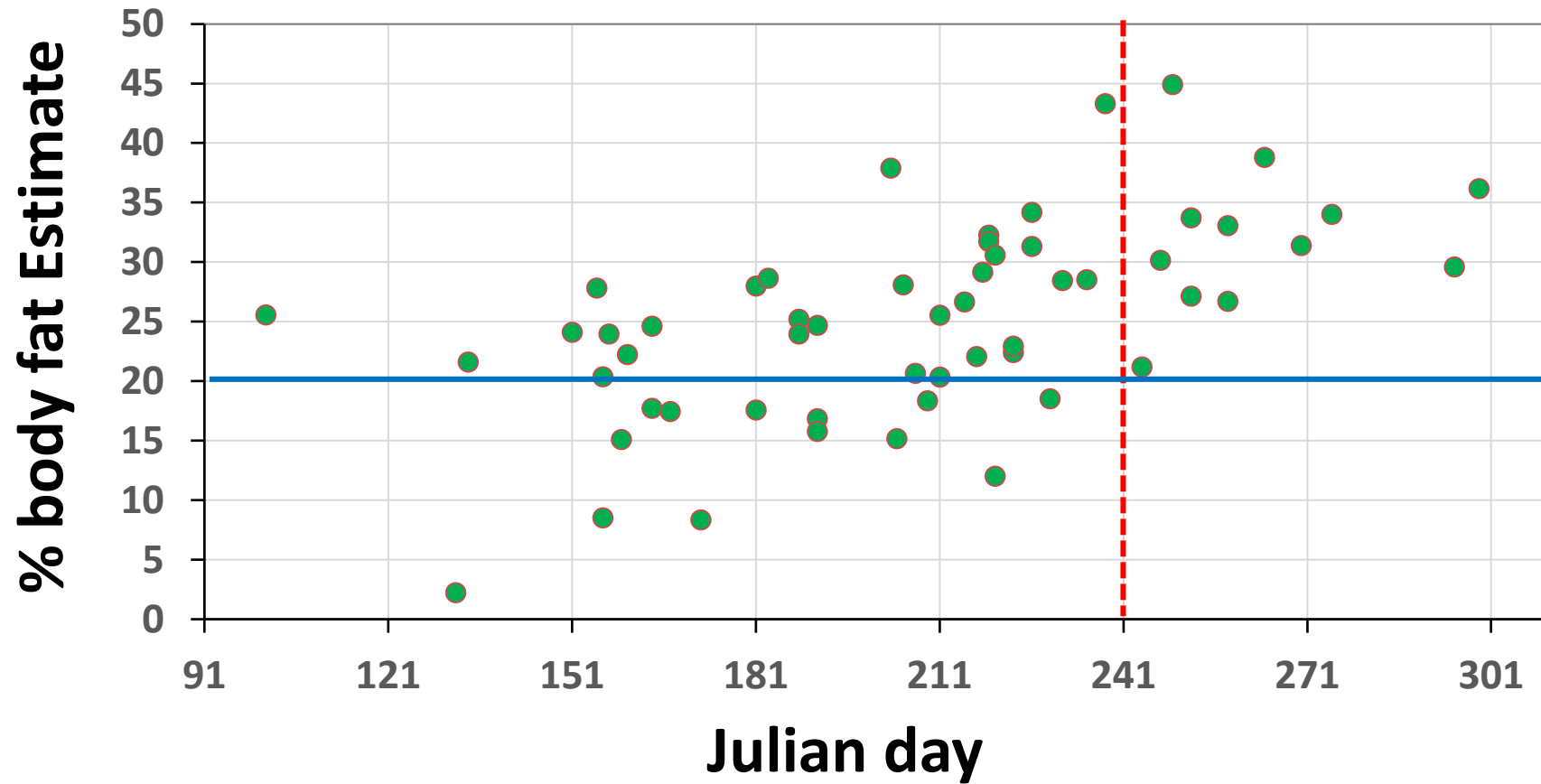
## Mortality

- Primary causes inside DMA: site conflict, self–defense, and livestock
- 2021 mortality rates in DMA
  - Independent females = 5.7%
  - Independent males = 8.1%
  - 33% of mortalities occurred outside the DMA

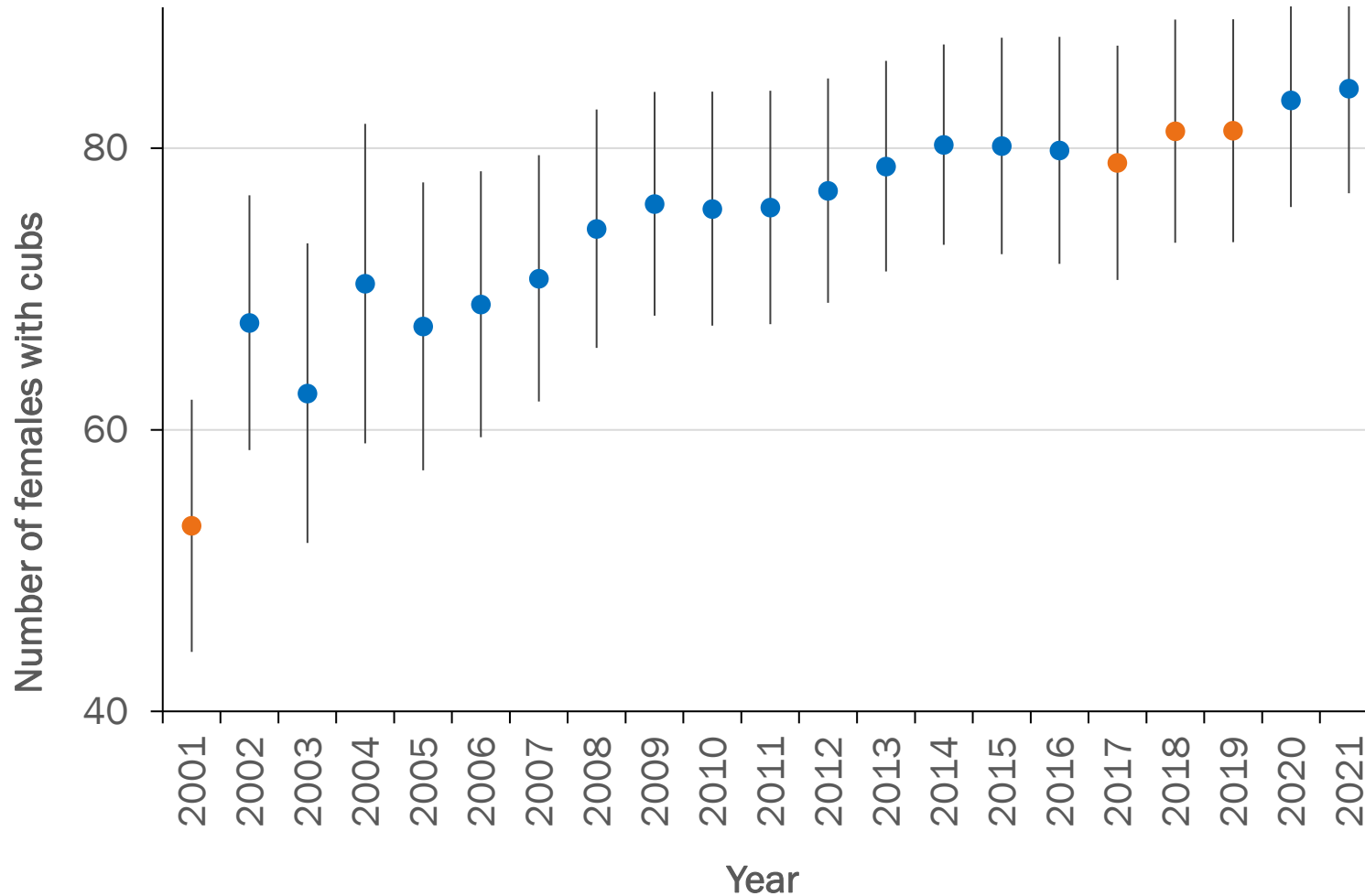
## Food supply

- Good berry production, good moth–site year, average whitebark pine crop
- % body fat of captured bears

# % body fat by Julian date 2021

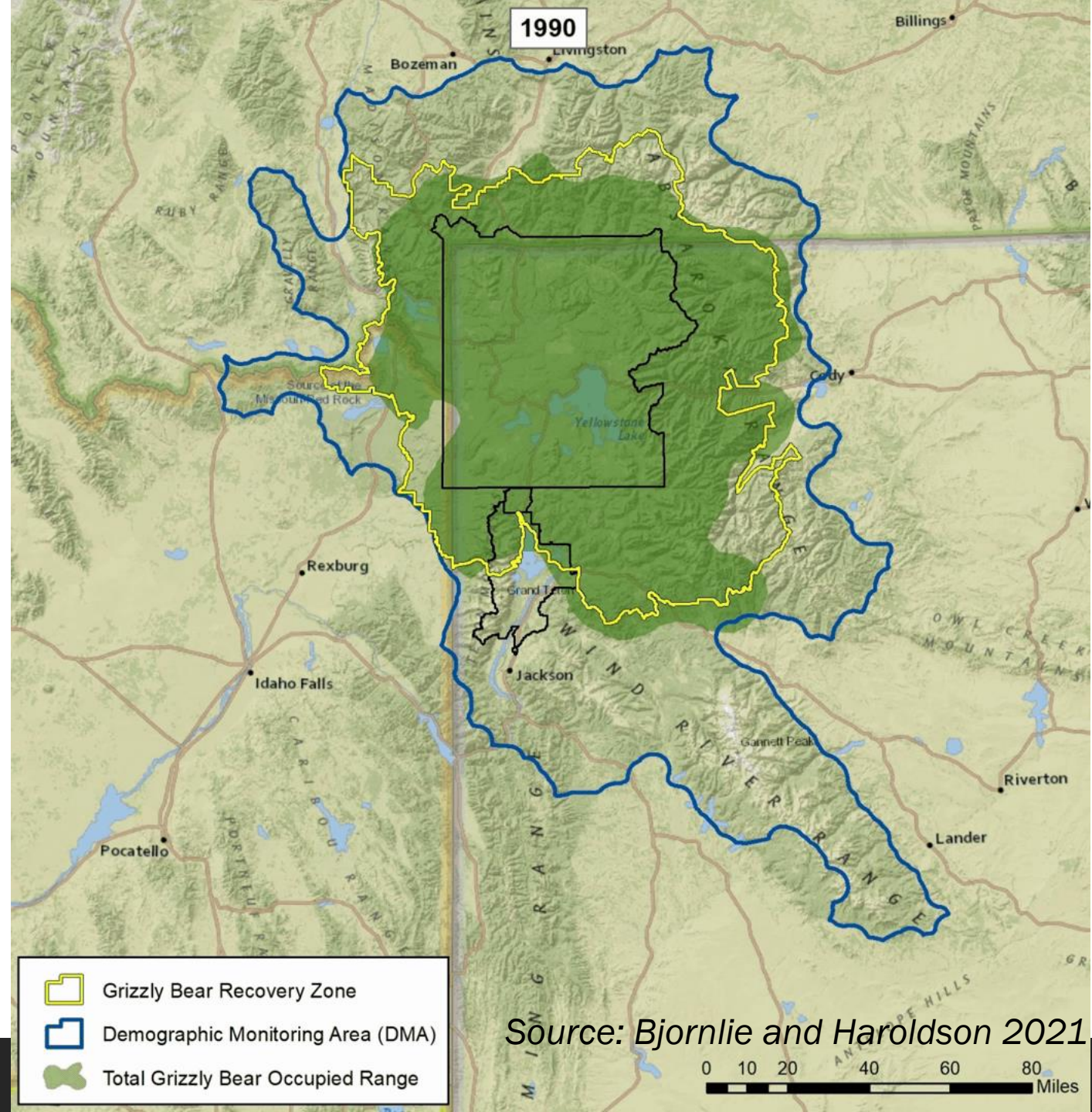


# Trend in estimated females with cubs 2001–2021 (DMA; 16–km Chao2 method)



# Occupied range 1990-2020

- 2020: 70,468 km<sup>2</sup> (27,208 mi<sup>2</sup>)
- 4% expansion/year
- 98% of DMA
- 31% outside of DMA
- >12,000 km<sup>2</sup> private land





# Advancing Demographic Monitoring: Progress Report

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INTERAGENCY GRIZZLY  
BEAR STUDY TEAM



# Progress report

Chao2<sub>16km</sub> based estimates: quick review

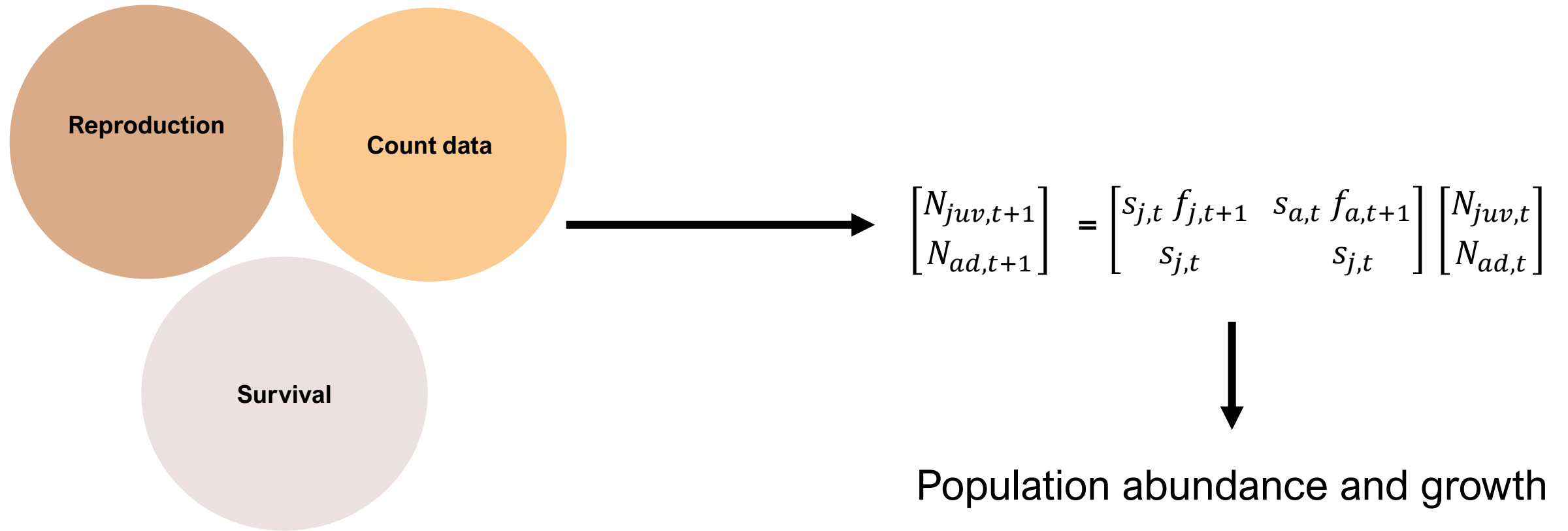
Integrated Population Models (IPM): overview

IPM application to GYE: structure and results

Considerations and final steps

# Traditional population estimation

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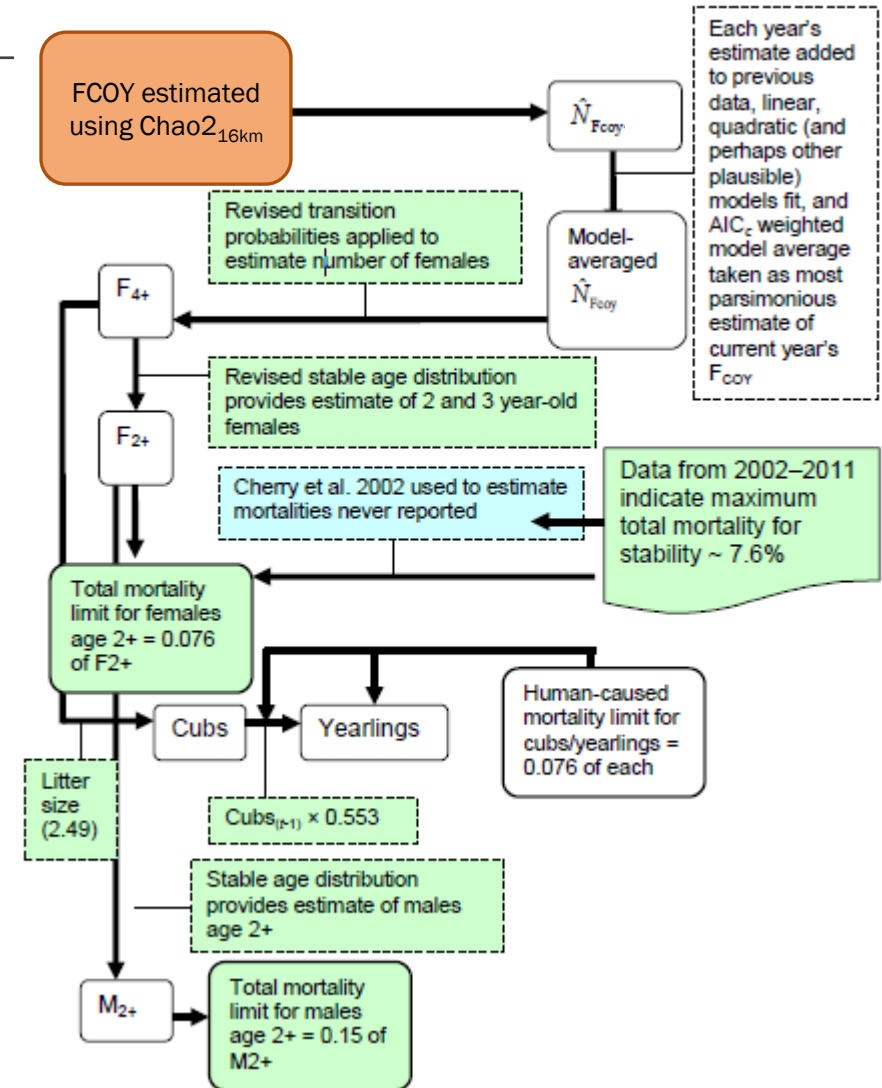
# Chao2 estimation

## Foundation

- Modification of 2012 workflow
- Females with cubs
  - Chao2<sub>16km</sub>

## Limitations

- No annual estimates of vital rates
- Uncertainty not fully propagated
- Separate process for different parameters



Modified from IGBST Demographic Workshop Report (2012)

# Integrated Population Model (IPM)

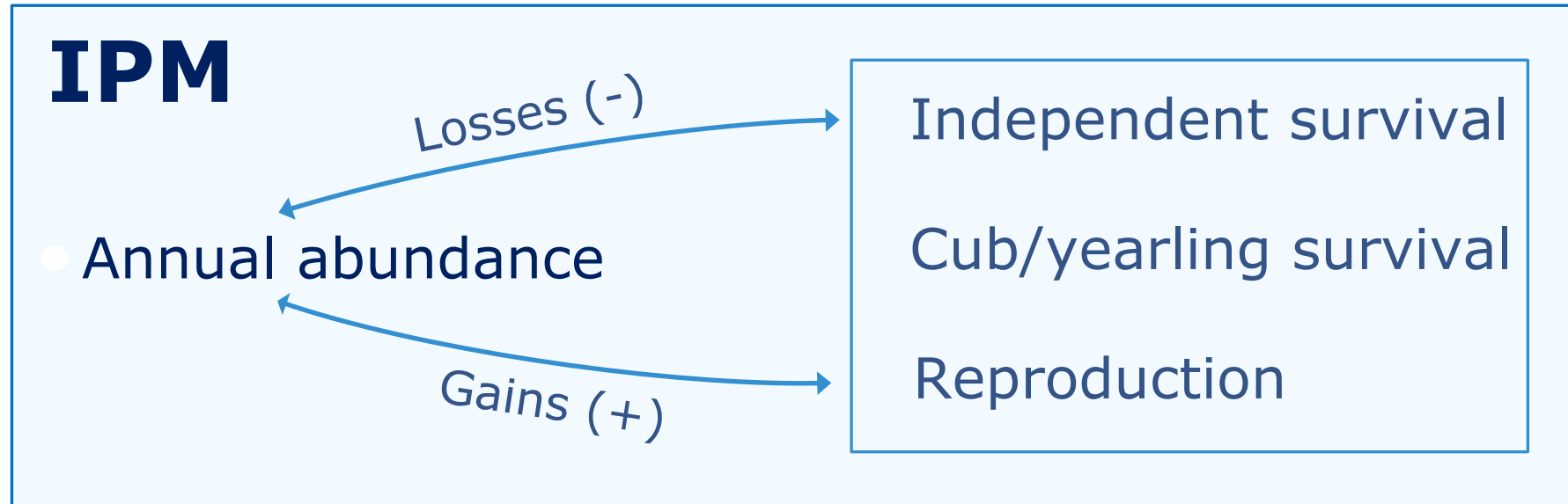
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Any model that jointly analyzes data on  
population size and demographic  
parameters

*Source: Schaub and Abadi (2011)*

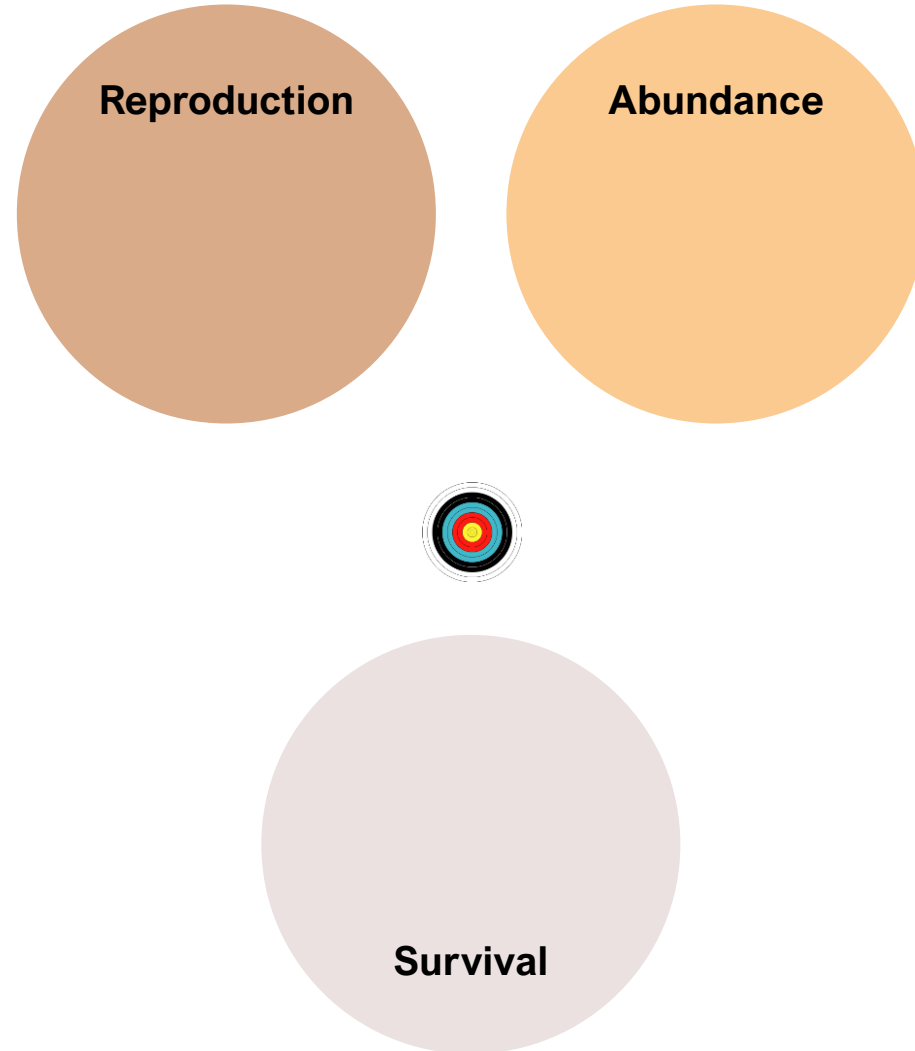
# GYE grizzly bears

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# “Overlapping consensus”

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# Benefits of IPMs

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- Precision and accuracy of parameter estimates
  - Estimates are “weighted” by information content in different data sets
- Assessment of changes in population structure over time



*Source: Schaub and Kery (2022)*

# Benefits of IPMs

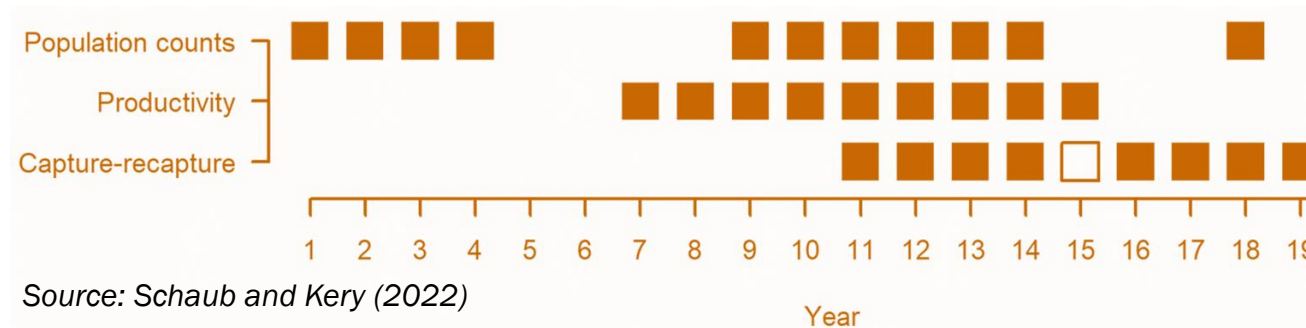
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## Self-consistent estimates

- Reconciles estimates from different data, increases reliability

## Flexible structure

- Diversity of data types can be used
- Accommodates missing or incomplete data



- Evaluate cost and contributions of different data sources

# Development and implementation

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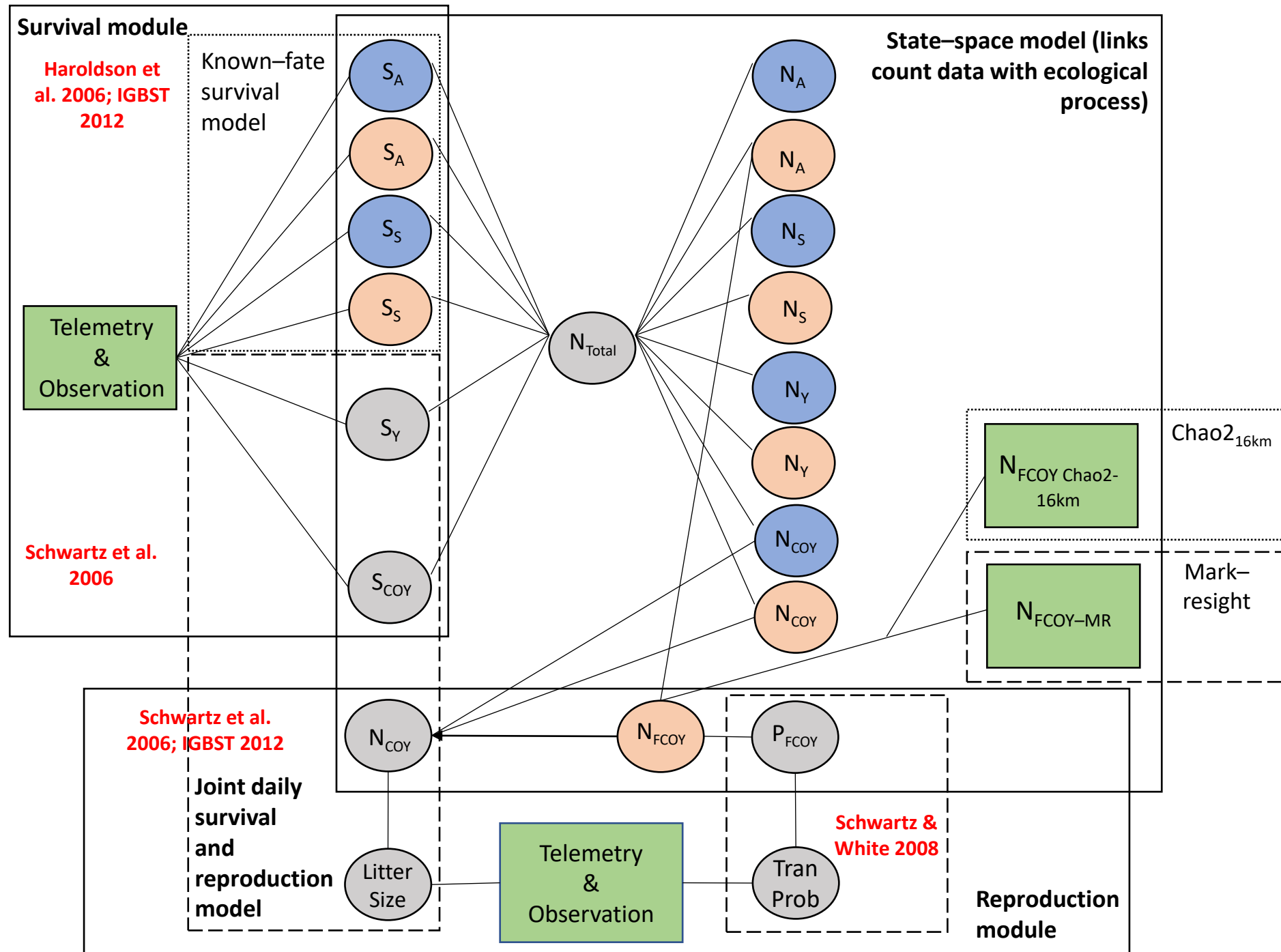
## SpeedGoat & University of Montana

- [www.speedgoat.io/story](http://www.speedgoat.io/story)
- Dr. Paul Lukacs, Dr. Josh Nowak
- Independent research group



## Other projects

- Montana Fish, Wildlife and Parks – Mountain lion, American black bear
- Idaho Fish and Game – Mule deer
- South Dakota Game, Fish, and Parks – White-tailed deer
- Western Association of Fish and Wildlife Agencies – Sage grouse



Knight et al. 1995; Keating et al. 2002; Cherry et al. 2007; Schwartz et al. 2008; IGBST, 2012, 2021;

Higgs et al. 2013

# Results

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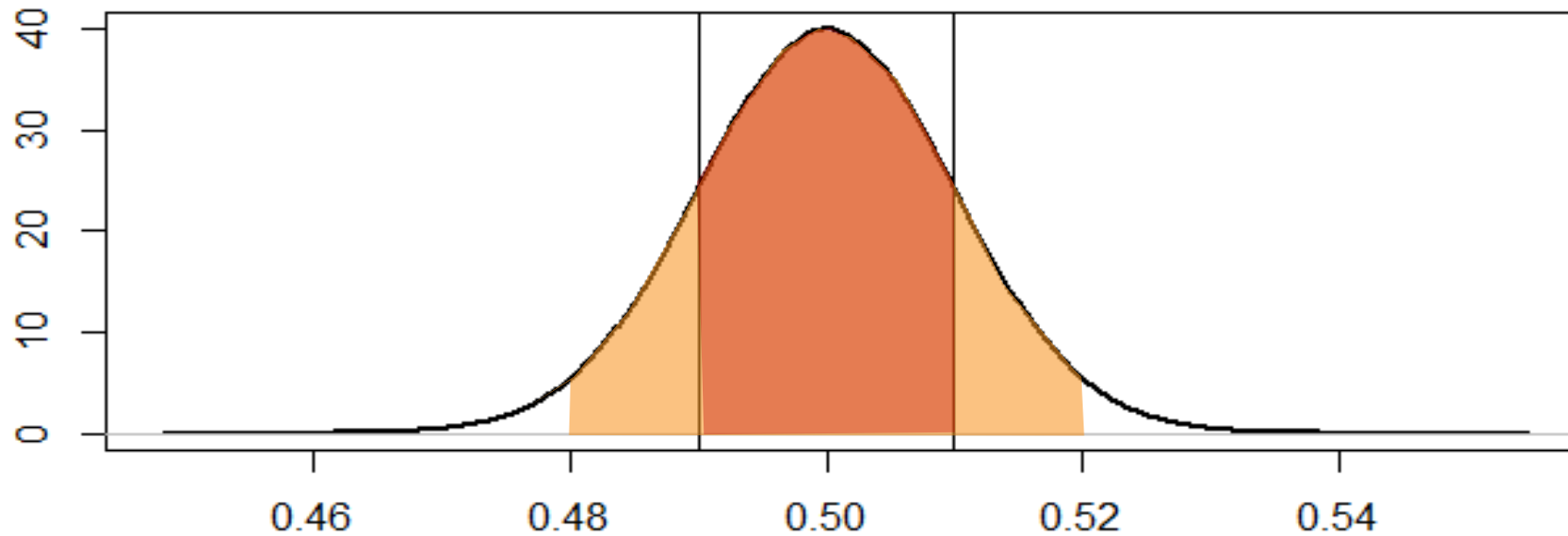


*Photo: Jake Davis*

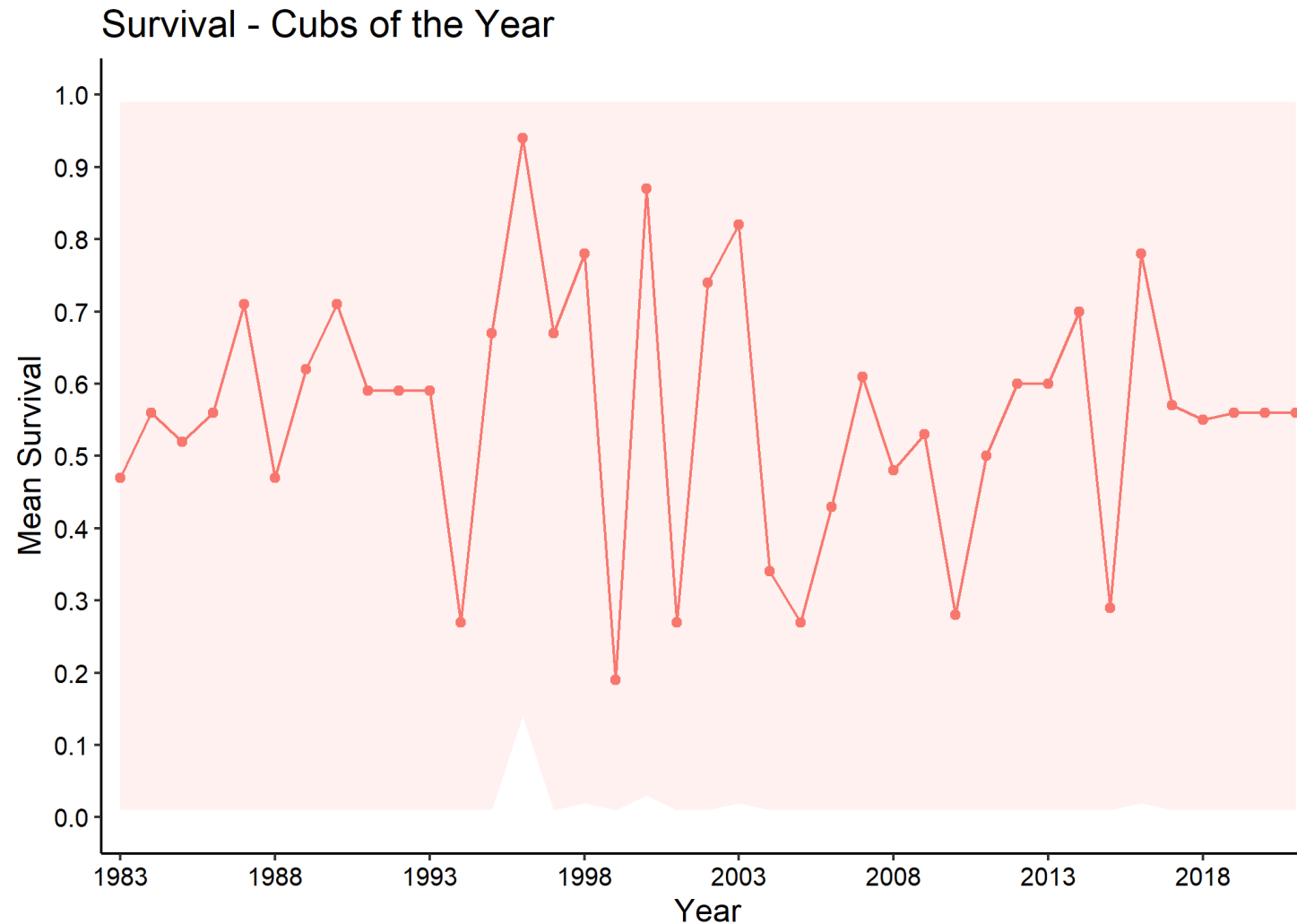
# Bayesian Credible Intervals

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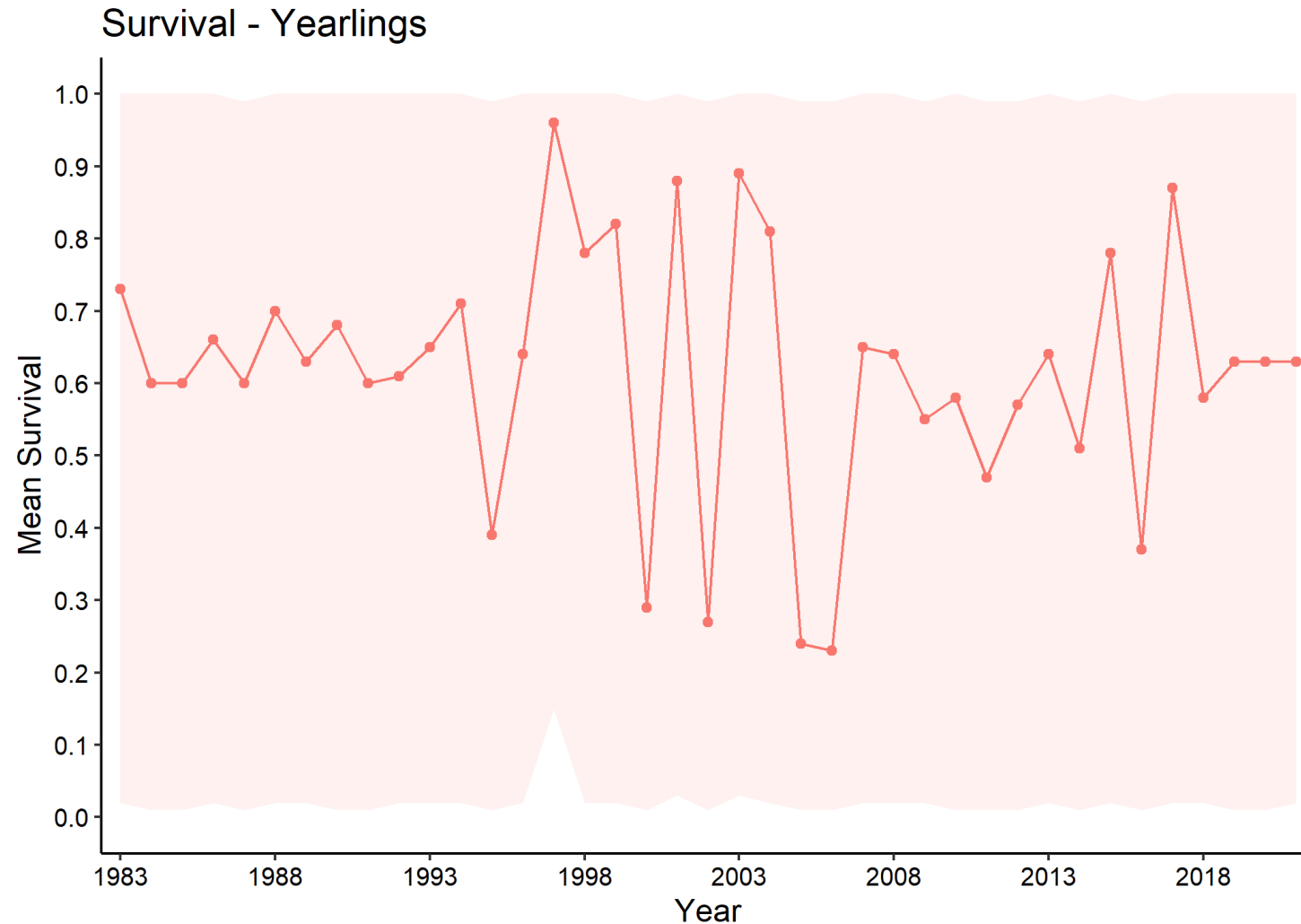
- Summarizes the uncertainty surrounding an estimated parameter
- Distribution of possible values of a parameter



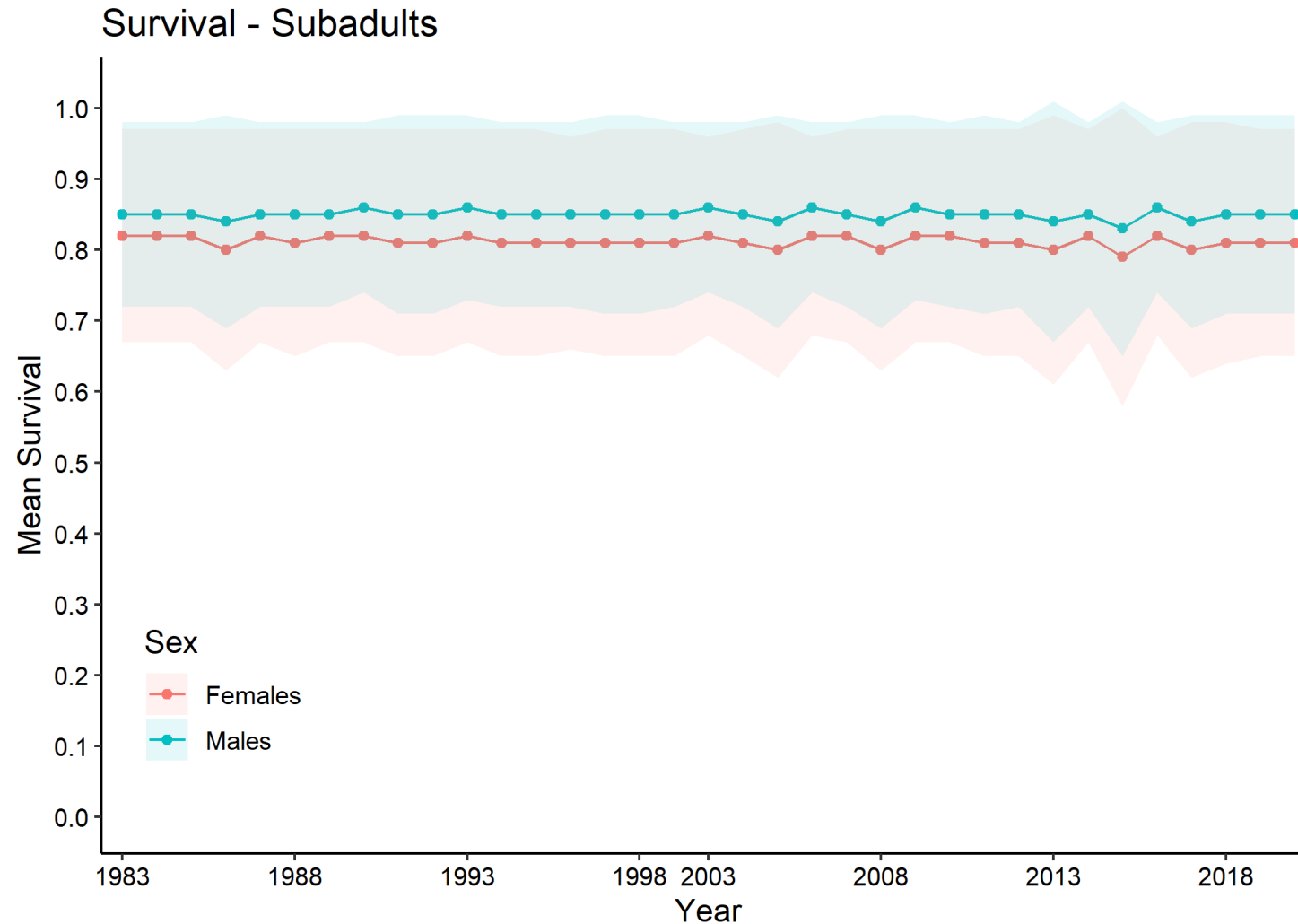
# Vital rates: cub survival



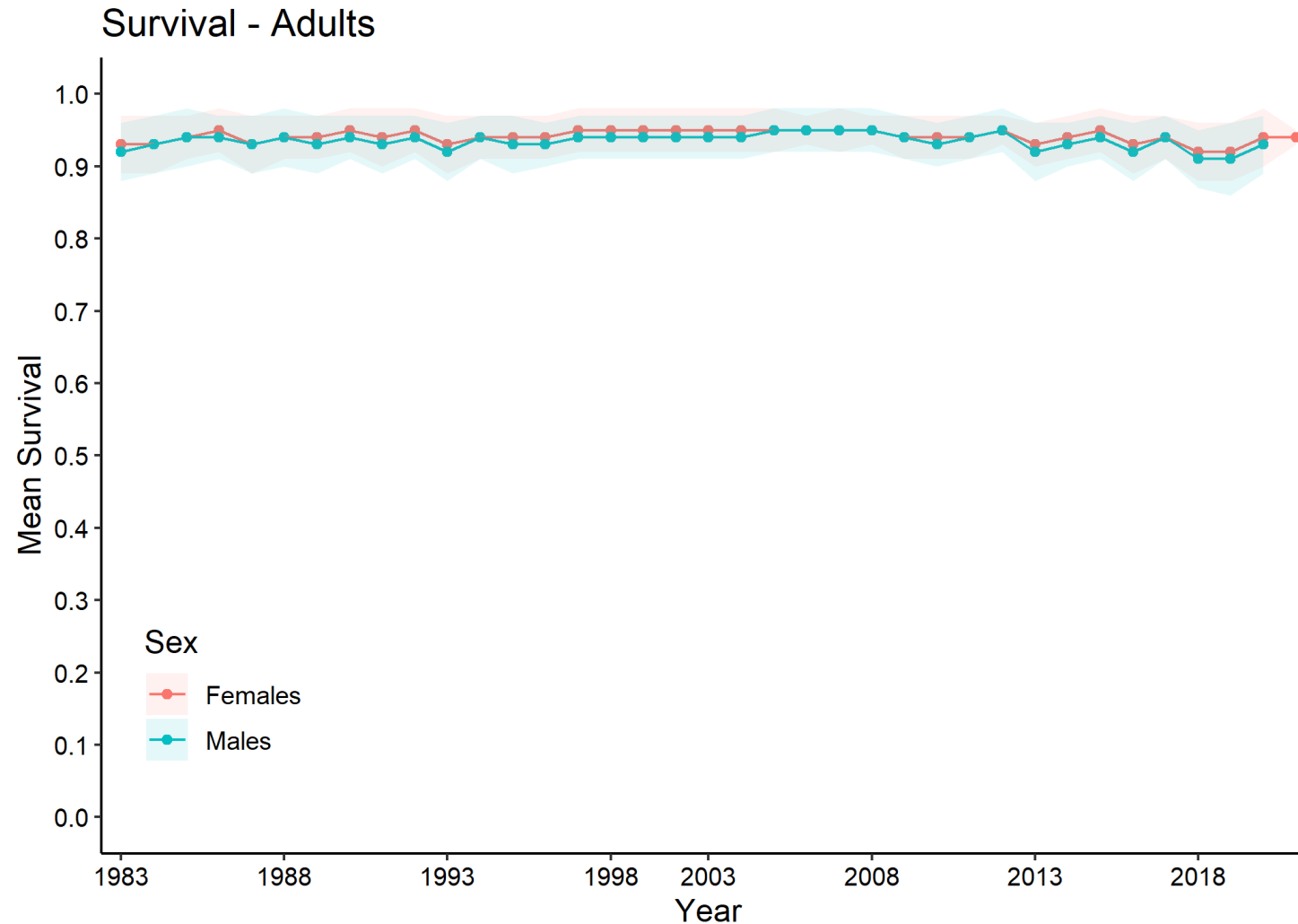
# Vital rates: yearling survival



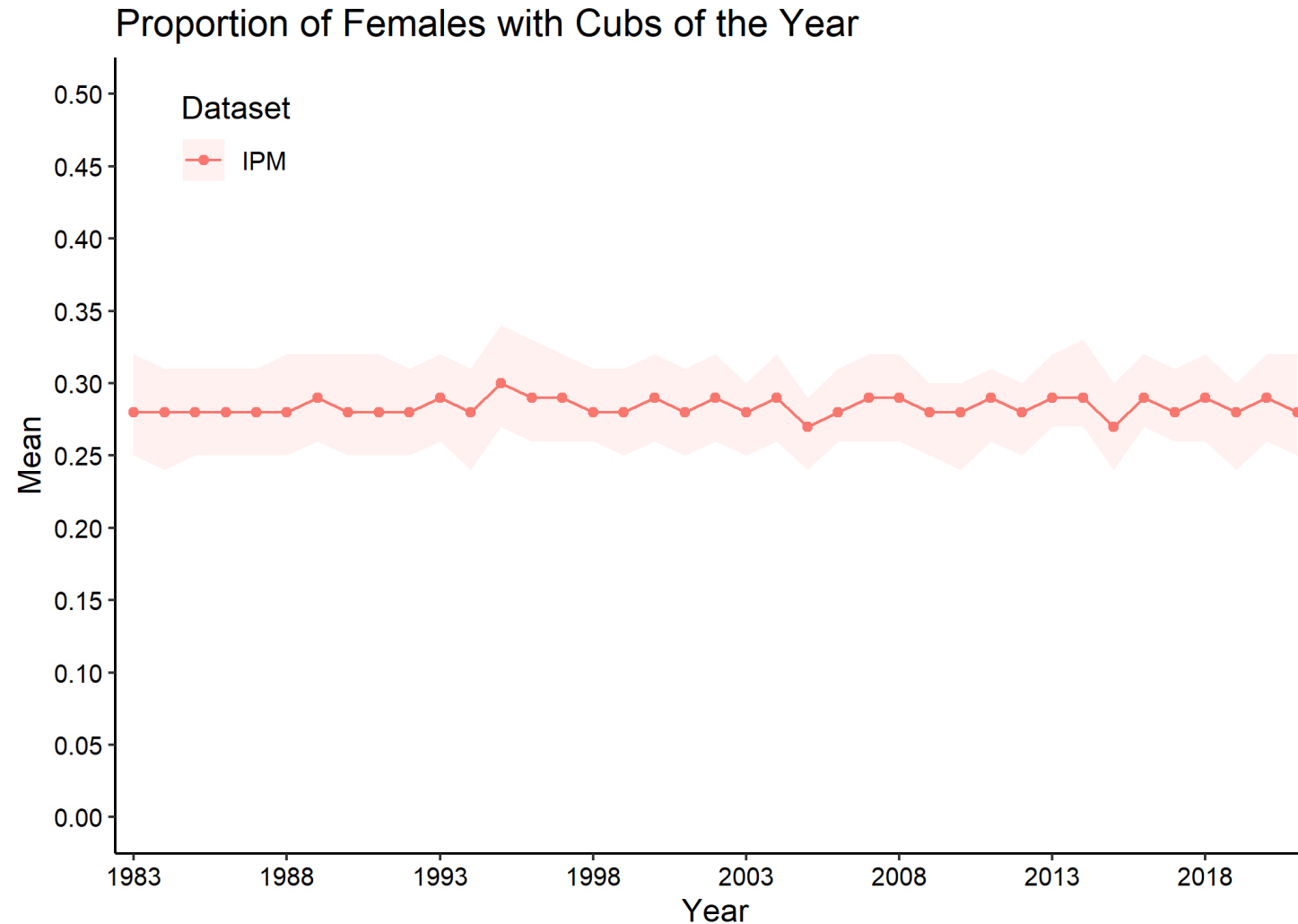
# Vital rates: subadult survival



# Vital rates: adult survival



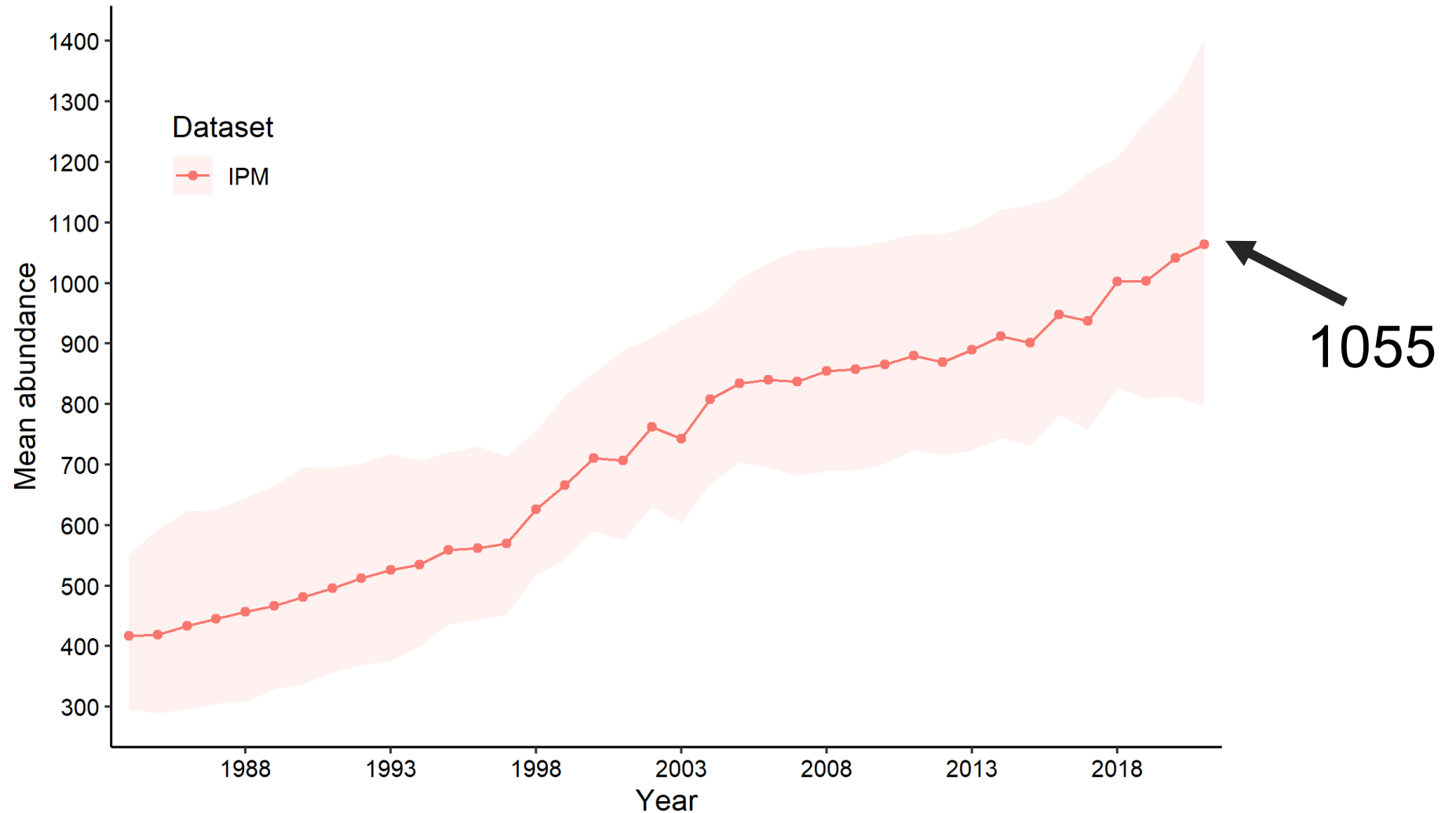
# Vital rates: reproduction



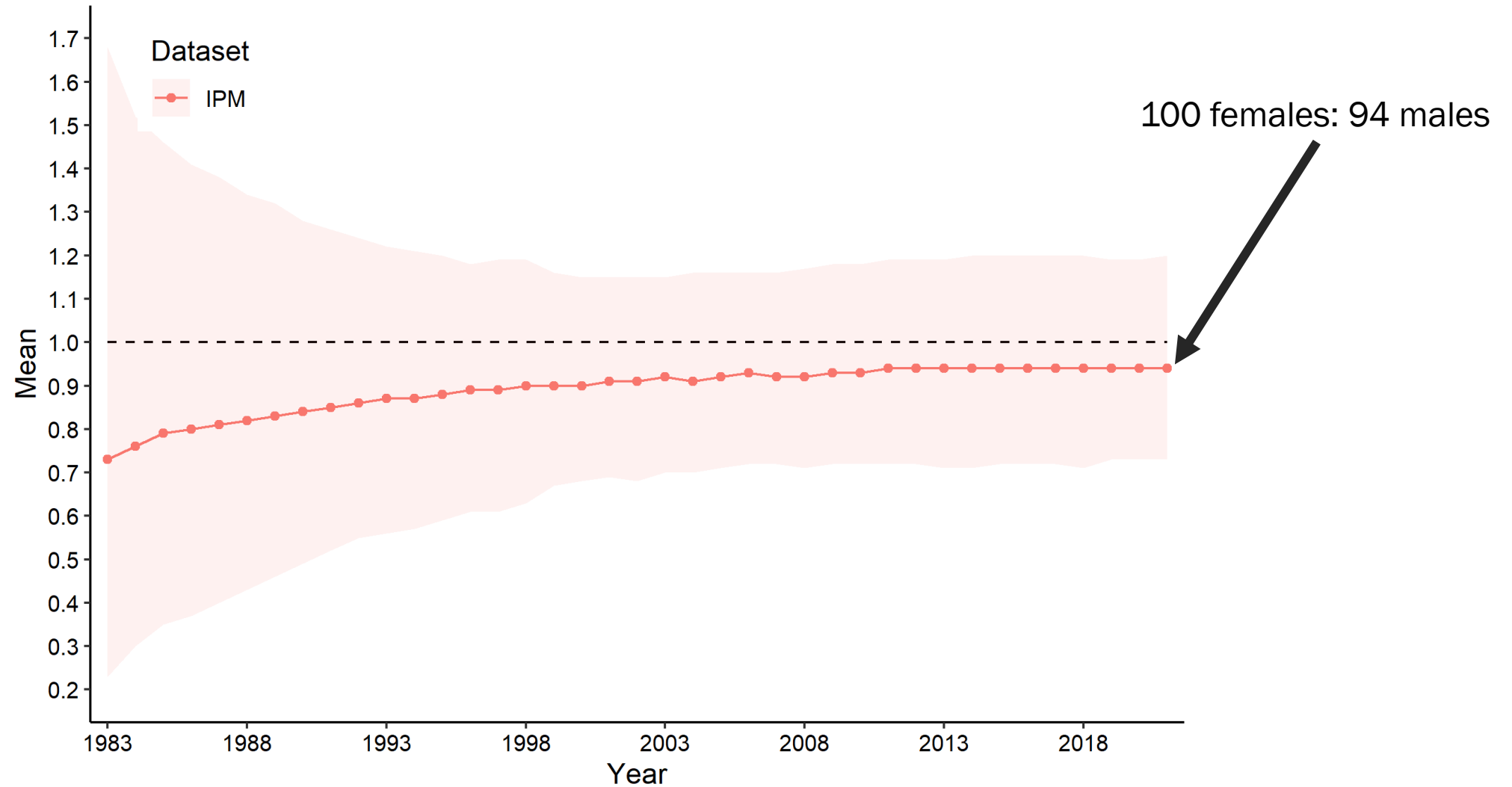
# IPM-specific estimates

Vital rate	Period 1983–2001		Period 2002–2021	
	Point estimate	95% CI	Point estimate	95% CI
Cub survival	0.58	0.02–0.99	0.54	0.01–0.99
Yearling survival	0.66	0.02–0.99	0.58	0.02–0.99
Subadult F survival	0.87	0.84–0.91	0.87	0.84–0.91
Subadult M survival	0.88	0.72–0.98	0.88	0.71–0.99
Adult F survival	0.94	0.93–0.95	0.94	0.93–0.95
Adult M survival	0.93	0.92–0.94	0.93	0.92–0.94
Litter size	2.7	2.16–3.25	2.6	2.06–3.15
Proportion of females with cubs	0.28	0.25–0.32	0.28	0.26–0.31
Annual growth rate (%)	3.0	0.79–1.29	1.4	0.77–1.27
Population abundance (period end year)	723	591–906	1055	756–1424

# Total abundance



# Sex ratio



# Bear density effects



The Journal of Wildlife Management 80(2):300–313; 2016; DOI: 10.1002/jwmg.1005

## Research Article

## Density Dependence, Whitebark Pine, and Vital Rates of Grizzly Bears

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CECILY M. COSTELLO, *College of Forestry and Conservation, University Montana, University Hall, Room 309, Missoula, MT 59812, USA*

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**ABSTRACT** Understanding factors influencing changes in population trajectory is important for effective wildlife management, particularly for populations of conservation concern. Annual population growth of the grizzly bear (*Ursus arctos*) population in the Greater Yellowstone Ecosystem, USA has slowed from 4.2–7.6% during 1983–2001 to 0.3–2.2% during 2002–2011. Substantial changes in availability of a key food source and bear population density have occurred. Whitebark pine (*Pinus albicaulis*), the seeds of which are a valuable but variable fall food for grizzly bears, has experienced substantial mortality primarily due to a mountain pine beetle (*Dendroctonus ponderosae*) outbreak that started in the early 2000s. Positive growth rates of grizzly bears have resulted in populations reaching high densities in some areas and have contributed to continued range expansion. We tested research hypotheses to examine if changes in vital rates detected



# Benefits

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- Developed independently (Univ. Montana)
- IPM takes full advantage of all IGBST data
- Previous work corroborates IPM results
- Update annually, e.g., 15-year moving window
- Flexible implementation
- Potential for multi-ecosystem model (e.g., NCDE)
- Tools for cost-benefit analysis and to evaluate different management scenarios

# Final steps

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- Executive summary to YES committee (in prep)
- Additional development (simulations, projection tools)
- Prepare manuscript for peer-review journal
- Present utility of IPM for YES to evaluate management scenarios (spring 2023)

# Acknowledgments

- Univ. Montana/SpeedGoat:  
Paul Lukacs, Josh Nowak,  
Hans Martin
- IGBST members and  
agencies



*Photo: Jake Davis*