Humpback Chub Population Dynamics throughout the Colorado River Ecosystem

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Project G: Humpback Chub (HBC) Population Dynamics throughout the Colorado River Ecosystem

- **Project elements and objectives:**
  - G.1: HBC population modeling
  - G.2: Annual spring/fall HBC abundance estimates in the lower 13.6 km of the Little Colorado River (LCR)
  - G.3: Juvenile HBC monitoring near the LCR confluence
  - G.4: Remote PIT tag array monitoring in the LCR
  - G.5: Monitoring HBC aggregation relative abundance and distribution
  - G.6: Juvenile chub monitoring - West
  - G.7: Chute Falls HBC translocations
  - G.9: Backwater seining

- **Funding Amount and Source:** $1.47 million AMP

- **Products:** 6 published journal articles, 4 reports, 6 conference presentations (see AMWG annual report)

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G.1-3  HBC population monitoring in and around the Little Colorado River
Little Colorado River

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Closed models:
- Assumptions: No immigration/emigration and Survival is 100%
- Requires short time between mark and recapture event

Open models:
- Allows for survival and movement
- Need at least 3 capture occasions
- More robust to some model assumptions

It is useful to fit both model types to see whether they agree
Colorado River

Little Colorado River

Adult abundance in LCR

Aggregation

Outmigration

Spring spawning migration

Resident

Skipped spawning
Adult HBC abundance in LCR aggregation (open model)
Spring abundances of HBC ≥150 mm and ≥200 mm in lower 13.6 km of LCR (closed model)
Adult HBC spawning rate
(i.e., movement between CR and LCR)
(open model)

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Colorado River

Little Colorado River

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Colorado River

Little Colorado River

July age-0 abundance in LCR
Age 0 HBC abundance in LCR in July
(closed model)

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Juvenile HBC abundances
(closed model)

blue = age-0 fish in fall
red = age-1 fish in spring

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Fall juvenile HBC abundance in JCM reach
(mostly closed model)
Colorado River

Little Colorado River

Juvenile abundance

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Colorado River

Subadult abundance

Little Colorado River

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Spring abundances of HBC (150-199 mm) in lower 13.56 km of LCR with new 1,250 trigger (closed model)

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Fall HBC subadult abundance in JCM reach
(open model)
G.4 Remote PIT tag array monitoring in the LCR: Multiplexeer (MUX)

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Comparison of spring 2017 data show that USFWS and LCR MUX are detecting different components of the HBC population.

LCR MUX is probably better at detecting larger fish that might be trap shy.

<table>
<thead>
<tr>
<th></th>
<th>Captured by USFWS</th>
<th>Detected on LCR MUX</th>
</tr>
</thead>
<tbody>
<tr>
<td>All HBC</td>
<td>2860</td>
<td>2622</td>
</tr>
<tr>
<td>HBC with previous capture &gt;199mm TL</td>
<td>484</td>
<td>1651</td>
</tr>
</tbody>
</table>
Adult abundance is steady (possibly increasing), but juvenile production has been low for three years.

Autonomous PIT tag antennas (like the MUX) may provide valuable detection information about fish that are hard to sample with hoop nets.
G.7 Chute Falls Translocations
## Date, numbers, and sizes of HBC collected from the LCR for translocations (2003-2018)

<table>
<thead>
<tr>
<th>Date</th>
<th>Chute Falls * Size (mm)</th>
<th>SNARRC</th>
<th>Shinumo</th>
<th>Havasu</th>
<th>Size (mm)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/1/03</td>
<td>283 50-100</td>
<td></td>
<td></td>
<td></td>
<td>283</td>
<td></td>
</tr>
<tr>
<td>7/30/04</td>
<td>299 50-100</td>
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<td></td>
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<td>299</td>
<td></td>
</tr>
<tr>
<td>7/29/05</td>
<td>567 50-100</td>
<td></td>
<td></td>
<td></td>
<td>567</td>
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</tr>
<tr>
<td>7/22/08</td>
<td>299 ~80-130</td>
<td>207</td>
<td>&lt;80</td>
<td>506</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/13/08</td>
<td>300 ~80-130</td>
<td>100</td>
<td>&lt;130</td>
<td>400</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/24/09</td>
<td>194 ~80-130</td>
<td>205</td>
<td>83</td>
<td>482</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/10/09</td>
<td>238 &lt;130</td>
<td></td>
<td></td>
<td>238</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/16/10</td>
<td>108 ~80-130</td>
<td>175</td>
<td>&lt;80</td>
<td>283</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/5/10</td>
<td></td>
<td></td>
<td></td>
<td>600</td>
<td></td>
<td></td>
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<tr>
<td>11/9/11</td>
<td>96 ~80-130</td>
<td>200</td>
<td>300</td>
<td>596</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/12/12</td>
<td>212 ~80-130</td>
<td>202</td>
<td>300</td>
<td>914</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/24/13</td>
<td>73 &lt;30</td>
<td></td>
<td>&lt;30</td>
<td>73</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7/11/13</td>
<td>99 &lt;80</td>
<td></td>
<td></td>
<td>99</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/7/13</td>
<td>303 ~80-130</td>
<td>11</td>
<td>300</td>
<td>614</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/1/14</td>
<td></td>
<td></td>
<td>&lt;130</td>
<td>660</td>
<td></td>
<td></td>
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<tr>
<td>10/31/14</td>
<td>305 65-137</td>
<td></td>
<td>&lt;130</td>
<td>305</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5/28/15</td>
<td></td>
<td></td>
<td>&lt;30</td>
<td>315</td>
<td></td>
<td></td>
</tr>
<tr>
<td>11/1/15</td>
<td>303 61-128</td>
<td></td>
<td></td>
<td>303</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/27/16</td>
<td>137 58-146</td>
<td></td>
<td></td>
<td>137</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6/16/17</td>
<td></td>
<td>139</td>
<td>&lt;40</td>
<td>315</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/26/17</td>
<td>315 66-120</td>
<td></td>
<td></td>
<td>315</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10/29/18</td>
<td>49 63-115</td>
<td></td>
<td></td>
<td>49</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Totals</td>
<td>3,470</td>
<td>1,082</td>
<td>1,311</td>
<td>2,175</td>
<td>8,038</td>
<td></td>
</tr>
</tbody>
</table>
Above Chute Falls - Number of juvenile HBC translocated (black) and adult abundances (red & grey)
Below Chute Falls (Atomizer reach) - Adult HBC abundances (red & grey)

Provisional. Do not cite.
Chute Falls translocation multi-state model

- Multi-state model
- Three different habitats:
  - Lower LCR
  - Translocated LCR (includes upper Atomizer reach)
  - Colorado River
- Each habitat has different growth/survival
- Fish can move between habitats
Survival is higher for translocated HBC than for HBC that remain in lower LCR.
Growth (probability of moving to next size class) of translocated HBC is similar or faster to that of fish in the lower LCR.
Number of adults that result from a one-time translocation of 300 fish above Chute Falls

Translocate 300 fish in year 0 (80-150mmTL)
Comparison of HBC that have and have not been translocated above CF

Purple = translocated above CF
Red = not translocated

Provisional. Do not cite.
Net benefit of one-time translocation
(difference between two groups in previous slide)

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Net benefit of translocating 300 fish every year amounts to 350 extra adults in LCR aggregation.
Summary

- Higher growth rates and increased survival appear to be a result of translocating fish to above Chute Falls.

- Downstream movement may be one factor ultimately precluding permanent colonization of HBC above Chute Falls.

- Translocations are relatively easy and inexpensive beneficial conservation action.
G.5 Monitoring Colorado River aggregations of Humpback Chub
Species catch by aggregation trip (2010-2018)
Species catch (nonnatives only) by aggregation trip (2010-2018)
HBC CPUEs at aggregation and non-aggregation sites

2018
HBC CPUEs at aggregation and non-aggregation sites

Periods
CPUEs of adult HBC by year in western Grand Canyon

Year


Mean (±SE) Captures per Hoop Net Set (n)

Havasu
Fern Glen
Froggy Fault
Fall Canyon
Pumpkin Spring
Bridge City
Spencer-Surprise
Length frequencies of HBC during agg 2010-2013 trips vs 2014-2018 (western Grand Canyon)

- Reach 1 (Havasu-Lava)
- Reach 2 (Lava-Diamond)
- Reach 3 (below Diamond)
Seining CPUEs of HBC in western Grand Canyon
Closed population estimates of HBC and Flannelmouth Sucker (FMS) in the mainstem

- In 2017 we estimated closed abundances of HBC and FMS by size categories in the JCM East and JCM West reaches.

- Our strategy was to use the aggregation trip as a marking event, followed by the JCM monitoring as a recapture trip.

- This was repeated in 2018, but at one additional site below Diamond Creek near Bridge City.
Closed population estimates and densities (fish/mile) of HBC by size class near Bridge City in fall 2018 (RM 236.7-238.7; 2 miles of river)

<table>
<thead>
<tr>
<th>Length (mm)</th>
<th>Marked</th>
<th>Captured</th>
<th>Recaptured</th>
<th>N</th>
<th>Lower</th>
<th>Upper</th>
<th>CV</th>
<th>p1</th>
<th>p2</th>
<th>Adj. Density</th>
</tr>
</thead>
<tbody>
<tr>
<td>100-149</td>
<td>10</td>
<td>67</td>
<td>3</td>
<td>140</td>
<td>94</td>
<td>186</td>
<td>0.17</td>
<td>0.04</td>
<td>0.30</td>
<td>63</td>
</tr>
<tr>
<td>150-199</td>
<td>81</td>
<td>149</td>
<td>27</td>
<td>385</td>
<td>280</td>
<td>490</td>
<td>0.14</td>
<td>0.18</td>
<td>0.33</td>
<td>174</td>
</tr>
<tr>
<td>200-249</td>
<td>28</td>
<td>95</td>
<td>18</td>
<td>199</td>
<td>139</td>
<td>260</td>
<td>0.15</td>
<td>0.19</td>
<td>0.64</td>
<td>90</td>
</tr>
<tr>
<td>250-299</td>
<td>41</td>
<td>143</td>
<td>13</td>
<td>324</td>
<td>234</td>
<td>415</td>
<td>0.14</td>
<td>0.09</td>
<td>0.32</td>
<td>147</td>
</tr>
<tr>
<td>&gt;=300</td>
<td>20</td>
<td>100</td>
<td>7</td>
<td>214</td>
<td>150</td>
<td>279</td>
<td>0.15</td>
<td>0.07</td>
<td>0.35</td>
<td>97</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>1,263</td>
<td>1,263</td>
<td>571</td>
<td></td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>
HBC and FMS density (fish/mile) in Bridge City reach fall 2018

The graph shows the density of Humpback Chub (blue bars) and Flannelmouth Sucker (orange bars) in different length categories (TL) in Bridge City reach during fall 2018. The density is measured in fish per mile. The categories are:
- 100-149
- 150-199
- 200-249
- 250-299
- >300

The data indicates a higher density of Humpback Chubs in the 150-199 length category compared to other categories, while Flannelmouth Suckers show a peak density in the 200-249 length category. The error bars indicate the variability in the data.
Adult HBC densities (fish/mile) by size category in the mainstem at 3 select locations
Summary

- Native fish comprised 99.8% of hoop net catches in the mainstem aggregation trip in 2018.
- HBC and FMS hoop net CPUEs continue to be high in western Grand Canyon (although somewhat lower than 2017).
- Since 2014, western Grand Canyon has been populated by HBC representing all size classes.
- Thus far, successful closed mark-recapture efforts for HBC have occurred at JCM East (2017, 2018) and JCM West (2017), and at Bridge City (2018), with the most successful (sufficient recaptures within 50 mm size classes) being at Bridge City (2018).
Thank you