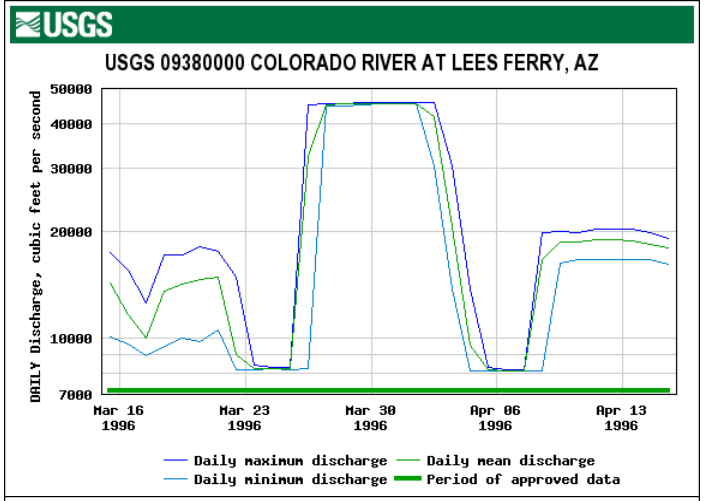
Biological Resources

- Food Base
- Riparian Vegetation
- Trout
- Native Fish
- Nonnative Fish

High Flow Experiments

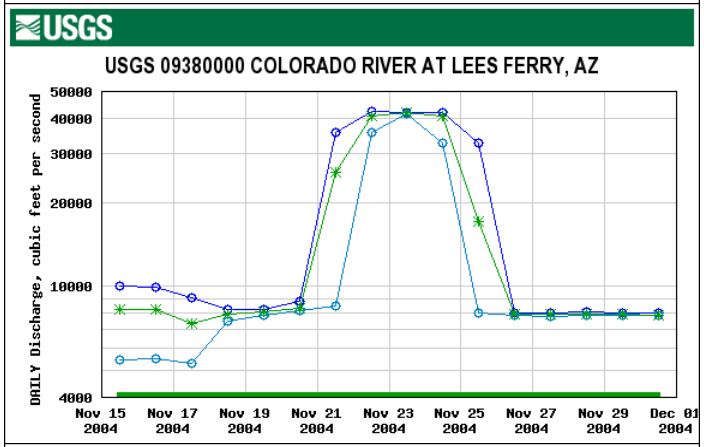
March 26 to April 7, 1996

- **8,000 cfs – 4 days**
- **45,000 cfs – 7 days**



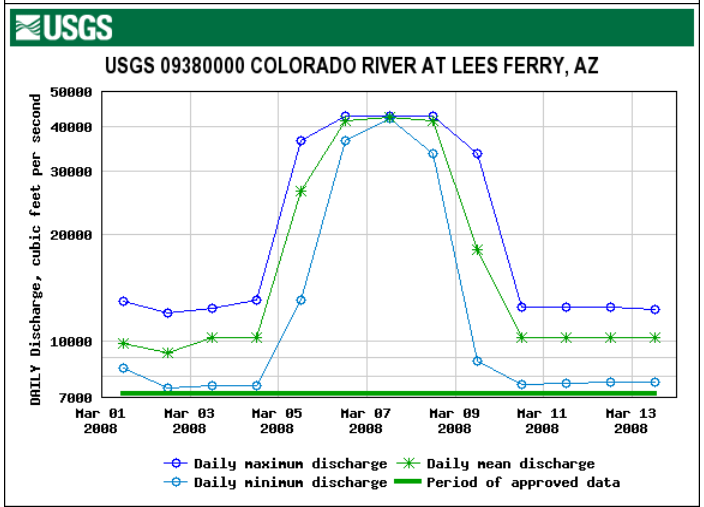
November 21–23, 2004

- **8,000 cfs – 5 days**
- **41,000 cfs – 60 hr**

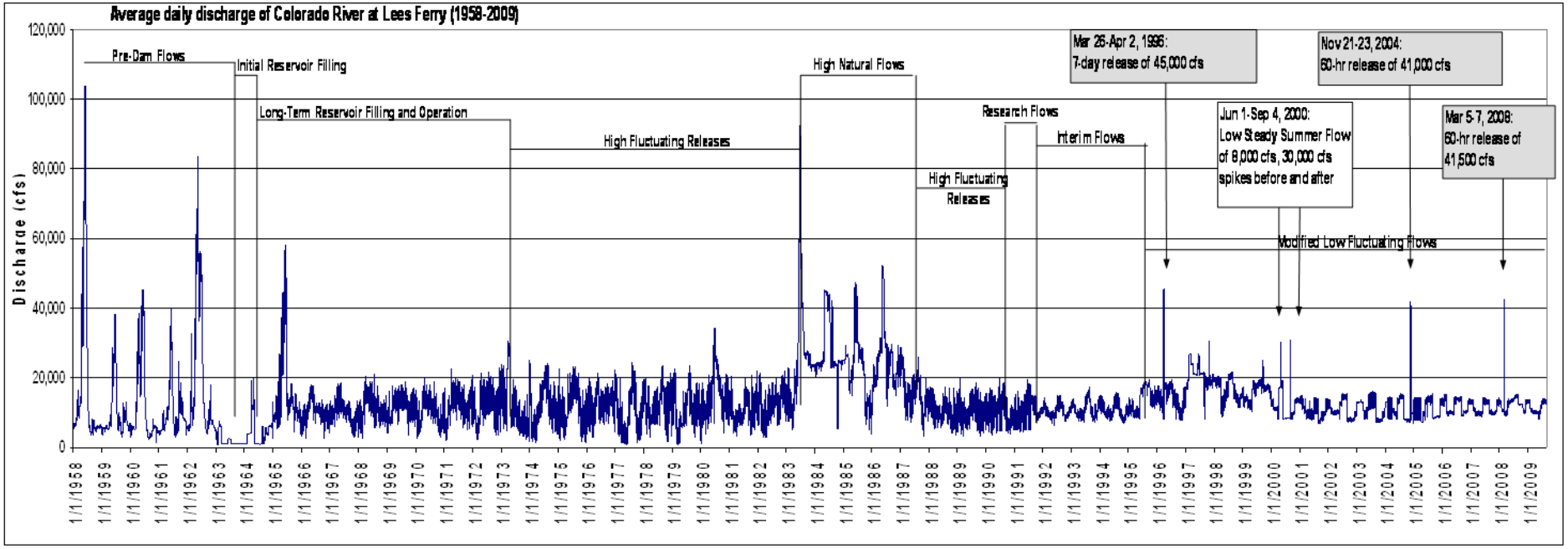


March 5-7, 2008

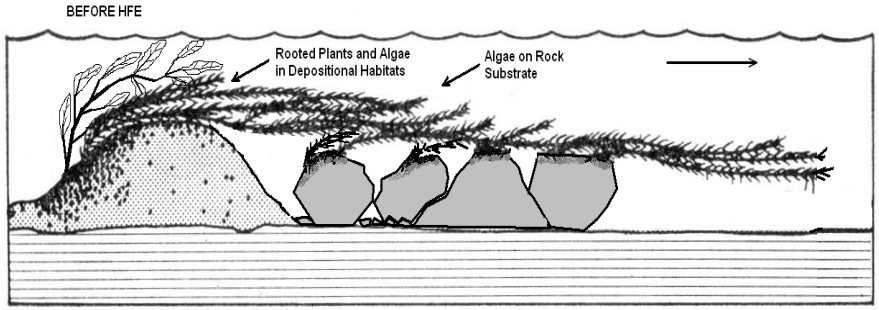
- **41,500 cfs – 60 hr**

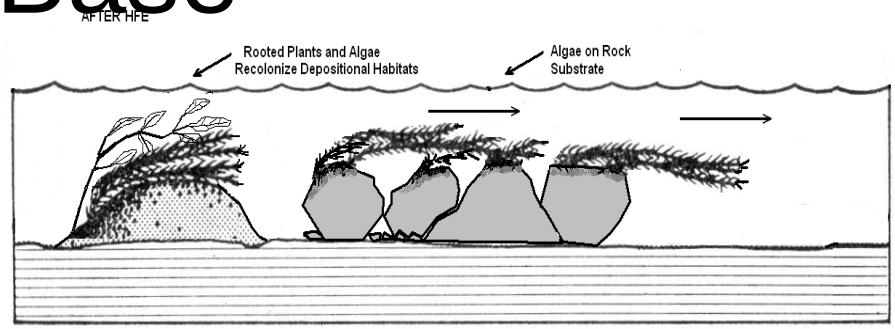


Timeline of Flows



Food Base





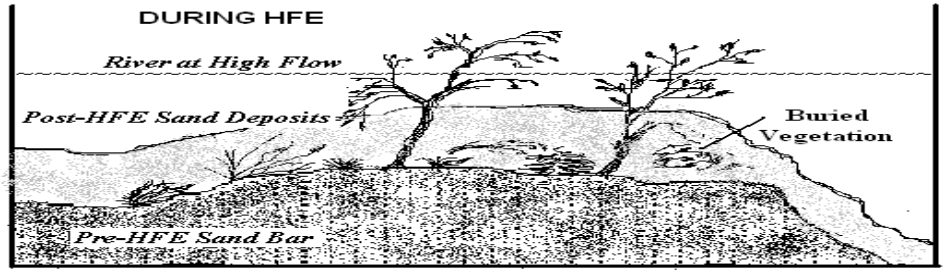
March 26-April 2, 1996

- **90% of instream plants & algae uprooted at LF.**
- **50% inverts exported—5 mo. recovery.**
- **Scoured senescent material.**
- ***Gammarus* reduced—recovery 8+ mo.**
- **Primary production increased 2-fold; P/R up 1.3 to 2.6.**
- **Recovery slower on depositional habitats than on cobble.**
- **Invert reduction attributed to desiccation from low steady pre- and post- 8,000 ft^3/s.**
- **Recovery helped by clear post-HFE flows.**
- **Nutrients stored in buried vegetation were mineralized.**

March 5-7, 2008

- **Total invertebrate biomass immediately reduced by export.**
- **Greatest reductions in biomass of New Zealand mudsnails and *Gammarus* persisted for 15 mo.**
- **Reduced indigestible items (mudsnails) and increased digestible food of trout.**
- **Increased sand in backwaters and reduced silt and organic matter.**
- **Densities of blackflies, midges, and dipterans in backwaters decreased, but recovered in 2 mo.**
- **Recovery of snails slower than other invertebrates; i.e., 5 mo.**

Riparian Vegetation



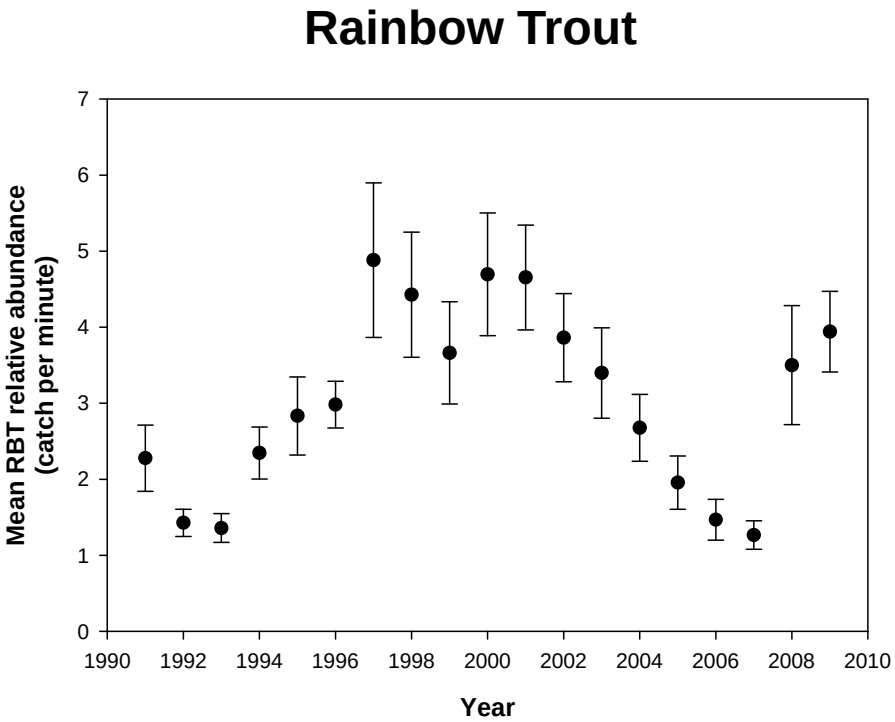
March 26-April 2, 1996

- **Total vegetative cover reduced by 20%; recovered in 5 mo.**
- **Plants on sand bars were buried rather than uprooted.**
- **HFE occurred before tamarisk seed production; little seedling establishment or germination.**
- **High release scoured top 10 cm of soil and reduced seed banks by about 45%.**

March 5-7, 2008

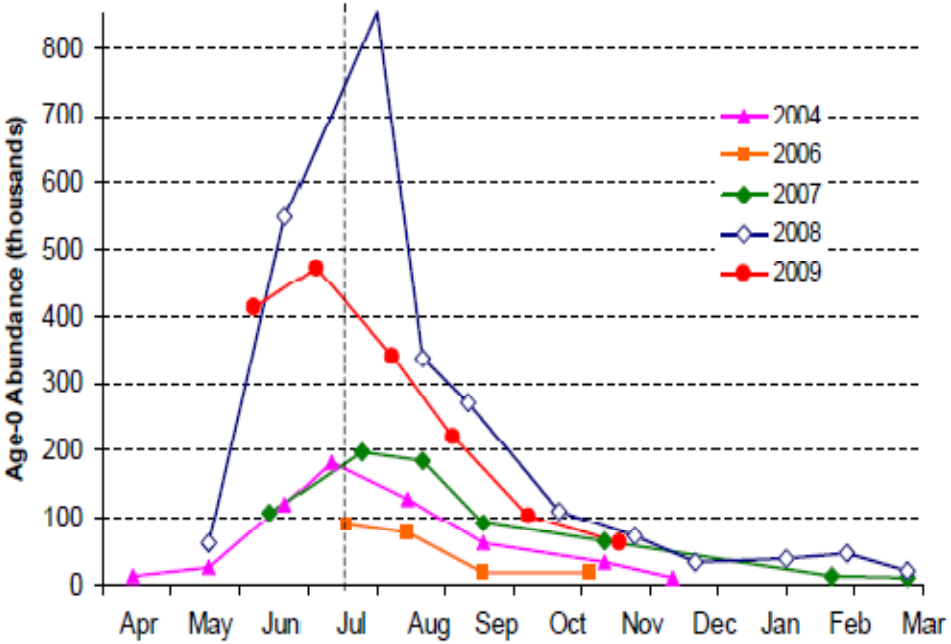
- **Most vegetation scoured below 20,000 ft^3/s.**
- **Plants on sand bars were buried rather than uprooted.**
- **HFE occurred before tamarisk seed production; little seedling establishment or germination.**
- **Coarse sand deposits limited seedling establishment and favored clonal species.**

Trout
(March 26-April 2, 1996)



- **Little direct effect on RBT spawning, survival of young, abundance, or condition.**
- **Catch rate of RBT increased by 66% from 1996 to 1997.**
- **Downstream displacement of juvenile RBT not significant to population; few adults displaced.**

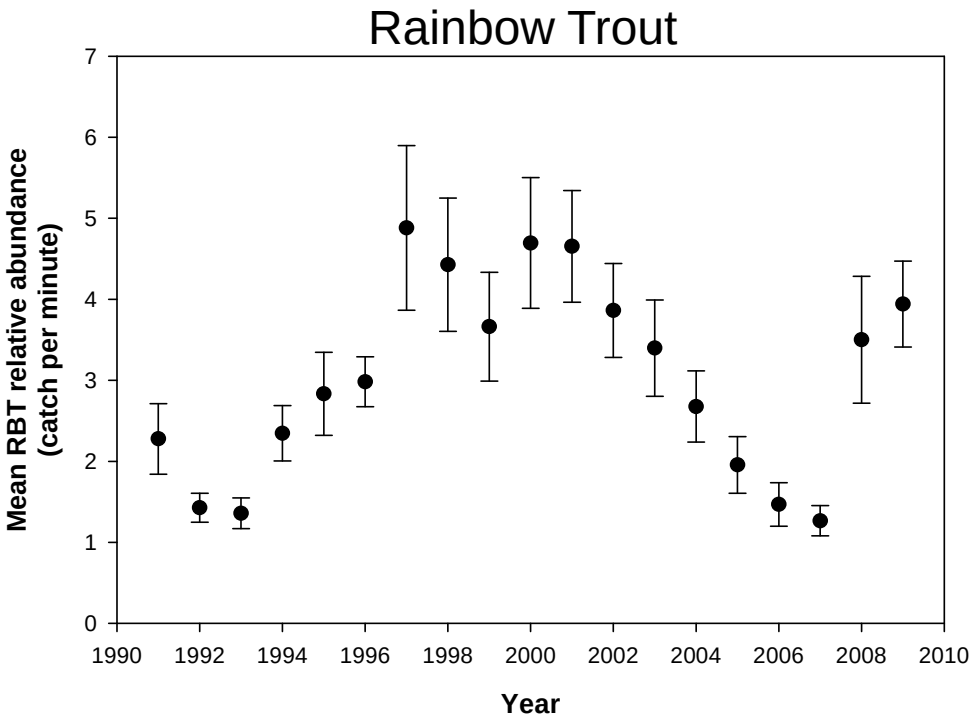
Trout (1 of 3)
(March 5-7, 2008)



Korman et al. 2010

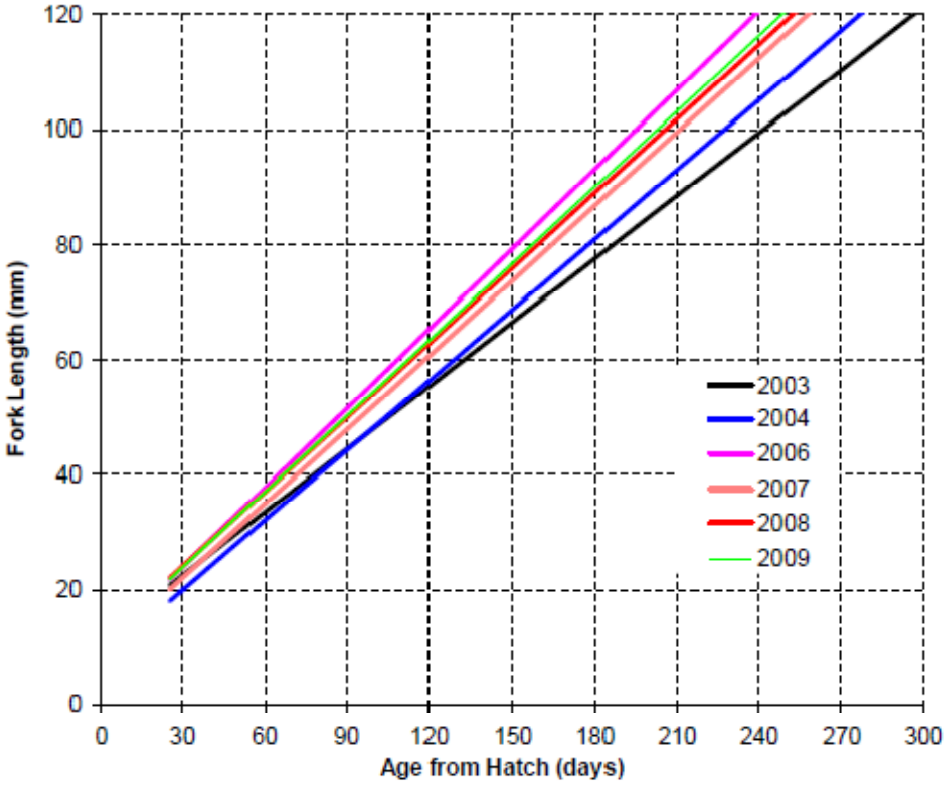
- **Peak spawning estimated by the spawn-timing model in 2008 was February 21.**
- **Survival rates for fish hatching before and until 1 month after HFE (about April 15) much lower than expected, with opposite occurring for fish hatching after this date.**
- **Early survival rate was much higher in 2008 and 2009 following the 2008 HFE.**

Trout (2 of 3)
(March 5-7, 2008)



- **Peak count of 571 redds on February 28, just before the HFE; count declined >50% to 253 redds on March 14 (detection?).**
- **Age-0 abundance much higher in July 2008 and 2009 than expected, given number of viable redds.**
- **No observed negative effect on age-0 densities at near-shore sites.**
- **Trout abundance highest in 2008 and 2009 after HFE**

Trout (3 of 3)
(March 5-7, 2008)

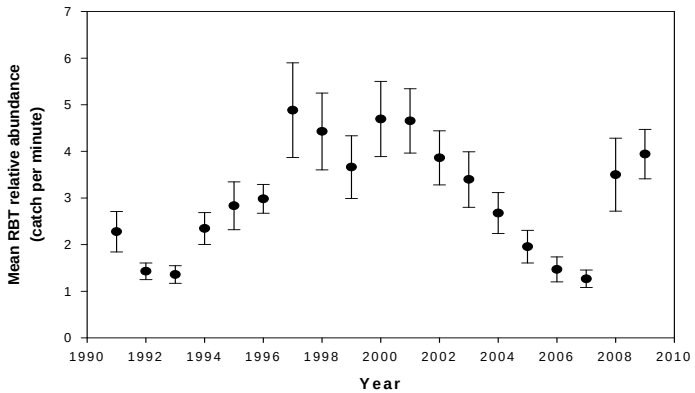


Korman et al. 2010

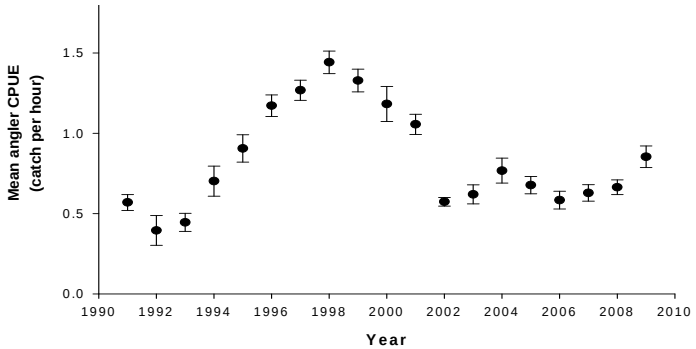
- **Growth rate highest in 2006 (0.46 mm/day), when age-0 abundance was lowest. Growth was nearly as high in 2008 (0.43 mm/day) and 2009 (0.44 mm/day.**
- **Growth rates higher after the March 2008 HFE. HFE did not have large effect on size structure of age-0 trout population.**
- **Proportion of larger fish increased slightly after both November 2004 and March 2008 HFEs, indicating that smaller fish were more vulnerable to high flows.**

Rainbow Trout

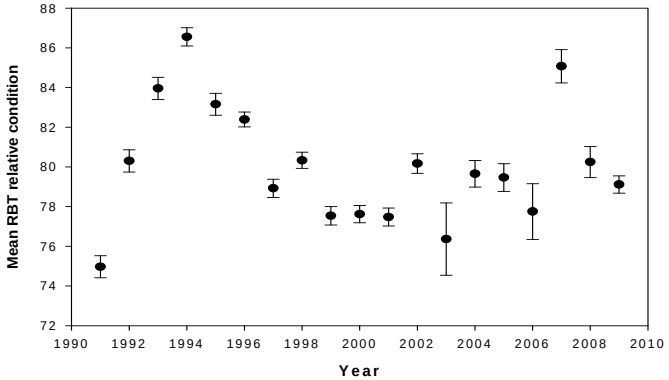
Abundance
(EL Catch/Min.)



Angler Catch



Condition



Native Fish (1 of 5)
(March 26-April 2, 1996)

- **21% increase in number of backwaters (31 to 39), most were reduced or unavailable 1 mo. after HFE.**
- **Decrease in densities of juvenile BHS in backwaters and shorelines attributed to habitat shift to offshore habitats and not to HFE.**
- **FMS densities did not change; fish reoccupied backwaters, shorelines.**

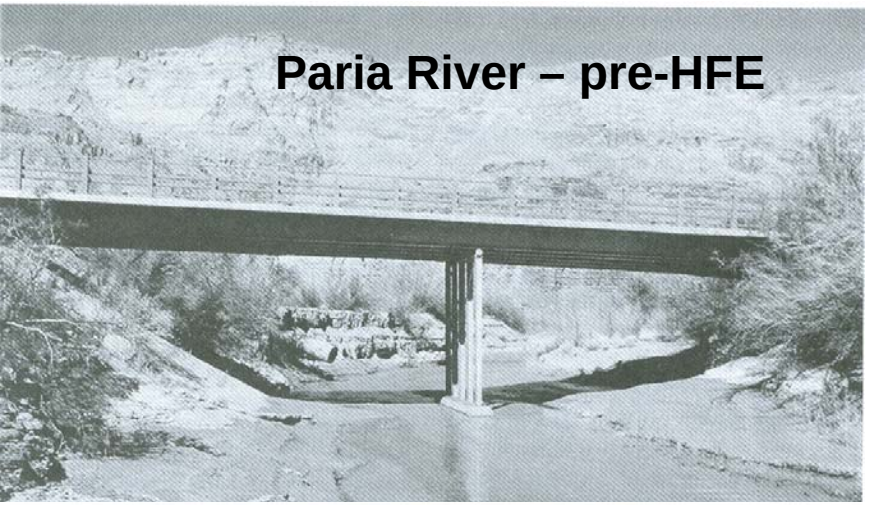
Native Fish (2 of 5)
(March 26-April 2, 1996)

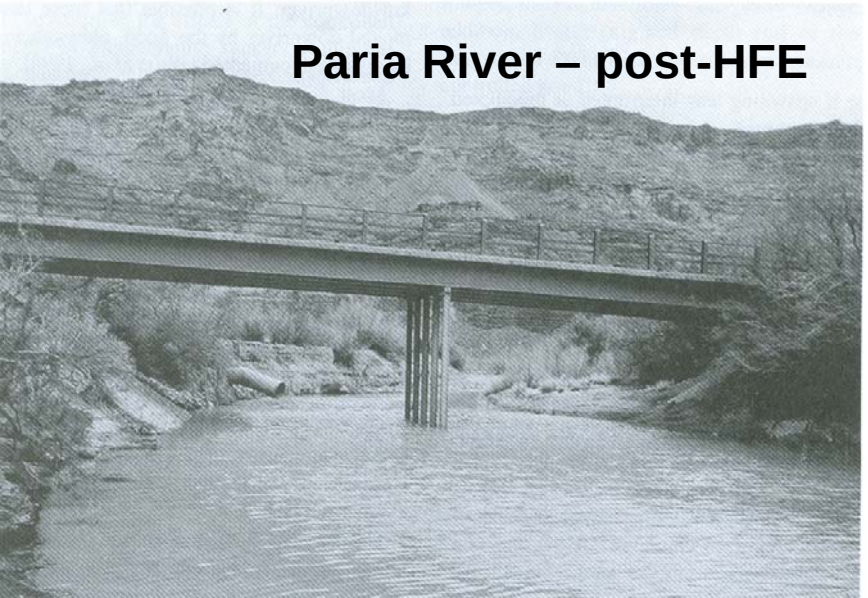
- **Shoreline densities of juvenile HBC before and after high release did not differ significantly.**
- **Age-1 and 2 along rocky, steep-angle talus shorelines moved upslope with increasing flows and back downslope with receding flows, remaining in less than about 3 feet of water.**
- **Adult HBC located in low-velocity areas in large recirculating eddies during high release.**

Native Fish (3 of 5)
(March 26-April 2, 1996)

- **Shoreline densities of SPD before and after high release did not differ significantly.**
- **SPD left debris fans, moved to talus, and returned.**

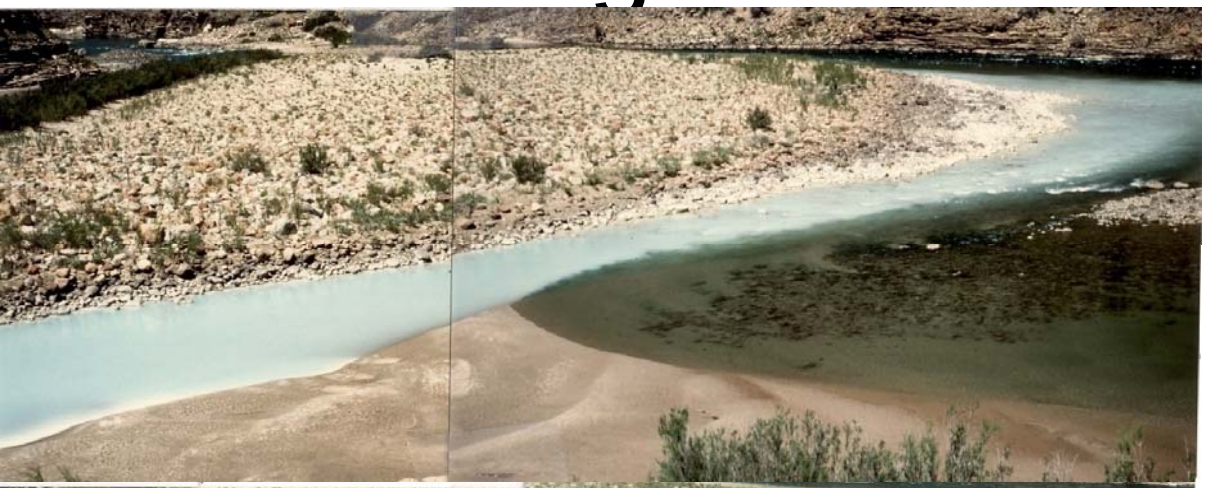
Native Fish (4 of 5)
(March 26-April 2, 1996)





- **Paria River ponded for about 700 yds.**
- **FMS spawned during HFE.**
- **Larval FMS descended from Paria River in summer 1996.**
- **No significant effect to movement of adult FMS; 84% of tagged fish stayed in LF; 66% stayed in Paria pond.**

Ponding of LCR—1996 HFE



Low Mainstem

Base LCR (230 ft3/s)

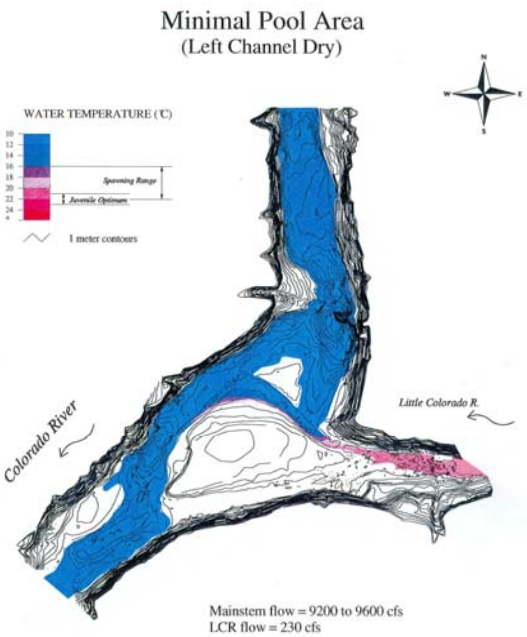
Low Mainstem

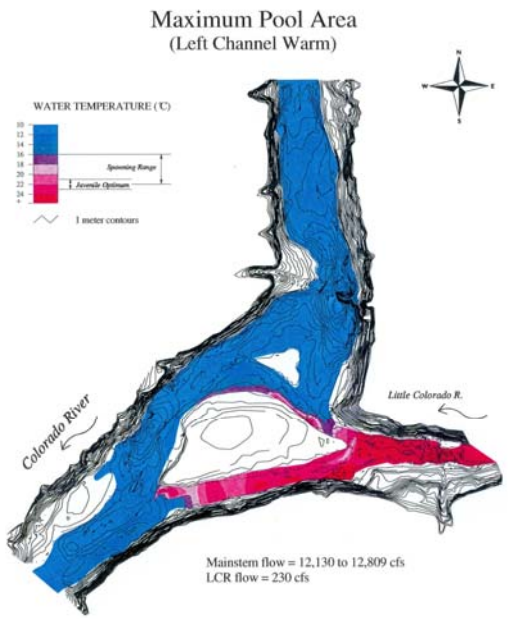
High LCR

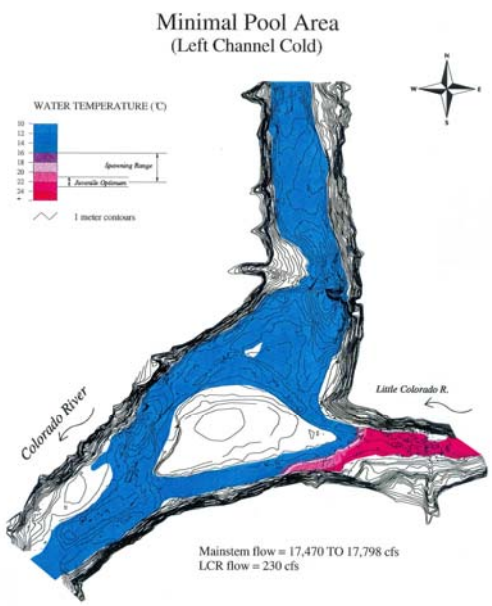
High Mainstem

Base LCR (230 ft3/s)

Ponding of LCR—1996 HFE







Mainstem:
9200-9600 ft3/s

LCR: 230 ft3/s

Mainstem:
12,130-12,809 ft3/s

LCR: 230 ft3/s

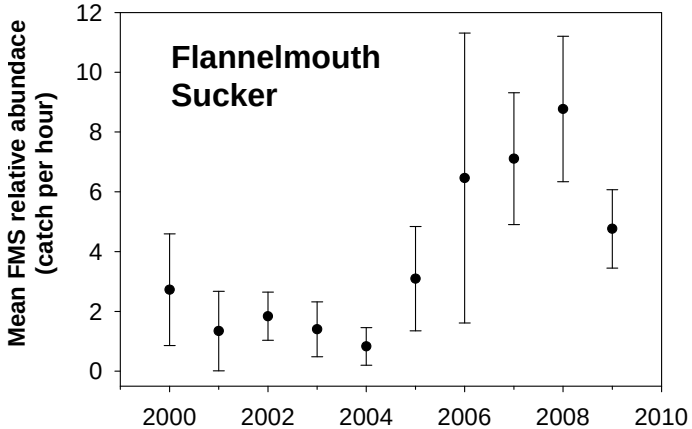
Mainstem:
17,470-17,798 ft3/s

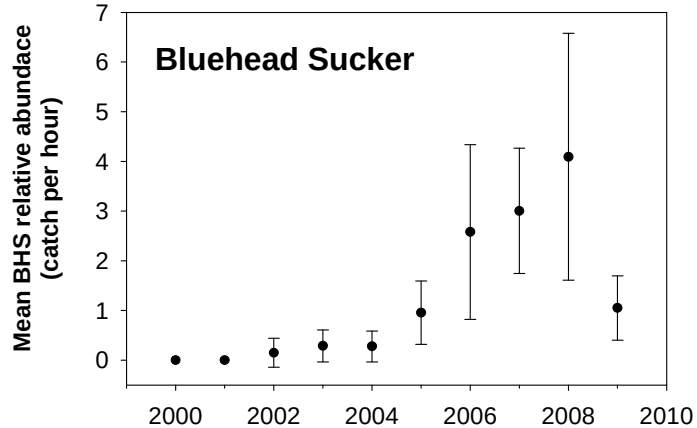
LCR: 230 ft3/s

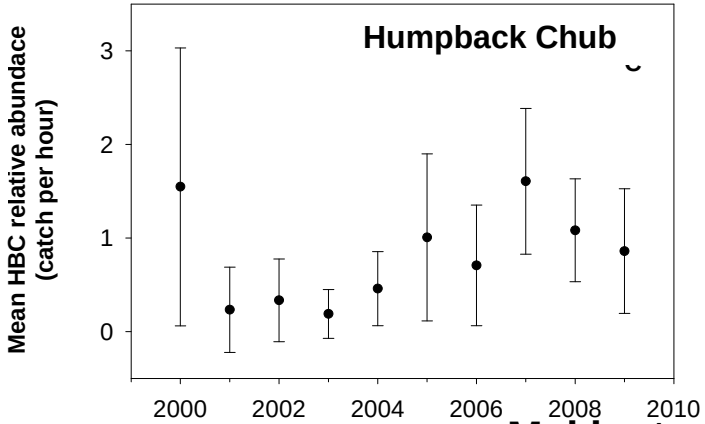
Nonnative Fish
(March 26-April 2, 1996)

- **FHM and PKF decreased significantly as backwaters were inundated and fish were transported downstream.**
- **Recovery within 5 mo. with local reproduction and reinvasion from tributaries.**
- **Numbers of RS, RDS, CP too low.**

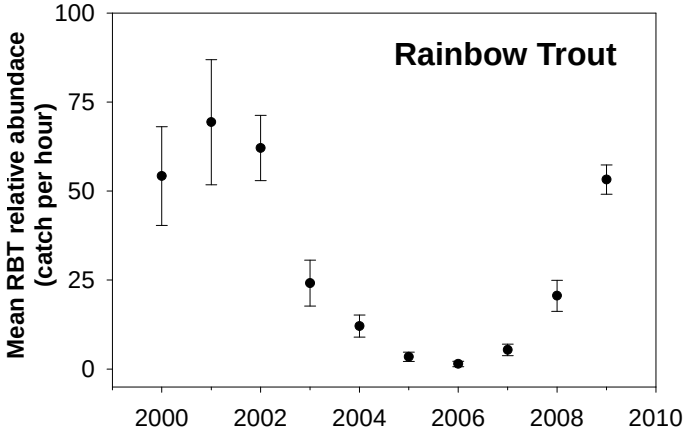
Native Fish

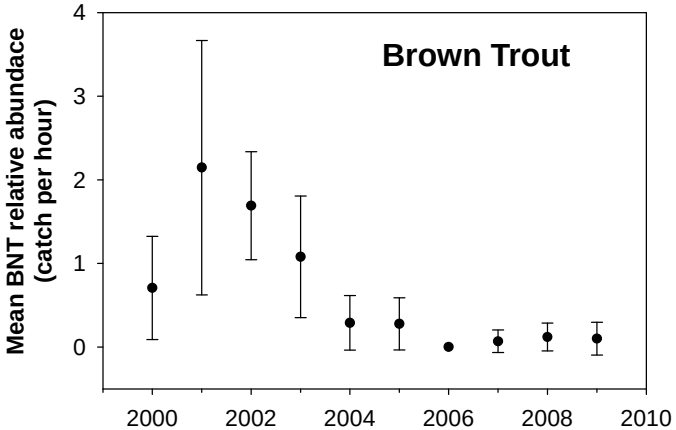


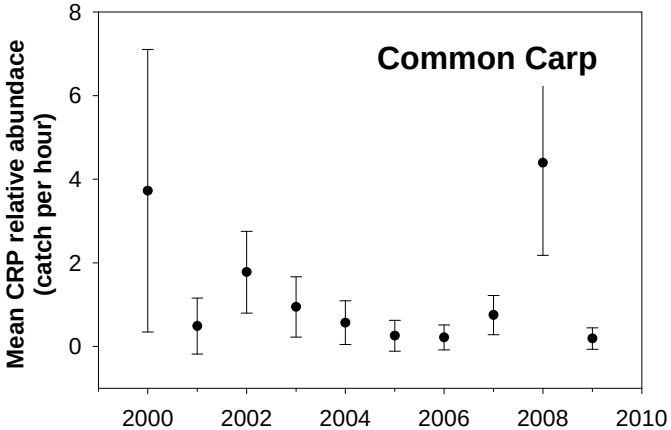




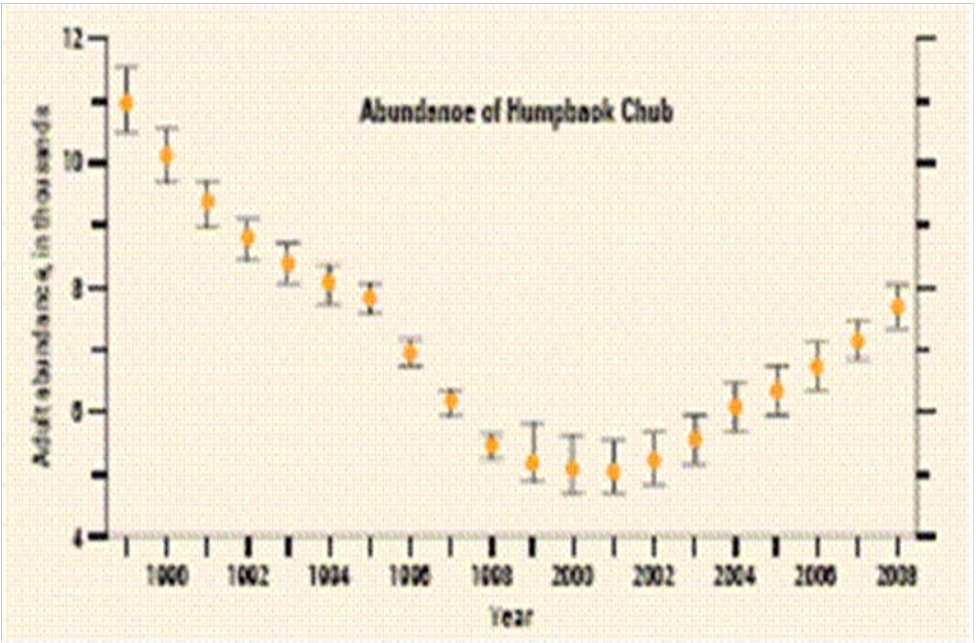
Nonnative Fish



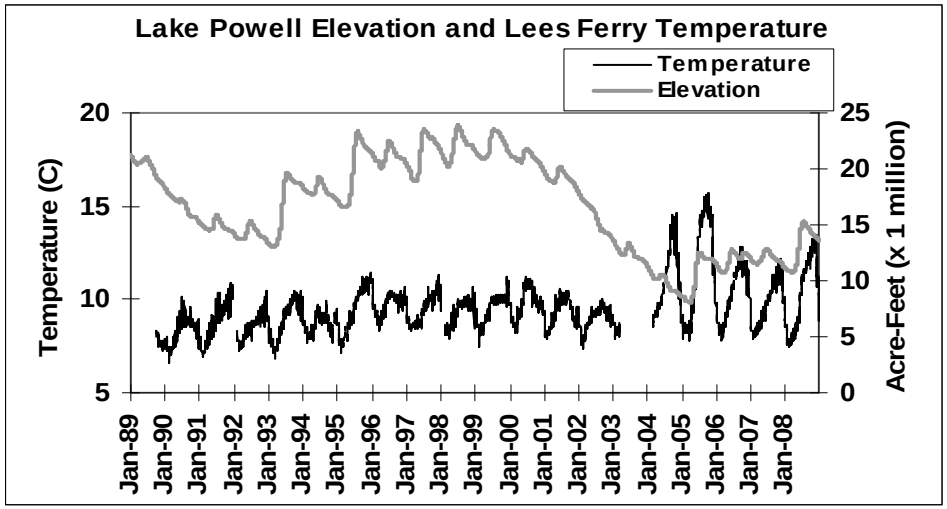




Makinster and Persons (2010a, 2010b)


Abundance of Humpback Chub
Adult abundance, in thousands
12
10
8
6
4
1990
1992
1994
1996
1998
2000
2002
2004
2006
2008
Year

HUMPBACK CHUB
Gila cypha


Lake Powell Elevation and Lees Ferry Temperature
Temperature
Elevation
Temperature (C)
20
15
10
5
Acre-Feet (x 1 million)
25
20
15
10
5
0
Jan-89
Jan-90
Jan-91
Jan-92
Jan-93
Jan-94
Jan-95
Jan-96
Jan-97
Jan-98
Jan-99
Jan-00
Jan-01
Jan-02
Jan-03
Jan-04
Jan-05
Jan-06
Jan-07
Jan-08