Long-Term Monitoring of Fish Populations from NCD Project Sites

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Limiting Factors & Ecological Function

- Biology
- Physicochemical
- Geomorphology
- Hydraulics
- Hydrology

Courtesy Will Harmon, USFWS
Fish populations = Ecological Indicator

Colden et al. 2005
How do you improve a fish population?

Stocking
How do you improve a fish population?

Stocking

Regulations
How do you improve a fish population?

Stocking

Regulations

Habitat
Basics of Stream Habitat

Modified from Schlosser and Angermeier 1995
Basics of Stream Habitat

Modified from Schlosser and Angermeier 1995
Basics of Stream Habitat

- Spawning Habitat
- Refuge Habitat
- Feeding Habitat

Modified from Schlosser and Angermeier 1995
Fish move:
- Daily
- Seasonally
- In stochastic events

Movement frequency and distance is affected by:
- Species
- Resource availability
- Age

Habitats can be miles apart

Modified from Schloesser and Angermeier 1995
Basics of Stream Habitat

- Spawning Habitat
- Refuge Habitat
- Feeding Habitat
- Barrier
Scale

Fausch et al. 2002
Aquatic Habitats in Colorado

- Eastern Plains Rivers and Streams
- Mountain Streams
- Colorado Plateau/Wyoming Basins Rivers and Streams
- Transition Zone Streams
- Rio Grande Rivers and Streams
Critical Trout Habitat Functions

1) Salmonid Forage Production Areas
2) High Flow Refugia
3) Low Flow & Winter Refugia
4) Spawning Habitat
5) Rearing Habitat
6) Adult Cover
7) Connectivity

Courtesy Dave Rosgen, Wildland Hydrology
Natural Channel Design: Reference Reach
Natural Channel Design: Fundamentals

Existing
Natural Channel Design: Fundamentals

Existing + Reference
Natural Channel Design: Fundamentals

Existing + Reference = Proposed
Monitoring Results: Buckley Ranch

BACI study
Control-Untreated
Boulder-Treated
Boulder-Treated Vs Control-Untreated
Boulder-Treated Vs Control-Untreated

Monitoring Period:
1990-2018: 28 YEARS!

Pre- vs Post:
- Boulder-Treated: Brown Trout biomass increased 56% compared with pre-project baseline.
- Control-Untreated: Brown Trout Biomass declined 53% over the same time 26-year post-monitoring period.
Boulder-Treated Vs Control-Untreated

Monitoring Period:
1990-2018: 28 YEARS!

Boulder vs Control:
• Brown Trout biomass in the boulder-treated averaged 32% higher over the control-untreated reach for entire monitoring period

• Average difference in biomass (within year) was 183% (range 10-472 %) boulder over control
Toewood-Treated
Toewood-Treated Vs Control-Untreated

Brown trout biomass (lbs/acre) vs Year:
- 2010: Toewood-Treated (high), Control-Untreated (low)
- 2011: Toewood-Treated (mid), Control-Untreated (low)
- 2012: Toewood-Treated (high), Control-Untreated (low)
- 2013: Toewood-Treated (mid), Control-Untreated (low)
- 2014: Toewood-Treated (mid), Control-Untreated (low)
- 2015: Toewood-Treated (mid), Control-Untreated (low)
- 2016: Toewood-Treated (high), Control-Untreated (low)
- 2017: Toewood-Treated (mid), Control-Untreated (low)
- 2018: Toewood-Treated (high), Control-Untreated (low)
Toewood-Treated Vs Control-Untreated

Monitoring Period:
2010-2018: 8 YEARS

Toewood-Treated vs Control:
• Brown Trout biomass in the toewood-treated reach averaged 34% higher over the control-untreated reach for entire monitoring period.

• Average difference in biomass (within year) was 173% (range 40-245%) toewood over control.
Toewood-Treated Vs Boulder-Treated

The chart shows the comparison of Brown trout biomass (lbs/acre) between Toewood-Treated and Boulder-Treated from 2010 to 2018. The chart indicates that there is no significant difference in biomass between the two treatments over the years.
Monitoring Period:  
2010-2018: 8 YEARS

Toewood-Treated vs Boulder-Treated:

- Brown trout biomass in the toewood-treated reach averaged 7% higher over the boulder-treated for entire monitoring period

- Average difference in biomass (within year) was 18% (range -2-43%) toewood over boulder
Reference
Toewood-Treated Vs Reference

Monitoring Period:
2010-2018: 8 YEARS

- Brown trout biomass in the reference reach averaged 107% higher over the toewood-treated for entire monitoring period

- Average difference in biomass (within year) was 194% (range 46-460%) reference over toewood
Does Toewood Create More Sucker-Holes?
Does Toewood Create More Sucker-Holes?

- **Toewood-Treated**
- **Boulder-Treated**
- **Control-Untreated**

**White Sucker biomass (lbs/acre)**

- Toewood-Treated: 20 lbs/acre
- Boulder-Treated: 60 lbs/acre
- Control-Untreated: 100 lbs/acre
Species Composition

Toewood-Treated

- Brown Trout
- Rainbow Trout
- White Sucker
- Native
Species Composition

Toewood-Treated

- White Sucker
- Native
- Rainbow Trout
- Brown Trout

Boulder-Treated

- White Sucker
- Native
- Rainbow Trout
- Brown Trout
Species Composition

Toewood-Treated

- White Sucker
- Native
- Rainbow Trout
- Brown Trout

Boulder-Treated

- White Sucker
- Native
- Rainbow Trout
- Brown Trout

Control-Untreated

- White Sucker
- Native
- Brown Trout
- Rainbow Trout
Clear Creek
Goals

1) Remove armored rip rap
2) Improve floodplain connectivity
3) Convert single stage to three-stage
4) Establish riparian vegetation
5) Enhance in-channel bedform features (i.e. spawning area development and depth cover)
Overview

High-Intensity

Low-Intensity

High-Intensity
Low-Intensity
Low-Intensity

Before

Single-stage
Confinement=1.2
F-stream type
Low-Intensity

After
Single-stage
Confinement=1.2
F-stream type
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Quantity</th>
<th>Units</th>
<th>Total</th>
<th>% of Total Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat Boulder</td>
<td>81</td>
<td>Each</td>
<td>234</td>
<td>35%</td>
</tr>
<tr>
<td>Boulder Structure</td>
<td>1</td>
<td>Each</td>
<td>9</td>
<td>11%</td>
</tr>
<tr>
<td>Boulder Toe</td>
<td>250</td>
<td>LF</td>
<td>2,708</td>
<td>9%</td>
</tr>
<tr>
<td>Pool Development</td>
<td>4</td>
<td>Each</td>
<td>14</td>
<td>29%</td>
</tr>
<tr>
<td>Point-Bar Development</td>
<td>0</td>
<td>SF</td>
<td>5,420</td>
<td>0%</td>
</tr>
<tr>
<td>Floodplain Development</td>
<td>0</td>
<td>SF</td>
<td>18,775</td>
<td>0%</td>
</tr>
</tbody>
</table>
Low-Intensity Treatment: Trout Density (#/mile)

Brown Trout Density (#/mile)

Year

- 2012
- 2013
- 2014
- Spring 2015
- 2015
- 2016
- 2017
- 2018

CONSTRUCTION
Low-Intensity Treatment: Trout Density (#/mile)

77% increase
Low-Intensity Treatment: Trout Biomass (lbs/acs)

Brown Trout Biomass (lbs/acre)

Year


CONSTRUCTION
Low-Intensity Treatment: Trout Density (#/mile)

77% increase

Low-Intensity Treatment: Trout Biomass (lbs/ acres)

59% increase
High-Intensity Before
Single-stage
Confinement=1.2
F3/2-stream type
High-Intensity

After

Three-stage

Confinement=2.0

Bc3/2 -Stream Type
High-Intensity

Before
High-Intensity
After
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Quantity</th>
<th>Units</th>
<th>Total</th>
<th>% of Total Project</th>
</tr>
</thead>
<tbody>
<tr>
<td>Habitat Boulder</td>
<td>153</td>
<td>Each</td>
<td>234</td>
<td>65%</td>
</tr>
<tr>
<td>Boulder Structure</td>
<td>8</td>
<td>Each</td>
<td>9</td>
<td>89%</td>
</tr>
<tr>
<td>Boulder Toe</td>
<td>2,458</td>
<td>LF</td>
<td>2,708</td>
<td>91%</td>
</tr>
<tr>
<td>Pool Development</td>
<td>10</td>
<td>SF</td>
<td>14</td>
<td>71%</td>
</tr>
<tr>
<td>Point-Bar Development</td>
<td>5,420</td>
<td>SF</td>
<td>5,420</td>
<td>100%</td>
</tr>
<tr>
<td>Floodplain Development</td>
<td>18,775</td>
<td>SF</td>
<td>18,775</td>
<td>100%</td>
</tr>
</tbody>
</table>
High-Intensity Treatment: Trout Density (#/mile)

160% increase
High-Intensity Treatment: Trout Biomass (lbs/acre)

- 2013: Low Biomass
- 2014: Low Biomass
- Spring 2015: Construction
- 2015: Moderate Biomass
- 2016: Moderate Biomass
- 2017: High Biomass
- 2018: High Biomass
High-Intensity Treatment: Trout Density (#/mile)

160% increase

High-Intensity Treatment: Trout Biomass (lbs/ acres)

408% increase
Summary

Restoration of natural stream forms (NCD) may restore natural habitats that provide the functions necessary for improving fish populations over time.
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- Departure from reference conditions may have negative consequences to fish populations that may not recover without physical intervention.
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- Restoration of natural stream forms (NCD) may restore natural habitats that provide the functions necessary for improving fish populations over time.

- Departure from natural conditions may have negative consequences to fish populations that may not recover without physical intervention.

- Assess limiting factors that may occur outside of geomorphology (channel forms) including departures from natural hydrologic regimes, hydraulics, physicochemical properties, and barriers.
Summary

Not all treatment alternatives are equal. Some treatments will accomplish a “bigger bang for the buck”
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Not all treatment alternatives are equal. Some treatments will accomplish a “bigger bang for the buck”

Carefully consider selection of reference reaches for biological monitoring. Use an average of multiple reference sites if possible