

Presentation to AMWG of Results of an Independent Review of Methods Used to Assess Status and Trend of Humpback Chub

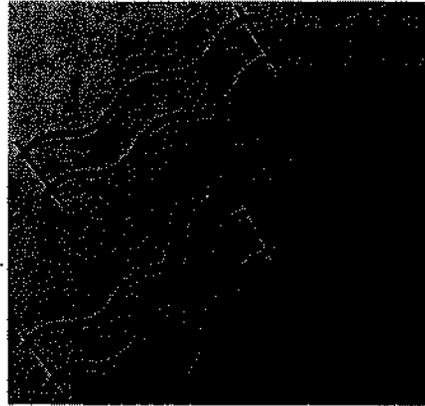
- I. Concepts and definitions
- II. Assessment of current methods, etc.
- III. Recommendations

Concepts and Definitions Population Parameters of Primary Interest

- N = population size of adults
- T = trend in population size over 5 years

Concepts and Definitions Population Closure

- Geographic closure:
 - N is defined with respect to a spatially explicit geographic area, e.g., the population within the sampled boundaries of Black Rocks Canyon
- Demographic closure:
 - During the time period of sampling in a given year, N is constant



Concepts and Definitions Capture-recapture Estimation Models

- Closed:
 - Assumes geographic and demographic closure
 - Basic relationship is $N = C / p$
 - Given adequate data, models are good at identifying sources of variation in p due to heterogeneity in capture among fish or behavioral response to first capture (CAPTURE)
 - Sampling time frame is short relative to life history of HBC, i.e., weeks or a few months
 - Multiple sampling occasions in a relatively short time frame

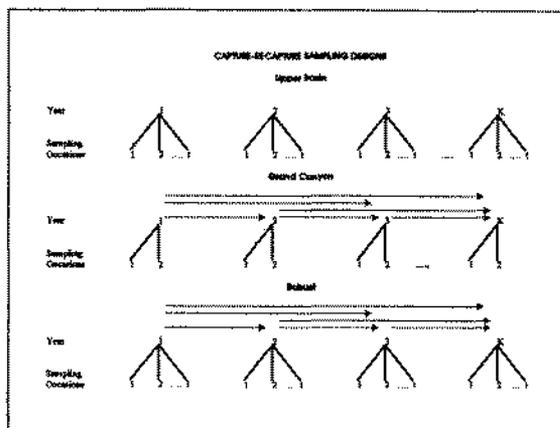
Concepts and Definitions Capture-recapture Estimation Models

- Open:
 - Assumes geographic closure
 - Relaxes demographic closure among years
 - Allows immigration and/or mortality/emigration during the study (Jolly-Seber Age Models, ASMR)
 - Can additionally estimate Trend, mortality/emigration rate, immigration rate
 - Requires more data because models have more parameters
 - Accommodates longer time frames (years)
 - Classic application assumes a single sampling occasion per year
 - Generally cannot handle variation in p within years, which causes bias in estimation of N

Concepts and Definitions

Capture-recapture Estimation Models

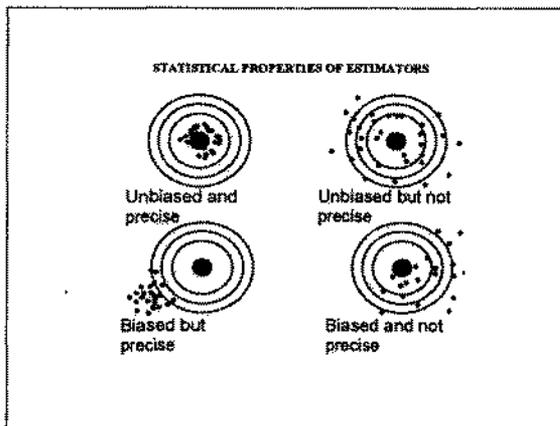
- **Robust:**
 - Assumes geographic closure
 - Uses closed models to analyze data from multiple sampling occasions within a year
 - Uses Open models to estimate additional parameters
 - Optimizes use of all the data within and among years
 - Has flexibility to accommodate sources of variation in sampling and demographics



Concepts and Definitions

Statistical concepts

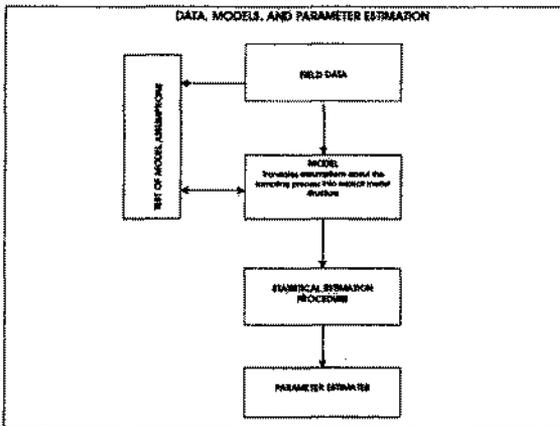
- **Bias:**
 - Does the estimator produce the 'right answer' on the average? If so, it is unbiased.
- **Precision:**
 - How reliable or variable is the estimator?
- Both properties of capture-recapture estimators are affected by the number of captures and capture probability



Concepts and Definitions

Statistical concepts

- **Model selection:**
 - Let the data objectively determine what model assumptions are reasonable
 - Compare alternative models to determine the most parsimonious synthesis of the data



Concepts and Definitions Statistical concepts

- Statistical errors in trend detection, given a specific sampling design and estimation procedure:
 - Type I: What is the probability that we infer a significant trend in population size when there is none?
 - Type II: Given a specific trend in population size, what is the probability that we detect it?

Panel Assessment of Data, Estimation Methods, Sampling Designs, and Constraints Upper Basin

1. Number of sampling occasions and capture probabilities are low
2. Geographic and demographic closure assumptions are probably OK (if Black Rocks and Westwater combined)
3. Reasonable population estimates are possible for Black Rocks and Westwater populations, but are problematic for Yampa, Desolation, and Cataract

Panel Assessment of Data, Estimation Methods, Sampling Designs, and Constraints Upper Basin

4. Relatively short term (4 years) data set
5. Fall sampling is less problematic and produces larger capture probabilities
6. Available recapture data among years not currently utilized

Panel Assessment of Data, Estimation Methods, Sampling Designs, and Constraints Grand Canyon

1. Capture probabilities are generally higher than UB and higher in spring (LCR) than in fall (LCR and mainstem)
2. Large spring population size in LCR
3. Only 2 sampling occasions within a season
4. Geographic closure during spring sampling of LCR a potential problem due to timing of spawning migration
5. Demographic closure within a year OK

Panel Assessment of Data, Estimation Methods, Sampling Designs, and Constraints Grand Canyon

6. Long term data set (15 years)
7. Appropriate to use age-specific open models to take advantage of among year information, but biases in estimates of N are possible due to unaccounted variation in capture probabilities
8. ASMR model based on similar foundation to well-established Jolly-Seber Age models
9. No formal model selection in ASMR

Recommendations

1. Continue fall sampling in the Upper Basin and spring sampling in LCR only
2. Increase number of sampling occasions within a year to 4 in the Upper Basin
3. Increase number of sampling occasions to 4 in the LCR or conduct telemetry to improve assessment of potential bias in population estimates and geographic closure
4. Conduct cross-validation of ASMR and Jolly-Seber-Age method

Recommendations

5. Conduct Monte Carlo computer simulation studies to evaluate performance (bias and precision) of alternative sampling designs, and to evaluate error rates in trend analysis
6. Work toward a common analysis framework of the robust design to maximize statistical efficiency and improve understanding of HBC population dynamics
7. Conduct workshops in simulation techniques and use of recommended estimation methods