



**Universidad Michoacana de San Nicolás de  
Hidalgo**  
**Conservation of Goodeids and Co-Occurring  
Fishes in Central Mexico**



**“Reproductive ecology of native Goodeids and  
introduced livebearers at the Teuchitlán Springs”**

**Speaker:**

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Ictiología y Conservación.  
Laboratorio de Biología acuática UMNSH.

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# Introduction

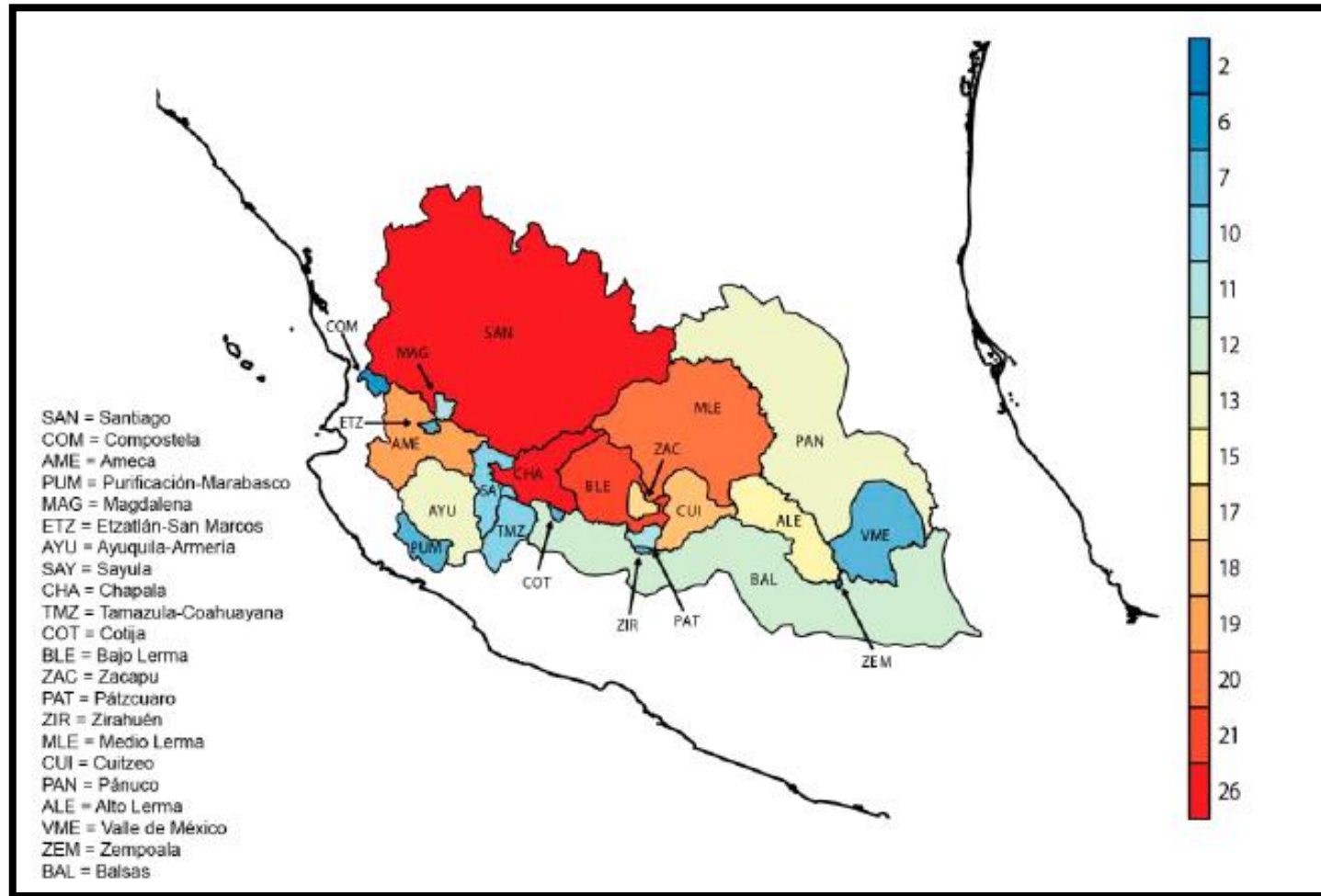


Fig. 1. Map of the distribution of Goodeids  
Taken by García-Andrade, 2017.

One of the most  
important is the  
Goodeidae.

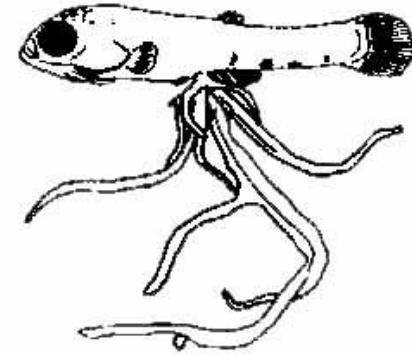
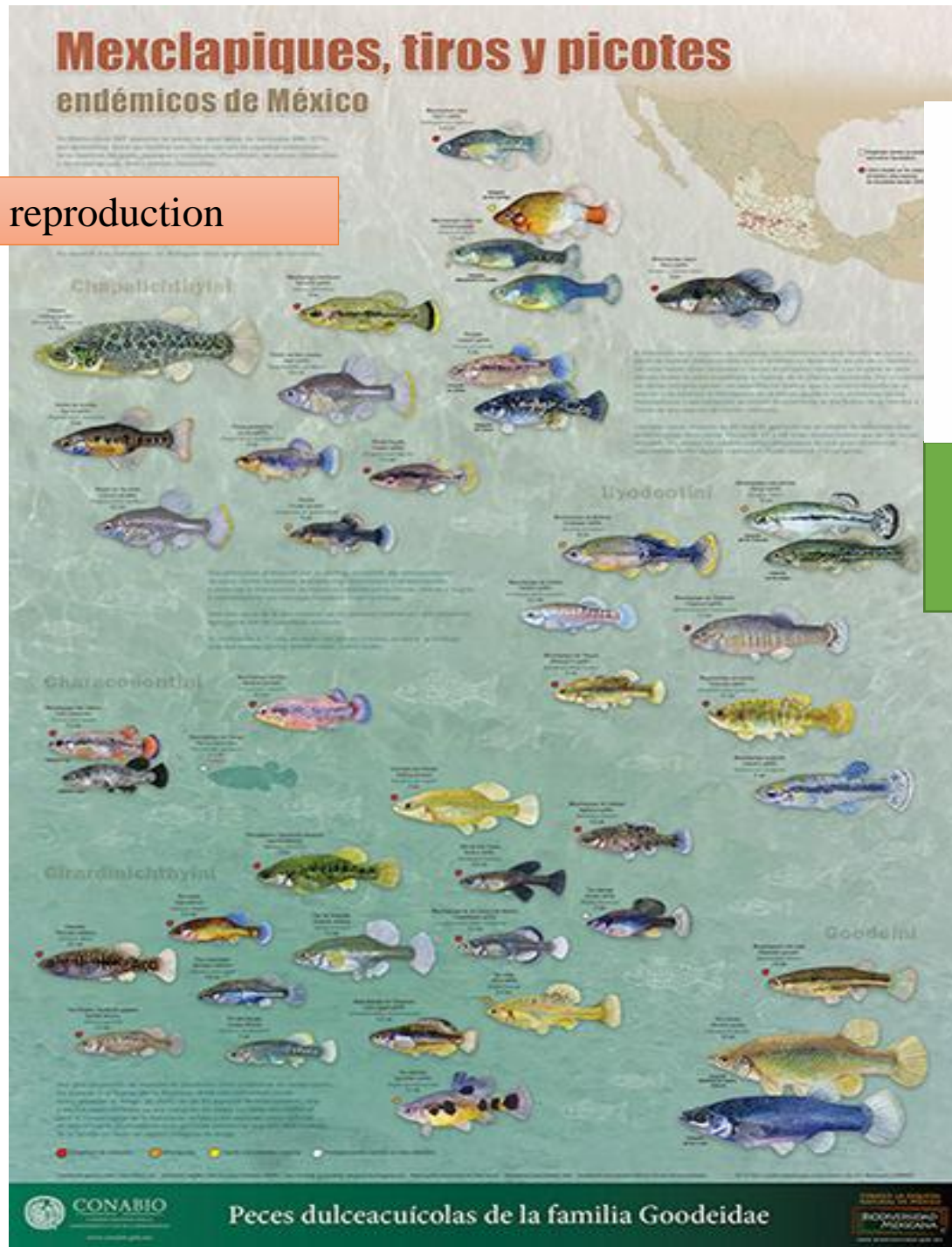
Endemic species in  
Central of México.

Most of them are  
livebearers

42 species.

# Mexclapiques, tiros y picotes endémicos de México

Exclusive reproduction



Trophothenia  
Nutrition  
absorption



## However...

Most of the species of Goodeid are in any category in the IUCN  
Damage or critically endangered!!  
Some of them are considered extinct in their natural habitat,  
like *Skiffia franceses* and *Zoogoneticus tequila*.

Lost of diversity of  
species are principal to:

Water  
exploitation



Introduction of  
exotic species



Polluted water



Anthropogenic  
activities



# Native and endemic species from Teuchitlán



*Goodea atripinnis*



*Ameca splendens*



*Zoogoneticus purhepechus*

Anthropic  
activities.

What has  
produced a  
decrease in native  
fish.



Spring

Historical report of 20  
native species (López-  
López y Paulo-Maya,  
2001).



# Exotic species



*Poecilia sphenops*

*P. sphenops* has been reported since 1996

*P. bimaculatus* in 2015

(López-López and Paulo-Maya, 2001; Mar-Silva, 2018).



*Pseudoxiphophorus bimaculatus*



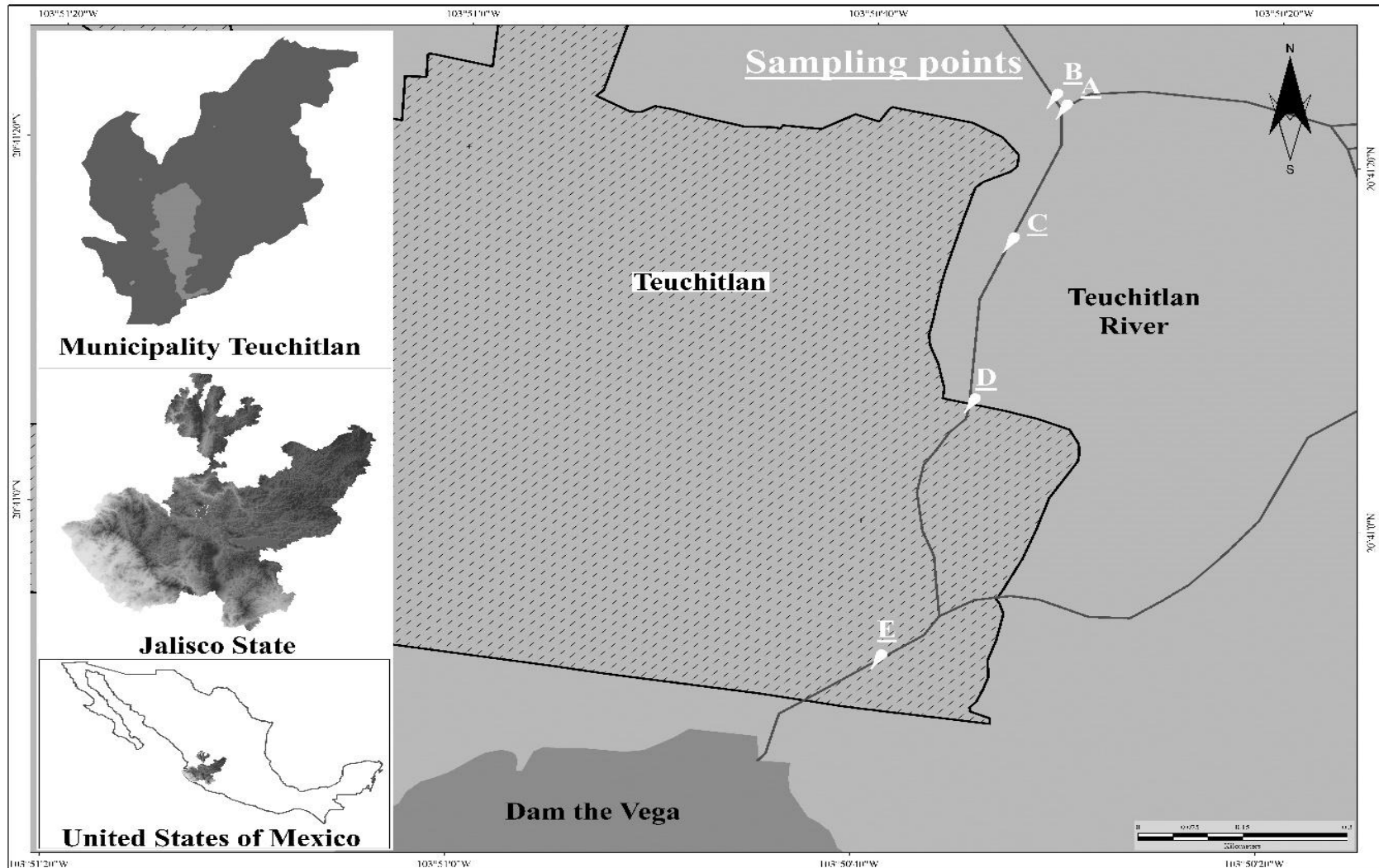
There is a lacking of studies about reproduction of this particular species in this place.

# Objective:

The aim of this study was to investigate the reproductive biology of the invasive species (*Poecilia sphenops*, *Pseudoxiphophorus bimaculatus*) and the native (*Goodea atripinnis*, *Ameca splendens*, *Zoogoneticus purhepechus*) and to describe the annual variation in their reproduction relative to environmental conditions in the Teuchitlán River.



# Materials and methods



Samples sites (A, B, C, D y E) in the Teuchitlán River.



## Sampling sites from Teuchitlán River





Fish collected by net  
(chinchorro) and  
electroshock



Fish were preserved in formaldehyde.

In the laboratory fish were identify, measure,  
counted following the criteria of Gomez-  
Marquez *et al.*, (1999).



# Statistic analysis

## Variables

Fertility  
(Schoenherr, 1997)

Sex ratio and first maturity  
size  
(Sparre y Venema 1997).

Gonadal stages.

Gonadosomatic index  
(Vargas and Sostoa, 1996).

Size structure  
(Sturges, 1926).



For Poeciliids  
(Contreras-MacBeath and  
Ramírez-Espinoza 1996)

For Goodeids  
(Ramírez-Herrejón *et al.*, 2007)





# Variables

Fulton factor

Growth rates (Froese, 2006).

Multivariate analysis (Oksabe *et al.*, 2015).



# Results and discussion



# Chapter 1

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### ORIGINAL ARTICLE

WILEY   

## Reproductive biology of the invasive species *Pseudoxiphophorus bimaculatus* and *Poecilia sphenops* in the Teuchitlán River, México

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#### Summary

Reproductive biology of invasive species is not often studied relative to the invasion process, although it may provide an accurate indicator of the invasion stage. We evaluated the reproductive biology of the exotic fish species *Pseudoxiphophorus bimaculatus* and *Poecilia sphenops* in the Teuchitlán River, Jalisco, Mexico by fertility, size at first maturity, sex ratio, gonad maturity stage, gonadosomatic index, condition factor, size-structure, and habitat. The reproductive variables were related to environmental characteristics using the non-metric analysis of multidimensional scaling. A total of 1374 specimens of *P. bimaculatus* and 571 of *P. sphenops* were captured by seine net-



# Chapter 2

## Submitted on Acta Ichthyologica Et Piscatoria



### Reproductive biology of three native livebearer fish species in the Teuchitlán River, Mexico

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**Type:**

Full paper

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**Keywords:**

Goodeids, Livebearers, Reproductive habitat, Teuchitlán River

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**Summary:****Background**

The Ameca basin in central Mexico, especially the Teuchitlán River, hosts a rich native and endemic ichthyofauna; however, these species have not been studied, and their habitat has been transformed by anthropogenic activities. The aim of this study was to comprehensively evaluate the reproductive cycle of three native goodeids, and to describe the annual variation in the reproduction of each species, as well as their associations with habitat characteristics in the Teuchitlán River, Mexico. The results of this study have important conservation implications and can be used to support specific conservation actions to maintain biological diversity in the Teuchitlán River.

2029 individuals of exotic species  
894 individuals of native species



*Ameca splendens*

Lower abundance of native  
species downstream



*Zoogoneticus purhepechus*



Site D



Site E

# Fertility (embryos per female)

## Exotic species



*P. sphenops*  
 $30 \pm 32.51$



*P.*  
*bimaculatus*  
 $16 \pm 2.27$

## Native species

*A. splendens*  
 $7 \pm 3.25$



*Z.*  
*purhepechus*  
 $8 \pm 3.17$



*G. atripinnis*  
 $9 \pm 2.47$





# Sex ratio

Native species

Exotic species

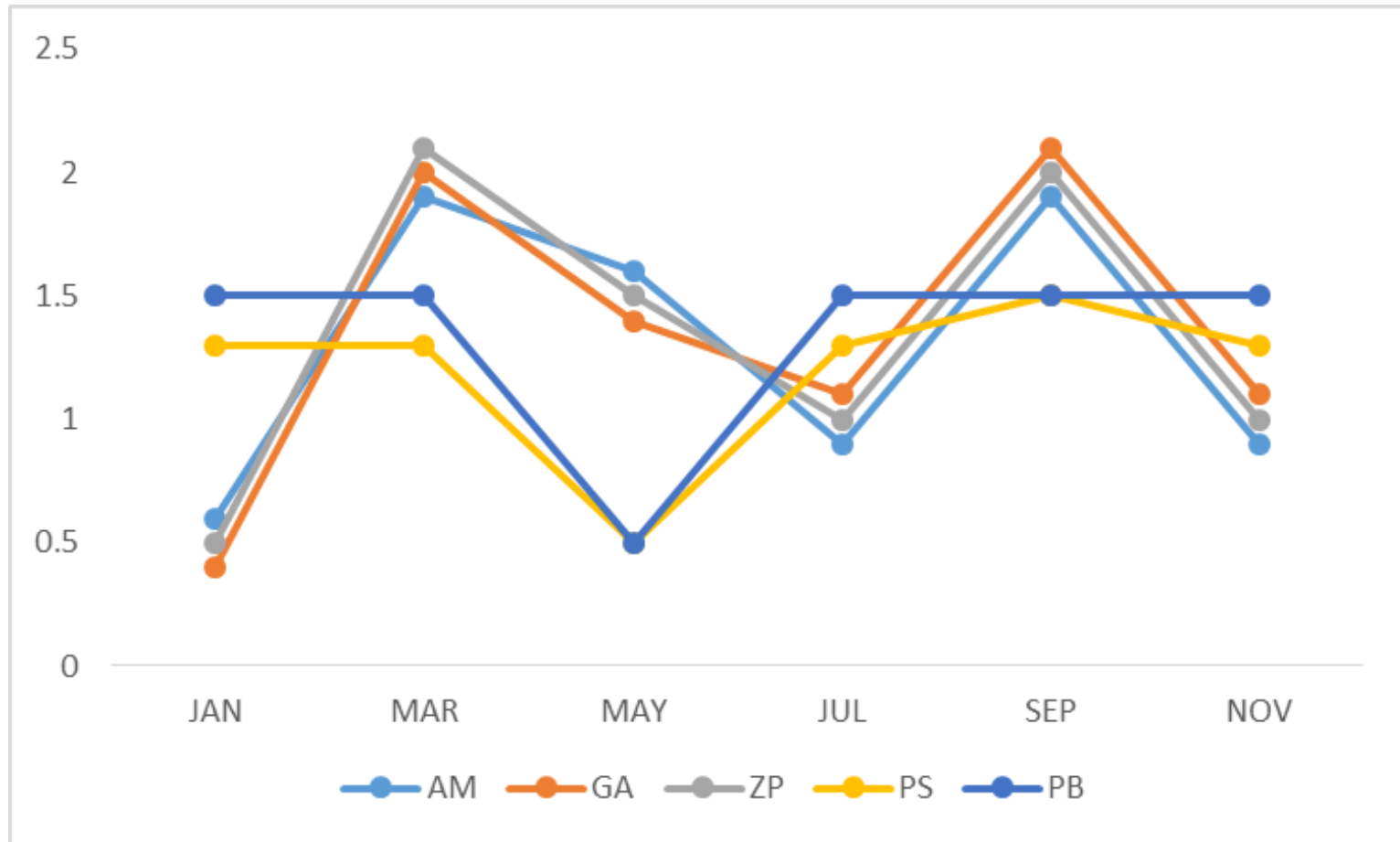
In the springs 1:1  
(Females: males)



Along the river  
More females than  
males.

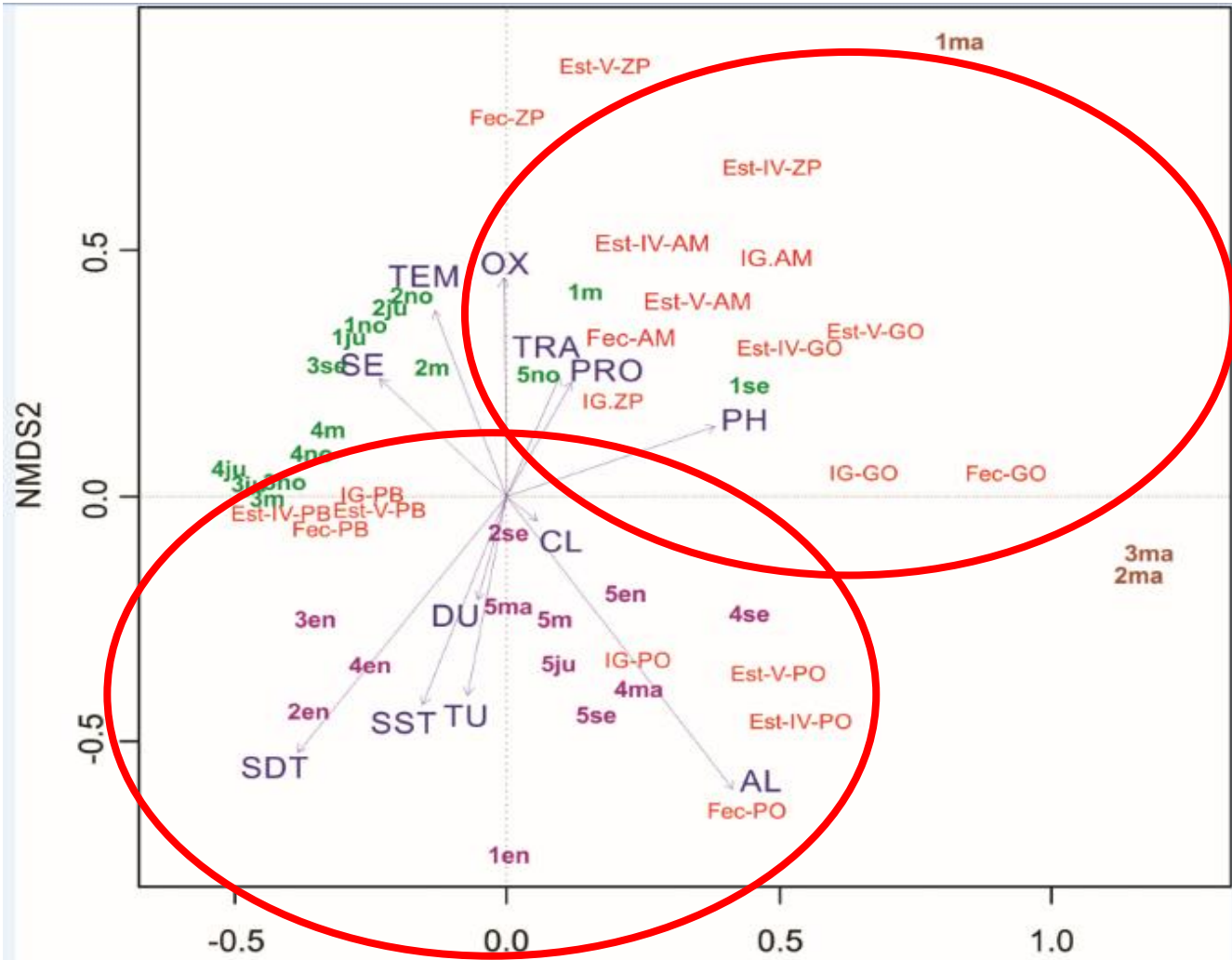
More females than  
males along the  
river and the  
springs.

# Reproductive period



Bimonthly variation in the gonadosomatic index (GSI) for *G. atripinnis* (GA), *A. splendens* (AM), *Z. purhepechus* (ZP), *P. sphenops* (PS) and *P. bimaculatus* (PB) in Teuchitlán River.

## Multivariate analysis

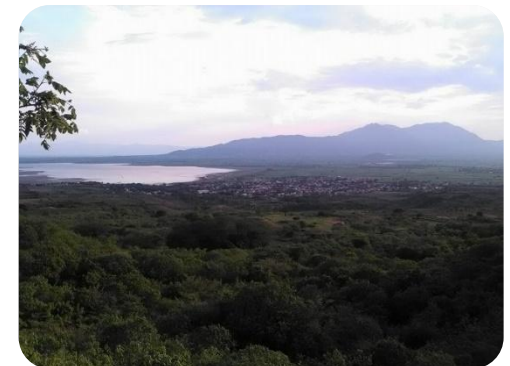


Non-metric analysis of multidimensional scaling (NMDS) for *P. bimaculatus* (PB), *P. sphenops* (PO), *G. atripinnis* (GO), *A. splendens* (AM) and *Z. purhepechus* (ZP) from the Teuchitlán River. Sites (1, 2, 3, 4, 5), months (en = January, ma = March, m = May, ju = July, se = September, no = November). Reproductive variables (, IV and V = Mature fish, IG = gonadosomatic index, FEC = fertility). Physical and chemical water characteristic and attributes of visual based habitat assessment for each study site (OX = dissolved oxygen, Al = total alkalinity, Cl = Chlorophyll a, DU = total hardness, pH = pH, TU = turbidity, SE = sedimentation, PRO = depth, TRA = transparency, TEM = water temperature, SST = suspended solids, SDT = total dissolved solids).



# Conclusion

- *Goodea atripinnis* is widely distributed along the river, showing a complete structure of sizes.
- The endemic species (*A. splendens*, *Z. purhepechus*) show lower abundance downstream.
- Native species presented two reproductive periods, May and the second September.
- Exotic species showed continues reproductive peaks through the year.
- Sex ratio is 1:1 (female: male) upstream for native species, females predominated among *P. bimaculatus* and *P. sphenops*.
- Fertility in native species is lower compared with exotic species.
- NMDS showed that native species are found associated with clean, deeper waters, more dissolved oxygen in water, and a neutral pH.
- Exotic species related with polluted sites with more solids dissolved on water, more turbid and more alkaline.





Thanks!!



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Project “Reintroducción de *Zoogoneticus tequila* al río Teuchitlán y sus manantiales”





Thanks team Teuchitlán!!





Thanks for you attention!!

Questions??

