Predicting the Potential Geographic Distributions of Non-native fishes in Florida

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**Introduction**

Due to its subtropical climate, status as a major hub for the pet trade, large population size, and extensive hydrologic alteration, Florida is a hotspot for non-native fish introductions. Many of these non-native fish are both numerous and widespread, having successfully overwintered and reproduced for several decades. Some, such as the Mayan Cichlid and Pike Killifish, have been documented having severe negative impacts on native fish populations. While their current Floridian ranges are largely well documented, one big unanswered question remains: How will non-native fish ranges respond to climate change?

**Research Methods**

- Species distribution modeling (SDM) using Maxent
  - Relates current presence records with geospatial bioclimatic data
  - Predicts future habitat suitability as a result of climate change (since ecological niches are conservative through time)

- Presence records:
  - US invasive range: USGS NAS database
  - Native and invasive range elsewhere: GBIF
  - Only where Minimum Temperature of Coldest Month (BIO6) was above published lower lethal limits for each species

- WorldClim bioclimatic layers:
  - Only layers relevant to non-native fish biology in Florida included
  - Autocorrelated factors removed
  - 2.5 minute resolution
  - Cropped to include HydroSHEDS watersheds where thinned presence records occurred

**Bioclimatic Layers**

<table>
<thead>
<tr>
<th>Minimum Temperature of Coldest Month (BIO6)</th>
<th>Mean Temperature of Driest Quarter (BIO9)</th>
<th>Precipitation of Wettest Month (BIO13)</th>
<th>Precipitation of Driest Month (BIO14)</th>
</tr>
</thead>
<tbody>
<tr>
<td>% Contribution</td>
<td>Permutation Importance</td>
<td>% Contribution</td>
<td>Permutation Importance</td>
</tr>
<tr>
<td>Pike Killifish</td>
<td>BIO6 (54%)</td>
<td>BIO6 (68.8%)</td>
<td>BIO9 (14.2%)</td>
</tr>
<tr>
<td>African Jewelfish</td>
<td>BIO6 (68.8%)</td>
<td>BIO6 (73.6%)</td>
<td>BIO8 (13.5%)</td>
</tr>
<tr>
<td>Mayan Cichlid</td>
<td>BIO6 (54%)</td>
<td>BIO6 (73.6%)</td>
<td>BIO6 (13.5%)</td>
</tr>
<tr>
<td>Butterfly Peacock Bass</td>
<td>BIO6 (87.8%)</td>
<td>BIO6 (94.7%)</td>
<td>BIO1 (4.9%)</td>
</tr>
</tbody>
</table>

**Synthesis and Significance**

- Nearly all non-native fishes are predicted to expand their distributions in Florida
- But the Everglades will become less suitable for three of the species we modelled
- African Jewelfish and Mayan Cichlids are already dominant in areas of the Everglades
- If it becomes LESS suitable for them, what will this mean for the native community?
- The Butterfly Peacock Bass, a species with the highest lower lethal limit, is predicted to expand into more of the Everglades. What will this mean for the native community?

- These predictions are CONSERVATIVE
- Freshwater springs may serve as thermal refugia permitting non-native persistence north of our predictions
- Many of these species can tolerate saltwater→salinity bridge dispersal?
- Unless we intervene, uninvasd ecosystems may be colonized by these potentially invasive species with unpredictable consequences