Fish Community Response To Temperature Changes in Grand Canyon

Assessment of Risk and Recommendations for Monitoring

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Thanks---
Dave Speas
Dennis Kubly
Amy Cutler
Mark McKinstry
APPROACH TO NONNATIVES IN GRAND CANYON

1. Identify native and nonnative species in or near Grand Canyon.

2. Evaluate benefit/risk to each species from temperature change.

3. Identify most effective monitoring strategy to detect response.

4. Develop and implement effective removal strategy, as necessary.
1. NATIVE FISH SPECIES (10)

Current Residents
1. humpback chub
2. flannelmouth sucker
3. bluehead sucker
4. speckled dace

Extirpated or Questionable
5. razorback sucker
6. roundtail chub
7. bonytail
8. Colorado pikeminnow

Tributary Species
9. Little Colorado spinedace
10. Zuni bluehead sucker
## NONNATIVE FISH SPECIES PRESENT (19)

<table>
<thead>
<tr>
<th></th>
<th>Fish Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>black bullhead</td>
</tr>
<tr>
<td>2</td>
<td>channel catfish</td>
</tr>
<tr>
<td>3</td>
<td>yellow bullhead</td>
</tr>
<tr>
<td>4</td>
<td>brown trout</td>
</tr>
<tr>
<td>5</td>
<td>rainbow trout</td>
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<tr>
<td>6</td>
<td>threadfin shad</td>
</tr>
<tr>
<td>7</td>
<td>common carp</td>
</tr>
<tr>
<td>8</td>
<td>fathead minnow</td>
</tr>
<tr>
<td>9</td>
<td>golden shiner</td>
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<tr>
<td>10</td>
<td>red shiner</td>
</tr>
<tr>
<td>11</td>
<td>mosquitofish</td>
</tr>
<tr>
<td>12</td>
<td>plains killifish</td>
</tr>
<tr>
<td>13</td>
<td>walleye</td>
</tr>
<tr>
<td>14</td>
<td>striped bass</td>
</tr>
<tr>
<td>15</td>
<td>black crappie</td>
</tr>
<tr>
<td>16</td>
<td>bluegill</td>
</tr>
<tr>
<td>17</td>
<td>green sunfish</td>
</tr>
<tr>
<td>18</td>
<td>largemouth bass</td>
</tr>
<tr>
<td>19</td>
<td>smallmouth bass</td>
</tr>
</tbody>
</table>
NONNATIVE FISH SPECIES ABSENT (7)
(with possible access)

1. flathead catfish
2. gizzard shad
3. grass carp
4. redside shiner
5. sand shiner
6. Utah chub
7. blue tilapia
2. EVALUATE BENEFIT/RISK (Risk Assessment Model)

A. Evaluate benefits of temperature change to humpback chub and other native fish species.

B. Quantify risks associated with response of nonnative fish to changed water temperatures.
Risk Assessment Model

11 Model Parameters

1. Presence/absence by region
2. Maximum adult size
3. Food habits
4. Known competitor/predator
5. Preferred temperature range
6. Reproductive potential
7. Multiple (fractional) spawners
8. Riverine species
9. Adapted to fast river
10. Diurnal/nocturnal feeder
11. Temperature Degree Days
TAXA IN RISK MODEL

- 36 Fish Species
- 4 Fish Parasites (AT, LC, TN, WD)
- 9 Zooplanktors
- 12 Primary producers
- 19 Macroinvertebrates

80 Taxa Total
Six Reaches for Risk Assessment
Spawning

Cool and Cold Water Species

Warm Water Species

Obligate Warm Water Species

Degrees Centigrade
Cool and Cold Water Species
Warm Water Species
Obligate Warm Water Species
Incubation

Degrees Centigrade
Growth Cool and Cold Water Species Warm Water Species Obligate Warm Water Species

Degrees Centigrade
Model uses average daily temps

Minimum, median, maximum temperatures at GCD, 1990-2005

Predicted temperatures for GCD releases with a 2-unit SWS

Predicted temperatures of the Colorado River at the LCR with a 2-unit SWS
SAMPLE OUTPUT

Glen Canyon Dam to Paria River

Paria River to LCR

Response by fish to 2-unit SWS

LCR to Bridge Canyon

Bridge Canyon to Pearce Ferry
Native Fish

Glen Canyon Dam to Paria River

Assessment Scores and Percent Difference

Paria River to LCR

Assessment Scores and Percent Difference

Native Fish
Fish Species of Greatest Risk
(aka: The Dirty Dozen)

1. Smallmouth bass—predaceous, prolific
2. Brown trout—predaceous
3. Rainbow trout—competitor, predator
4. Red shiner—prolific, predaceous, competitor
5. Common carp—omnivorous, prolific, versatile
6. Channel catfish—nocturnal predator, populous
7. Fathead minnow—tolerant, competitive
8. Green sunfish—prolific, predaceous
9. Black bullhead—nocturnal omnivore
10. Walleye—predaceous!
11. Flathead catfish—predaceous, prolific
12. Grass carp—vegetarian, fluvial
3. MONITORING STRATEGY

1. Recognize Sources
2. Identify Habitat Guilds—BW, SH, TR, MS
3. Target Life Stage—season, locale, habitat
4. Synoptic Sampling Initially
5. Use Appropriate Gear Array
LAKE MEAD
Channel catfish
Red shiner
Fathead minnow
Plains killifish
Largemouth bass
Walleye
Striped bass
Tilapia

OUTSIDE SOURCES
Flathead catfish
Grass carp
Redside shiner
Sand shiner
Rock bass
Crayfish

RESIDENTS
19 Species

LAKE POWELL
Smallmouth bass
Striped bass
Walleye
TF & GZ shad

TRIBUTARIES
Red shiner
Fathead minnow
Plains killifish
Green sunfish
Largemouth bass
Channel catfish
Rock bass**
## FISH OF GREATEST RISK (Reproductive Habitat Guilds)

<table>
<thead>
<tr>
<th>Species</th>
<th>Spawning/Nursery</th>
<th>Juveniles</th>
<th>Adults</th>
</tr>
</thead>
<tbody>
<tr>
<td>smallmouth bass, green sunfish</td>
<td>Guarded nests in 1-3 ft on GR, CO</td>
<td>Shallow shores in structure</td>
<td>Steep drop offs near structure</td>
</tr>
<tr>
<td>brown trout, rainbow trout</td>
<td>Shallow GR, CO bars</td>
<td>Shorelines</td>
<td>Mid-channel</td>
</tr>
<tr>
<td>red shiner, fathead minnow, redside shiner, common carp</td>
<td>Shallow warm quiet backwaters, shorelines</td>
<td>Warm backwaters, shorelines</td>
<td>Warm backwaters, shorelines</td>
</tr>
<tr>
<td>channel catfish, black bullhead, flathead catfish</td>
<td>Crevices, structure</td>
<td>Shallow, near structure</td>
<td>Various</td>
</tr>
<tr>
<td>walleye</td>
<td>Broadcast over riffles</td>
<td>Shallow shores in structure</td>
<td>Deep cool areas</td>
</tr>
<tr>
<td>grass carp</td>
<td>Pelagic spawners in flowing water</td>
<td>Shallows with vegetation</td>
<td>Prefer vegetation</td>
</tr>
</tbody>
</table>
4. CONTROL/REMOVAL

1. Identify sensitive life stage(s)—”Achilles Heel”
2. Exercise flow options, when possible
3. Implement mechanical control, as necessary
4. Establish success criteria (Ricker, Beverton-Holt, Shaefer)
5. Develop/implement institutional controls (nonnative fish stocking policy)

NOTE: Once certain species have become established, they cannot be eradicated!
HOW MANY FISH MUST BE REMOVED TO AFFECT REPRODUCTIVE/RECRUITMENT POTENTIAL?

“Break The Back of The Population”
Ricker Stock Recruitment Curve

Utah Lake Carp

Ricker Curve
\[ R = aP e^{-BP} \]

Replacement Line

Age 1 Recruits \((R \times 10^7)\)

A = MSY; B = Max recruitment; C = Replacement level

\[ Pm=4,115,226 \]

\[ Pr=6,207,819 \ (83\%) \]
Schaefer Yield Curve -- Utah Lake Carp
Unrestricted Harvest

“Tragedy of the Commons”

\[ Y = 10.96 \ln(x) + 11.932 \]

Effort (Years)