Long-term study of reservoir cascade in Southeastern Brazil reveals spatio-temporal gradient in fish assemblages

Raquel C. Loures  
Cemig Geração e Transmissão, Belo Horizonte, Minas Gerais, Brazil

Paulo S. Pompeu  
Federal University of Lavras, UFLA, Lavras, Minas Gerais, Brazil

Follow this and additional works at: https://scholarworks.umass.edu/fishpassage_conference
Long-term study of reservoir cascade in Southeastern Brazil reveals spatio-temporal gradient in fish assemblages

Raquel Coelho Loures
Paulo dos Santos Pompeu

*Marine and Freshwater Research*
69(12) 1983 - 1994

*Fish Passage 2018*
*Hydropower and Fish Symposium*
*Albury, Australia*
1338 hydropower dams in Brazil: (BIG/ANEEL, 30/10/2018)

- 693 < 3 MW
- 427 3 - 30 MW
- 218 > 30 MW

Installed Power per district (kW)

<table>
<thead>
<tr>
<th>Power (KW)</th>
<th>Installed Power per district (kW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 a 1.000.000</td>
<td>0 - 1000 kW</td>
</tr>
<tr>
<td>1.000.001 a 5.000.000</td>
<td>1001 - 5000 kW</td>
</tr>
<tr>
<td>5.000.001 a 10.000.000</td>
<td>5001 - 10000 kW</td>
</tr>
<tr>
<td>acima de 10.000.001</td>
<td>acima de 10.000 kW</td>
</tr>
<tr>
<td>acima de 4.000.001</td>
<td>acima de 4001 kW</td>
</tr>
</tbody>
</table>
INTRODUCTION

Uatumâ River in Amazon State

Balbina Reservoir, Brazil (NASA, Images of Change)
Reservoir cascade:
the loss of connectivity by impoundments leads to longitudinal shifts of gradients in different variables (e.g. temperature, substrate, nutrients and biodiversity)

long-term monitoring to determine impacts of river damming

River Continuum Concept (Vannote et al. 1980)
Evaluate spatio-temporal changes in fish assemblages in Araguari reservoir cascade system.
Sampling sites in the Araguari reservoir cascade system (475 km).
- Year of reservoir filling
- Capacity installed (MW)
- Reservoir area (km²)

**Araguari reservoir cascade, Upper Paraná River basin, Brazil**
From 1993 to 2015, 23 years of monitoring

Fish were caught using gillnets with mesh sizes from 3, 4, 5, 6, 7, 8, 10, 12, 14 and 16 cm (opposite knot length)

We only considered sampling events that clearly indicated sample effort = 111 samples
RESULTS AND DISCUSSION

- 72 fish species sampled, representing five orders and 19 families.
- 58 species were native to the basin
- 14 non-native
  - 10 from other Brazilian basins and
  - 4 from other countries
RESULTS AND DISCUSSION

12 migratory species were recorded

- Brycon orbignyanus
- Leporinus friderici
- Megaleporinus macrocephalus
- Megaleporinus obtusidens
- Pinirampus pirinampu
- Pseudoplatystoma corruscans
- Prochilodus lineatus
- Salminus brasiliensis
- Salminus hilarii
- Pimelodus maculatus
- Piaractus mesopotamicus
- Zungaro jahu

Images: Ota et al., 2018
How does fish species richness vary over time?
How does fish species richness vary among the reservoirs?

**Violin plot comparing the distribution pattern of richness among reservoirs**

- **Total (P = 0.093)**
- **Native (P = 0.008)**
- **Non-native (P < 0.001)**
- **Migratory (P < 0.001)**
Is there a longitudinal gradient in fish assemblages along the cascade?

nMDS using Bray–Curtis dissimilarity index
(ANOSIM: $P < 0.01$; $R = 0.585$)
RESULTS AND DISCUSSION

What are the factors structuring native fish assemblage in the reservoir cascade?

Marginal and sequential test results from distance-based linear models (DistLM).

<table>
<thead>
<tr>
<th>Group</th>
<th>SS(trace)</th>
<th>Pseudo-F</th>
<th>P</th>
<th>Explained variation (%)</th>
<th>AIC</th>
<th>Cumulative explained variation (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Marginal test</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>22535</td>
<td>7.39</td>
<td>0.001</td>
<td>6.35</td>
<td>6.35</td>
<td></td>
</tr>
<tr>
<td>Area</td>
<td>25301</td>
<td>8.36</td>
<td>0.001</td>
<td>7.13</td>
<td>7.13</td>
<td></td>
</tr>
<tr>
<td>Position</td>
<td>68645</td>
<td>26.12</td>
<td>0.001</td>
<td>19.33</td>
<td>19.33</td>
<td></td>
</tr>
<tr>
<td>Piscivorous</td>
<td>34964</td>
<td>1.89</td>
<td>0.001</td>
<td>9.85</td>
<td>9.85</td>
<td></td>
</tr>
<tr>
<td>Herbivorous</td>
<td>31120</td>
<td>3.43</td>
<td>0.001</td>
<td>8.76</td>
<td>8.76</td>
<td></td>
</tr>
<tr>
<td>Omnivorous</td>
<td>15746</td>
<td>1.66</td>
<td>0.007</td>
<td>4.43</td>
<td>4.43</td>
<td></td>
</tr>
<tr>
<td>Invertivorous</td>
<td>14965</td>
<td>2.38</td>
<td>0.003</td>
<td>4.21</td>
<td>4.21</td>
<td></td>
</tr>
</tbody>
</table>

Sequential test:

| +Position           | 68645     | 26.12    | 0.001 | 19.33                    | 875.99| 19.33                            |
| +Area               | 27821     | 11.62    | 0.001 | 7.83                     | 866.65| 27.17                            |
| +Age                | 19879     | 8.91     | 0.001 | 5.60                     | 859.77| 32.76                            |
| + Herbivorous       | 28696     | 4.74     | 0.001 | 8.08                     | 851.56| 40.84                            |

Non-native species: Metynnis maculatus
The observed longitudinal gradient suggested an additive effect of nearby reservoirs in fish assemblage structure.

Possible cumulative effects in reservoir cascade must be carefully considered in the first stage of hydropower development plans, in river basin inventories, when alternatives for dam construction are being studied.

The influence of longitudinal position of the reservoir along the cascade demonstrates the importance of larger spatial scales analysis.

Finally, the monitoring of non-native fish species populations is also crucial to inform any program that aims to prevent, control or eradicate such species.
Thanks for your attention!
Raquel Loures
raquel.fontes@cemig.com.br
quelloures@gmail.com