# Experimental Results Panel Discussion:

"Assessing the Value of Experimentation in Support of Glen Canyon Dam Adaptive Management Program Information Needs"

October 26th

15:30 to 16:30

# Update on Experimental Planning/Knowledge Assessment Review

**Josh Korman, Ecometric Research**
**Part I "KAW"**

**and**

**Ted Melis and Barbara Ralston, GCMRC**
**Part II "Ideas About Phase V Experimental Design"**

# Part I: Objectives of Knowledge Assessment

1. Identify actions that are understood well enough to be treated as long-term management actions if appropriate (***"hybrid design"***).

2. Evaluate uncertainties about the effects of management actions on key resources in CRE.

3. Develop strategic science questions that would need to be addressed to reduce uncertainties.

4. Identify modelling, research, monitoring and experimental designs required to answer the science questions.

# Highlights from Fish Matrix

| Performance Measure | Species | Increase in GCD Release Water Temp. | Overall Effect of Increased Fluctuations Relative to MLFFA | BHBF with adequate sand supply | Sustained Low Steady Flow (summer-fall) | Mechanical Removal of Coldwater Exotics (Mainstem and Trib) |
|---|---|---|---|---|---|---|
| **YOY/Juvenile nearshore rearing** | HBC | + | - | | + | + |
| | FMS | + | - | | + | + |
| | | | | | | |
| **Invasive Fish Species** | Coldwater | + | - | **NA** | + | - |
| | Warmwater | + | - | | + | |
| | | | | | | |
| **Adult Population** | HBC | | | | | |
| | FMS | + | | | + | |

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| Performance Measure | Location and/or Species | Increase in GCD Release Water Temp. | Overall Effect of Increased Fluctuations Relative to MLFFA | Reduce Variation in Monthly Volume | BHBF with adequate sand supply | BHBF without adequate sand supply | HMF with adequate sand supply | HMF without adequate sand supply | Sustained Low Steady Flow (summer-fall) | High Sustained Flow (ponding-spring) | Mechanical Removal of Coldwater Exotics (Mainstem and Trib) | Mechanical Removal of Warmwater Exotics | Supplementation from Hatchery | Translocation of HBC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Food base** | Glen | + | | + | | | | | - | | | | | |
| | Grand | | - | | | | | | - | | + | | | |
| | | | | | | | | | | | | | | |
| **Mainstem spawning & incubation** | HBC | + | | | | | | | + | | + | + | | |
| | FMS | + | - | | | | | | + | | + | + | | |
| | RBT-Glen | | - | + | | | | | + | + | | | | |
| | RBT-Marble | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **YOY/Juvenile nearshore rearing** | HBC | + | - | + | | - | | - | + | | + | + | | |
| | FMS | + | - | + | | - | | - | + | | + | + | | |
| | RBT-Glen | + | - | + | - | - | - | - | + | + | | | | |
| | RBT-Marble | | - | + | - | - | - | - | + | + | | | | |
| | | | | | | | | | | | | | | |
| **Invasive Fish Species** | Coldwater | + | - | | | | | | + | | - | | | |
| | Warmwater | + | - | | | | | | + | | | - | | |
| | | | | | | | | | | | | | | |
| **Disease** | Asian Fish Tapeworm | + | | | | | | | | | | | | |
| | Whirling Disease | + | | | | | | | | | | | | |
| | | | | | | | | | | | | | | |
| **Adult Population** | HBC | | | | | | | | | | | | | + |
| | FMS | + | | | | | | | + | | | | | |
| | RBT #s - Glen | + | - | | | | | | + | | | | | |
| | RBT Size - Glen | + | + | | | | | | + | | | | | |
| | RBT #s- Marble | | - | | | | | | + | | - | | | |
| | | | | | | | | | | | | | | |
| **Angling Opportunity and Quality** | Glen | + | - | + | - | - | - | - | - | - | | | | |

# Native Fish Science Questions

1. What ultimately limits native fish populations:
   - production of young fish from tributaries
   - spawning and incubation in the mainstem
   - survival of YoY and juvenile stages in the mainstem
   - growth and maturation in the adult population as influenced by mainstem conditions?

2. What is the relative importance of increased water temperature, shoreline stability, food availability, and predators on the survival of early life stages of native fish?

3. How important are backwaters and vegetated shoreline habitats to the overall growth and survival of YoY and juvenile native fish?

4. Do the potential benefits of improved rearing habitat outweigh negative impacts owing to increases in non-native fish abundance or disease?

# Part II: Revisiting Experimental Design for Water Year 2007 to 2011

## Historical Perspective Behind Phase V?

# When Do Experimental Treatments Become Management Actions?

**What is the Distinction Between Experimentation and Management Action? All Efforts are Intended to Provide Resource Benefit…**

**Process of Ongoing Dialogue Between Managers & Scientists** We know that stable flows that are "low" (less than 10,000 cfs range) are most effective at conserving sand, amplifying warming downstream and stabilizing near-shore habitats. Short-duration BHBF-type releases (2-4 days at 41,000-45,000 cfs)) can mobilize sand from the lower channel and deeper eddies and deposit this material to higher elevation shorelines relatively quickly when sand supply is enriched. The MLFF has likely improved recreational rafting and camping, as well as angling, but there no data on this (SCORE).

**Clearly Identified Management Goals & Objectives** Are the desired outcomes of the GCD-AMP both Measurable & Attainable? Example: Mechanical Removal - methods developed during 2003-2005 research are known to reduce the abundance and distribution of exotic, coldwater species within treatment reaches in Marble & Grand Canyons and the reduced abundance can apparently be maintained through continued implementation. Is this currently a stated Management Objective?

**Environmental Compliance Beyond Experimentation?** For experimental treatments to become management actions, decision makers would presumably need to modify the Record-of-Decision, but this is only an option following compliance requirements . . .

# "The Original Proposed Approach of 2002, with Five Treatments"

**IMPLEMENT TREATMENT** **DO NOT IMPLEMENT TREATMENT**

## The Design Did Not Build on History of Previous Work . . .

## Though Useful as Starting Point, It Was Not Fully Adopted . . .

| | Increased Fluctuations In Daily Flows | Mechanical Removal of Rainbow Trout in GC | Stable-Low Flows in Fall | TCD (Future) | Beach Habitat Building Flow |
|---|---|---|---|---|---|
| WY2002-03 | | | | | |
| WY2003-04 | | | | | |
| WY2004-05 | | | | | |
| WY2005-06 | | | | | |
| WY2006-07 | | | | | |
| WY2007-08 | | | | | |
| WY2008-09 | | | | | |
| WY2009-10 | | | | | |
| WY2010-11 | | | | | |
| WY2011-12 | | | | | |
| WY2012-13 | | | | | |
| WY2013-14 | | | | | |
| WY2014-15 | | | | | |
| WY2015-16 | | | | | |
| WY2016-17 | | | | | |
| WY2017-18 | | | | | |

# The 2002 Revised Design with Two Controlled and Two Randomized Treatments [May 2004]

**IMPLEMENT TREATMENT** **DO NOT IMPLEMENT TREATMENT**

## Evolution in Design on Basis of Progress & Historical Perspective Continued

| Water Year | MLFF + Designer Flow Treatments in Winter and Summer/Fall | Mechanical Removal of Rainbow Trout in GC (non-optimized) | Naturally Warmed owing to Low Reservoir | Beach Habitat Building Flow (Paria Trigger) |
|---|---|---|---|---|
| WY2003 | MLFF + ExpFF | Remove Fish | Warming Event | Non-Trigger |
| WY2004 | MLFF + ExpFF | Remove Fish | Warming Event | Non-Trigger |
| WY2005 | Plus, Stable Fall | Remove Fish | Warming Event | Fall BHBF Test |
| WY2006 | Plus, Stable Fall | Remove Fish | Warming Event | No Testing |
| WY2007 | MLFF + ExpFF | Do Not Remove Fish | Warming Event | Event ??? |
| WY2008 | MLFF + ExpFF | Do Not Remove Fish | Random ??? | Event ??? |
| WY2009 | Plus, Stable Fall | Do Not Remove Fish | Random ??? | Event ??? |
| WY2010 | Plus, Stable Fall | Do Not Remove Fish | Random ??? | Event ??? |
| WY2011 | MLFF + ExpFF | Remove Fish | Random ??? | Event ??? |
| WY2012 | MLFF + ExpFF | Remove Fish | Random ??? | Event ??? |
| WY2013 | Plus, Stable Fall | Remove Fish | Random ??? | Event ??? |
| WY2014 | Plus, Stable Fall | Remove Fish | Random ??? | Event ??? |
| WY2015 | MLFF + ExpFF | Do Not Remove Fish | Random ??? | Event ??? |
| WY2016 | MLFF + ExpFF | Do Not Remove Fish | Random ??? | Event ??? |
| WY2017 | Plus, Stable Fall | Do Not Remove Fish | Random ??? | Event ??? |
| WY2018 | Plus, Stable Fall | Do Not Remove Fish | Random ??? | Event ??? |

# Update on Lake Powell

- Reservoir Level
  - Current Elevation - 3602.0 ft (98 ft from full)
    - low for 2005 – 3555.1 ft on 4/8/2005
    - lowest elevation since May 1969
  - Current Live Storage 12.0 MAF (49%)
  - Projected Low (March 2006) – 3593.0 ft
  - Projected High (July 2006) – 3625.7 ft
- Warmer GCD Releases
  - Maximum observed temperatures
    - 11/14/2003 – 13.2°C (56°F)
    - 10/5/2004 – 15.5°C (60°F)
    - 10/11/2005 – 15.8°C (61°F)
    - WY 2006 est. 12-13°C depending on hydrology

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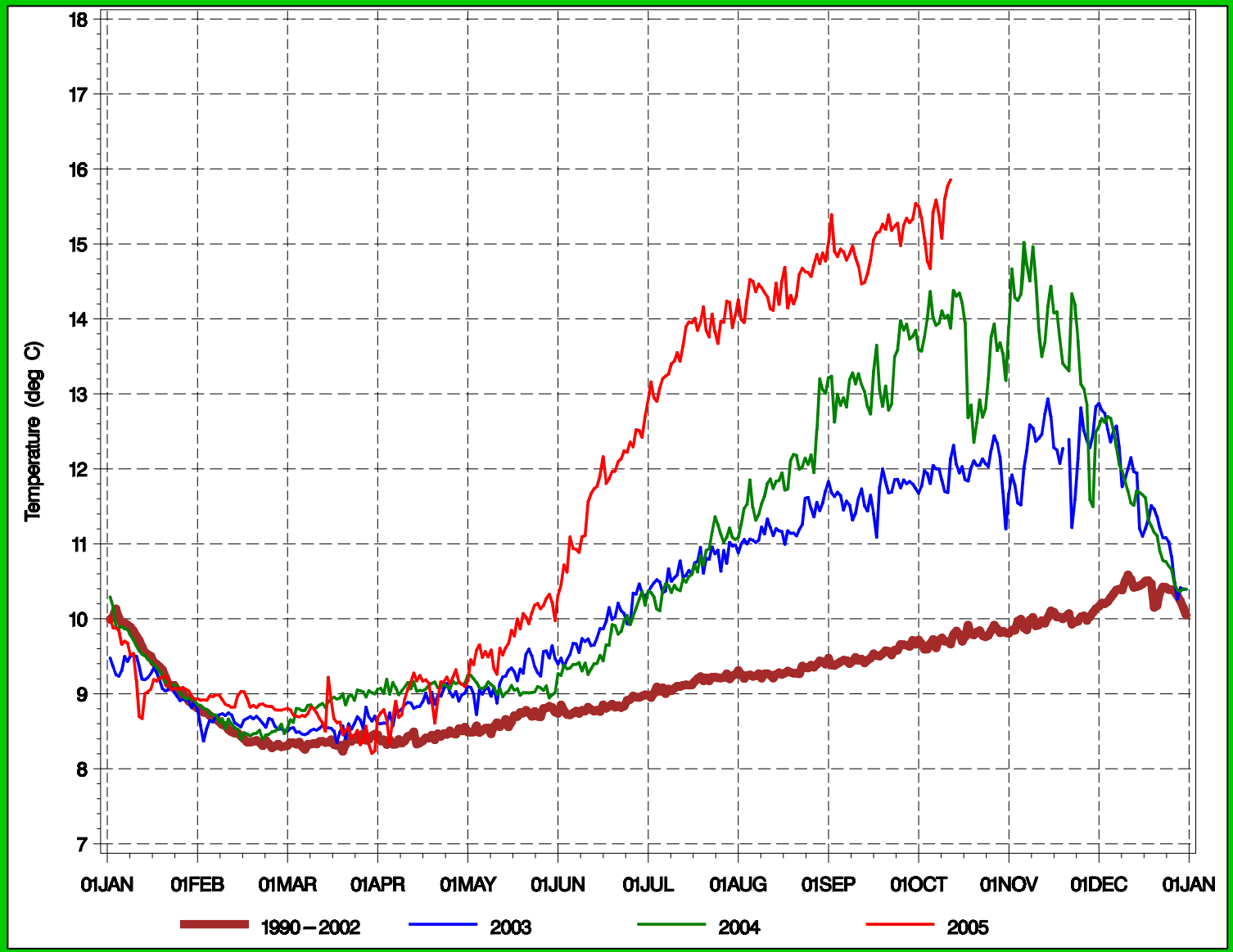
# Mean Daily Temperature Patterns below Glen Canyon Dam

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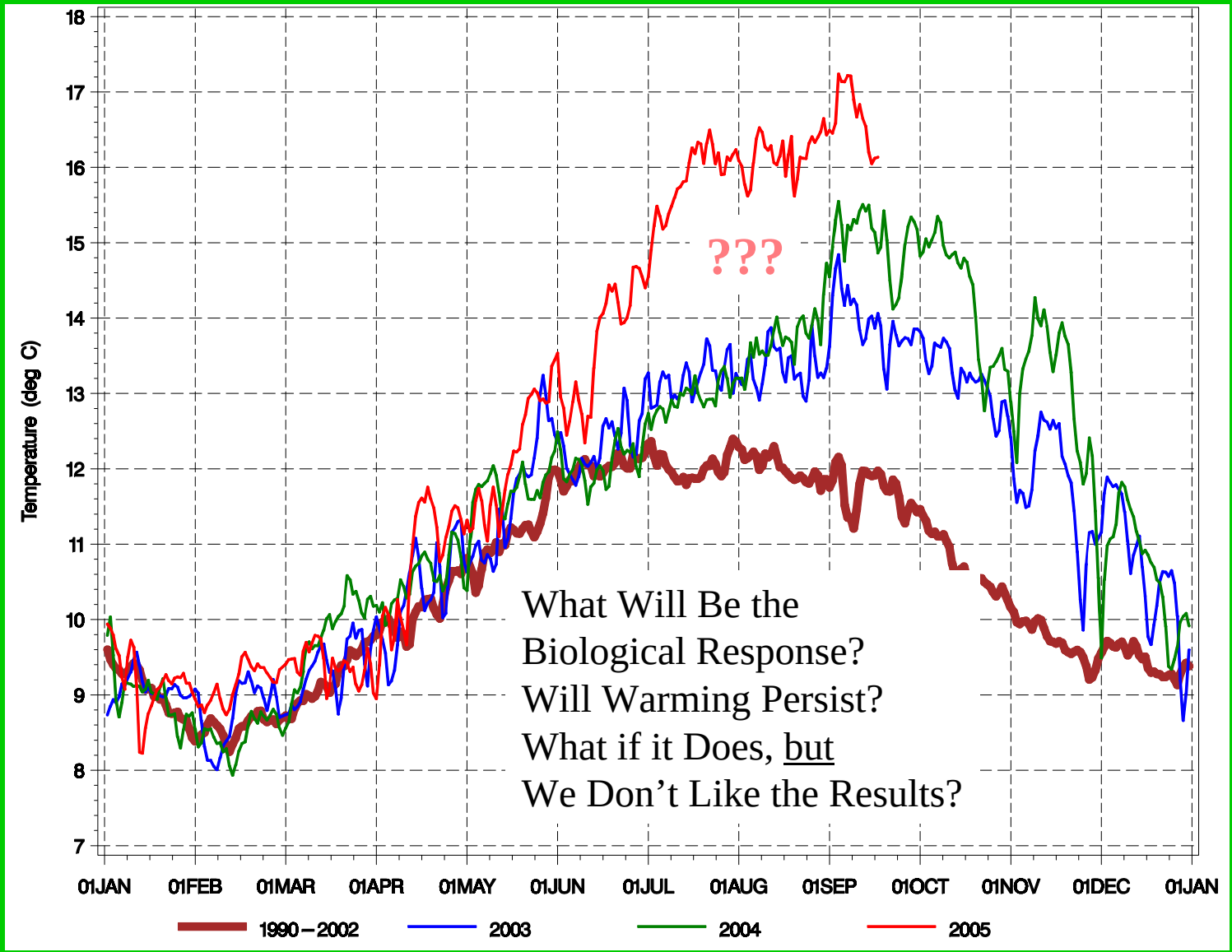
# Mean Daily Temperature Patterns at Little Colorado River, RM 61




Mother Nature Got Involved in the Experiment in a Big Way!

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# Historical Perspective on EXP

- Let's Step Back and Look
  - MLFF+BHBF is the approved Management Action (baseline)
  - EXP treatments include: reducing coldwater exotics, plus EXP trout suppression flows, and Fall BHBF test
  - Nature decided to add thermal element
  - Managers decided to add LCR Translocation (conservation)

- Comparing Policies: Stable Shoreline Habitat vs. Warmer River
  - "Fluctuating Flows" we decide???
  - "Temperature Control" nature's own device?

Warming was added to the MLFF operation after a decade of not being implemented!

**Now What?**


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# Status of Evolved Design on Basis of Historical Perspective

**IMPLEMENT TREATMENT** **TREATMENT NOT IMPLEMENTED**

| Water Year, w/ HBC & RBT Recruitment Success [+ or -] | Dominant Dam Operation (with Seasonal Variants Toward "Designer Flows," but All Within ROD) | Mechanical Removal of Rainbow Trout in GC (with Progressive Optimization) | Naturally Varied Temperature (Relative to August Average at GCD, RM61) [+, 0, -] | Beach/Habitat Building Flow (Paria, LCR River Sand Inputs Relative to Historic Mean) [+, 0, -] |
|---|---|---|---|---|
| WY1991, **[0,0]** | EXP Flows | No Exotic Control | **[0,nd]** | [-,-](No BHBF) |
| WY1992, **[-,+]** | Interim only | No Exotic Control | **[-,-]** | [+,-](No BHBF) |
| WY1993, **[-,+]** | Interim only | No Exotic Control | **[0,-]** | [+,+](No BHBF) |
| WY1994, **[-,+]** | Interim only | No Exotic Control | **[-,-]** | [-,-](No BHBF) |
| WY1995, **[-,+]** | Interim only | No Exotic Control | **[0,0]** | [0,0](No BHBF) |
| WY1996, **[0,+]** | Interim+BHBF | No Exotic Control | **[0,0]** | [-,-](W/ BHBF) |
| WY1997, **[0,+]** | MLFF only | No Exotic Control | **[0,0]** | [+,-](No BHBF) |
| WY1998, **[+,+]** | MLFF+HMF | No Exotic Control | **[0,0]** | [+,-](No BHBF) |
| WY1999, **[+,+]** | MLFF only | No Exotic Control | **[0,0]** | [+,- (No BHBF) |
| WY2000, **[+,+]** | MLFF+LSSF+HMF | No Exotic Control | **[0,+]** | [-,-](No BHBF) |
| WY2001, **[?,+]** | MLFF only | No Exotic Control | **[0,0]** | [+,-](No BHBF) |
| WY2002, **[?,-]** | MLFF only | No Exotic Control | **[0,0]** | [-,-](No BHBF) |
| WY2003, **[?,-]** | MLFF+EXP FF | Experimental Fish Removal | **[+,+]** | [-,-](No BHBF) |
| WY2004, **[?,0]** | MLFF+EXP FF | Experimental Fish Removal | **[+,+]** | [-,-](No BHBF) |
| WY2005, **[?,?]** | MLFF+EXP FF+Fall Testing | Experimental Fish Removal | **[++,++]** | [+,+](W/ BHBF) |
| ***WY2006, decision [?,?]** | MLFF+Fall Testing | Experimental Fish Removal | **???** | **???**(No BHBF) |
| WY2007, **[?,?]** | MLFF only | Density Dependent MR?? | **???** | **???** |
| WY2008, **[?,?]** | MLFF only | Density Dependent MR?? | **???** | **???** |

# Considering Historical Perspective and Recent Results?

## Let's Consider the Continued MLFF Options – Option #1

**Forward Titration that Could Evolve to a Factorial Design** In fact, we have 15 years of a Forward Titration design already behind us with pretty solid data for both sediment and fisheries! The MLFF (and its precursor, Interim operation) was implemented from 1991 through 2001 with no Mechanical Removal or persistent thermal warming event. Then, we continued mostly MLFF operations and implemented MR along with Nature's Own version of the Selective Withdrawal Structure since 2002! Hence, after an 11-year long "block" of MLFF with cold water and unconstrained RBT recruitment, we are now heading into the 4th year of a block of MR coupled with a warm main-channel "event." What to do?

Selective Withdrawal Structure might be a handy tool to have in our experimental kit right now. Pursue Mechanical Removal of Warm & Cold fish species?

**MLFF Under the Range of Upper Basin Hydrologic Cycle** If we continue monitoring the MLFF under the paired implementation of MR and warming, we have no way of ensuring that warming will continue. Perhaps we continue MR and let nature decide the end of the warm event, or try to manage the system to prolong warming (while building the SWS)?

Managers might choose to enhance the probability of a HBC recruitment signal by recommending stable Fall flows, but that could confound ability to discern MR & Temp from Habitat Stability?

Remember, Carl said "…it ain't just about learning . . . It's about comparing policies that managers are willing to commit to in order to benefit the resources!"

# Considering Historical Perspective and Recent Results?

## What About Option #2 (add Stable Fall Flows)

**Evaluating Stable Flows vs. Mechanical Removal and Warming**

**What to do in the next 5-year phase (Phase V)?**

**MLFF Under the Range of Upper Basin Hydrologic Cycle** **There is some chance that the Native Fishes response below GCD is dominated by Upper Basin Hydrology (cycles of wet/cold & dry/warm) once interactions with exotics are limited (through use of MR or other factors limiting their success). Perhaps flow stability should only be added to the Forward Titration (our most costly treatment) after a sustained monitoring period under MLFF+MR+Warm Event? If no recruitment occurs by 2011, then a combination of stable flows, MR and warming (with operation of a SWS) could be the next step in the Forward Titration turned Factorial.**

**We Should Recognize that In 5 More Years, Our Experiment will be 20-years old (old enough to go to college)!**

# SWS Could Allow Factorial Design w/ Decade Scale Blocks

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|---|---|---|---|---|
| WY1998, **[+,+]** | MLFF+HMF | No Exotic Control | **[0,0]** | [+,-](No BHBF) |
| WY1999, **[+,+]** | MLFF only | No Exotic Control | **[0,0]** | [+,- (No BHBF) |
| WY2000, **[+,+]** | MLFF+LSSF+HMF | No Exotic Control | **[0,+]** | [-,-](No BHBF) |
| WY2001, **[?,+]** | MLFF only | No Exotic Control | **[0,0]** | [+,-](No BHBF) |
| WY2002, **[?,-]** | MLFF only | No Exotic Control | **[0,0]** | [-,-](No BHBF) |
| WY2003, **[?,-]** | MLFF+EXP FF | Experimental Fish Removal | **[+,+]** | [-,-](No BHBF) |
| WY2004, **[?,0]** | MLFF+EXP FF | Experimental Fish Removal | **[+,+]** | [-,-](No BHBF) |
| WY2005, **[?,?]** | MLFF+EXP FF+Fall Testing | Experimental Fish Removal | **[++,++]** | [+,+](W/ BHBF) |
| ***WY2006, decision [?,?]** | MLFF+Fall Testing | Experimental Fish Removal | **[++,++]** | **???**(No BHBF) |
| WY2007, **[?,?]** | MLFF only | Experimental Fish Removal | **[++,++]** | **???** |
| WY2008, **[?,?]** | MLFF only | Experimental Fish Removal | **[++,++]** | **???** |
| WY2009, **[?,?]** | MLFF only | Experimental Fish Removal | **[++,++]** | **???** |
| WY2010, **[?,?]** | MLFF only | Experimental Fish Removal | **[++,++]** | **???** |
| ***WY2011, decision [?,?]** | MLFF only | Experimental Fish Removal | **[++,++]** | **???** |
| WY2012, **[?,?]** | MLFF only | Experimental Fish Removal | **[++,++]** | **???** |
| WY2013, **[?,?]** | MLFF only | Stop MR | **[++,++]** | **???** |