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Low Summer Steady Flows Report Status & Preliminary Conclusions

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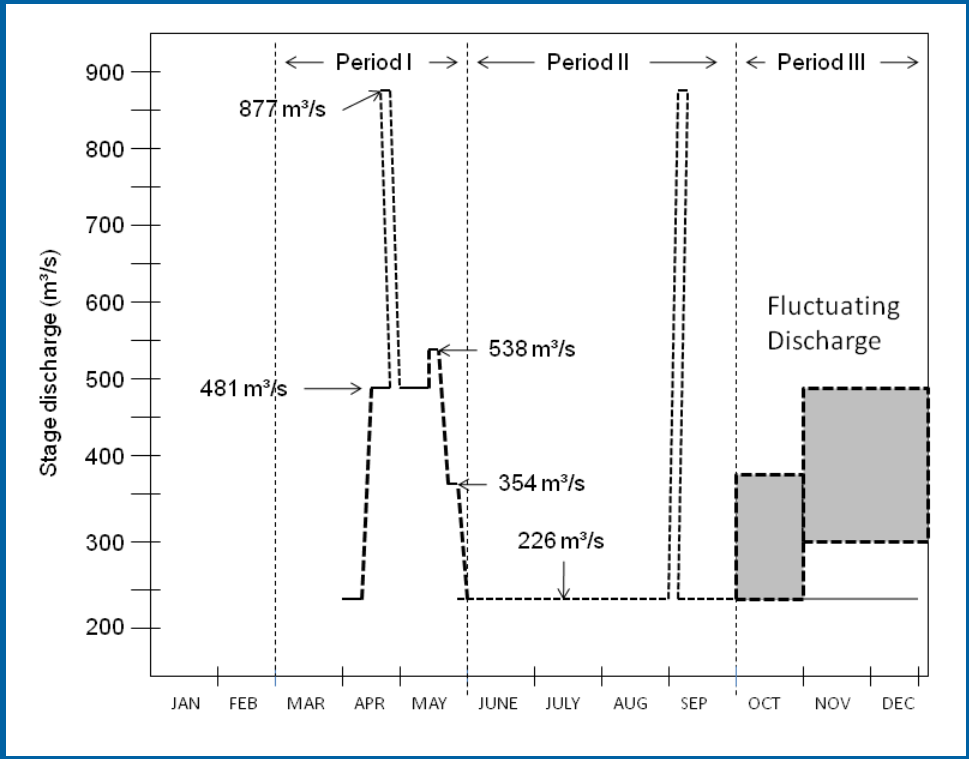
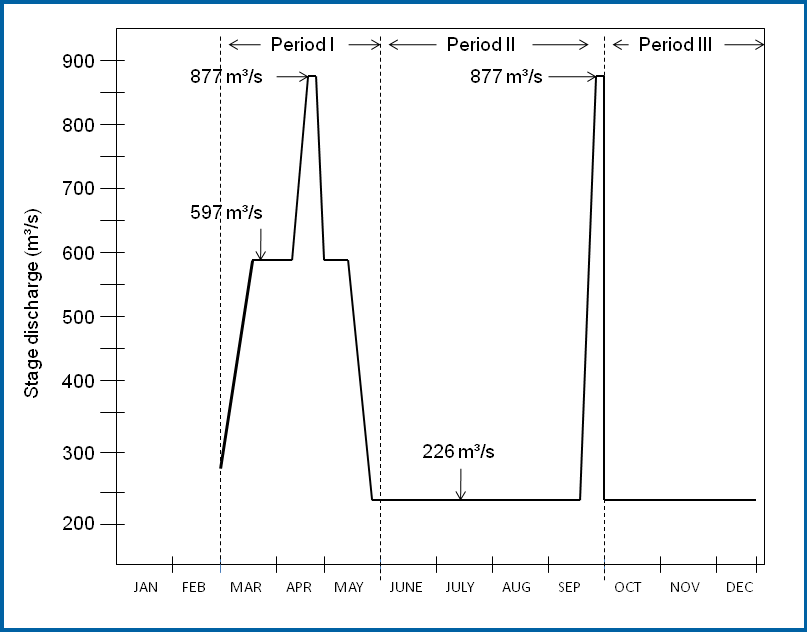


Background

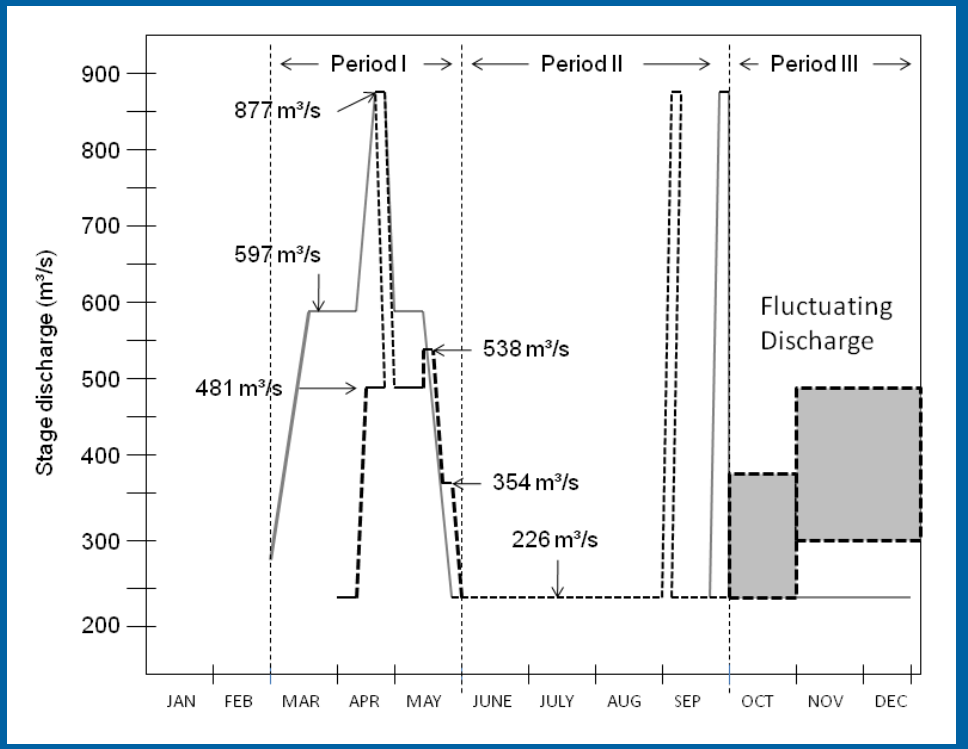
- **U.S. Bureau of Reclamation identified need for plan of experimental flows (SASF) for native fishes.**
- **SWCA developed plan beginning in 1998 w/finalized plan in Spring 2000.**



-To enhance survival and growth of young native fishes by providing stable, warm, productive shoreline nursery habitats
-To increase recruitment of native fishes
-To minimize adverse effects of nonnative fishes
-To contribute to recovery of endangered humpback chub.

Background

- Inflows indicated an 8.23 MAF year
- Discussion of implementing SASF- biological opinion RPA began in January
- Decision to implement in March
- Reduced planning time
- Little monitoring in place
- Revised hydrograph
  - Shortened spring
  - Earlier fall HMF
  - Removed Period III



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Background

- Request for synthesis document of LSSF experiment by AMWG
- Workshops of Principle Investigators and stakeholders to identify key findings and information needs
- Scatter of P.I.s, limited availability of P.I.s to do additional analysis, and HFE in 2008 resulted in single effort within GCMRC
- Draft report through peer review – responding to reviewer comments
- Final approval and posting as USGS Open-file Report in January/February

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Resources/element studied during LSSF experiment

- Physical resources –
  - sediment transport/storage
  - Habitat availability
  - Mainstem & shoreline temperatures
- Biological resources –
  - Lees Ferry and downstream response of fish
  - Riparian vegetation
- Cultural resources
  - Recreation – campsites, safety, experience
  - Economics – power, local economy

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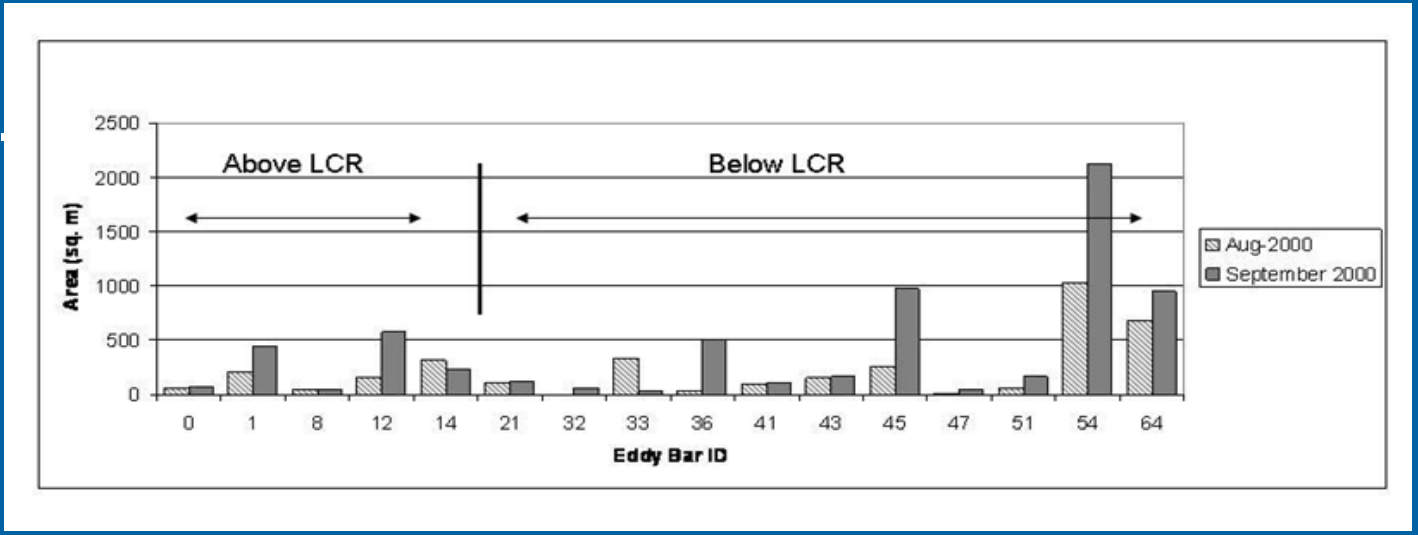
Habitat/sediment export

Short-duration high flows (HMF) export sediment in the absence of inputs (Schmidt and others, 2007) They can be used to enlarge backwater habitats (Goeking and others, 2003)

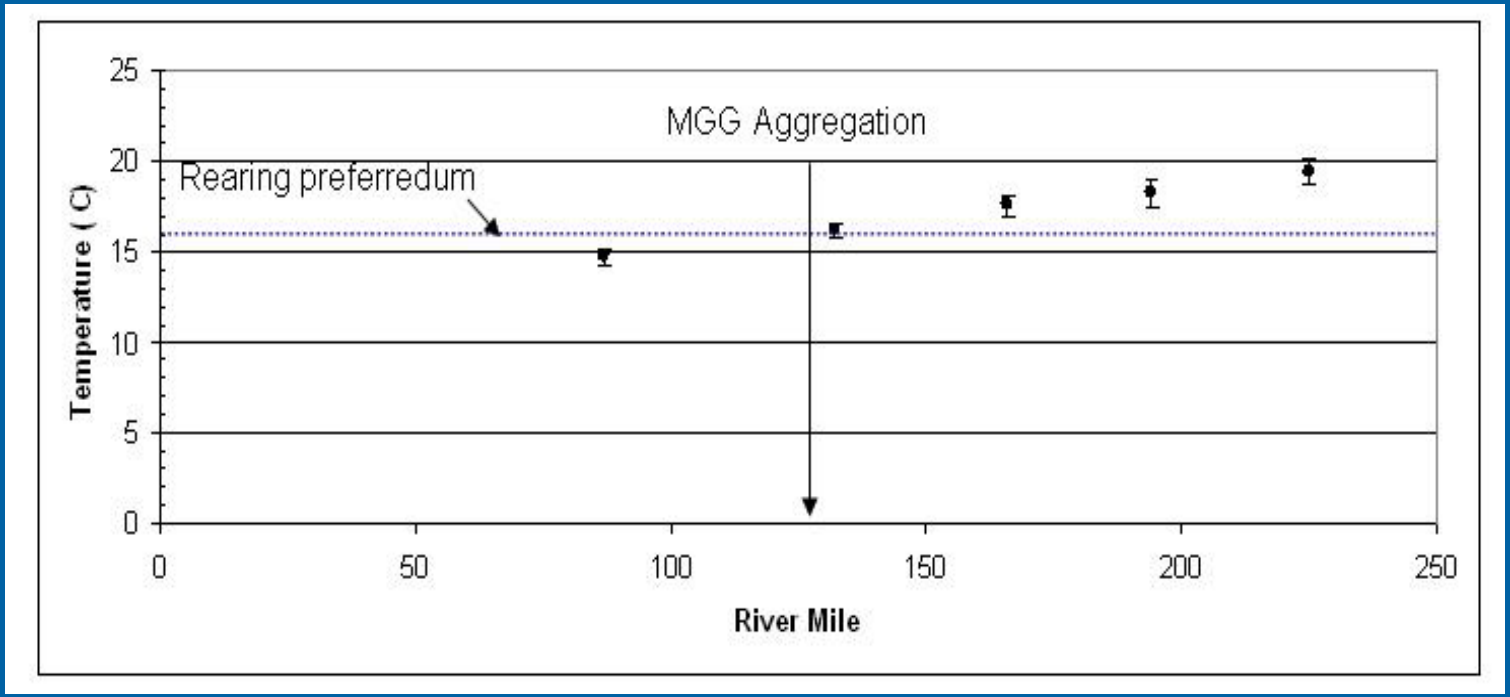


Shoreline habitat availability is controlled by local geomorphology, but generally increases with decreasing discharge (Korman and others, 2004; Protiva and others, 2010)

Mainstem temperatures

Mainstem warming is geographically dependent and affected by volume and release temperatures (Wright and others, 2007).

Warming was not greater than under MLFF w/similar volumes



Mean mainstem temperatures June – August 2000 for RM 87-225

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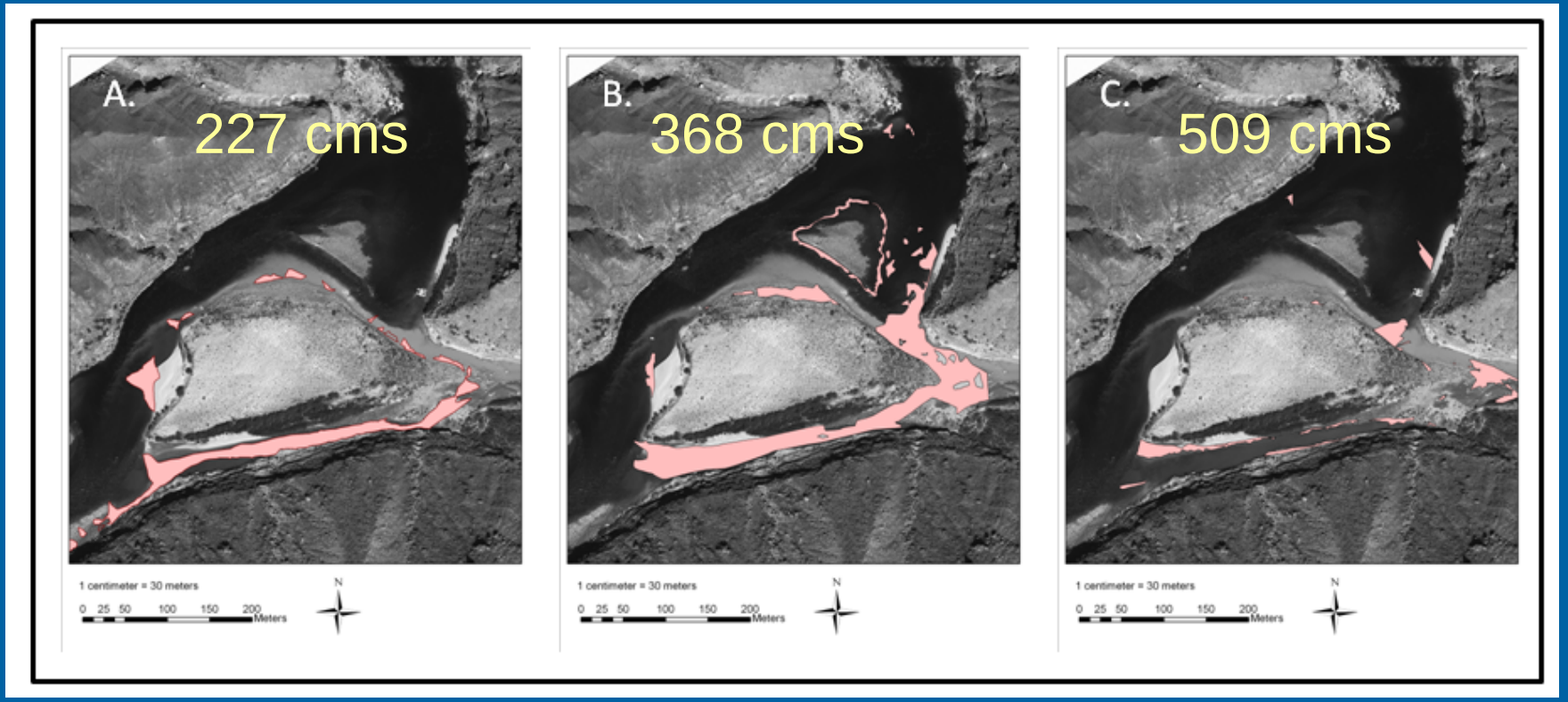
LCR Ponding/velocities



From Protiva and others, 2010

Greater low velocity areas (<2m/s) at 368 cms (12-13k cfs)

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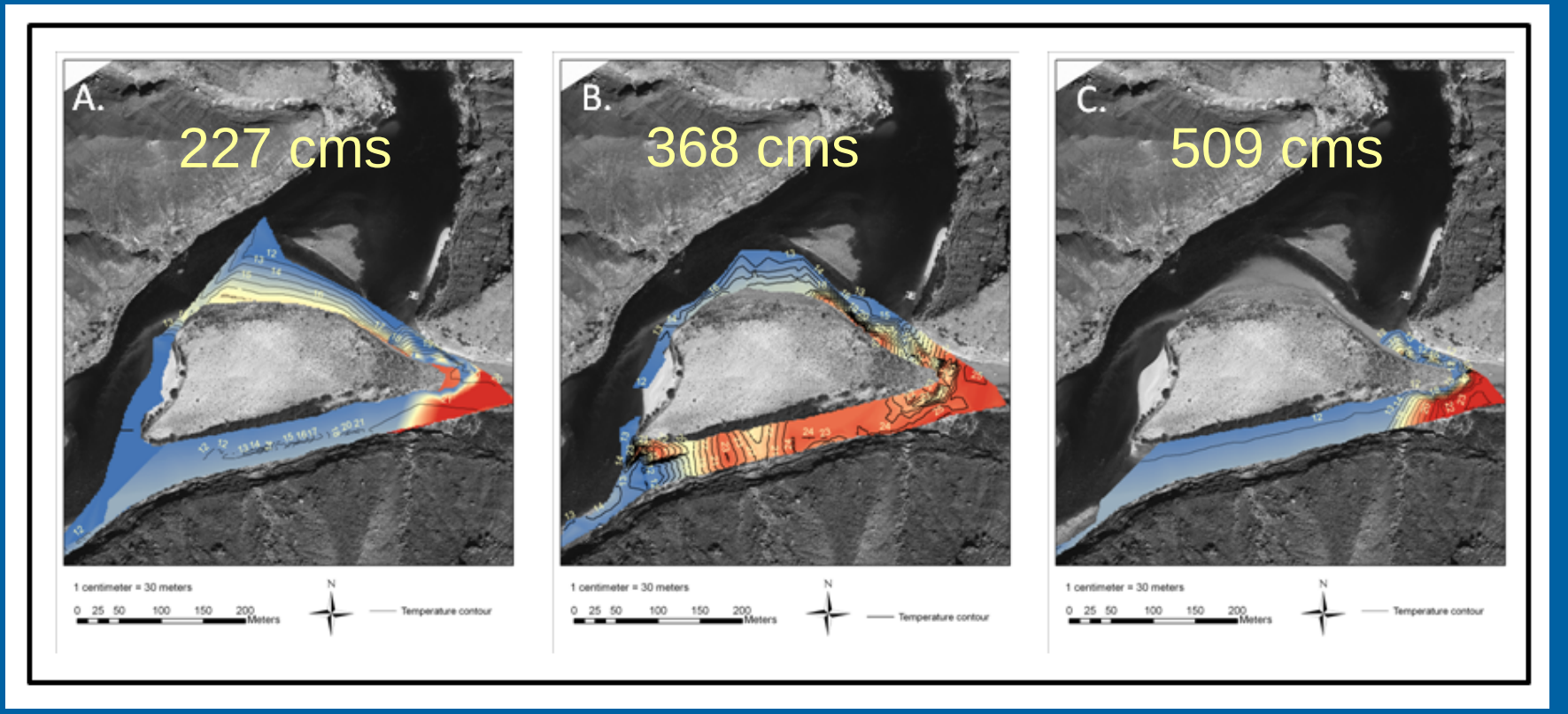
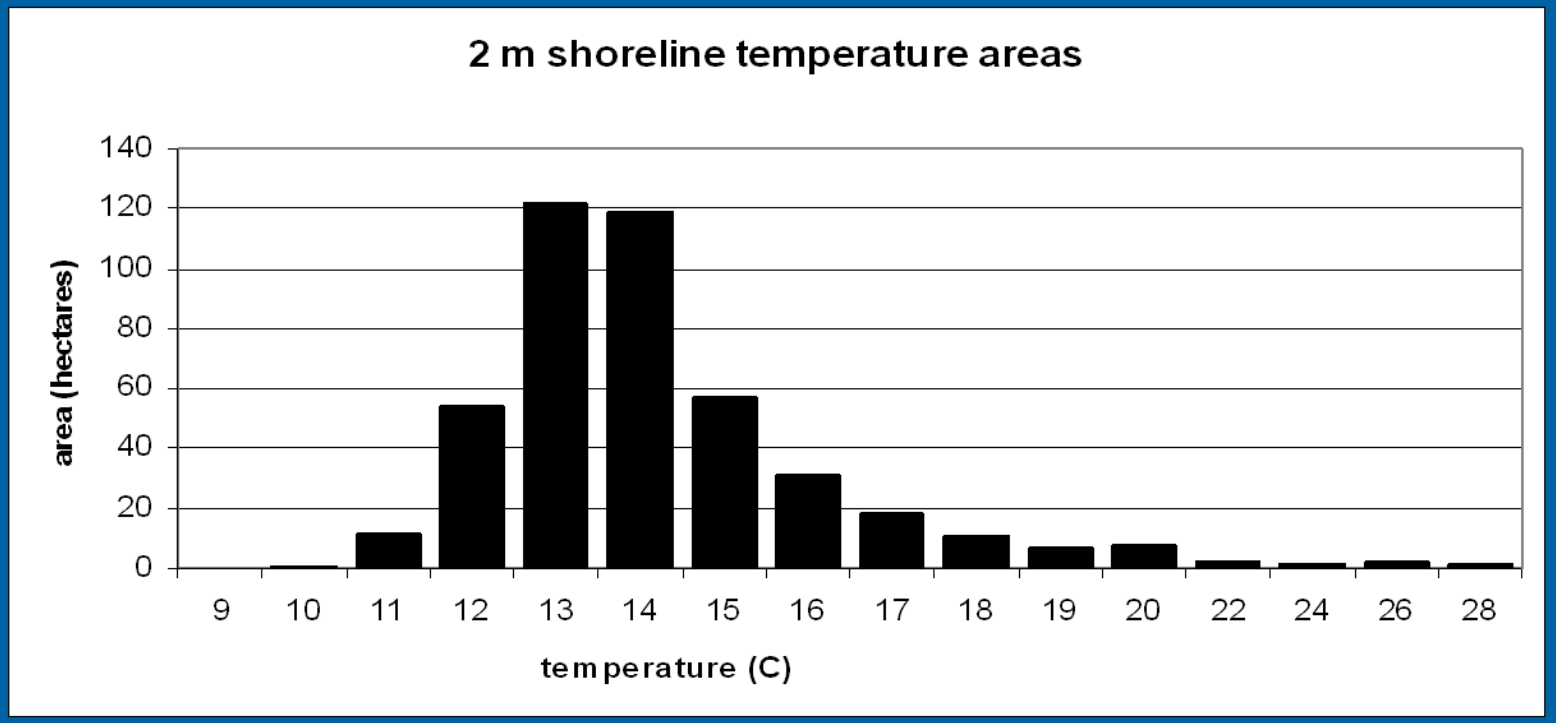
Ponding temperatures



From Protiva and others, 2010

Mainstem volumes/temperatures affect LCR inflow and concentrate warm tributary temperatures at 368 cms

Shoreline temperatures RM 30-72



Warming along shorelines occurred though warming was fragmented

Biological Resources

Long-term monitoring approaches in development in 2000

- 1st terrestrial PEP in March 2000
- Aquatic PEP not scheduled until 2001
- Monitoring mainstem – trout, carp and LCR spring/fall mark/recapture initiated in 2000.

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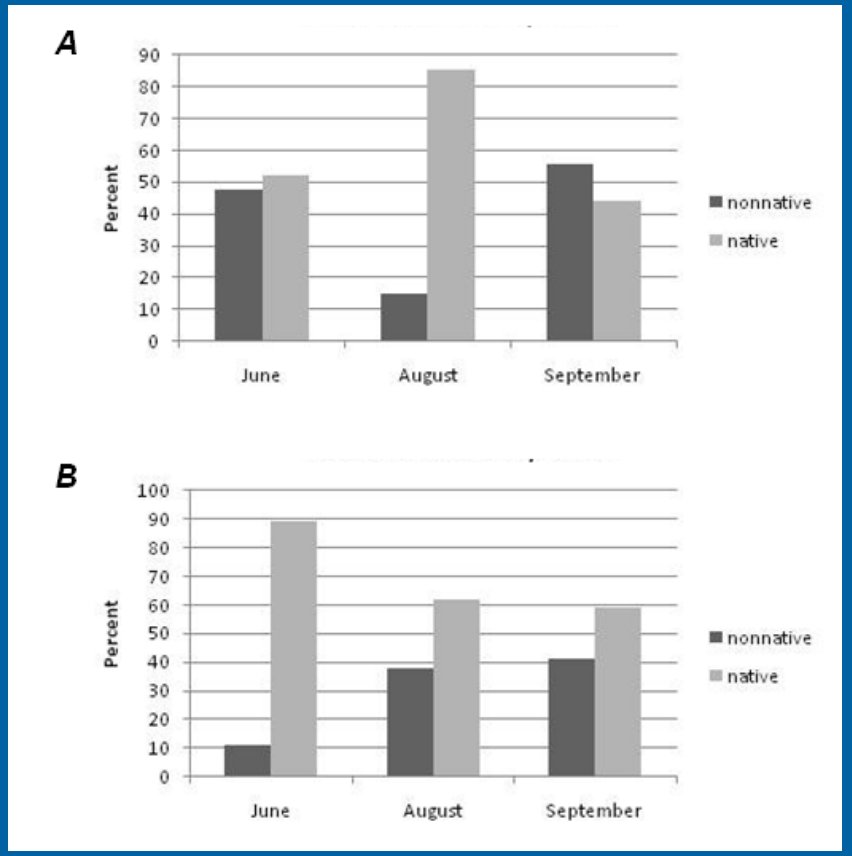
Biological Resources

Downstream Fish

- Nonnative fish abundance in seining samples were similar to previous years (Trammell and others, 2002)
- Increased abundance of native fish in seining samples
- More native fish below RM 150 in all seining samples



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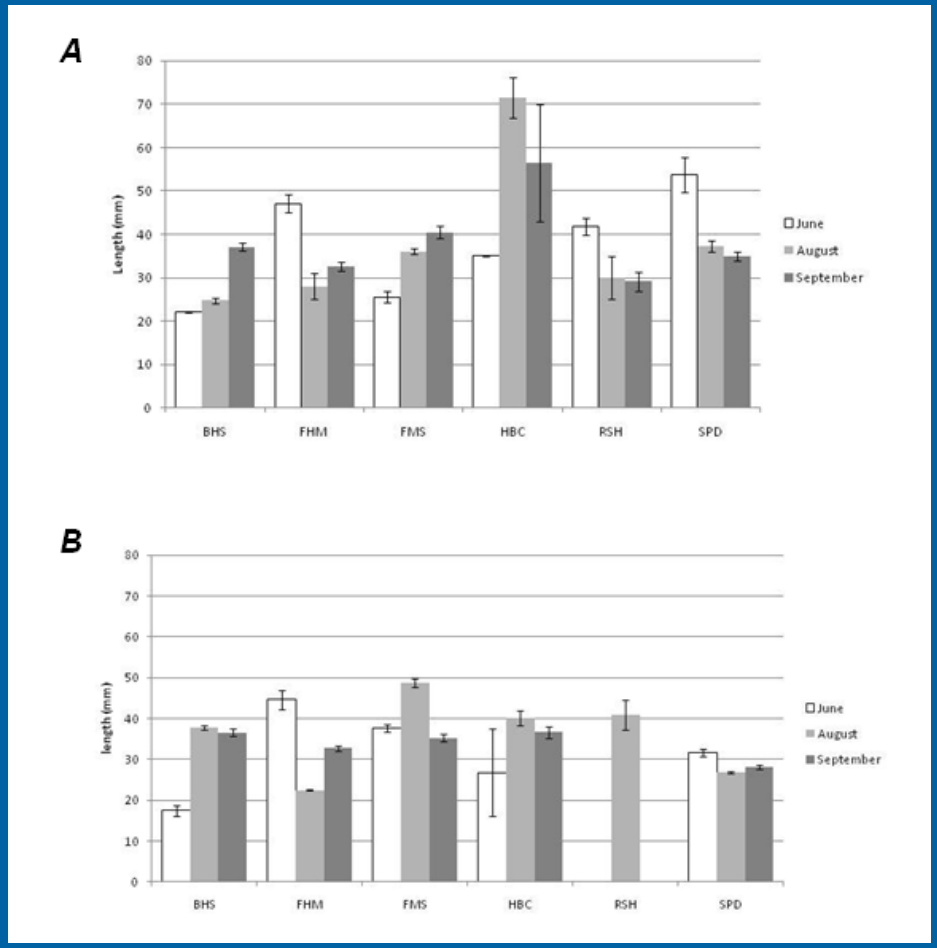
Biological Resources

Downstream Fish

- Mean length of fish was similar to previous years
- Increases in HBC, FMS, BHS lengths associated with tributary contributions
- Reduction in length of nonnatives associated with mainstem recruitment through summer



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Biological Resources

Downstream Fish

- Trout/brown trout numbers approached their greatest numbers in 2000 and 2001 in mainstem may have affected native fish survivorship (high water clarity + predation)
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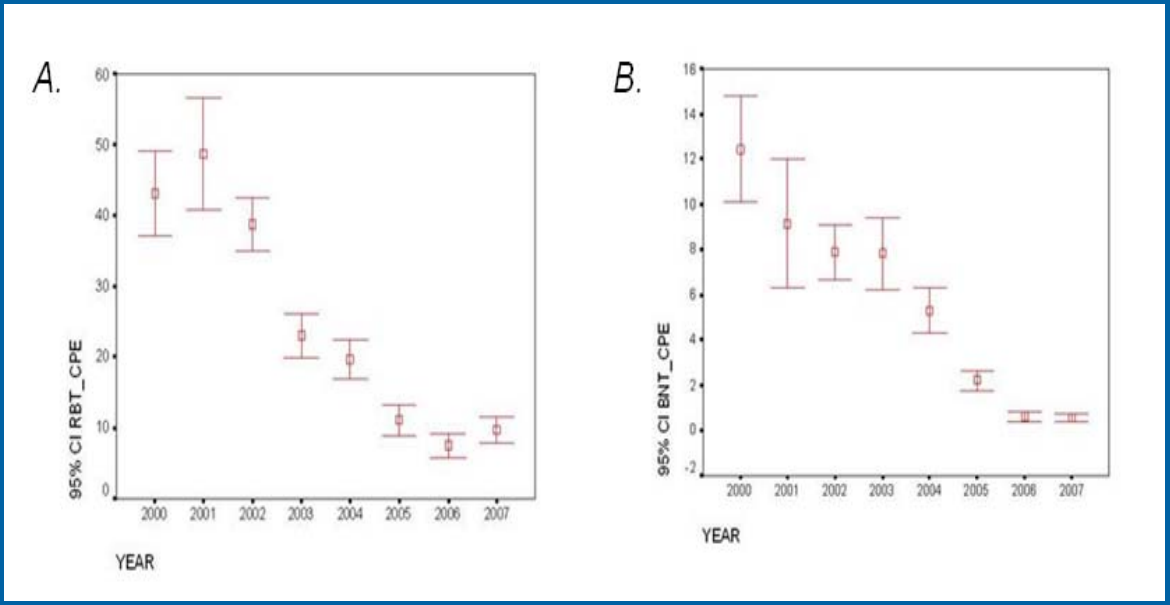

From AGFD, unpublished

Downstream fish

- Native fish did not respond +/- to hydrograph
  - Tributaries play a large role in native fish reproductive success. Do not know how unsuccessful native fish are in spawning/larval recruitment.
  - Spring high flows are likely to small in magnitude and too short to be effective- if spawning/larval survivorship is a problem.
  - May have had increased survival and mainstem spawning in Western Grand Canyon by Flannelmouth sucker- warmer water.
- Mainstem operations may benefit predatory nonnatives by increasing water clarity
- Native fish response possibly dependent on predator abundances.
- Critical to have robust monitoring in place to evaluate response.

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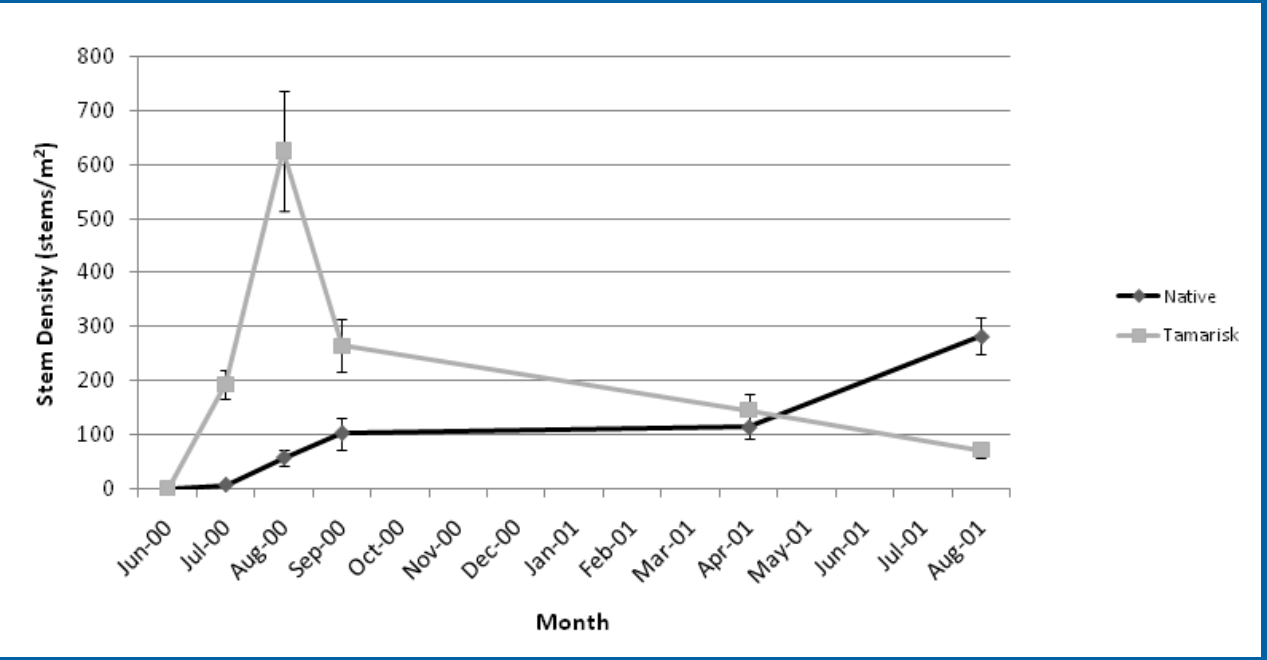
Riparian vegetation

Spring and summer hydrograph provided opportunity for tamarisk seedling establishment

- Spring flows scoured shoreline
- June steady flows timed w/tamarisk seed production



From Porter, 2002

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Recreation

Rafting

- Easier and more campable area
- Mid-elevation sandbar area increase following HMF
- Accidents early but learning occurs – boaters adjust
- Perceptions affected by trip participants, guides, experience – most passengers/participants perceive experience as excellent

Recreation

Rafting

- More time spent on water (50 percent less time at attraction sites (e.g., 3.5 hrs vs. 7 hrs) (Roberts and Bieri, 2001)
- Attraction site selection changed slightly beyond the top three sites all trips tend to visit (Deer Creek, Redwall, Havasu
- LCR Pumpkin Spring vs Elves Chasm, Nankoweap hike

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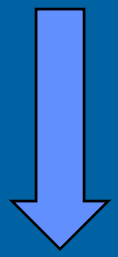
Recreation

Angling Quality - accessibility, fish size, and quantity

Minimum discharge, fluctuation magnitude, fish density, food availability



Fish abundance, condition of fish size class

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Recreation

- Better shoreline access for wading
- HMFs limited angling
- Invertebrate biomass – little affected by LSSF
- Exception - - New Zealand mudsnail biomass increased significantly under steady flows
- May HMF -- may have delayed production values by a month compared with previous years
- September HMF displacing fish was not studied
- Fishery was showing decline prior to 2000 and difficult to assess angling quality associated with LSSF

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Economics

Limited to financial costs to power customers, commercial recreation businesses, regional costs.

- **Power customer costs ($32 million)**
  - **Shifted water allocation & onset of basin-wide drought**
  - **reduced power generation**
  - **spot market costs in summer for replacement power and market price fixing in 2000 (e.g., Enron)**
  - **short notice prevented buying supplemental power in blocks prior to experiment.**

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Economics

Commercial recreation – 124,000

- **Day rafting not affected**
- **White water rafting – $70,000**
  - **equipment damage early in summer**
  - **Refund evacuated trip**
- **Angling - $33,000**
  - **Cancel trips during HMF (spring and fall)**
  - **Holiday weekend HMF in September may have affected more than if planned in mid-week.**

- **Total cost include evacuation costs, related – businesses – health care, lodging, restaurants**

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Learning Opportunities

- Implementing flows intended to mimic historic conditions in river systems that are highly constrained by water delivery requirements and the needs of multiple resources is challenging.
- The magnitude and duration of discharges required for a response by one resource may be in direct conflict with other resources.
- Yet, approaching experimentation in a manner that mitigates for impacts to resources can produce a weak experimental design and a poor or undetectable response by the target resource (Webb and others, 2010).
- The resulting information can be inconclusive for some resources, but costly to others, and can promote the perception that environmental flows are costly, yield little benefit to the target resources, and thus fail to demonstrate the benefits of an environmental flow.
- Follow-up cost/benefit evaluations might suggest that the experiment does not merit repeating. Success of an ecosystem scale experiment is further limited when time for planning an experiment and associated monitoring is reduced, as occurred in 2000.

Learning Opportunities

- Complicated hydrograph reduced learning opportunities
- Mainstem experiments should focus on life stages affected by mainstem operations
  - High spring flows run counter to sediment conservation goals and have little effect on tributaries, but a short pulse reworks sediment and creates campable area/backwaters for summer.
  - Habitat stability is key variable – September HMF disrupted this.
  - Mainstem spawning is limited by mainstem temperatures w reservoir temperatures a strong driver
- Lack of monitoring weaken interpretive ability
- Publishing results is important step in learning.