Native-nonnative Interactions; Factors Influencing Predation and Competition

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Project G: Trout/chub interactions

- Effects of competition between rainbow and brown trout and humpback chub

- Relative predation vulnerability of juvenile chub to adult conspecifics and to rainbow and brown trout

- Effects of water temperature, fish size and turbidity on predation vulnerability to rainbow and brown trout
Confluence of the Colorado River and Little Colorado Rivers in Grand Canyon
Rainbow and brown trout do consume native fish in Grand Canyon


but population level impacts are difficult to assess because predation vulnerability is highly variable depending on the sizes of the prey and predators and physical conditions under which the predation interactions take place.
Predation Methods

- 4 trout predators per tank
- 12 chub prey per tank (in baskets)
- Allowed to acclimate for 24- h
- Baskets tipped – Live fish counted 24 h later
How can lab data tell us anything useful?

Lab data does **not** tell us what humpback chub predation vulnerability is in the mainstem Colorado River.

- but it can tell us what environmental factors are most important and how relationships are likely to change.
Number and sizes of fish used to evaluate the relationship between water temperature, fish size, turbidity and predation vulnerability

<table>
<thead>
<tr>
<th></th>
<th>Number of Replicates</th>
<th>Number of Trout</th>
<th>Trout Total Length (mm)</th>
<th>Prey Species</th>
<th>Number of Chub</th>
<th>Chub Total Length (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Rainbow Trout</strong></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>12</td>
<td>48</td>
<td>299 (283 - 319)</td>
<td>Bonytail</td>
<td>144</td>
<td>77 (70 - 85)</td>
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<tr>
<td></td>
<td>24</td>
<td>96</td>
<td>275 (261 - 291)</td>
<td>Humpback chub</td>
<td>288</td>
<td>65 (45 - 87)</td>
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<tr>
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<td>12</td>
<td>48</td>
<td>305 (281 - 324)</td>
<td>Roundtail chub</td>
<td>144</td>
<td>63 (47 - 71)</td>
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<tr>
<td></td>
<td>24</td>
<td>96</td>
<td>288 (260 - 330)</td>
<td>Bonytail</td>
<td>288</td>
<td>66 (60 - 70)</td>
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<tr>
<td></td>
<td>80</td>
<td>320</td>
<td>289 (261 - 321)</td>
<td>Bonytail</td>
<td>960</td>
<td>66 (60 - 70)</td>
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<tr>
<td><strong>Brown Trout</strong></td>
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<td>12</td>
<td>48</td>
<td>246 (230 - 273)</td>
<td>Bonytail chub</td>
<td>144</td>
<td>77 (67 - 90)</td>
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<td>36</td>
<td>144</td>
<td>263 (218 - 341)</td>
<td>Humpback chub</td>
<td>432</td>
<td>70 (45 - 91)</td>
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<td>12</td>
<td>48</td>
<td>231 (214 - 245)</td>
<td>Roundtail chub</td>
<td>144</td>
<td>58 (44 - 67)</td>
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<td>24</td>
<td>96</td>
<td>288 (260 - 330)</td>
<td>Bonytail</td>
<td>288</td>
<td>66 (60 - 70)</td>
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<tr>
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<td>64</td>
<td>256</td>
<td>260 (210 - 399)</td>
<td>Bonytail</td>
<td>786</td>
<td>67 (60 - 70)</td>
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<tr>
<td><strong>Totals</strong></td>
<td><strong>300</strong></td>
<td><strong>1152</strong></td>
<td><strong>2658</strong></td>
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</tbody>
</table>

Preliminary data, do not cite
Percent (%) probability that a juvenile chub will survive predation by a 285 mm rainbow trout as chub size increases from 45-85 mm TL at 10, 15 and 20 °C, with trout size held constant at 285 mm TL.

Preliminary data, do not cite
Percent (%) probability that a juvenile chub will survive predation by a 285 mm brown trout as chub size increases from 45-85 mm TL at 10, 15 and 20 °C, with trout size held constant at 285 mm TL. Note that the y-axis on the brown trout is reduced by half.

Preliminary data, do not cite
Roundtail chub grown at three water temperatures in the laboratory for 9 months. It's not just about instantaneous predation vulnerability; it's also about growth!
Percent (%) probability that a juvenile chub at 55 mm TL will survive predation by rainbow trout as trout size increases from 220 – 300 mm TL at 10, 15 and 20 °C, with chub size held constant at 55 mm TL.
Percent (%) probability that a juvenile chub at 55 mm TL will survive predation by brown trout as trout size increases from 220 – 300 mm TL at 10, 15 and 20 °C, with chub size held constant at 55 mm TL. Note that the y-axis on the brown trout is reduced by half.
Sifted mud down to <63 microns and blended before mixing in trial tanks
Preliminary trials

50 FNU

200 FNU

500 FNU

1000 FNU
Percent probability of survival for juvenile humpback chub (60 mm TL) exposed to predation by rainbow trout (285 mm TL) as turbidity increases from 0 – 150 FNU at 15° C.
Rainbow Trout Summary

<table>
<thead>
<tr>
<th>NTU</th>
<th>Survival</th>
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<tr>
<td>25</td>
<td>46%</td>
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<tr>
<td>50</td>
<td>62%</td>
</tr>
<tr>
<td>75</td>
<td>60%</td>
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<tr>
<td>100</td>
<td>75%</td>
</tr>
<tr>
<td>150</td>
<td>80%</td>
</tr>
</tbody>
</table>

Clear trials: 0% survival

Preliminary data, do not cite
Percent probability of survival for juvenile humpback chub (60 mm TL) exposed to predation by brown trout (285 mm TL) as turbidity increases from 0 – 150 FNU at 15° C.
Percent probability of survival for juvenile chub exposed to predation by adult roundtail chub (260 mm TL) or rainbow trout (260 mm TL) at 20°C in overnight laboratory trials.
Percent probability of survival for juvenile chub exposed to predation by adult roundtail chub (260 mm TL) at 15° C or rainbow trout (260 mm TL) at 10° C in overnight laboratory trials.
Percent probability of survival for juvenile chub exposed to predation by adult roundtail chub (260 mm TL) at 10° C or rainbow trout (260 mm TL) at 10° C in overnight laboratory trials.
Preliminary data, do not cite
Let's evaluate the lab data in terms of what we see in the field

1. Differences in water temperature
2. Changes in Prey Size
3. Changes in average trout size
4. Annual variability in turbidity
Water Temperatures: Colorado River near Little Colorado River Confluence

**1998**

Average = 11.1 °C

**2005**

Average = 16 °C

5 °C increase

(UGS gage 09383100: http://www.gcmrc.gov/discharge_qw_sediment/station/GCDAMP/09383100)
Length Frequency histograms for Age-0 humpback chub in July in the Little Colorado River

Dzul and Yakulic, GCMRC, 2014 unpublished Data, do not cite
Preliminary data, do not cite
Annual variability in turbidity

Turbidity at Grand Canyon gauge July 1 to Nov 1

Year
2008 2009 2010 2011 2012 2013 2014

# of Days with Turbidity above 40 FNU
100
80
60
40
20

Preliminary data, do not cite
Evaluate Scenarios in JMP
Conclusions

- Brown trout are bad news for native fish!
- A small chub is a vulnerable chub!
- Increases in chub size greatly reduce predation vulnerability!
Conclusions

• Relatively small changes in turbidity may be sufficient to alter predation dynamics of rainbow trout on humpback chub!