Near-Term Threat of Smallmouth Bass Establishment below Glen Canyon Dam

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On behalf of the Smallmouth Bass Task force organized by Kirk Young and including Drew Eppehimer, Jeff Arnold, Lucas Bair, Jan Boyer, Craig Ellsworth, Eric Frye, Sky Hedden, Kerri Pedersen, Pilar Rinker, Scott Rogers, Robert Schelly, Laura Tennant, Melissa Trammell and David Ward.
Where smallmouth bass (*Micropterus dolomieu*) have invaded in the Colorado River basin, they are considered the biggest threat to native fish species.
Why aren’t Smallmouth Bass already established in Grand Canyon?

Cold releases from Glen Canyon Dam
Low propagule pressure

Epilimnion – warmer water
Hypolimnion – cold water
Lake Powell
Image by B. Healy

Turbidity at the inflow to Lake Mead
Pearce Ferry Rapid – recent barrier
What is changing?

• Lower lake levels likely to increase entrainment; lake surface closer to penstocks

• Release temperatures are becoming warmer and suitable for reproduction and growth at Lees Ferry
Outline

• How much entrainment is required to establish a population?

• Are conditions suitable for smallmouth bass?

• How reversible is a smallmouth bass invasion?

• How can the risk of smallmouth bass invasion be minimized?
Conceptual Model of Smallmouth Bass (SMB) Entrainment Risk

- # of SMB available for entrainment
- Fish Distribution by Depth
- Lake Powell Elevation
  - Reservoir elevation drives penstock depth

Penstock Entrainment (numbers of fish passed through dam)

Survival Rate

SMB abundance in Lees Ferry at beginning of year

SMB abundance in Lees Ferry at end of year

Survival Rate

Greater than?

Minimum population size required in Lees Ferry for establishment
Statistical Model of Entrainment Risk

Inflows Outflows (Bank Storage, Evaporation)

Penstock Entrainment (numbers of fish passed through dam)

Survival Rate

SMB abundance in Lees Ferry at beginning of year

Survival Rate

SMB abundance in Lees Ferry at end of year

Greater than?

# of spawners required to establish SMB in Lees Ferry

(Preliminary, do not cite)
Entrainment risk if elevation is held constant at a particular value.
Results based on March 24-month study

Lake Powell elevation (ft)

- Max: P(Est) < 0.001
- Most: P(Est) = 0.11
- Min: P(Est) = 0.28

Time:
- Mar-22
- Sep-22
- Mar-23
- Sep-23

(Preliminary, do not cite)
Hypothetical scenario 1
Hypothetical scenario 2
Outline

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Temperature and SMB Suitability in Lees Ferry

(Preliminary, do not cite)
Temperature and SMB Suitability at LCR Reach

(Preliminary, do not cite)
Temperature and SMB Suitability at Diamond Creek Reach

(Preliminary, do not cite)
Tributary Thermal Suitability (2000-present)

**LCR**
- Number of traces with SMB population growth = 21 / 21
- Mean lambda of population growth = 2.44

**Bright Angel**
- Number of traces with SMB population growth = 21 / 21
- Mean lambda of population growth = 2.42

**Kanab**
- Number of traces with SMB population growth = 21 / 21
- Mean lambda of population growth = 2.44

**Havasu**
- Number of traces with SMB population growth = 21 / 21
- Mean lambda of population growth = 2.44

(Preliminary, do not cite)
Outline

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• How can the risk of smallmouth bass invasion be minimized?
How reversible is a smallmouth bass invasion?

- **Scenario 1** - Increased SMB population in Lees Ferry or downriver, but not reproducing (not established)
  - Perhaps reversible if action taken quickly

- **Scenario 2** - Established population in Lees Ferry
  - Perhaps reversible over many years if spawning is disrupted every year

- **Scenario 3** - Established population(s) downriver of Lees Ferry
  - Extreme changes to dam operations required on a decadal timescale

- **Scenario 4** - Established populations in tributaries
  - Perhaps reversible with extensive removal and see scenario 3
Entrainment relationships with lake elevation

Risk increases over time as SMB accumulate in LF

(Preliminary, do not cite)
Temperature suitability relationships with lake elevation

(Preliminary, do not cite)
Outline

• How much entrainment is required to establish a population?

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• How reversible is a smallmouth bass invasion?

• How can the risk of smallmouth bass invasion be minimized?
Can Entrainment risk be reduced?

**Short term:**
Minimize time spent drawing from surface waters
  
  DROA
  
  Bypass

**Mid term:**
Fish exclusion in forebay, e.g., bubble curtain, CO2 curtain

**Long term:**
Changes to infrastructure
Different approaches to Manage SMB via Temperature

- No change
  - When temps at penstocks > 16 °C, operate at < 13 °C one day/week until Sept 4 (~13 days)
- Keep temps < 16 °C until Sept 4 (~84 days)
- Keep temps < 16 °C year round (~110 days)
Keep Temps at Lees Ferry < 16 °C All Year

(Preliminary, do not cite)
Keep Temps at Lees Ferry < 16 °C until Sept 25

(Preliminary, do not cite)
Keep Temps < 13 °C until Sept 25, one day/week

(Preliminary, do not cite)
Conclusions

• SMB are a greater threat to native fish & rainbow trout than any other invasive fish currently present in the system.

• Reservoir conditions are changing to support increased entrainment and establishment below Glen Canyon Dam.

• Limiting entrainment & controlling temperature are the only large-scale tools currently available.

• Quickly responding to small scale presence of SMB may buy more time.

• Reversing SMB establishment downriver/ in tributaries likely to be a drawn out and expensive process and may not be possible.
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