Determining Homing Abilities of Nesting Male Threespine Stickleback

Marielle V. Martin, Katherine Van Dame, Sidney Ryan, and Yoel E. Stuart

Abstract

Homing, a behavior demonstrated by the threespine stickleback allows an organism to return to their home site when displaced. We predicted that male stickleback fish would home well because they guard their young in nests and have high incentive to return. Here we marked and displaced nesting male stickleback over a variety of distances to see whether homing ability declines with distance displaced. Our results show that stickleback can home, but there was no significant relationship between the distance and return rate. However, some nests were taken over by new males after displacement, meaning that even if the experimental fish returned, they had no nest to access. Removing these "evicted males" from the data reveals a stronger negative trend between distance and return.

(A) Complete data	Beta	Standard error	Z value	P value
Intercept	0.0608	0.6345	0.969	0.338
Distance	-0.02291	0.01922	-1.192	0.233
(B) Without evictions	Beta	Standard error	Z value	P value
Intercept	1.7978	0.8632	2.083	0.0373
Distance	-0.0463	0.02431	-1.905	0.0568

Table 1: results of the binary logistic regression for (A) the complete data set and (B) data subset to only males whose nests had not been taken over by unmarked males

Introduction:

Homing is the phenomenon of an organism returning to its home range after being displaced. It is present across diverse vertebrae taxa and can very between populations and even individuals.[1,2,3,4] Homing likely evolved due to its potential to increase individual fitness by allowing organisms to build awareness of refugia and resources.[2, 5]

The threespine stickleback fish is one organism able to home.[2, 5] It has been suggested that stickleback home using landmark recognition.[5] Stickleback also have highly conserved nesting behavior, including reversal of sex roles, as the males oversee guarding the nest.

The aim of this study was to test whether nesting male stickleback return to their nests after displacement, and whether return rate diminishes with increased distance. If stickleback use landmark recognition to home, then an increase in distance would decrease the likelihood of having familiar landmarks the stickleback could use to home. We hypothesized that when displaced, nesting male stickleback would return to their nests and that the likelihood of return would decrease as the distance they were displacement increased.

Methods

This study was conducted on Vancouver Island, British Columbia in Lower Stella Lake where breeding males had been observed (T. Sasser, *personal communication)*. We dry-suit snorkeled to find males displaying nesting behavior. Once confirmed as nesting. Nests were marked, a GPS coordinate for the nest was taken, and the fish was captured via dipnet. GoPro cameras were also set up to observe returns.

To mark stickleback, we anesthetized individuals using a dilute tricaine solution (MS222). We then used Super Glue to adhere one a bead to each pelvic spine. Bead colors included black, pink, red, orange, yellow, light green, dark green, light blue, dark blue, and white for a total of ten colors and 100 color combinations.

We allowed stickleback to recover from anesthesia and, after observing healthy swimming behavior, we released them at a fixed point near the center of the work area. GPS coordinates of the release points and the nests were used to calculate distance between the nesting site and the point of release. Animal use was approved by Loyola University Chicago IACUC (Project 2853).

Due to the low spotting rate of GoPros, diver observation was also used to quantify returns. We moved slowly and carefully and remained at marked nests until other, un-beaded stickleback were present to help ensure that our presence hadn't scared any beaded stickleback that may have returned.

Results

We caught and marked 42 nesting stickleback males in. Forty-one survived marking and were released. Displacement distance averaged 28.8m (s.d. = 17.0m; range 3m-58m). We re-spotted 20 beaded stickleback after release with 14 spotted by diver alone, 4 observed by both GoPro and diver, and two fish observed by GoPro alone. All the marked and re-spotted stickleback were observed at the nests from which they were taken, indicating that the males can and do return to their nests following displacement. We found that return was negatively but not significantly related to distance displaced (β = -0.02, p = 0.233; Table 1) for the complete data set. When the 7 evicted males were removed from the data set, the strength of the relationship increased (β = -0.04), nearly significantly so (p = 0.057), despite the smaller sample size.

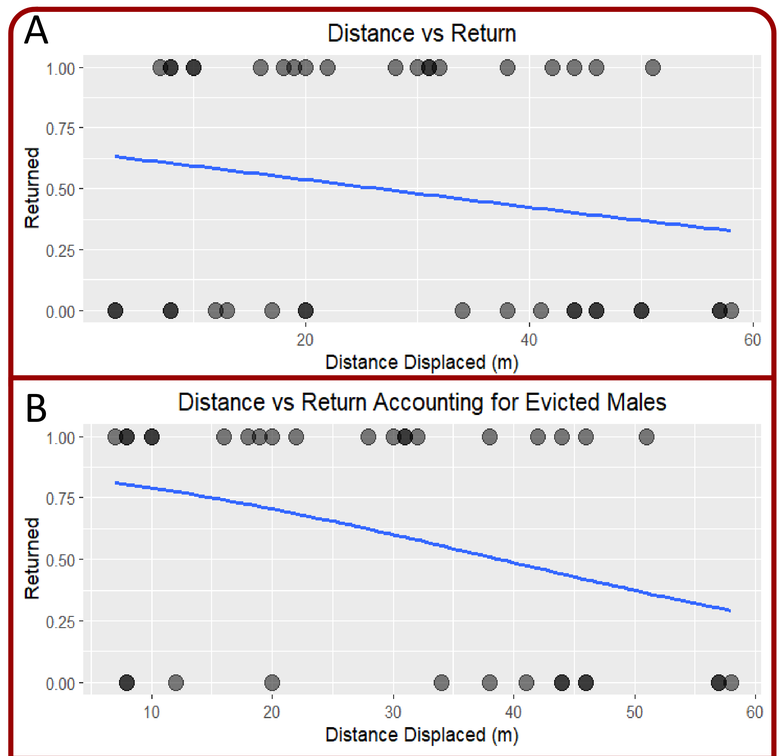

Figure 1: logistic regression graphs of distance displaces vs return rate for (A) all captured and released stickleback and (B) the data set where any evicted males were removed

Discussion/Conclusions

In this experiment, we found that nesting males were able to return to their nests following displacement. Frequency of return decreased with distance, though not with statistical significance. Possible reasons for this include small sample size, misidentification of nesting males, or the displacement range being too small. When evicted males were removed from the analysis, the negative correlation was stronger, though still not significant. These results indicate that nesting male stickleback have homing capabilities, an incentive to return, and that the distance displaced likely influences their ability to return.

Acknowledgements

We thank D. Bolnick, T. Neely-Streit, Z. Pitsenberger, D. Rennison, T. Sasser, T Veen, and J Weber for help in study design and field work. We thank the British Columbia Ministry of Environment for research permits. Funding was provided by Loyola University Chicago College of Arts and Sciences, consisting of a Biology Department Summer Research Fellowship (MM), the Mulcahy Fellowship (MM and SR) and the Provost Fellowship (SR).

Citations

1. Taylor, et al. (2016) *ICES Journal of Marine Science*; 2. Ward, et al. (2013) *Behavior;* 3. Schmidt (2004) *Ecology Letters*; 4. Keefer, et al. (2014) *Rev Fish Biol Fisheries*; 5. Ivanova, et al. (2019) *Evolutionary Ecology Research*

LOYOLA UNIVERSITY CHICAGO
AD · MAJOREM · DEI · GLORIAM
1870

Preparing people to lead extraordinary lives