

The loss of Goodeids and other fish populations

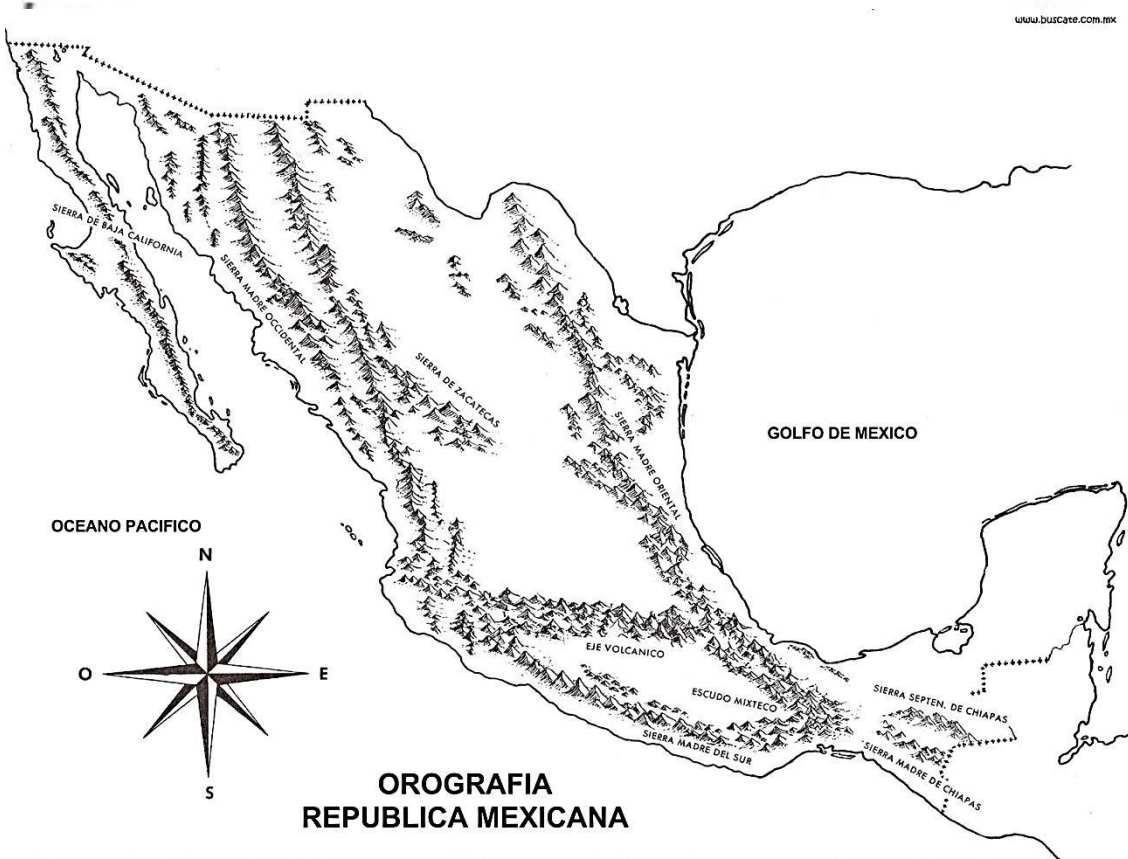


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Central Mexico

60% North American freshwater fishes (384 spp)



NEARTIC

Ictaluridae and Cyprinidae



NEOTROPICAL

Poeciliidae and Cichlidae



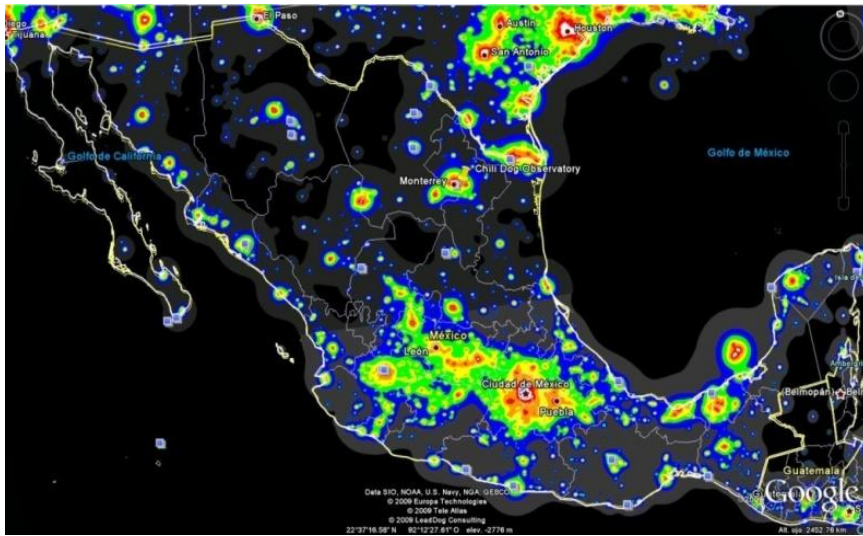
AUTOCHTONOUS

Atherinopsidae and Goodeidae

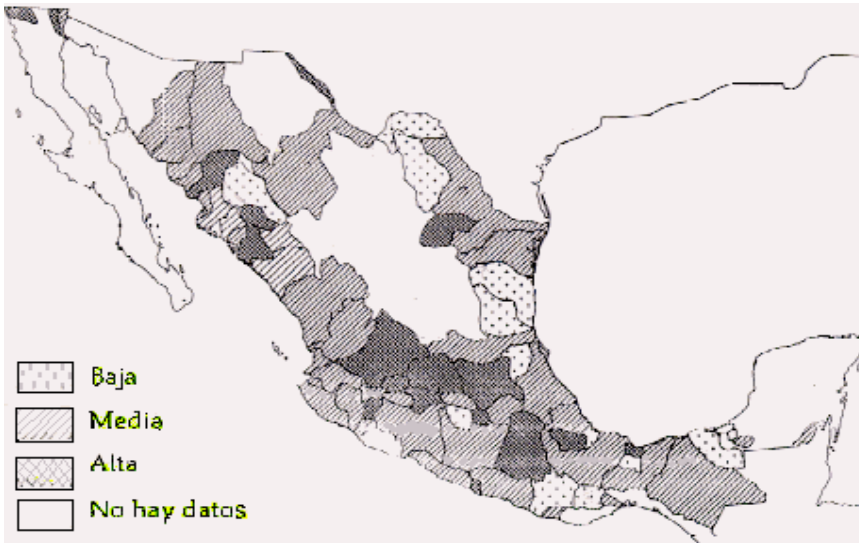
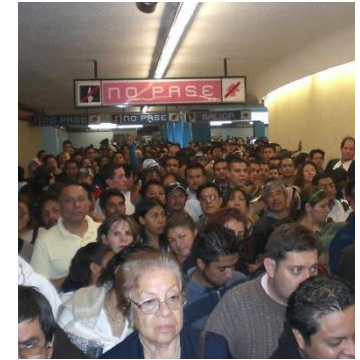


100 native species - 80% endemic

Anthropogenic activity



112.3 million of habitants
70% inhabits in Central Mexico



67% of the industry of the country



20% of the superficial water

Fuente: Comisión Nacional del Agua. "Estrategias del Manejo de Agua en México".

Agriculture and cattle raising



Pollution



Exotic species



Cultural, economical and social value

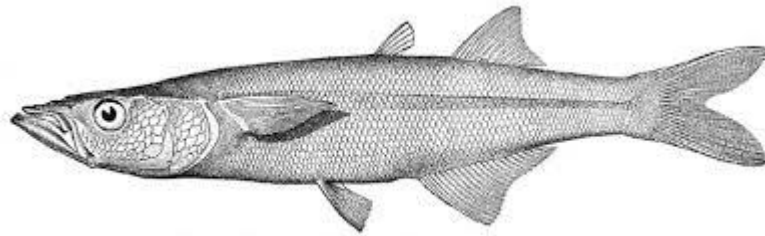


FIG. 15.—*Chirocentrus diázi* Jordan & Snyder, nov. species. Type.



Goodeids

- Endemicity
- Viviparity
- Matrotrophy



Species at risk

Deacon *et al.*, 1979

123 native species need protection because of their rareness

Espinoza *et al.*, 1993

31% of the fishes in Mexico are at risk, danger of extinction or extinct

SEMARNAT-059. List of flora and fauna included in a risk category

DOF 1994- **140 spp**

DOF 2001- **185 spp**

DOF 2010- **204 spp**

Contreras-Balderas *et al.* (2003).

Out of 506 mexican species:

169 at risk

25 extinct

BASES DE DATOS

Base de datos de la Universidad Michoacana de San Nicolás de Hidalgo

Base de datos de la Universidad de Michigan

Base de datos del Dr. John Lyons

Base de datos del Dr. Mathew Helmus

Base de datos del Dr. Norman Mercado Silva

- 110 native species
- 37 exotic species
- 88 endemic to Central México

Changes in distribution

Previous registers (1900-1998)

Actual registers (1999-2009)

Local extinction:

When a species did not show actual registers in one or more than one sampled sites of each region.

Regional extinction:

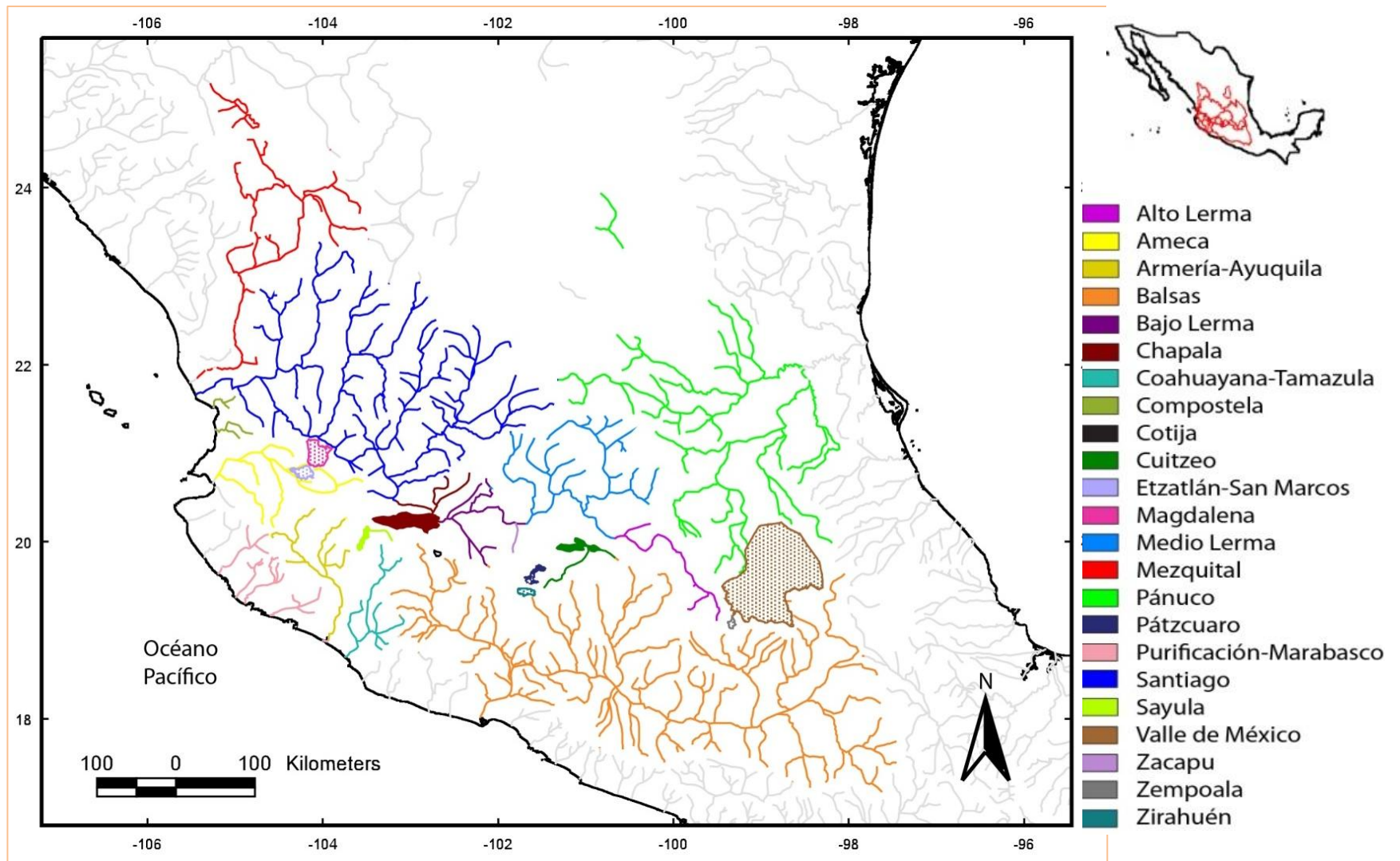
When one of the locally extinct species inhabits another locality in the region.

Permanence rate $PR = \frac{AR}{PR}$

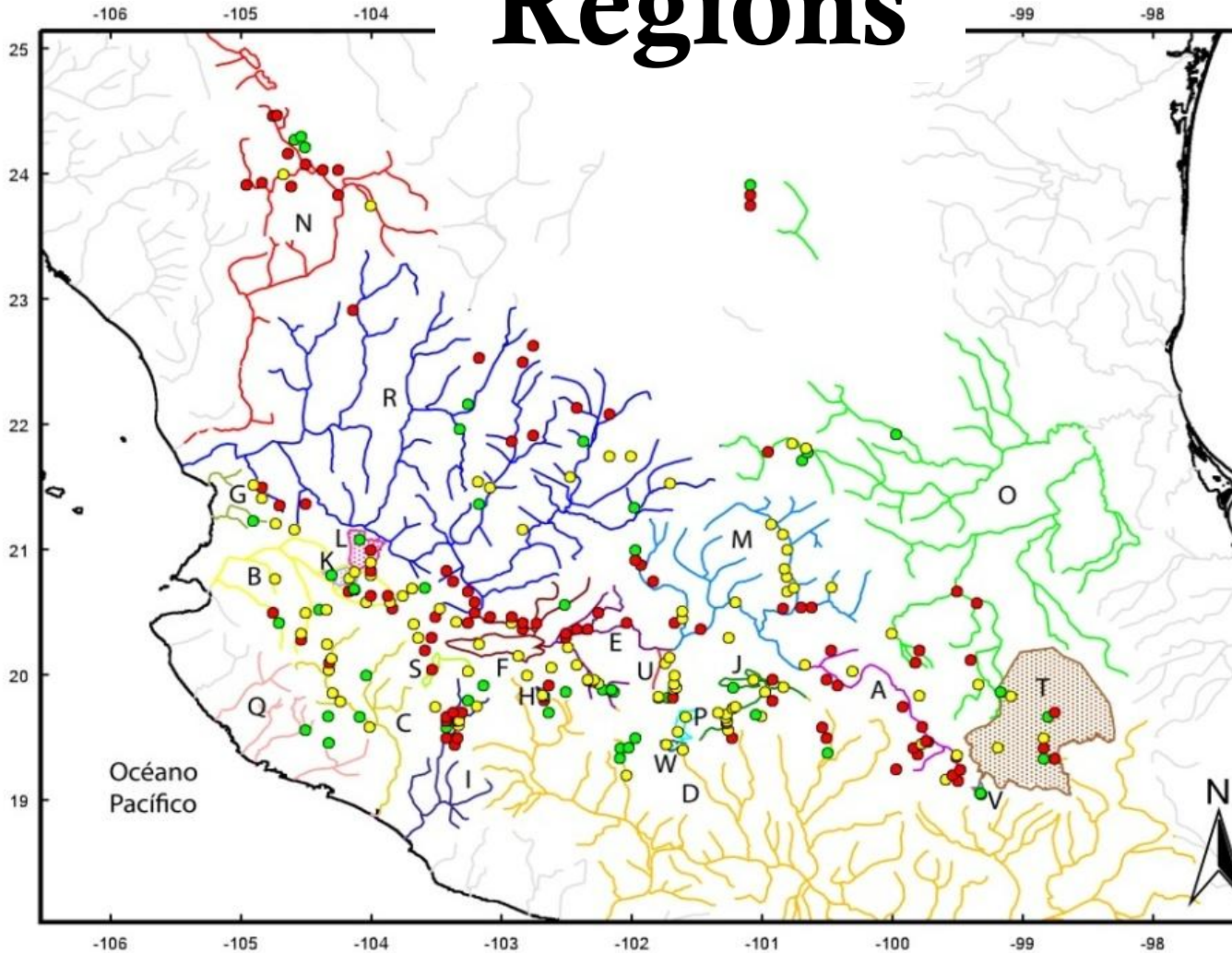
where:

AR sites with actual registers

PR sites with previous registers



Regions



- 54
- 114
- 118

81.12% of the sites have lost at least one specie

74 local extinctions

100 0 100 Kilometros

- Sites where all the species showed actual registers
- Sites where at least one species did not show actual registers
- Sites where the species did not show actual registers

Diversidad ictiológica de especies nativas y especies exóticas históricamente registrada en cada región del centro de México.

Región	S Especies nativas	S Especies exóticas	S total de especies
Santiago	22	18	40
Chapala	25	10	35
Cuitzeo	17	16	33
Ameca	18	11	29
Bajo Lerma	19	10	29
Medio Lerma	19	10	29
Pánuco	19	9	28
Zacapu	16	12	28
Armería-Ayuquila	17	9	26
Balsas	16	10	26
Mezquital	14	10	24
Sayula	15	5	20
Cotija	9	8	17
Pátzcuaro	10	6	16
Alto Lerma	10	5	15
Compostela	8	6	14
Valle de México	6	7	13
Coahuayana-Tamazula	9	3	12
Etzatlán-San Marcos	7	4	11
Zirahuén	7	4	11
Magdalena	8	1	9
Purificación-Marabasco	8	1	9
Zempoala	2	3	5
Total de especies	110	37	147

(S) Riqueza específica, que indica la diversidad Alfa de cada región.

Endemic species of each region of Central Mexico

Cuenca	Endemic species
Chapala	7 <i>Algarsea popoche</i> , <i>Chirostoma chapalae</i> , <i>Chirostoma contrerasi</i> , <i>Chirostoma labarcae</i> , <i>Chirostoma promelas</i> , <i>Chirostoma sphyraena</i> , <i>Yuriria chapalae</i>
Pánuco	7 <i>Ataenobius toweri</i> , <i>Dionda dichroma</i> , <i>Herichthys bartoni</i> , <i>Herichthys cyanoguttatus</i> , <i>Herichthys labridens</i> , <i>Ictalurus mexicanus</i> , <i>Xenophorus captivus</i> .
Mezquital	<i>Characodon audax</i> , <i>Characodon lateralis</i> , <i>Chirostoma mezquital</i> , <i>Cyprinodon meeki</i> , <i>Notropis aulidion</i>
Ameca	<i>Allodontichthys polylepis</i> , <i>Allotoca goslinei</i> , <i>Notropis amecae</i> , <i>Yuriria amatlana</i> , <i>Zoogoneticus tequila</i>
Pátzcuaro	<i>Algarsea lacustris</i> , <i>Allotoca diazi</i> , <i>Chirostoma grandocule</i> , <i>Chirostoma patzcuaro</i>
Alto Lerma	<i>Algarsea barbata</i> , <i>Chirostoma riojai</i> , <i>Notropis marhabatiensis</i>
Balsas	<i>Allotoca catarinae</i> , <i>Chapalichthys pardalis</i> , <i>Ictalurus balsanus</i>
Purificación-Marabasco	<i>Poecilia chica</i> , <i>Poecilia turneri</i> , <i>Xenotaenia resolanae</i>
Coahuayana-Tamazula	<i>Allodontichthys tamazulae</i> , <i>Allodontichthys hubbsi</i>
Santiago	<i>Algarsea monticola</i> , <i>Poeciliopsis prolifica</i>
Zacapu	<i>Allotoca zacapuensis</i> , <i>Notropis grandis</i>
Armería-Ayuquila	<i>Allodontichthys zonistius</i>
Cotija	<i>Chapalichthys peraticus</i>
Cuitzeo	<i>Chirostoma charari</i>
Medio Lerma	<i>Chirostoma bartoni</i>
Valle de México	<i>Evarra bustamantei</i>
Zirahuén	<i>Allotoca meeki</i>
Bajo Lerma	-
Compostela	-
Etzatlán-San Marcos	-
Magdalena	-
Sayula	-
Zempoala	-

Species with local and regional extinctions in the different discrete regions

BASIN	EXTINCT SPECIES
Chapala	Algansea popoche , <i>Algansea tincella</i> , <i>Chiostoma arge</i> , <i>Chiostoma humboldtianum</i> , <i>Lampetra spadicea</i> , <i>Notropis calientis</i> , <i>Skiffia multipunctata</i> , * <i>Yuriria chapalae</i>
Medio Lerma	<i>Allotoca dugesii</i> , <i>Azteculla sallaei</i> , <i>Chiostoma aculeatum</i> , <i>Chiostoma bartoni</i> , <i>Hubbsina turneri</i> , <i>Ictalurus dugesii</i> , * <i>Notropis calientis</i> , * <i>Scartomyzon austrinum</i>
Sayula	Algansea aphaea , <i>Algansea tincella</i> , <i>Alloophorus robustus</i> , <i>Notropis calientis</i> , <i>Poecilia butleri</i> , * <i>Skiffia francesae</i> , <i>Skiffia multipunctata</i> , * <i>Zoogoneticus purepechus</i>
Balsas	* <i>Algansea tincella</i> , <i>Chiostoma melanococcus</i> , <i>Girardinichthys multiradiatus</i> , * <i>Ictalurus balsanus</i> , * <i>Sicydium multipunctatum</i>
Bajo Lerma	<i>Chiostoma arge</i> , <i>Chiostoma jordani</i> , <i>Chiostoma lucius</i> , <i>Notropis calientis</i> , <i>Xenotoca variata</i>
Mezquital	* <i>Characodon lateralis</i> , * <i>Codoma ornata</i> , * <i>Dionda episcopa</i> , EXTINT , * <i>Scartomyzon austrinum</i>
Santiago	<i>Allotoca dugesii</i> , <i>Chiostoma arge</i> , <i>Chiostoma humboldtianum</i> , * <i>Gobiesox fluviatilis</i> , <i>Zoogoneticus purepechus</i>
Alto Lerma	Algansea barbata , <i>Algansea tincella</i> , <i>Notropis marhabatiensis</i> , <i>Yuriria alta</i>
Ameca	* <i>Algansea amecae</i> , * <i>Notropis amecae</i> , <i>Skiffia francesae</i> , * <i>Zoogoneticus tequila</i>
Pánuco	* <i>Azteculla sallaei</i> , * <i>Poeciliopsis infans</i> , <i>Girardinichthys multiradiatus</i> , <i>Girardinichthys viviparus</i>
Armería-Ayuquila	* <i>Algansea aphaea</i> , * <i>Poeciliopsis infans</i> , <i>Zoogoneticus purepechus</i>
Valle de México	<i>Algansea tincella</i> , <i>Azteculla sallaei</i> , EXTINT , * <i>Epiplatys spilargenteus</i>
Zirahuén	* <i>Alloophorus robustus</i> , <i>Allotoca dugesii</i> , <i>Skiffia lermiae</i>
Cuitzeo	<i>Chiostoma charari</i> , <i>Hubbsina turneri</i>
Etzatlán-San Marcos	<i>Algansea amecae</i> , <i>Scartomyzon austrinum</i>
Compostela	<i>Goodea atripinnis</i>
Pátzcuaro	<i>Chiostoma patzcuaro</i>
Purificación-Marabasco	-
Zacapu	-
Zempoala	-

A. popoche*, *A. barbata*, *Chiostoma bartoni*, *C. charari*, *C. patzcuaro*, *N. marhabatiensis

52 regional extinctions
6 endemic species could be extinct

Especies extintas regionalmente; * especies extintas localmente, cuentan con registros en localidades no contempladas en este estudio. Las especies endémicas se muestran en color rojo.

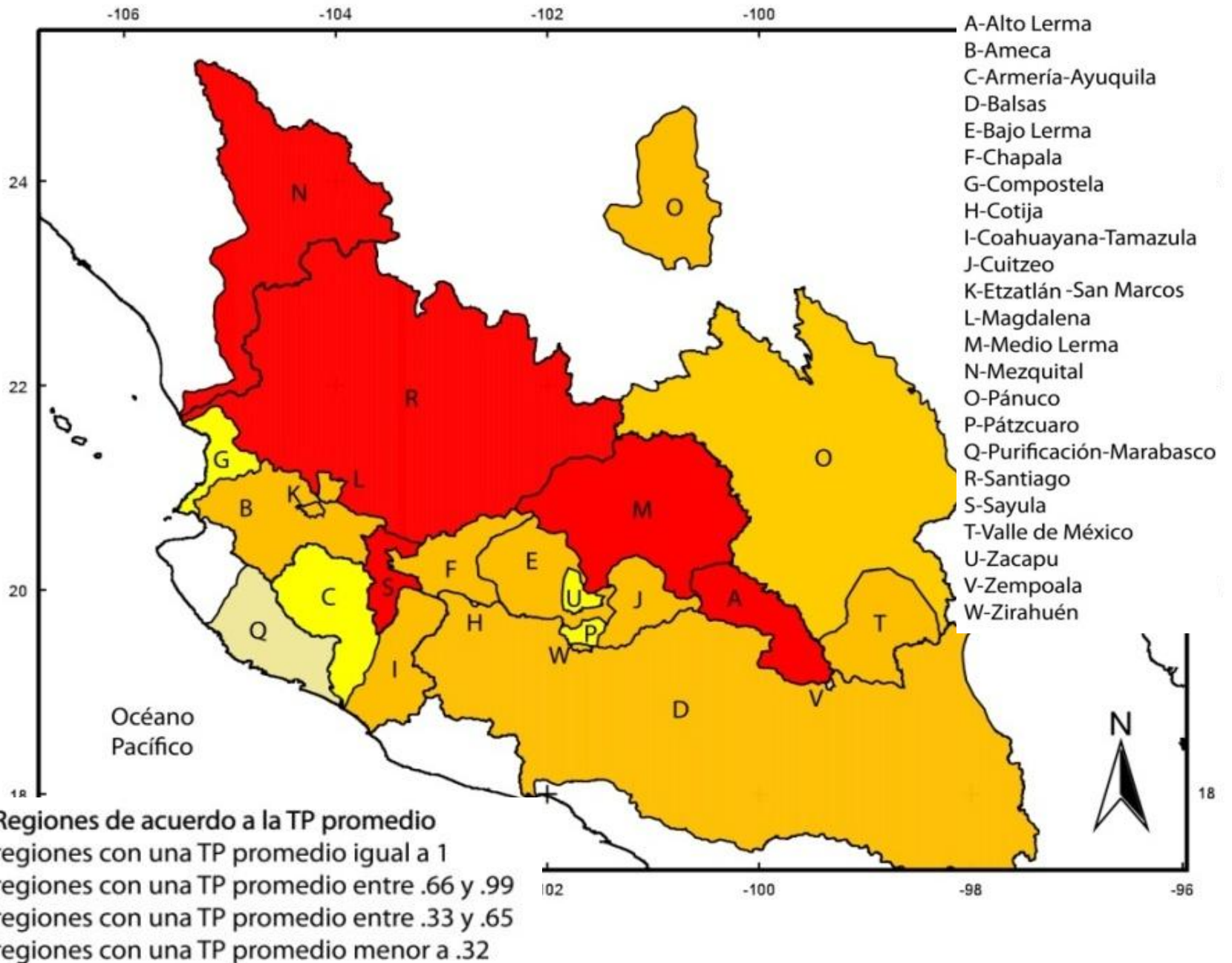
Permanence rate

PR mean by regions= 0.52

Clasificación de the 23 regions of central Mexico by their permanence rate (PR) of the species.

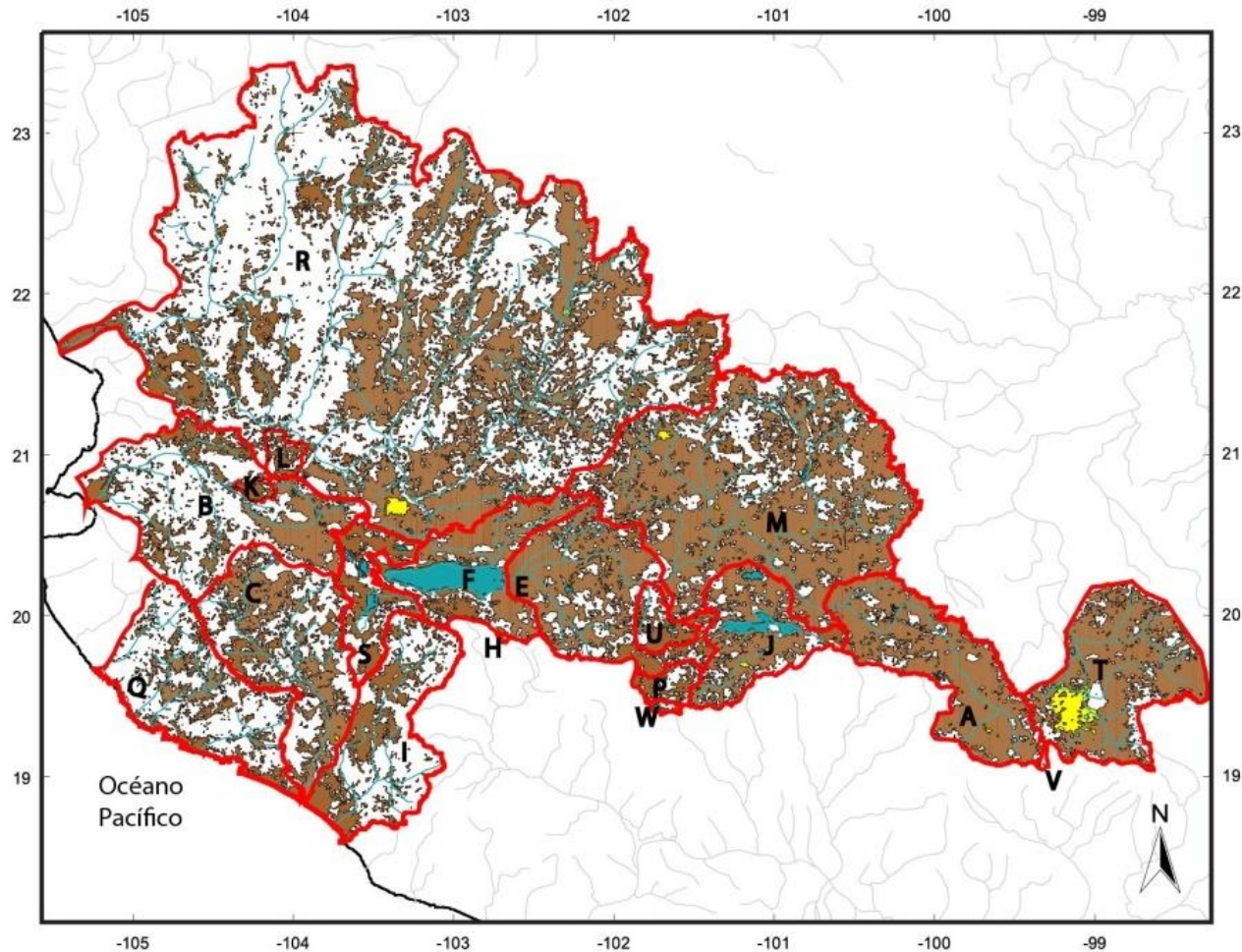
Grupo	Región (TP promedio)
1	Mezquital (0.21); Alto Lerma (0.24); Santiago (0.25); Medio Lerma (0.29); Sayula (0.3)
2	Ameca (0.33); Bajo Lerma (0.33); Chapala (0.33); Zirahuén (0.36); Valle de México (0.39); Pánuco (0.4); Magdalena (0.42); Cuitzeo (0.44); Coahuayana-Tamazula (0.49); Balsas (0.54); Etzatlán-San Marcos (0.62).
3	Armería-Ayuquila (0.69); Compostela (0.75); Zacapu (0.85); Cotija (0.89); Pátzcuaro (0.9); Purificación-Marabasco (1); Zempoala (1).

1= PR lower than 33%; 2= regions with a PR 33% and 66%; 3= regions with a TP higher than 66%.



Effects of the anthropogenic land

Anthropogenic land: Important cities, agricultural land and cattle raising land



Área superficial de las regiones de estudio, área de suelo con uso antropogénico y su correspondiente porcentaje, especies extintas y la Tasa de permanencia promedio de cada región.

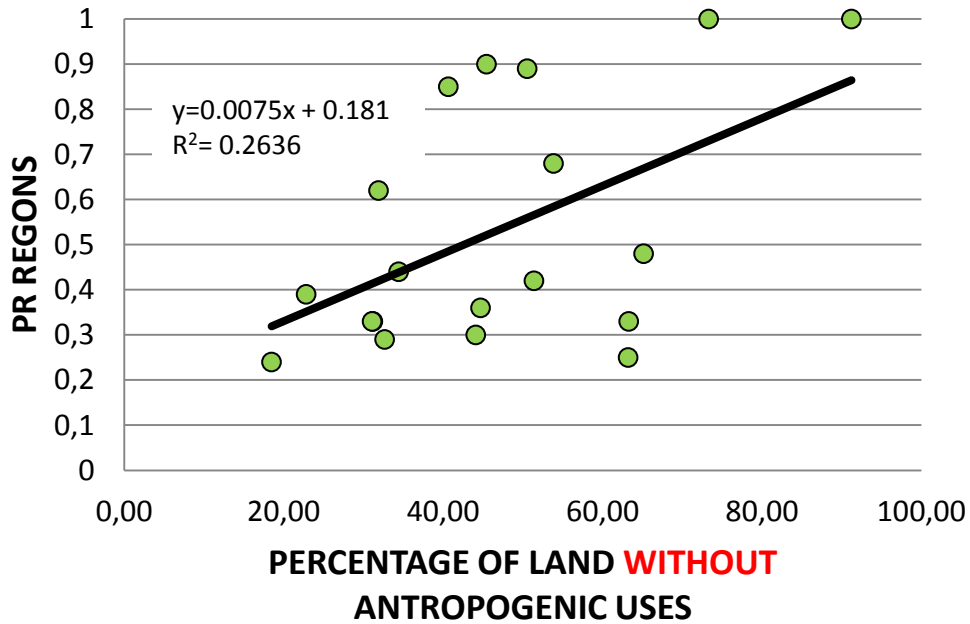
Región	Área superficial ha	Ciudades importantes, manejo agrícola, forestal y pecuario (plantaciones) ha	Porcentaje de suelo con usos antropogénicos	Especies extintas	TP promedio
Alto Lerma	70.3960	57.4010	81.5401	4	0.24
Valle de México	79.4190	61.3090	77.1969	3	0.39
Chapala	43.5470	30.0120	68.9186	7	0.33
Bajo Lerma	72.1280	49.6440	68.8276	5	0.33
Etzatlán-San Marcos	2.2360	1.5230	68.1127	2	0.62
Medio Lerma	212.5670	143.1610	67.3486	6	0.29
Cuitzeo	41.7500	27.3840	65.5904	2	0.44
Zacapu	9.5200	5.6510	59.3592	0	0.85
Sayula	27.9240	15.6140	55.9161	6	0.30
Zirahuén	1.1100	0.6140	55.3153	3	0.36
Pátzcuaro	7.6030	4.1490	54.5706	1	0.90
Cotija	0.2810	0.1390	49.4662	1	0.89
Magdalena	5.5250	2.6860	48.6154	1	0.42
Armería-Ayuquila	85.0590	39.2640	46.1609	1	0.68
Santiago	658.5730	242.3660	36.8017	4	0.25
Ameca	104.6930	38.4490	36.7255	1	0.33
Coahuayana-Tamazula	67.7320	23.6110	34.8594	0	0.48
Purificación-Marabasco	77.1680	20.6020	26.6976	0	1.00
Zempoala	0.5800	0.0510	8.7931	0	1.00



Percentage of land **without**
anthropogenic uses



PR per region



**POSITIVE CORRELATION OF
51.3%**

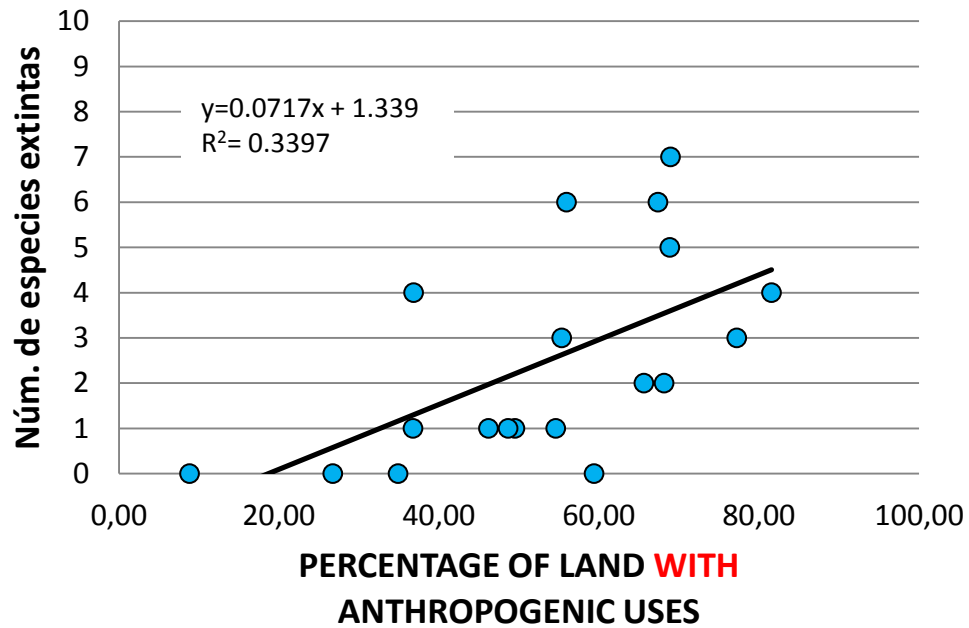




Percentage of land **with**
anthropogenic uses



> Extinct species

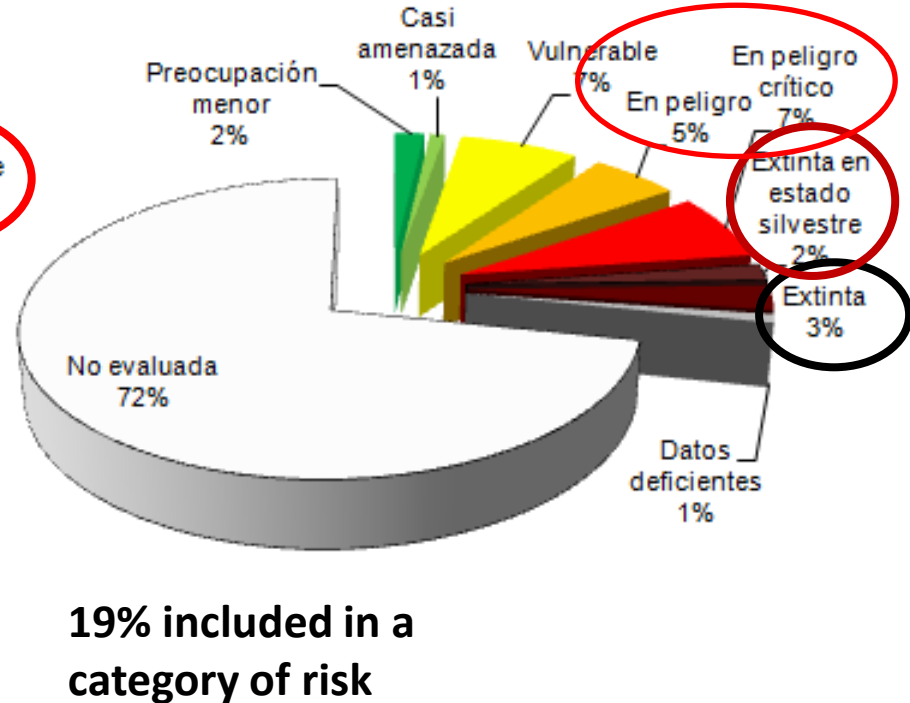
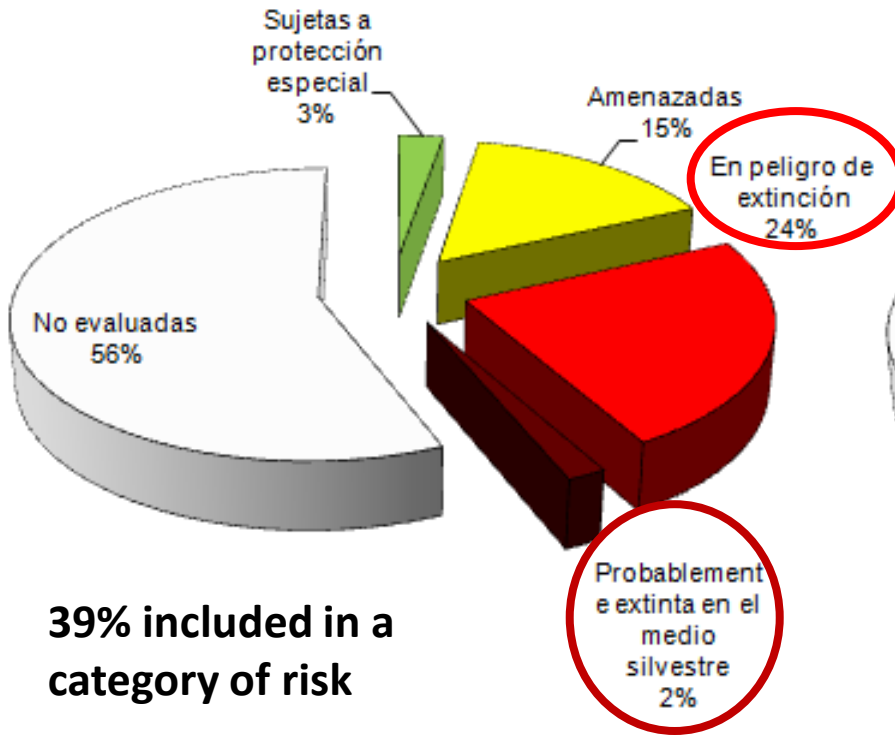


**POSITIVE CORRELATION OF
58.2%**



Species

Conservation status of native species



NOM-059-SEMARNAT-2010

IUCN

Permanence rate

23 (21.5%) species showed a PR of 0

22- PR= 0 < 33%

26-PR= 34-65%

15-PR=66-99%

21 (19.63%) species did not disappear from any site with previous registers

General permanence rate of 0.47%

G. conspersa

Regional 0

Local 93%

A. sallaei

Regional 33%

Local 90%

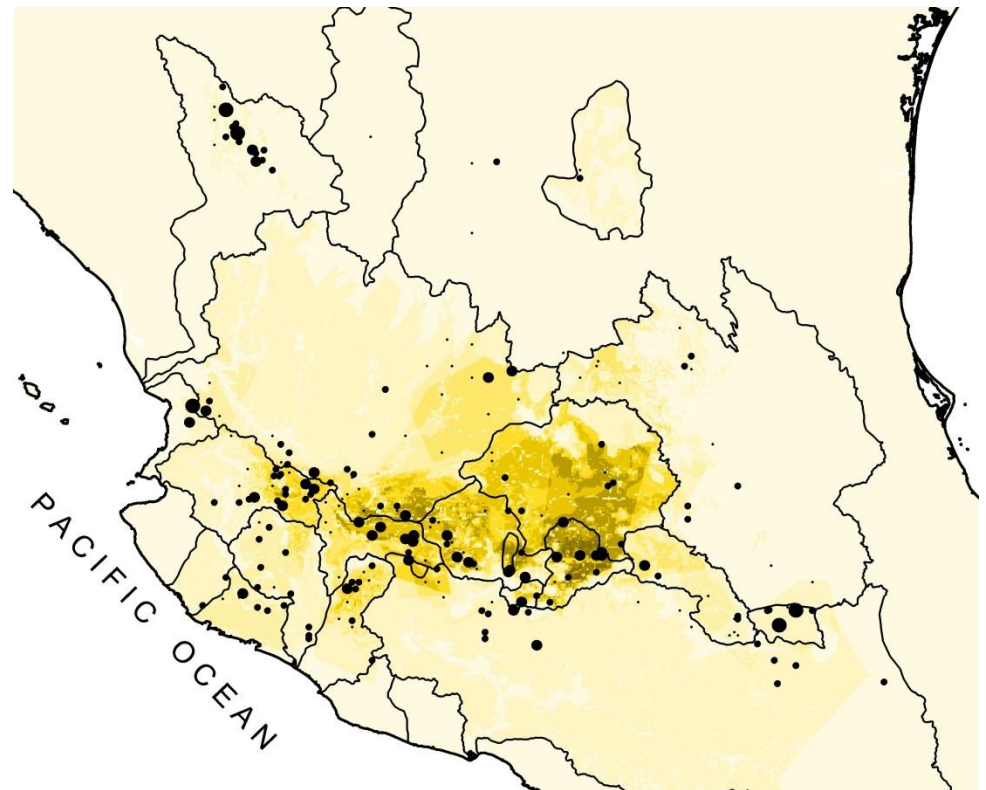
A. dugesii

Regional 60%

Local 78%



What's happening with the Goodeids?



Domínguez-Domínguez *et al.*, 2008

PR=1

Allotoca catarinae

9



PR>0.50

Allodontichthys zonistius

7



PR<0.50

Characodon audax

16



PR=0

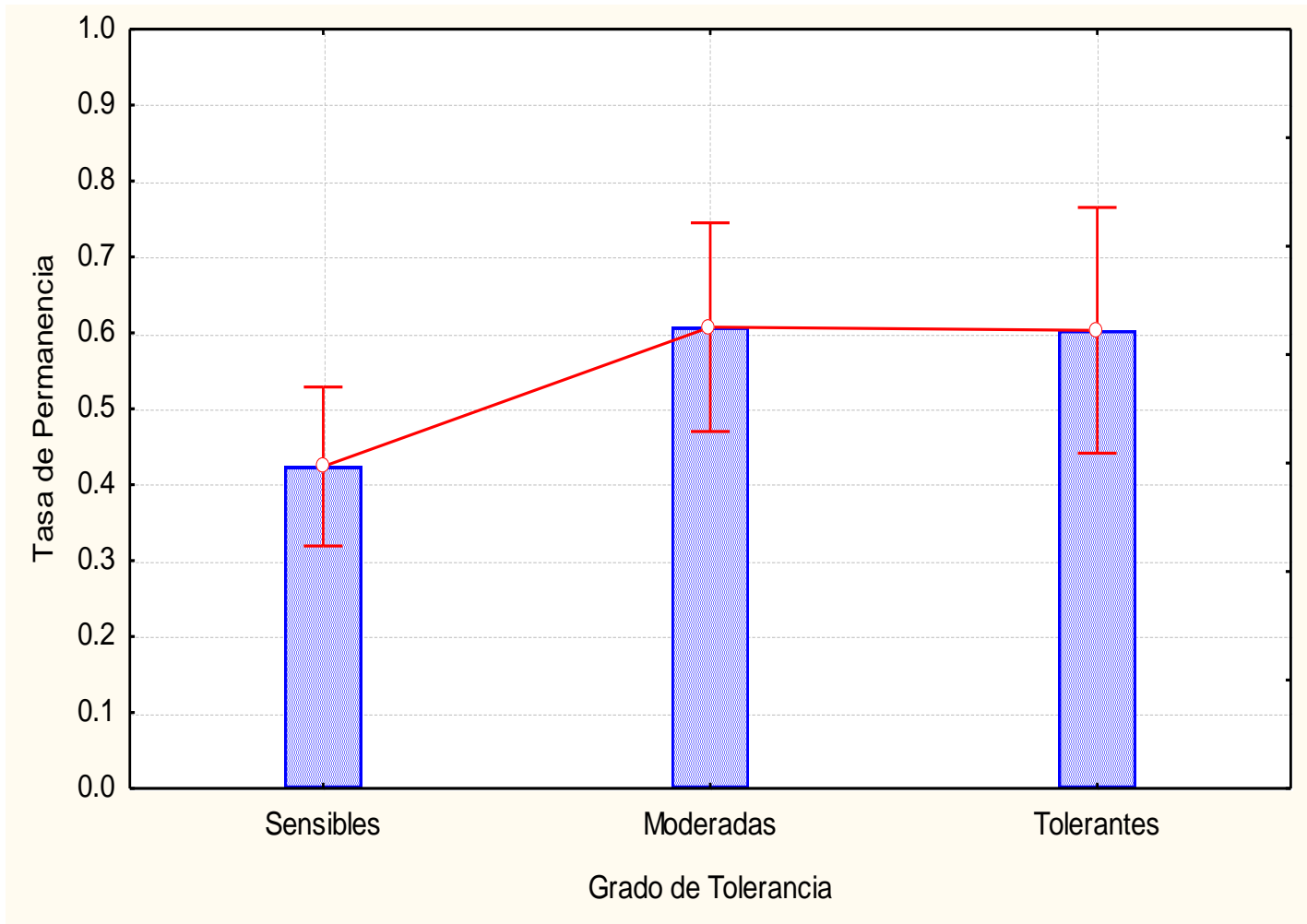
Zoogoneticus tequila

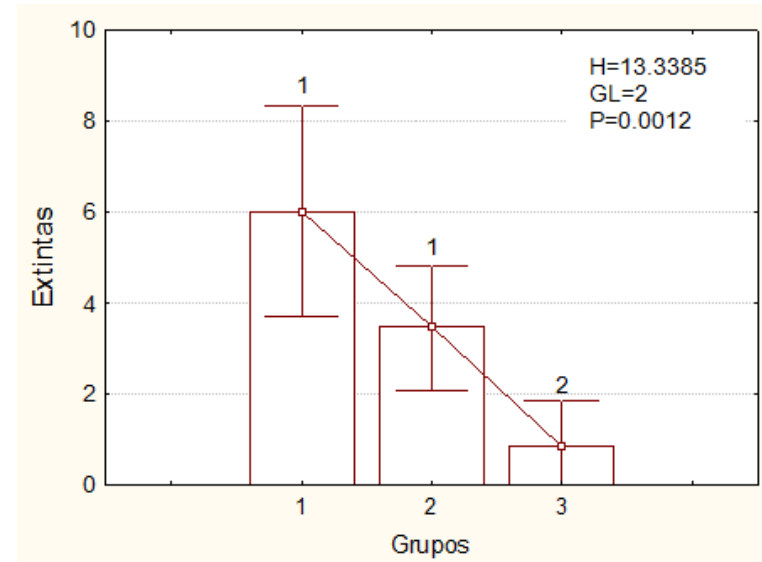
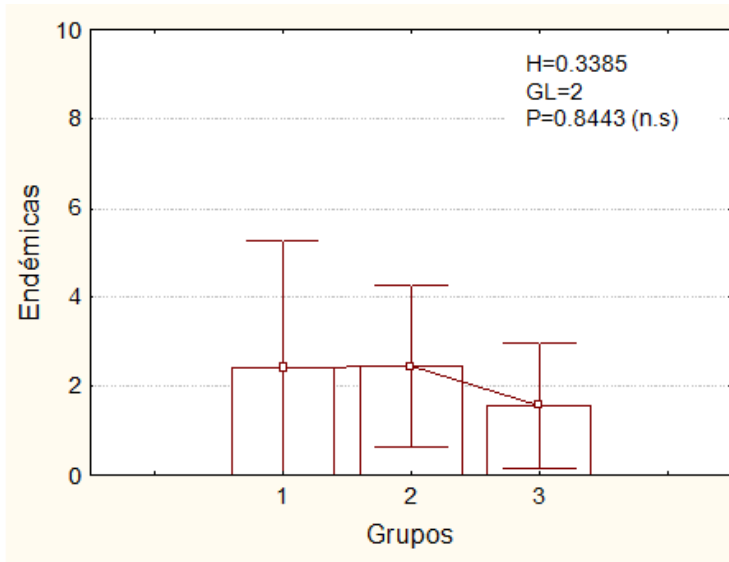
3



Species sensitivity affects??

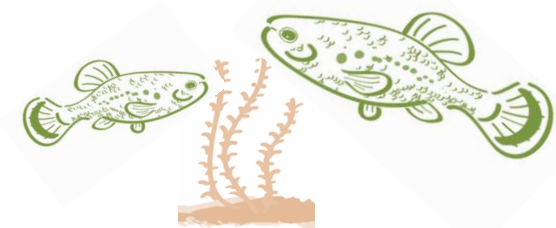
Permanence rate (PR) mean of the species according to their sensitivity
Mercado-Silva *et al.* (2002).





Endemic and extinct species by groups according to their mean PR and its standard deviation

There is no significant difference among the proportion of the sensitivity of the species by group of PR



Extotic species

Oreochromis spp.



Cyprinus carpio



Lepomis cyanellus

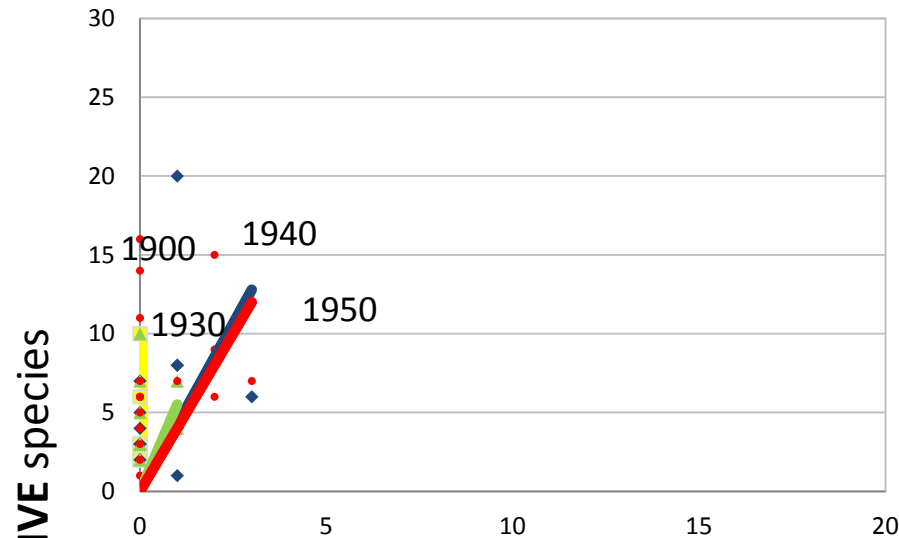


Micropterus salmoides

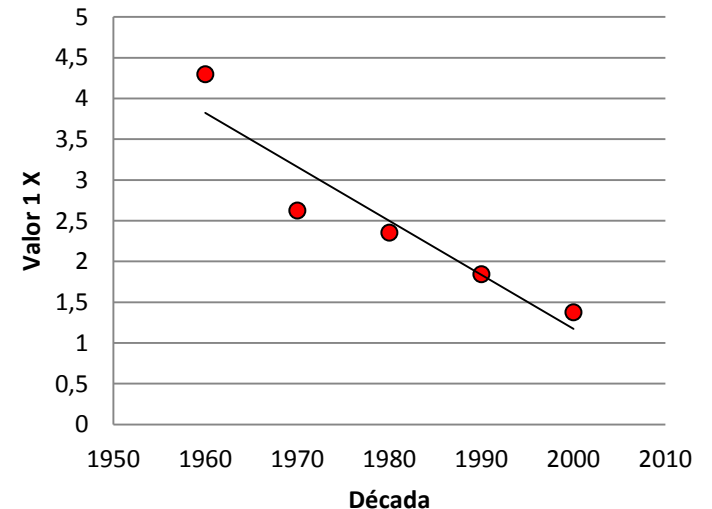
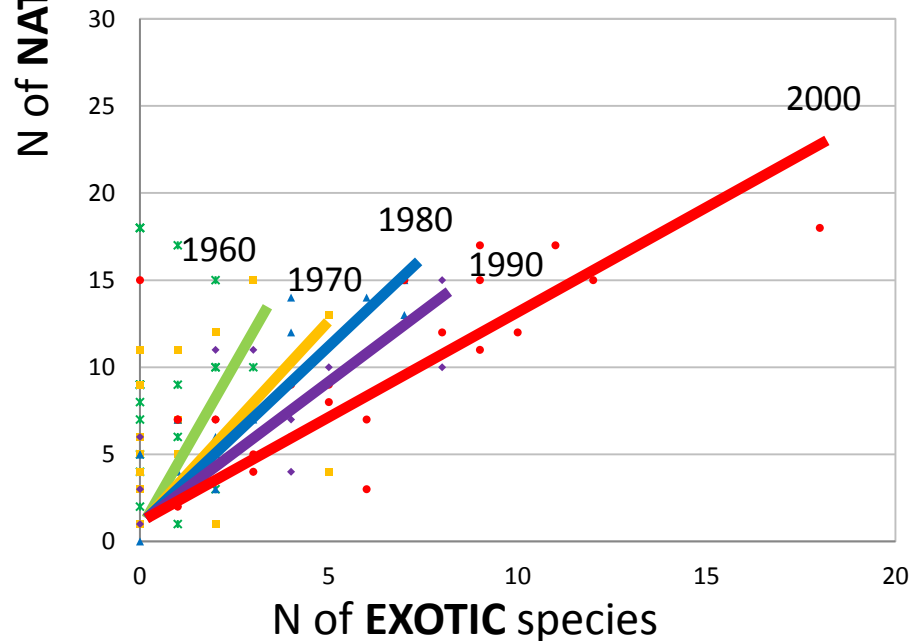


37
exotic
species

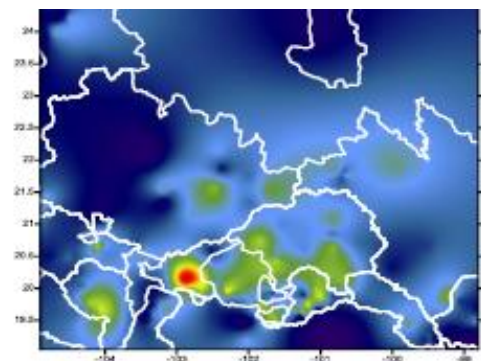
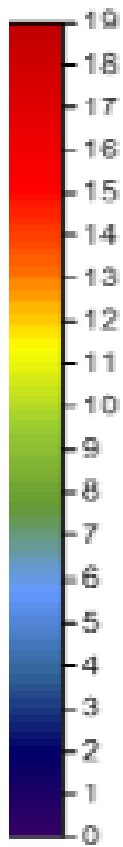
Effects of the extotic species



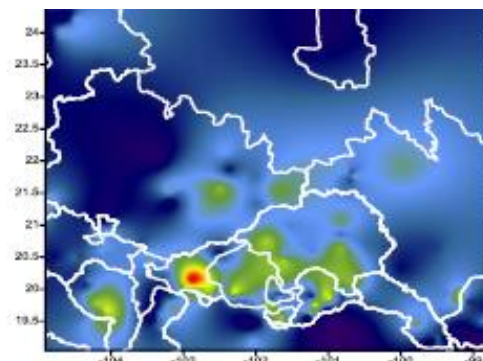
Exotic species diversity increased in time while the native one decreased on a very accelerating rate



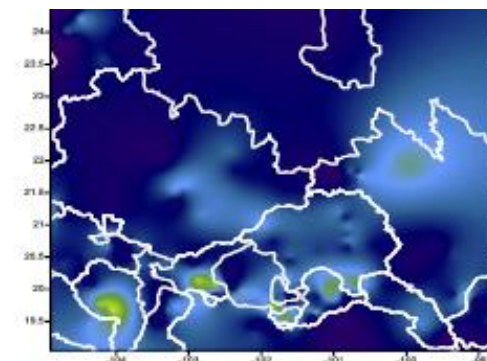
Núm. de especies



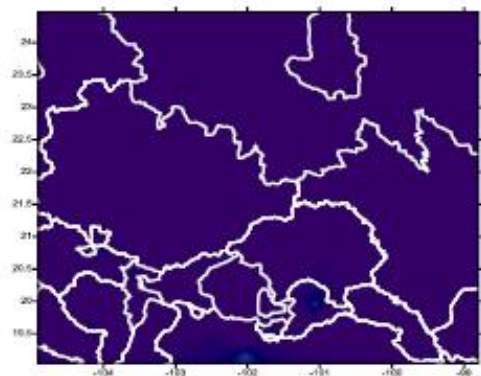
S Nativas Período de 1900-1950



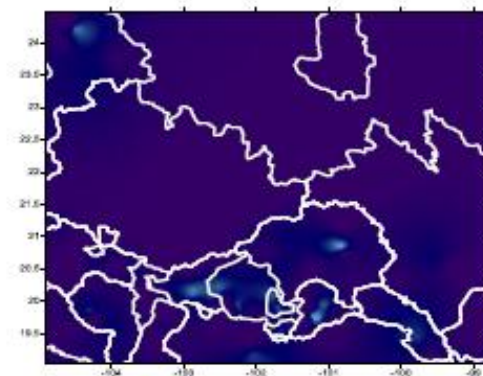
S Nativas Período de 1960-1990



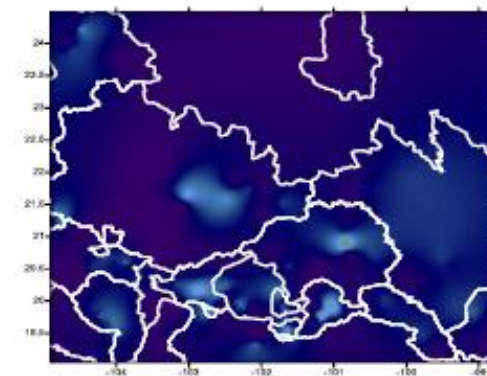
S Nativas Década del 2000



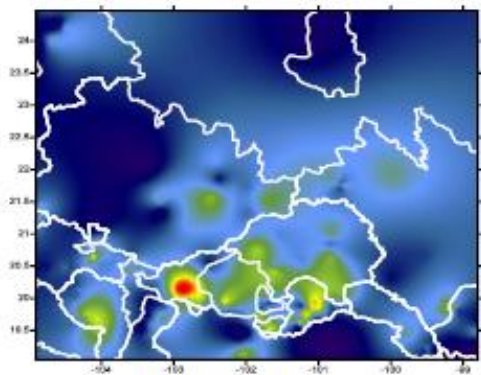
S Exóticas Período de 1900-1950



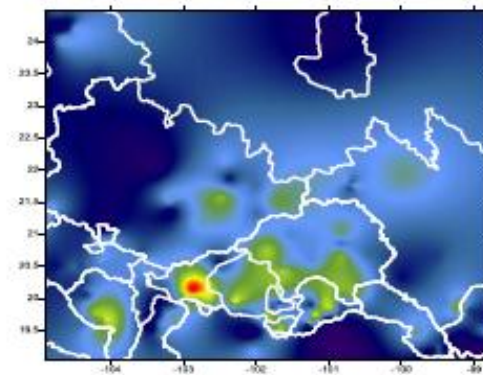
S Exóticas Período de 1960-1990



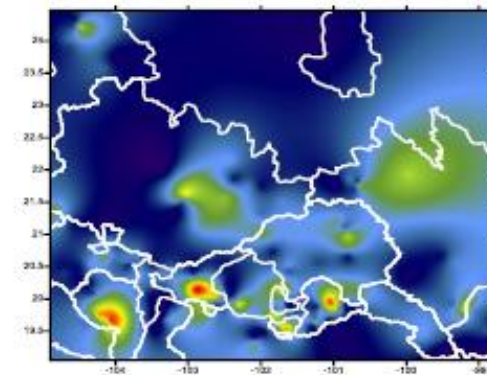
S Exóticas Década del 2000



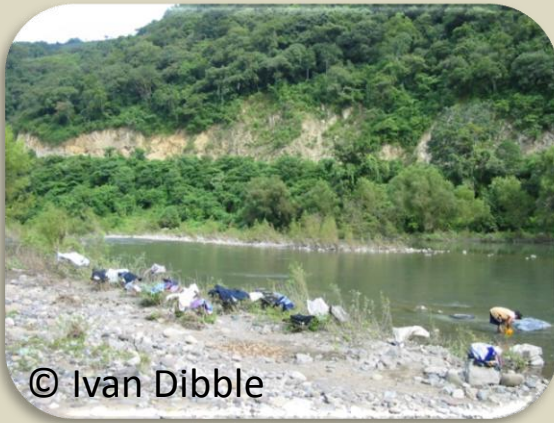
S Total Período de 1900-1950



S Total Período de 1960-1990



S Total Década 2000



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**Negative impacts
on the
freshwater fishes**



Recomendations

- Instauration of conservation areas and their habitats
- Include the scientific people in the environmental decision as well as the establishment and modification of environmental normativity
- Creation of an effective normativity that controls the aquaculture programs of exotic species, avoiding them to invade habitats
- Educate the people about the problems that native species are facing and the way they can start acting