Variation in vital rates of age 1 humpback chub *Gila cypha* in the Little Colorado River

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Photo of adult humpback chub. Credit: Mike Dodrill.

Introduction:

Ecologists often estimate vital rates to model population growth trajectories and identify sensitive life history parameters of imperiled species or populations. We assessed spatiotemporal variation in growth, movement, and survival of age1 humpback chub living in the Little Colorado River (LCR), Grand Canyon, AZ from 2009-2013.

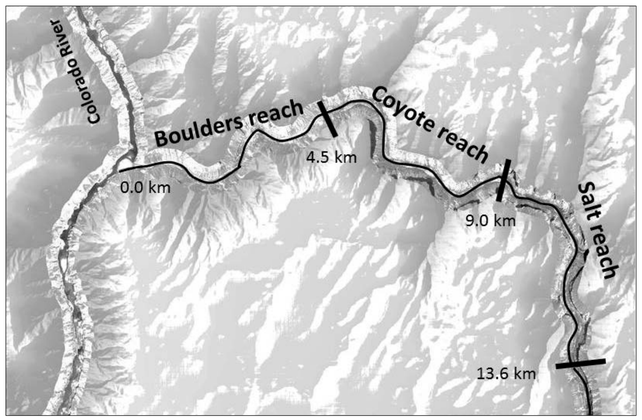


***Figure 1**. Map of the lower 13.6 km of the Little Colorado River. The map depicts the three sites used for statistical analyses: Boulders reach, Coyote reach, and Salt reach. Black rectangles depict boundaries between reaches.*

Methods:

Data were collected as part of monitoring surveys conducted by the US Fish and Wildlife Service (USFWS; see Van Haverbeke et al. 2013). We assessed spatial effects on growth, survival, and density across three sites in the LCR: "Boulders" reach, "Coyote" reach, and "Salt" reach (Figure 1).

- We used linear models to describe subadult chub growth during two time periods:
  April – October (summer growth model)
  October – May (winter growth model)
- We used a multistate model to estimate survival, capture probability and movement. Here, we defined states based on spatial location within the Little Colorado River.
- We estimated density by dividing catch by the estimates of capture probability from the best-fit multi-state models.
- We used Akaike's criterion (AIC) to select the most parsimonious models.

Growth:

- Over all sites and years, the best growth models predicted:
  - Summer model: 0.18-0.30mm/day for a fish of average size (119 mm total length)
  - Winter model: 0.07-0.15mm/day for fish of average size (161 mm total length)
- There were some spatial patterns in summer growth, with higher growth occurring at more upstream reaches
- There was no spatial or temporal pattern in winter growth rates.

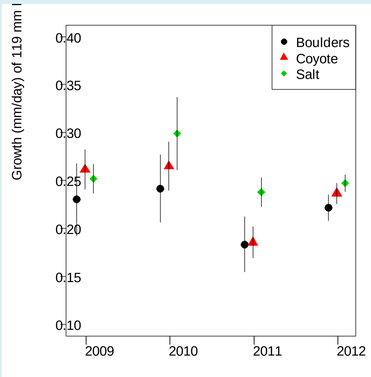


***Figure 2.** Graphs of daily growth for age 1 humpback chub from April to October for a chub of total length 119 mm.*

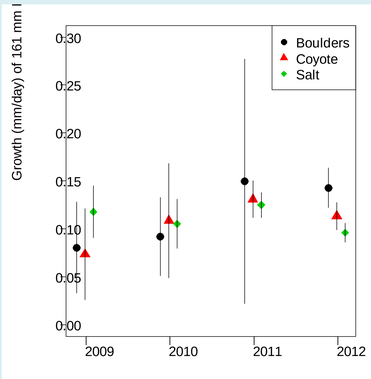
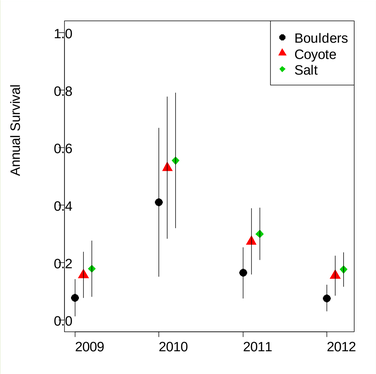
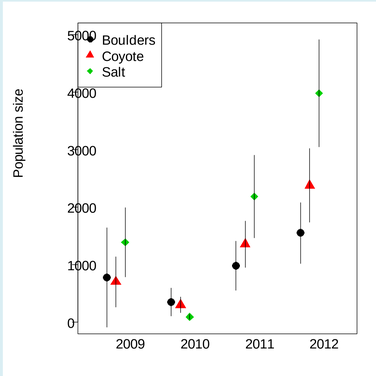


***Figure 3.** Graphs of daily growth for age 1½ humpback chub from October to May for a chub of total length 161 mm.*



Survival: Apparent survival was highest for age1 chub in 2010. Apparent survival was estimated to be higher in Salt and Coyote compared to Boulders reach.

***Figure 4.** Graphs of annual survival for age 1 humpback chub Error bars represent 95% confidence intervals.*



Density: Densities were lowest in 2010 and highest in 2012. Densities tended to be highest at Salt reach, except in 2010.

***Figure 5.** Chub density during either May (2009, 2012) or June (2010, 2011). Estimates of density pertain only to l year old chub between 100-140mm total length in early April.*

Movement: Overall, movement rates were fairly low. Upstream movement was estimated to be greater than downstream movement.

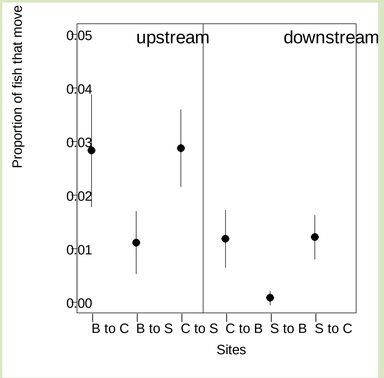


***Figure 6.** Proportion of subadult chub that move between reaches in the Little Colorado River each month. Sites are abbreviated as B (Boulders), C (Coyote), and S (Salt).*

Discussion:

- High summer growth and high densities at Salt indicate that Salt reach may contain more food resources for age 1 chub.
- Apparent survival was estimated to be lower at the most downstream site compared to the upstream sites; however, this could be in part due to increased emigration into the Colorado River at downstream sites.
- Temporal variability in survival was high, as illustrated by high survival in 2010 and low survival in 2009 and 2012.
- Density was lowest in 2010, a year when apparent survival was high. The low densities could lead to decreased competition for food, which would cause higher survival rates (i.e., density dependence).
- Preferential upstream movement might be influenced by higher food availability in the upper reaches. More studies need to be conducted to test this hypothesis.

***Figure 7**. Photo of the Little Colorado River, AZ.*

Acknowledgements: U.S. Fish and Wildlife Service, Glen Canyon Dam Adaptive Management Program, Navajo Nation Department of Fish and Wildlife, Bureau of Reclamation

Literature Cited: Van Haverbeke, D. R., D. M. Stone, L. G. Coggins, and M. J. Pillow. 2013. Long-term monitoring of an endangered desert fish and factors influencing population dynamics. Journal of Fish and Wildlife Management **4**.

Preliminary Data from Dzul, Yackulic, and Stone 2014, Do Not Cite