

# Possible Effects of a Temperature Control Device on The Lees Ferry Rainbow Trout Fishery

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## Standard Environmental Temperature (SET)

SET = is the temperature at which all physiological systems are operating optimally.

### SET for Rainbow trout = 15°C

For each degree Celsius below SET there is an 8.25% decrease in growth rate from the optimum permissible at SET (Haskell 1955).

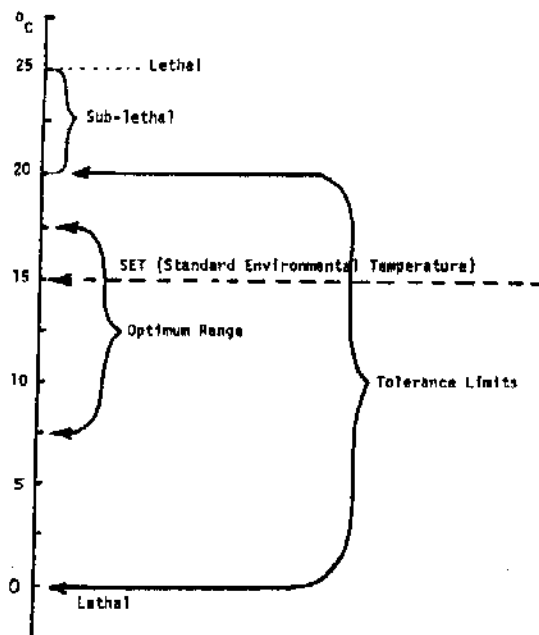


Figure 1. Temperature tolerance of rainbow trout showing optimum range and preferred temperature (SET). From Michigan Hatchery Manual, 1968.

## Growth

### Better growth and survival at 13°C than 10°C

Fry and fingerlings grew more rapidly and had lower mortality in ponds heated to 13.4°C than 10°C (Morton 1962). Fingerlings grew best at 13°C (Markus 1962). Fluctuations in daily temperatures improves feeding and growth over constant temperatures (Behnke 1992).

## Spawning

### Eggs won't develop in ovaries at high temperatures - need <12.2°C for six months

Hume (1955) reported a few females spawned in July, though no males were ripe, in a California hatchery where water temperatures were high, 12-17°C. Lewis (1944) reported that difficulty was encountered in securing eggs from rainbows held at 15.5°C, but those fish produced satisfactorily when held at 13.4°C. Rainbow trout eggs will not develop normally in the brood fish if constant water temperatures above 56°F (13.3°C) are encountered prior to spawning. Brood fish should be held in water temperatures below 56°F (13.3°C), and preferably not above 54°F (12.2°C) for at least six months before spawning (Piper et al. 1982).

### Spawning Temperature, 10-16°C

Spawning typically begins when daily maximum temperature reaches 6-9°C (Behnke 1992). Optimum spawning is at 10-16°C (Piper et al. 1982).

## Egg Hatching

### Mean hatching time (Piper et al. 1982):

Temperature (°C)	Days to Hatching
10	31
12	24
15.7	19

### Need 630 Celsius temperature units for hatching and swim-up

Behnke (1992) reports that trout generally need 330 Celsius temperature units (CTU; sum of mean daily temperature above 0°C) for eggs to hatch (22 days at 15°C, 33 days at 10°C) and an additional 300 CTU for development to emergence from gravel.

## Temperature tolerance to 25°C

Trout begin to stress and stop feeding at 22°C, can tolerate temperature up to 25°C for short periods of time and begin to die at 28°C (Carlander 1969; Behnke 1992).

## Disease/Parasites

### Parasites may increase

Both species composition and incidence of parasites and diseases may increase with increasing temperature. For example, *Flexibacter columnaris* (Holt et al. 1975) and *Yersinia ruckeri* (Bullock 1984) become problematic at temperatures >15°C.

Whirling disease (*Myxosoma cerebralis*) has not yet been found in Lees Ferry. *M. cerebralis* uses oligochaetes, which are common inhabitants of the sediments in Grand Canyon (AGFD 1996), as an intermediate host (Kent et al. 1994). It is likely that increased water temperatures will increase oligochaete density and distribution. Rate of development of *M. cerebralis* is temperature-dependent (Lom and Dyková 1995). It takes three months at 12°C to produce spores and clinical signs appear 2 - 8 weeks after exposure. The clinical signs are more frequently seen at 17°C than at other temperatures.

## Competition/Predation

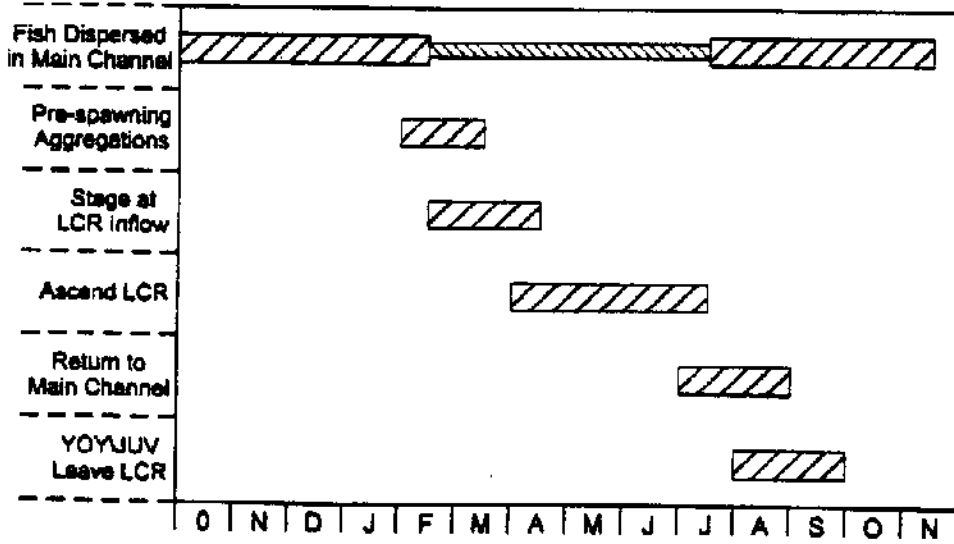
At 12-15°C, juvenile steelhead showed no affect of competition with redbside shiners, but at 19-22°C, steelhead production declined by 54% (Reeves et al. 1987).

Striped bass successfully hatch at temperatures of 14-20°C (Scott and Crossman 1973). Walleye spawn and eggs successfully hatch at temperatures between 5-11°C (Scott and Crossman 1973). Smallmouth bass prefer temperatures from 20-31°C, successfully spawn at temperatures of 15 -25°C and 90% of juveniles survived temperatures as low as 2.5°C when acclimated at 15°C (Carlander 1977).

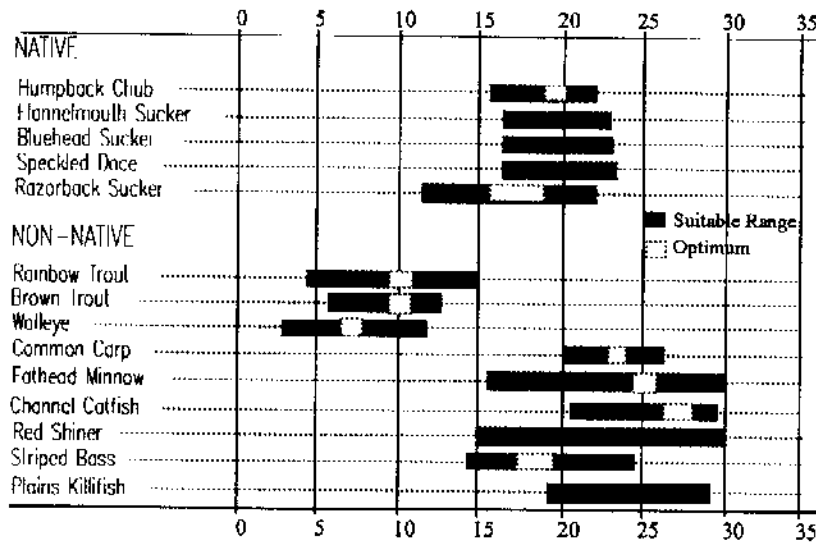
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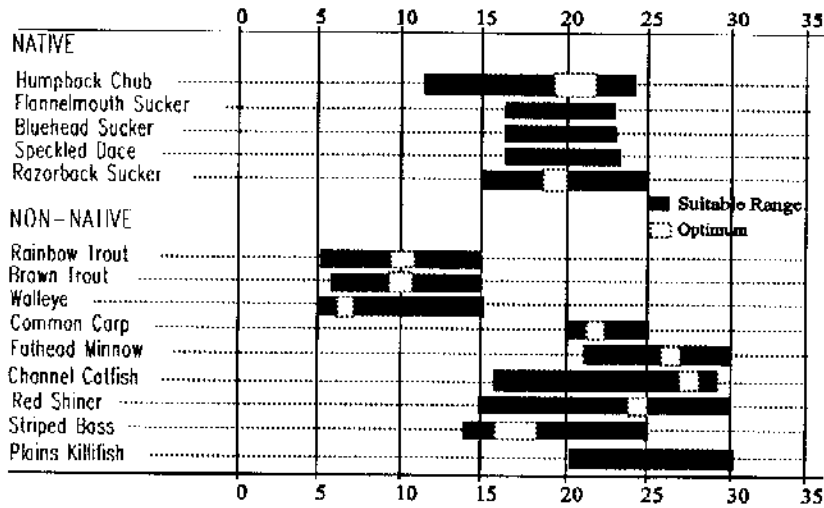
### Life History Schedule for Humpback Chub Colorado River In Grand Canyon



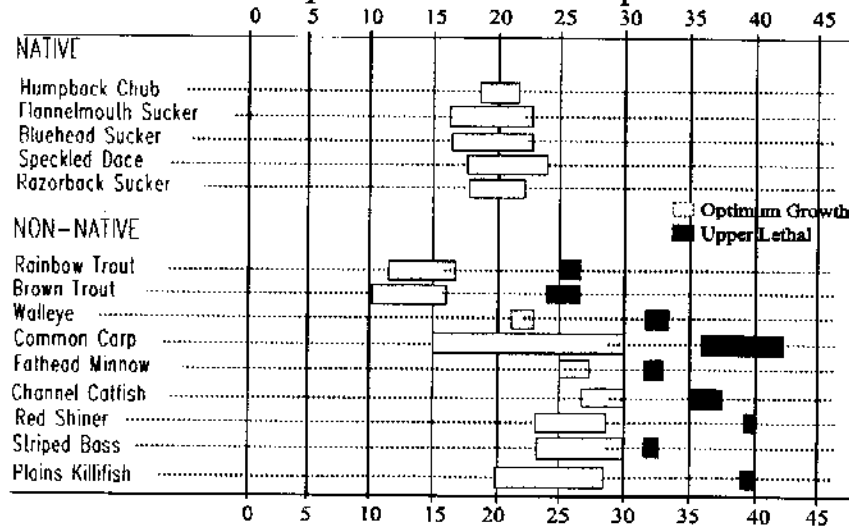
### Spawning Temperature For Colorado River Fishes



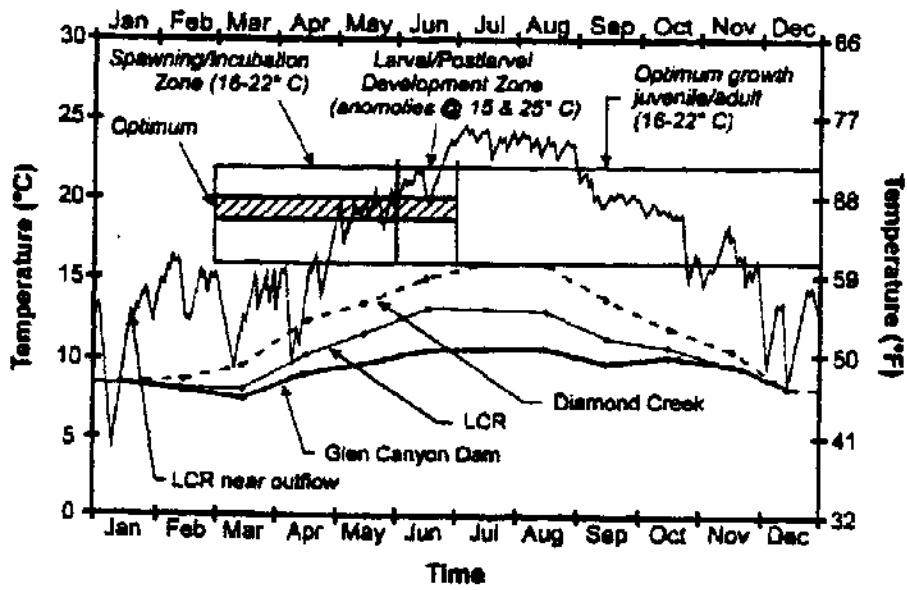
### Egg Hatching Temperature For Colorado River Fishes



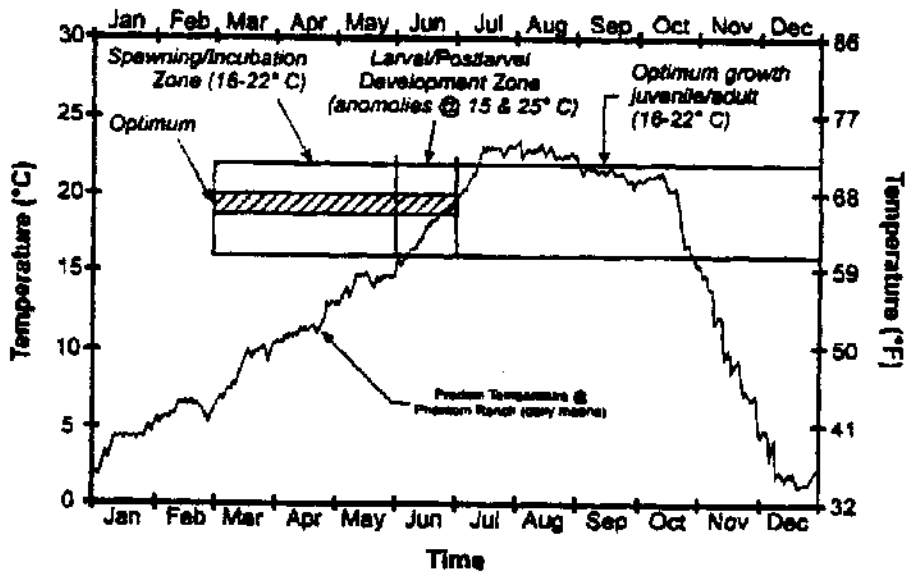
### Lethal And Optimum Growth Temperatures



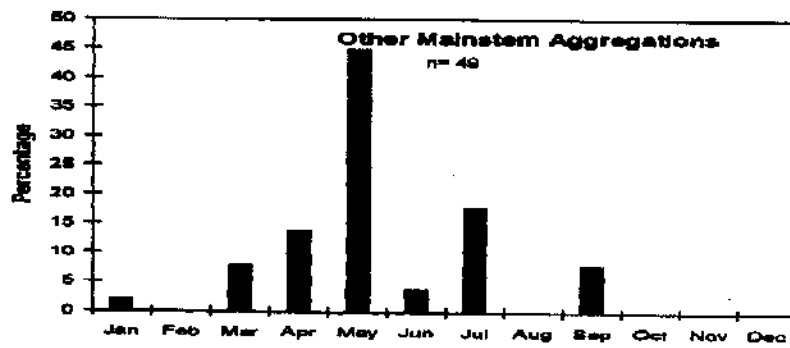
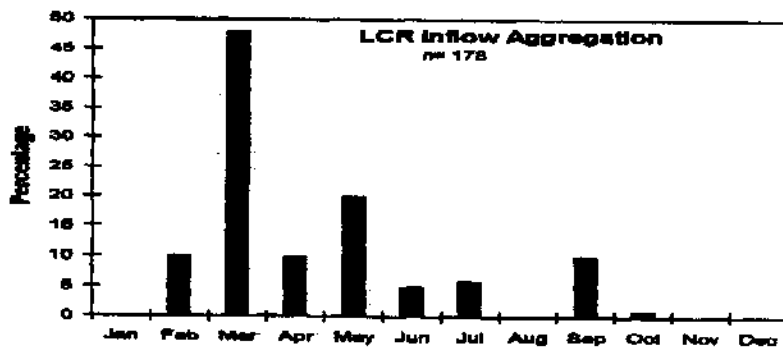
**B. Suitable Temperature Zones for Humpback Chub  
(Postdam Conditions)**



**A. Suitable Temperature Zones for Humpback Chub  
(Predam Conditions)**

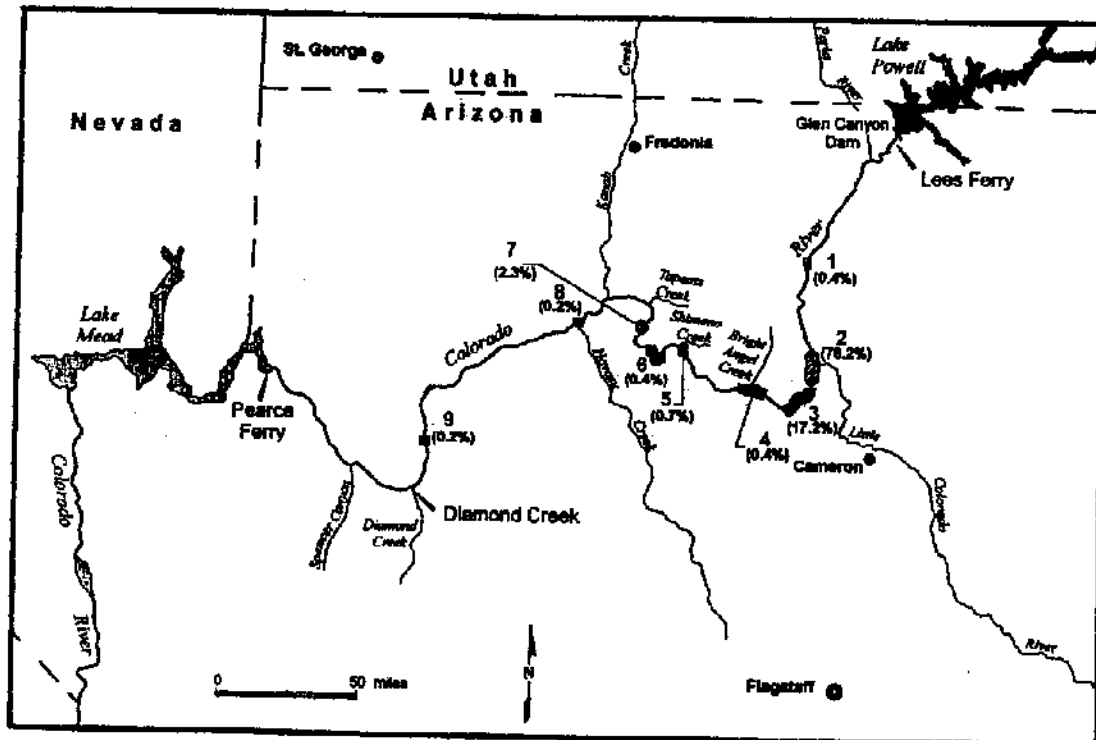


### HUMPBACK CHUB IN SPAWNING CONDITION

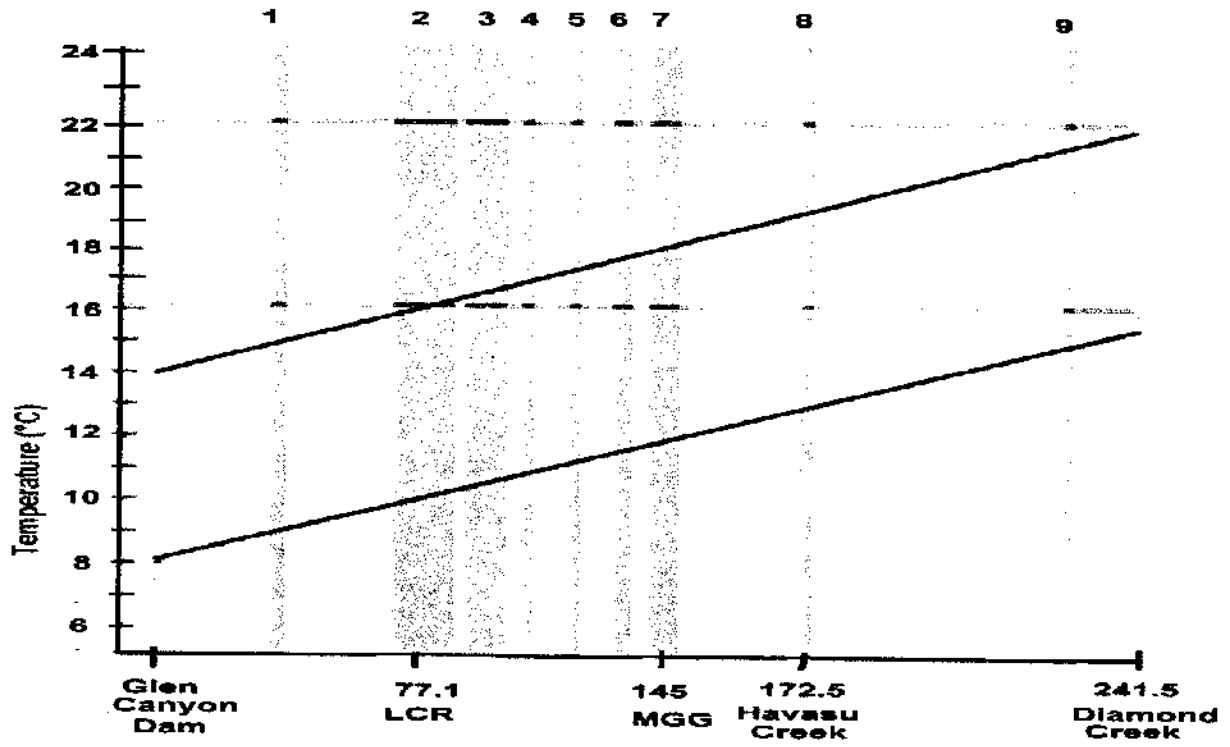




NINE AGGREGATIONS OF HUMPBACK CHUB



**TEMPERATURE AT NINE AGGREGATIONS OF HUMPBAC CHUB**



## TARGET TIMES AND TEMPERATURES

<u>SPECIES</u>	<u>TIME</u>	<u>TEMPERATURE</u>
Humpback Chub - LCR	March-May	16-22°C
Humpback Chub - Mainstem	April-July	16-22°C
Flannelmouth Sucker - Paria	March-April	17-23°C
Flannelmouth Sucker - Mainstem	March-June	17-23°C
Bluehead Sucker - Paria	March-April	17-23°C
Bluehead Sucker - Mainstem	March-June	17-23°C

