Extractive Control effects on *Gambusia holbrooki*: the case of an exotic fish population from an isolated semi-arid stream (SE, Spain).

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Female of *Gambusia holbrooki*

INTRODUCTION

Gambusia holbrooki (Girard 1859) is a Poeciliid among the most invasive fish worldwide (IUCN) widely spread in Iberian Peninsula. It is considered one of the main causes of the reduction of *Aphanius iberus* populations, an Iberian endemic species which is catalogued Endangered (EN) by several Spanish , international laws and IUCN.
A LIFE-Nature project (www.carm.es/siga/europa/life0035) has been making exclusive efforts to increase the survival of two defined genetic units of *A.iberus* in the southeast of Spain. This project includes a control programme by periodical extraction of *G. holbrooki* from an isolated population cohabiting with *A. iberus* in a small semiarid creek (Chicamo stream).
The objective of the present study was to determine the effects of the extraction control on the biology traits of that population of *G. holbrooki*.

METHODS

The sampling site was an isolated stretch (<300 m long) of the Chicamo stream just in its source, where the initial density of *G. holbrooki* was not very high.
From November 2005 to December 2008 a total of 72 extractive sampling events were carried out, (weekly on reproductive period: April-September). Fish were extracted by sieving (1 mm mesh size) for a minimum of 30 minutes and setting 20 minnow-traps for roughly 24 hours.
Total captures were sexed and measured (TL, mm), 1567 individuals were eviscerated to get the total weight (TW, g), eviscerate weight (EW, g) and gonadal weight (GW, g).
Relative population density was monitored twice per season by catch per unit of effort (CPUE; 1 unit being a passive trap for 12h).
Age and Population structure was assessed using both scales and monthly length-frequency distributions. Polimodal decomposition was based on the method described by Bhattacharya (1967) and NORMSEP (SEParation of the NORMally distributed components) (FiSAT Ver. 1.01).
Size diversity indices were evaluated on the nonparametric approach described by Quintana *et al*. (2008).
Somatic Condition and **Gonadal Activity** status were indexed by predicted values of the ANCOVAs (factor: seasons) from EW-TL and GW-TL relationships respectively (proposed by García-Berthou & Moreno-Amich 1993).

- García-Berthou E & Moreno-Amich R. 1993. Multivariate analysis of covariance in morphometric studies of the reproductive cycle. Can J Fish and Aquat Sci 50: 1394–1399.
- Quintana XD, Brucet S, Boix D, López-Flores R, Gascón S, Badosa A, Sala J, Moreno-Amich R & Egozcue JJ. 2008. A nonparametric method for the measurement of size diversitywith emphasison data standarization. Limnol Oceanogr Methods 6: 75-86.

Iberian peninsula

Sampling area in Chicamo Stream (SE Spain), sampling methods and target species

RESULTS & CONCLUSIONS

- Relative densities were significantly lower in autumn, winter and spring of 2007 (Fig 1), no individuals were captured during 2008.
- Maximum CPUE means appeared at the beginning of the study (Autumn 2005, Winter 2006) and decreased throughout the extraction period. CPUEs were significantly lower for the last year of the study ($CPUE_{2005}$= 3.1±2.2; $CPUE_{2006}$= 0.8±0.3; $CPUE_{2007}$= 0.5±0.02; Kruskal-Wallis H=21.4 p<0.001).
- Age structure showed three classes in females (F) (0+, 1+ and 2+) and two in males (M) (0+ and 1+). Length frequency distributions along the study period showed important changes (much clear in Autumn) with a significant decrement of long individuals (males>30mm TL; females>40mm TL) (Figs 2 and 4).
- Cohort 1+ of M disappeared two months earlier (June) during the 2007 reproductive period (Fig 3).

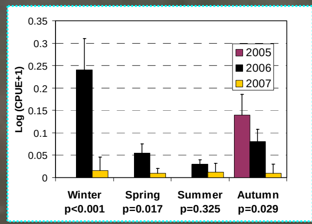


Figure 1. CPUE of *G. holbrooki* along the study period. Comparisons of CPUE between years have been made by ANOVA (p < 0.05).

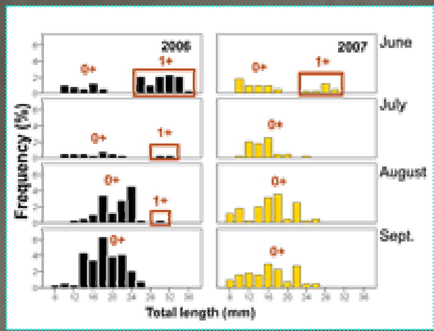


Figure 3. Length Frequency Distribution during recruitment period.

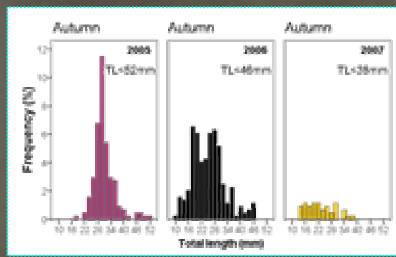


Figure 2. Length-frequency distributions of individuals for autumn (October-December).

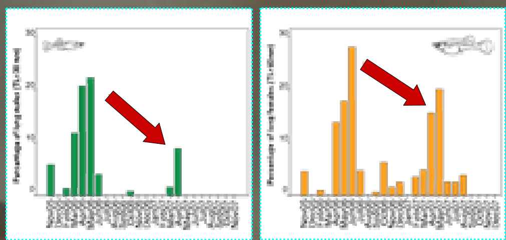


Figure 4. Relative abundance of long males (TL>30mm) and long females (TL>40mm) respect to the total CPUE of every month.

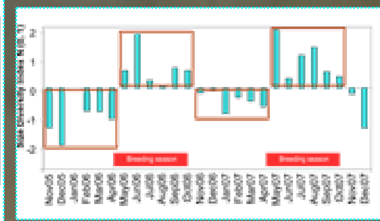
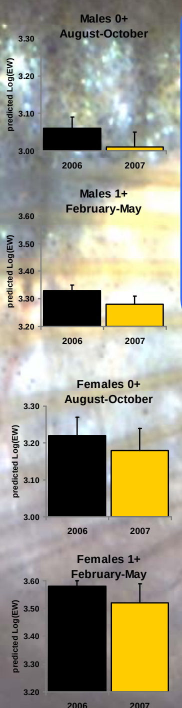


Figure 5. Normalized values of Size Diversity Index (DI) of the population along the study period.

Somatic Condition



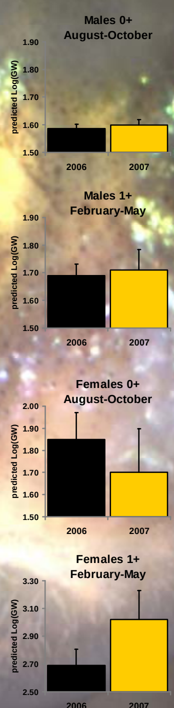
	EW-TL Relationships	R^2
2006	LogEW= -5.01+3.40LogTL	0.91
2007	LogEW= -4.95+3.38LogTL	0.97
	ANCOVA	
Slope	F(1,146)= 0.01; p= 0.909	
y-intercept	F(1,146)= 0.03; p= 0.861	
	ANOVA (predicted EW)	
2006	3.06±0.16 F = 3.33; p= 0.070	
2007	3.01±0.13	

	EW-TL Relationships	R^2
2006	LogEW= -5.19+3.43LogTL	0.94
2007	LogEW= -4.66+3.27LogTL	0.93
	ANCOVA	
Slope	F(1,223)= 2.04; p= 0.154	
y-intercept	F(1,223)= 234.8; p< 0.001	
	ANOVA (predicted EW)	
2006	3.33±0.13 F = 7.13; p= 0.008	
2007	3.28±0.14	

	EW-TL Relationships	R^2
2006	LogEW= -4.23+3.08LogTL	0.97
2007	LogEW= -4.31+3.11LogTL	0.99
	ANCOVA	
Slope	F(1,200)= 0.18; p= 0.676	
y-intercept	F(1,200)= 0.14; p= 0.712	
	ANOVA (predicted EW)	
2006	3.22±0.26 F = 1.26; p= 0.263	
2007	3.18±0.24	

	EW-TL Relationships	R^2
2006	LogEW= -4.52+3.18LogTL	0.98
2007	LogEW= -4.28+3.11LogTL	0.99
	ANCOVA	
Slope	F(1,271)= 2.68; p= 0.102	
y-intercept	F(1,271)= 393.9; p< 0.001	
	ANOVA (predicted EW)	
2006	3.58±0.19 F = 2.62; p= 0.107	
2007	3.52±0.36	

Gonad Activity



	GW-TL Relationships	R^2
2006	LogGW= -2.10+1.52LogTL	0.15
2007	LogGW= -2.91+1.91LogTL	0.14
	ANCOVA	
Slope	F(1,136)= 0.21; p= 0.647	
y-intercept	F(1,136)= 1.12; p= 0.291	
	ANOVA (predicted GW)	
2006	1.59±0.07 F = 0.85; p= 0.356	
2007	1.60±0.06	

	GW-TL Relationships	R^2
2006	LogGW= -8.21+4.13LogTL	0.56
2007	LogGW= -11.3+5.38LogTL	0.70
	ANCOVA	
Slope	F(1,122)= 0.17; p= 0.684	
y-intercept	F(1,122)= 100.7; p< 0.001	
	ANOVA (predicted GW)	
2006	1.69±0.21 F = 0.18; p= 0.671	
2007	1.71±0.20	

	GW-TL Relationships	R^2
2006	LogGW= -20.2+8.91LogTL	0.44
2007	LogGW= -16.7+7.63LogTL	0.38
	ANCOVA	
Slope	F(1,133)= 0.43; p= 0.513	
y-intercept	F(1,133)= 0.41; p= 0.521	
	ANOVA (predicted GW)	
2006	1.85±0.62 F = 1.55; p= 0.215	
2007	1.70±0.57	

	GW-TL Relationships	R^2
2006	LogGW= -27.4+11.6LogTL	0.78
2007	LogGW= -24.6+10.7LogTL	0.85
	ANCOVA	
Slope	F(1,244)= 2.02; p= 0.157	
y-intercept	F(1,244)= 26.49; p< 0.001	
	ANOVA (predicted values)	
2006	2.69±0.06 F = 8.12; p= 0.005	
2007	3.02±0.10	

- In both cycles, Size Diversity Index showed a similar pattern, although November-April values are significantly higher in 2007 (ANOVA p=0.01; SDI_{2006}=0.90, SDI_{2007}=1.35). SDIs during the breeding season (April-September) did not present significant differences (ANOVA p=0.46). Maxima values in the reproductive period are consequence of the presence of new born individuals, however, high values in the non-reproductive period of the second cycle could probably indicate significant variations in the size structure of the population (Fig 5).
- Temporal variation in somatic condition of M and F showed a similar pattern in both cycles (2006 and 2007).
- In both sexes, there were a tendency to reduce the condition status in the second cycle (2007). However, predicted values of EW in 0+ cohorts were not significantly different.
- During the post-winter period when condition values in 1+ cohorts are increasing, there were significant differences between cycles (2006 and 2007) in both the y-intercept of EW-TL relationships and in the predicted EW values. In M, the lower values of the predicted EW obtained in 2007 could be influenced by the lower occurrence of longest individuals (Fig 4).
- In both sexes, temporal variation in gonad activity showed a similar pattern. Y-intercept of GW-TL relationships and predicted values of GW in 0+ cohorts were not significantly different during its breeding period (August-October).
- During the maturation period and the first stage into the reproductive season when gonad activity in 1+ cohorts are highest, there were significant differences between cycles (2006 and 2007) in both the y-intercept of GW-TL and in the predicted GWs. F of 2007 (1+ cohort) showed higher reproductive effort than the same age-class in 2006 measured as a significant increment in the predicted GWs.
- Higher variation was observed in Sex-ratio during 2007. Moreover, just in the beginning of the breeding season (April-May), the second cycle (2007) showed lower proportion of F than in the same period of 2006 (X^2 p=0.025).
- During the first part of the recruitment period (May-July) in 2007, new-born ratio in relation to adults was significantly higher than in 2006 (X^2 p<0.001), but not at the end of this period (August-November, X^2 p=0.490) probably as a result to the extraction control.