Risk assessment of the ornamental fish trade in Mexico: analysis of freshwater species and effectiveness of the FISK (*Fish Invasiveness Screening Kit*)

R. Mendoza, S. Luna, & C. Aguilera

In Mexico

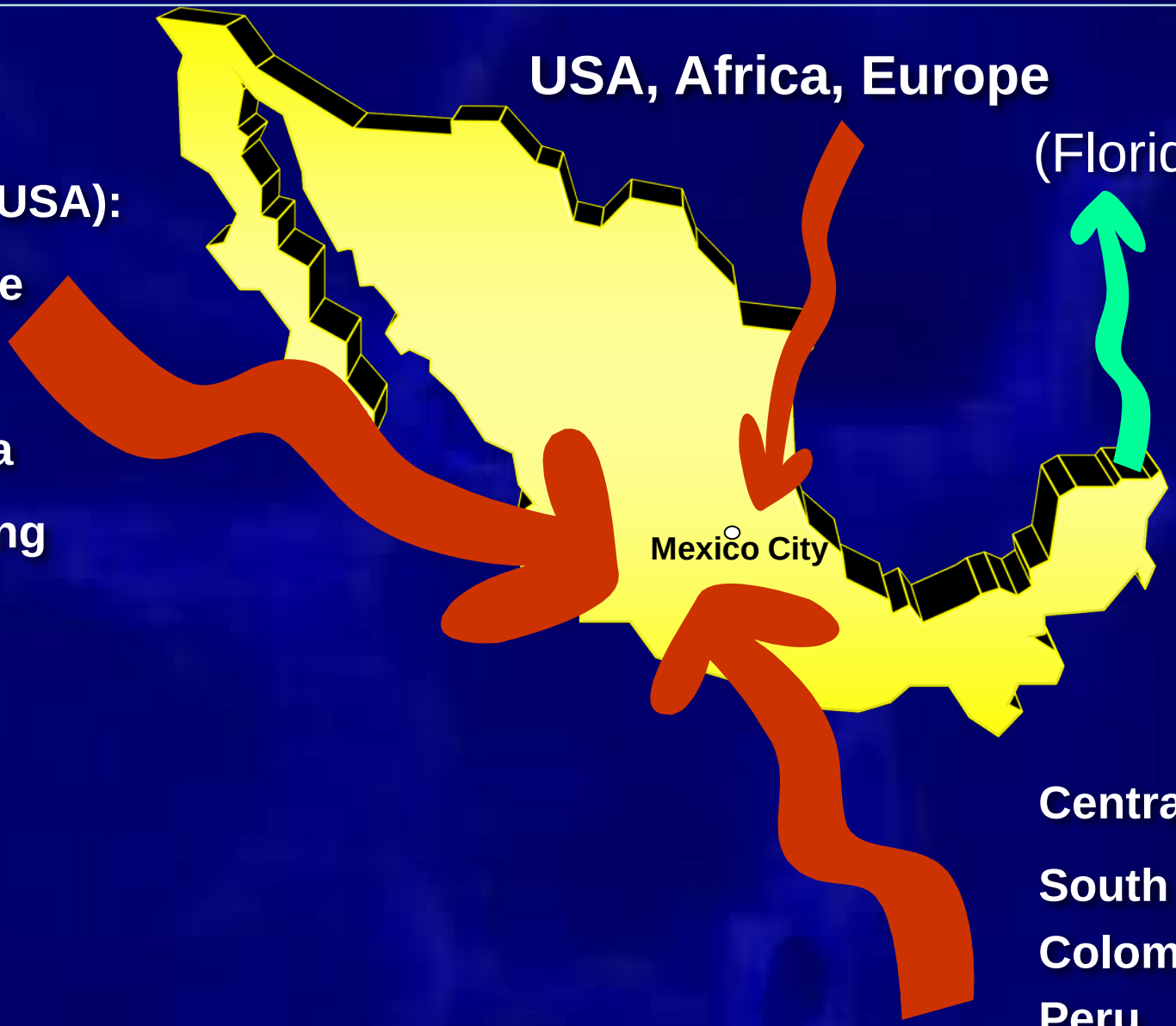
43 million FW fish/year

48% imported (20,640,000)

52% produced (22,360,000)

More than 700 varieties

IMPORTATIONS & EXPORTATIONS



Asia (By USA):

Singapore

Thailand

Indonesia

Hong Kong

Central America

South America:

Colombia

Peru

NATIONAL PRODUCTION

70´s

FARMS IN

3 STATES

EARLY 90´s

FARMS IN

11 STATES

AT THE PRESENT 341 FARMS

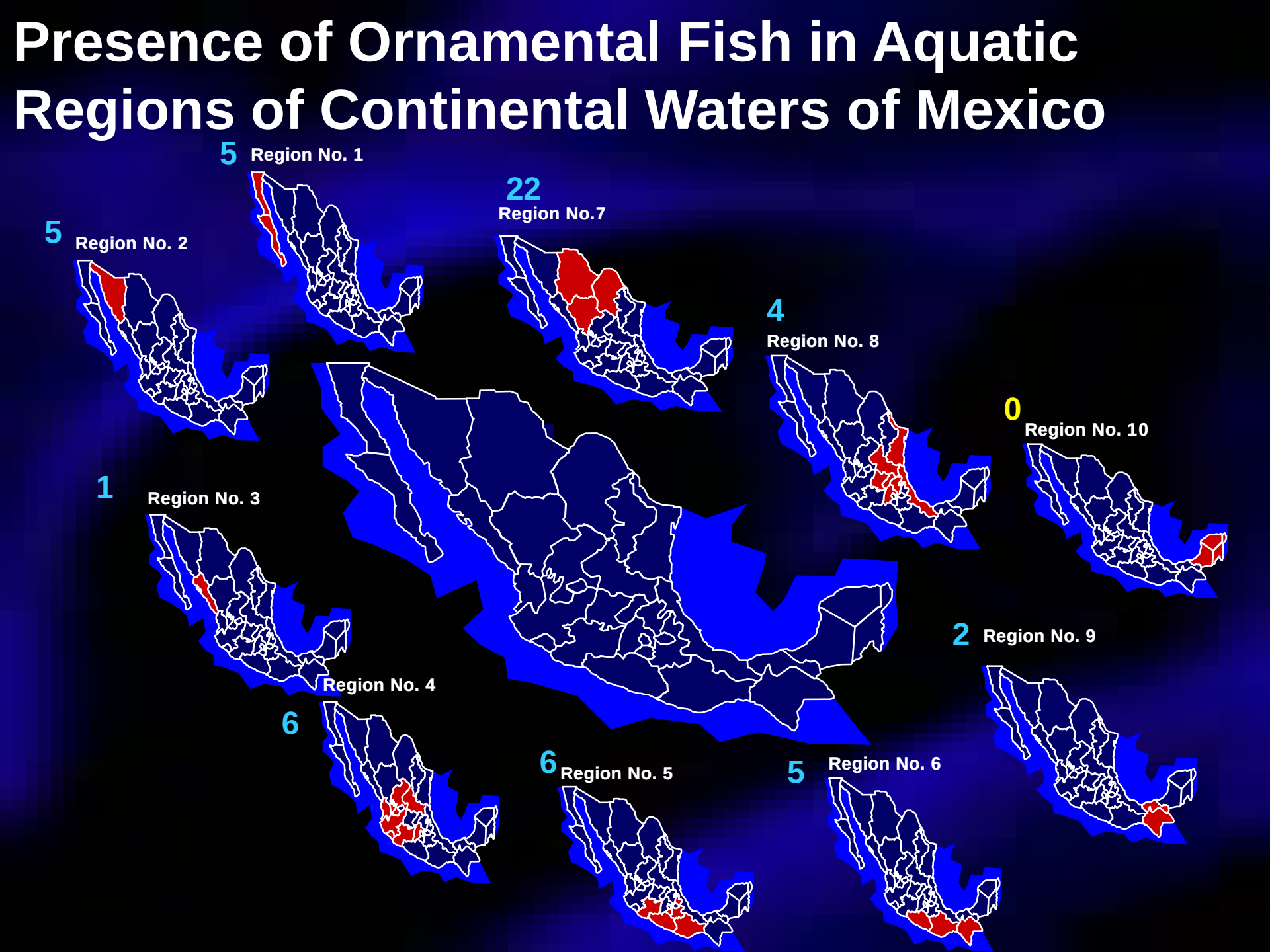
IN 21 STATES

180 OFFICIALLY REGISTERED

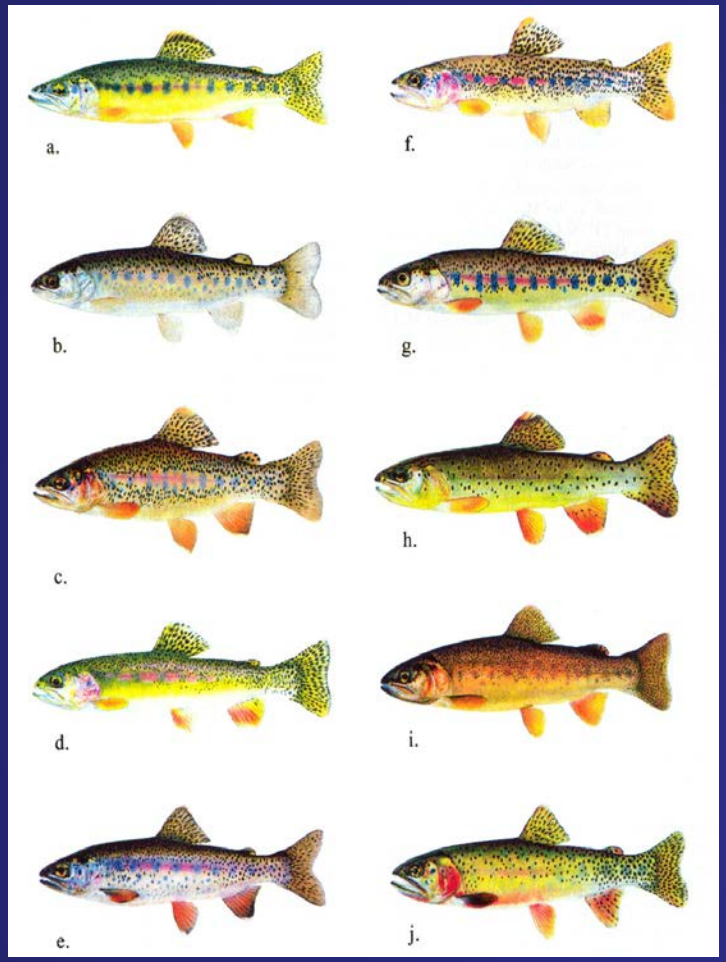
INTER-TROPICAL

ZONE

Presence of Ornamental Fish in Aquatic Regions of Continental Waters of Mexico



545 NATIVE FW FISH SPECIES



(Hendrickson et al.,, 2002)

Cuadro 1.2. Número de especies para grandes grupos taxonómicos en cada una de las categorías que describe la NOM-059-SEMARNAT-2010.

Grupo taxonómico	Probablemente extintas	En peligro de extinción	Amenazadas	Sujetas a protección especial	Total
Algas y briofitas	0	0	2	6	8
Hongos	0	10	28	8	46
Pteridofitas	0	6	8	16	30
Gimnospermas y angiospermas	6	177	330	436	949
Invertebrados	0	20	12	17	49
Peces	13	81	80	30	204
Anfibios	0	7	44	143	194
Reptiles	0	27	142	274	443
Aves	19	95	126	152	392
Mamíferos	11	52	124	104	291
Total	**49**	**475**	**896**	**1 186**	**2 606**

Fuente: CONABIO con base en SEMARNAT 2010.

Quinto Informe Nacional de México ante el Convenio sobre la Diversidad Biológica - 2014

The number of exotic species has increased from 55 in the 80s to 115 at the present, from which 67 have already established

FISK v2.03 - Risk Assessment Toolbox

Non-native Freshwater Fish

Risk Screening Kit (FISK) v2

Use Toolbox

- Run Assessment
- Define RA Area

Advanced Functions

- Unprotect
- Export Data

Toolbox Help

- Overview
- Scoring
- Exporting Data
- Credits

Exit Excel

- Save and Close
- Close No Save

FISK Calibration

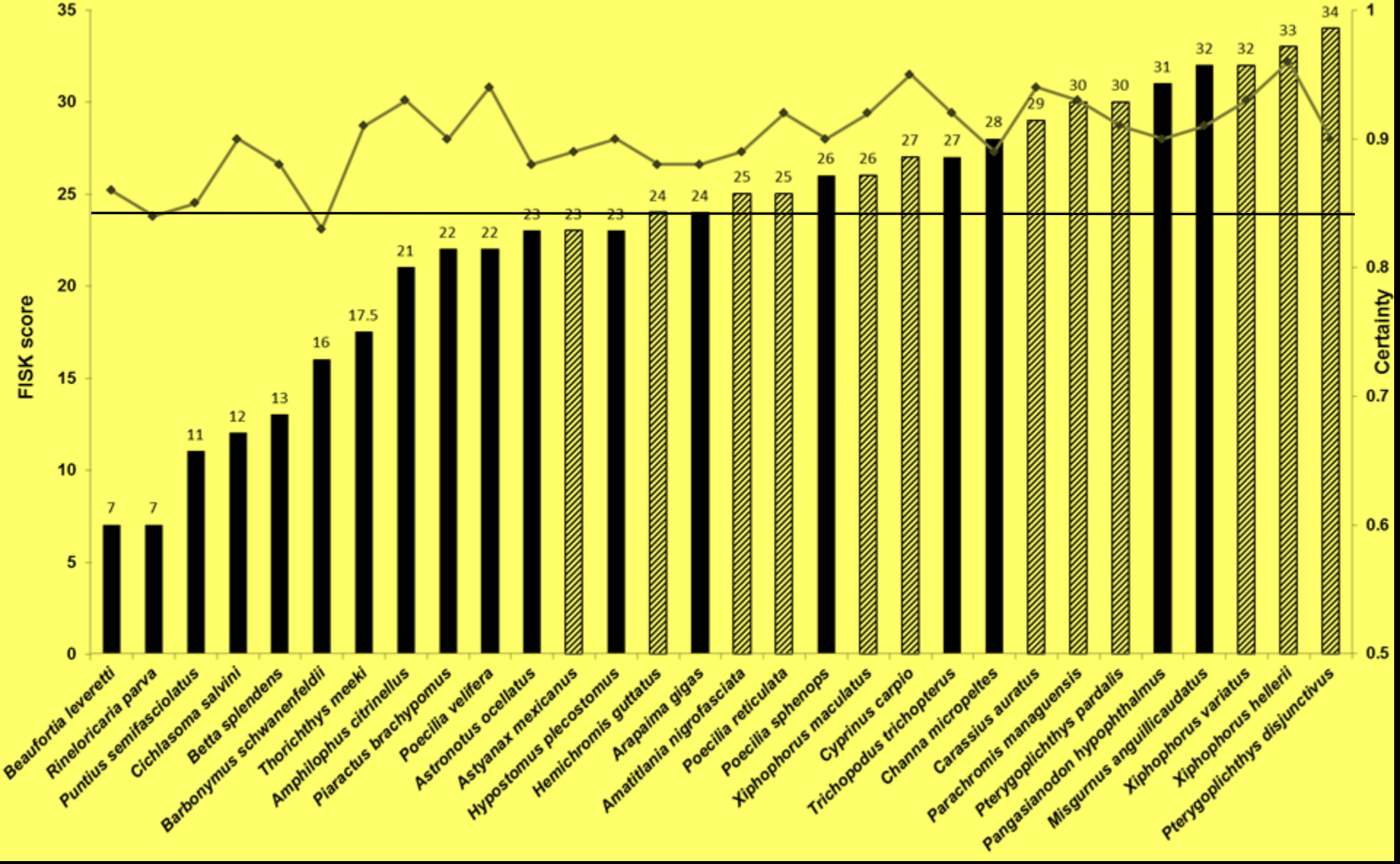
- FISK 1 calibrated and used for identifying high-risk fishes
  - UK
  - Belarus
  - Brazil
  - Japan
- FISK 2 was updated for broader climatic zones and its feasibility was confirmed for
  - Australia
  - Hong Kong
  - Turkey
  - Balkans Region
  - Finland
  - Iberian Peninsula
  - Portugal
  - Hungary

Fish species

- 700 FW fish species regularly traded in Mexico were filtered for synonyms/varieties
- 368 ornamental species were taxonomically validated
- Submitted to revision for previous establishment or invasive reports elsewhere (ISSG, DIAS, GBIF, IABIN, NAS, NEMESIS, NISBase, NOBANIS)
- All species were ranked according to their number of reports and top 30 species were subjected to analysis using the FISK v2
- Two modeling algorithms (GARP and MaxEnt) were used for each species to evaluate climate match

Calibration

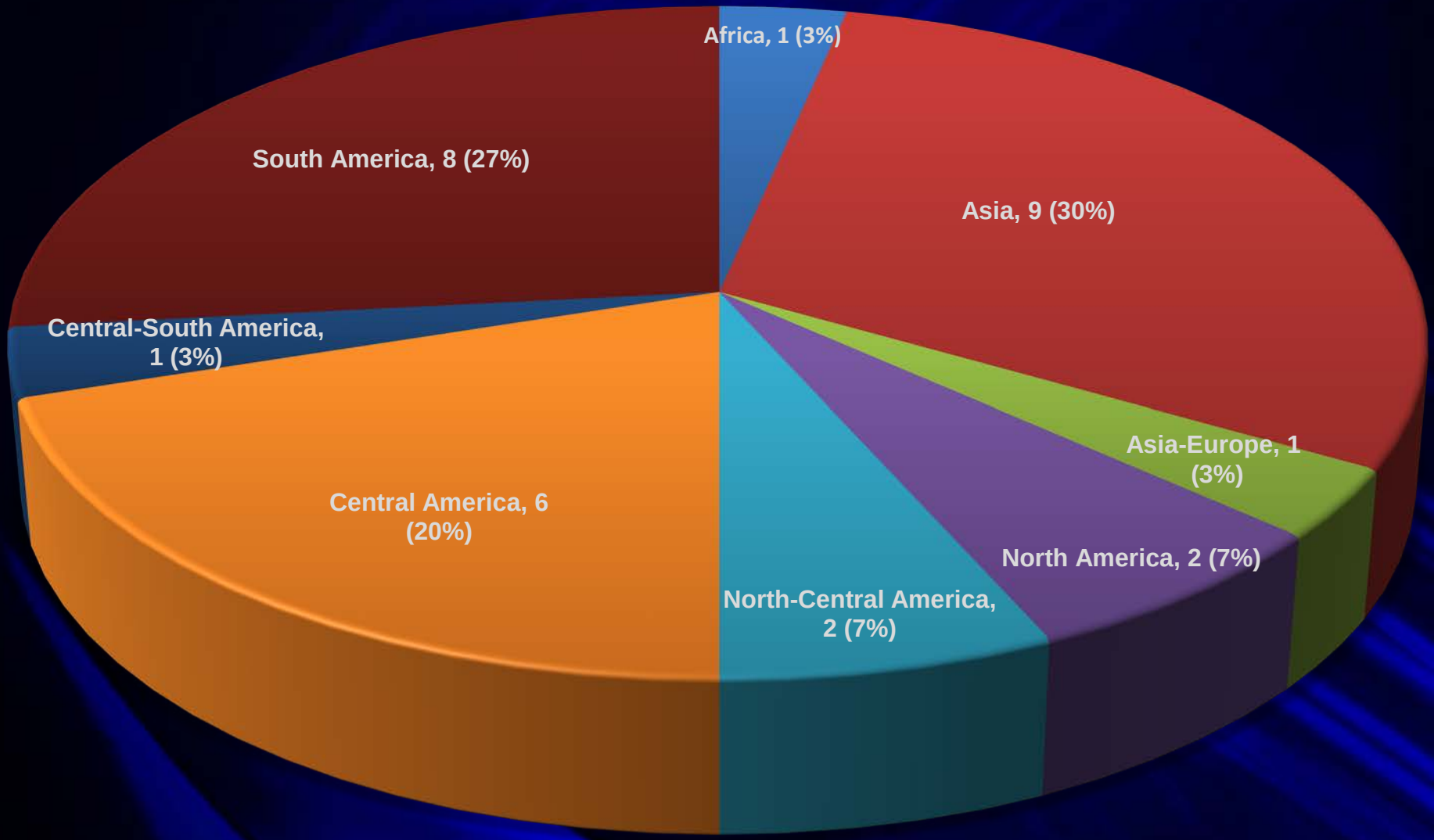
- Species were classified (after FISK analysis) into ***invasive*** (introduced abundant and/or with documented impacts) or ***non-invasive*** for Mexico
- Calibration was carried out using a *Receiver Operating Characteristic* (ROC) curve
- Youden's index (J) was estimated to determine the best threshold for high-risk species



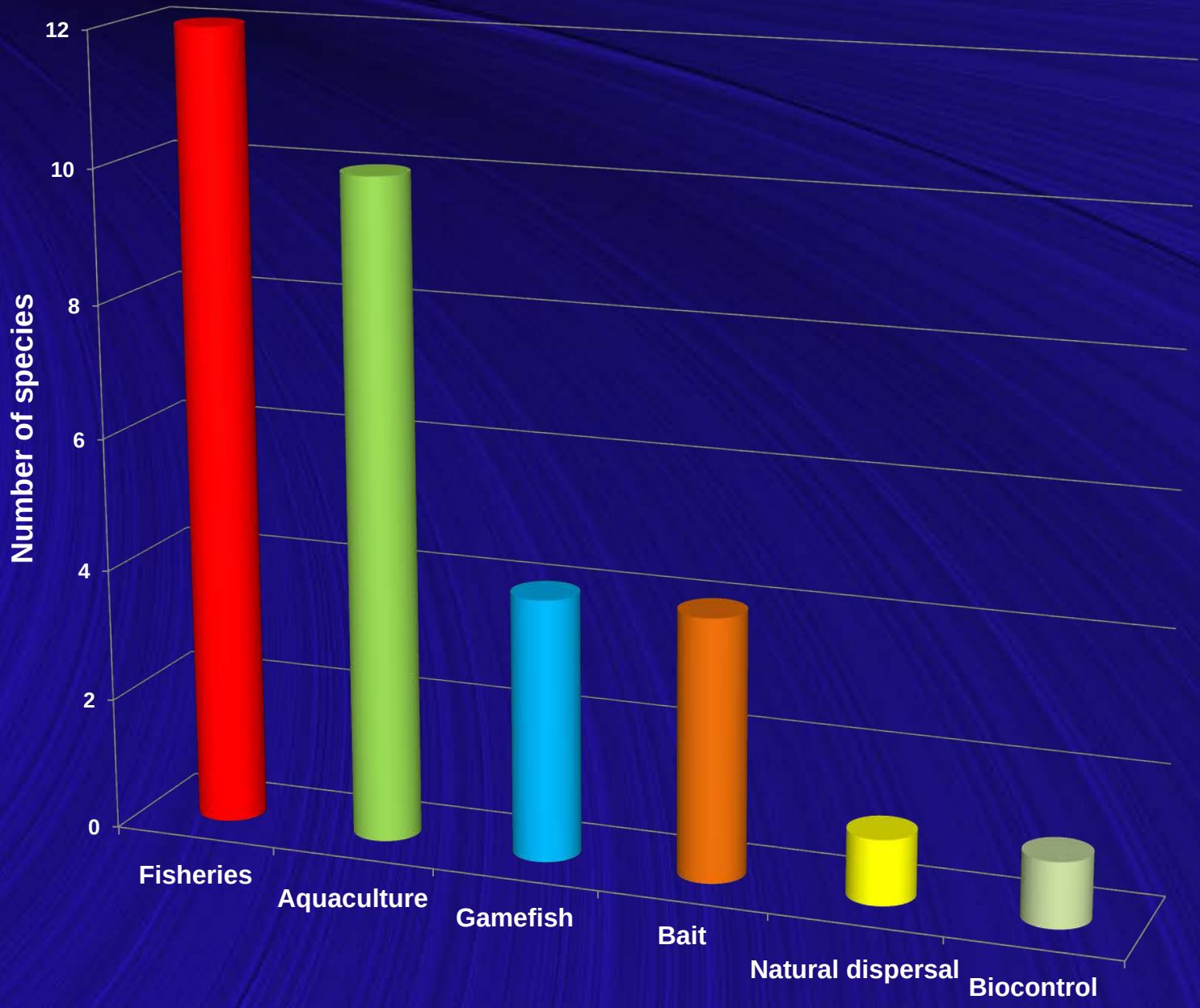
17 species were classified into the high-risk category

Cichlidae, Poecilidae, Cyprinidae and Loricariidae

SOURCE OF INVASIVE SPECIES



INTRODUCTION PATHWAYS



Cyprinus carpio

Carassius auratus

Poecilia reticulata

Betta splendens

X. hellerii

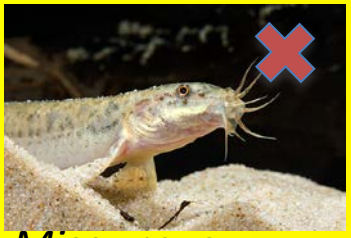
Astronotus ocellatus

Barbonymus schwanenfeldii

Trichopodus tricopterus

Poecilia sphenops

Amatitlania nigrofasciata



Misgurnus anguillicaudatus

Parachromis managuensis

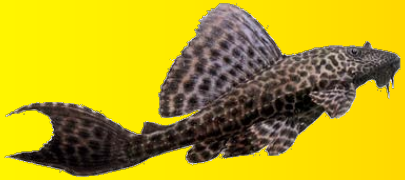
Cichlasoma salvini

Thorichthys meeki

Pterygoplichthys disjunctivus

Xiphophorus variatus

Xiphophorus maculatus



Hypostomus plecostomus

Piaractus brachypomus

Amphilophus citrinellus

Hemichromis guttatus

Higher FISK Scores

a) Biogeographic conditions present in Mexico
b) The important propagule pressure of several high risk species
c) Different inherent attributes displayed by these 17 species

INVASIVE ATTRIBUTES AND INVASION POTENTIAL

- Sanitary threats
- Hardiness
- Predation potential
- Agonistic behavior
- Reproductive traits
- Propagule pressure
- Impacts
- Presence in Natural Protected Areas

First international workshop on the Environmental Risk Evaluation for transgenic fish in Mexico

September 10th and 11th 2015

UANL
UNIVERSIDAD AUTÓNOMA DE NUEVO LEÓN

CONABIO

navegación
- Portada

temas
- Especies
- Rutas de introducción
- Análisis de riesgo

material de apoyo
- Documentos
- Preguntas frecuentes
- Referencias
- Reuniones y talleres
- Diplomado especies invasoras
- Ligas

acceso restringido
- Entrar
- NAPPO
- Ayuda
- Glosar

sobre e
- Contacto

buscar
Ir Buscar

Especies invasoras - Peces

Esta lista se encuentra en contínua actualización, las especies que aquí se presentan no constituyen un listado exhaustivo, su intención es servir como guía.

Es importante considerar que algunas especies nativas* de México se consideran invasoras si son introducidas a otras partes del país, por lo que los listados que estamos elaborando pronto contendrán información referente a la región en donde se reporta a una especie como invasora.

Agradeceremos mucho a nuestros usuarios, expertos en el tema, que nos hagan llegar información o nombres de especies que consideren que se deben de incluir, al correo especiesinvasoras@conabio.gob.mx, de tal manera que con su apoyo y el trabajo de CONABIO, esta información pueda estar disponible lo antes posible.

Las sexta y séptima columnas deben interpretarse de acuerdo con la siguiente simbología.

Estado de invasión

NE	Especie **no establecida** en México
Conf	Se requiere **confirmar** en México
E	**Establecida** en México

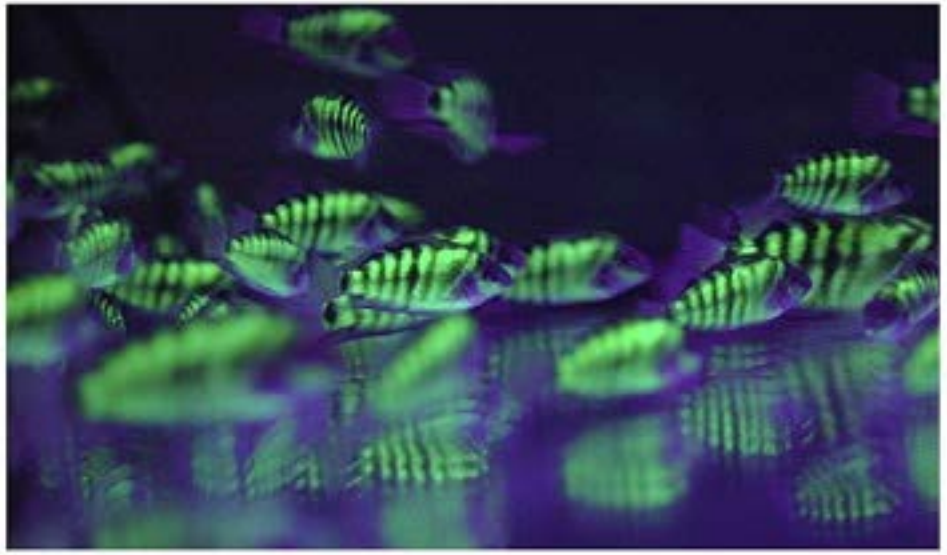
Rutas de introducción

T	**Transporte** de bienes y personas
C	**Comercio** de organismos vivos
H	Otras actividades **humanas**
N	Fenómenos **naturales**
D	Origen **desconocido**

Anfibios | Reptiles | Aves | Mamíferos | **Peces**

Insectos | Crustáceos | Moluscos | Otros invertebrados | Plantas | Algas

Nombre científico	Grupo	Familia	Nombre común	Ambiente	Estado de la invasión	Rutas de introducción	Ligas
Algansea lacustris	Cyprínidos	Cyprinidae	Acumura	Dulceacuícola	E	C	ITIS FishBase
Amatitlania nigrofasciata	Cíclidos	Cichlidae	Convicto, chanchito	Dulceacuícola	E	C	ITIS FishBase
Ambloplites rupestris	Centrarquidos	Centrarchidae	Lobina de roca	Dulceacuícola	E	C	ITIS FishBase
Ameiurus melas	Ictalúridos	Ictaluridae	Bagre negro, bagre cabeza toro	Dulceacuícola	E	C	ITIS FishBase



CONABIO
COMISIÓN NACIONAL PARA EL CONOCIMIENTO Y USO DE LA BIODIVERSIDAD

CARB (“Coordinación de Análisis de Riesgo y Bioseguridad)

INFORMACIÓN TAXÓNOMICA
REPRODUCTIVA

POSIBLES RIESGOS A
ESPECIES DE IMPORTANCIA
CONSERVACIÓN
COMERCIAL

MÉTODOS DE TRANSFERENCIA
CONSTRUCCIONES DE RIESGO
EVENTOS
EFECTOS PLEIOTRÓPICOS

CARNIVORAS
POTENCIAL INVASOR
MIGRADORAS etc

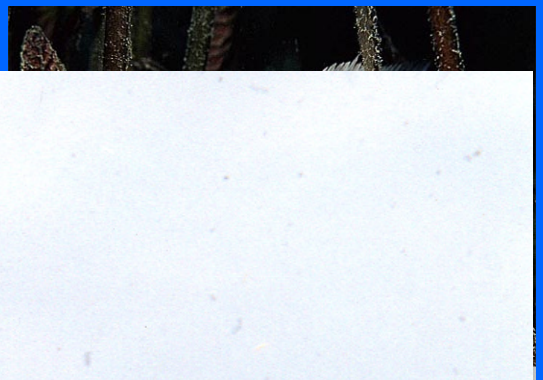
SIMILITUD CLIMÁTICA
ANPs etc.

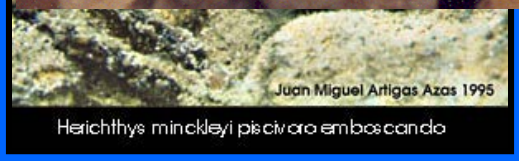
Evaluation of alternatives for the control of the African jewel cichlid (*Hemichromis sp*)

Cuatro Ciénegas

Location in Mexico

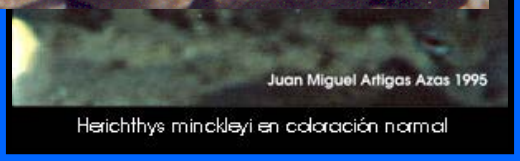
Coordinates: 26°59′10″N 102°3′59″W





Herichthys minckleyi piscívoro emboscando

Herichthys minckleyi oligomelánico, Poza la Becerra



Herichthys minckleyi en coloración normal

Mexipyrgus carranzae

Nymphophilus minckleyi

Mexithauma quadripaludium

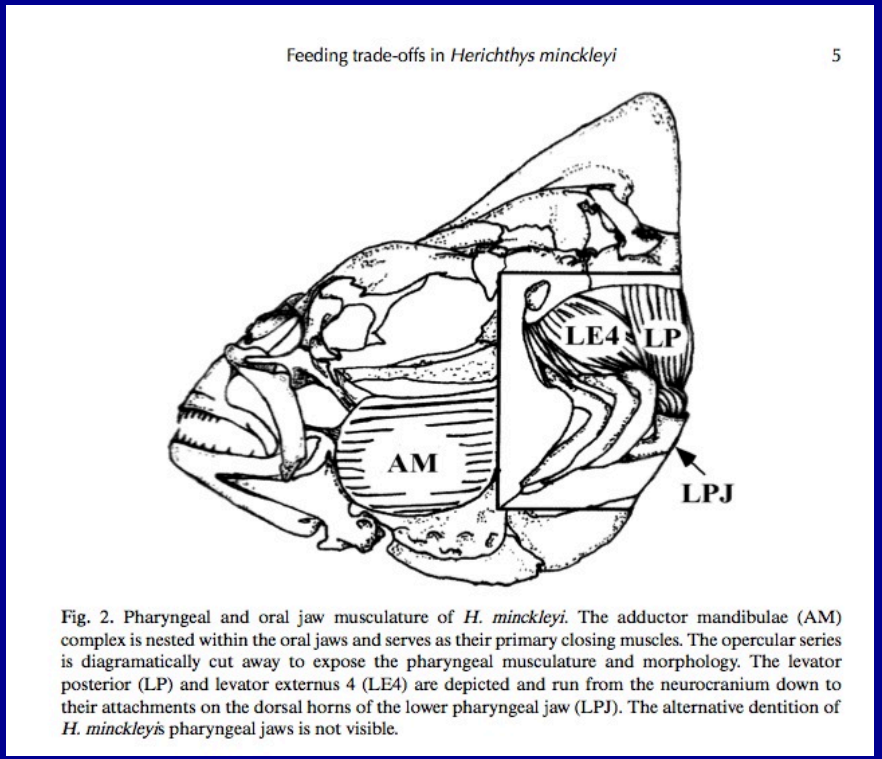
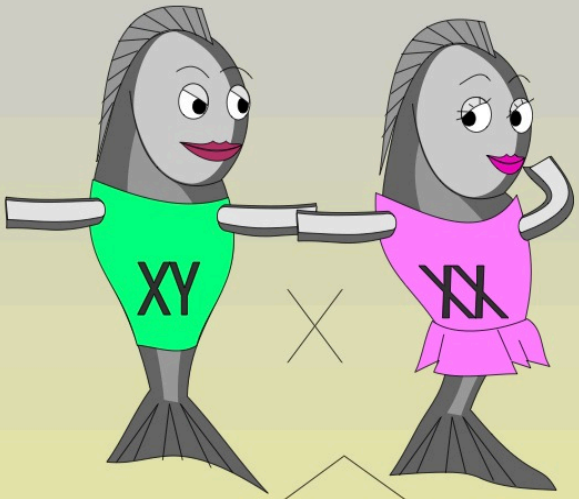


Fig. 2. Pharyngeal and oral jaw musculature of *H. minckleyi*. The adductor mandibulae (AM) complex is nested within the oral jaws and serves as their primary closing muscles. The opercular series is diagramatically cut away to expose the pharyngeal musculature and morphology. The levator posterior (LP) and levator externus 4 (LE4) are depicted and run from the neurocranium down to their attachments on the dorsal horns of the lower pharyngeal jaw (LPJ). The alternative dentition of *H. minckleyi*'s pharyngeal jaws is not visible.

STROMATOLITES

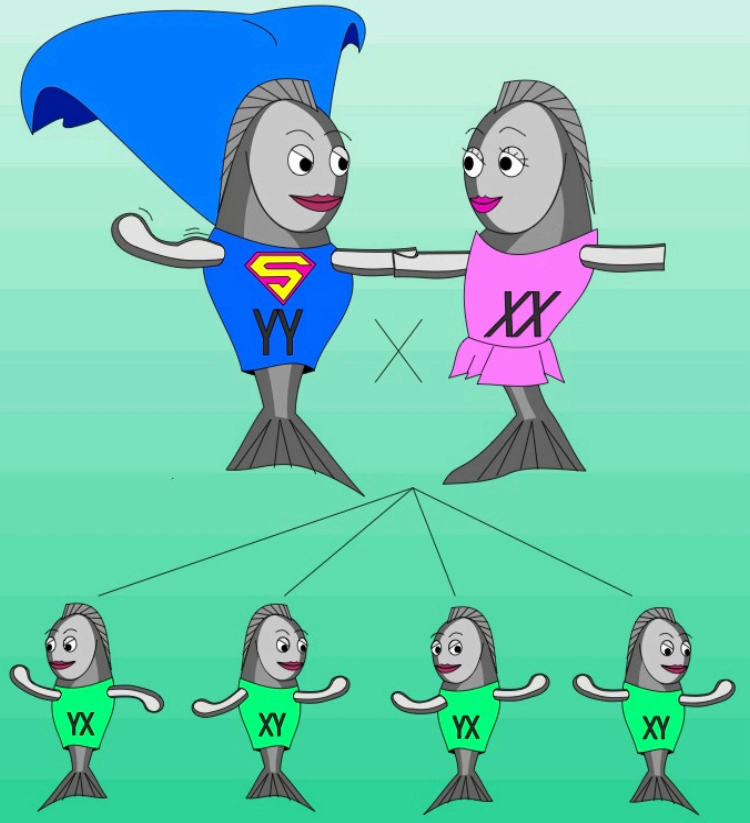
The YY male technology

THEN



Normal crosses produce equal proportion of males and females

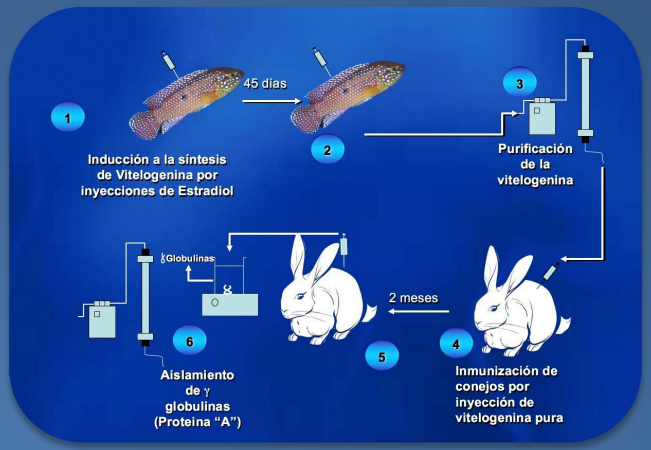
NOW



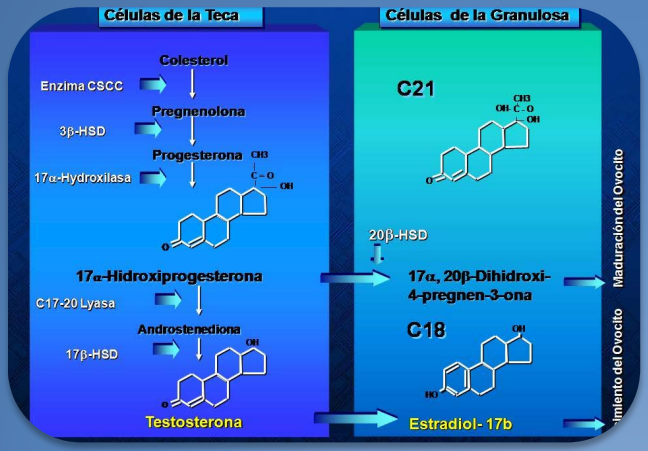
YY males produce only male progeny (GMT®)

Machos	Hembras	Crom. sexuales	Gen de referencia
Gen DMRT1	Gen FIGLA		Gen 18S ribosomal
Gen AMH	Gen DAX1A		
Gen CYP11B2	Gen CTNNB1B	Gen Dax1 - ChrX	
Gen WNT4B	Gen FOXL2A	Gen DMY - ChrY	
	Gen WNT4A		

Molecular biomarkers



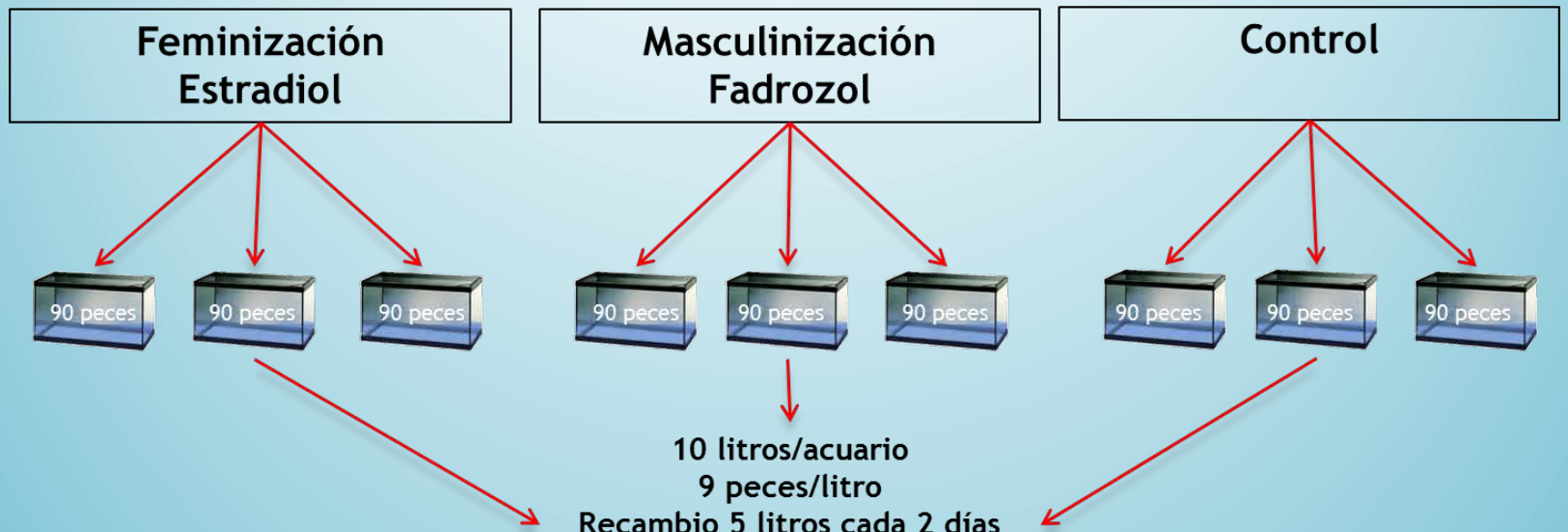
Vitellogenin



P450-Aro

Karyotype

Tratamientos

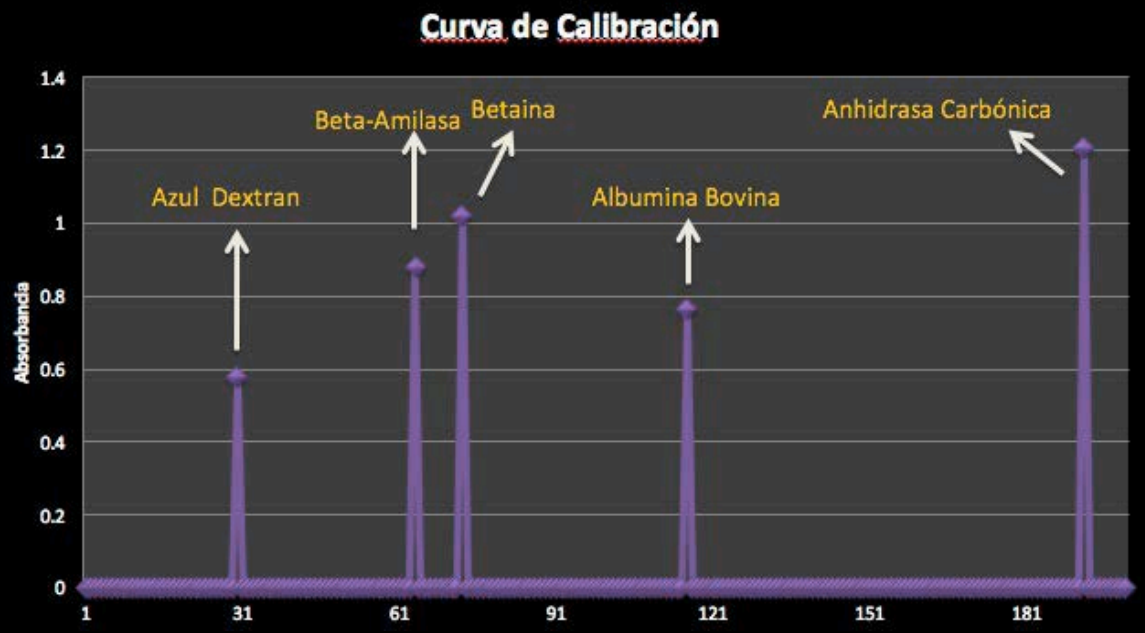


10 litros/acuario
9 peces/litro
Recambio 5 litros cada 2 días
Inicio: día 15 dde
Fin: día 50 dde

Muestreos

Día 10	9 peces/réplica
Día 20	9 peces/réplica
Día 30	9 peces/réplica
Día 40	9 peces/réplica
Día 50	9 peces/réplica
Día 60	9 peces/réplica

Total 54 peces/réplica


Curva de Calibración
Absorbancia
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1
31
61
91
121
151
181
Azul Dextran
Beta-Amilasa
Betaina
Albumina Bovina
Anhidrasa Carbónica

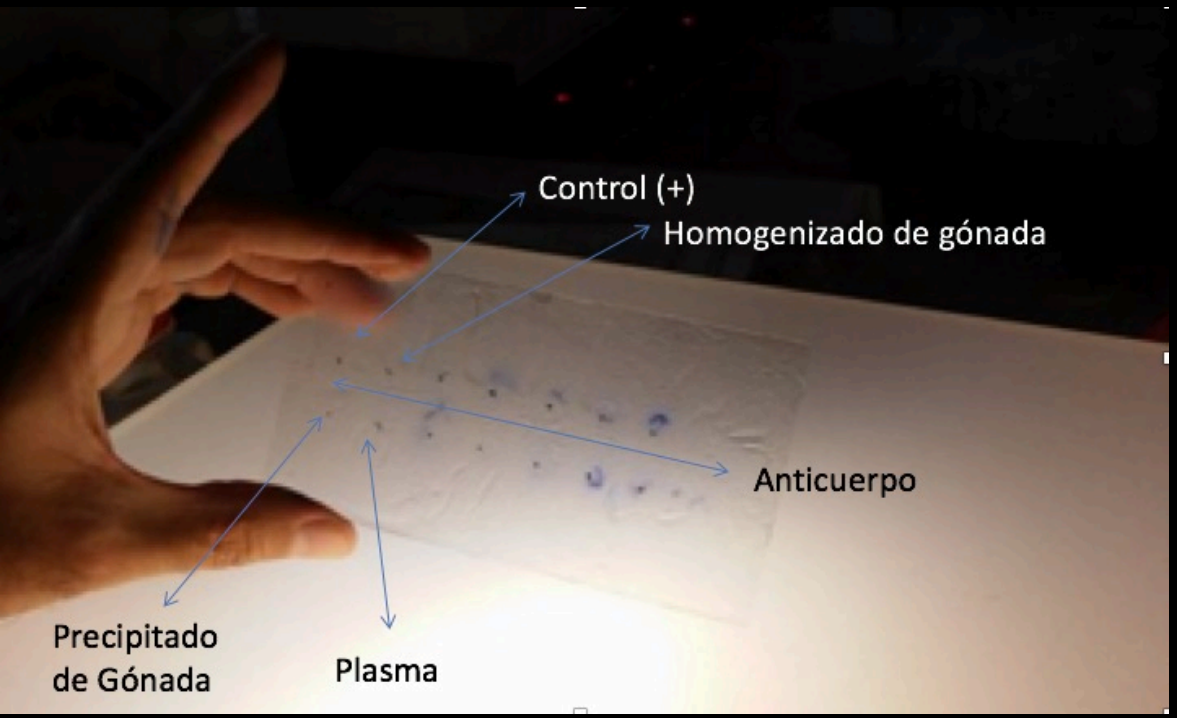
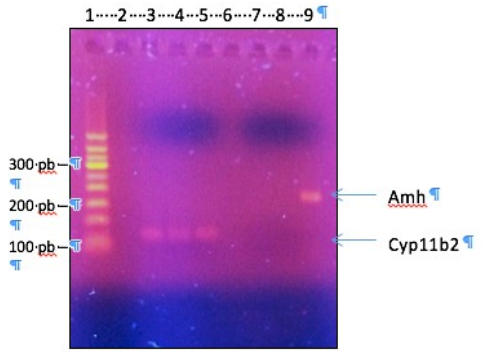
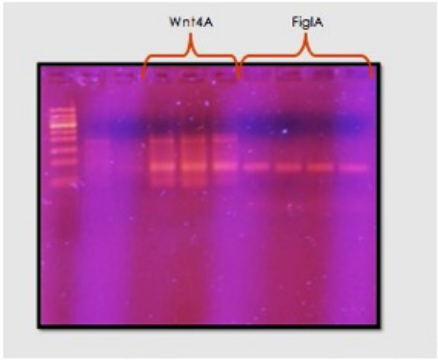

Control (+)
Homogenizado de gónada
Anticuerpo
Precipitado de Gónada
Plasma

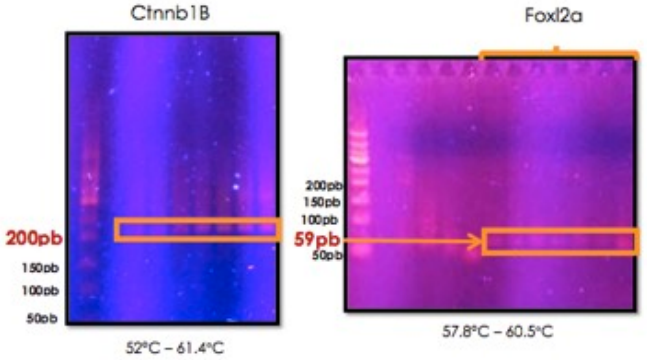
Figura 26.- Extracción de RNAt a partir de gónadas de *H. guttatus*.



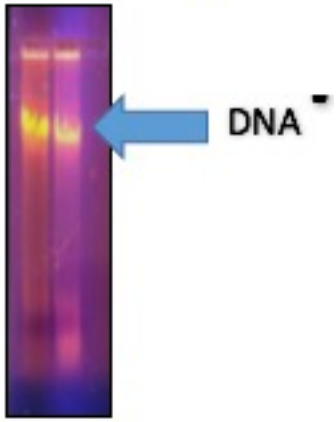
- Amplificación por RT-PCR de los genes marcadores de macho Amh y Cyp11b2.

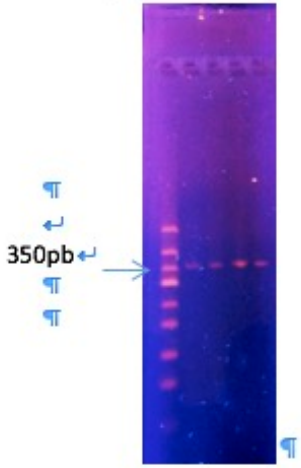


3.- Amplificación por RT-PCR de los genes marcadores de hembras Wnt4A y



29.- Amplificación por RT-PCR de los genes marcadores de hembras Ctnnb1B y Foxl2a. Gel de agarosa al 2% teñido con bromuro de etidio.





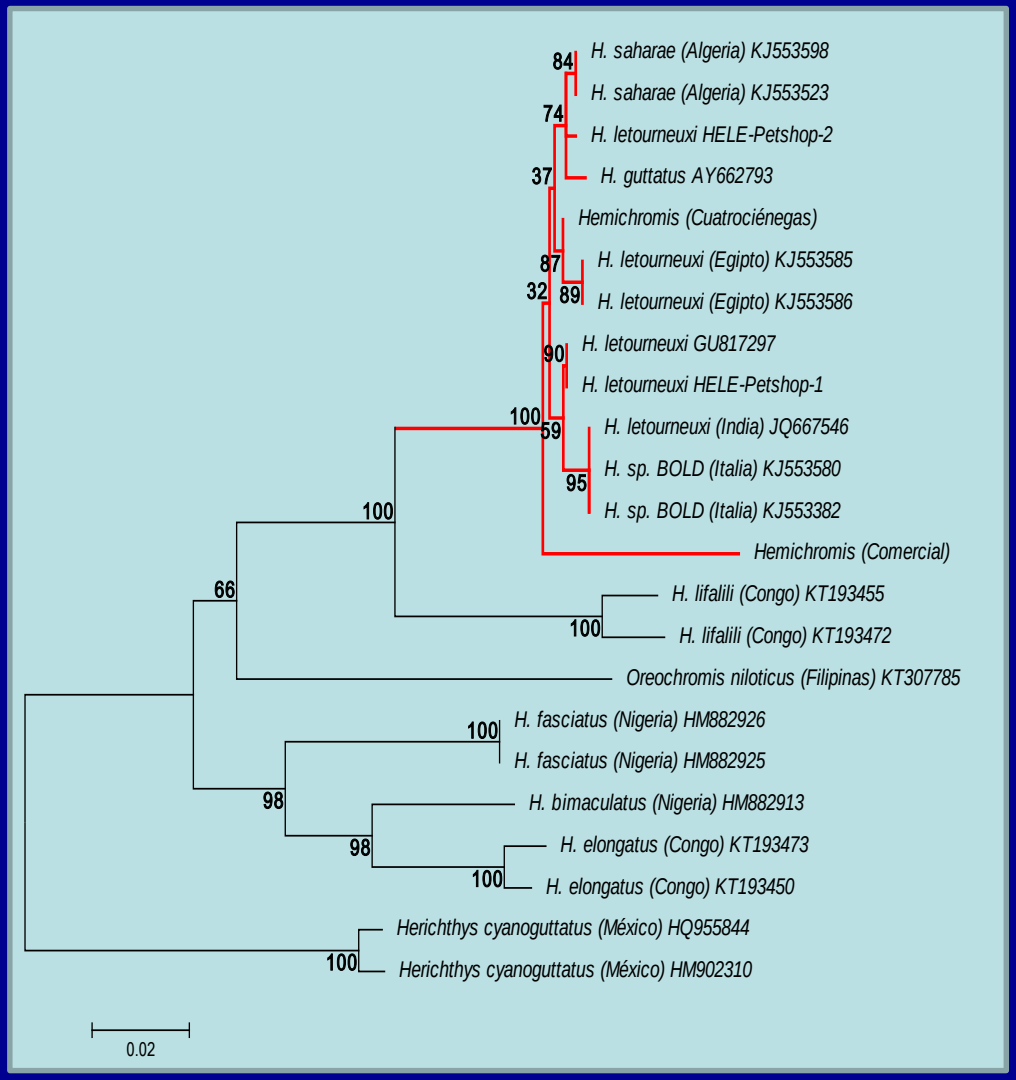
Dax1

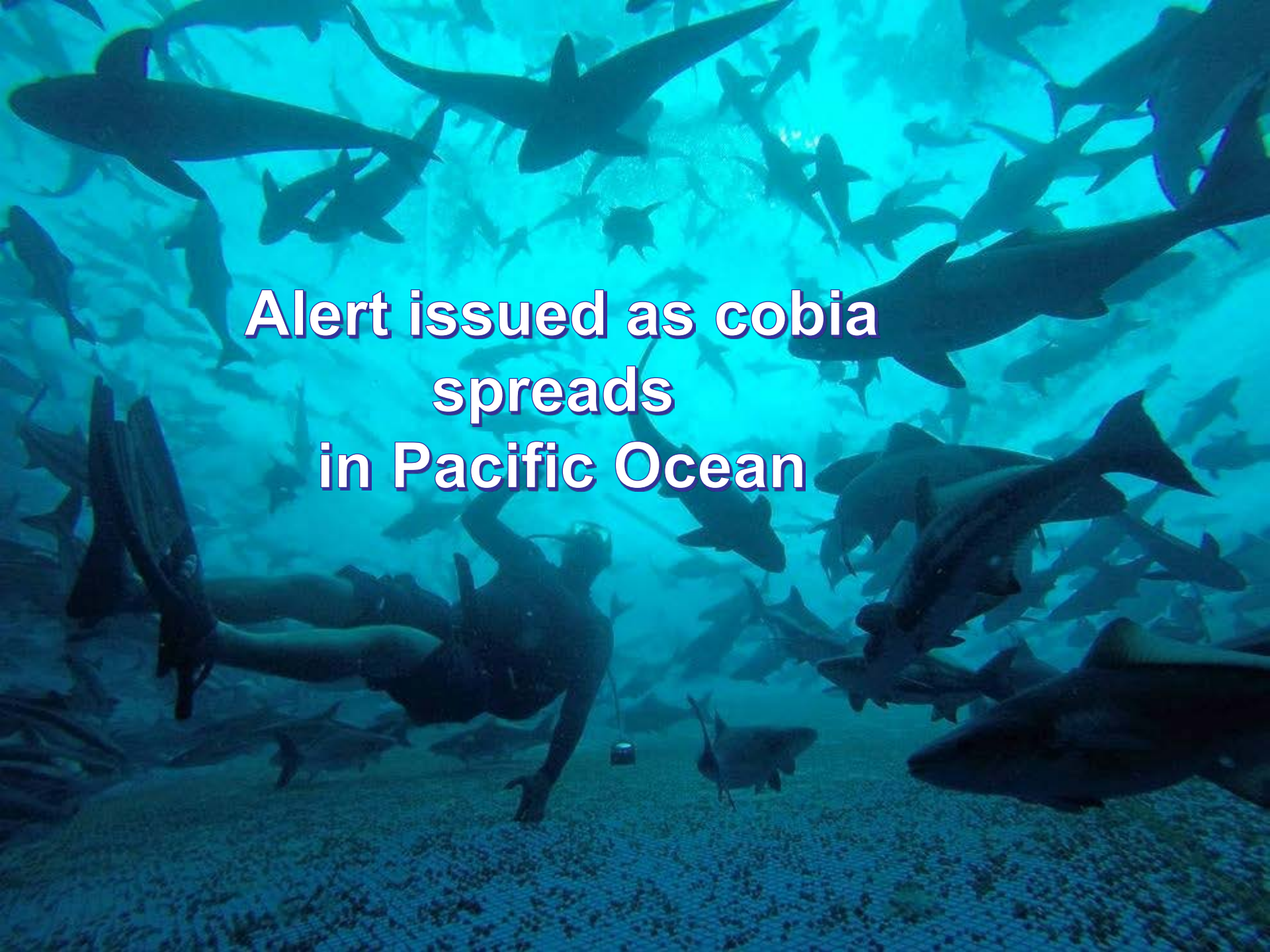
31.- Amplificación por PCR del gen Dax1a sobre ADNg, empleado como marcador

Hemichromis guttatus

Hemichromis letourneuxi

BARCODE




Alert issued as cobia
spreads
in Pacific Ocean

The native range of the Cobia (*Rachycentron canadum*) includes the Atlantic and Indo-west Pacific oceans, but not the eastern two thirds of the Pacific ocean

INVASIVE??

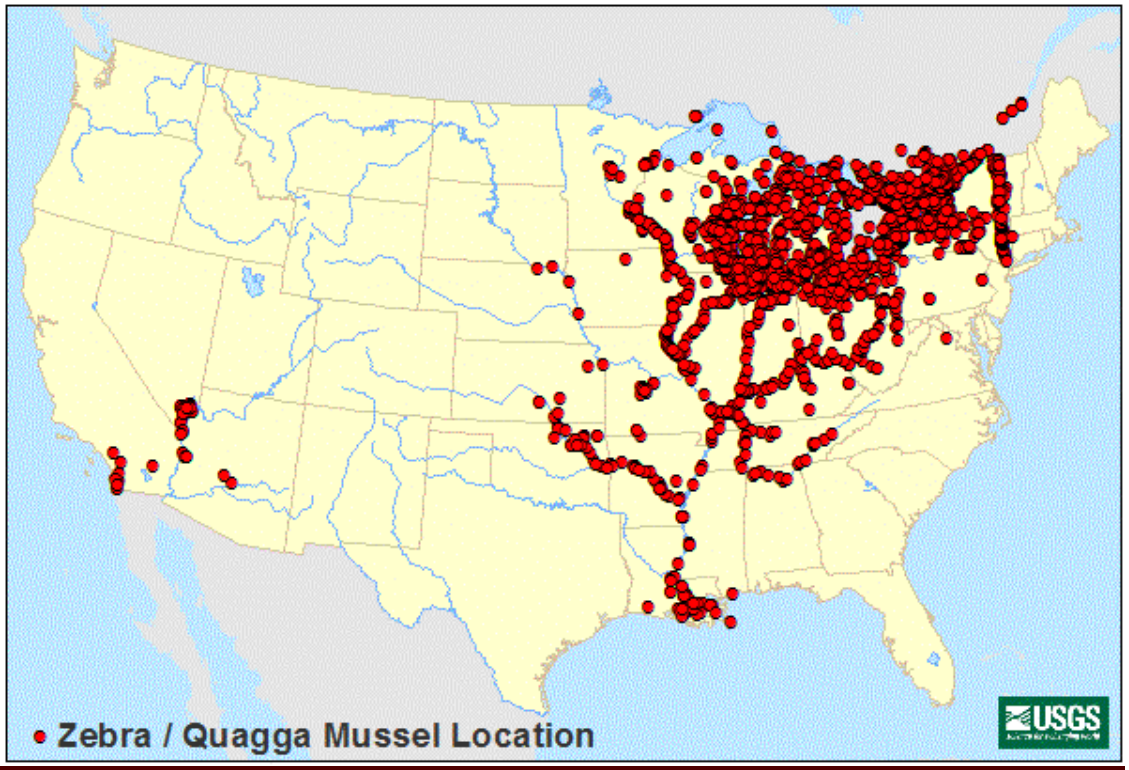
***ROSS ROBERTSON* (Smithsonian Tropical Research Institute)**

- Potential for major disruption of the area's ecosystems
- Highly migratory
- Highly cannibalistic
- Found up to depths of 1200 m
- Adapt quickly to different water temperatures and salinity, sometimes being found in estuaries and mangrove swamps
- Effects of a Cobia population in the East Pacific likely will take many years to become fully evident

***DAN BENNETI* (University of Miami´s Rosenstiel School of Marine and Atmospheric Science)**

- Behavior is not conducive to any major potential impact
- Form small schools
- If there are too many of them, they will eat each other during early developmental stages
- Escapements reported in Puerto Rico and the Bahamas about ten years ago, and cobia have not been found in any numbers in those areas since then

Gobiomorus dormitor



Quagga and Zebra Mussel Sightings Distribution in California, 2007- 2015

LOCATIONS

1 Lake Havasu - San Bernardino Co. - January 2007
2 Colorado River - Parker Dam - San Bernardino Co. - Jan 2007
3 Copper Basin Reservoir - San Bernardino Co. - March 2007
4 Colorado River Aqueduct - Riverside Co. - July 2007
5 Lake Matthews - Riverside Co. - August 2007
6 Lake Skinner - Riverside Co. - August 2007
7 Dixon Lake - San Diego Co. - August 2007
8 Lower Otay Reservoir - San Diego Co. - August 2007
9 San Vicente Reservoir - San Diego Co. - August 2007
10 Murray Reservoir - San Diego Co. - September 2007
11 Lake Miramar - San Diego Co. - December 2007
12 Sweetwater Reservoir - San Diego Co. - December 2007
13 San Justo Lake - San Benito Co. - January 2008
14 El Capitan Reservoir - San Diego Co. - January 2008
15 Imperial Dam - Imperial Co. - February 2008
16 Lake Jennings - San Diego Co. - April 2008
17 Olivenhain Reservoir - San Diego Co. - March 2008
18 Irvine Lake - Orange Co. - April 2008
19 Rattlesnake Reservoir - Orange Co. - May 2008
20 Lake Ramona - San Diego Co. - Mar 2009
21 Walnut Canyon Reservoir - Orange Co. - July 2009
22 Kraemer Basin - Orange Co. - September 2009
23 Anaheim Lake - Orange Co. - September 2009
24 Black Gold Golf Course Pond - Orange Co. - January 2010
25 Lake Poway - San Diego Co. - April 2010
26 Shadow Lake Estates lake - Riverside Co. - April 2012
27 Coachella Canal - Riverside Co. - July 2012
28 Coachella Canal Irrigation Lateral - July 2012
29 Lake Cahuilla - Riverside Co. - July 2012
30 Ridgemark Golf Course - San Benito Co. - Oct 2012
31 Lake Piru - Ventura Co. - December 2013
32 Lake Forest I - Orange Co. - February 2014
33 Lake Forest Keys - Orange Co. - March 2014

Quagga mussels
Zebra mussels

0 50 100 Miles

N

Orange Co.
Riverside Co.
San Diego Co.

0 10 20 Miles

Data Sources: California Dept. of Fish and Wildlife, City of San Diego Water Authority, Imperial Irrigation District, Helix Water District, Irvine Ranch Water District, Coachella Valley Water District, National Park Service. Map produced by the U.S. Geological Survey, October 20, 2015.

USGS

Zebra Mussel in Mexico

NATIONAL WATER COMMISSION
El Florido

El Carrizo Dam