



# Recent advances in population modeling, preliminary estimates, and their relevance to BO triggers

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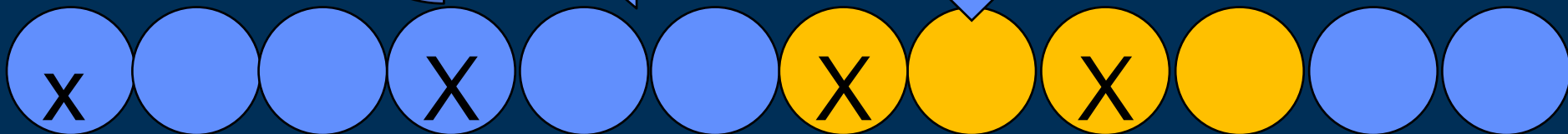
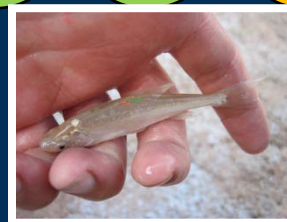
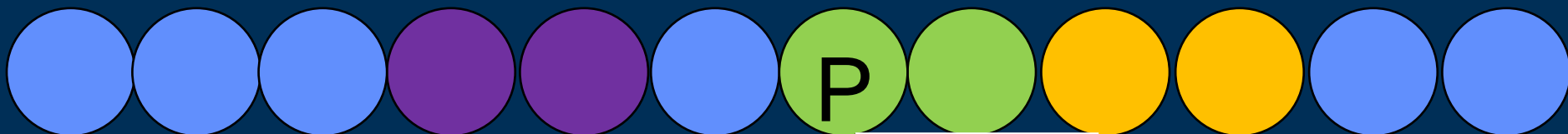
**U.S. Geological Survey, Southwest Biological Science Center, Grand Canyon Monitoring and  
Research Center**

# Outline

- Review of timing of HBC sampling in and near LCR
- Comparison of methods used for HBC population assessment
- Multistate modeling of HBC – background
- Multistate modeling – preliminary results
- BO triggers

# Monthly schedule

Little Colorado River



Colorado River

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Multistate models	Time step: Monthly (trips)  Spatial structure: Yes	Includes tag loss; Heterogeneity in rates over space and within year; Movement.	Relatively data hungry; Assumes NSE representative of CR.

# Multistate Model - Background

- 3 spatial locations (LCR, NSE, rest of CR)
- 3 Size groups (4-10cm; 10-20cm; 20cm<)
- Incorporates information from tag loss studies.
- Assumes CR fish don't move around much,
- Assumes that NSE is representative.

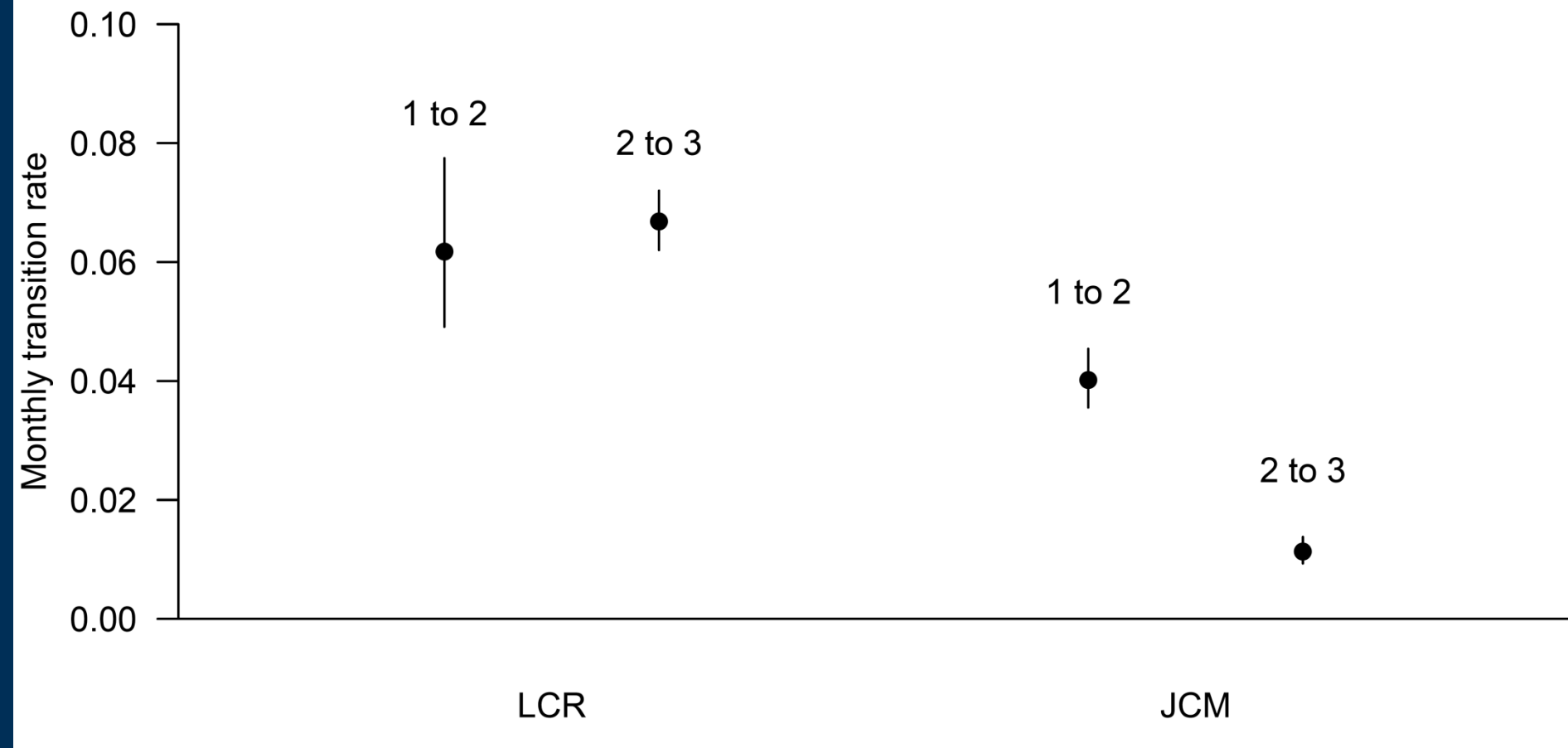
# Multistate Model - Background

- Parameters of interest
  - Survival (6;  $\psi_t^{L1}$ )
  - Transition between size classes (4;  $\gamma_t^{L12}$ )
  - Movement (6,  $\alpha_t^{LM1}$ )
  - Proportion of CR fish in NSE ( $\tau$ )
  - Recapture probabilities (82)
- State specific abundances also estimated (derived parameter).



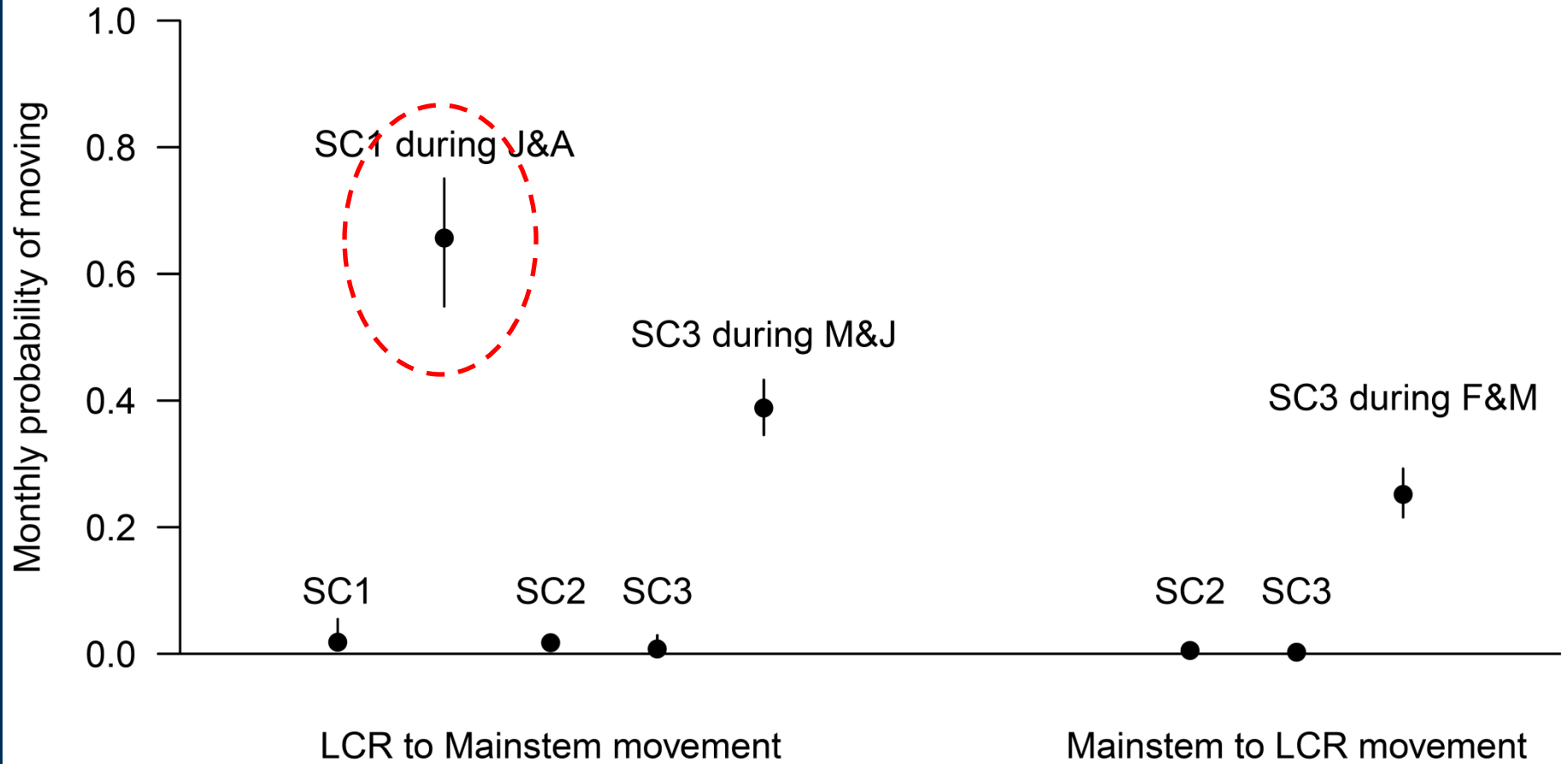


# Size Transitions

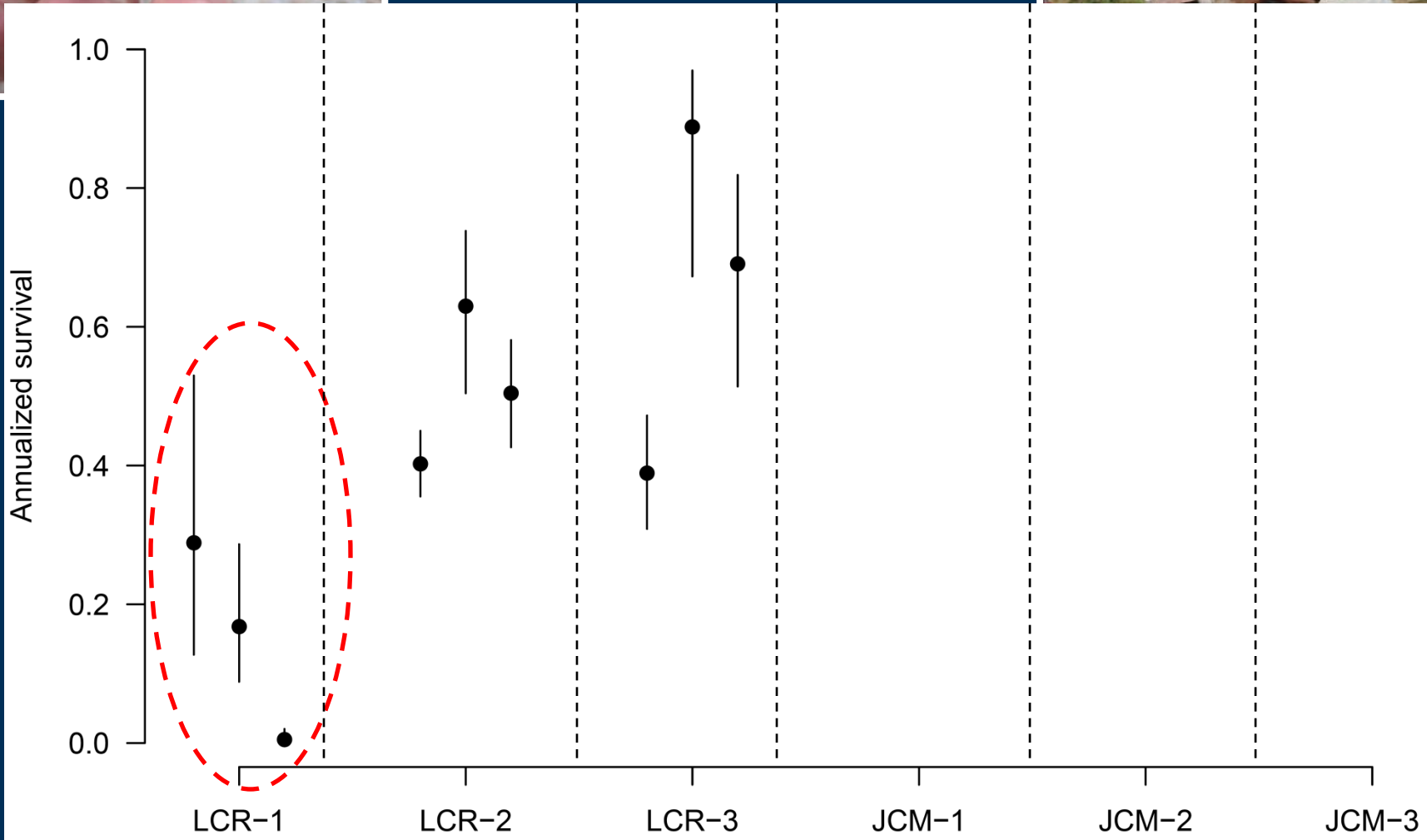


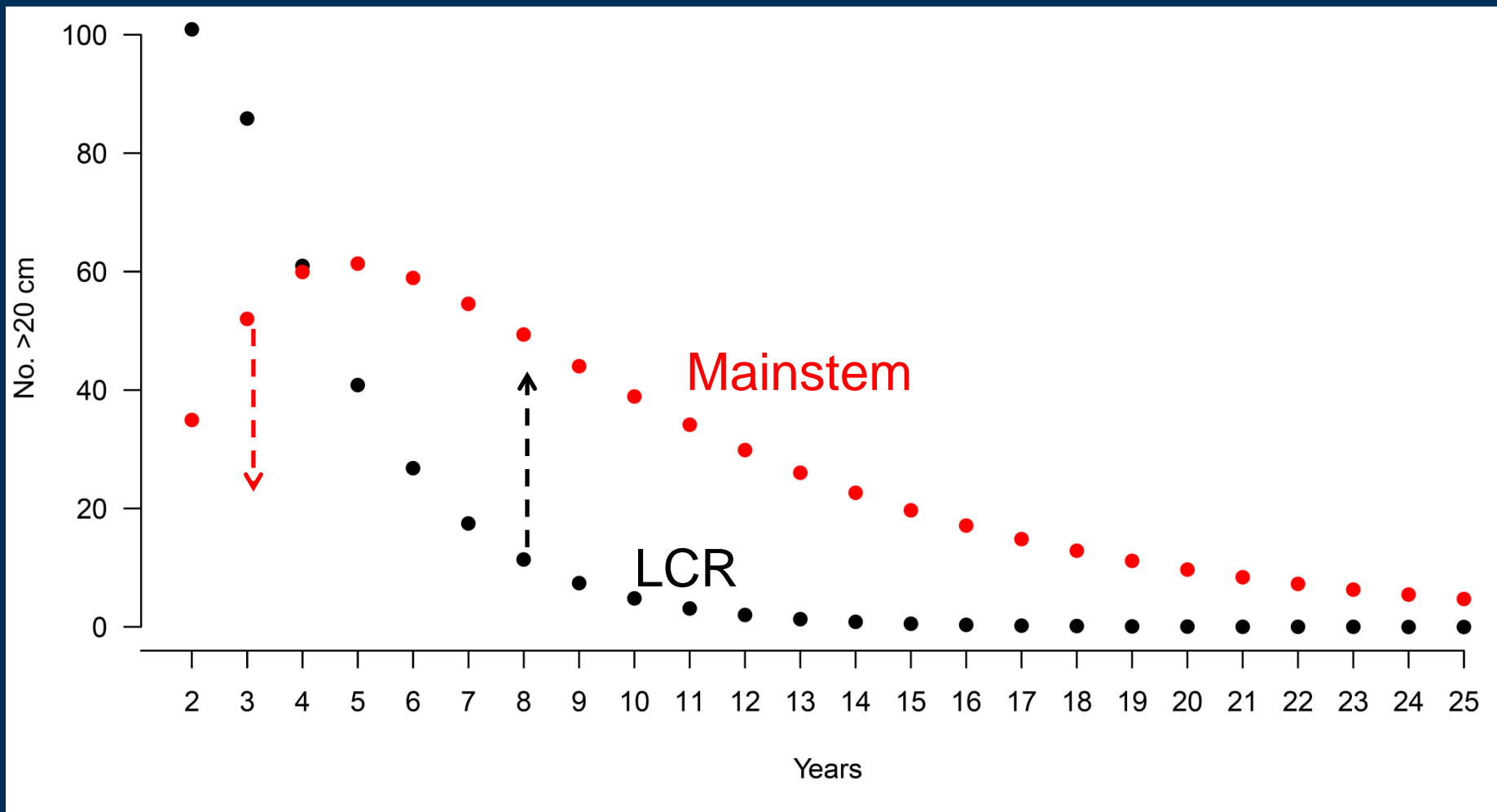


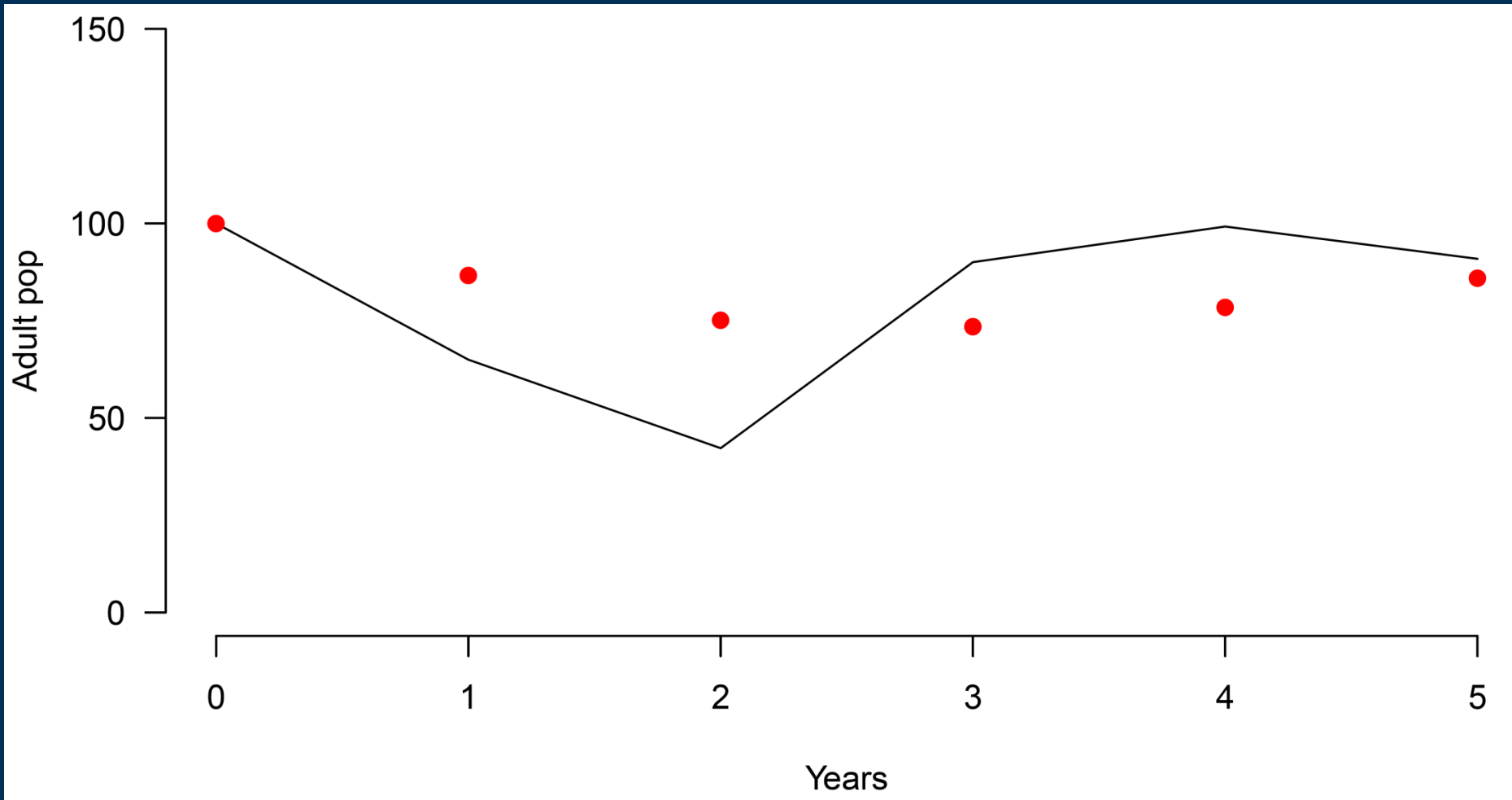
# Movement

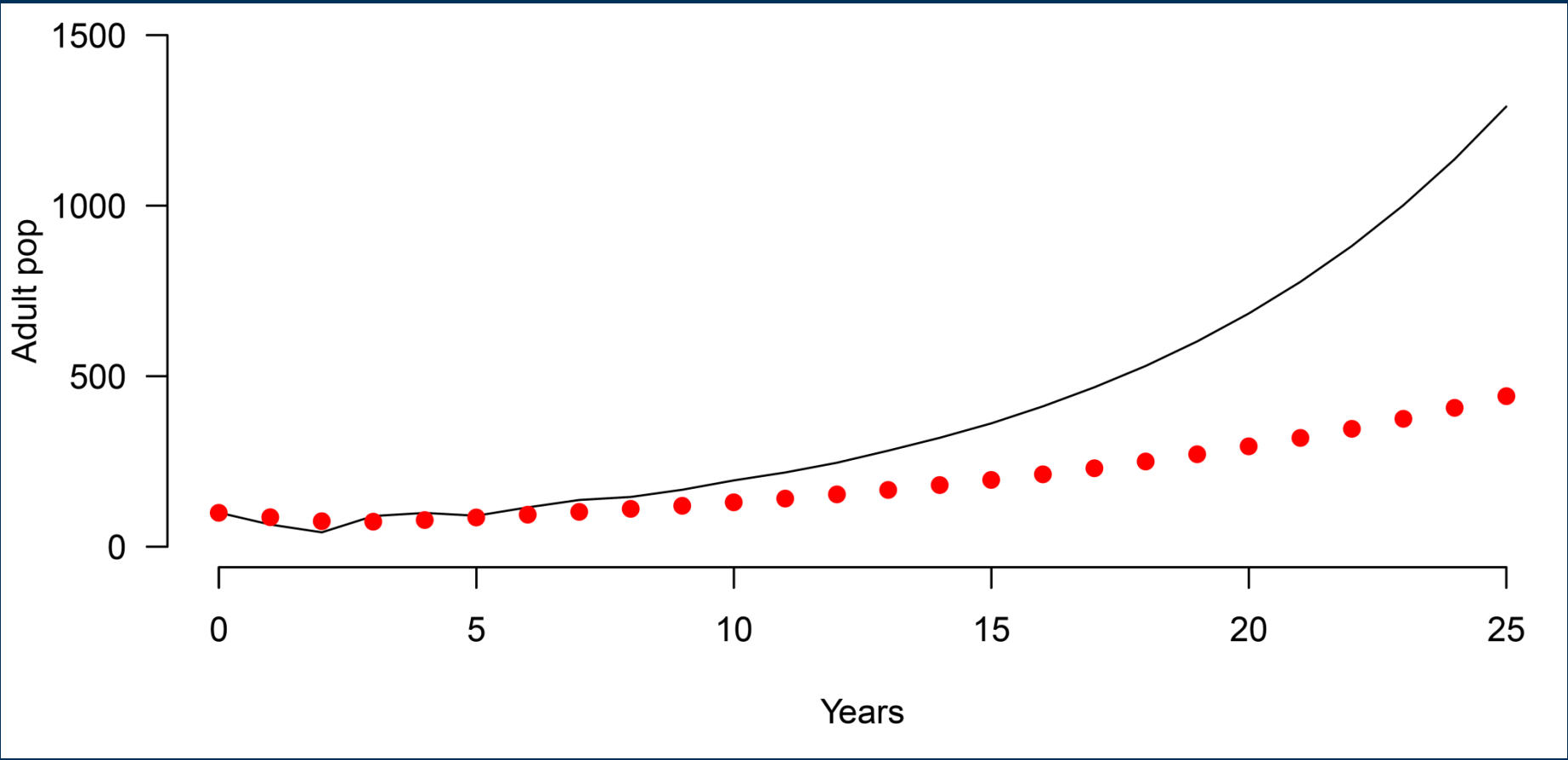


# Survival

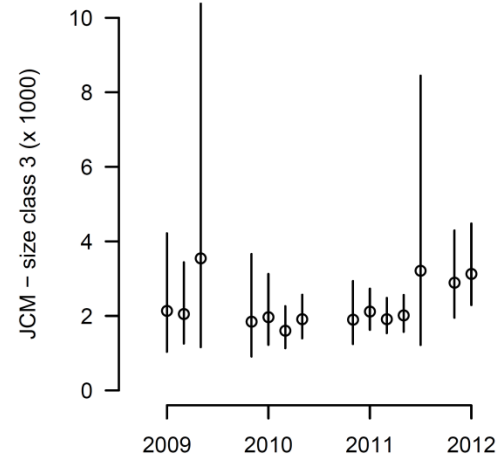
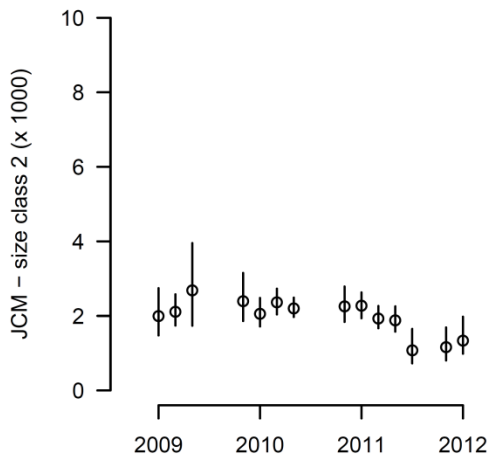
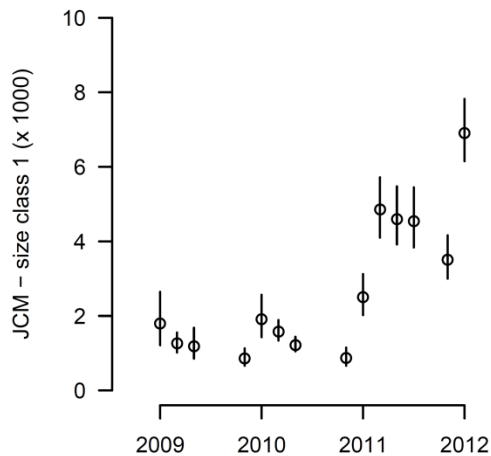
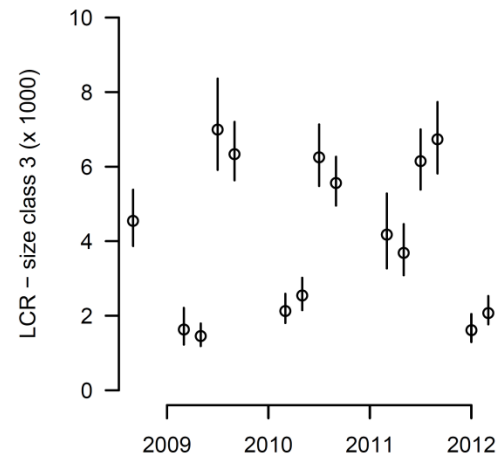
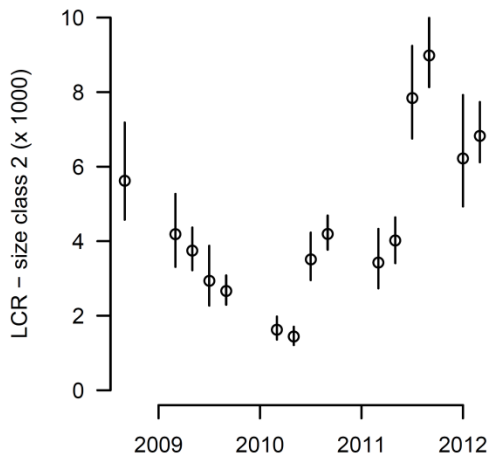
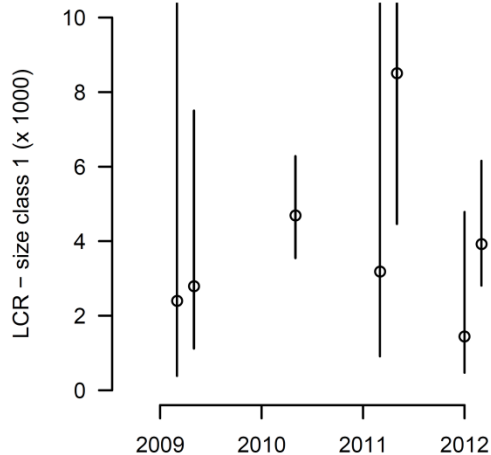




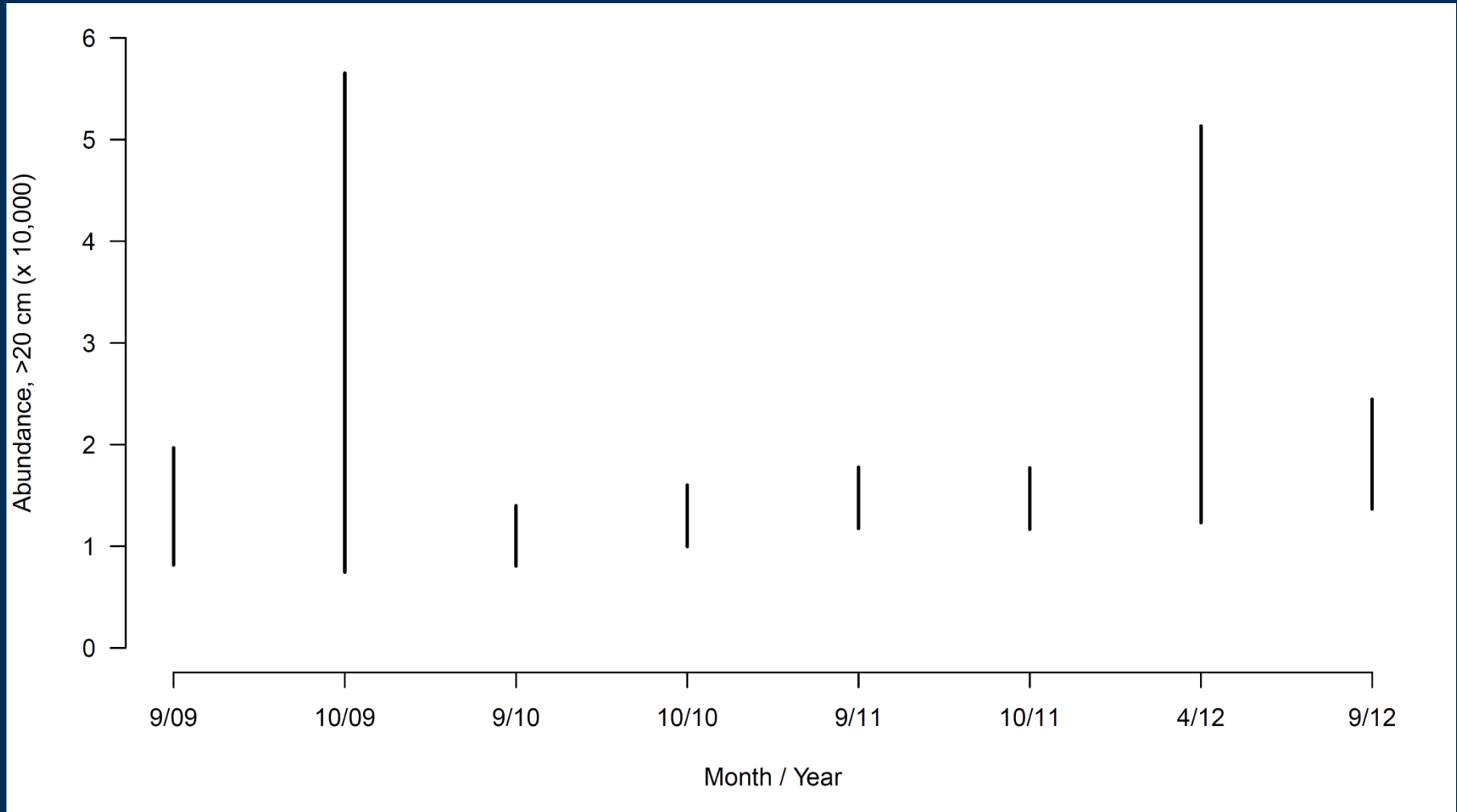




# State specific abundances



# Abundance over 20 cm





# BO triggers

- **Adult humpback chub <7000 fish**
- **OR**
- **ALL 3**
  - **LCR pop of ~size class 2 <910 fish**
  - **Temperature <12° C for 2 consecutive years**
  - **Survival of size class 1 in JCM drops 25% from preceding year**

# BO triggers

- **AND**
- **Rainbow trout abundance over 760**
  - Korman closed model estimates ~450 (330-600)
  - Open models?
- **AND**
- **Brown trout abundance over 50**
  - Unknown – 8 total fish caught

# Acknowledgements

- **US – Fish and Wildlife Service**
- **Bill Pine and NSE group**
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- **National Park Service**
- **Bureau of Reclamation**
- **Navajo Nation Department of Fish and Wildlife**