Mechanical Removal of Nonnative Fishes from the Colorado River within Grand Canyon

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Preliminary Results: Subject to Peer Review and Revision
In 2002, concern for the downward trend in humpback chub abundance prompted experimental adaptive management actions including removal of non-native fish. Melis et al. 2006
Background and Motivation

- Jan 2002, AMWG directed GCMRC to develop a plan of experimental flows:
  - “In concert with RPA flows for native fish during 2002-2003 request that the GCMRC, in consultation with the TWG, design an experimental flows sequence that tests hypotheses for conservation of sediment. Report to AMWG in April 2002 on the proposed flow sequence.”

- Chief of GCMRC directs staff to design an experiment to address questions related to providing better management of Sediment **AND** Native Fish.

- What are the factors potentially influencing native fish population dynamics?
  - Dam Operations
  - Water temperature
  - Parasites
  - Non-native Fish (LCR and Mainstem)
  - Backwaters
What are the factors likely influencing native fish population dynamics that we have the ability to test?

- Dam Operations
- Water temperature
- Non-native Fish (Mainstem)
February 2002, GCMRC proposes a 16 year study to address questions related to providing better management of Sediment AND Native Fish.

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<tr>
<th>Year</th>
<th>Mechanical Removal</th>
<th>Fluctuating Flows</th>
<th>Temperature Control Device</th>
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Objectives

- Evaluate Efficacy of Removing Nonnative Fish
  - To what extent can we remove non-native fishes from a large reach (17 km) of the Colorado River?

- Evaluate Effect of Nonnative Fish Removal on the Population Dynamics of Native Fishes
  - Will humpback chub recruitment increase as a result of non-native removal?
Methods - Study Site

Little Colorado River Non-Native Fish Removal Study Area with Reaches and Sampling Unit Boundaries
Methods - Removal

- 2003 to 2006 - 6 trips/year
  - Jan, Feb, Mar (Winter)
  - Jul, Aug, Sep (Summer)

- Electrofishing
  - 4-5 depletion passes within each 500m site
  - Euthanized all non-native fish
  - Live release of all native fish, pit tagged if TL>150mm
Methods – Removal Data Analysis

- Constructed abundance estimates for rainbow trout using a Hierarchical Bayes Removal Model (Dorazio et al. 2005).
  - Assumed that site-specific capture probability is drawn from a common Beta distribution.
    - Prior on capture probability.
  - Assumed that site-specific abundance is drawn from a common Poisson distribution.
    - Prior on abundance.
- Model based aggregation of between site data.
  - Allows sites with high measurement error to be informed or “shrunk” towards the common mean.
Methods - Hoopnetting

- **Hoopnet sampling**
  - 30 sites - 3 sets/trip
  - Primarily used as a measure of juvenile humpback chub relative abundance
Results: Efficacy of Removal Efforts for Non-native Fish
Results - Catch by Mass

Electrofishing Species Composition in the LCR Removal Reach

0 10 20 30 40 50 60 70 80 90 100
Percent Composition by Mass

Jan-03 Feb-03 Mar-03 Apr-03 May-03 Jun-03 Jul-03 Aug-03 Sep-03 Oct-03 Nov-03 Dec-03

Electrofishing Catch by Species in the LCR Removal Reach

0 500 1000 1500
Total Catch (Kg)

Jan-03 Feb-03 Mar-03 Apr-03 May-03 Jun-03 Jul-03 Aug-03 Sep-03 Oct-03 Nov-03 Dec-03

Legend:
- Humpback.Chub
- Flannelmouth.Sucker
- Bluehead.Sucker
- Speckled.Dace
- Cyprinids
- Centrarchids
- Black.Bullhead
- Channel.Catfish
- Brown.Trout
- Rainbow.Trout
Results - Rainbow Trout Capture Probability

Rainbow Trout Capture Probability in the Little Colorado River Removal Reach (95% Credible Intervals)

Trip Date

Capture Probability

- Upstream
- Downstream
Results - Rainbow Trout Abundance

Rainbow Trout Abundance in the Little Colorado River Removal Reach (95% Credible Intervals)
Results - RBT Density

Rainbow Trout Density in the Little Colorado River Removal Reach

Rainbow Trout Density (fish/500m/side)

Trip Date
Results - Immigration Rate

Net Immigration Rate to the Upstream Portion of the LCR Reach

[Graph showing net immigration rate for different time intervals (Jan-Feb, Feb-Mar, Mar-July, July-Aug, Aug-Sep, Sep-Jan) for the years 2003 to 2006.]
Results: Indicators of Possible Native Fish Population Response
Results - Humpback Chub Relative Abundance

Hoop Net Catch Rate of Humpback Chub Below the LCR Confluence (95% Confidence Intervals)

Start Removal Project
Results - Humpback Chub Length Distribution

Length Distribution of Hoopnet Caught Humpback Chub

- 2003 (n=480)

Total Length (mm)

Density

0.000 0.005 0.010 0.015 0.020 0.025

0 50 100 150 200 250 300
Results - Humpback Chub Length Distribution

Length Distribution of Hoopnet Caught Humpback Chub

- 2003 (n=480)
- 2004 (n=1084)
Results - Humpback Chub Length Distribution

Length Distribution of Hoopnet Caught Humpback Chub

- 2003 (n=480)
- 2004 (n=1084)
- 2005 (n=811)
Results - Humpback Chub Length Distribution

Length Distribution of Hoopnet Caught Humpback Chub

- 2003 (n=480)
- 2004 (n=1084)
- 2005 (n=811)
- 2006 (n=558)
Results - Humpback Chub Length Distribution

Length Distribution of Hoopnet Caught Humpback Chub

- 2003 (n=480)
- 2004 (n=1084)
- 2005 (n=811)
- 2006 (n=558)
Results - Humpback Chub Relative Abundance

Electrofishing Catch Rate of Humpback Chub in the LCR Removal Reach (95% Confidence Intervals)
Results – HBC Length Distribution

Length Distribution of LCR Removal Reach Humpback Chub

Total Length (mm)

Density

2003 (n=243)
Results – HBC Length Distribution

Length Distribution of LCR Removal Reach Humpback Chub

- Total Length (mm)
- Density

2003 (n=243)
2004 (n=376)
Results – HBC Length Distribution

Length Distribution of LCR Removal Reach Humpback Chub

- 2003 (n=243)
- 2004 (n=376)
- 2005 (n=1098)
Results – HBC Length Distribution

Length Distribution of LCR Removal Reach Humpback Chub

- 2003 (n=243)
- 2004 (n=376)
- 2005 (n=1098)
- 2006 (n=889)
Results - Sucker Relative Abundance

Electrofishing Catch Rate of Flannelmouth and Bluehead Sucker (95% Confidence Intervals)

Trip Date

CPUE (Fish/Hour)

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© John Rinne

Flannelmouth Sucker
Bluehead Sucker
Results – FMS Length Distribution

Length Distribution of LCR Removal Reach Flannelmouth Sucker

Total Length (mm)

Density

0.000
0.001
0.002
0.003
0.004
0.005
0.006

0 200 400 600

2003 (n=900)
Results – FMS Length Distribution

Length Distribution of LCR Removal Reach Flannelmouth Sucker

Total Length (mm)

Density

2003 (n=900)
2004 (n=1239)
Results – FMS Length Distribution

Length Distribution of LCR Removal Reach Flannelmouth Sucker

- 2003 (n=900)
- 2004 (n=1239)
- 2005 (n=2648)
Results – FMS Length Distribution

Length Distribution of LCR Removal Reach Flannelmouth Sucker

- 2003 (n=900)
- 2004 (n=1239)
- 2005 (n=2648)
- 2006 (n=2548)
One Big Confounding Factor!

- Water temperature
  - Cold water temperature following installation of Glen Canyon Dam is known to inhibit vital rates for native fishes.
    - Growth (Clarkson and Childs 2000, Robinson and Childs 2001)
    - Reproduction (Hamman 1982)
    - Swimming ability (Ward et al. 2002)
    - Predation Risk (Ward and Bonar 2003)
One Big Confounding Factor!

Water Temperature near LCR Confluence

Water Temperature


Mean Daily Temperature (deg C)

01JAN 01FEB 01MAR 01APR 01MAY 01JUN 01JUL 01AUG 01SEP 01OCT 01NOV 01DEC 01JAN

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<td>“Even More Naturally Elevated Temp”</td>
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<td>5 (2007)</td>
<td>(Non-natives in low abundance)</td>
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Conclusions

- **Non-native Removal Efficacy**
  - Mechanical Removal appears to be an effective way to control salmonids in the mainstem Colorado River.
    - Rainbow trout abundance reduced to near target level (<10% original abundance) in 2005 and 2006.
    - Catch composition (by mass) of non-native fish reduced from >90% to <40%.
    - Capture Probability ~10-20% / pass

- **Native Fish Trends**
  - Relative abundance assessments (catch-rate) no substitute for mark-recapture based stock assessments to determine recruitment trends.
    - Assessment of 2003 cohort will require 2007 and 2008 monitoring data.
  - However, there have been large increases in juvenile humpback chub relative abundance. Additionally, flannelmouth and bluehead sucker displaying overall positive trends in relative abundance.
  - Relative influence of non-native fish versus temperature still unknown.
Predictions

- **Rainbow Trout trends**
  - Very preliminary indications of rainbow trout recovery both in Glen and Marble Canyons.

- **Water Temperature?**

- **Other nonnative species**
  - Smallmouth Bass, Crayfish, Others?