

Evaluation of the Statistical Properties of Mark-recapture Estimators of Grand Canyon Humpback Chub Abundance and Trend

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Acknowledgements

- USGS GCMRC
- Lew Coggins, Bill Pine, Carl Walters, Jeff Laake
- Mark Bruder, Glen Knowles, Bill Persons, Rich Valdez

Background

- HBC listed as endangered in 1967
- 2002 downlisting demographic criteria for the Grand Canyon population
 - ❖ > 2100 adults during 5 year monitoring period
 - ❖ Non-declining population with natural recruitment

Background

- Capture-recapture estimation methods used since 1987
- A variety of sampling designs and statistical models can be used to estimate population parameters
- Statistical accuracy and precision of the estimates depends on validity of the demographic and temporal dynamics assumptions that underlie each design/model
- Expert panel convened in 2003 recommended a computer simulation study

Project Objectives

- Use a Monte Carlo simulation model to evaluate the statistical performance of alternative estimators of age-specific population size, trend, and recruitment under different scenarios:
 - Sampling designs (when, where, how often)
 - Capture effort → probability of capture
 - Population demographic structure
 - Movement dynamics
- Synthesize results and make recommendations

Presentation Objectives

Use a **Monte Carlo simulation model** to evaluate the statistical performance of **alternative estimators** of **age-specific population size**, trend, and recruitment under different scenarios:

- **Sampling designs**

- Capture effort → probability of capture
- Population demographic structure
- Movement dynamics

Presentation Objectives

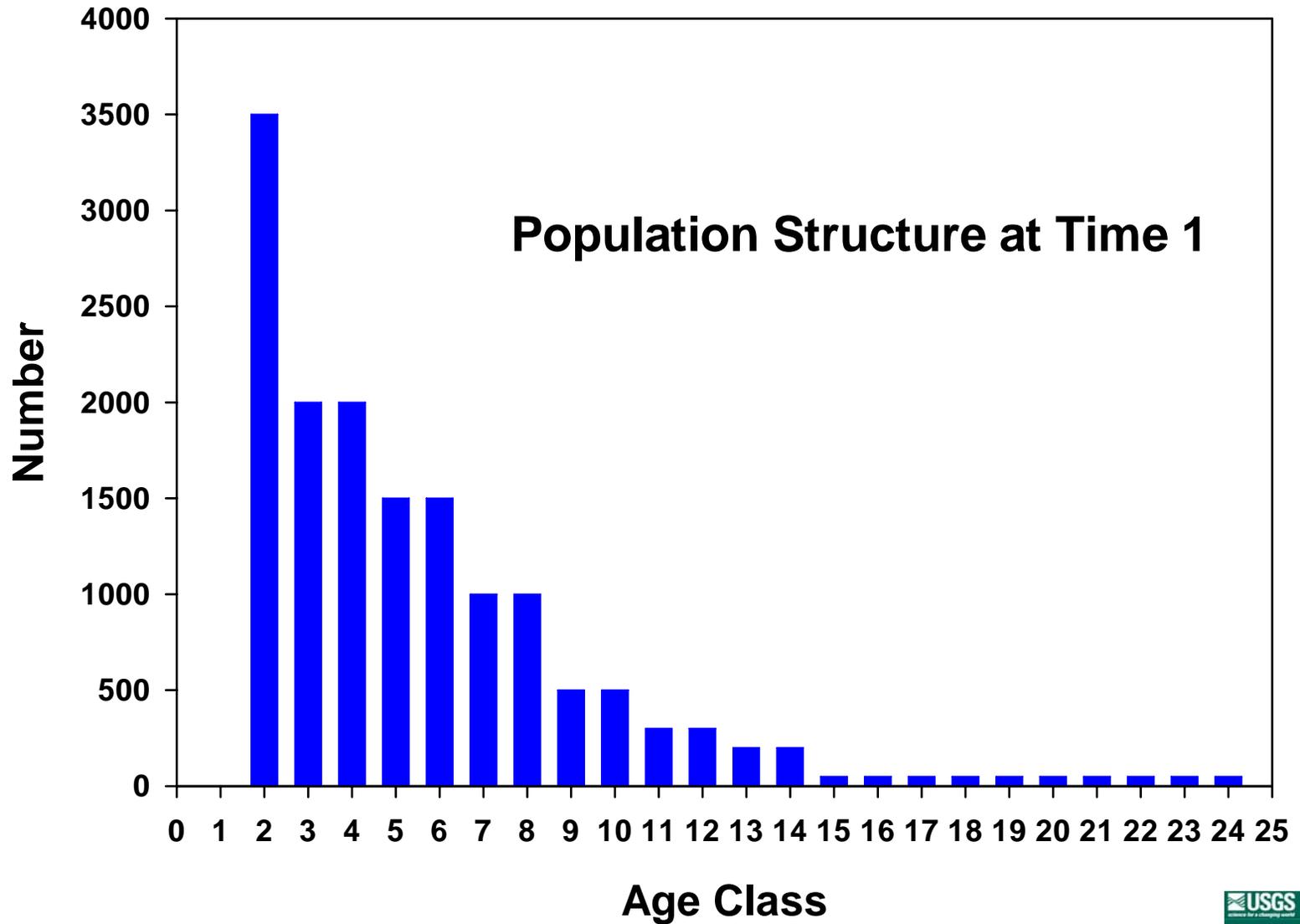
- Describe simulation model
- Illustrate simulation output

Estimation Models

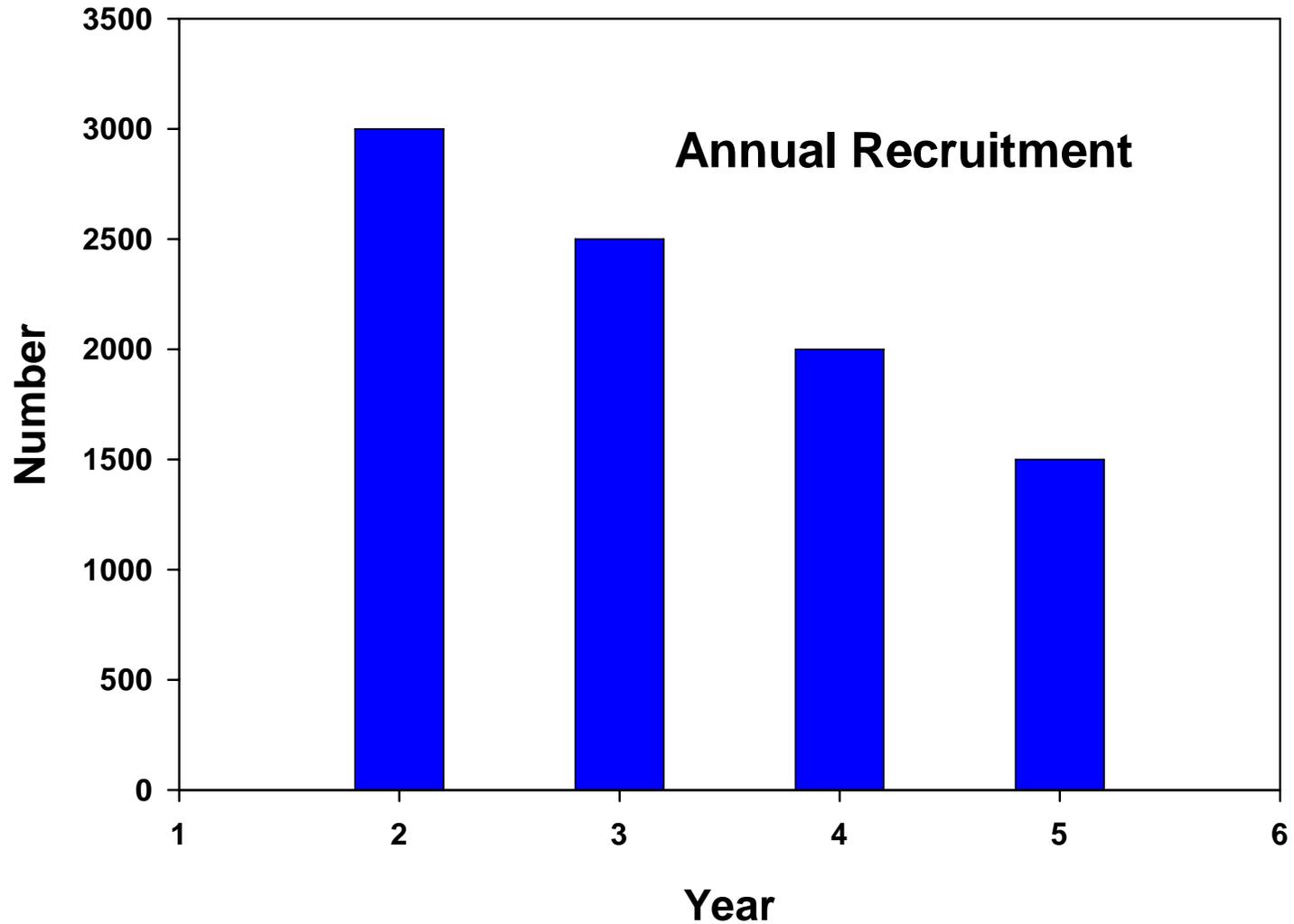
- Jolly-Seber
 - From Jolly-Seber (1965)
 - Maximum likelihood
 - Closed geographically
 - Open demographically
- CAPTURE
 - From Otis et al. (1978)
 - Maximum likelihood
 - Closed geographically and demographically
- Robust
 - From Pollock (1982)
 - Combination of Jolly-Seber and CAPTURE
- Age Structured Mark Recapture
 - From Coggins et al. (In press)
 - Virtual population analysis
 - Geographically closed
 - Demographically open



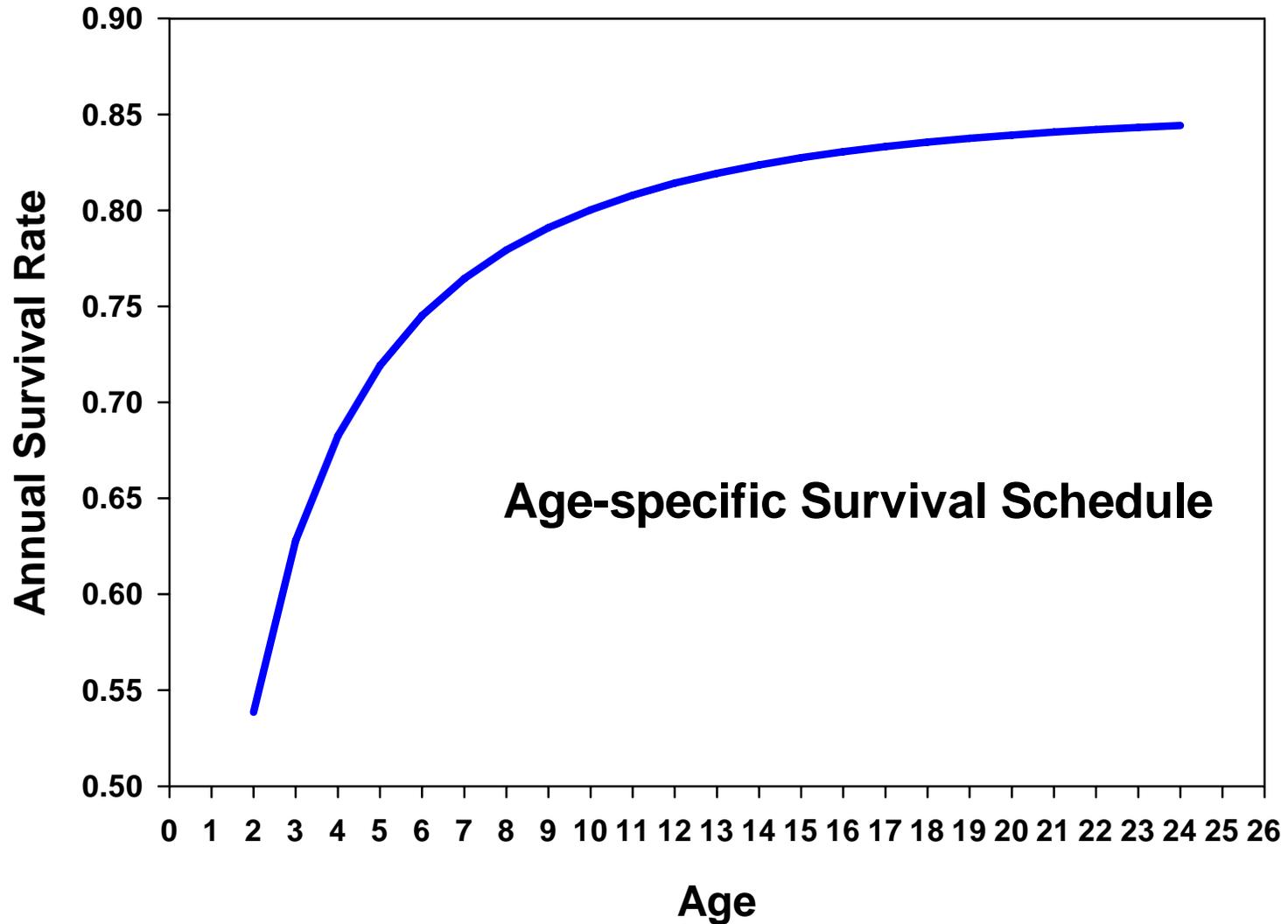
Population Demographics



Population Demographics



Population Demographics



February



**Colorado River Mainstem
(MS)**

**Little Colorado River
(LCR)**

March



**Colorado River Mainstem
(MS)**

**Little Colorado River
(LCR)**

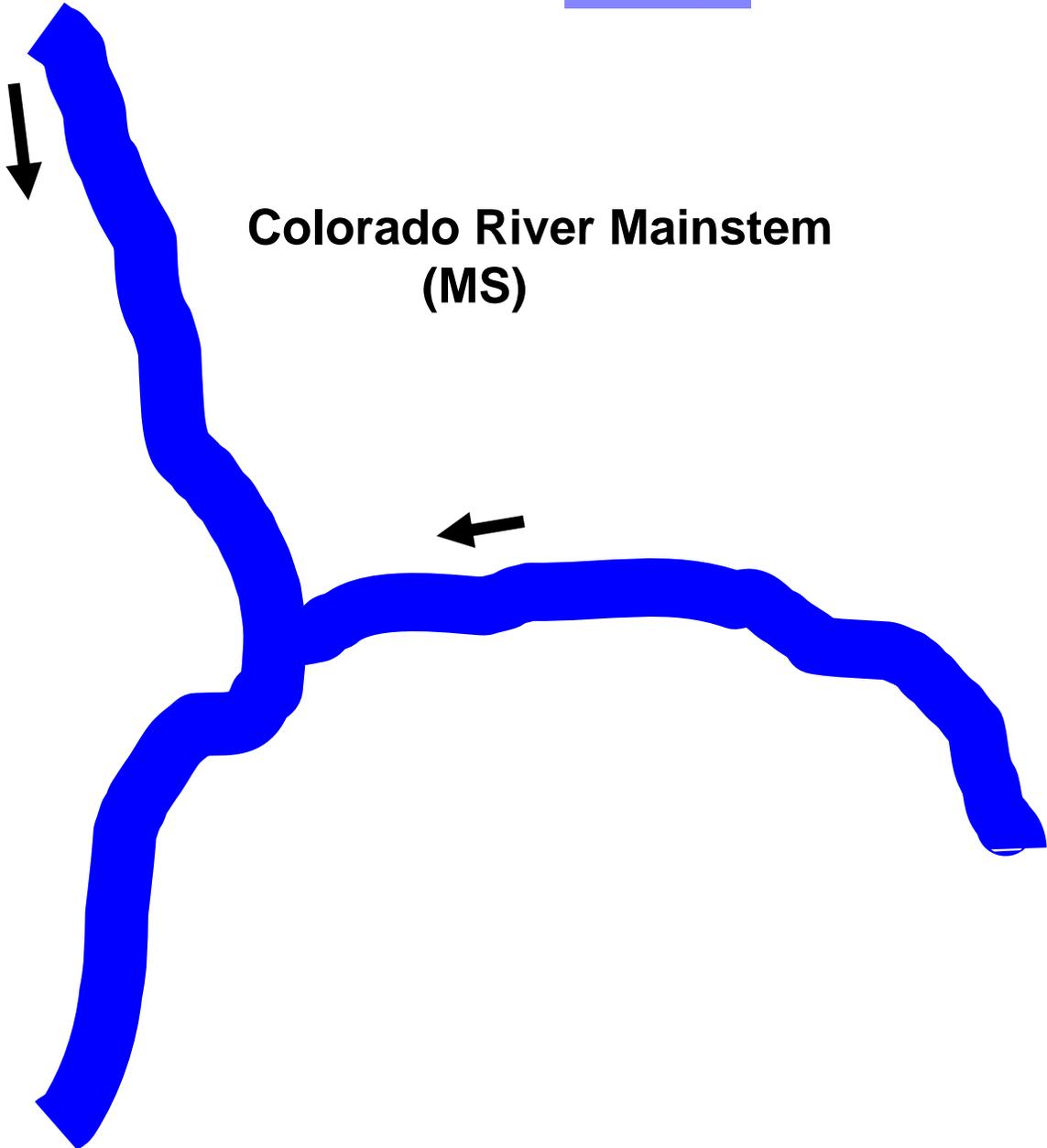
April



**Colorado River Mainstem
(MS)**

**Little Colorado River
(LCR)**

May



**Colorado River Mainstem
(MS)**

**Little Colorado River
(LCR)**

June-November



**Colorado River Mainstem
(MS)**

**Little Colorado River
(LCR)**

December-January



**Colorado River Mainstem
(MS)**

**Little Colorado River
(LCR)**

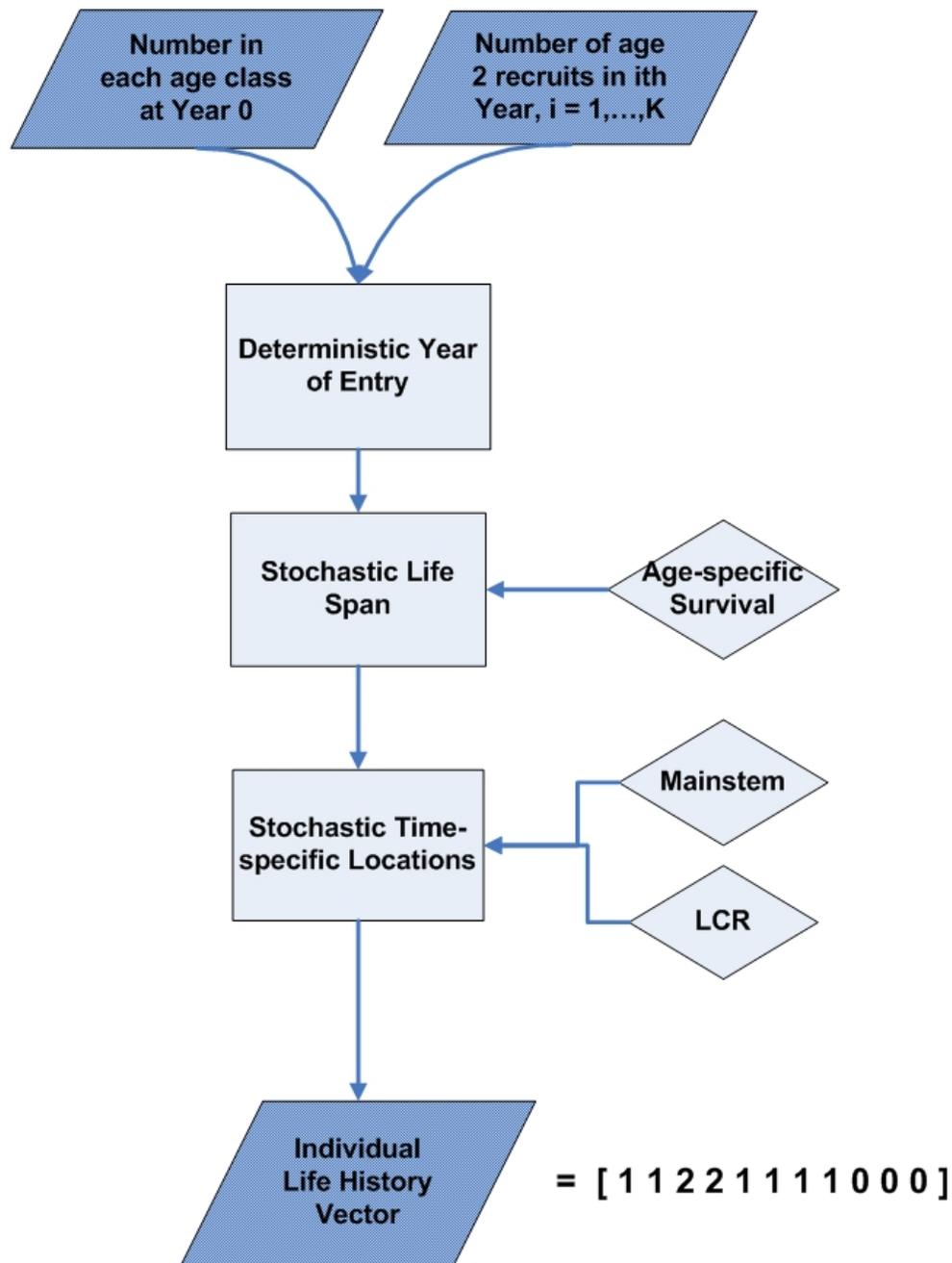
Sampling Designs

- **Spring Concurrent:**
 - MS + LCR: February, March, April
- **Fall Concurrent**
 - MS + LCR: August, September, October
- **Current GCMRC:**
 - MS: July, August
 - LCR: April, May, September, October

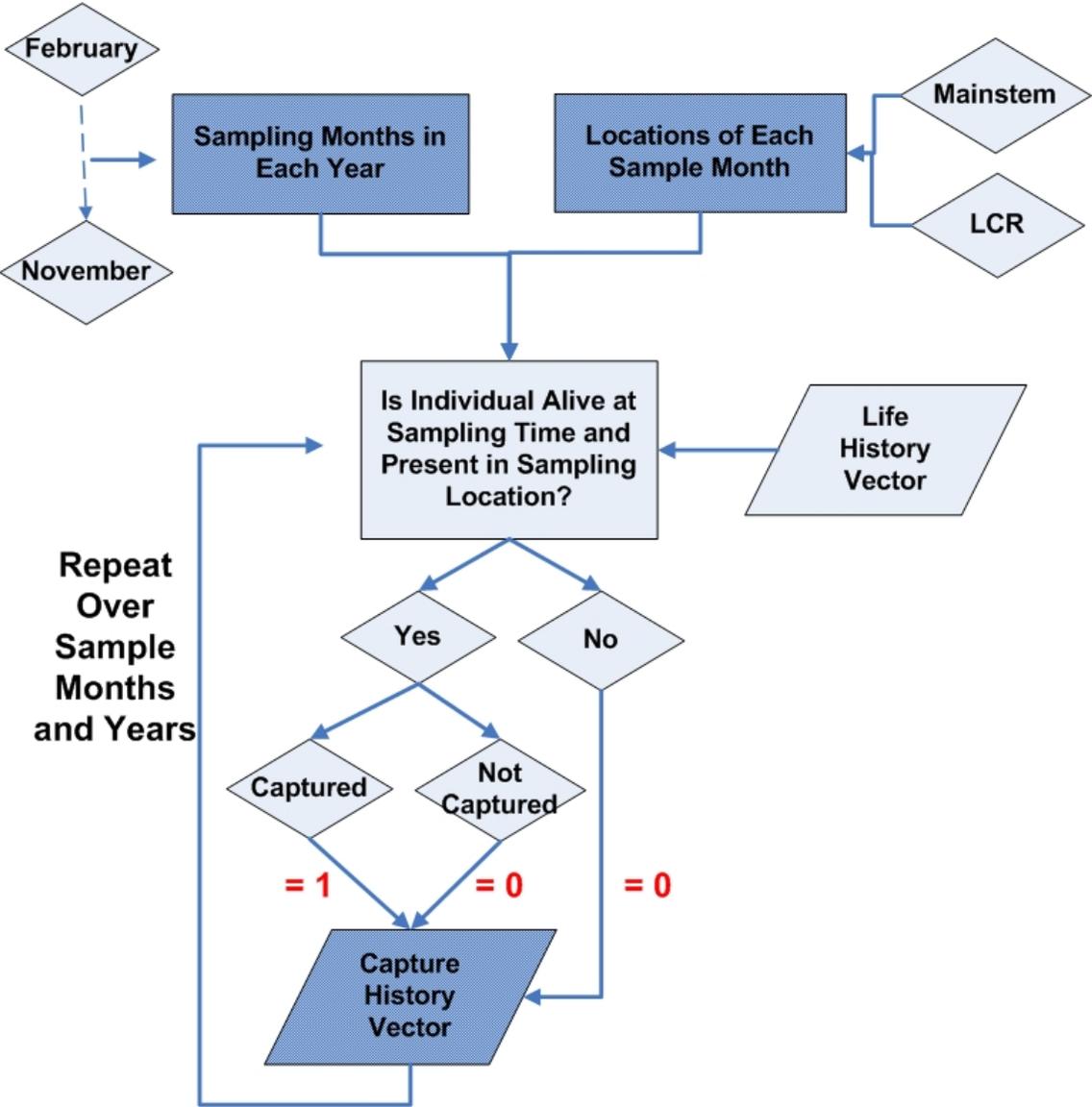
Capture Probabilities

Year	1	2	3	4	5
P (MS)	.07	.10	.07	.10	.07
P (LCR spring)	.20	.15	.30	.35	.25
P (LCR fall)	.20	.15	.30	.35	.25

Simulate Life History Vectors for All Individual Fish

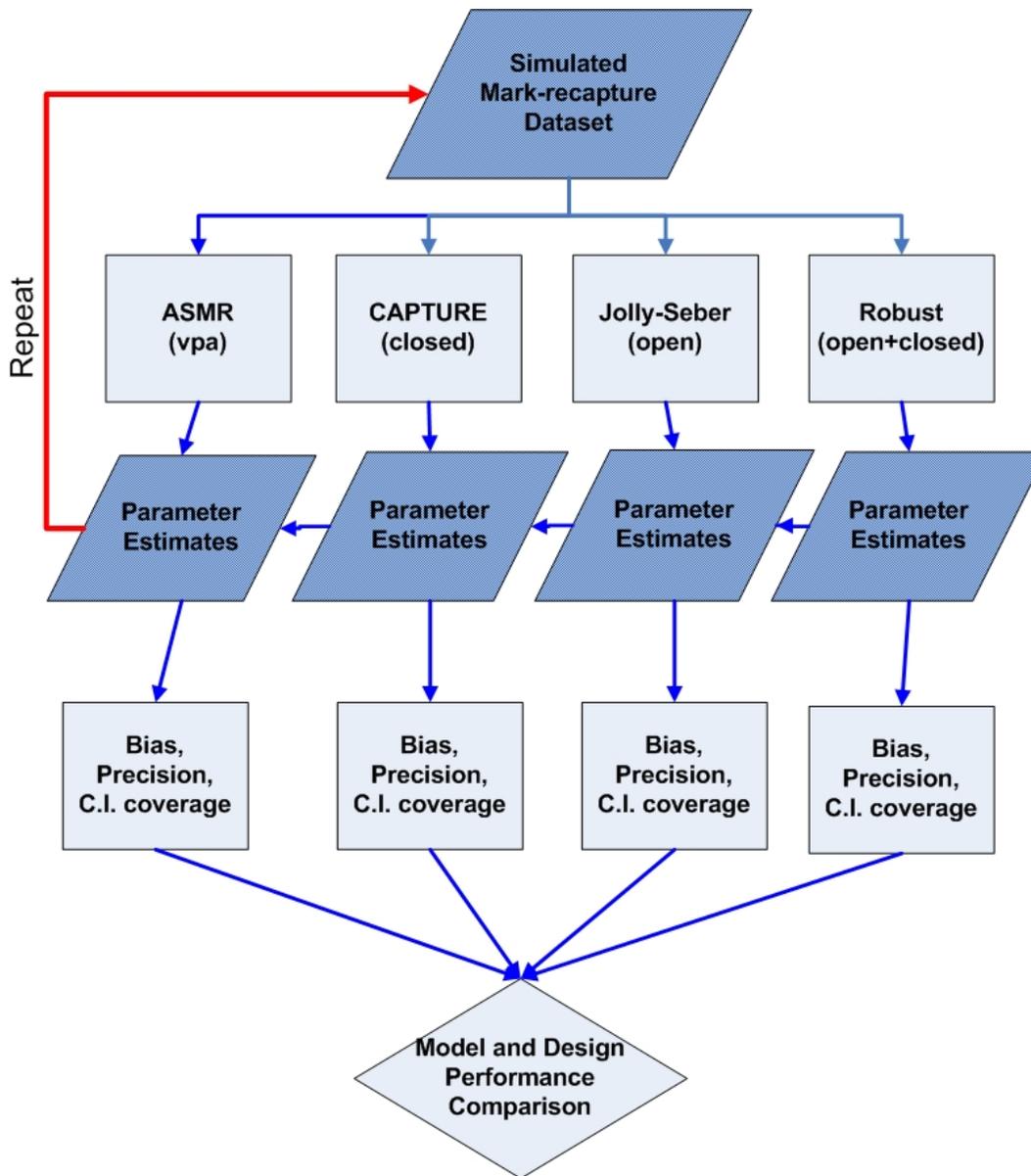


Simulate Capture History Vectors for All Individual Fish

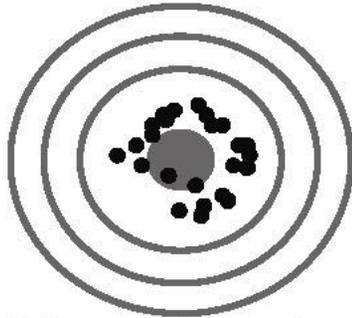


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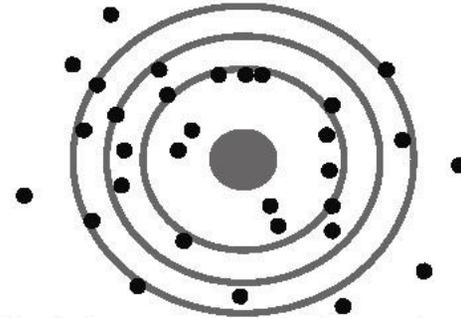
Model and Design Performance



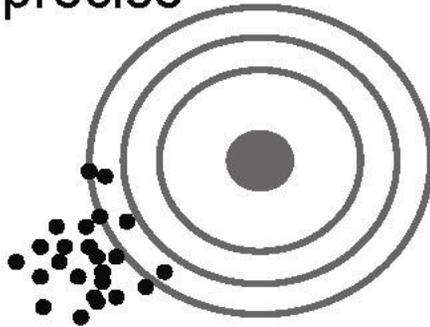
STATISTICAL PROPERTIES OF ESTIMATORS



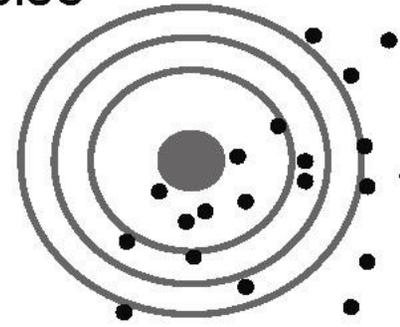
Unbiased and
precise



Unbiased but not
precise

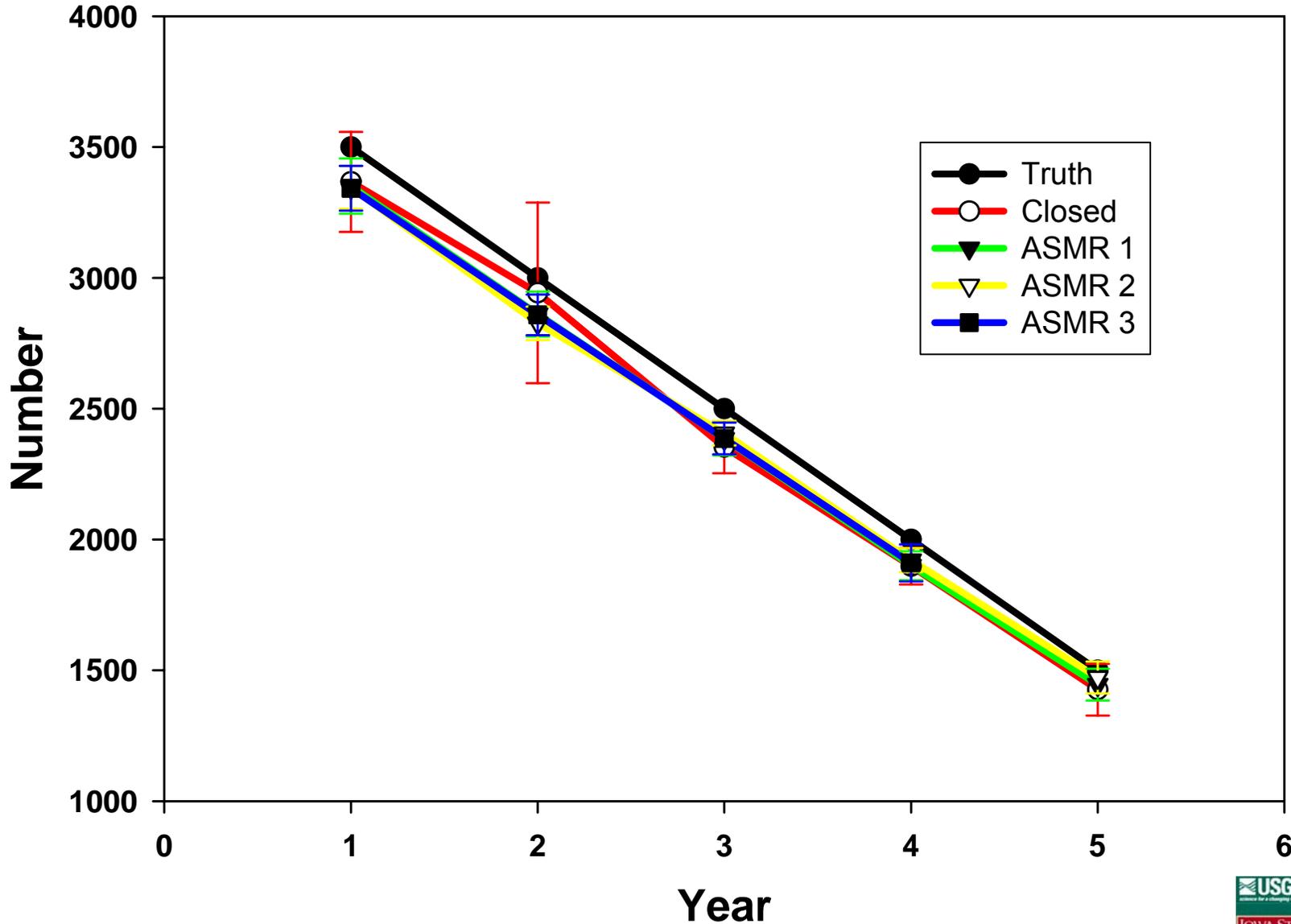


Biased but
precise

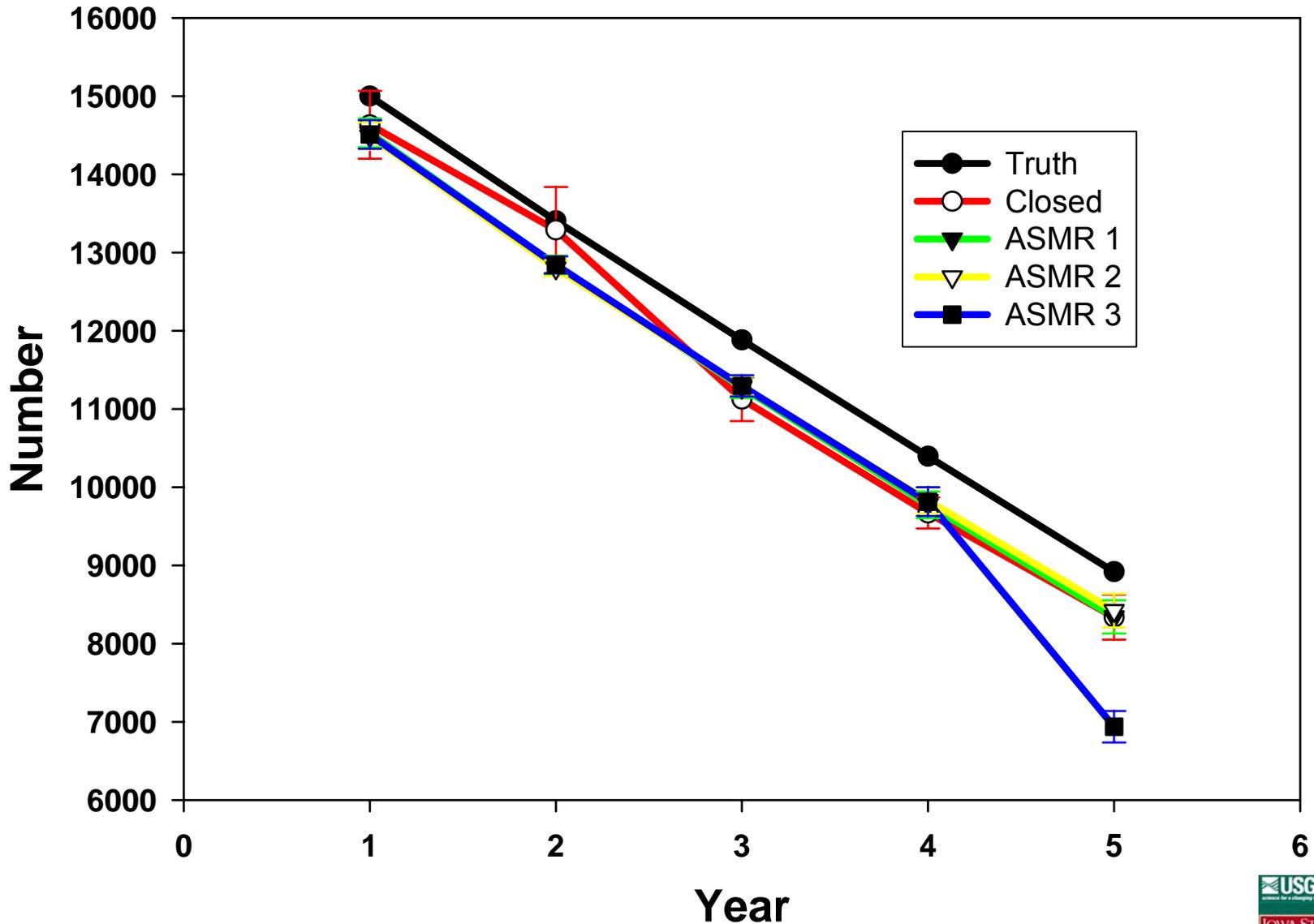


Biased and not
precise

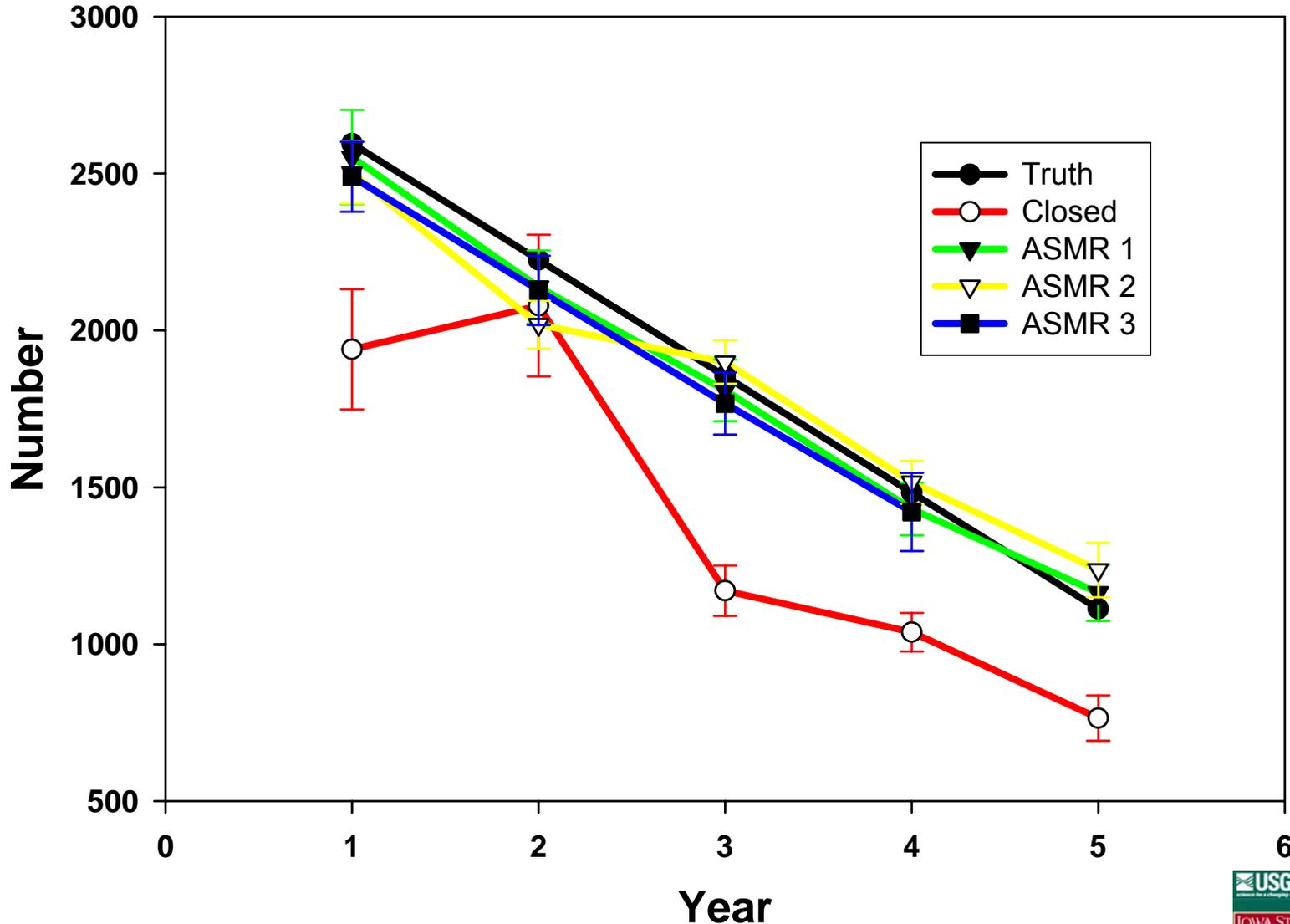
Spring Concurrent Sampling Age 2 Recruit Estimates



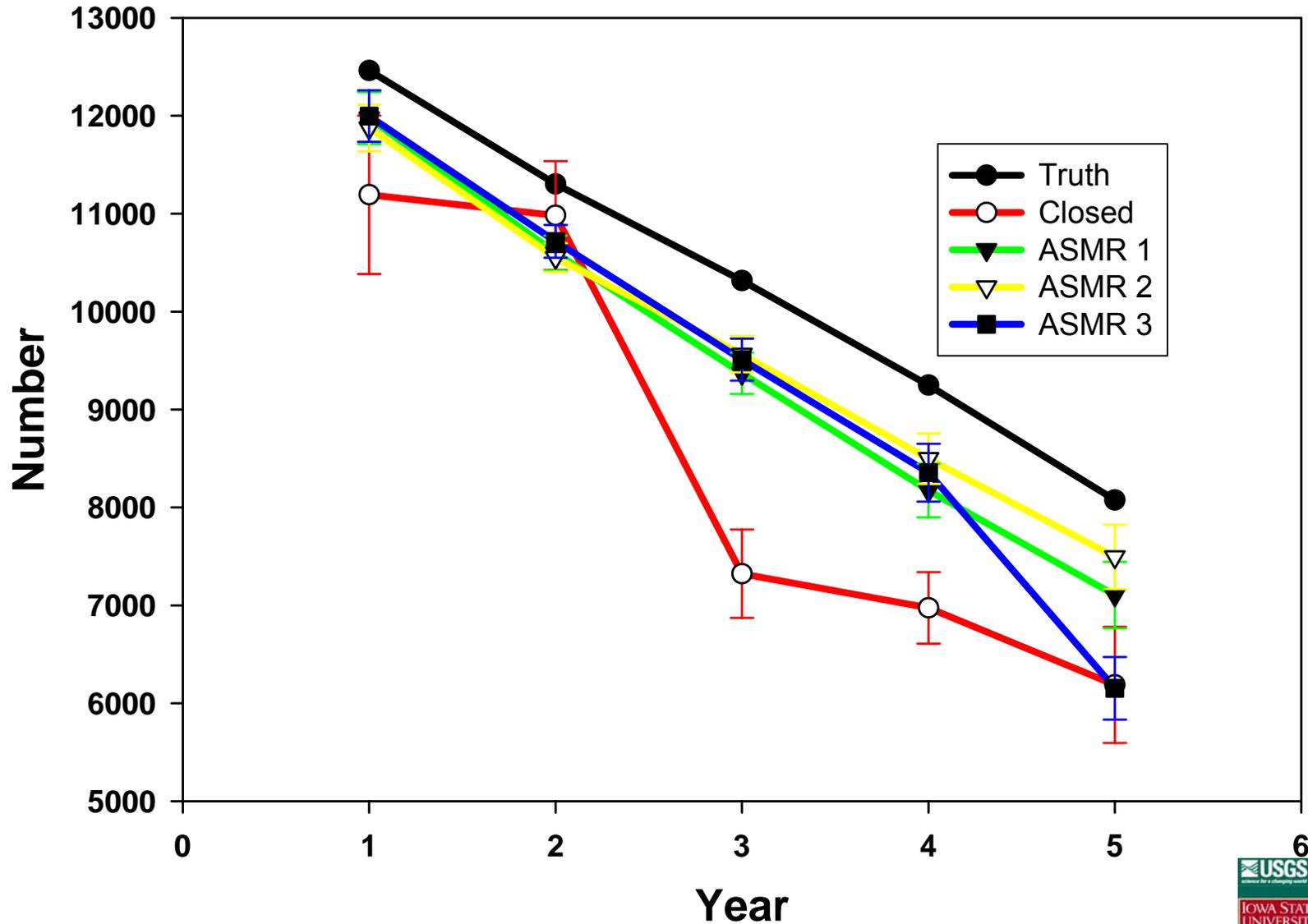
Spring Concurrent Design Total Population Estimates



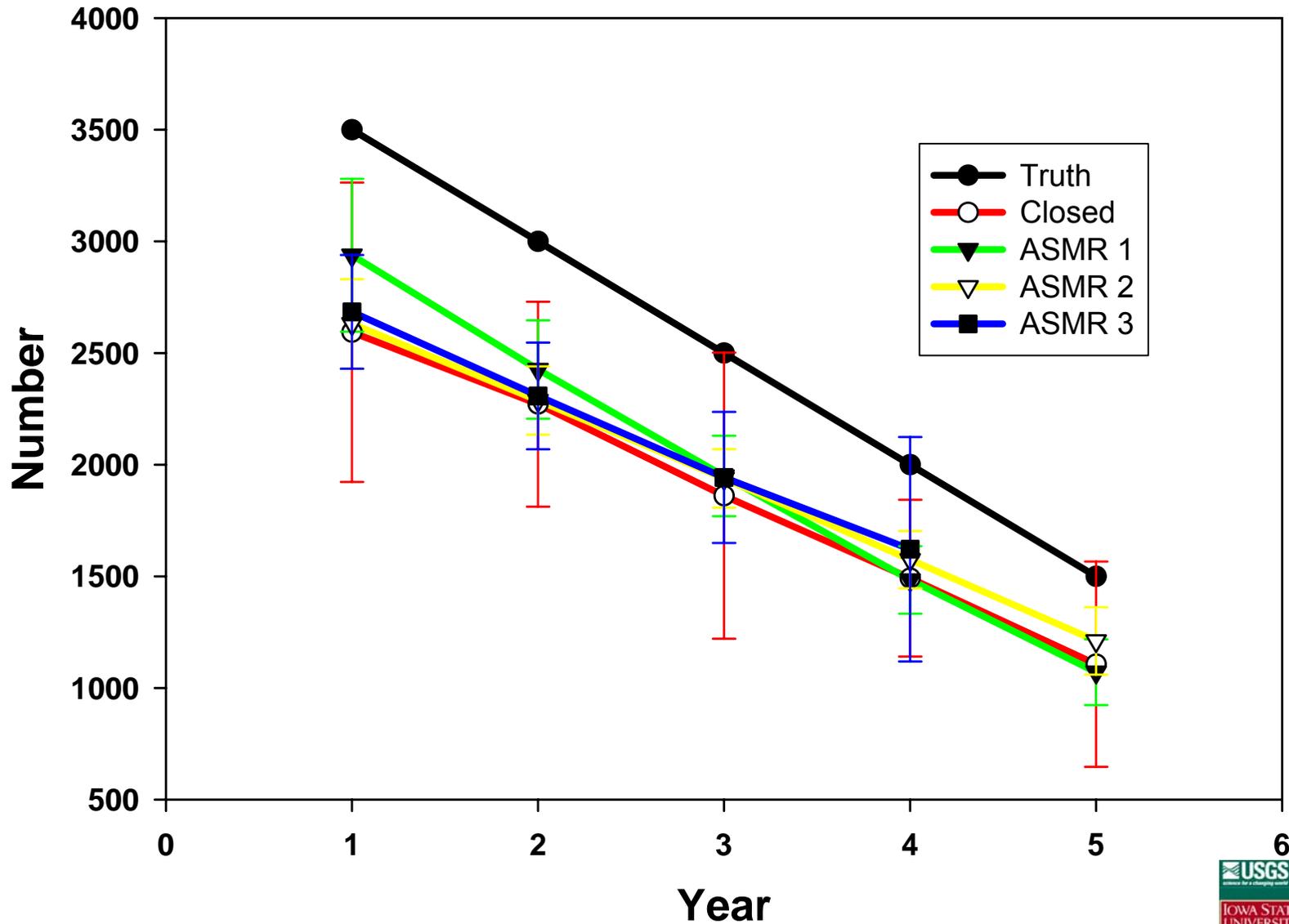
Fall Concurrent Sampling Age 2 Recruit Estimates



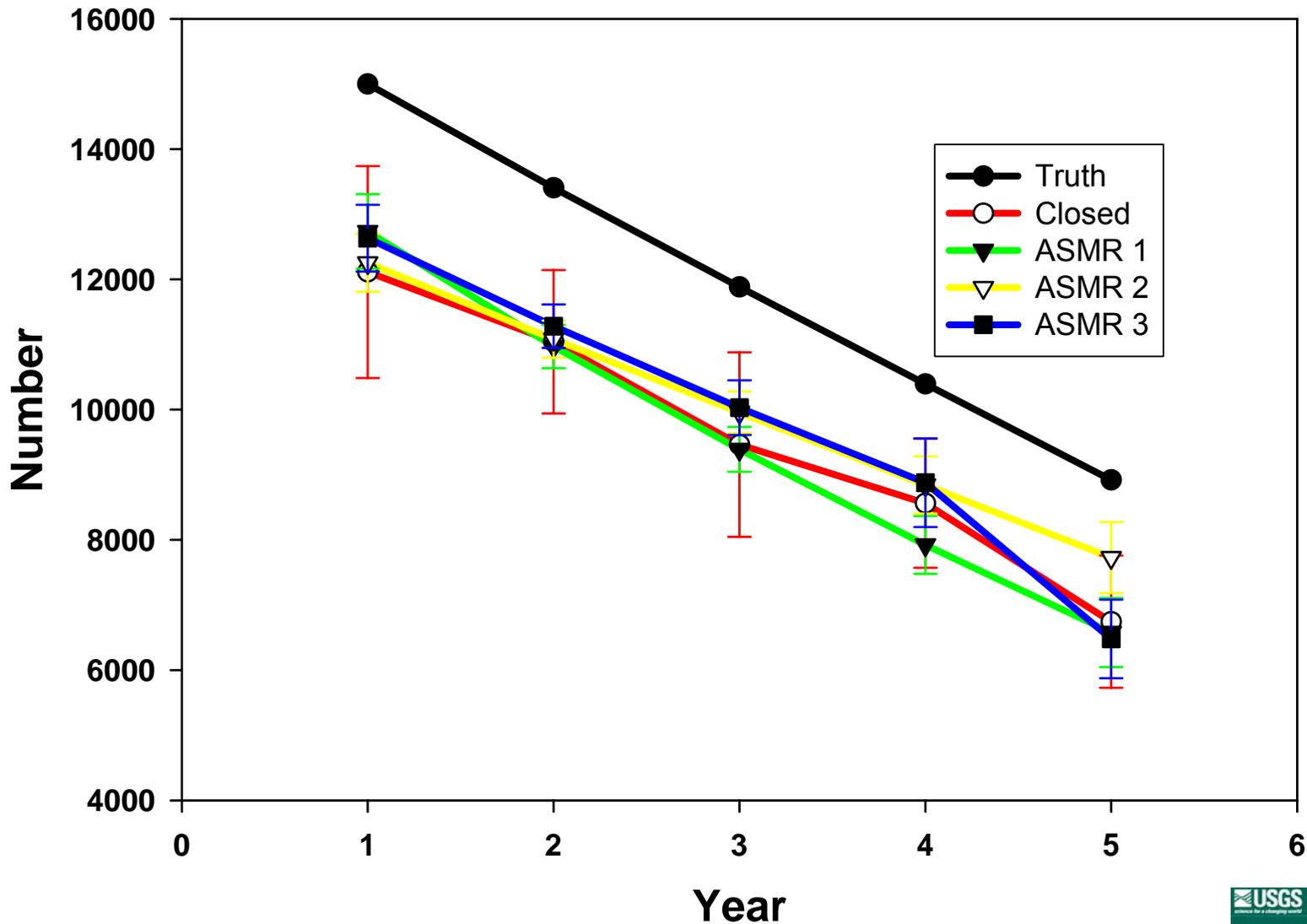
Fall Concurrent Sampling Total Population Estimates



GCMRC Current Sampling Age 2 Recruit Estimates



GCMRC Current Sampling Total Population Estimates



Future Work

- Complete simulations
 - Additional years and sampling occasions
 - Alternative survival schedules
 - Age misclassification
 - Capture probability heterogeneity
- Synthesize and interpret results
- Recommendations