Megafish movement: Testing stream fish movement paradigms using alligator gar

Florian Kappen, Joshuah S. Perkin, Maximiliaan Claus, Hayden Roberts, Matthew R. Acre, Daniel J. Daugherty, David L. Buckmeier

Introduction

- The restricted movement paradigm (RMP) posits that riverine fish populations consist of a stationary (σ_{stat}) and mobile (σ_{mob}) component whose heterogeneous movement behaviors result in leptokurtic distributions of movement data (Fig. 1).

- The high peak in these leptokurtic distributions originates from a stationary component that does not move far, while a wide spread at the tails originates from the often smaller mobile component that moves much further.

- Despite application on a global scale, the RMP is not yet tested for megafish (i.e., fishes >30 kg in adulthood). Therefore, we explored the application of the RMP to alligator gar (Fig. 2).

- We tested four hypotheses related to the RMP, including (H1) presence of leptokurtosis, (H2) a diffusive spread like dispersal with seasonal variation, (H3) individual fish switching between stationary and mobile behaviors, and that (H4) a general model for fish dispersal in rivers would predict alligator gar movement.

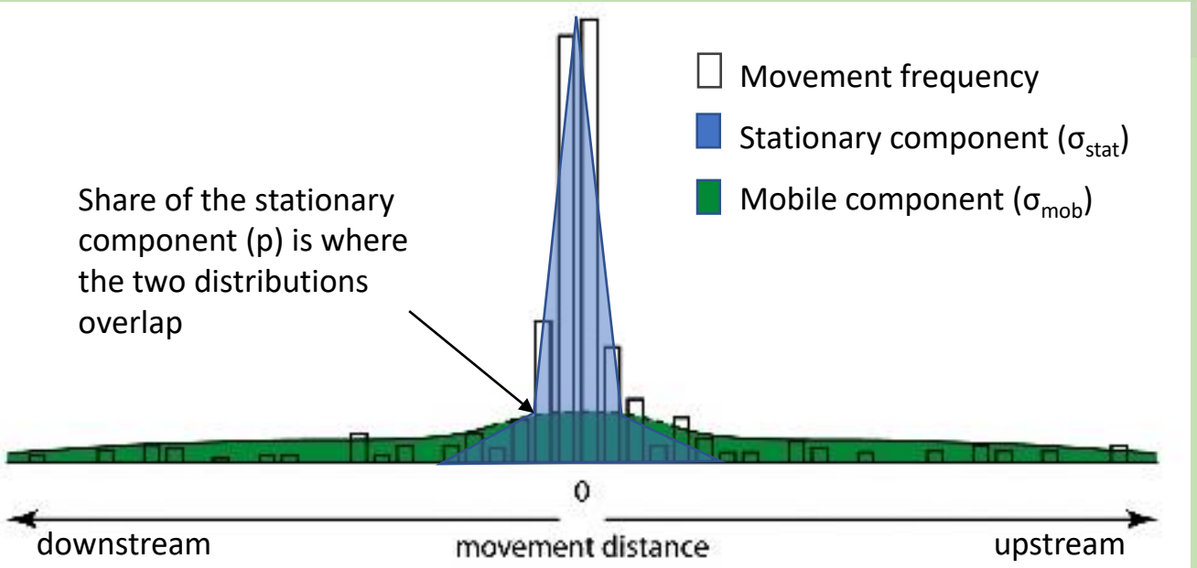

Figure 1. Example leptokurtic distribution with stationary and mobile components.

Figure 2. Florian Kappen posing with a >7 foot alligator gar tagged for research.

Materials and Methods

- We used previously published telemetry data collected from 42 alligator gar on the Lower Trinity River, Texas (Buckmeier *et al*. 2013) and analyzed dispersal (i.e., movement from tagging location) and displacement (i.e., movement from previous location).

- **(H1)** We tested for leptokurtosis using D'Agostino's test for normality and accepted H1 when leptokurtosis was present.

- **(H2)** We tested for increasing movement distances through time and variability with season for σ_{stat} and σ_{mob} using the 'fishmove' package in R. H2 was accepted if distances increased with time and showed seasonal variation.

- **(H3)** We classified individual fish per tracking event as stationary (movement < σ_{stat}) or mobile (movement > σ_{stat}) and accepted H3 if classifications varied.

- **(H4)** We compared observed movement components with predictions from Radinger & Wolter (2014) and accepted H4 if confidence intervals overlapped

Megafish movement: Testing stream fish movement paradigms using alligator gar

Florian Kappen, Joshuah S. Perkin, Maximiliaan Claus, Hayden Roberts, Matthew R. Acre, Daniel J. Daugherty, David L. Buckmeier

Results

- Leptokurtosis occurred in most of the tracking events (H1 supported; e.g., Fig. 3).
- Movement distances did not show a monotonic increase through time (Fig. 4) and only the mobile component was related to season (H2 partially supported).
- Individual fish switched between stationary and mobile movement behaviors, suggesting mobility was not fixed (H3 supported).
- The predictive model for fish dispersal in rivers consistently over-predicted alligator gar movement because of the absence of diffusive spread (H4 rejected).

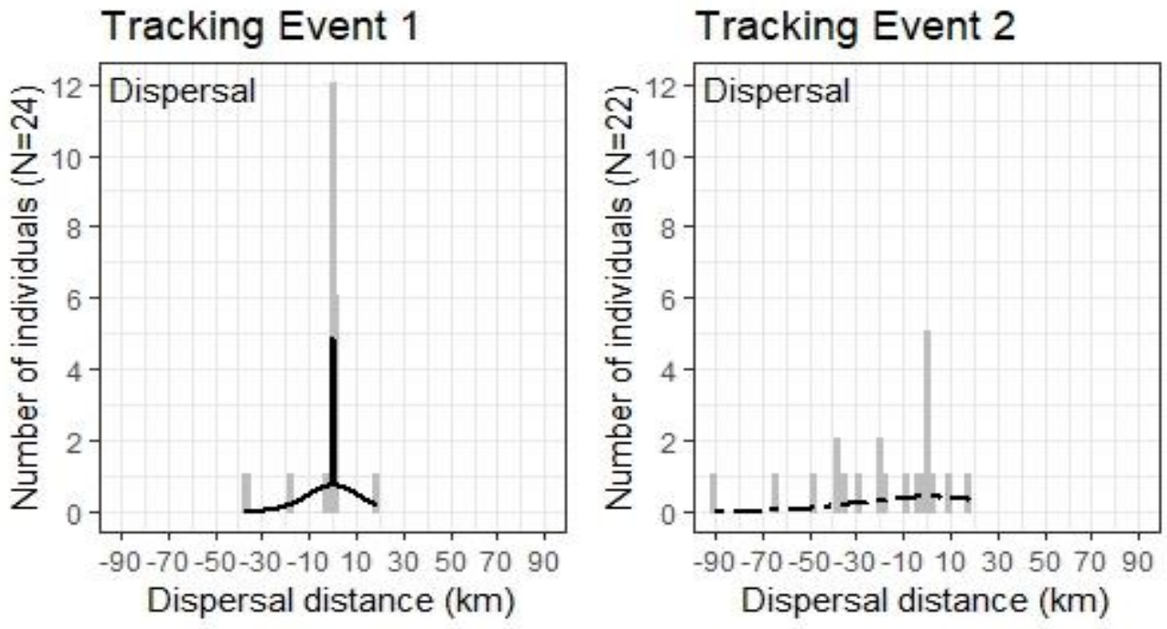

Figure 3: Visualized example of the analysis of leptokurtosis in alligator gar data distributions for dispersal distances per tracking event. Solid distribution lines represent leptokurtic distributions, while dashed lines represent distributions where no statistically significant for leptokurtosis.

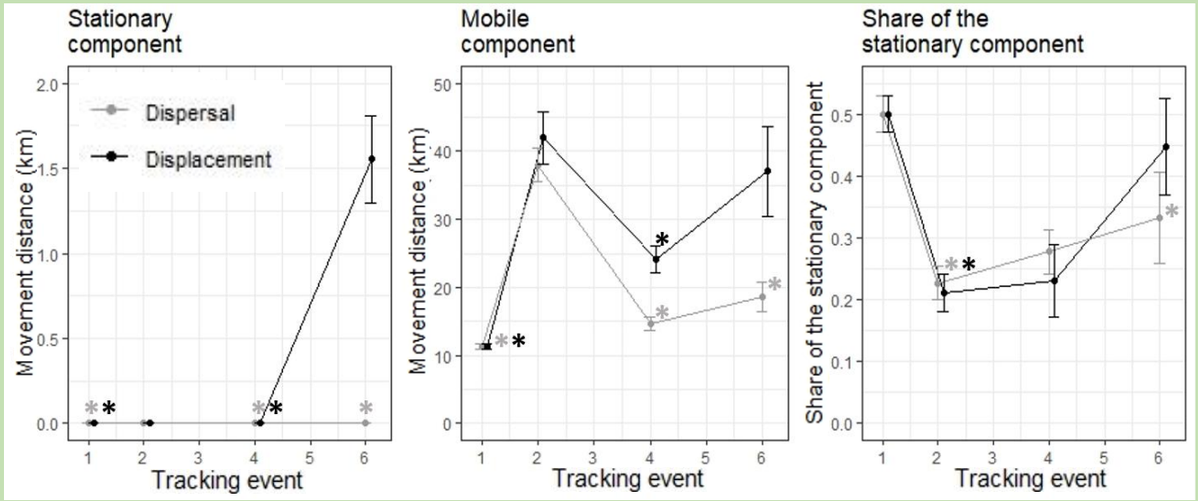

Figure 4: Comparison of dispersal versus displacement across multiple seasons (events 1 and 4 cool season, events 2 and 6 warm season) showing a fluctuating pattern in movement distance by the mobile component.

Discussion and Conclusions

- This study indicates that the RMP is applicable to a megafish species like the alligator gar, though general predictions of alligator gar movement remain elusive.
- Whereas dispersal in small bodied fishes is often characterized by a diffusive spread over time, this was not the case for alligator gar.
- We hypothesize that movements linking required habitats throughout different seasons better explain alligator gar movement. This was indicated by our results and in line with patterns observed in previous alligator gar movement studies.

Acknowledgements and References

- This was funded in part by the Texas Parks and Wildlife Department.

-Buckmeier et al. (2013). Alligator Gar movement and macrohabitat use in the lower Trinity River, Texas. Trans. AFS 142:1025-1035.
-Radinger & Wolter (2014). Patterns and predictors of fish dispersal in rivers. Fish & Fisheries 15:456-473.