

# The Effects Of Hydroperiod On Life-History Parameters Of Two Species Of Livebearing Fish (Poeciliidae) In The Florida Everglades

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## I. Introduction

Ecologists often make assumptions about the "stressfulness" of habitats based on fluctuation in the physical environment and its presumed effects on organismal vital rates such as age-specific survivorship or fertility. In aquatic habitats, fluctuations in water level leading to dry-down events are often considered "stressful" for fishes because it is assumed that reduced habitat area and crowding have adverse effects on survivorship and fertility. However, the degree of drying, as indicated by minimum water depth, is rarely constant among years in the Everglades. That variation may produce dramatically different effects on the fish community, depending on factors such as availability and quality of refuges that remain wetted. Furthermore, organisms typically have physiological and behavioral adaptations to compensate for environmental variability, including synchronization of reproductive and migratory patterns with environmental fluctuation, and phenotypic plasticity. Consequently, the matching of recurrent "stress" with measures of survivorship and reproduction are critical to produce predictive demographic models. While comparative statements about the relative stressfulness of habitats are common in the literature on life histories, we question the ability to make such comparisons without age-specific survival and fertility data. To improve the utility of management models such as ATLSS, we sought to estimate the effects of hydroperiod on demographic rates of two of the most common fish species in the Everglades, the sailfin molly and the least killifish (Poeciliidae) (shown below).



Sailfin molly  
(*Poecilia latipinna*)

Least killifish  
(*Heterandria formosa*)

## II. Methods

We used age-length relationships to estimate age-specific survival and fertility for sailfin mollies and least killifish from six sites in the Everglades that experience a gradient of hydrological conditions (Fig. 1). These six sites are the focus of long-term monitoring of fish communities, and we used samples collected from 1997 to 1999 to estimate age-specific survivorship curves and fertility schedules. From those data, we constructed life tables to compare patterns in vital rates of each species with hydroperiod. Also, we compared the idealized estimate of population growth rate from the life table to real population dynamics over the same time period. We used otoliths (Fig. 2) to determine the relationship between size and age for male, female, and juvenile sailfin mollies from the six study sites (Fig. 3). Calibrations indicated that this method was very accurate for juvenile fish, but tended to under-estimate age in older, mature specimens. We also dissected female fish from the long-term field collections to estimate size-specific fertility for females of each species. We used the otolith data to estimate the age of females, based on size, permitting us to transform these data into age-specific fertility tables for each study site.

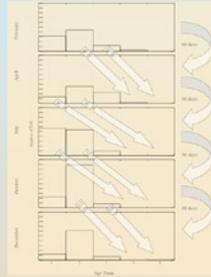


Fig. 4. By assuming our study populations are closed, we could use the temporal size-frequency data to estimate survivorship.

Clearly, the assumption of closed populations must be considered a convention used only for convenience

Fig. 3. Otolith analysis is used to estimate growth rate and size-age relationships.

\* This was repeated in two years with similar results

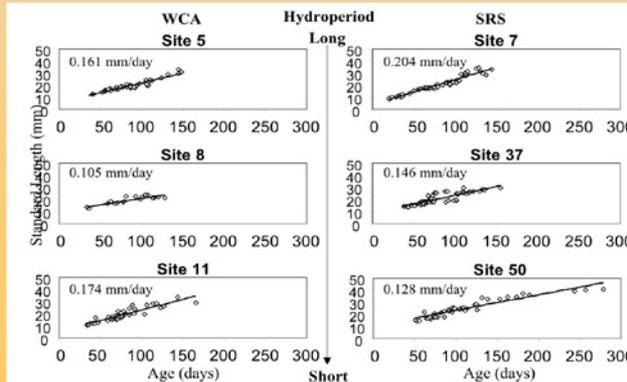


Fig. 2. Cross section of a sailfin molly otolith. The number of rings indicates the fish's age in days.



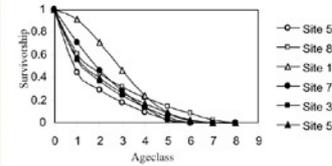
Fig. 2. Long-term aquatic animal study sites in the Everglades where this work was conducted.

## III. Results and Discussion

Our analyses indicated that growth rate and age-specific fertility differed among locations, and that some patterns could be explained by hydroperiod. However, many of the patterns were not consistent with the expectation that short-hydroperiod sites are more stressful for these two species. For example, the longest life expectation and highest lifetime fertility were noted at the short hydroperiod sites for both taxa. These results yielded greater estimates of population growth rate [r] for the two short-hydroperiod sites. Either both species have adaptations that permit them to circumvent the conditions that make these sites appear stressful to ecologists, or immigration is subsidizing populations in short-hydroperiod sites yielding a more favorable demographic profile than is actually realized by residents of the site.

Ongoing research on dispersal by similar species before and after droughts suggests a complex pattern that may include dispersal from long-hydroperiod sites to the short-hydroperiod sites, and persistence in local refuges. The exact role of dispersal in re-establishing short-hydroperiod fish populations appears to depend on local topography and ambient rainfall.

Alternatively, our data are consistent with the long-held hypothesis that small fish species experience less predation from piscivorous fish in short-hydroperiod than in long-hydroperiod habitats. This hypothesis predicts that these fishes experience longer life spans in short-hydroperiod sites, as we observed. More research is needed on the relative role of immigration as a mechanism to sustain small fish populations in short-hydroperiod marshes of the Everglades.



The resulting survivorship curve (illustrated above) can be combined with age-specific fertility to estimate population turnover using a life table approach (illustrated by the table below).

Age Class	Age	$l(x)$	$l'(x)$	$g(x)$	$l(x)l'(x)$	$l(x)l'(x)g(x)$	Estimate	Corrected
		$e^{-\sum_{t=0}^{x-1} m(t)}$	$e^{-\sum_{t=0}^{x-1} f(t)}$				$e^{-\sum_{t=0}^{x-1} (m(t)+f(t))}$	$e^{-\sum_{t=0}^{x-1} (m(t)+f(t))}$
0-29	0	0	1	0.710	0	0	0	0
30-59	1	1.039	0.710	0.644	0.738	0.738	0.521	0.505
60-89	2	1.464	0.457	0.607	0.569	1.339	0.333	0.315
90-119	3	1.662	0.278	0.499	0.462	1.385	0.162	0.149
120-149	4	1	0.139	0.179	0.139	0.554	0.034	0.031
150-179	5	0	0.025	0	0	0	0	0
180-209	6	0	0	0	0	0	0	0

$G = 2.000$  age classes (30 days)  $\Sigma R_x = \Sigma' = \Sigma'' = \Sigma''' =$   
 $R_{(est)} = 0.348$  ind/(ind\*30 days)  $2.008$   $4.016$   $1.051$   $1.000$   
 $Corr = 0.020$   
 $r_{(index)} = 0.378$  ind/(ind\*30 days)

## IV. Conclusion

This study suggests that management models of fishes must incorporate rapid recovery from drought events. Some species may experience greater population growth rates in short-hydroperiod habitats, although ultimate population sizes may be limited by periodic dry down, site productivity, and other factors.

## V. Acknowledgements.

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