Conservation/Recovery of Colorado Pikeminnow in Grand Canyon Biological Feasibility

Photo: Emery Kolb Collection, Northern Arizona University

Kirk Young

April 14, 2021

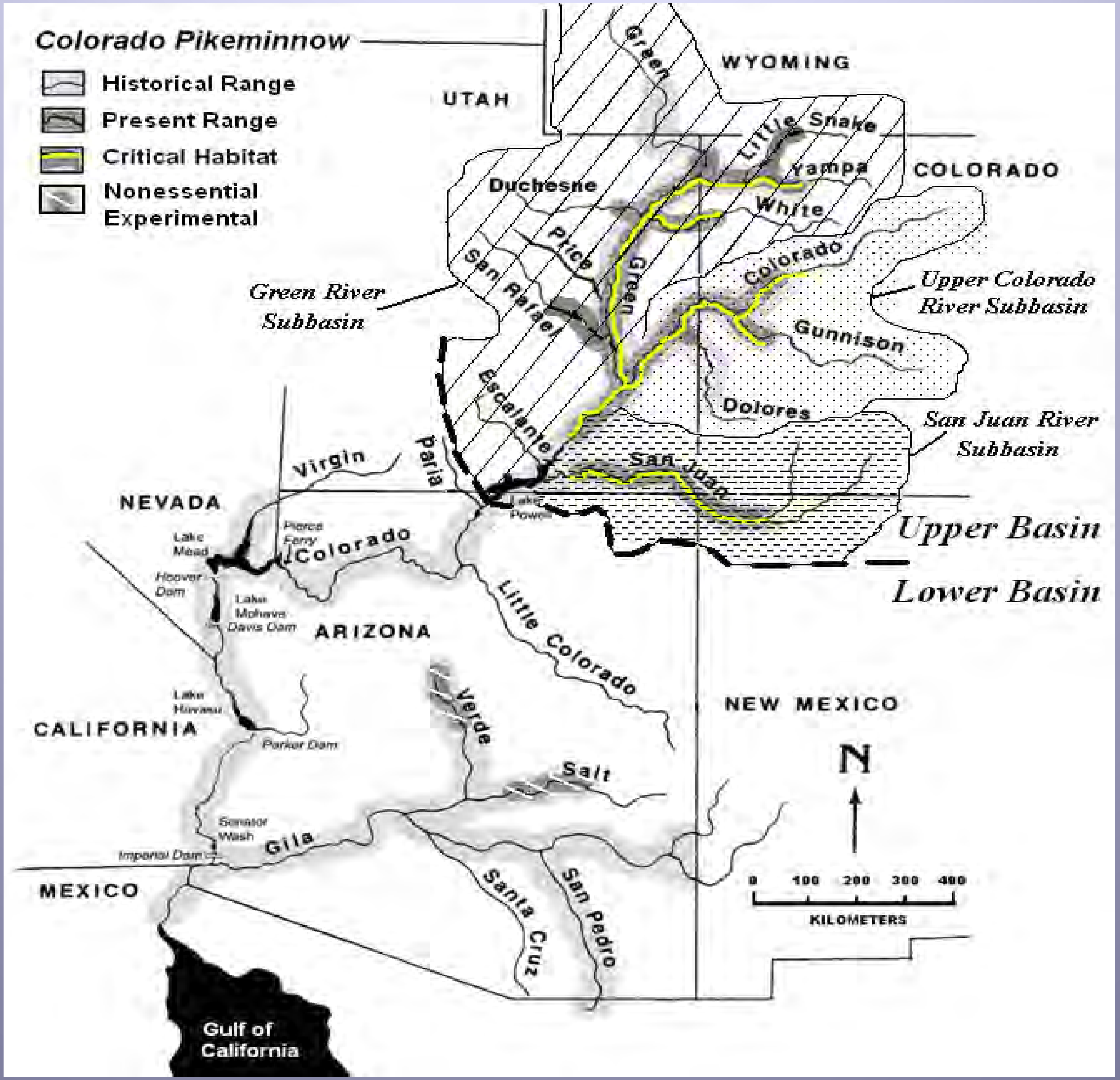
Colorado Pikeminnow in Grand Canyon Biological Feasibility

- **A little background**
- **What, How & Why?**

Photo: USFWS file photo, Upper Basin Recovery Program

Preliminary/Draft; do not cite

Background



Map: U.S. Fish and Wildlife Service, 2014

Preliminary/Draft; do not cite

Background (2)

Pikeminnow Archeological Records


Photo: Bat Conservation International

Stanton's Cave 4,000 ya

LCR - Salt Can. Cave


Photo: YouTube

Catclaw Cave below Hoover


Photo: Homolovi State Park Photo

Homolovi Site

Background (3)

Pikeminnow Historical Collections*/Reports

Photo: National Park Service, Historic River Photo Collection

Glen Canyon/Paria "Salmon": Settlers – 1880s
Stanton Christmas Meal – 1889
Dynamite Fishing – Loper early 1900s
*Museum specimen (UM) - 1934

Tapeats Creek "Salmon"
– Nevills 1948
- J. Doerr 1948

Shinumo Creek "Salmon"
- Nevills 1940; 1942
- Goldwater 1940

Below Lava 14-16 "Salmon" – Kolb 1911

Havasu Creek -
*Angler 1978

LCR @ Grand Falls "Salmon"
– Miller (via Sykes) early 1900s

Photo: Emery Kolb Collection, NAU

Photo: Emery Kolb Collection, NAU

What & How?

Phased Conceptual Approach:

- Phase 1 Pikeminnow Viability/Feasibility Assessment
- Phase 2 - If Viable/Feasible (based on phase 1) Experimentation to Assess Feasibility.
- Phase 3 - If Viable/Feasible (based on phase 2 experimentation) Plan Development and Implement Recovery Actions (translocation(s) & monitoring etc.).

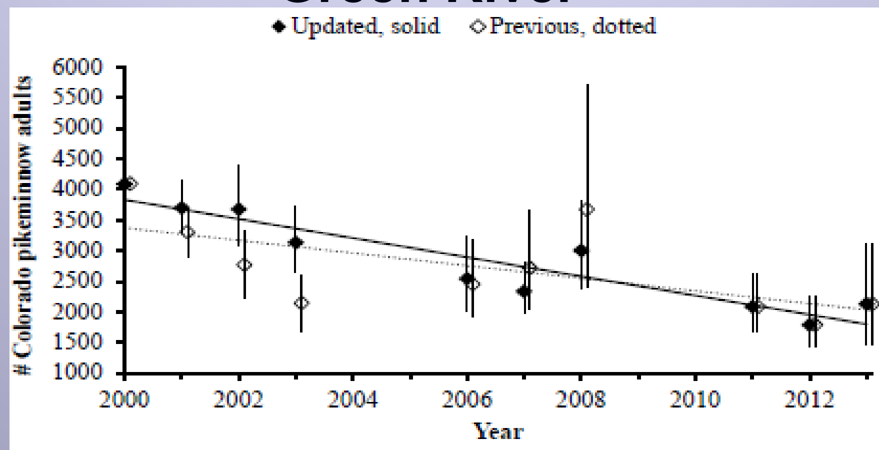
What & How? Phase 1

- Pikeminnow Viability/Feasibility Assessment
  - Paper exercise thru agreement with USGS
  - USGS – science provider
  - Steering Committee to guide process – reps with management authorities in GC: AZGFD, NG&F, HG&F, NDOW, NPS, FWS, USBR
  - Expert elicitation (w/field visit) – Science Panel
  - Draft Report (spring 2021)
    - Stakeholder review
    - USGS OFR (fall 2021)

WHY?

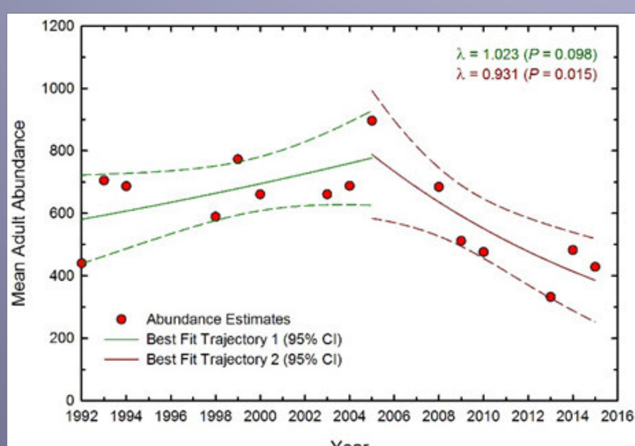
- Additional Conservation and Recovery Options May be Needed

Green River



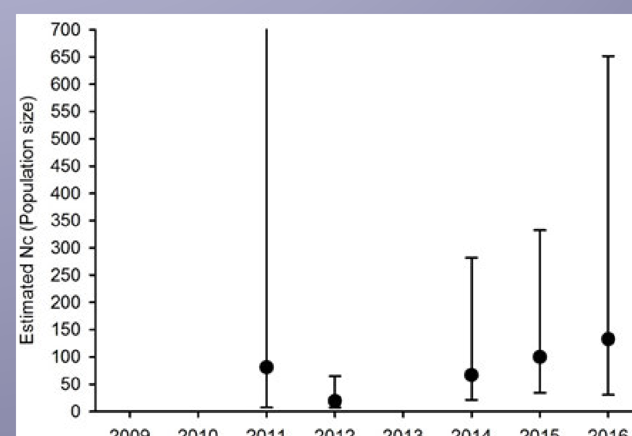
Bestgen et al. 2018

Upper Colorado River



Miller et al. 2018

San Juan River



Diver and Wilson 2018

Preliminary/Draft; do not cite

WHY? (2)

- **Supported by GCNP Comprehensive Fisheries Management Plan**

  - **Restore self-sustaining populations of extirpated fish species inc1uding Colorado pikeminnow, razorback sucker, bonytail, and roundtail chub as appropriate and to the extent feasible (if feasibility studies determine each species can be reasonably restored without impacting existing ESA-listed species).**

- **Native Fish Thriving in Grand Canyon**

WHY? (3)

"…These salmon were old friends of ours, being found from one end to the other of the Colorado, and on all its tributaries. They sometimes weigh twenty-five or thirty pounds, and are common at twenty pounds; being stockily built fish, with large, flat heads. They are not gamey, but afford a lot of meat with a very satisfying flavour."

E.L. Kolb 1915.

The Colorado Pikeminnow Reintroduction Feasibility Study

Kimberly Dibble, Kirk Young, and Charles Yackulic

GCDAMP Technical Work Group Meeting (virtual)
April 14, 2021


Grand Canyon
Photo: Emery Kolb Collection. NAU

U.S. Department of the Interior
U.S. Geological Survey

Presentation Outline

- Study Overview
  - Objectives
  - Process steps
  - Report structure
- Habitat assessment
  - Peak flows, base flows, water temperature, refuge/nursery habitat, forage base
- Recommendations and next steps

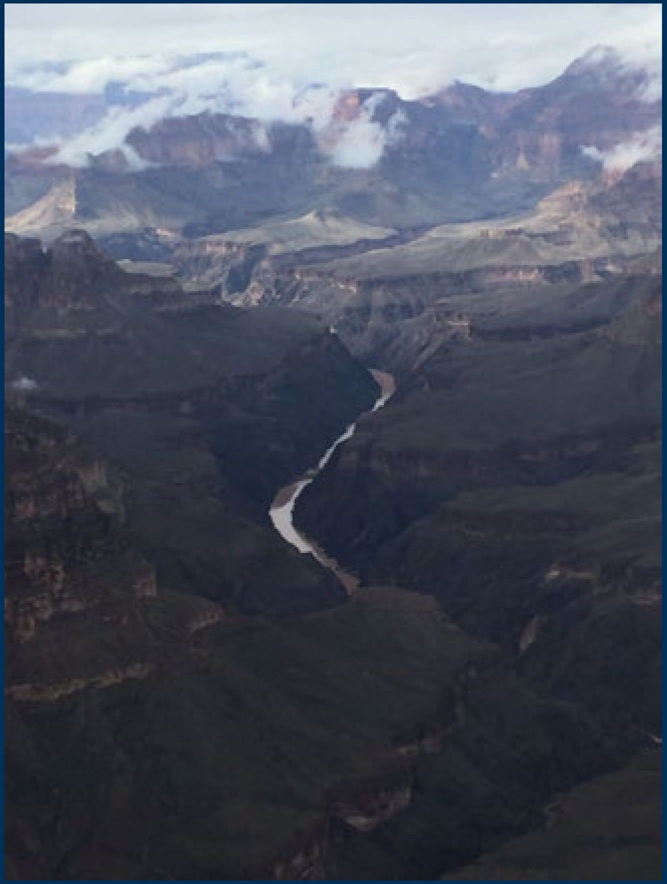


Photo: K. Dibble

USGS

Presentation Outline, cont.

- Study Overview
  - Objectives
  - Process steps
  - Report structure
- Habitat assessment
  - Peak flows, base flows, water temperature, refuge/nursery habitat, forage base
- Recommendations and next steps

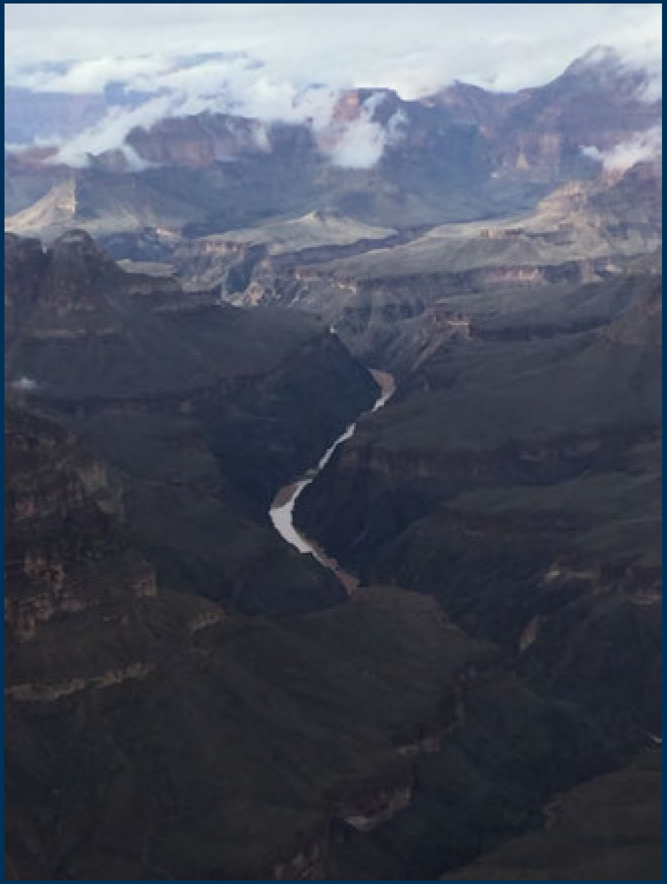


Photo: K. Dibble

USGS

Study Objectives

- Synthesize information on habitat requirements for all life history stages
- Convene Science Panel and elicit expert opinion on potential habitat suitability in Grand Canyon and its compatibility with the existing fish community
- Recommend strategies for research to inform reestablishing and recovering the Colorado Pikeminnow in Grand Canyon


Grand Canyon
Photo: Emery Kolb Collection. NAU


Lower Yampa River
Photo: Burton (1987)

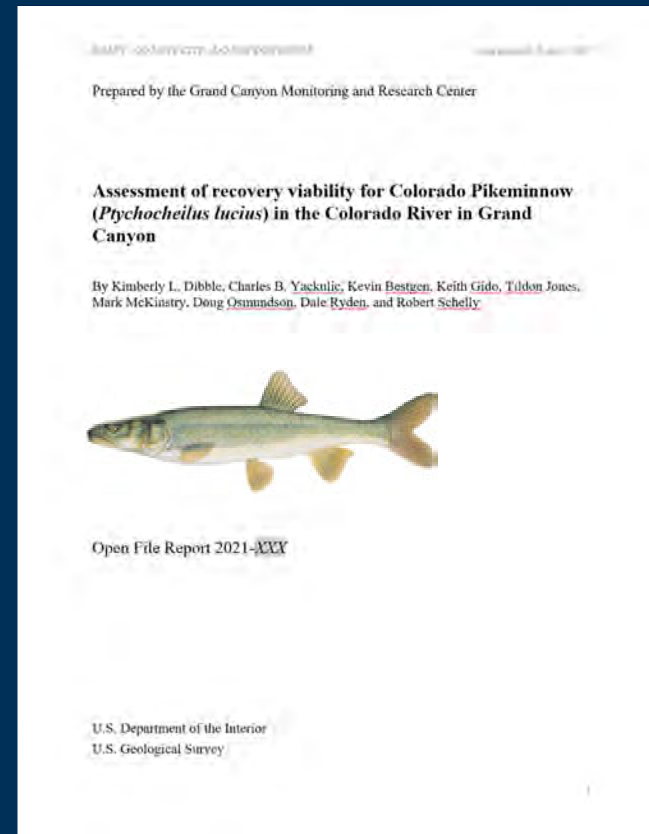
Process Steps

- Steering Committee
  - Meetings 2018-2019
- Science Panel
  - Structured survey & text
  - Workshop & river trip (Sept. 2019)
- Report completion
  - 1st draft: Dec. 2020
  - 2nd draft: May 2021
  - OFR: Fall/winter 2021

Steering Committee	Science Panel
Winkie Crook	Kevin Bestgen
Kim Yazzie	Keith Gido
Mark Grover	Robert Schelly
Brandon Senger	Mark McKinstry
Brian Healy	Tildon Jones
Emily Omana Smith	Doug Osmundson
Kirk Young	Dale Ryden

Report Sections

- Species description, distribution, and recovery efforts
- Habitat-related life history requirements
- Grand Canyon physical and biological characteristics
- Recovery viability in Grand Canyon
- Science Panel recommendations and next steps


Prepared by the Grand Canyon Monitoring and Research Center

Assessment of recovery viability for Colorado Pikeminnow (*Ptychocheilus lucius*) in the Colorado River in Grand Canyon

By Kimberly L. Dibble, Charles B. Yackulic, Kevin Bestgen, Keith Gido, Tildon Jones, Mark McKinstry, Doug Osmundson, Dale Ryden, and Robert Schelly

Open File Report 2021-XXX

U.S. Department of the Interior
U.S. Geological Survey

Illustration: J. Tomelleri

USGS

Section Structure

- **Topics and structure similar to SSA**
- **SSA identified five habitat attributes most likely to influence species viability**

Life History Stage	Habitat Attribute
Spawning adult	Peak flows
Egg	Base flows
Embryo/larva (in substrate)	Water temperature
Larva (dispersed)	Refuge/nursery habitat
Juvenile (age 0)	Forage base
Juvenile (age 1-2)	
Sub-adult and Adult	

USGS

Presentation Outline (2)

- Study Overview
  - Objectives
  - Process steps
  - Report structure
- Habitat assessment
  - Peak flows, base flows, water temperature, refuge/nursery habitat, forage base
- Recommendations and next steps

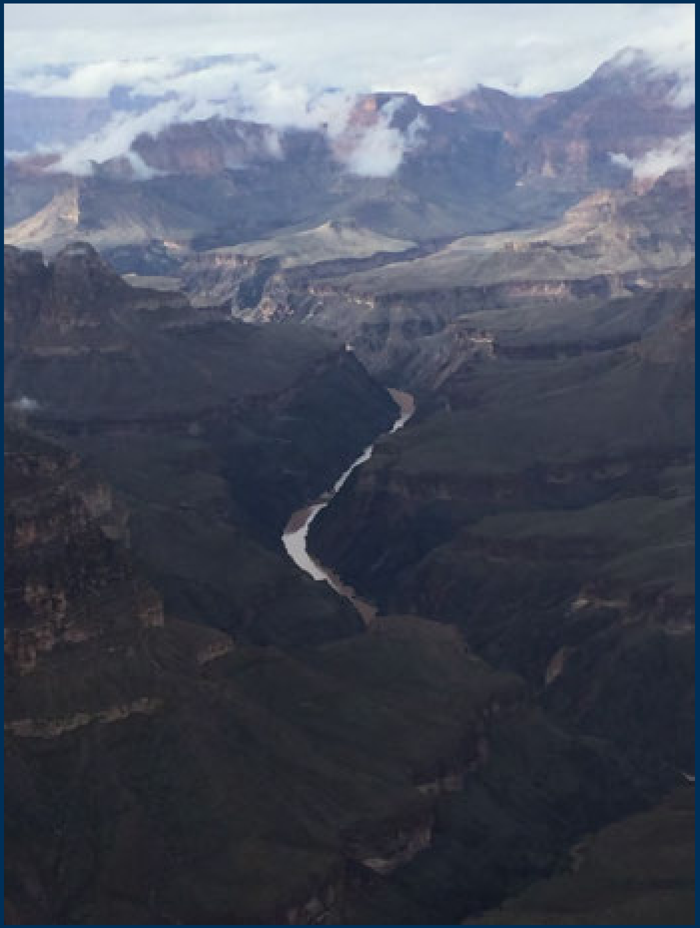
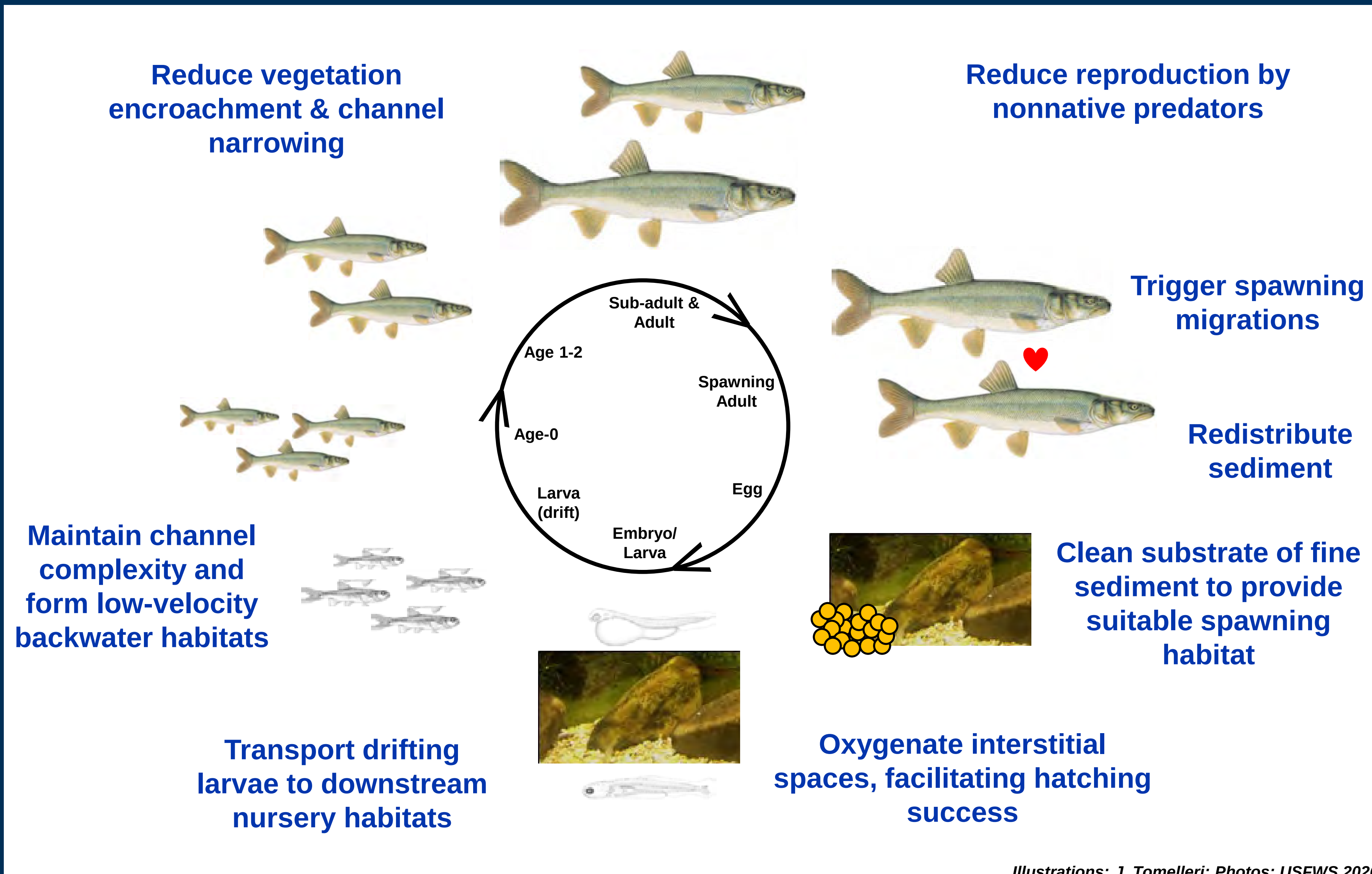


Photo: K. Dibble

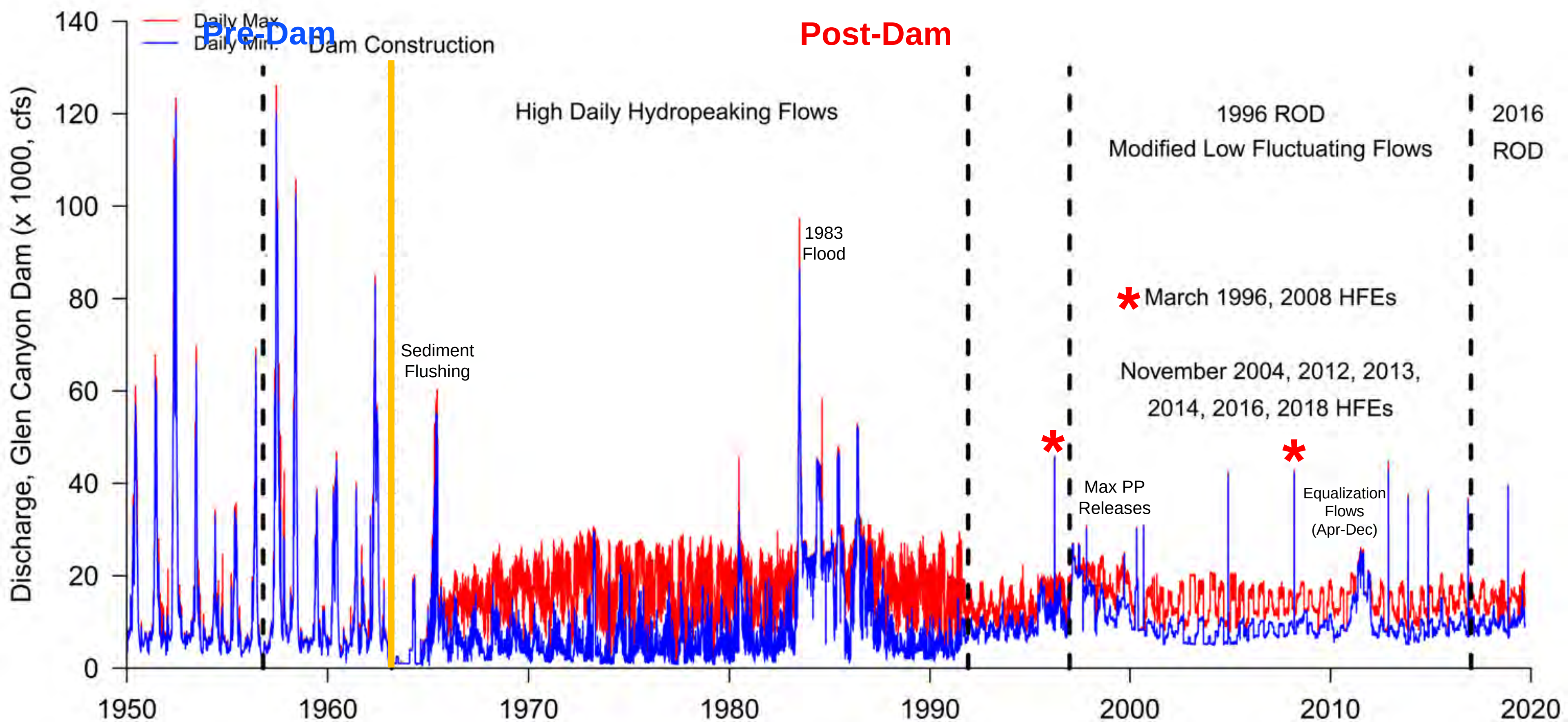
USGS

Peak Flows

Maintain channel complexity, form backwater nursery habitats, clean cobble for spawning, and transport drifting larvae to nursery habitats



Grand Canyon Flow Overview



Unpublished Data *Do Not Cite*

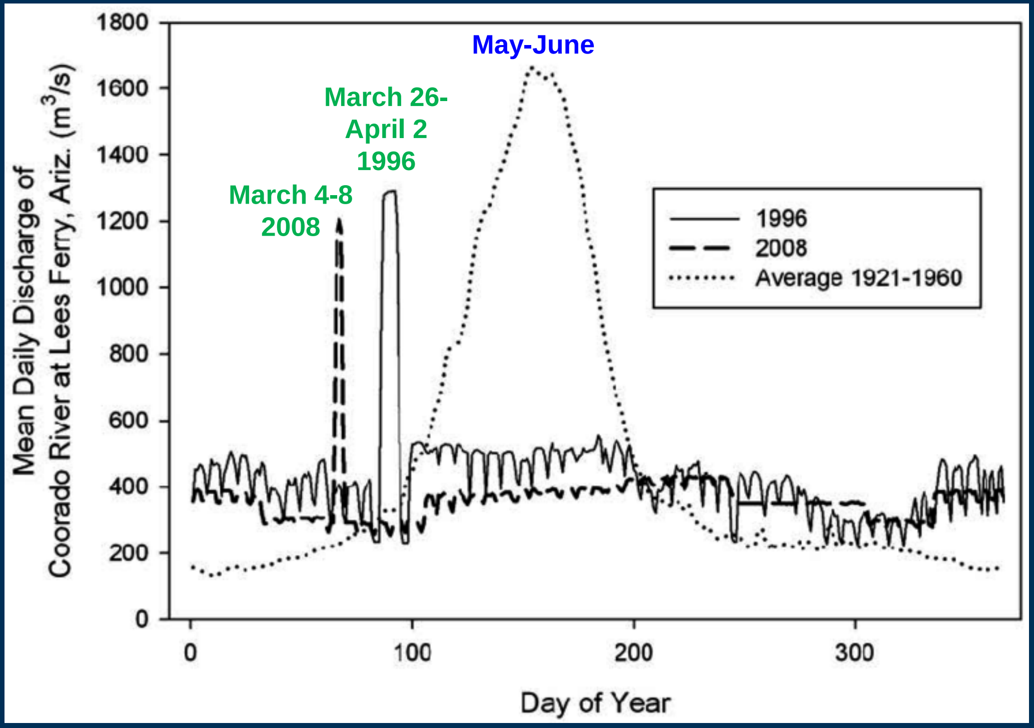
USGS

***Pre-dam*: Large spring floods, low and steady summer flows**

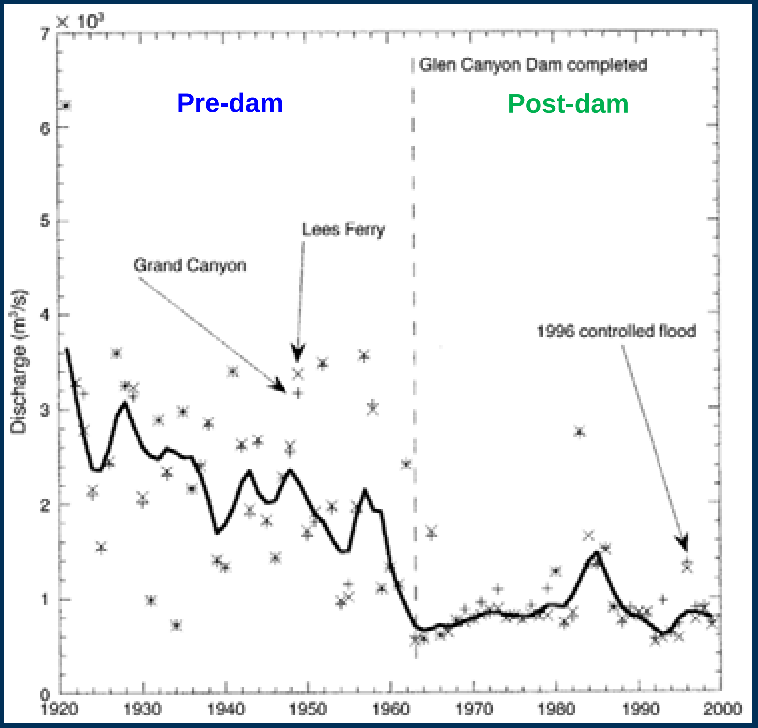
***Post-dam*: High daily hydropeaking, followed by MLFF regime**

- **Spring and fall-timed HFEs**
- **Releases up to Powerplant capacity**

Spring High Flow Experiments



Rosi Marshall et al. 2010



Schmidt et al. 2001

- Pre-dam spring flows higher in magnitude/duration & later than post-dam HFEs
- HFEs mobilize sediment off the bed for deposition on banks
    - Create sandbars for recreational use and to help protect cultural sites
    - Prevent vegetation encroachment into channel and on sandbars
    - Form low-velocity backwater habitats (ephemeral)
- Other: Spring Disturbance Flow, March 2021

Science Panel: Peak Flows

Potential Benefits

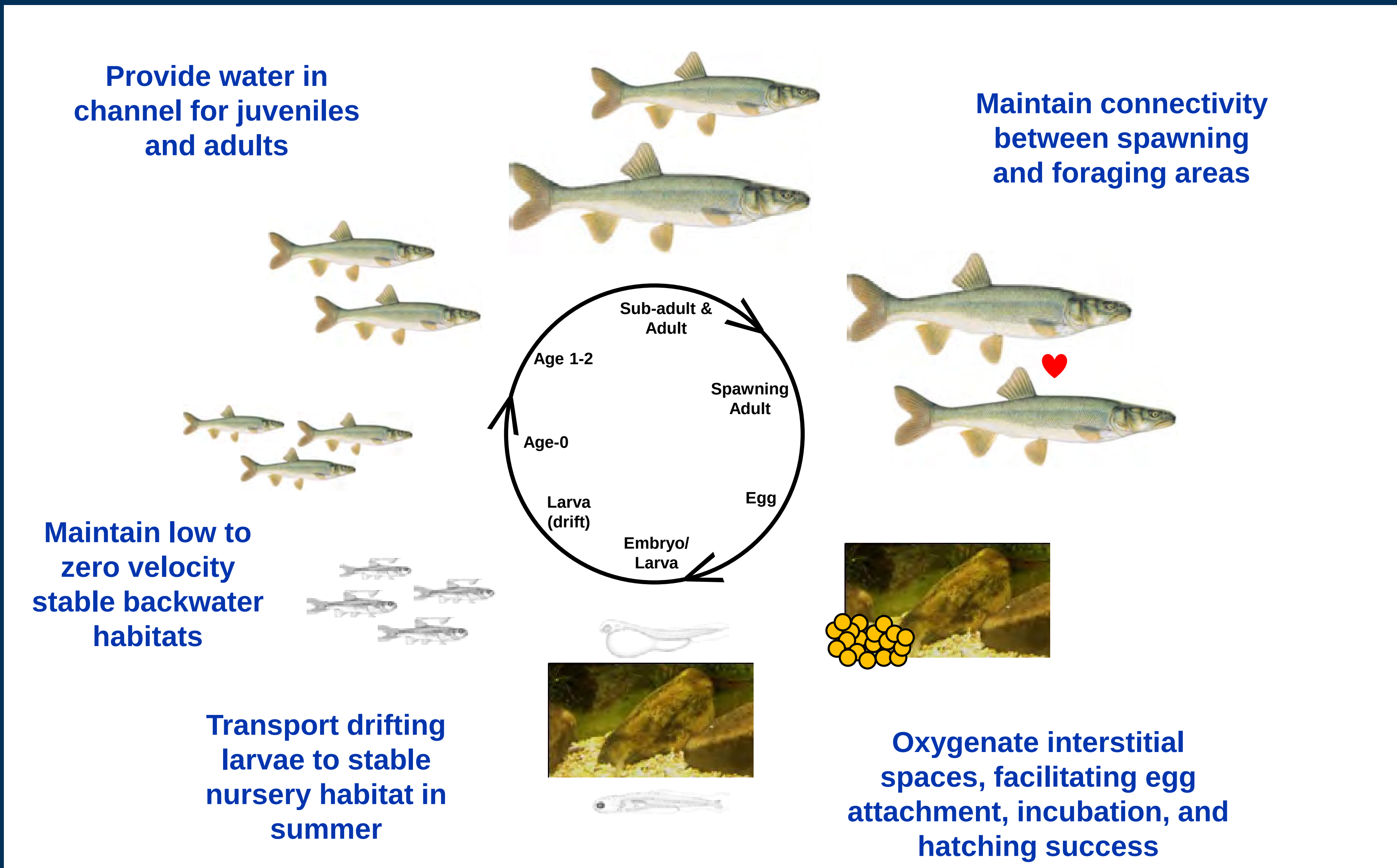
- Simulates spring flood (shorter)
- Removes fine sediment to improve spawning gravels
- Creates backwaters
- May trigger spawning migrations

Uncertainties

- May not substantially reduce embeddedness
- Unclear if HFEs will create well-oxygenated substrate for egg development
- Misses timing of larval drift (summer)

Base Flows

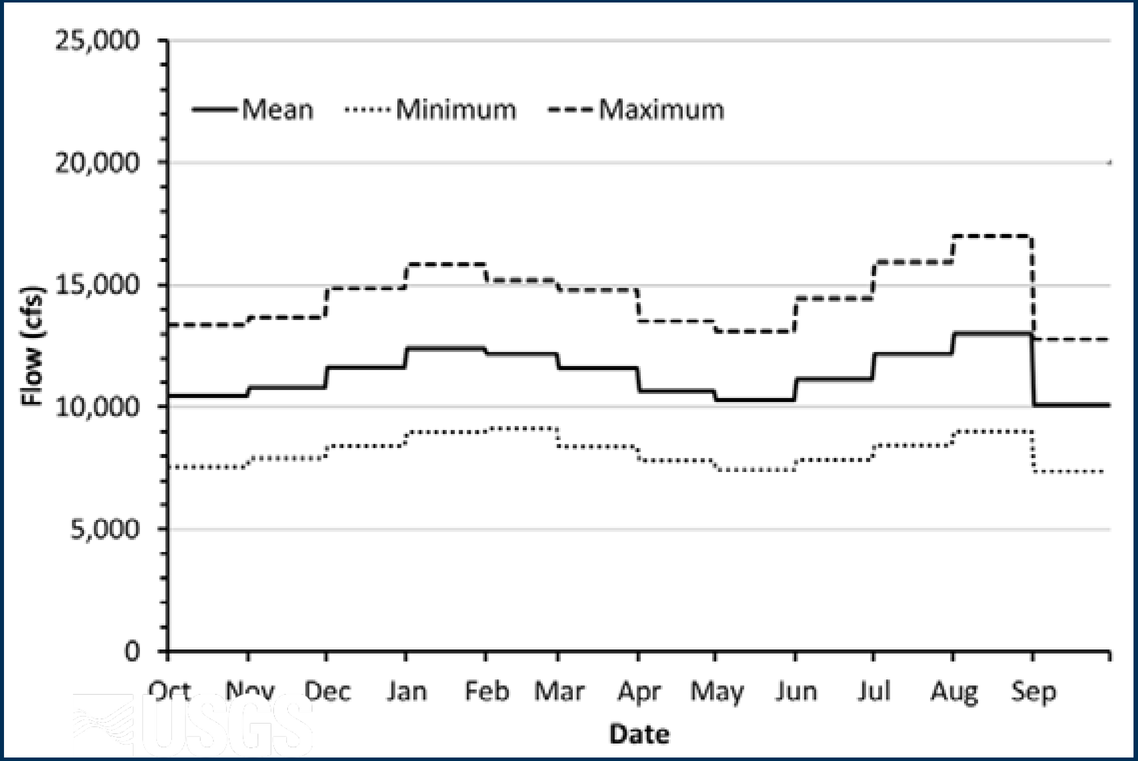
Maintain stable nursery habitat in summer and provide connectivity between spawning and foraging areas for adults



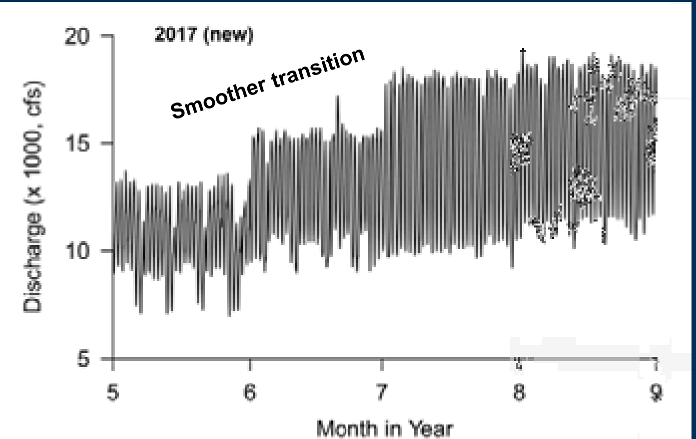
Illustrations: J. Tomelleri; Photos: USFWS 2020

Glen Canyon Dam Operations

- **2016 Record of Decision for the Glen Canyon Dam Long-Term Experimental and Management Plan, Final Environmental Impact Statement (Alternative D)**



LTEMP EIS, ROD 2016



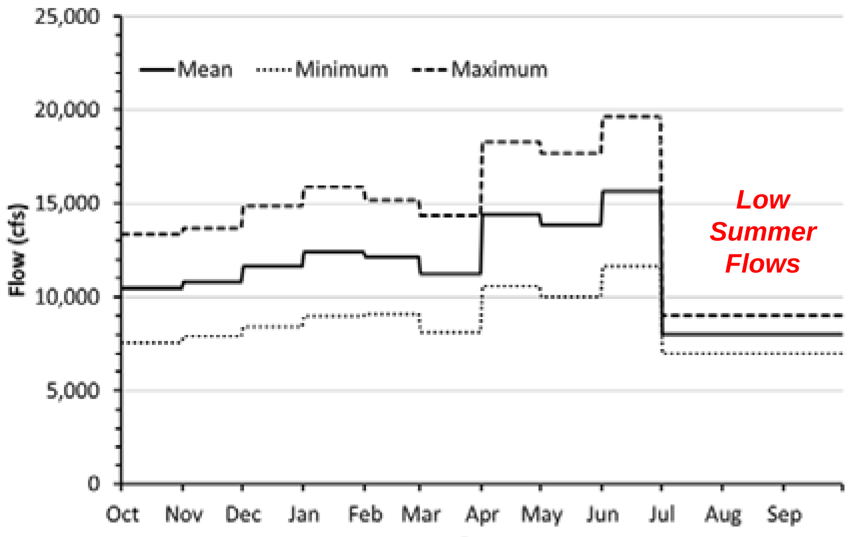
Unpublished Data – Do Not Cite

Parameter	Value
Flow	
Maximum	25,000 cfs
Minimum	5,000 cfs 8,000 cfs
Ramp Rates	
Ascending	4,000 cfs/hour
Descending	1,500 cfs/hour
Daily Flow Range	5,000 to 8,000 cfs

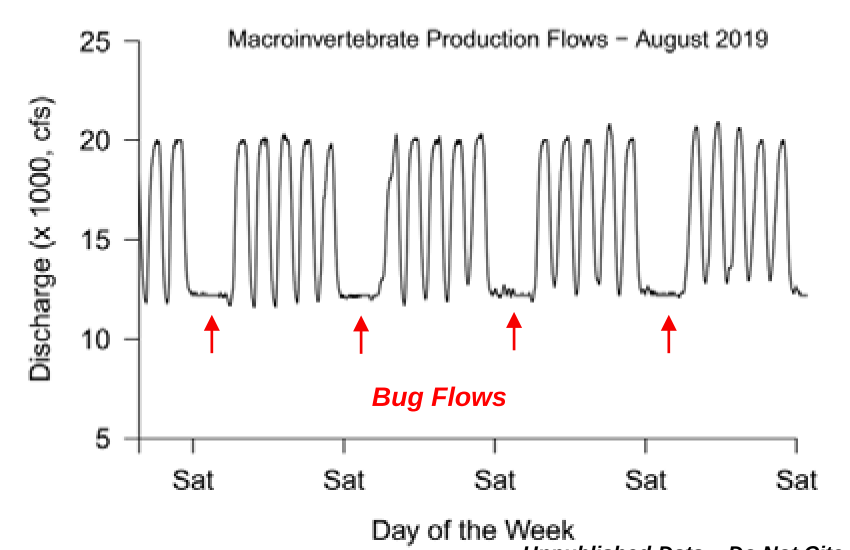
Low or Steady Flow Experiments

<u>**Experimental Releases allowed under 2016 ROD**</u>

- ***Low summer flows***
  - **July, August, September**
  - **2028 on; <10 maf release**
  - **Achieve ≥14°C at LCR**
- ***Macroinvertebrate Production Flows***
  - **May-August**
  - **Steady releases on Sat-Sun**
  - ***"Give bugs the weekend off"* (TK and Jeff)**



LTEMP EIS, ROD 2016



Unpublished Data – Do Not Cite

USGS

Science Panel: Base Flows

Potential Benefits

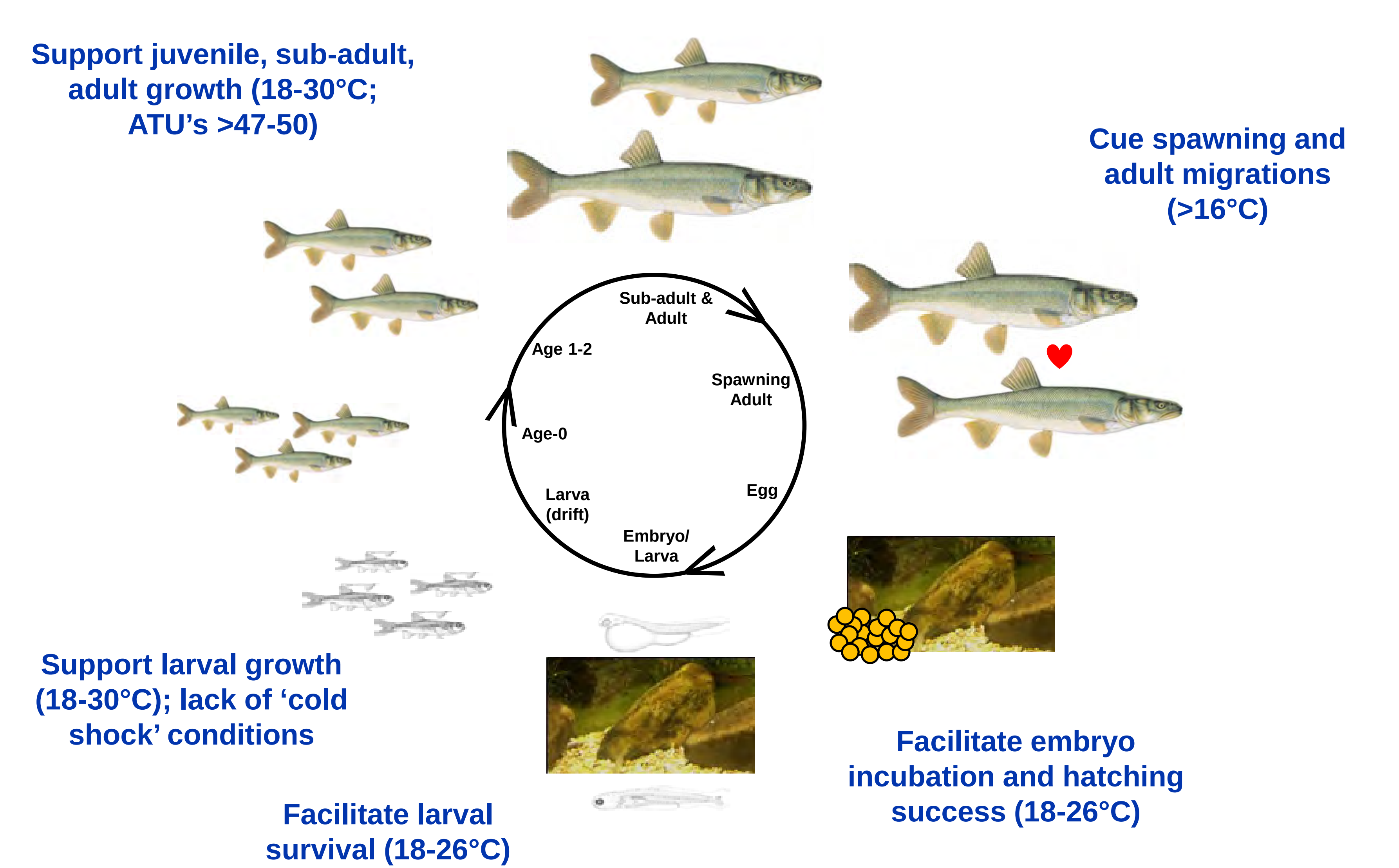
- Reliable source of water for movement
- Low/steady flows may improve conditions
- Native fish thriving despite altered flow & thermal regime
- Native fish use variety of habitats (e.g., talus)

Uncertainties

- Hydropeaking may:
  - Desiccate eggs
  - Displace larvae into Lake Mead
  - Decrease stability & persistence of backwaters
  - Impose energetic cost with stage change

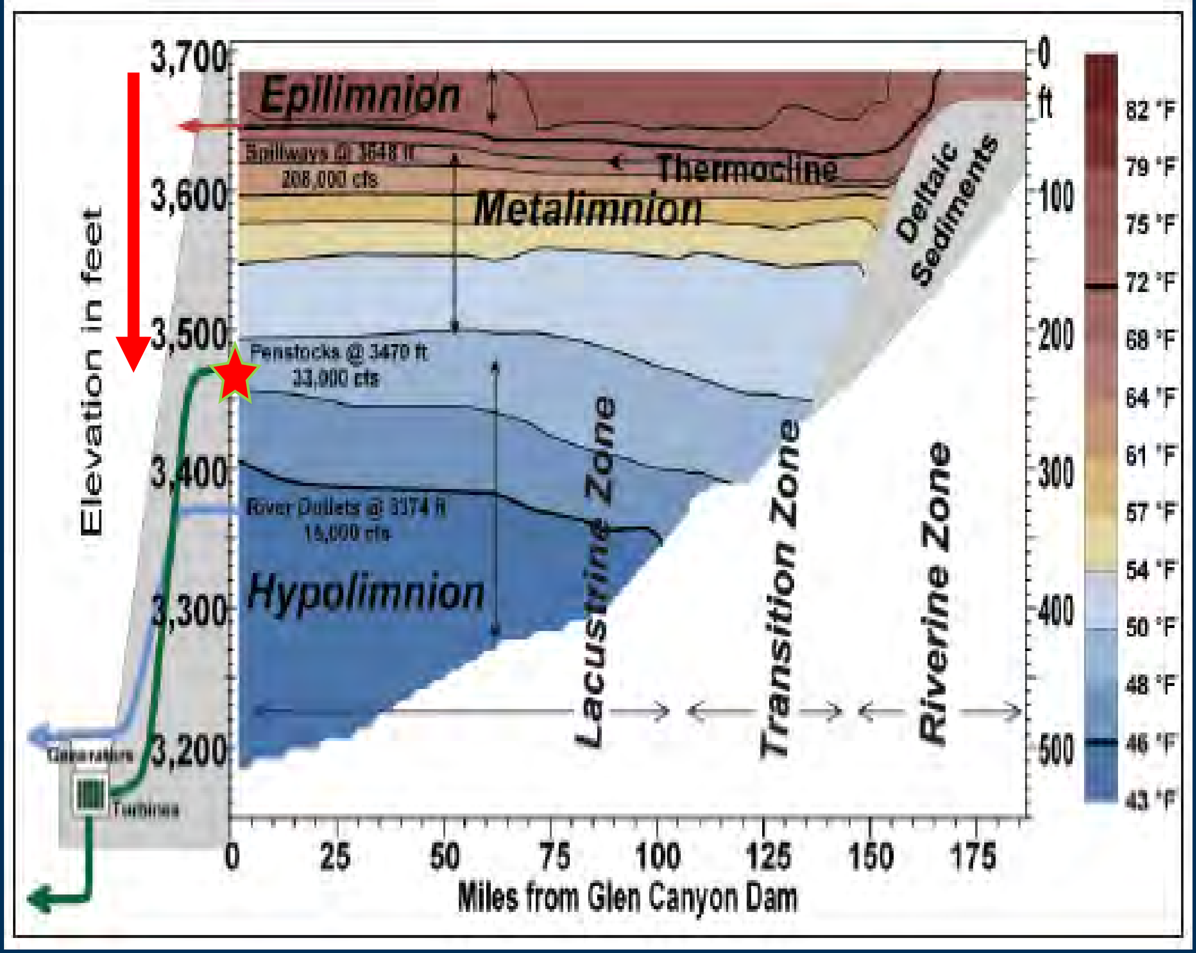
Water Temperature

Provide a thermal regime suitable for spawning, hatching, and growth



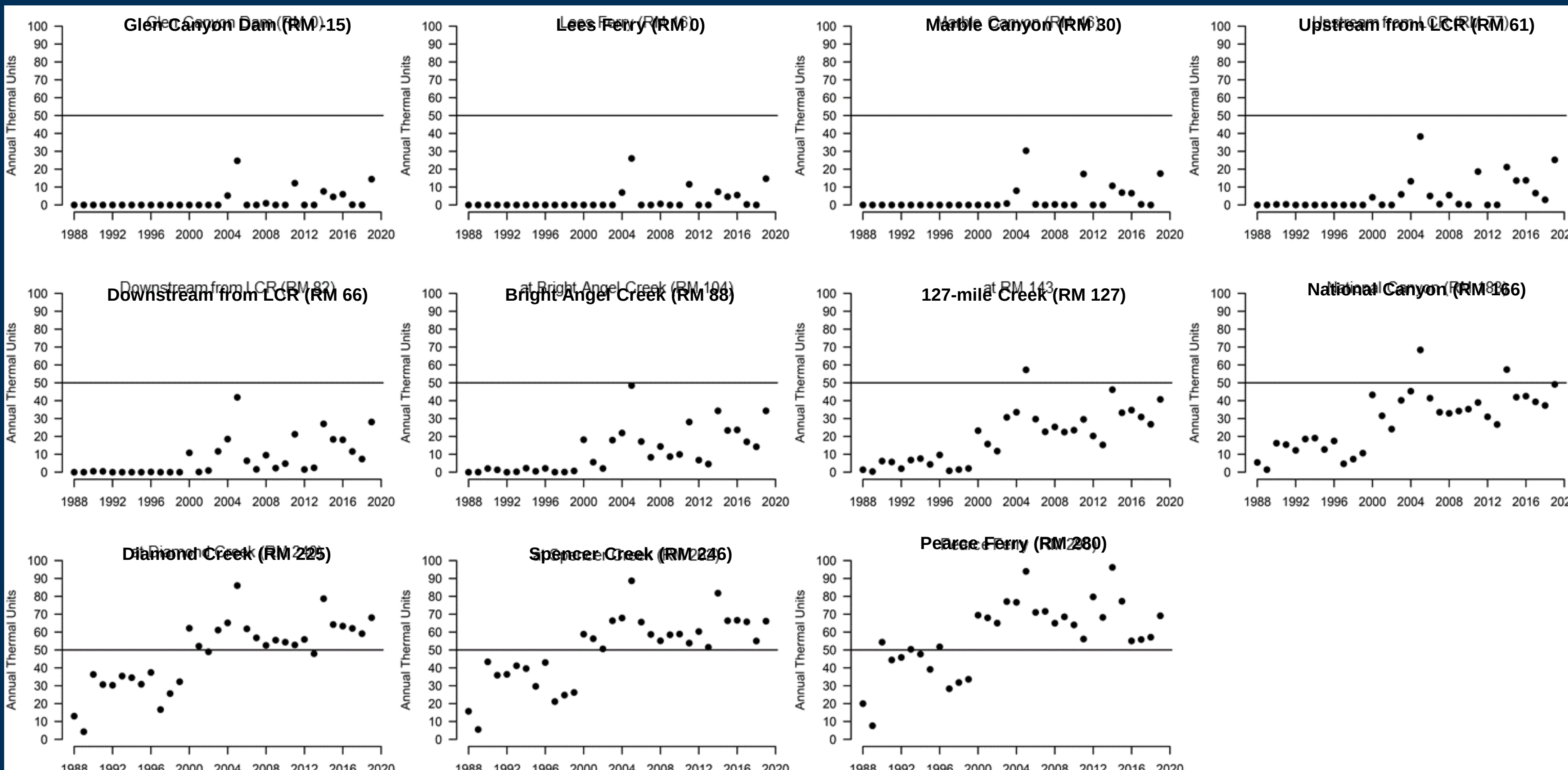
Illustrations: J. Tomelleri; Photos: USFWS 2020

Lake Powell Thermal Stratification



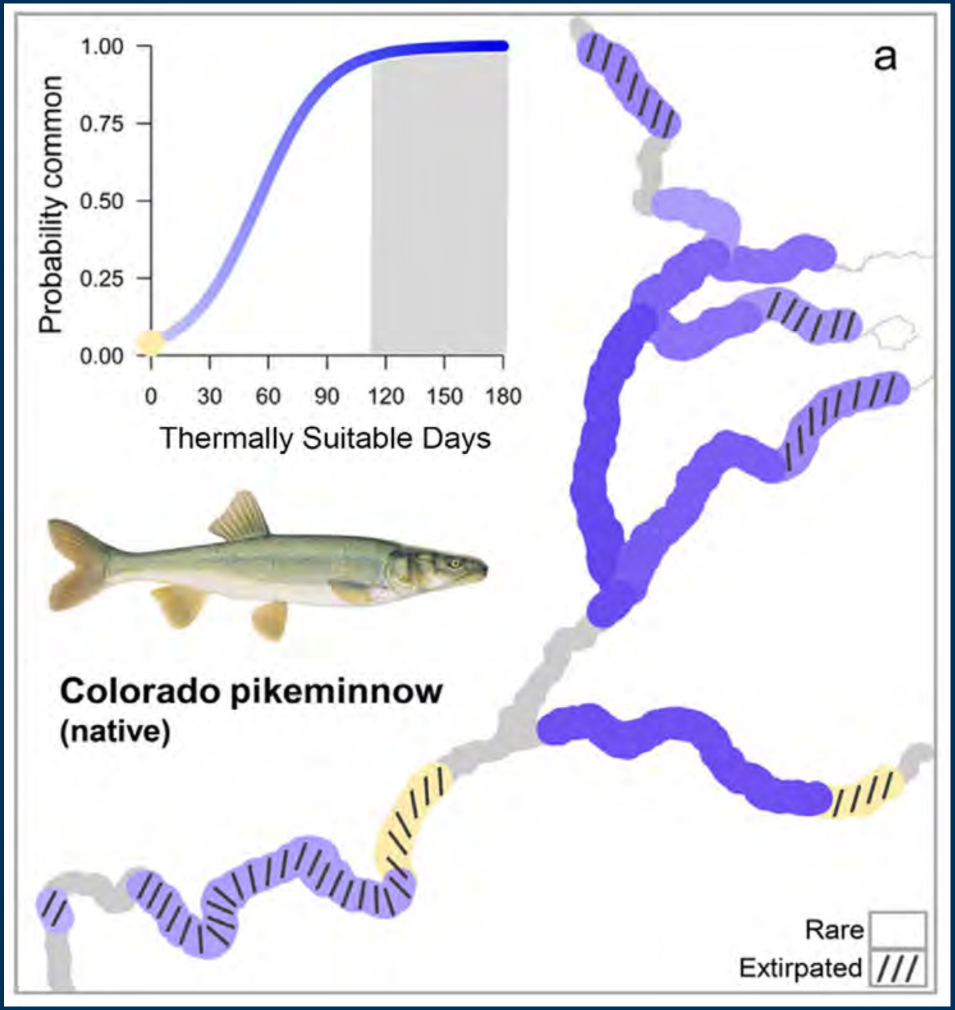
Vernieu et al. 2005

Annual Thermal Units in Mainstem



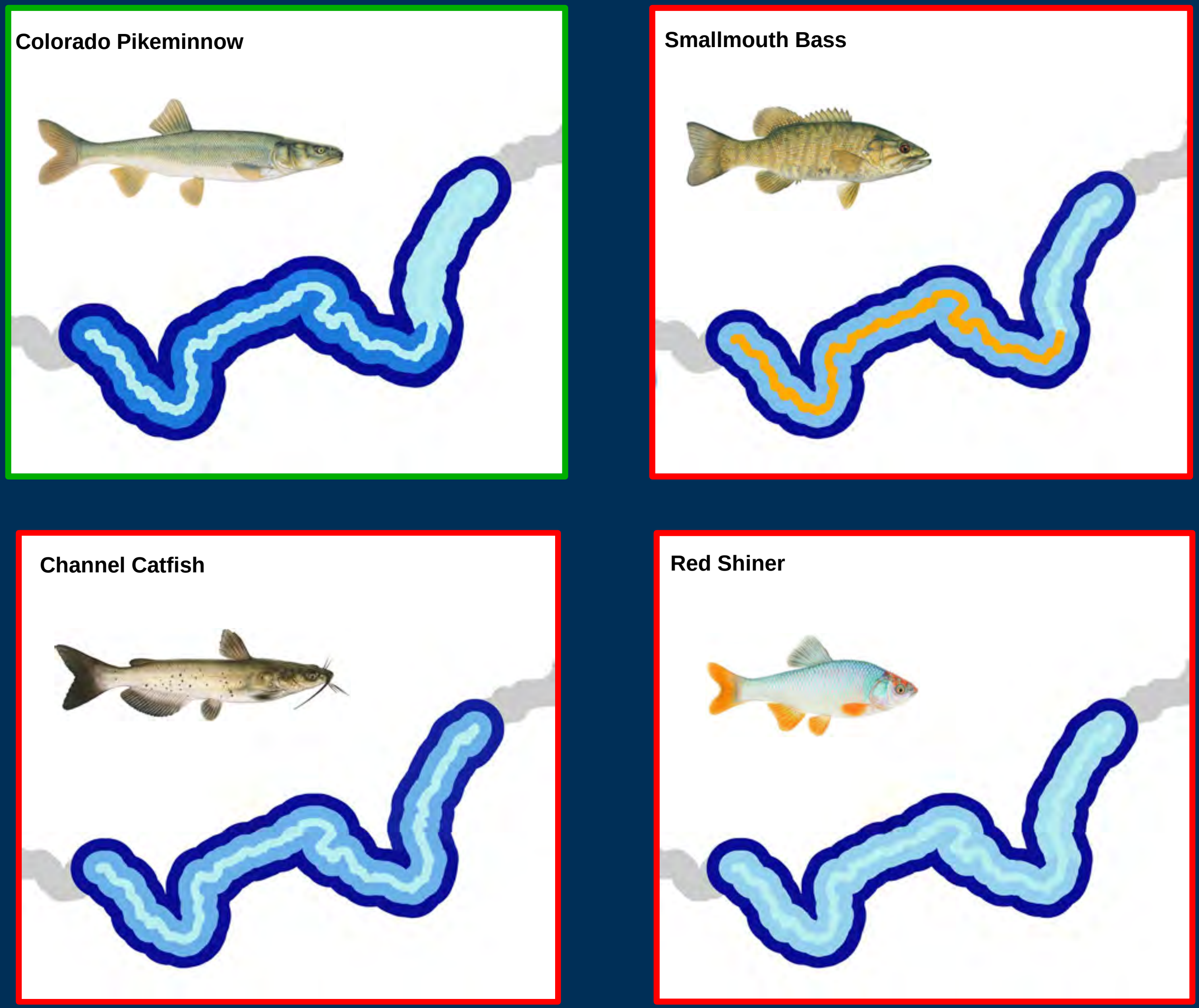
Unpublished Data Do Not Cite

Current Thermal Suitability



Dibble et al. 2021; Illustration: J. Tomelleri

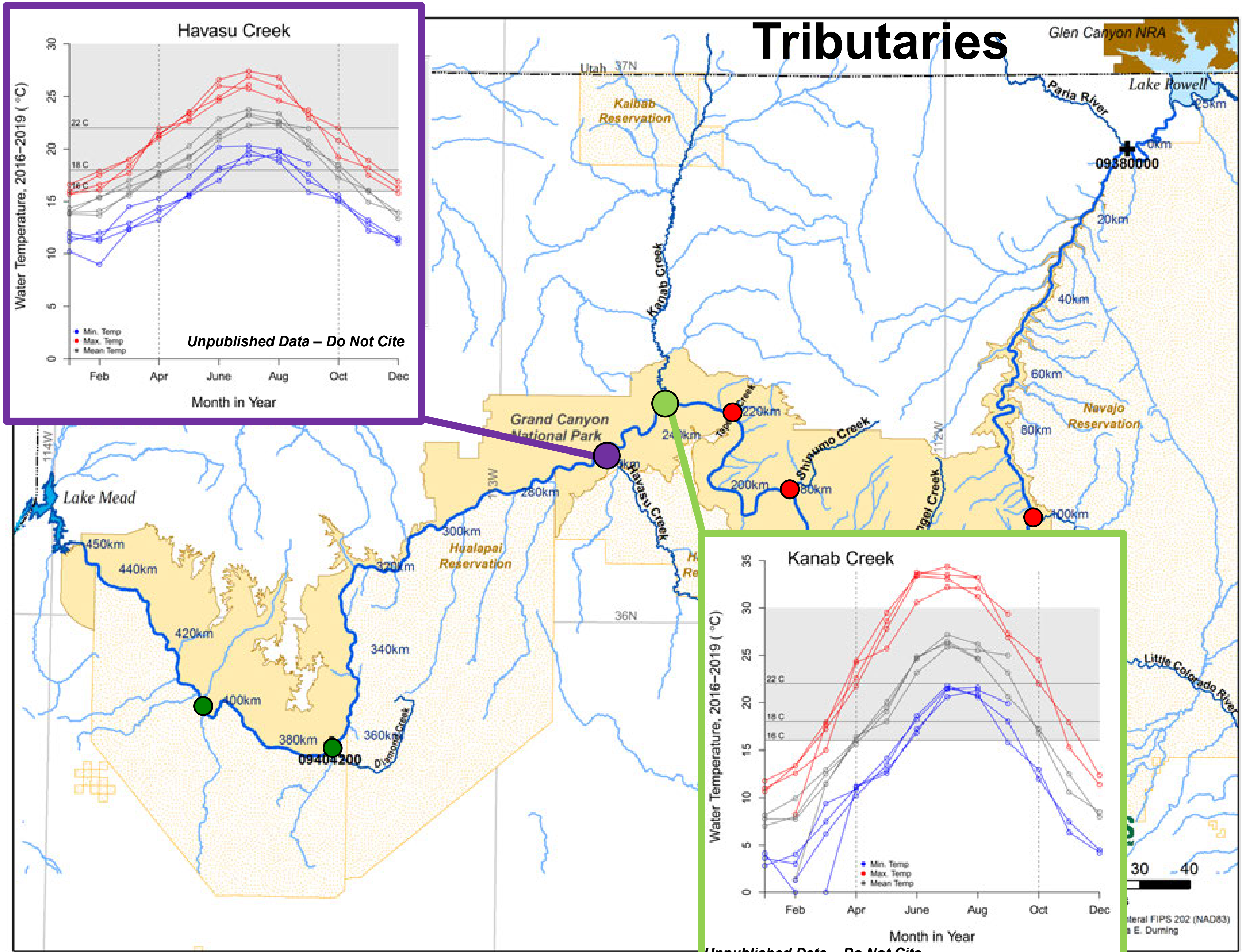
Future Thermal Suitability



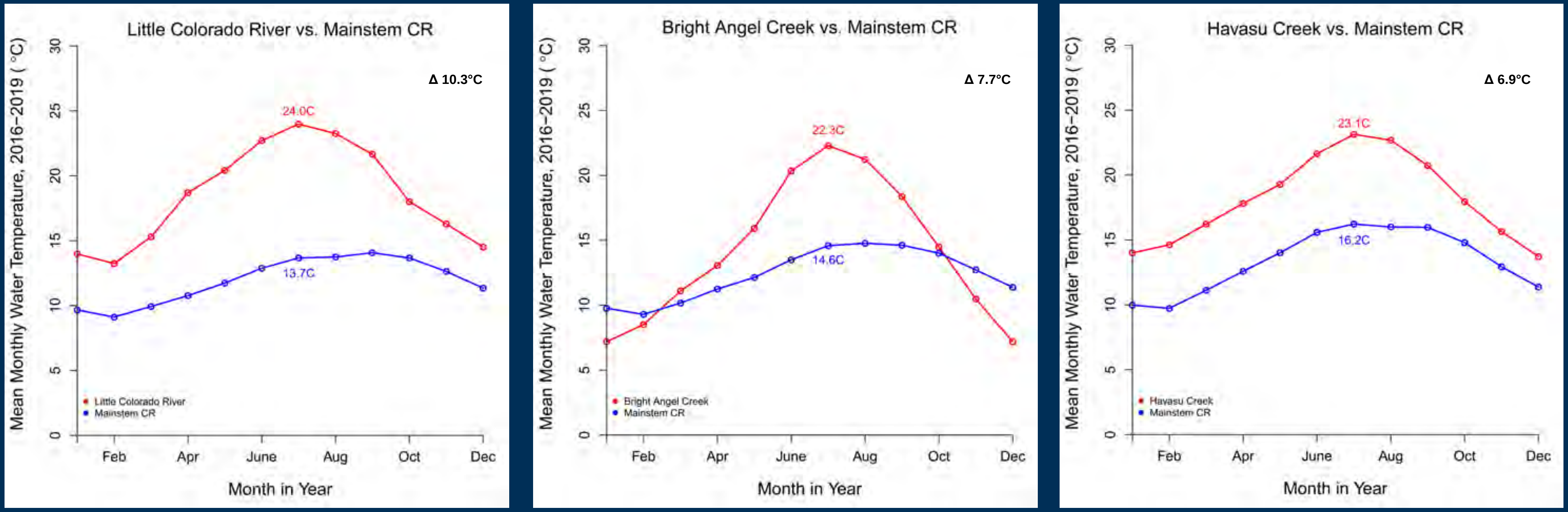
Dibble et al. 2021; Illustrations: J. Tomelleri

USGS

Tributaries



Cold Shock? What if CPM Spawn in Tributaries…



Upstream → Downstream

Unpublished Data Do Not Cite

USGS

Science Panel: Water Temperature

Potential Benefits

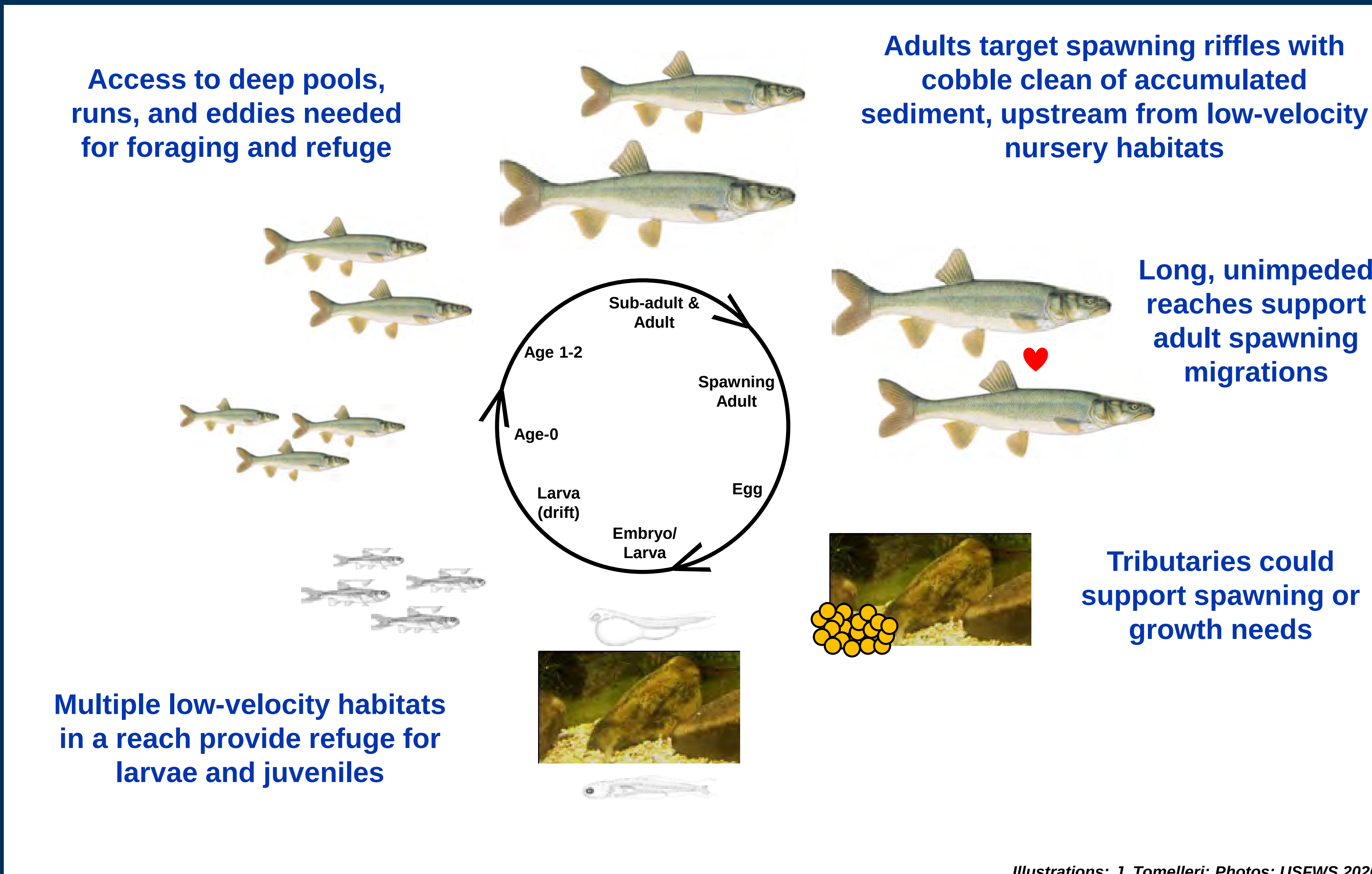
- Western GC could support CPM
  - >16°C: Cue spawning
  - 18°C: Support egg development & larval growth
- Non-natives lacking
- Pearce Ferry Rapid
- Warmwater tributaries

Uncertainties

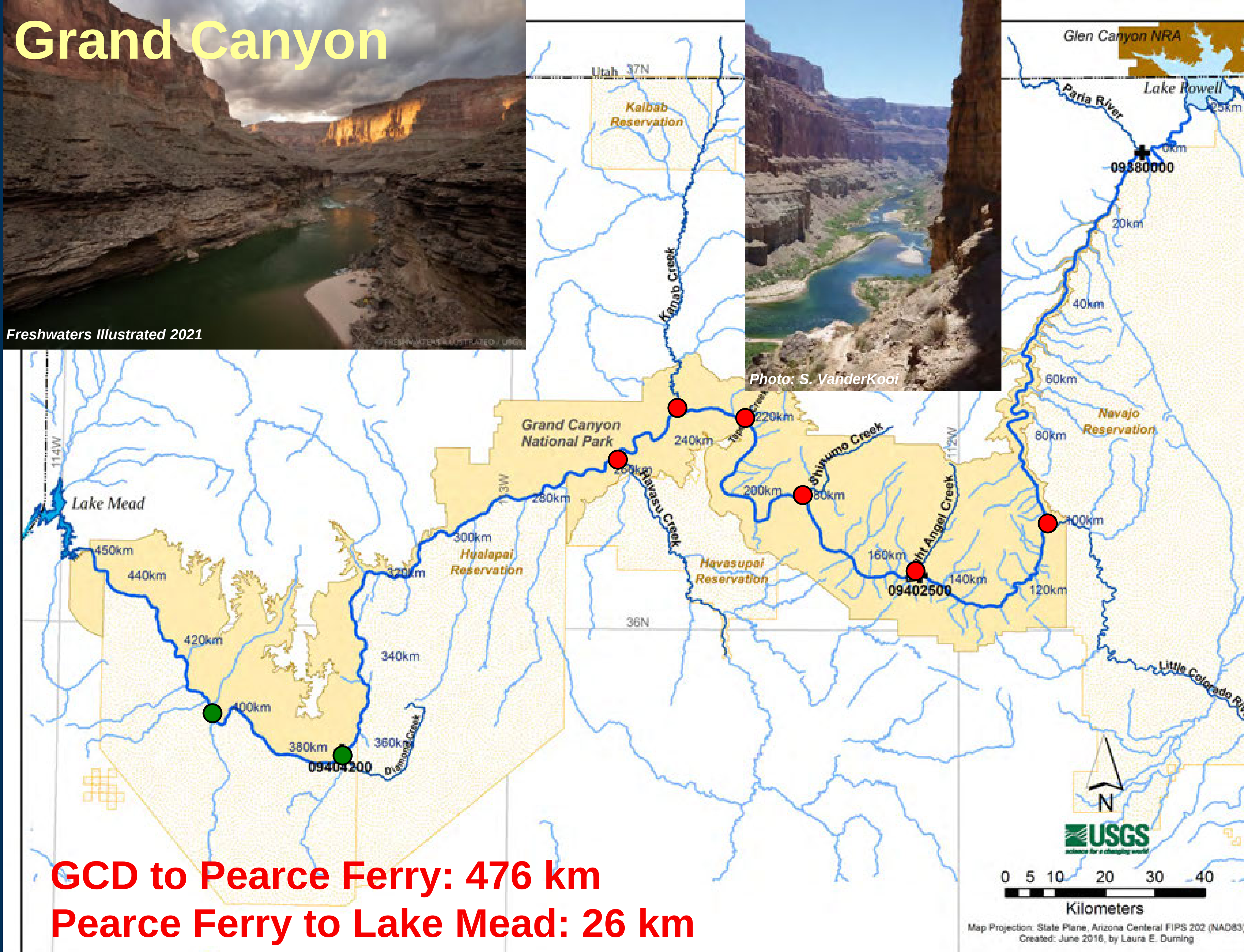
- Warming dependent on Lake Powell elevations
- Depressed summer temperatures & warmer winters (growth)
- Sufficient cues for spawning (flow/temp)
- Non-native invasion with warming trend

Refuge/Nursery Habitat

Redundant, complex, low-velocity habitat for spawning, rearing, and foraging



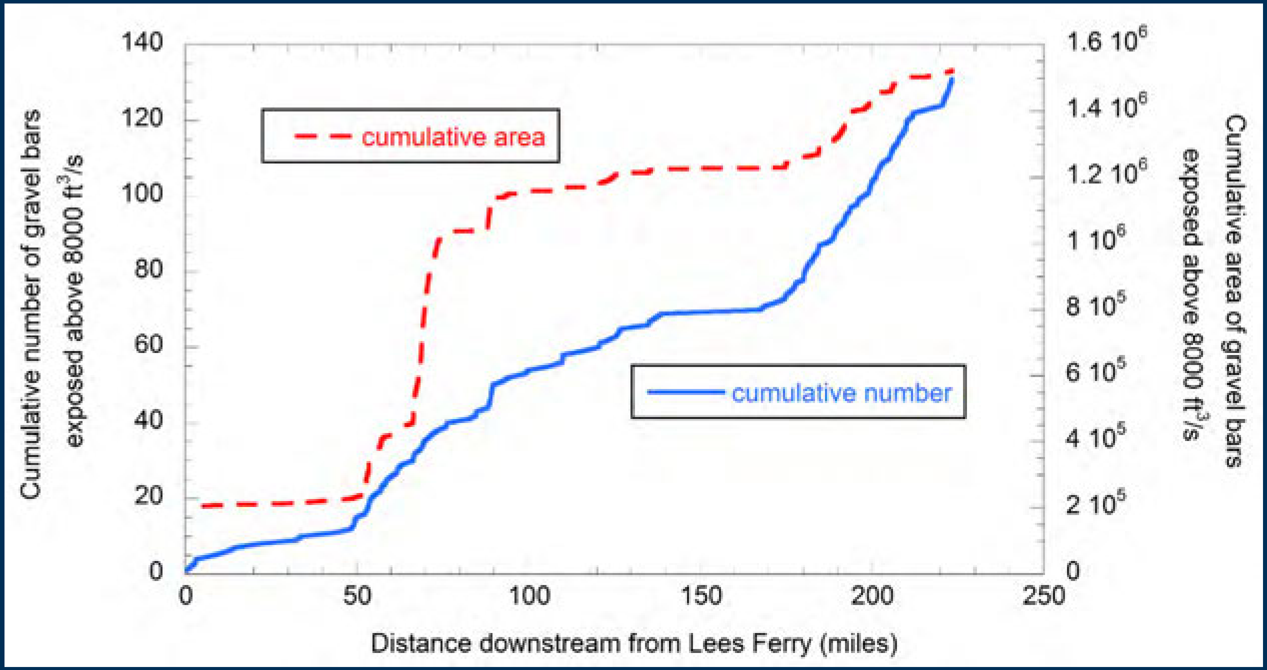
Grand Canyon



GCD to Pearce Ferry: 476 km

Pearce Ferry to Lake Mead: 26 km

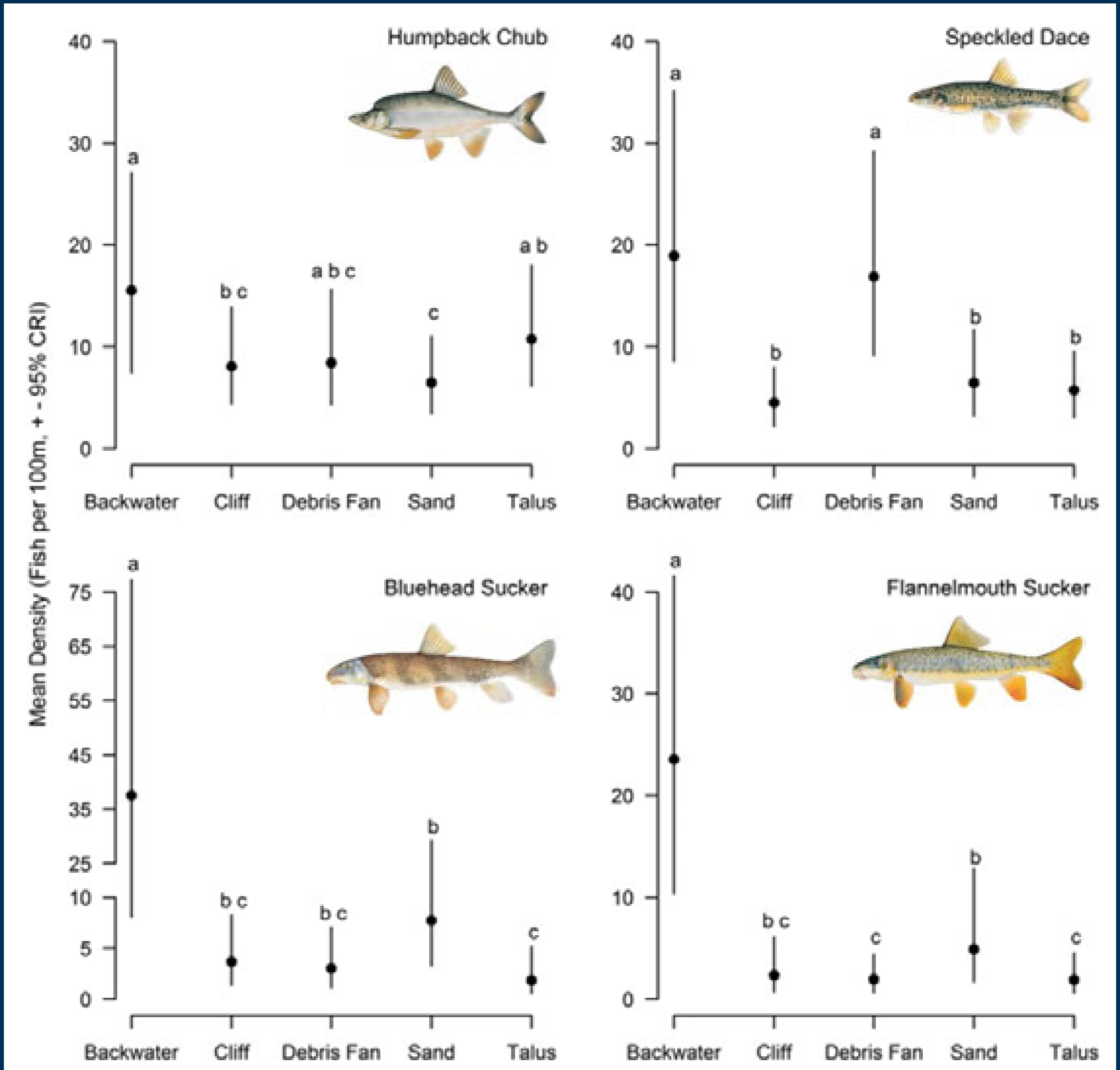
Mainstem Spawning Substrate

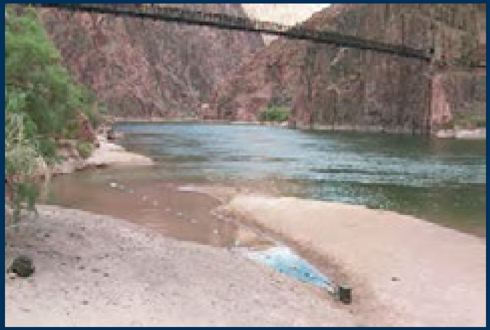


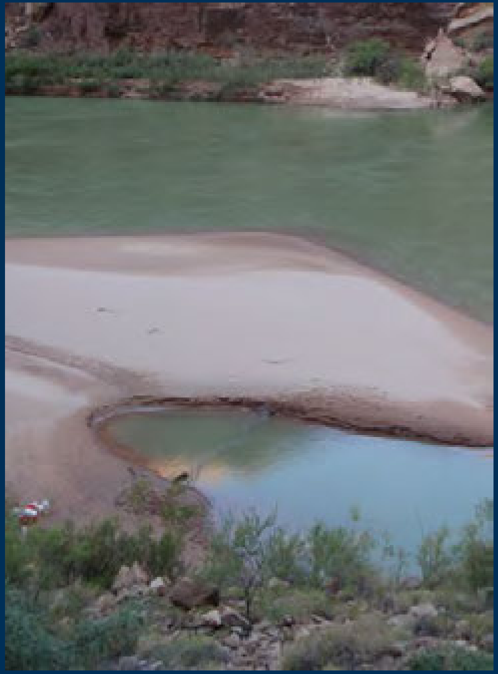
Kaplinski et al. 2020, and Unpublished Data *Do Not Cite*

Freshwaters Illustrated 2021

Fish in Backwaters & Other Habitat





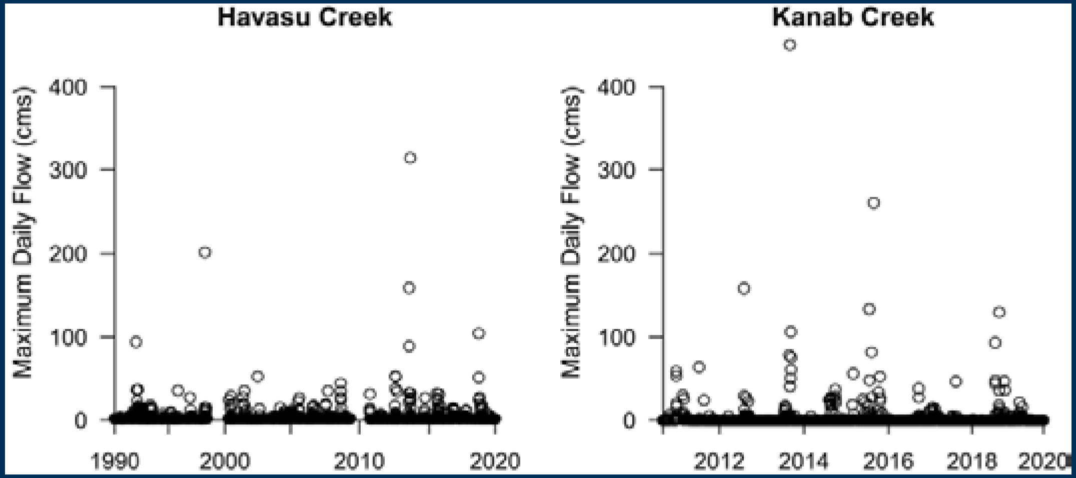


Dodrill et al. 2015

Low Flows and Backwaters

Freshwaters Illustrated 2021

Tributary Habitats



USGS

Unpublished Data *Do Not Cite*

Science Panel: Refuge/Nursery Habitat

Potential Benefits

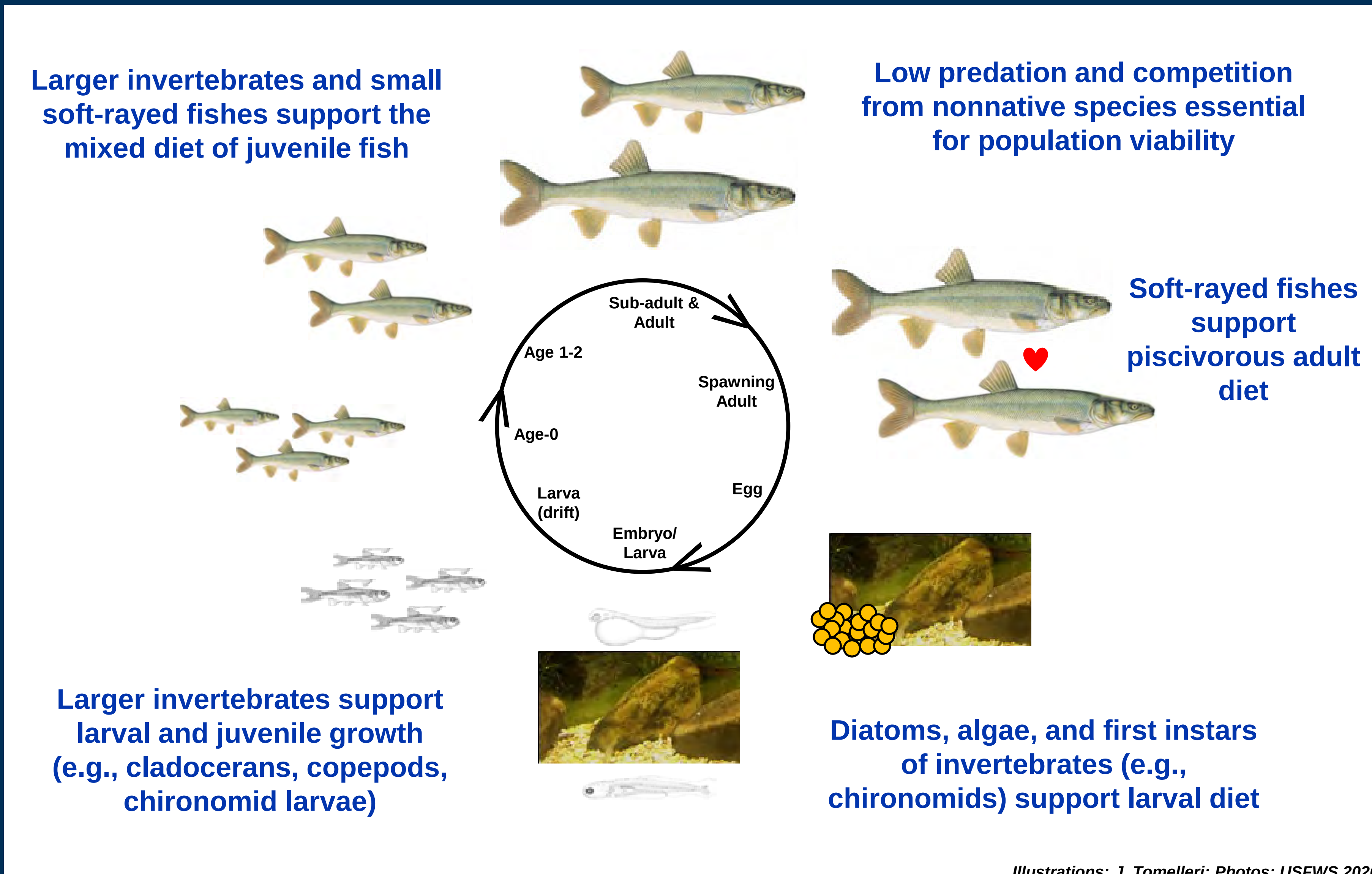
- Some suitable substrate available
- Monsoon season- new source of gravel
- Backwaters throughout GC
- HBC and FMS use other habitat types
- Lake Mead inflow

Uncertainties

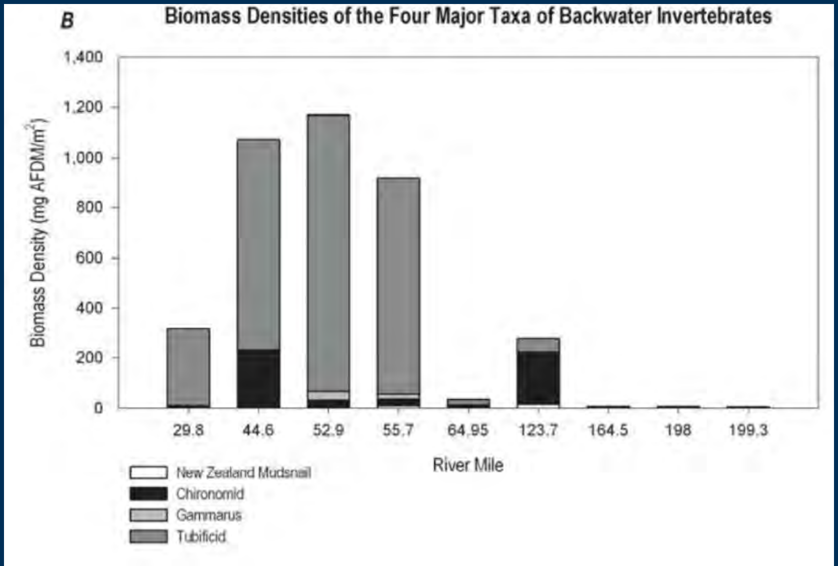
- Spawning substrate highly embedded
- Exposed bars small
- Backwaters ephemeral
- Larval fish- movement
- No off-channel habitat or floodplain wetlands
- Non-native predation- Lake Mead

Prey Resources

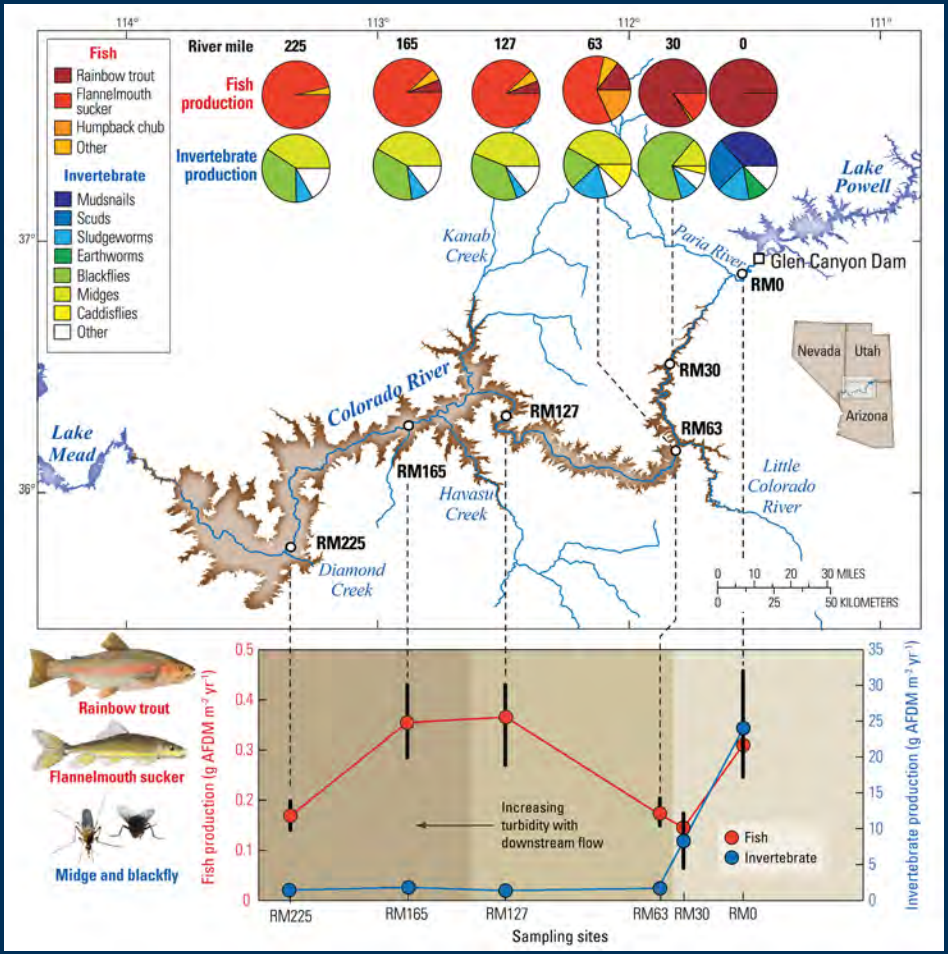
Abundant forage base that exhibits low predation and competition from nonnative species



Aquatic Invertebrate Production

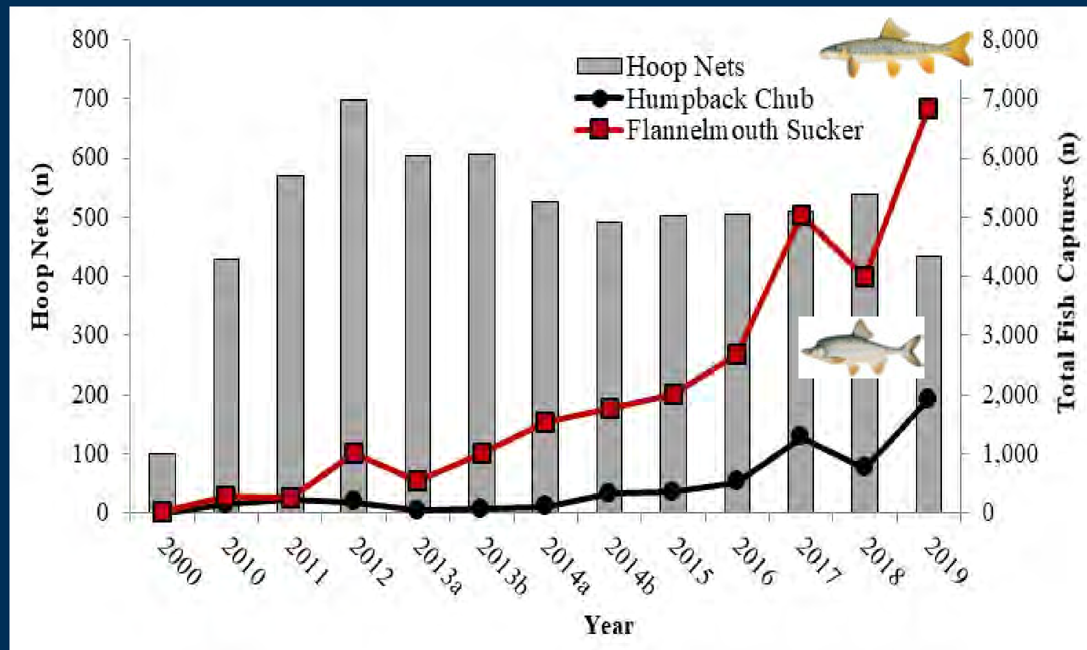


Behn et al. 2010

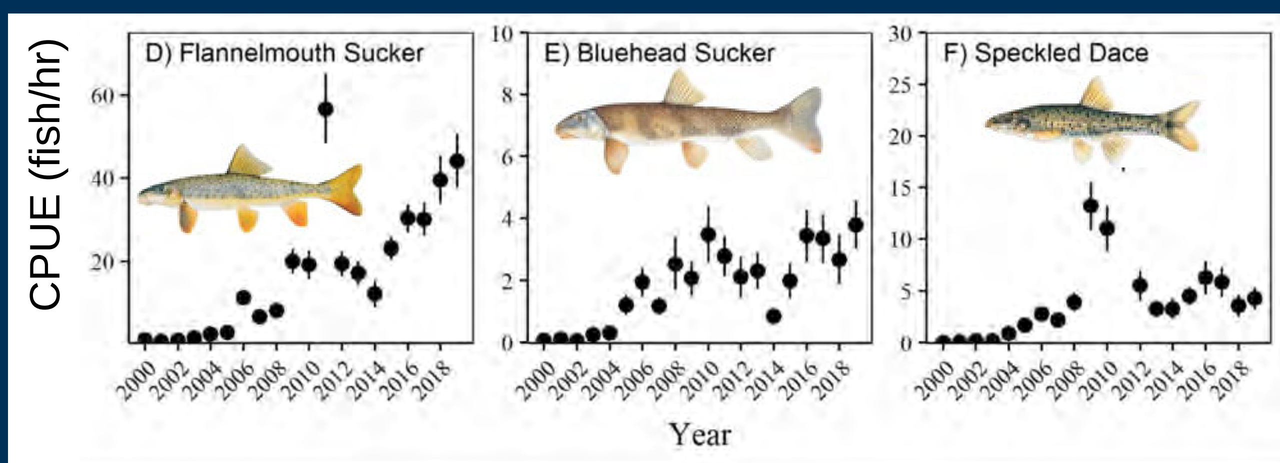


Kennedy et al. 2013

Trends in Native Fish Abundance



Van Haverbeke and Dzul, Preliminary Data – Do Not Cite

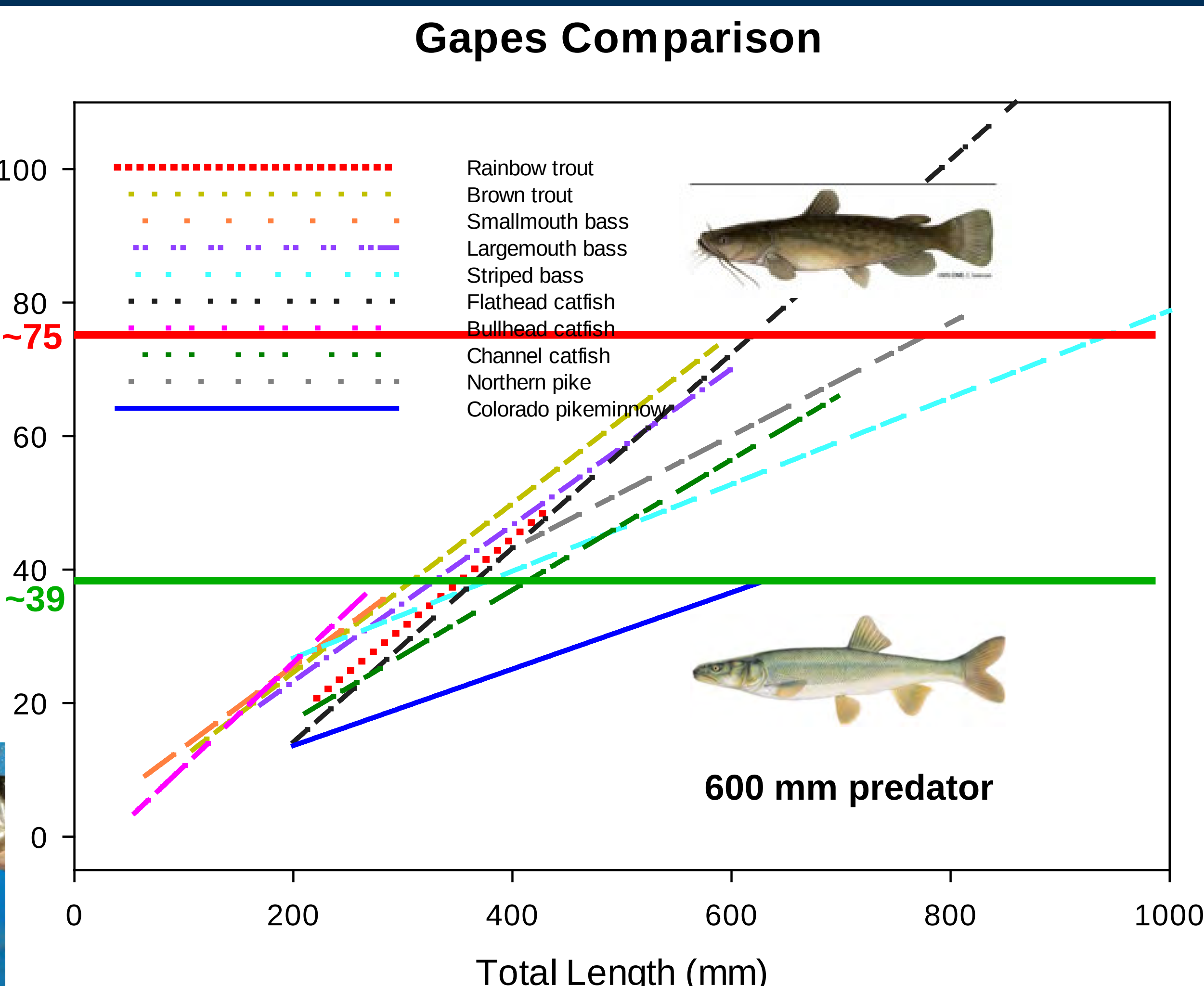


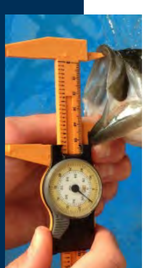
AZGFD, FY19 GCMRC Annual Report

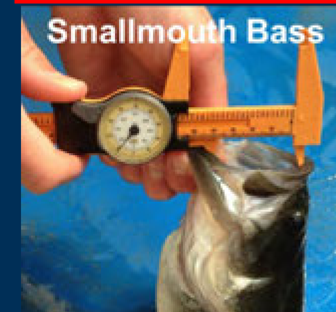
USGS

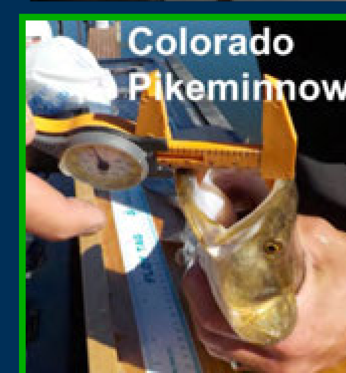
Illustrations: J. Tomelleri

Predation Potential



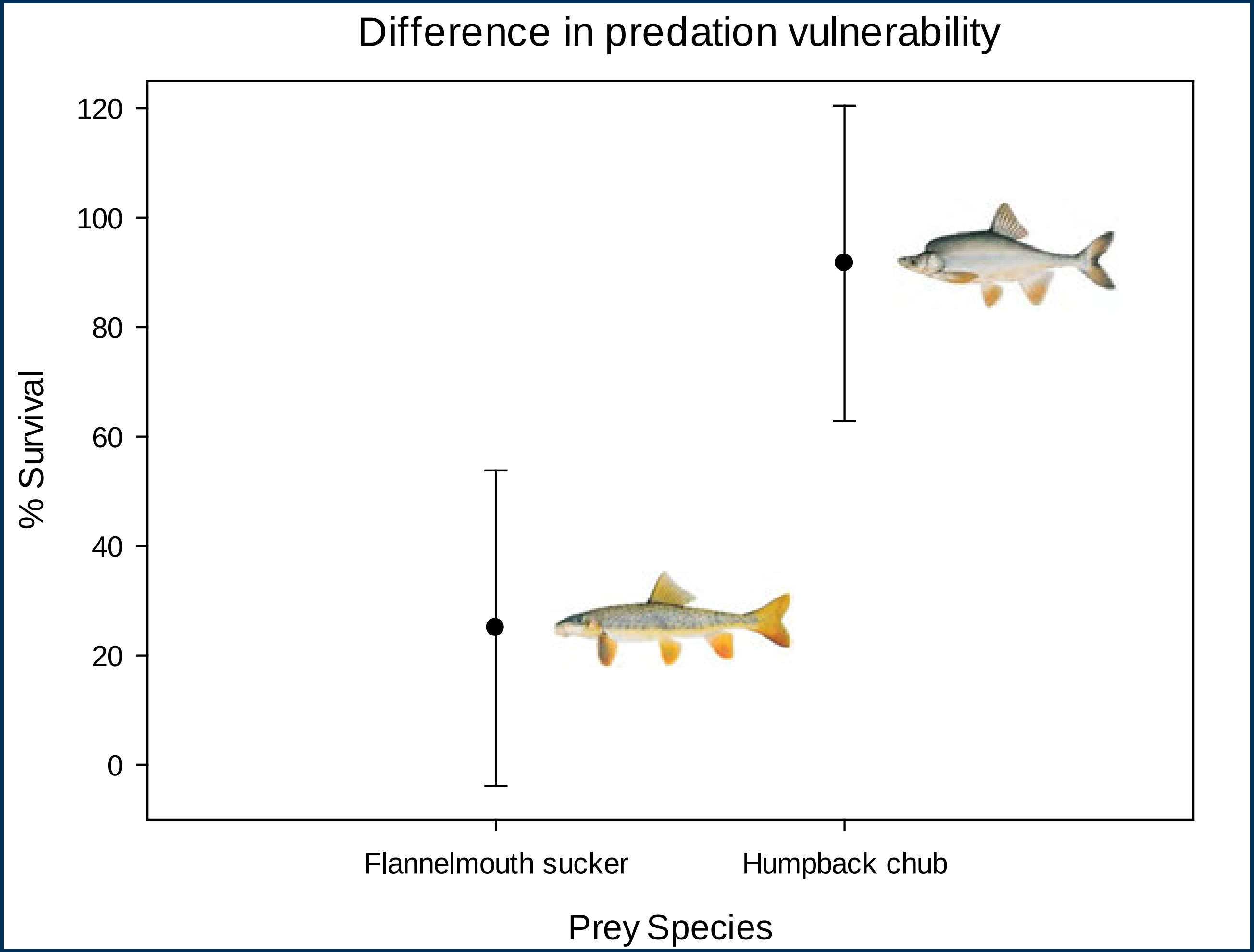






D. Ward, In Review, NAJFM; Photos: D. Ward; Illustrations: J. Tomelleri, C. Iverson

Predation Vulnerability



D. Ward, Unpublished Data Do Not Cite
Illustrations: J. Tomelleri

USGS

Science Panel: Forage Base

Potential Benefits

- Abundant prey base for sub-adults/adults
- Few non-native spiny-rayed fishes
- FMS abundant
- FMS selected over HBC in lab trials
- HBC likely not affected at pop level

Uncertainties

- Low algal/invertebrate productivity to support larval/juvenile fish
- Food web unstable, poor insect diversity
- Low production of small fishes (juveniles)

Presentation Outline (3)

- Study Overview
  - Objectives
  - Process steps
  - Report structure
- Habitat assessment
  - Peak flows, base flows, water temperature, refuge/nursery habitat, forage base
- Recommendations and next steps

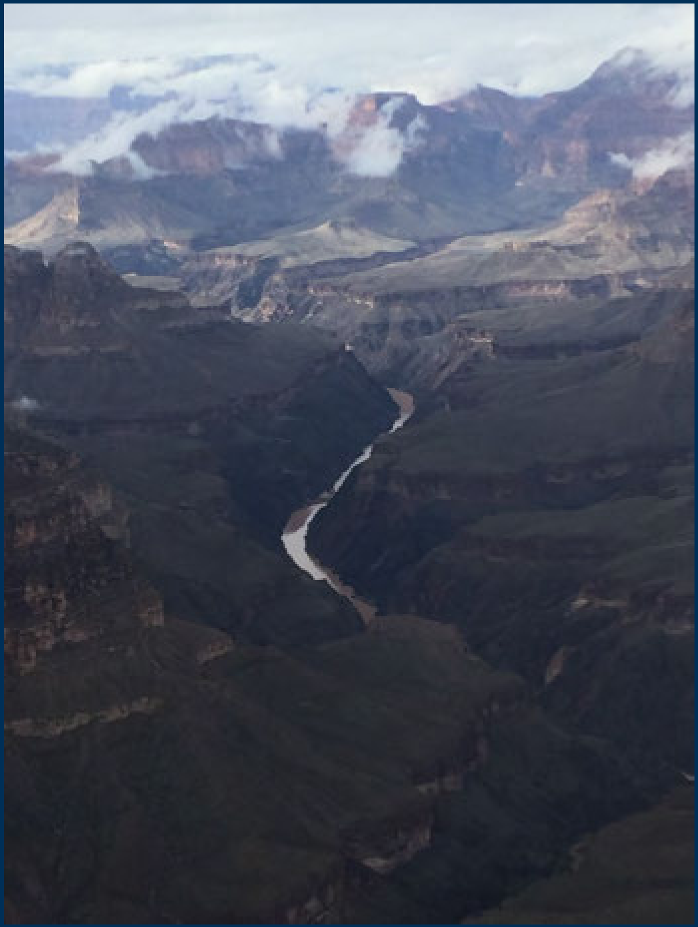


Photo: K. Dibble

USGS

General 😐 Thoughts from SP

- **Habitat attributes could satisfy some, but perhaps not all life history requirements**
  - **Substrate may not support egg development**
  - **Uncertainty on stable, redundant nursery habitats for larval and age 0-2 fish**
  - **Low productivity to support larval & juvenile fish**

- **Potential for low survival of early life history stages may create a recruitment bottleneck**

USGS

General Thoughts from SP

- **Habitat may support adult and sub-adult growth, foraging, home range development, migrations, and spawning**
- **Native populations of HBC and FMS thriving in western GC, even though habitat quality appears low relative to Upper Basin rivers**
- **HBC exhibit high condition factor, reside in habitats that support multiple life stages**
- **FMS are numerically more abundant**
- **GC lacks warmwater non-native predators**
- **GC providing good habitat for endemic natives**

Recommendation

The Colorado pikeminnow Science Panel recommends that wildlife resource managers pursue Phase II, which focuses on experimentation to assess reintroduction feasibility.

To meet this goal, the Panel developed a preliminary list of research questions to consider during the experimentation phase.

While not exhaustive, this list provides fodder for a discussion of future research priorities to resolve key uncertainties related to habitat suitability in order to better inform a decision on Colorado pikeminnow reintroduction into Grand Canyon (i.e., Phase III).

Questions?

Photo: Robert O. Hall, Jr.

kdibble@usgs.gov; (928) 556-7327

USGS