Advancing Demographic Monitoring: Progress Report

INTERAGENCY GRIZZLY BEAR STUDY TEAM

USGS science for a changing world
U.S. Department of the Interior

IGBST

Progress report

Integrated Population Models: quick primer

Preliminary findings

Implementation and next steps

Monitoring challenges

- Long-term data
- Different types and sources of data
- Varying frequency of data collections
- Missing data
- Changes in methods
- Multiple jurisdictions
- Multiple scales

Traditional approach

Separately estimate:

- Survival
- Reproduction
- Population size
- Etc.

Can result in data discrepancies

Hypothetical example

Survival rate + mortality rate = 1.0

250 female bears

Total mortality = 25, mortality rate = 25/250 = 0.10

Survival rate = 0.95

Which estimate is wrong, or are they all wrong?

Hypothetical example

Survival rate + *mortality rate* = *1.0*

250 female bears

Total mortality = 25, mortality rate = 25/250 = 0.10

Survival rate = 0.90

Hypothetical example

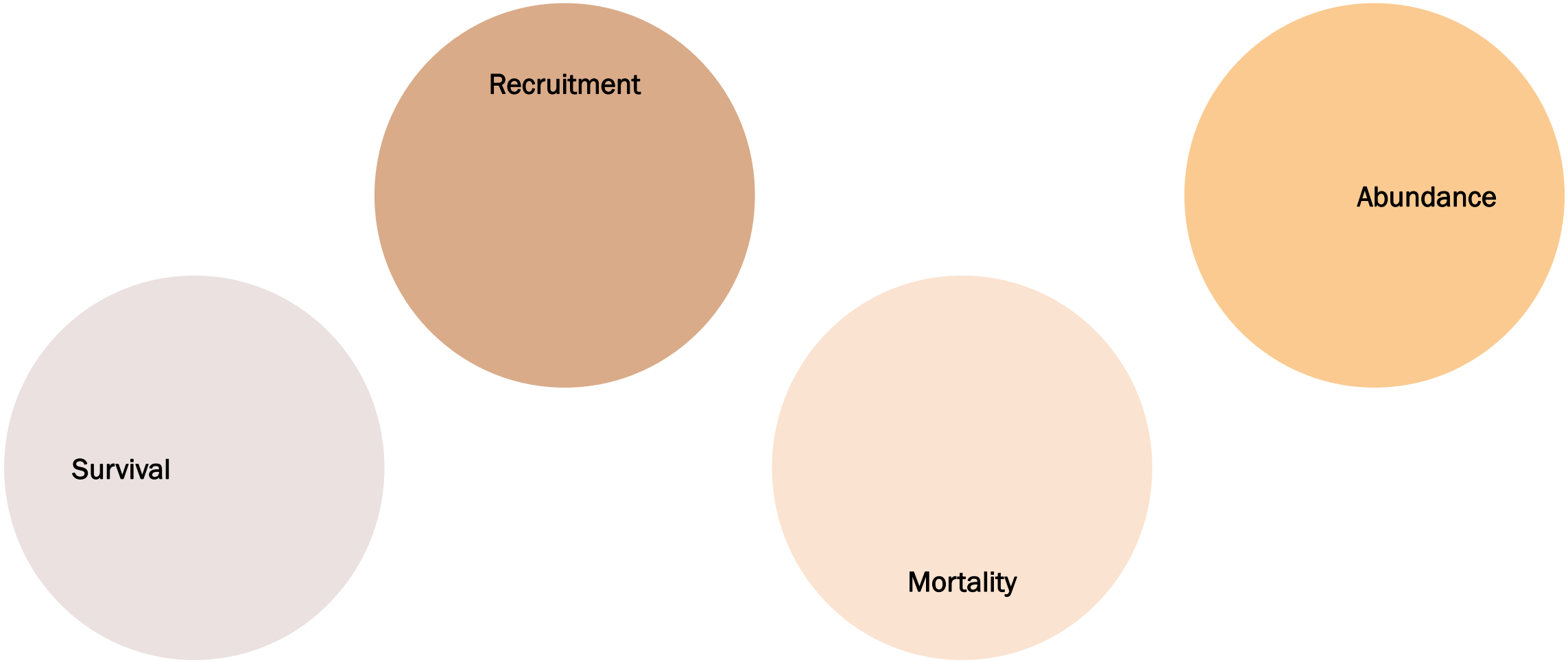
Survival rate + mortality rate = 1.0

500 female bears

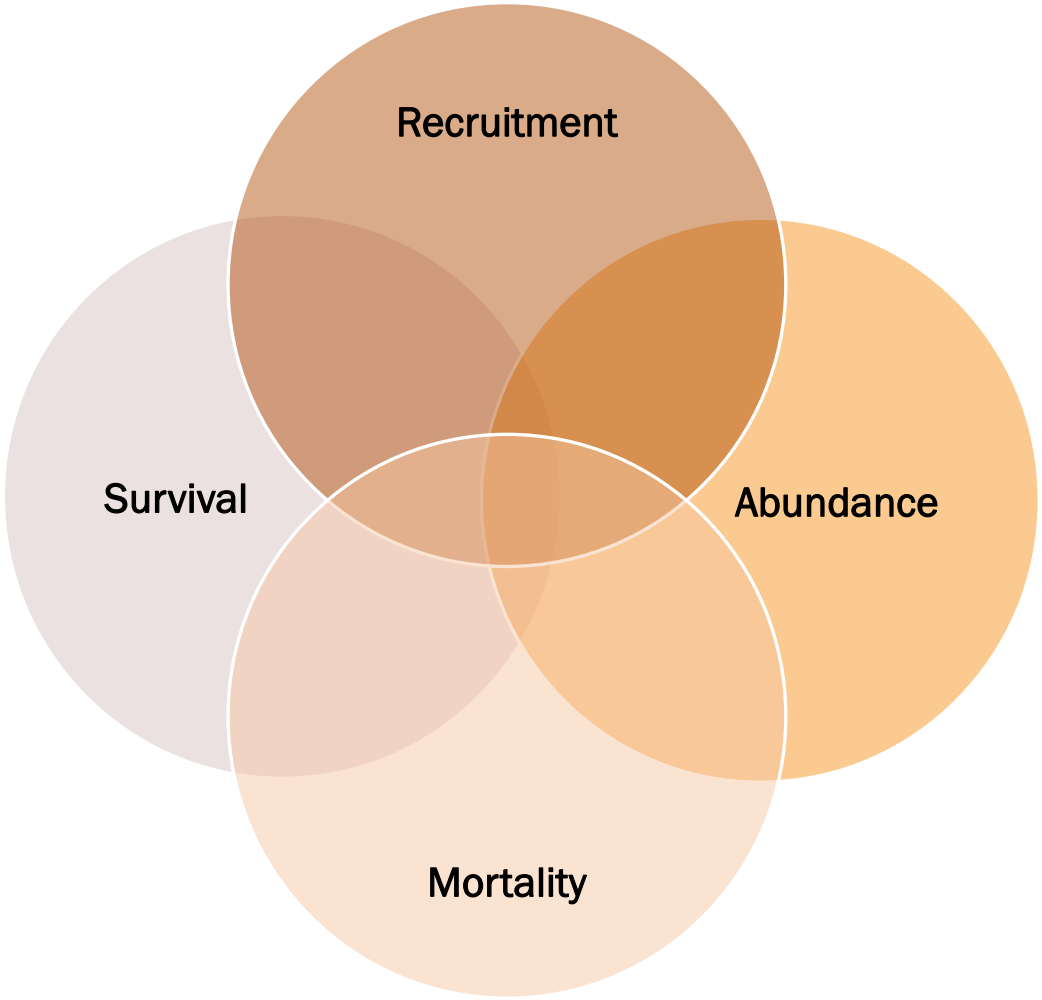
Total mortality = 25, mortality rate = 25/500 = 0.05

Survival rate = 0.95

“Overlapping consensus”



“Overlapping consensus”



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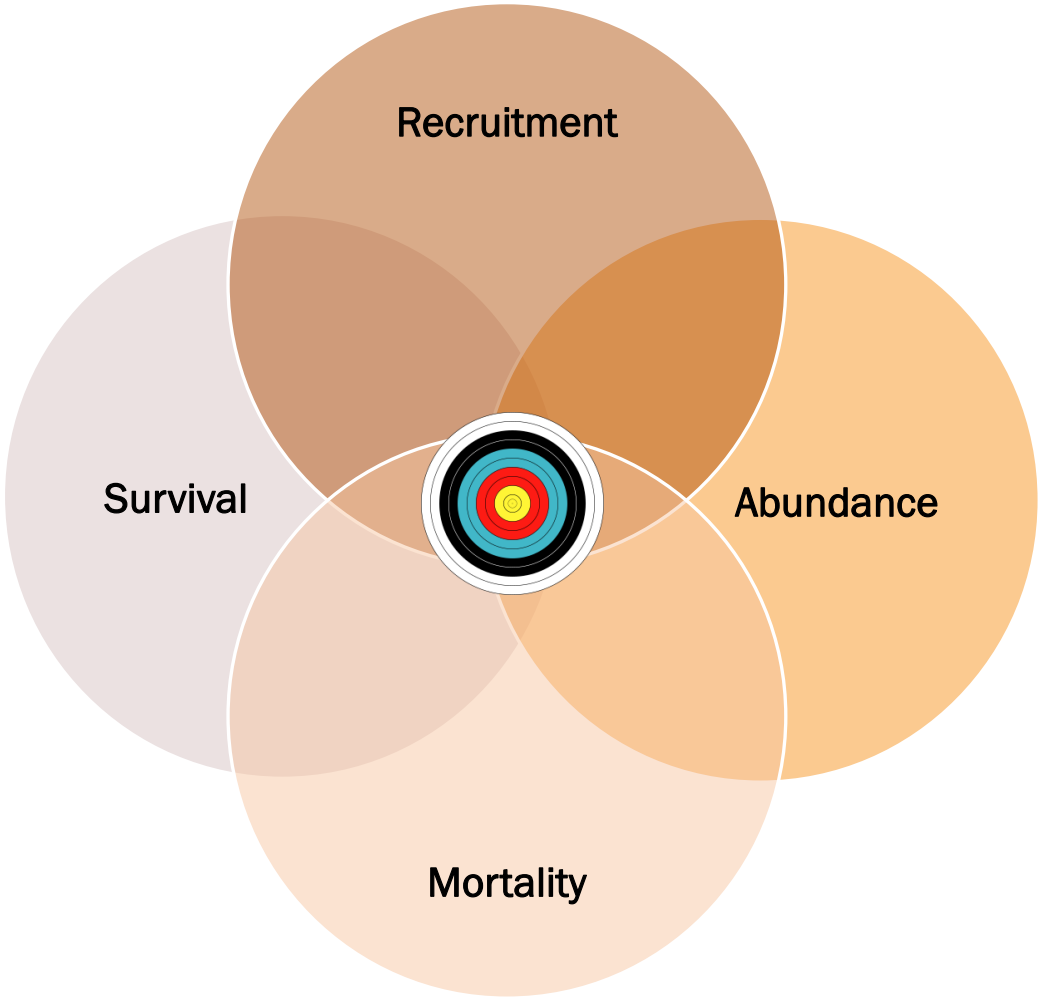
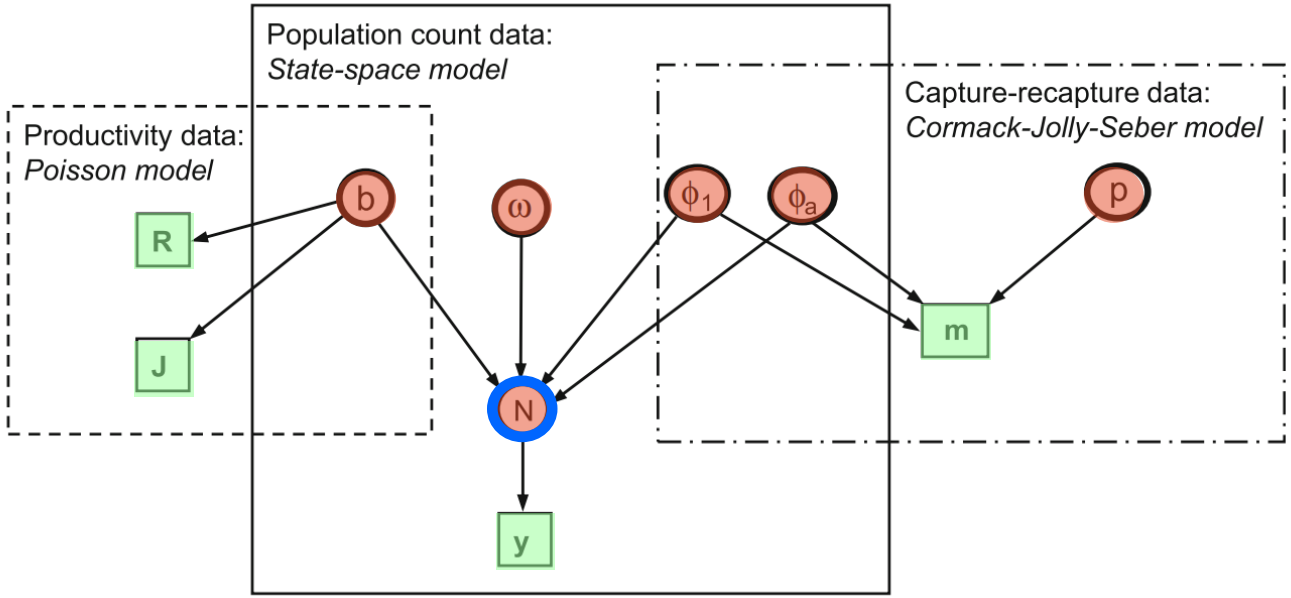


Integrated Population Model (IPM)

"Any model that jointly analyses data on population size and demographic parameters" (Schaub and Abadi 2011)



Making the most of limited data

Multiple models in one:

Process model: describes biology

$N_{newborns} = N_{adult\ females}$ x pregnancy rate x litter size

Observation models: relate data to parameters

- $N_{adult\ females}$ ← estimated (data)
- Pregnancy rate ← test animals (data)
- Litter size ← observed counts (data)

More data sources → better inference

Key attributes of IPM

Make sense of multiple sources of imperfect data

- Unified framework for analysis of all monitoring data
- Establish current population status, predict future population

Self-consistent estimates

- Reconciles estimates from different data → increases reliability

Useful outputs for management

- Greater transparency to inform management decisions

Flexible structure

- Incorporate new data, new methods, expert opinion, etc.
- Evaluate cost and contributions of different data sources

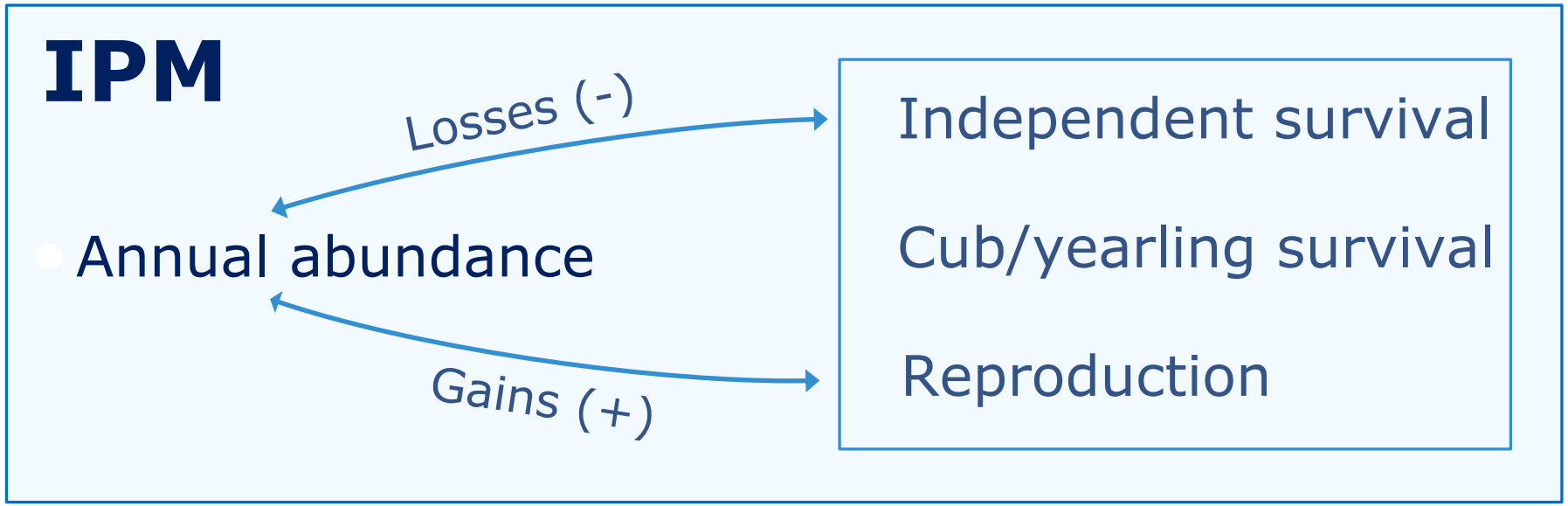
Enhancing wildlife governance

Wildlife Governance Principles (WMI)

- Strategic and adaptive thinking
- Evidence-based and broadly informed decision-making
- Transparency and accountability for decisions/actions
- Inclusive and diverse participation in decision-making
- Capacity to deliver conservation

Photo: S. Ard

IGBST: linking vital rates and abundance



Parameters are “self-reconciling” → reliable inference

Implementation

SpeedGoat & Univ. Montana

- www.speedgoat.io/story
- Paul Lukacs, Josh Nowak
- Independent research entity

Web-based application

- Common interface
- Common data storage and management
- Analysis framework

Common results

- Everyone on team is seeing same structure and results
- Addresses scale issues

SPDGT - Dev

- Home
- IPM
  - Setup
  - DB Mgmt
  - Plots
  - Tables
  - Build Report
- Survival
- Recruitment
- Transitions
- Expert Opinion

Logged in as

Logout

1) Overview | 2) Structure | 3) Mortalities | 4) Run

Burnin Length

500 | 25,500 | 50,000

500 5,500 10,500 15,500 20,500 25,500 30,500 35,500 40,500 45,500 50,000

MCMC Iterations

1,000 | 46,000 | 55,000

1,000 11,000 21,000 31,000 41,000 51,000 55,000

Thinning Rate

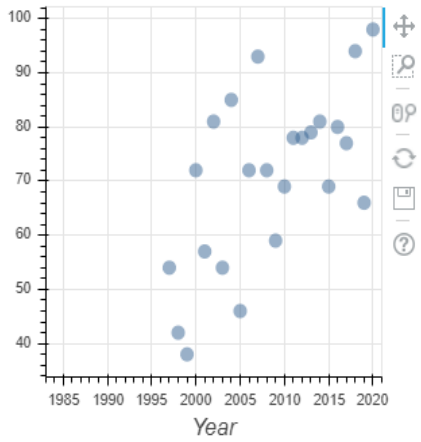
1 | 100

1 11 21 31 41 51 61 71 81 91 100

Automate Convergence

Fit Model

Chao2 | Proportion w/COY | Mark-Resight | Survival | Priors



Abundance | Survival | Reproduction | Reconstruction | Priors

Copy | Print | Column visibility

Year	Species	DAU	Sex	Age	Parameter	Mean	SE	Unit	Tau	LCL	UCL	fakeSE
All	All	All	All	All	All	All	All	All	All	All	All	All
1997	Grizzly Bear	GYE			Chao2_16km	54						false
1998	Grizzly Bear	GYE			Chao2_16km	42						false
1999	Grizzly Bear	GYE			Chao2_16km	38						false
2000	Grizzly Bear	GYE			Chao2_16km	72						false
2001	Grizzly Bear	GYE			Chao2_16km	57						false
2001	Grizzly Bear	GYE			Mark Resight	72	25		0	24	120	true
2002	Grizzly Bear	GYE			Chao2_16km	81						false

SPDGT - Dev

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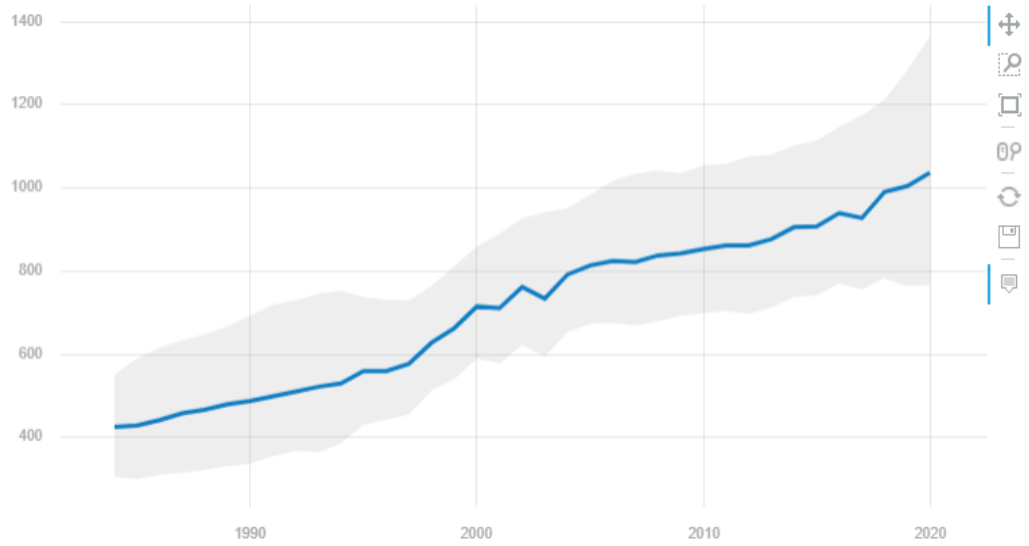
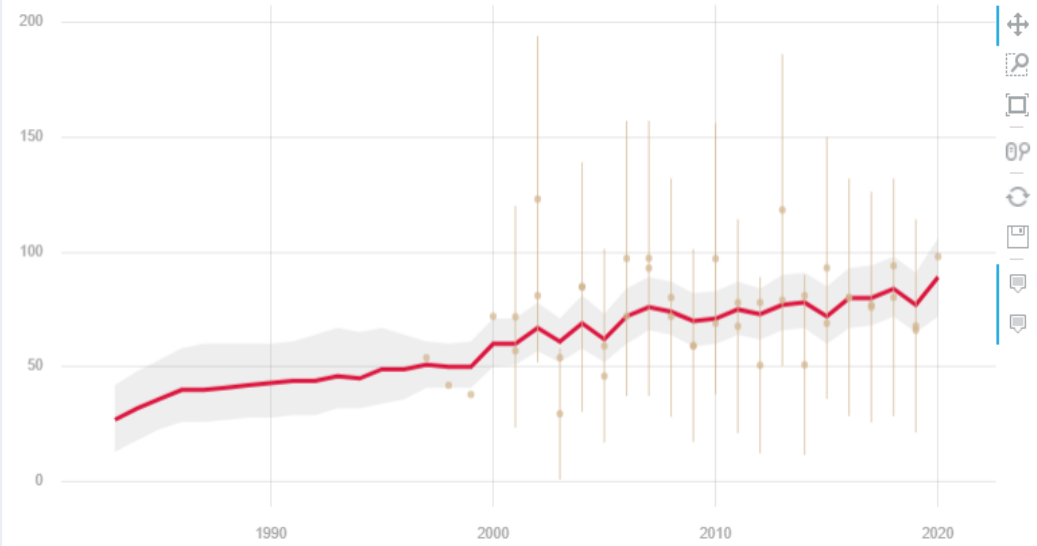
Total | Female | Male | Out of Den — Abundance



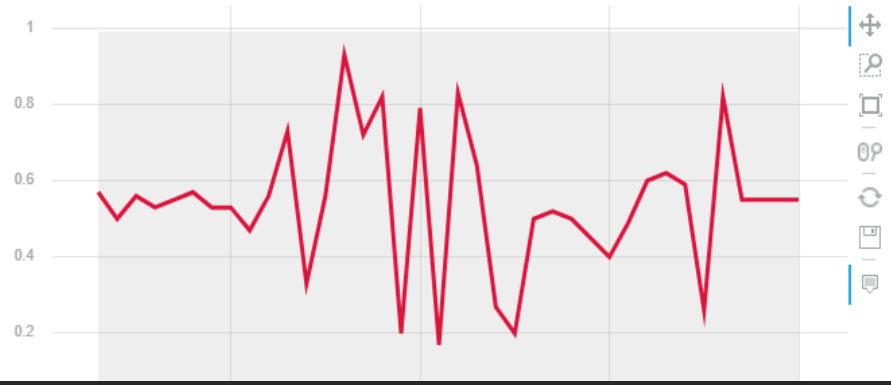
Females w/COY | Proportion w/COY | Number of Cubs Born | Litter Size | Sex Ratio — Ratios



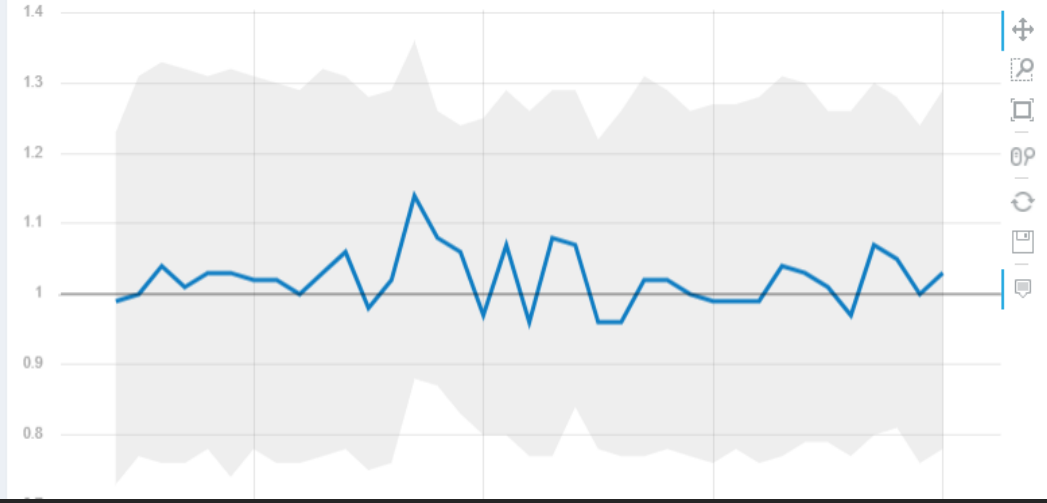
Female | Male — Survival

Age

YOY



Growth Rate — Misc



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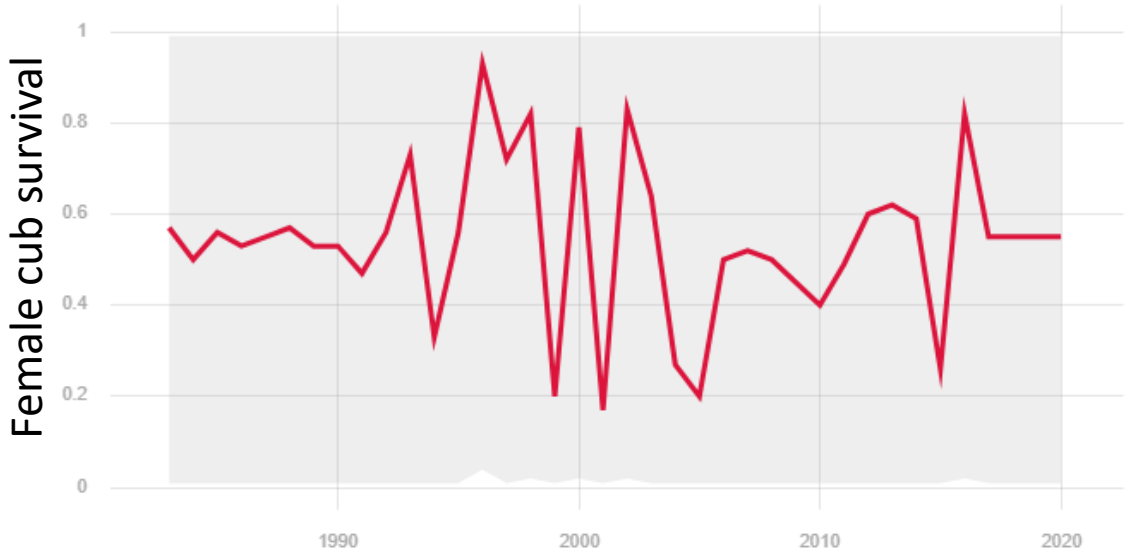
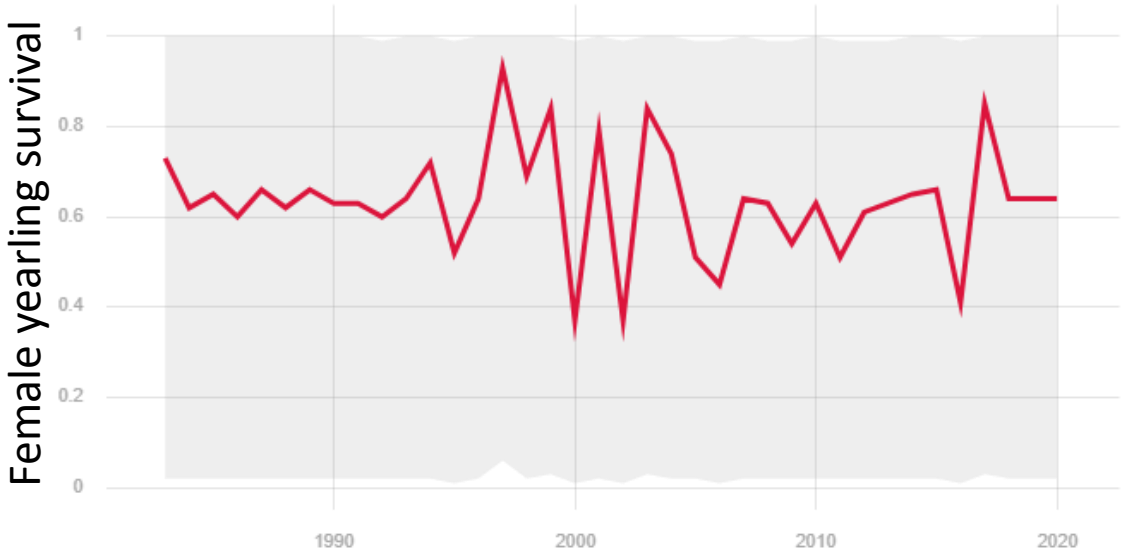
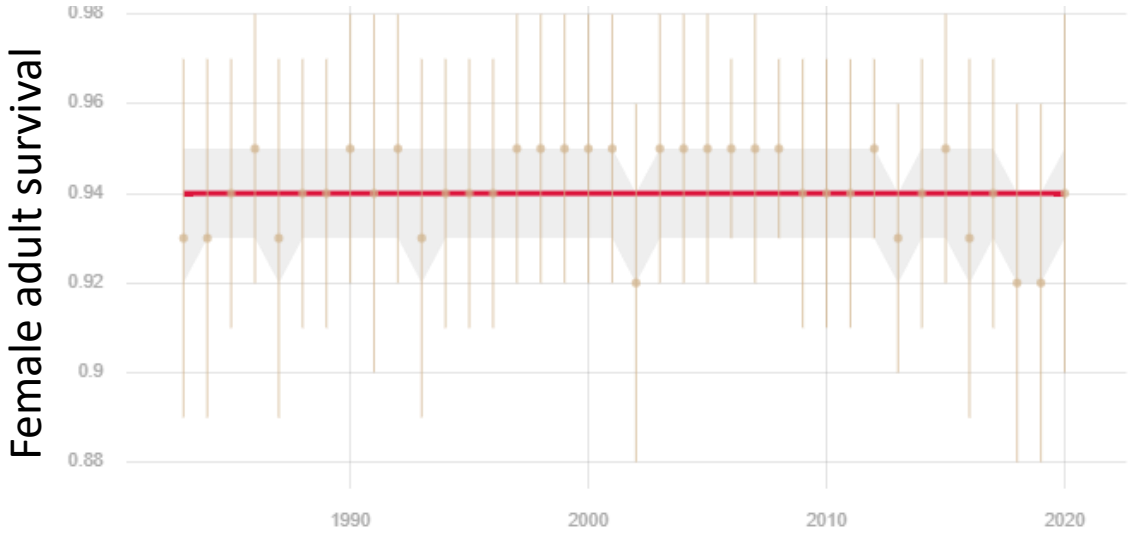
Preliminary Information-Subject to Revision. Not for Citation or Distribution.

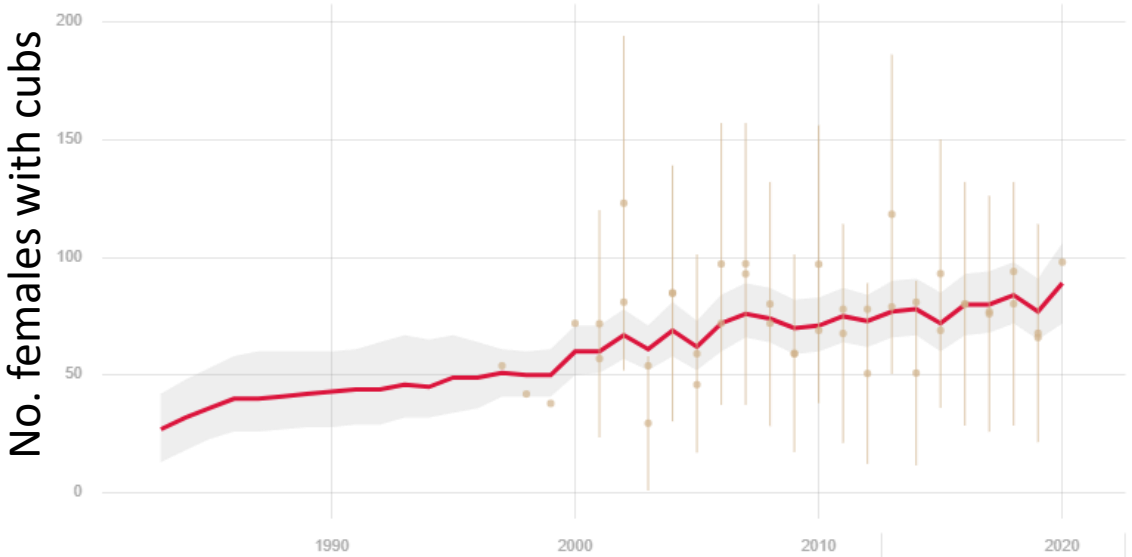
Vital rates: survival

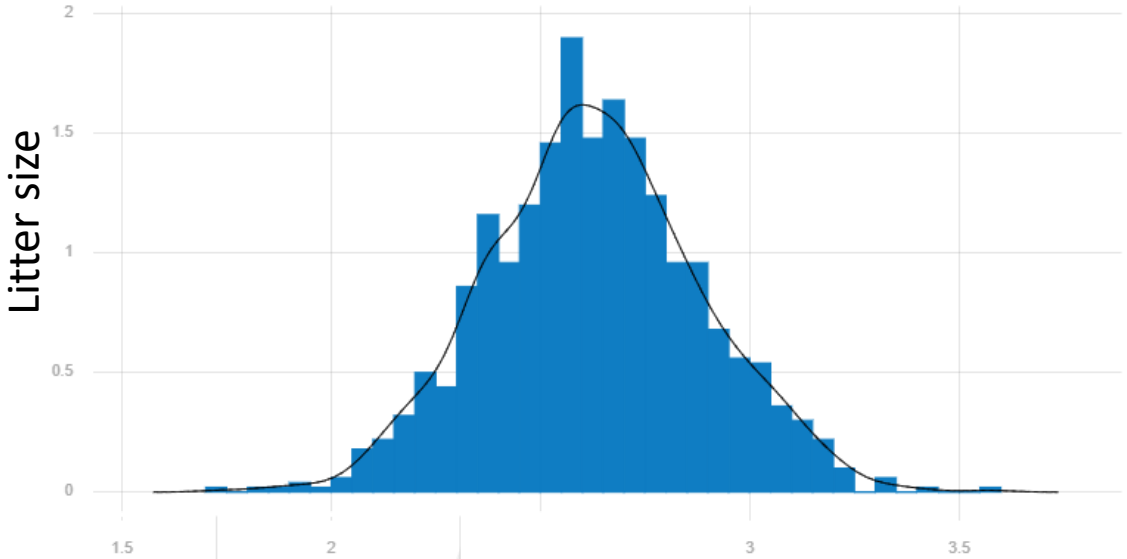


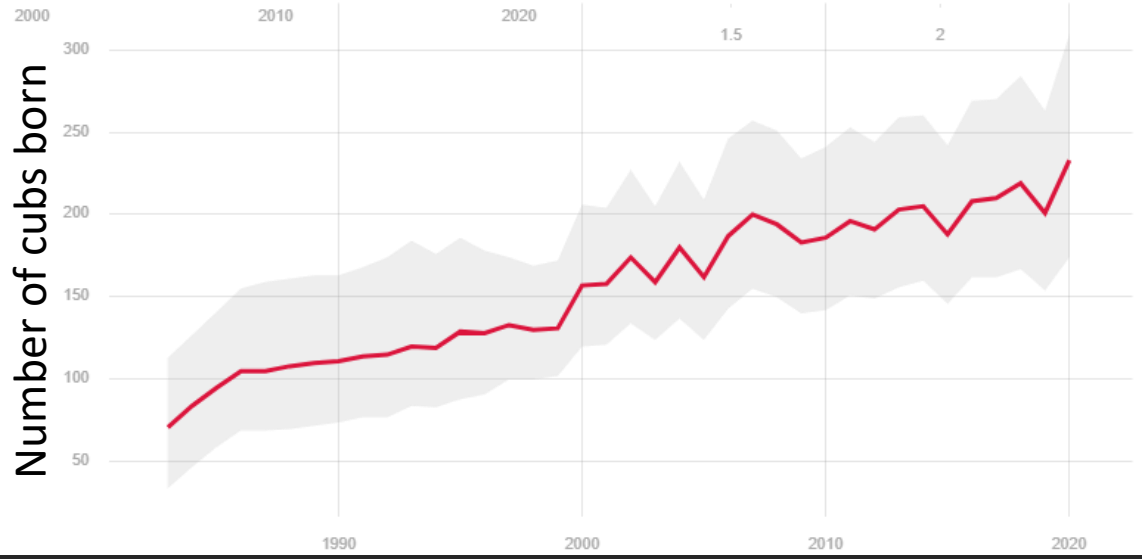




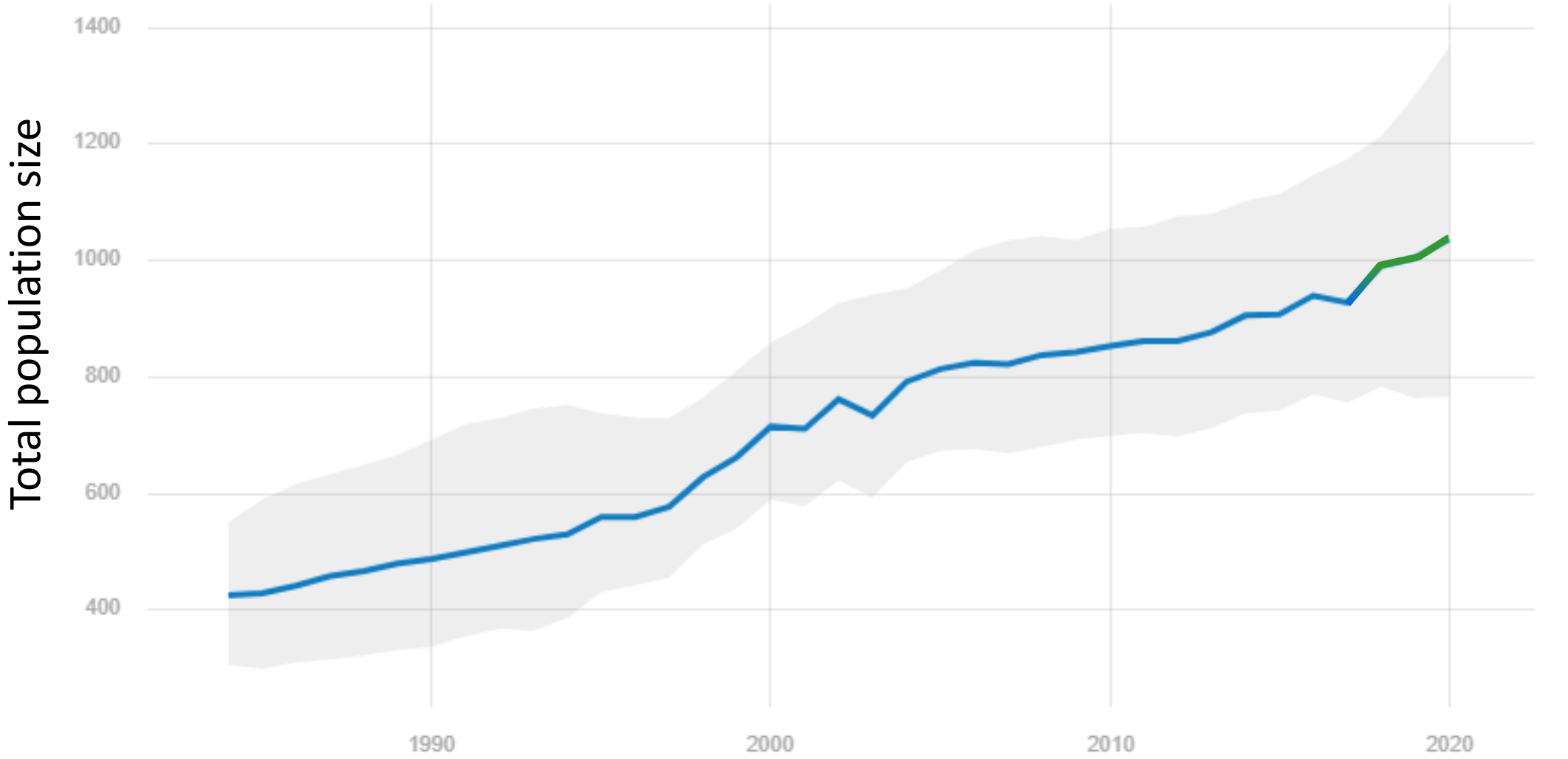
Vital rates: reproduction



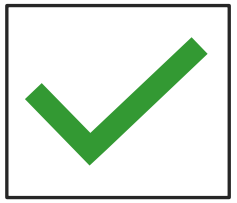
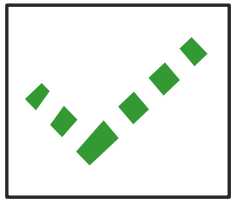




Population size



Ongoing and next steps

- Incorporate updated Chao2 (16 km) into IPM 
- Update with 2019-2021 data and final testing 
- Final reporting to YES (Spring 2022) 

Acknowledgments

- UM: Paul Lukacs, Josh Nowak, Hans Martin
- IGBST members and agencies

Photo: Jake Davis