

Relevant Grizzly Bear Science Greater Yellowstone Ecosystem

Denver Meeting
18-19 February 2015



Keith Crowley

Outline

Overview and background

1. Population estimation and trend

- A. Population trend
- B. New population estimation technique

2. Management flexibility

- A. Demographic Monitoring Area (DMA)
- B. Assessing sustainable mortality

Study Team Members

Bryan Aber (IDFG)

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Megan Higgs (MSU)

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Dan Tyers (USFS)

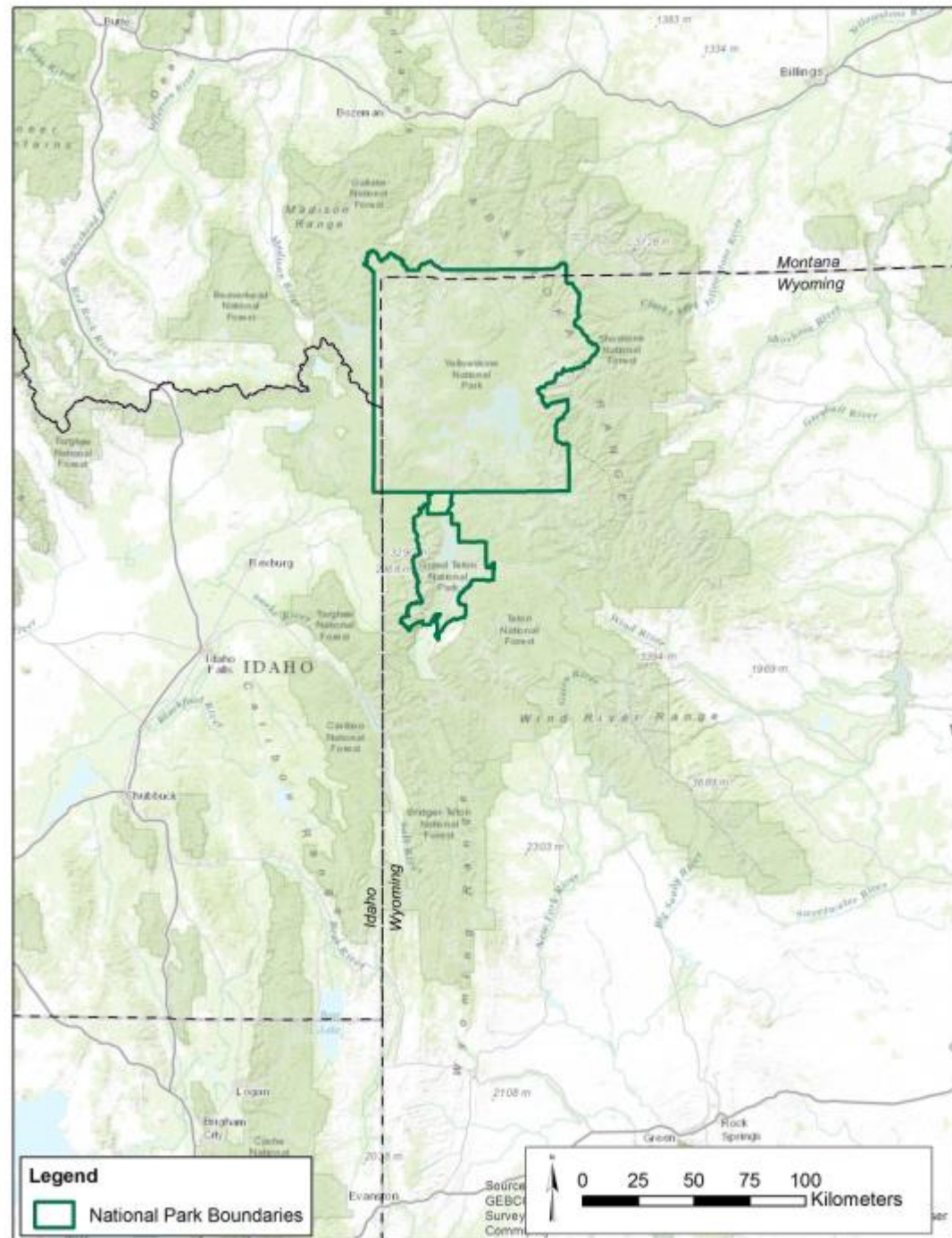
Frank van Manen (USGS)

Kate Wilmot (NPS)



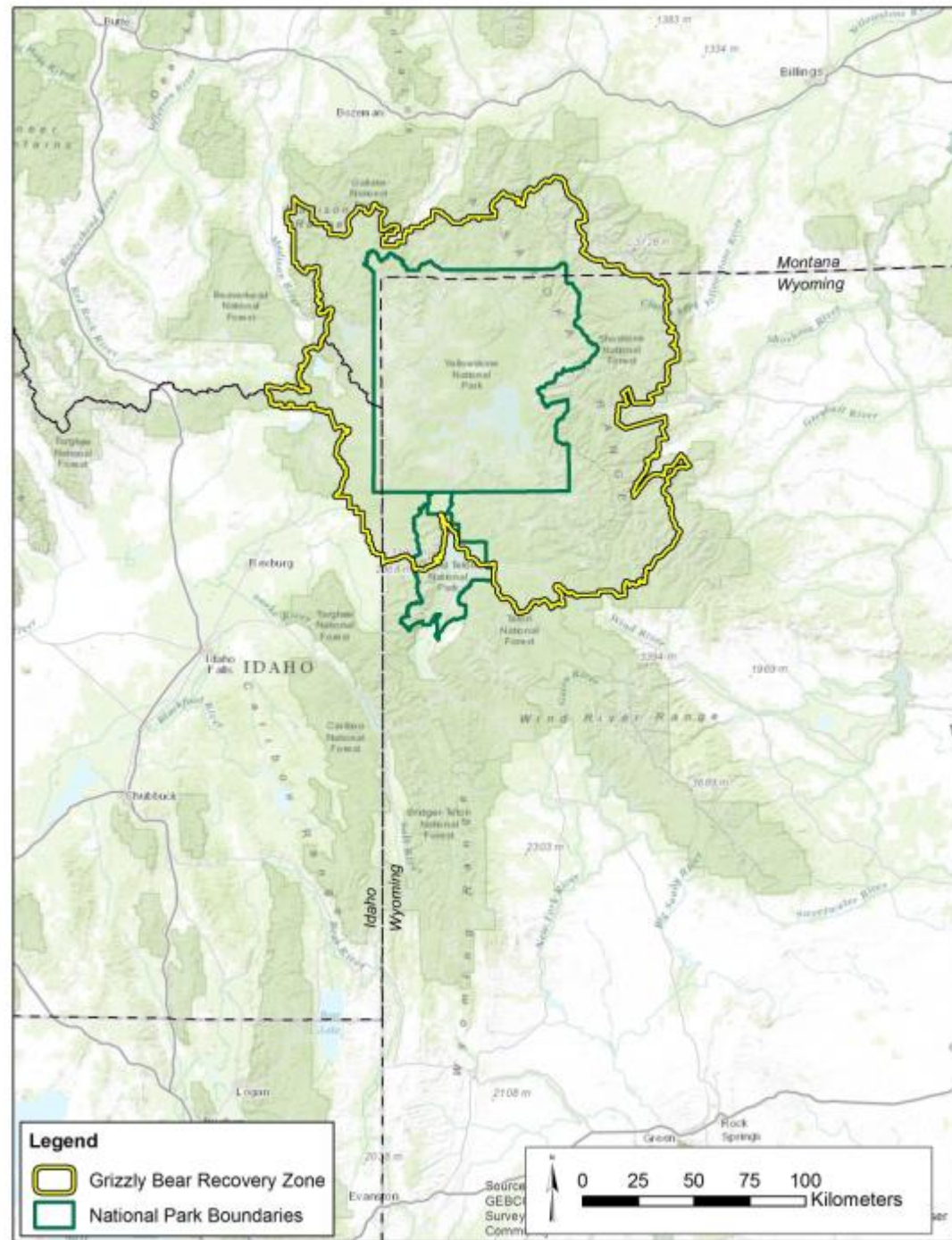
IGBST

- # IGBST



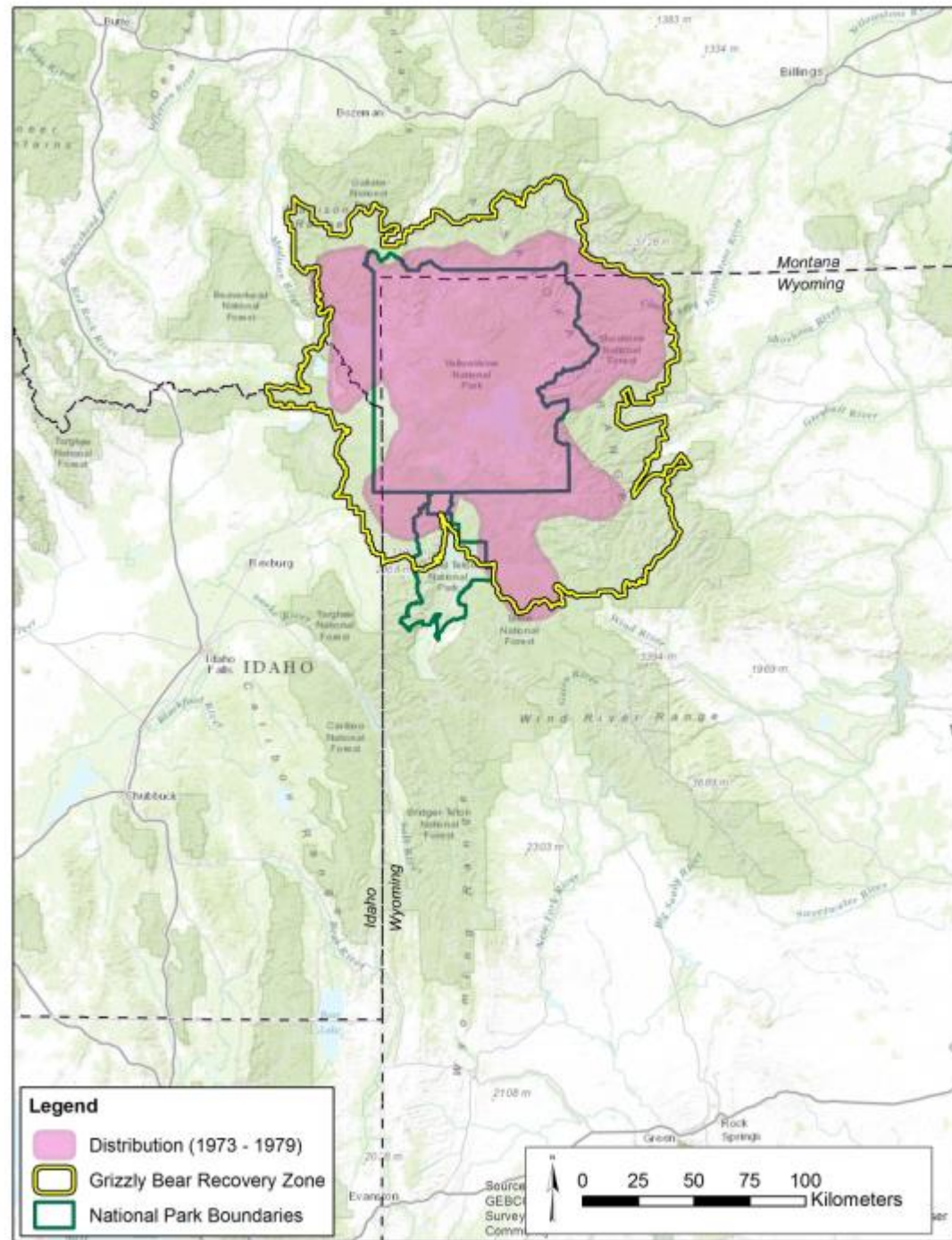
IGBST

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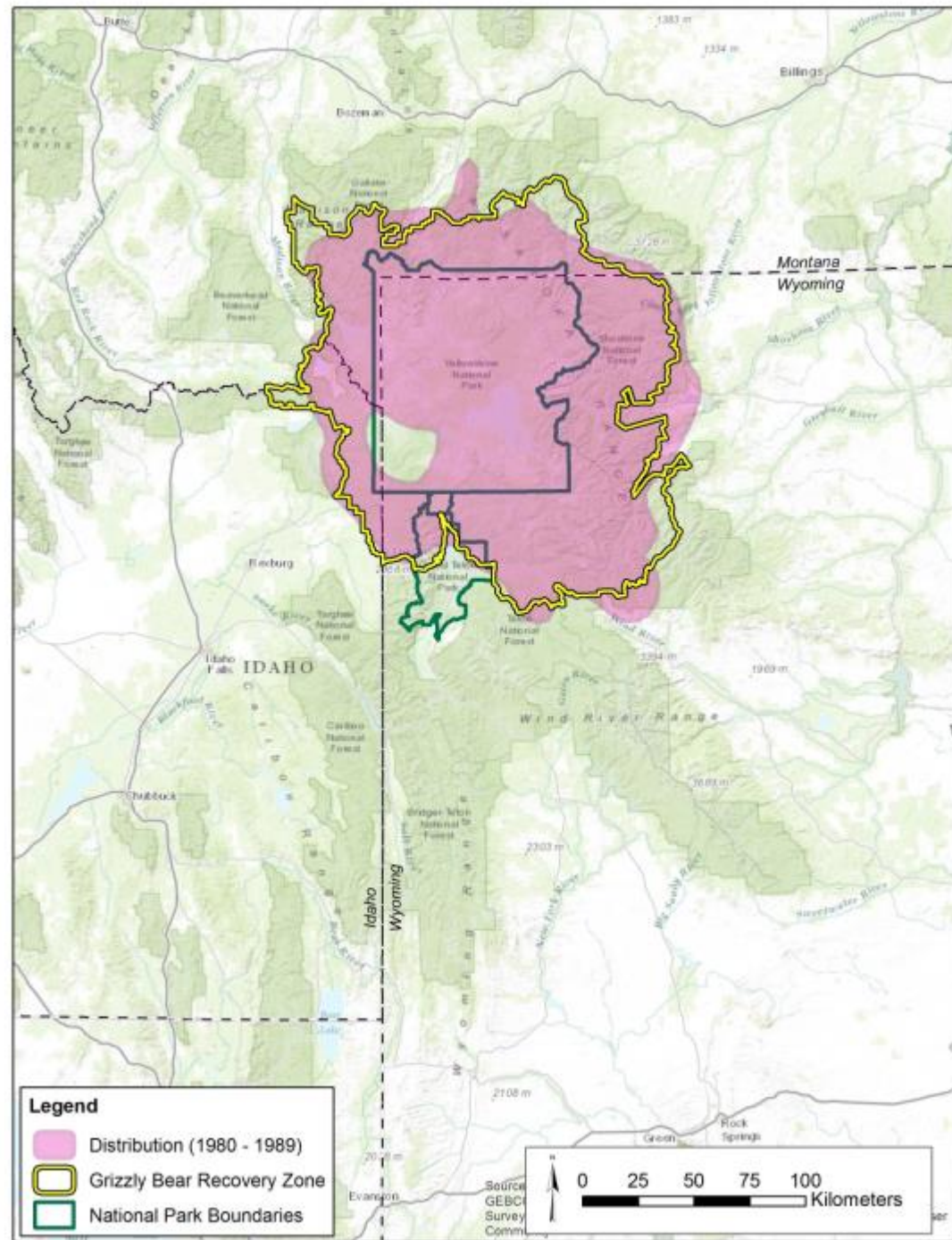
Greater Yellowstone Ecosystem

- Grizzly bear distribution
1973-1979
15,786 km²



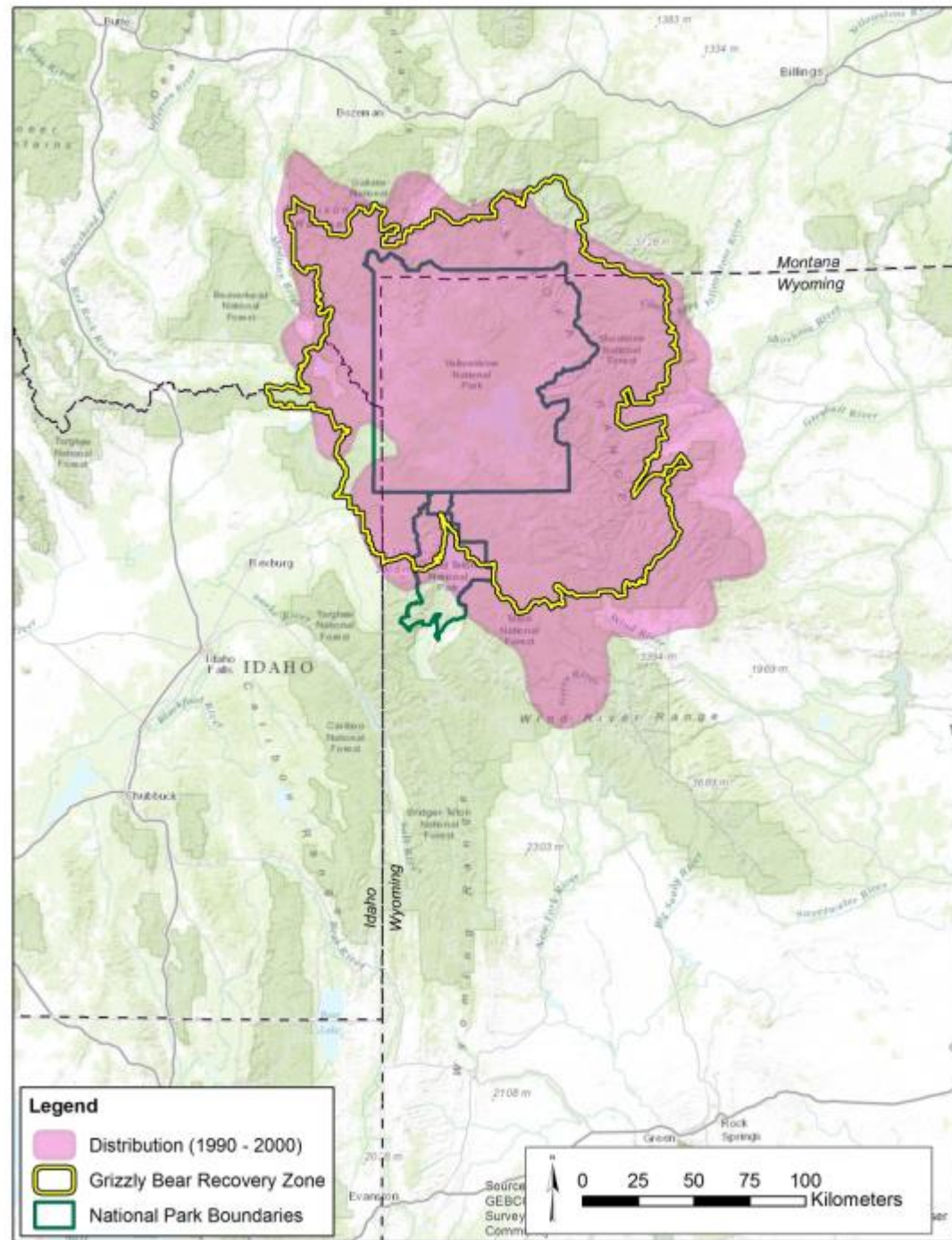
Greater Yellowstone Ecosystem

- Grizzly bear distribution
1980-1989
23,971 km²



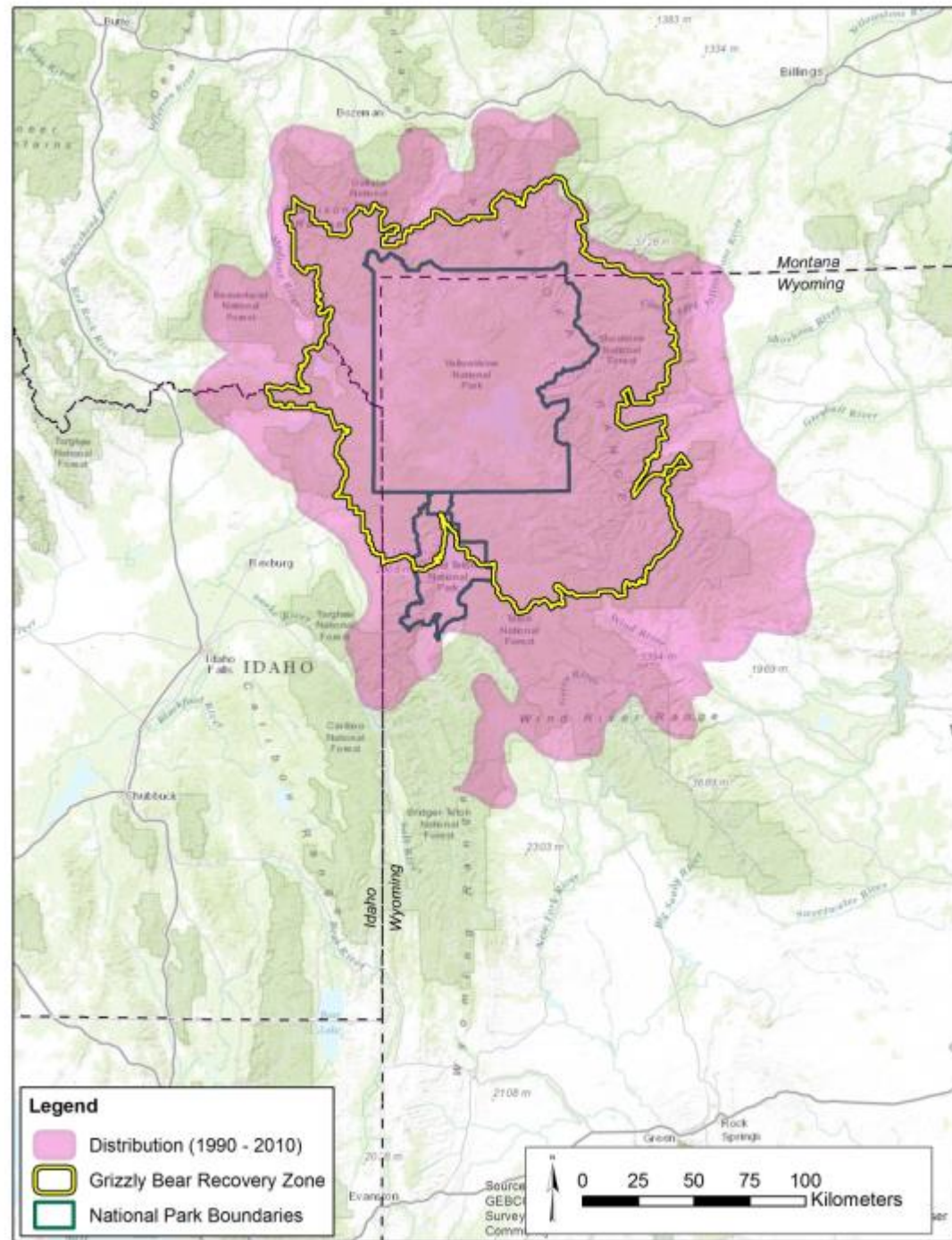
Greater Yellowstone Ecosystem

- Grizzly bear distribution
1990-2000
33,298 km²



Greater Yellowstone Ecosystem

- Grizzly bear distribution
Bjornlie et al. (2014)
1990-2010
50,280 km²



IGBST Demographic Workshops 2011-2012

- Directives from the Yellowstone Ecosystem Subcommittee (YES) of IGBC
- Two primary directives:
 - 1) Alternative population estimator
 - 2) Flexibility for mortality management
- 3 workshops (Feb 2011, Jul 2011, Feb 2012)
- IGBST members and external experts

Topic 1: Population Estimation and Trend

- A) Population trend based on 4 methods
- B) Mark-resight estimator

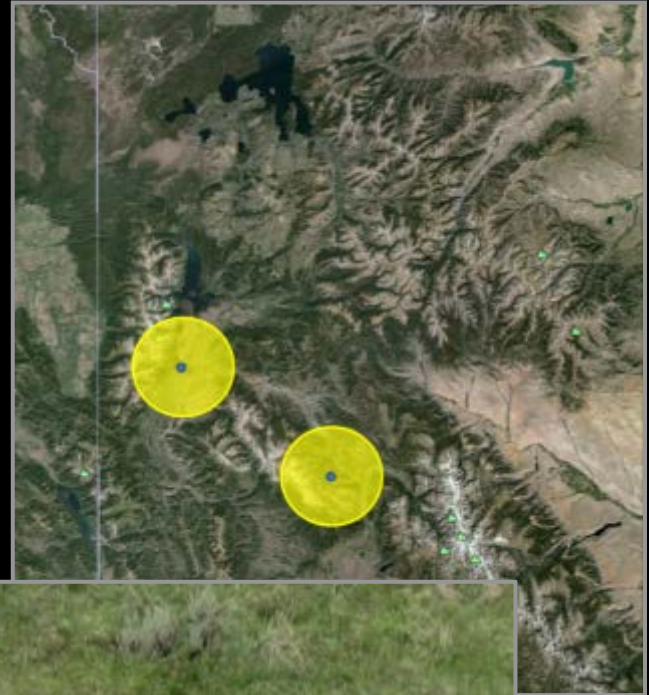
Challenges of Grizzly Bear Population Studies

- Low density and solitary
- Low observability (activity pattern, habitat)
- Remote and difficult terrain
- Achieving adequate sample size
- IGBST uses multiple methods for stronger inference

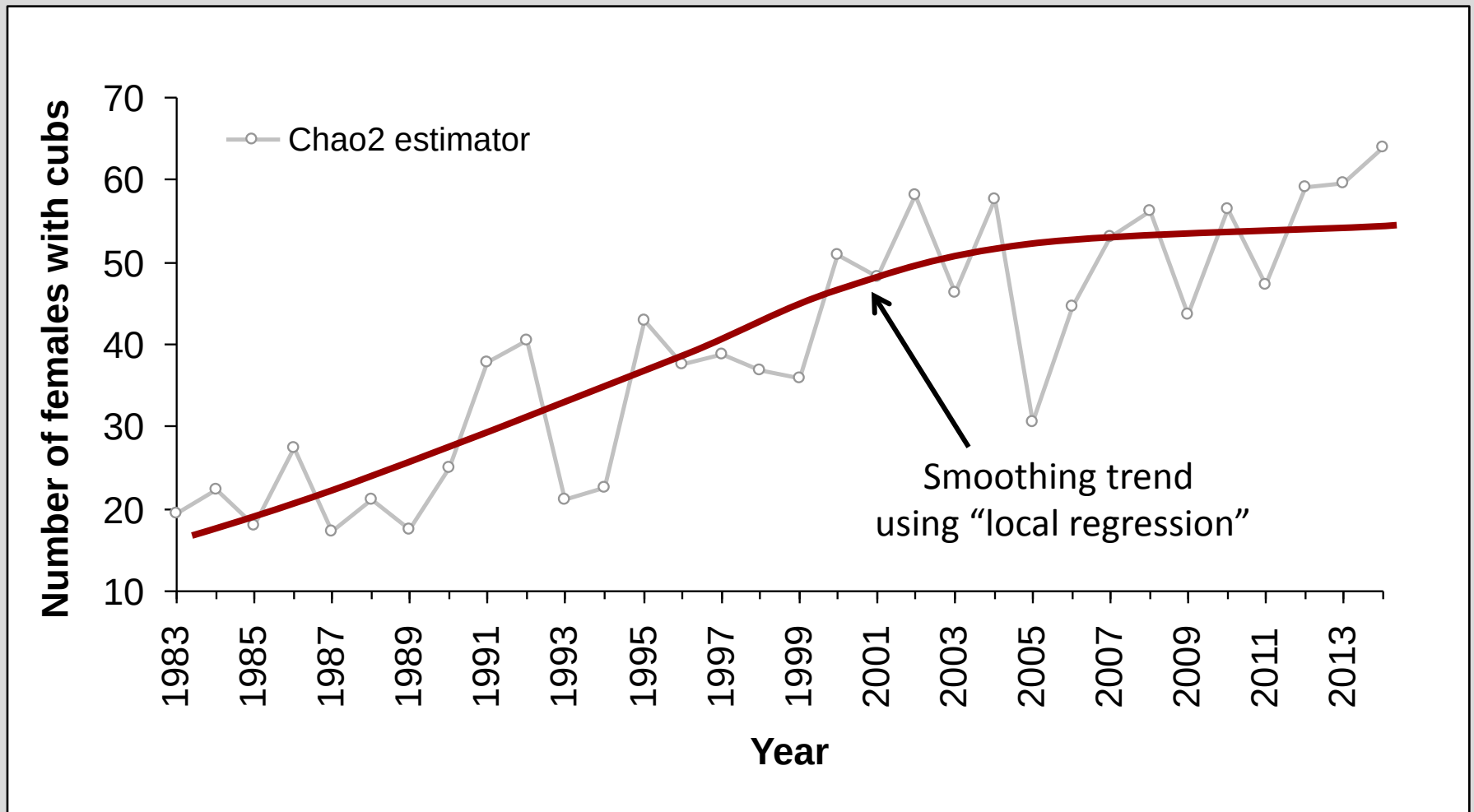
Population Trend



Method 1: Chao2 Estimator



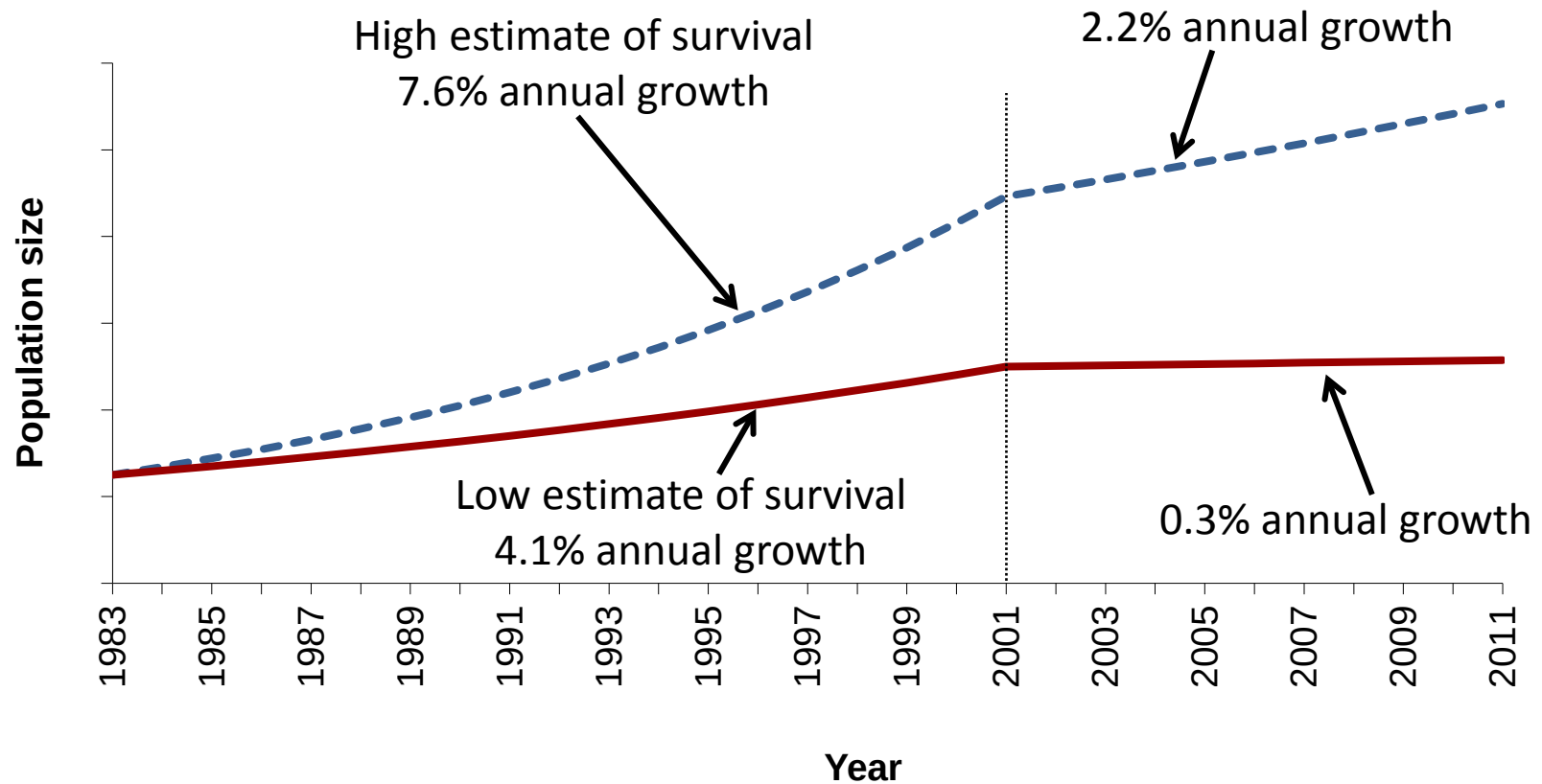
Chao2 Estimator



Method 2: Known-Fate Analysis



Population Projection

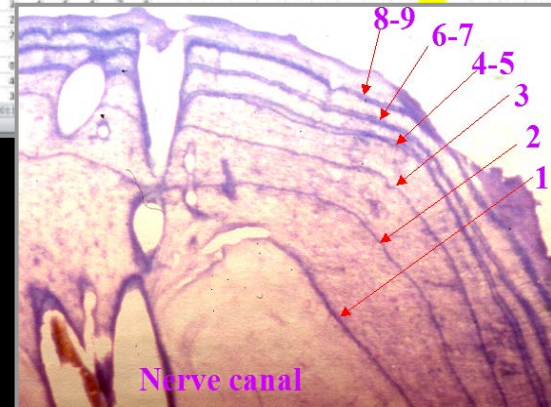


Method 3: Population Reconstruction (Minimum Known Alive)

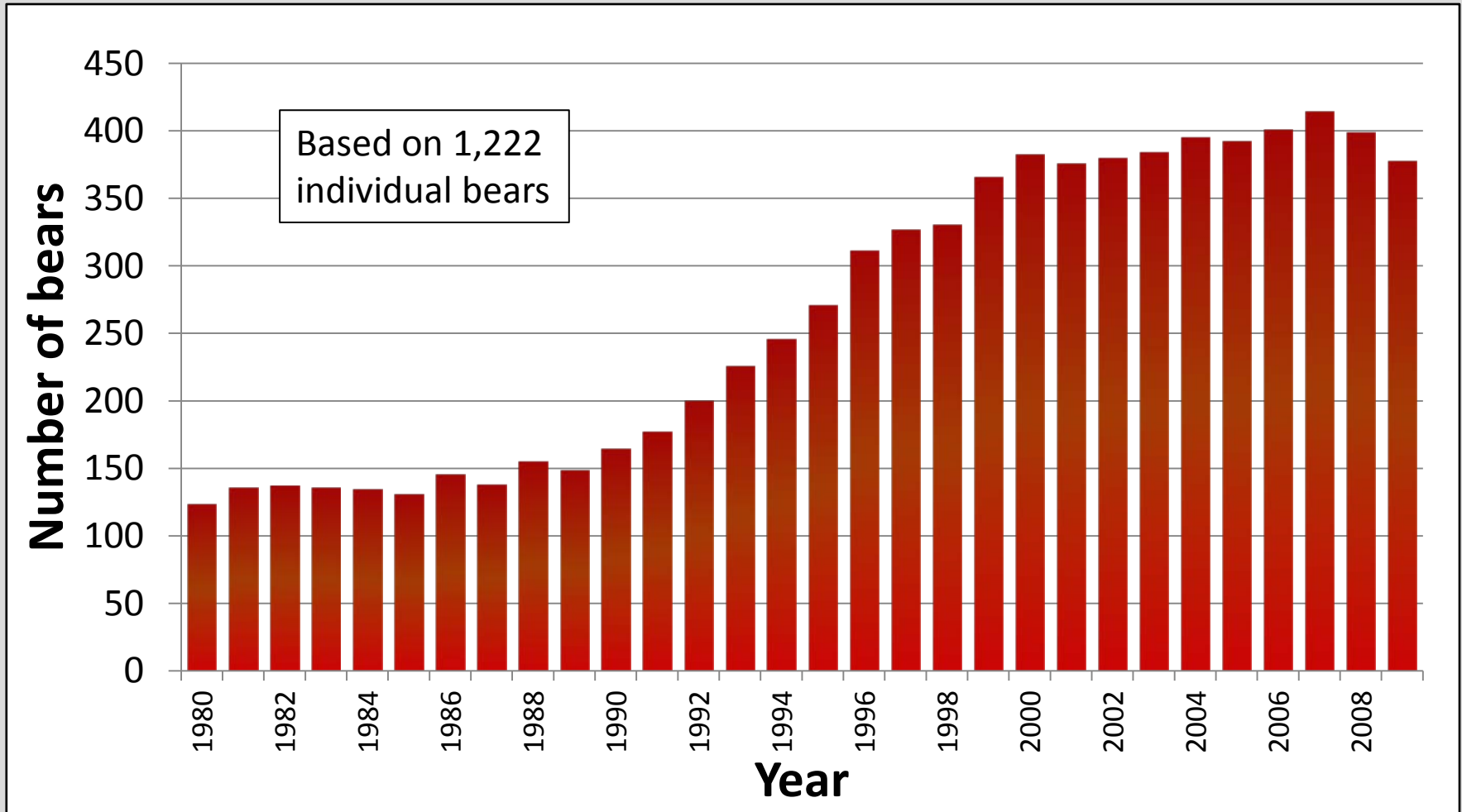


Microsoft Excel spreadsheet showing a population reconstruction table. The table has columns for Year (1990-2014) and rows for individual bears (e.g., 252, 256, 257, etc.). The table includes data for Mort Number, Max Age, and various age classes (e.g., 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 16, 17, 18, 19, 20, 21, 22).

Year	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
252	199015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
254	199011	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
256	199017	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
257	199017	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2
258	199017	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19
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262	199017	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12	12
263	199017	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20
264	199017	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4
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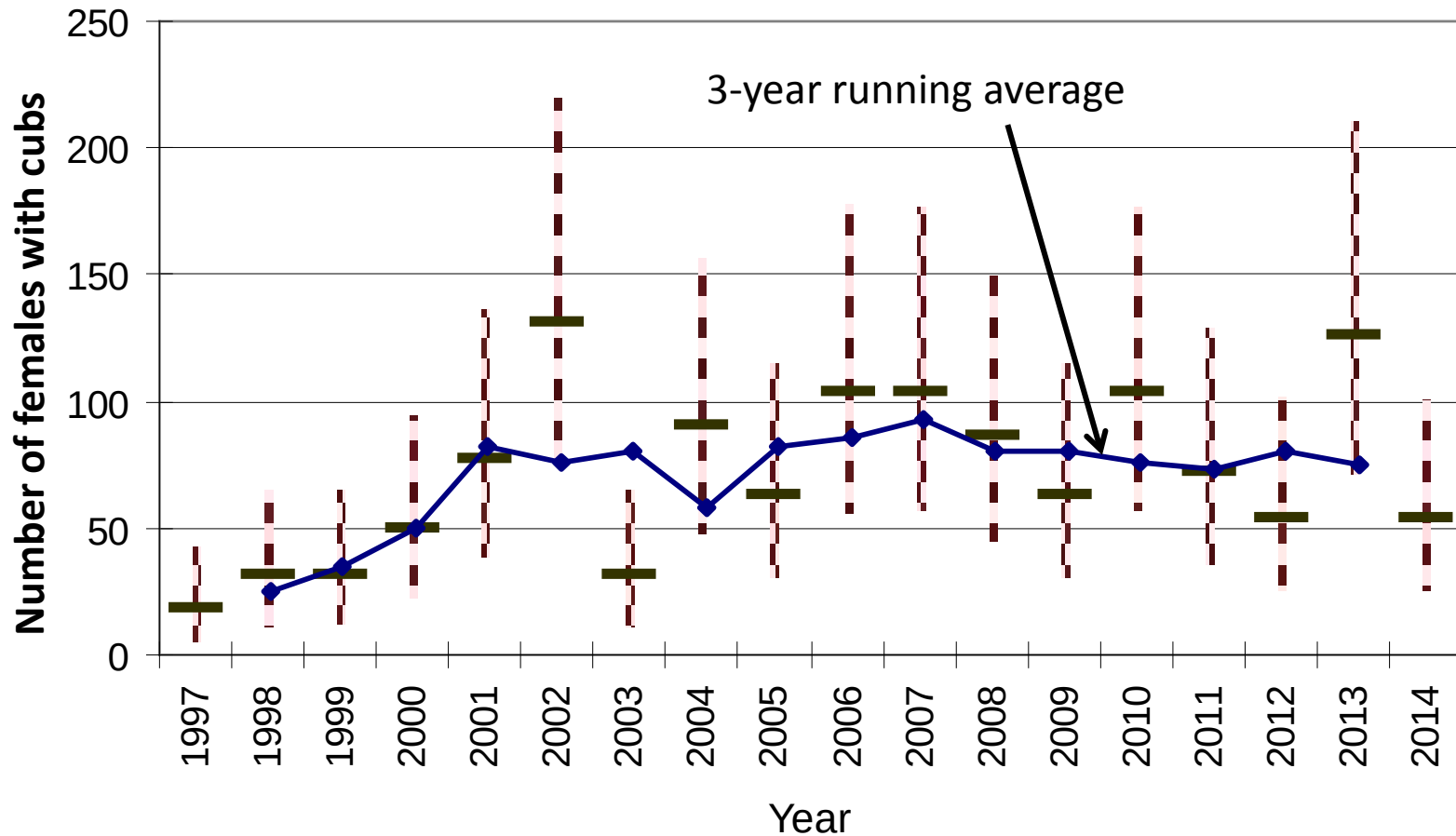
Population Reconstruction



Method 4: Mark-Resight of Radio-Marked Females with Cubs

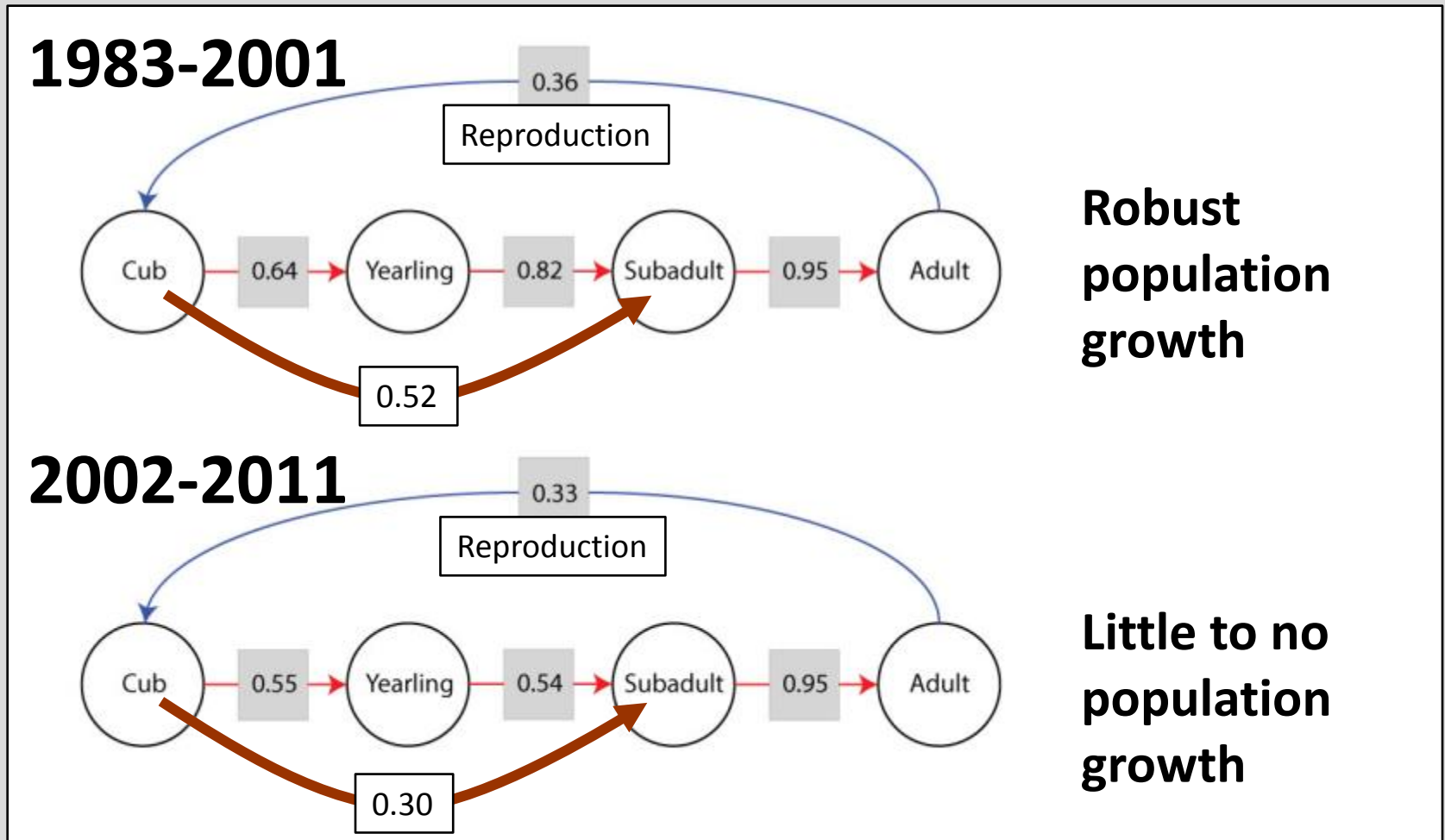


Mark-Resight Estimator

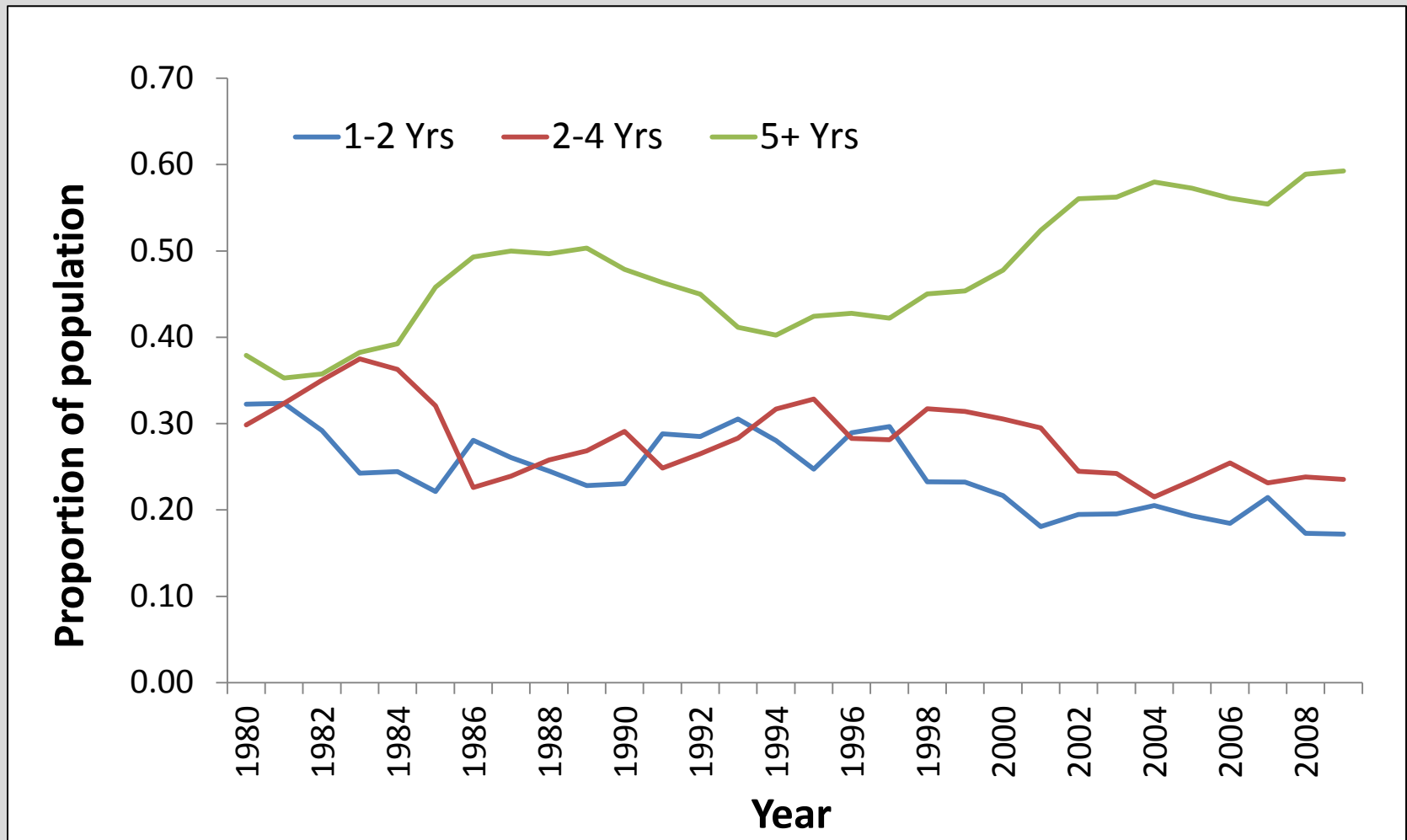


Mechanism Behind Slowing of Population Growth

Evidence from Known-Fate Analysis

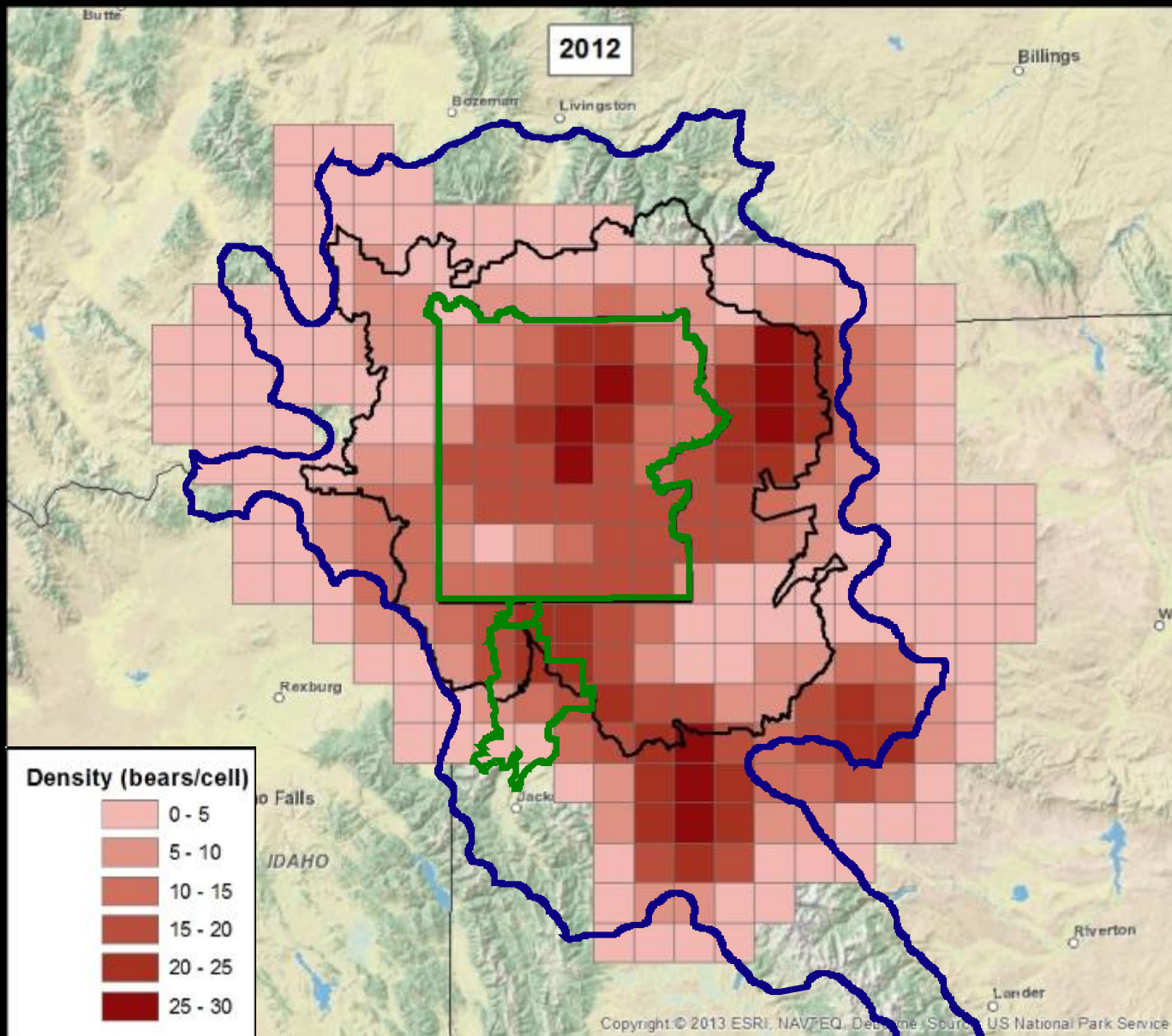


Changing Age Structure Population Reconstruction



Grizzly Bear Density Index

Based on 870 individual home ranges of bears ≥ 2 years of age



Conclusions: Population Trend

- 4 independent methods show minimal population growth since early 2000s
- First reported in 2012 (IGBST Workshop Report)
- Mechanism: lower survival of younger age classes
- Pattern follows predictions for populations of large vertebrates reaching carrying capacity (Eberhardt 1977)
- A population near carrying capacity is indicative of recovered population

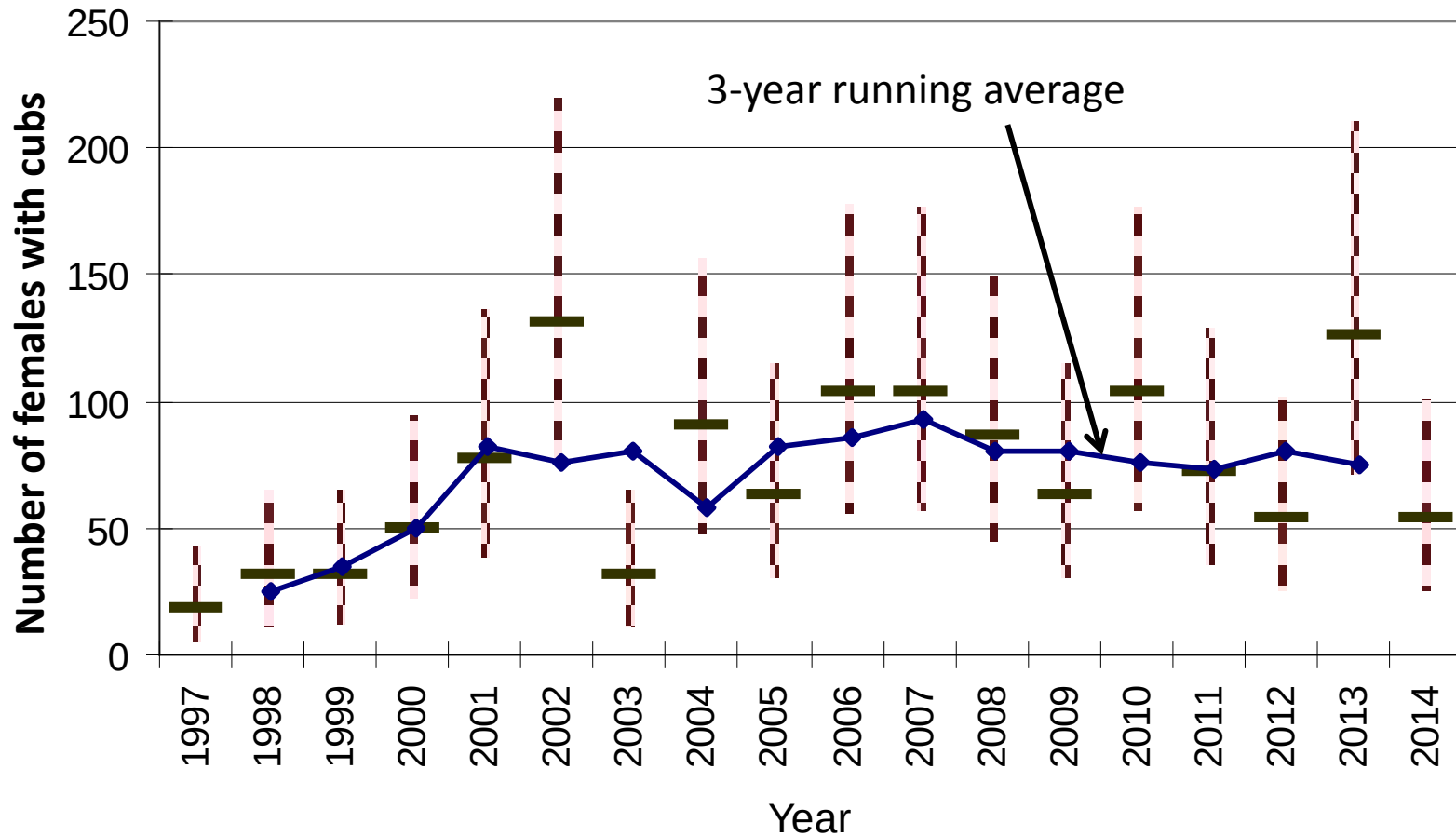
Population Estimation



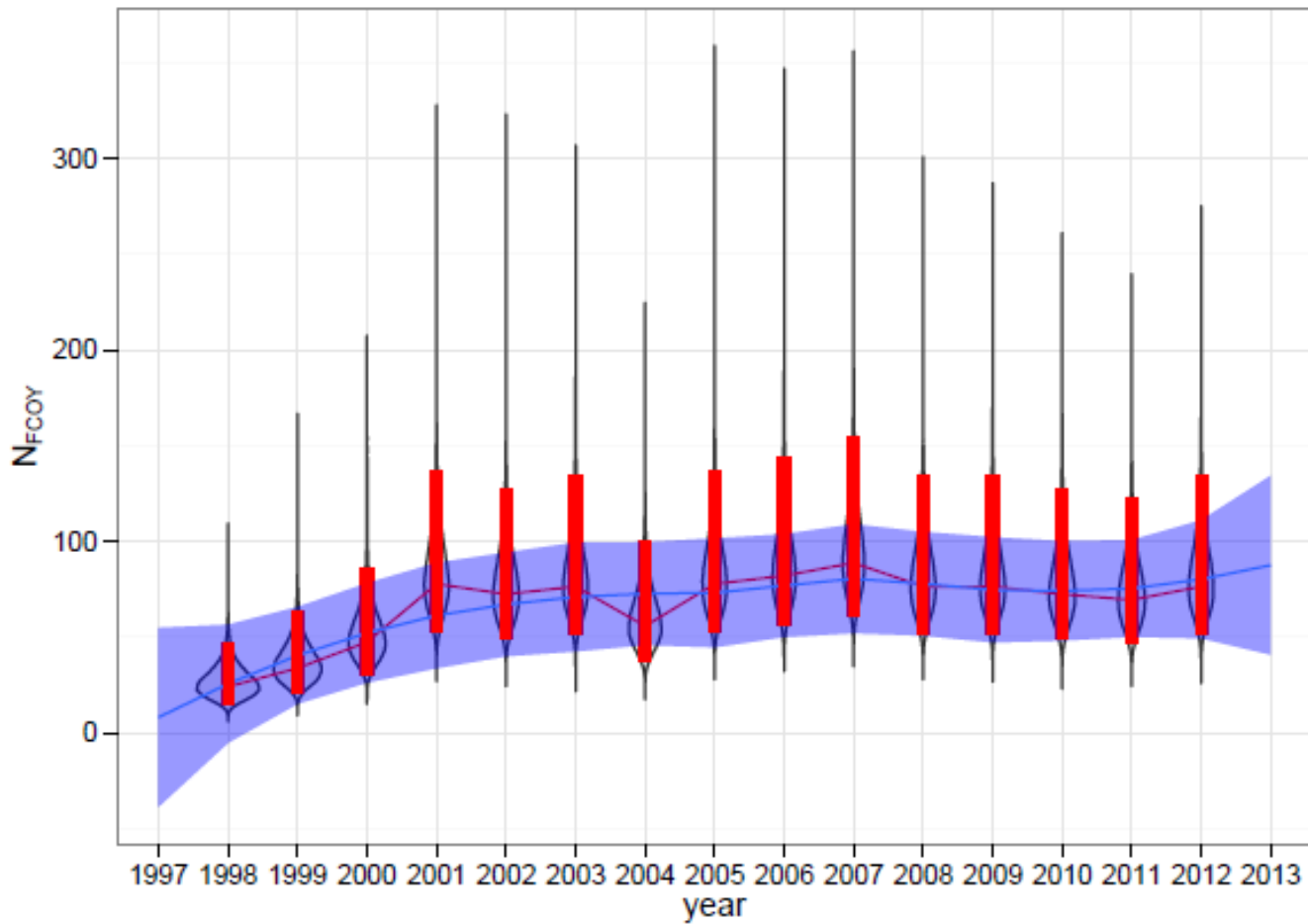
Mark-Resight: An Outcome from the Demographic Workshops

- Various new approaches were evaluated to address known underestimation in Chao2
- Workshop participants agreed mark-resight technique provided best alternative that can be applied with data collected since 1997
- Based on aerial observations of radio-marked vs. unmarked females with cubs
- Shown to be relatively unbiased but high variance (Higgs et al. 2013)

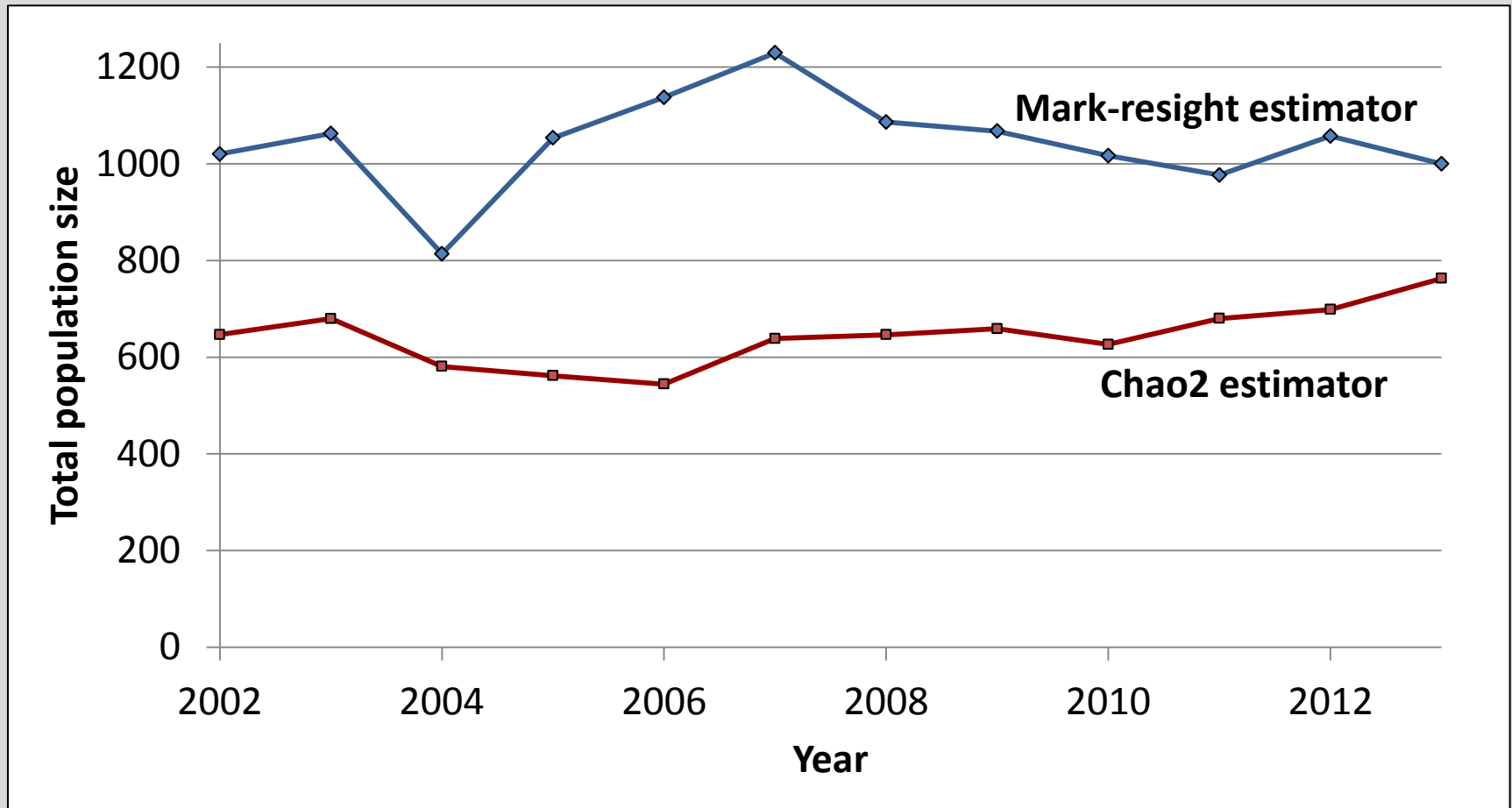
Mark-Resight Estimator



Mark-Resight Estimator



3-Year Running Average Chao2 and Mark-Resight Estimators



Implementation Steps for Mark-Resight Estimator

- 1) YES consensus to start implementation
 - Study team to address incorporating uncertainty into overall population estimate
- 2) Independent genetic approach to evaluate mark-resight
 - Evaluate if results support mark-resight
 - Publish findings in peer-review journal
- 3) Presentation to YES and IGBC – Summer/Fall 2015
 - Requires maintaining current sample (>25) of radio-marked, adult females; preferably more

Detecting Population Trends

- Grizzly bears have low reproductive potential; difficult to detect population change
- Chao2 estimator
 - Power to detect $\approx 5\%$ annual decline after 5 years (Harris et al. 2007)
- Mark-resight estimator
 - Power not yet tested but likely less than Chao2 estimator

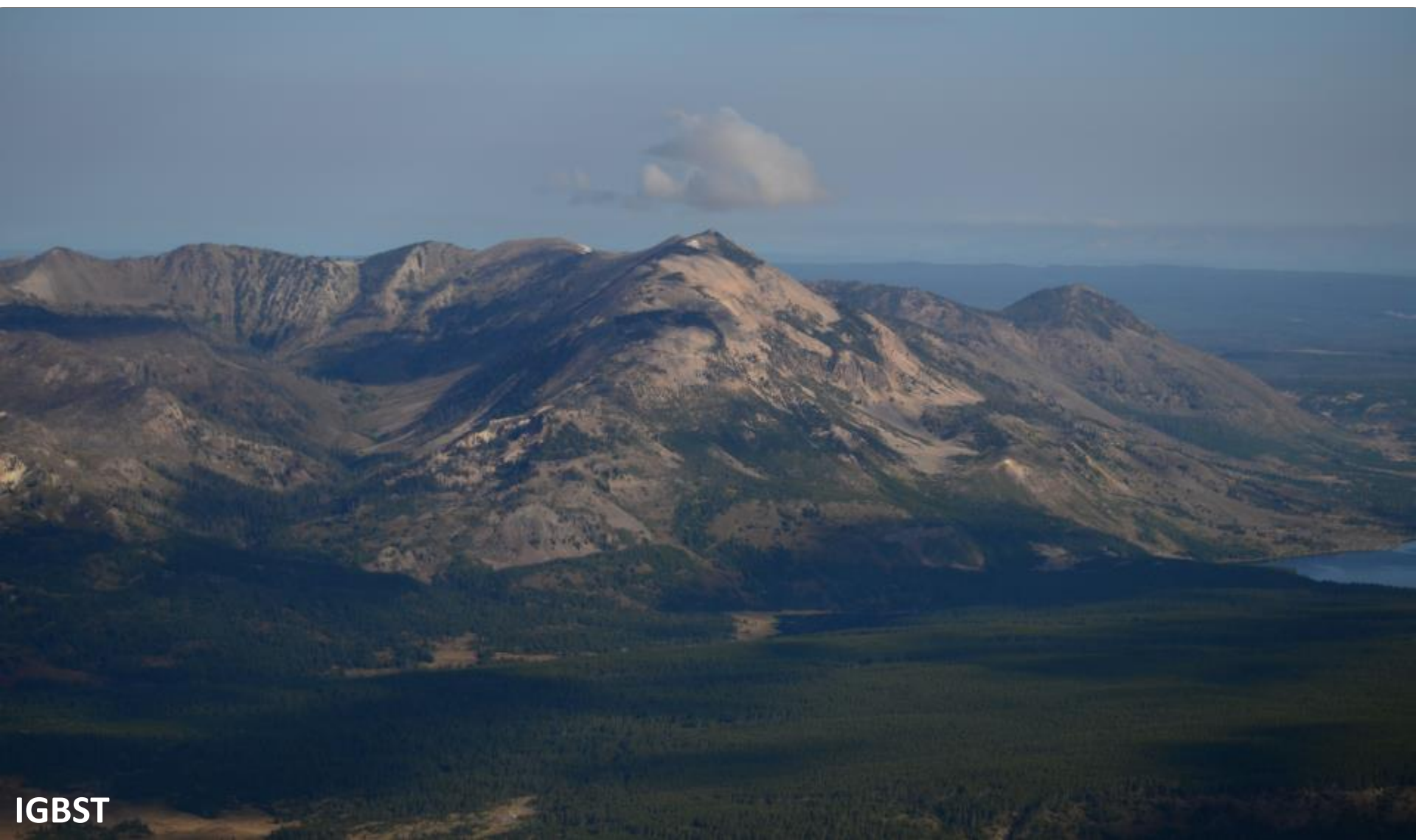
Conclusions: Population Estimation

- Mark-resight technique is relatively unbiased and produces higher population estimates
- Higher estimates are due to different technique, **NOT** an actual change in population size
- Mark-resight trend supports interpretation from other methods: minimum population increase since early 2000s

Topic 2: Management Flexibility

- A) Demographic Monitoring Area (DMA)
- B) Assess sustainable mortality

Demographic Monitoring Area (DMA)

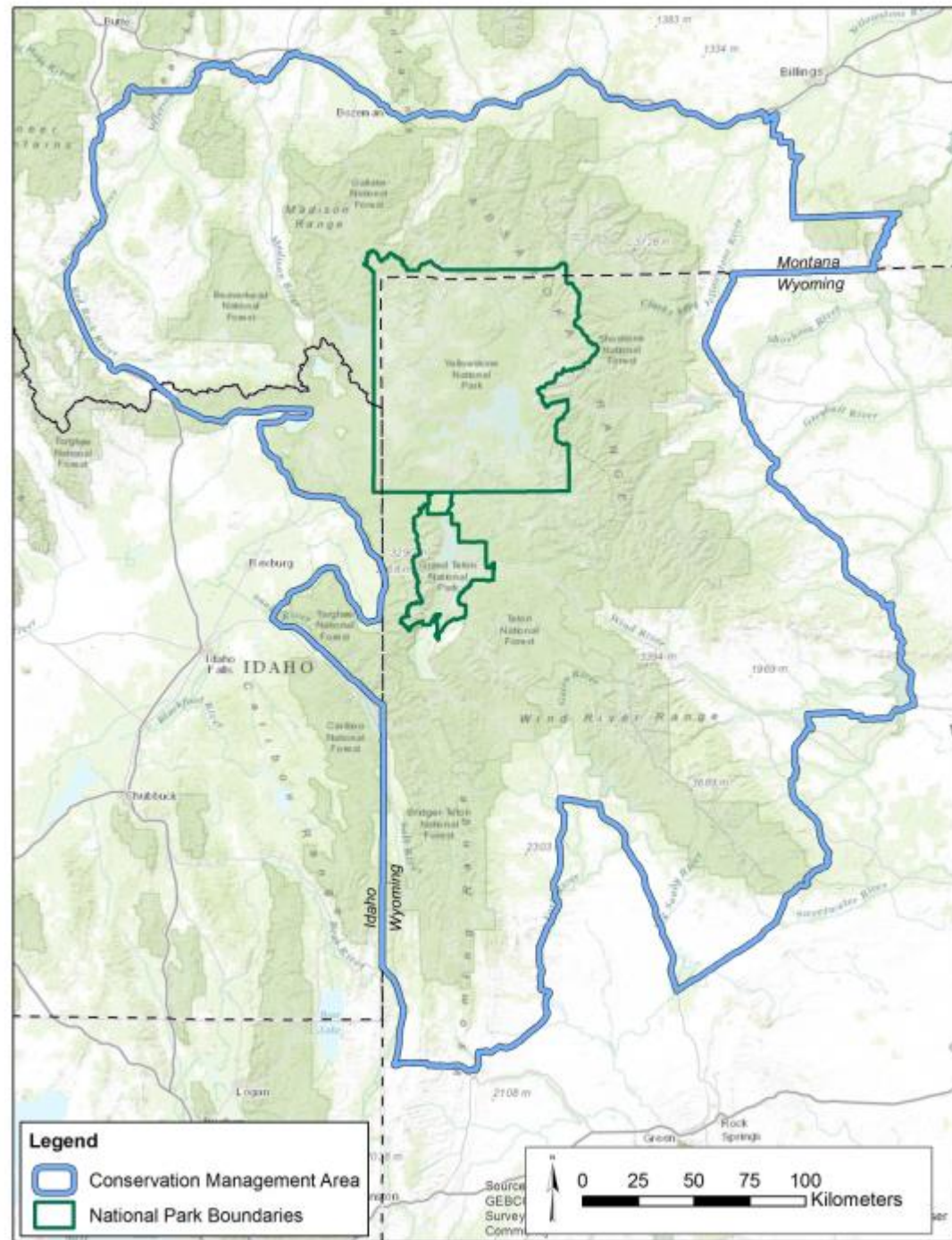


An Outcome from the Demographic Workshops

- Adopt the Demographic Monitoring Area (DMA) as the area for which population estimates will be derived and within which grizzly bear mortalities will be counted towards sustainable mortality limits
- Presented to Yellowstone Ecosystem Subcommittee Spring 2012
- Yellowstone Ecosystem Subcommittee approved adoption of DMA by committee vote

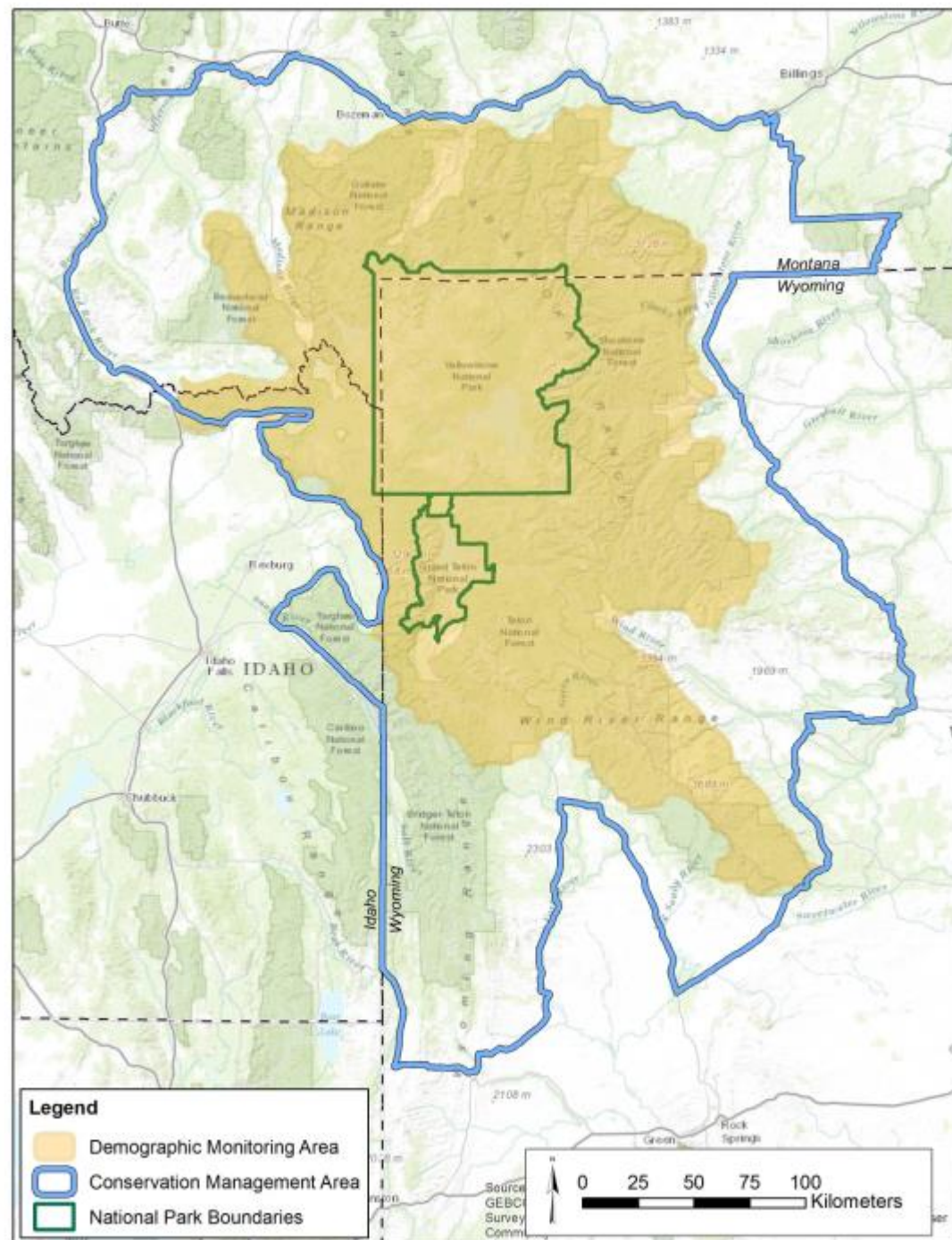
Demographic Management Boundaries

- Conservation Management Area
2007 Conservation Strategy
95,225 km²



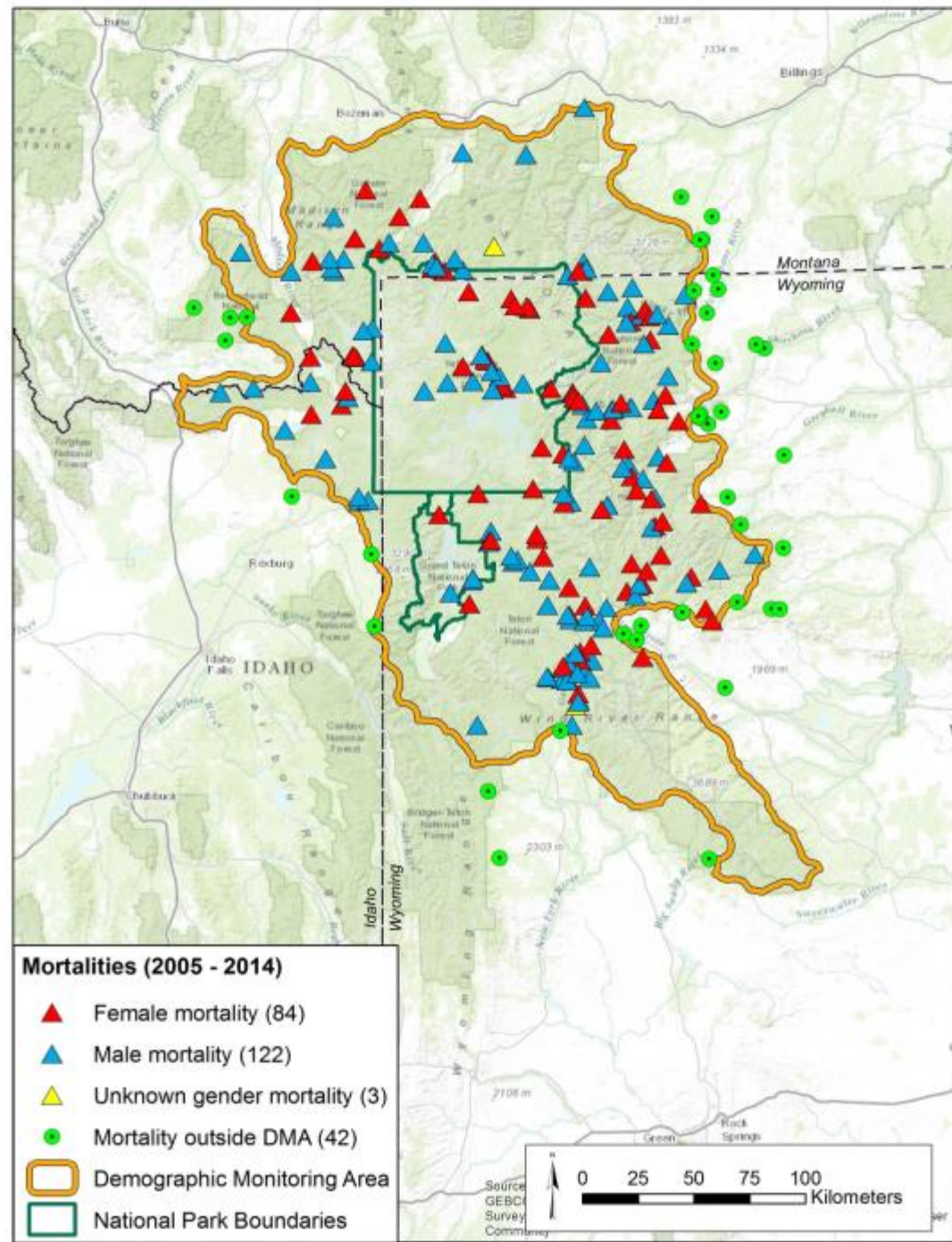
Demographic Management Boundaries

- Conservation Management Area
2007 Conservation Strategy
95,225 km²
- Demographic Monitoring Area
2012
49,931 km²

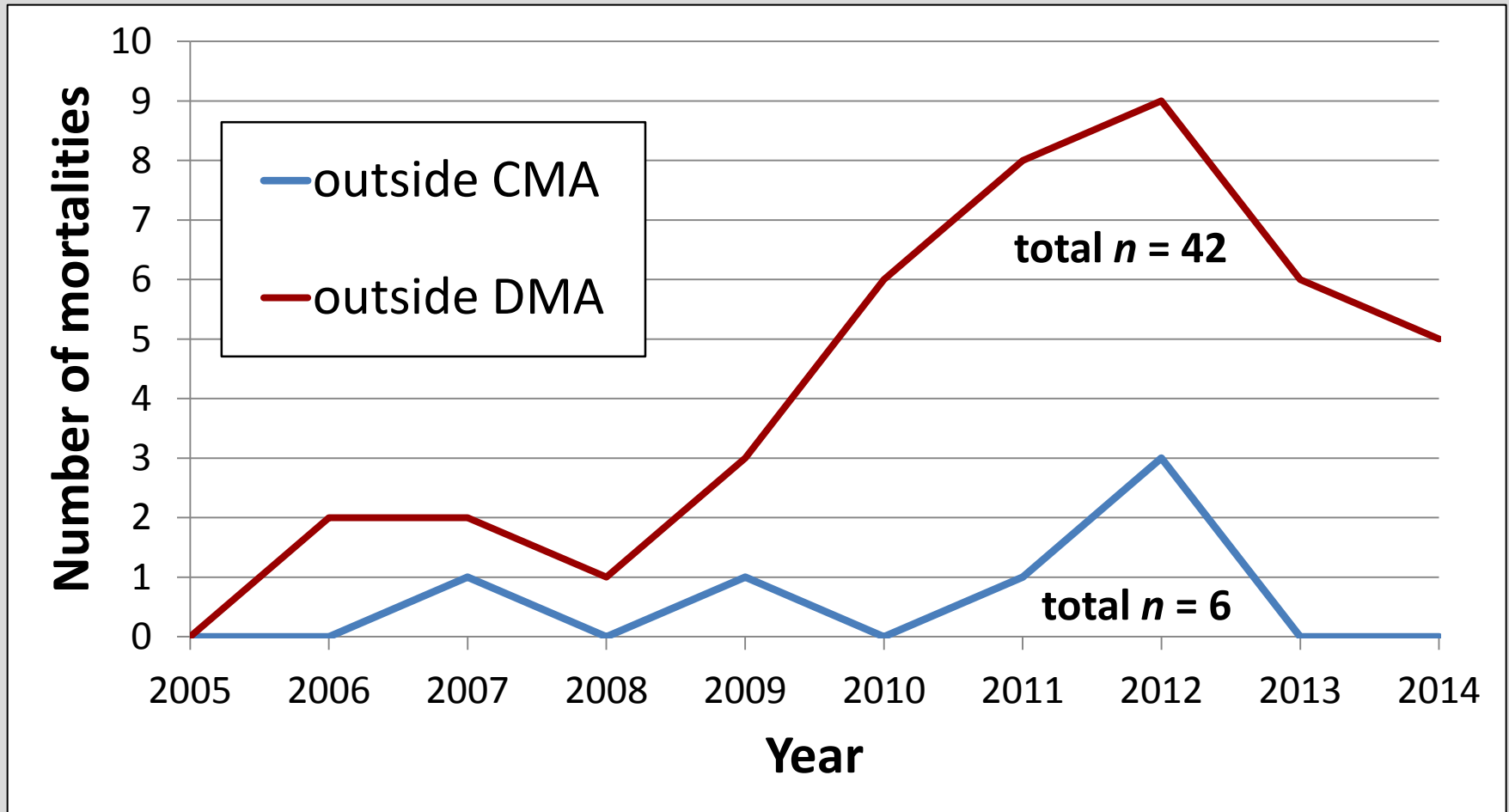


Mortality Locations Since 2005

- 42 mortalities outside the Demographic Monitoring Area
- 29 males, 13 females



Implications for Flexibility



Assessing Sustainable Mortality

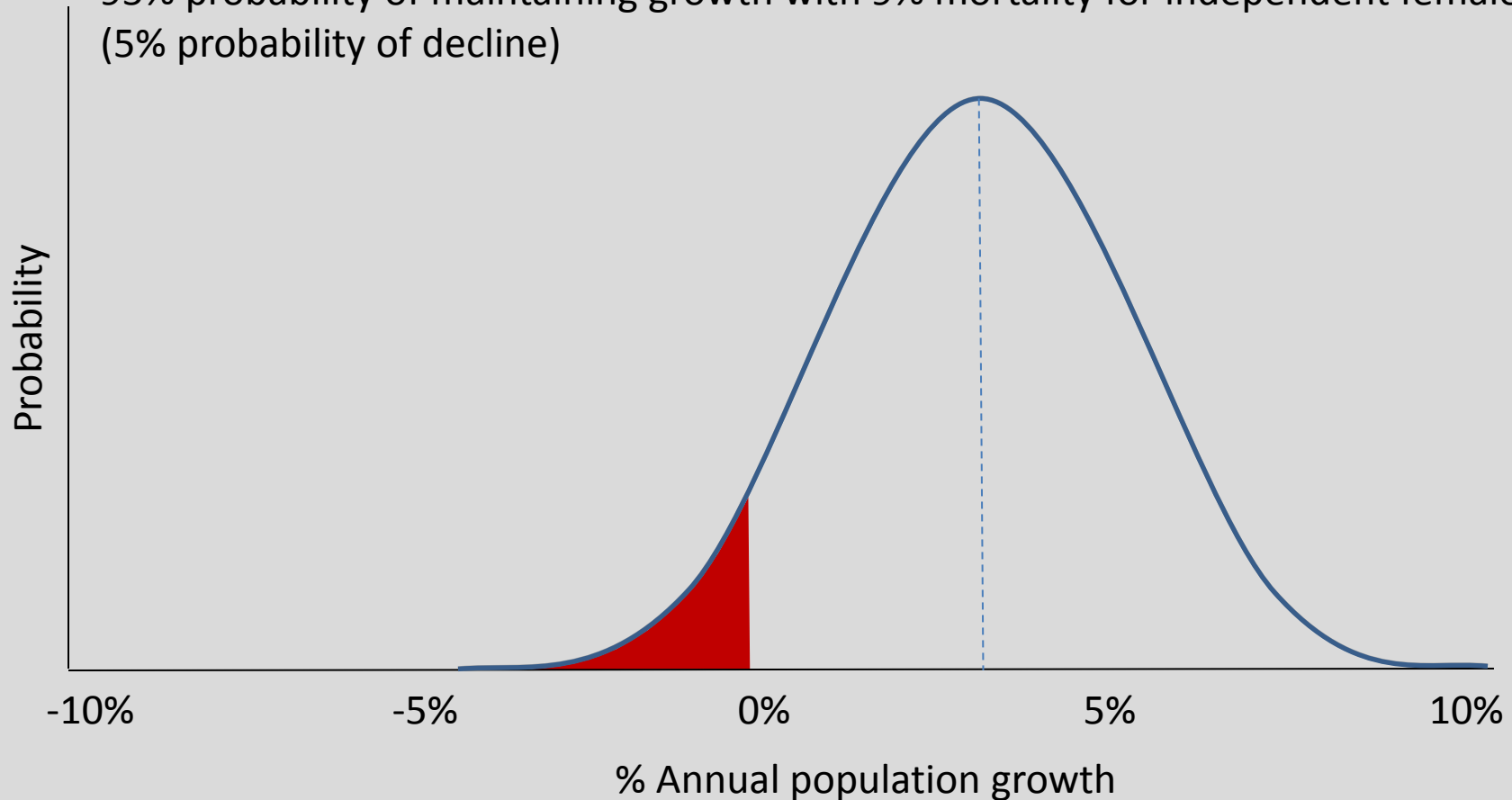
- Evaluated annually based on population estimate
- For independent females (≥ 2 yrs):
 - Previous: 9.0 % sustainable mortality (Schwartz et al. 2006)
 - New: 7.6% sustainable mortality (IGBST 2012)
- Reduced limit = less flexibility? **No**
 - Flattened population trajectory more vulnerable to decline
 - Flexibility from conceptual shift: managing for stability

Conceptual Shift in Assessing Sustainable Mortality

2007 Delisting Rule:

Robust population growth

95% probability of maintaining growth with 9% mortality for independent females
(5% probability of decline)



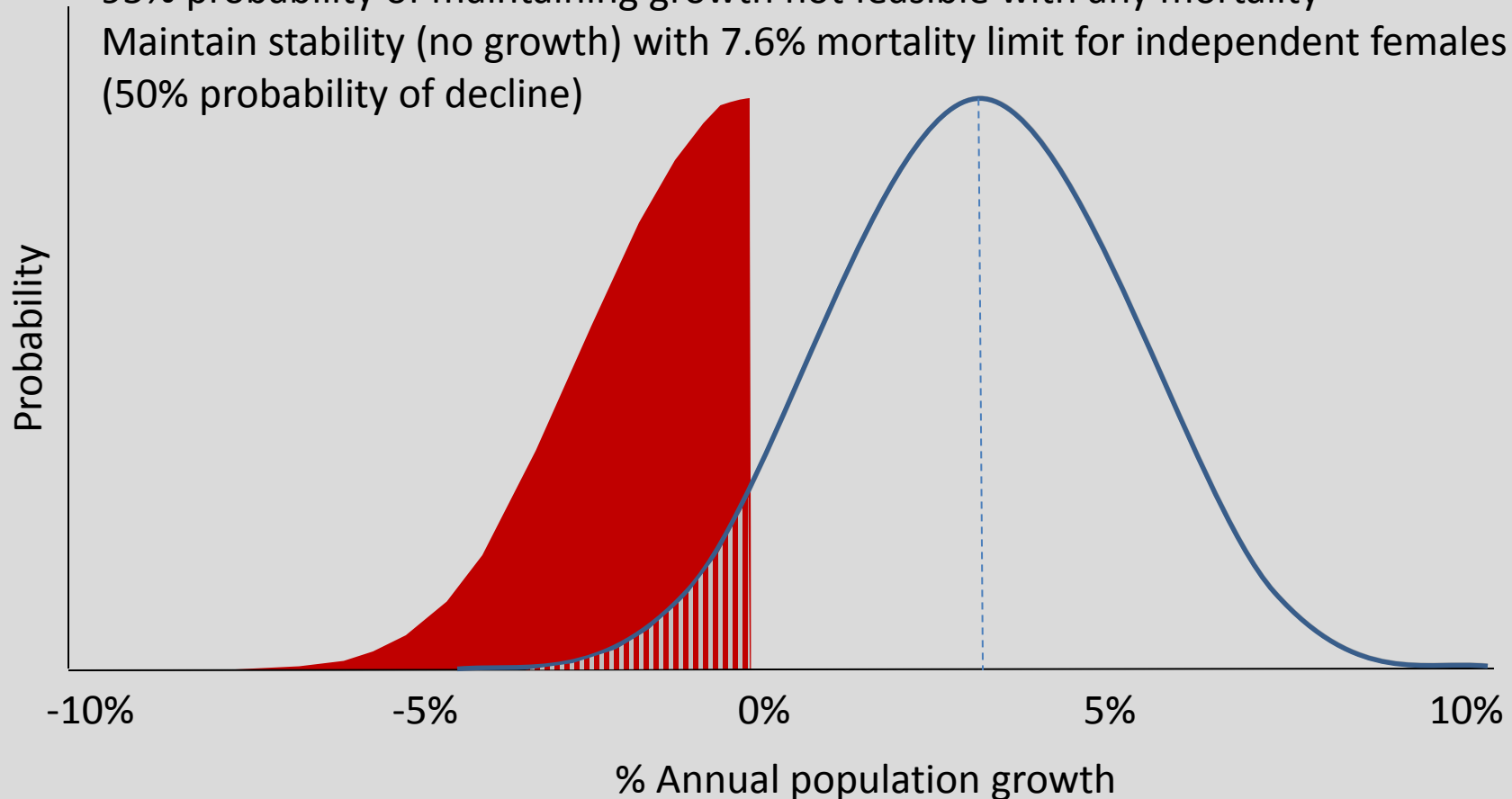
Conceptual Shift in Assessing Sustainable Mortality

2015 Delisting Approach:

Little or no population growth

95% probability of maintaining growth not feasible with any mortality

Maintain stability (no growth) with 7.6% mortality limit for independent females
(50% probability of decline)



Management Flexibility

Conclusions

- Scientific consensus and YES committee approval
- Demographic Monitoring Area most effective among options considered
- Conceptual shift in assessing sustainable mortality
- Flexibility anticipated to increase