Will Mexican Goodeids Survive The 21st Century?
The alarming decline and precarious future of wild Goodeid populations in Mexico

Sorting Goodeids from La Mintzita Springs, Michoacán

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Wild Mexican Goodeids – Fascinating Fishes That Live In Beautiful Places

- **Allotoca dugesi**
  - Manantlán Stream, Jalisco

- **Allodontichthys zonistius**
  - Lake Pátzcuaro, Michoacán

- **Xenoophorus captivus**
  - Amado Nervo Springs, Durango

- **Skiffia lermae**
  - Manantlán Stream, Jalisco
But Wild Goodeids Are In Trouble – Inhabit Densely Populated And Rapidly Developing Areas Of México

Mexico City

Tamazula Sugar Mill, Jalisco

Tomato fields, Michoacán

Zamora, Michoacán
Habitat Loss – Not Enough Water

Lago de Chapala, 1990: Normal dry season

Lago de Chapala, 1991: Drought
Habitat Degradation – Water Pollution

Lerma River, México

Ayuquila River, Jalisco

Turbio River, Guanajuato
Biological Contamination – Non-Native Species

Tilapia (Oreochromis and Tilapia species)

Rainbow trout (Oncorhynchus mykiss)

Common carp (Cyprinus carpio)

Platyfish (Xiphophorus variatus and X. maculatus)
2005: First published comprehensive
determination of conservation status
and trends of wild Goodeid fishes in Mexico

REPRESENTED SITUATION AS OF 2001
2001 Goodeid Species Status – Grim!

- Endangered: 23
- Extinct: 2
- Low Risk: 3
- Vulnerable: 13
New Goodeid Status Survey for 2011

Why so soon?

1) Decadal surveys warranted for rare fishes

2) Minor changes in conservation categories

3) Taxonomic changes within the Goodeids

4) Goodeids have continued to decline rapidly since 2001!
2011 Goodeid Species Status – Even More Grim!

- Endangered: 23
- Extinct: 5
- Low Risk: 3
- Vulnerable: 9
## 2001 vs. 2011 Goodeid Status

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<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Extinct</td>
<td>5</td>
<td>2</td>
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<tr>
<td>Endangered</td>
<td>23</td>
<td>23</td>
<td>8</td>
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<td>9</td>
<td>13</td>
<td>4</td>
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<td>3</td>
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<td>25</td>
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<tr>
<td>Total Species Recognized</td>
<td>40</td>
<td>41</td>
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Goodeid Population Trends 2001-2011 – Alarming!

- Stable: 14
- Decreasing: 23
- Extinct in 2001: 3
Breaking Down the 2011 Numbers…

1) Goodeid conservation designations based on International Union for the Conservation of Nature (IUCN) criteria
   - Minor updates in these criteria from 2001 to 2011

2) But Goodeid designations not formally recognized by IUCN…
   - Application process long and labor intensive
   - IUCN designation could impede exchanges by aquarists

3) And Goodeid designations also have no official legal standing with the Mexican government…
IUCN Category: Extinct

IUCN Definition – “…when there is no reasonable doubt that the last individual has died.”

2 SPECIES

Characodon garmani – Last observed in 1880’s; Habitat

Girardinichthys (Hubbsina) turneri – Last observed 1980’s; Taxonomic Change

- Lago de Cuitzeo/Río Grande de Morelia – Last observed 1980’s

- Traditionally also reported from Laguna de Zacapu, but this population, still present, as of 2003 considered a different species, Girardinichthys ireneae:
IUCN Category: Extinct in the Wild

IUCN Definition – “…when it is known only to survive in captivity…”

3 SPECIES

**Skiffia francesae** – Last observed in 1970’s. New Population?

**Allodontichthys polylepis** – Last observed in 2000. Habitat

**Allotoca goslinei** – Last observed in 2004. Non-Native Fish
2008: New & Intriguing *Skiffia* Population Discovered

*Skiffia francesae* thought to have occurred only in the Teuchitlán Springs in the upper Ameca River Basin.

New *Skiffia* found in tiny (swimming pool size) Cuyacapán Springs in the adjacent but isolated Sayula Lake Basin.
Cuyacapán *Skiffia* Status: The Data

*Skiffia francesae* – extinct in wild (formerly Teuchitlán springs in Ameca River basin)

*Skiffia multipunctata* – multiple locations in lower Lerma River basin

Genetically most similar

![Male](image1)

![Female](image2)

Cuyacapán *Skiffia*

Pigmentation most similar
1) Cuyacapán *Skiffia* is neither *S. francesae* nor *S. multipunctata* but rather probably a new species

- Therefore, *S. francesae* remains extinct in the wild

2) Tragically, the Cuyacapán springs completely dried up in 2010, and all fish there were killed.

- Fortunately, a captive population is in Morelia

- But do we have another “Extinct in the Wild” Goodeid?
2001: *Allodontichthys polylepis* Habitat Disappears

Upper Ameca River Basin, Jalisco
Habitat Loss - Water Diversions, Groundwater Pumping, 2001 Drought Spell Doom For Species

A riffle dweller. Human water use reduced stream flow, eliminating riffle habitats and populations. A 2001 drought may have finished the species.

2004: Non-Native Swordtail Does In *Allotoca goslinei*

Upper Ameca River Basin, Jalisco
Species Driven Extinct By A Non-Native Competitor

*Allotoca goslinei* was known from only one location, the tiny Potrero Grande Stream, Jalisco….

*Xiphophorus helleri* (green swordtail) invaded the stream between 2000 and 2004….
And *Allotoca goslinei* was quickly eliminated

<table>
<thead>
<tr>
<th>Year</th>
<th><em>Allotoca goslinei</em></th>
<th><em>Xiphophorus helleri</em></th>
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<tr>
<td>2000</td>
<td>90</td>
<td>0</td>
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<tr>
<td>2004</td>
<td>7</td>
<td>120</td>
</tr>
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<td>2006</td>
<td>0</td>
<td>298</td>
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<td>2007</td>
<td>0</td>
<td>259</td>
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Catch in standard 200-meter-long electrofishing survey
IUCN Category: Critically Endangered

IUCN Definition – “Known to exist at only a single location of < 10km$^2$ surface area” or “3 or fewer isolated populations of fewer than 250 mature adults each” or “a 90% decline in population size in the last 10 years”

16 SPECIES

Allotoca (Neoophorus) diazi, Allotoca maculata, Allotoca meeki, Allotoca zacapuensis, Ameca splendens, Ataeniobius toweri, Chapalichthys pardalis, Characodon audax, Characodon lateralis, Girardinichthys ireneae, Girardinichthys viviparus, Ilyodon cortesae, Neoophorus (Allotoca) regalis, Neotoca (Skiffia) bilineata, Xenoophorus captivus, Zoogoneticus tequila
2007: “New” *Ameca splendens* Populations Found

- El Moloya Springs, Jalisco
- Cuyacapán Springs, Jalisco
- Teuchitlán Springs, Jalisco
Now There Are Three *Ameca splendens* Habitats

**Described From**

Teuchitlán Springs, Upper Ameca River Basin

Large But Heavily Modified Habitat; Many Non-Native Species

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2007 – El Moloya Springs, Adjacent But Isolated Magdalena Lake Basin

Tiny and Vulnerable

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2007 – Cuyacapán Springs, Adjacent But Isolated Sayula Lake Basin

Tiny; DRIED UP IN 2010
2010: *Zoogoneticus tequila* Still Persists In The Wild
Rumors Of The Demise Of The Species Are False…

Very precarious – Remains only in an isolated ~20m² side spring within Teuchitlán Springs, Jalisco. Total adult population probably <100 fish

But What Is The Long-Term Viability Of This Population?
2010: Multiple Causes Endanger *Neoophorus regalis*

Los Reyes Valley, Michoacán/Jalisco Balsas River Basin
Range Shrinking Rapidly

1980 – 5 areas; 2000 – 3 areas; 2010 – 1 area

Los Reyes Stream, Michoacán – Present in 2002, gone by 2008; caused by habitat modifications/diversions for irrigation

Quitupán River, Jalisco – Present in 2004, gone by 2010; caused by exotic swordtail *Xiphophorus helleri*?

Huatarillo Stream, Michoacán – Present in 2010; last remaining locality; small numbers; site impacted by polluted runoff from town
2011: *Allotoca meeki* On The Brink Of Extinction

Lake Zirahuén Basin, Michoacán
Introduced Predator Drives Drastic Decline

Originally: Lake Zirahuén and tributaries

Mid 1980’s, largemouth bass (*Micropterus salmoides*) enter Lake Zirahuén

By 1990s, limited to isolated Lake Opopeo

Mid 2000’s, largemouth bass enter Lake Opopeo

By 2011, limited to Lake Opopeo outlet; rare
IUCN Category: *Endangered*

IUCN Definition – “Area of occupancy < 100\(\text{km}^2\) surface area” or “4-8 isolated populations with a total population of fewer than 2500 mature adults” or “a 50-70% decline in population size in the last 10 years”

7 SPECIES

*Allodontichthys hubbsi,*

*Allotoca dugesii,*

*Skiffia lermae, Skiffia multtipunctata,*

*Xenotoca eiseni,*

*Zoogoneticus purhepechus, Zoogoneticus quitzeoensis*
2008: Taxonomic Change “Endangers”
Zoogoneticus quitzeoensis

2001 Range of Zoogoneticus quitzeoensis
“VULNERABLE”
2008: Western Populations Split Off Into New Species Zoogoneticus purhepechus
IUCN Category: Vulnerable

IUCN Definition – “9-15 discrete populations with a total population of fewer than 10000 mature adults” or “a 30-50% decline in population size in the last 10 years”

9 SPECIES

Allodontichthys tamazulae, Allodontichthys zonistius, Alloophorus robustus, Allotoca catarinae, Chapalichthys encaustus, Girardinichthys multiradiatus, Ilyodon whitei, Xenotaenia resolanae, Xenotoca melanosa
2010: Exotics Reduce *Chapalichthys encaustus*

Lago de Chapala and adjacent rivers and smaller lakes
Ten Year Steep Decline In Lago de Chapala

1990’s: *Chapalichthys encaustus* abundant in Lago de Chapala

~2000: Invasion by two non-native Poeciliids

*Gambusia yucatana*  
*Poecilia sphenops*

2010: *Chapalichthys encaustus* relatively uncommon in Lago de Chapala
IUCN Category: Least Concern

IUCN Definition – “more than 15 discrete populations with a total population of more than 10000 mature adults” and “less than a 30% decline in population size in the last 10 years”

3 SPECIES

Goodea atripinnis (luitpoldi/gracilis)
Ilyodon furcidens (xantusi)
Xenotoca variata
What Can We Do To Ensure The Survival Of Wild Populations Of Mexican Goodeids?

Alloophorus robustus, Chapalichthys encaustus, Goodea atripinnis, Skiffia multipunctata, Zoogoneticus purhepechus; La Luz Springs, Michoacán
Conserving Wild Goodeids

1) Protect best remaining habitats for each species
   “Spring” species easiest; small habitats an advantage

La Angostura Springs, Laguna Zacapu, Michoacán
   *Alloophorus robustus*
   *Allotoca zacapuensis*
   *Girardinichthys ireneae*
   *Goodea atripinnis*
   *Skiffia lermae*
   *Xenotoca variata*
   *Zoogoneticus quitzeoensis*

La Mintzita Springs, Michoacán, (5 of above Goodeids) also one of the best
Examples Of Other Key Spring/Small Lake Habitats:

Lago Los Negritos, Michoacán
- *Allophorus robustus*
- *Chapalichthys encaustus*
- *Goodea atripinnis*

Durango Valley springs, Durango
- *Characodon audax*
- *Characodon lateralis*

Hacienda San Sebastian Stock Tank, Jalisco
- *Goodea atripinnis*
- *Xenotoca cf. eiseni*
- *Xenotoca melanosoma*
Spring Protection Has Many Other Benefits

e.g., drinking water, livestock/irrigation water, swimming and recreation

Cupatchiro Springs, Michoacán, is protected as a municipal water supply, helping conserve:

- *Alloophorus robustus*
- *Goodea atripinnis*
- *Skiffia multipunctata*
- *Zoogoneticus purhepechus*

But keeping out non-native species very difficult; “exotics” are the biggest threat to most springs

The Cupatchiro Springs already have:

Common carp (*Cyprinus carpio*)
Rainbow trout (*Oncorhynchus mykiss*)
Tilapia (*Oreochromis aureus*)
Protecting “Riverine” Goodeids More Challenging
Need a watershed approach; much larger areas must be conserved

*Allodontichthys hubbsi*
Tamazula River, Jalisco

*Xenotaenia resolanae*
Cuzalapa River, Jalisco
Existing Reserves Only Protect Some Species

Sierra de Manantlán Biosphere Reserve protects:
- Allodontichthys zonistius
- Ilyodon furcidens
- Xenotaenia resolanae

No reserves adequately protect:
- Allodontichthys hubbsi
- Allodontichthys tamazulae
- Ilyodon whitei
- Ilyodon cortesae
Conserving Wild Goodeids

2) Restore key degraded habitats (where practical)

Ayuquila River, Jalisco, example

Pre 1999

Sugar Cane, major crop

Gross pollution, no dissolved oxygen, no fish

Ayuquila River, major fishery, biodiversity

Sugar Mill, major employer; untreated discharges to:
25 Km Of River Below The Sugar Mill Was Fishless
1999: Sugar mill wastes diverted to irrigation canals

Passing for about 8 km through canals allows some solids to settle out, some breakdown of wastes; results in less-polluted discharge to river.
Partial treatment of discharge – partial fish recovery

Ayuquilia River Oxygen and Fish: January 2003

Graph showing dissolved oxygen (mg/l) and number of fish species as a function of river kilometer. The graph indicates a decrease in dissolved oxygen and an increase in fish species as you move downstream from 70 to 20 kilometer, with a notable sugar mill discharge event.
Ilyodon furcidens Has Re-Colonized River Below Mill
But Solving One Problem Creates Another…

Less pollution means clearer water

Clearer water leads to increased abundance and more effective predation by non-native *Micropterus salmoides*

More predation leads to many fewer *Ilyodon furcidens* in some areas
Conserving Goodeids

3) Establish and maintain captive breeding colonies

“Fish Ark” Captive Goodeid Facility
Universidad Michoacana de San Nicolas Hidalgo, Morelia, Michoacán

Species maintenance efforts by the GWG, ALA, other groups, and many individual hobbyists
Most urgent needs for captive rearing:

**Extinct in the wild:**

*Allodontichthys polylepis, Allotoca goslinei, Skiffia francesae, Cuyacapán Skiffia?*

**The most Critically Endangered in the wild:**

*Allotoca maculata, Allotoca meeki, Allotoca zacapuensis, Girardinichthys ireneae, Neoophorus regalis, Zoogoneticus tequila*

*Allotoca maculata*, Magdalena Lake, Jalisco

But **all** Goodeids warrant captive rearing!
Summary and Conclusions

1) Wild Goodeids are in serious trouble; most species are endangered and/or in serious decline

2) Primary threats are water quantity, water quality, and non-native species

3) Conservation requires protection, restoration, and captive rearing

4) GWG can play a key role by educating the public and advocating for Goodeid conservation, by continuing captive rearing, and by raising funds to support habitat conservation in Mexico
Sunrise over Lago de Pátzcuaro, Michoacán