Stranding of Rainbow Trout during Experimental Fluctuating Releases from Glen Canyon Dam on the Colorado River

Objective

- Examine the spatial and temporal extent of rainbow trout (RBT) stranding in the Lee's Ferry reach of the Colorado River.

Experimental Flow Regime

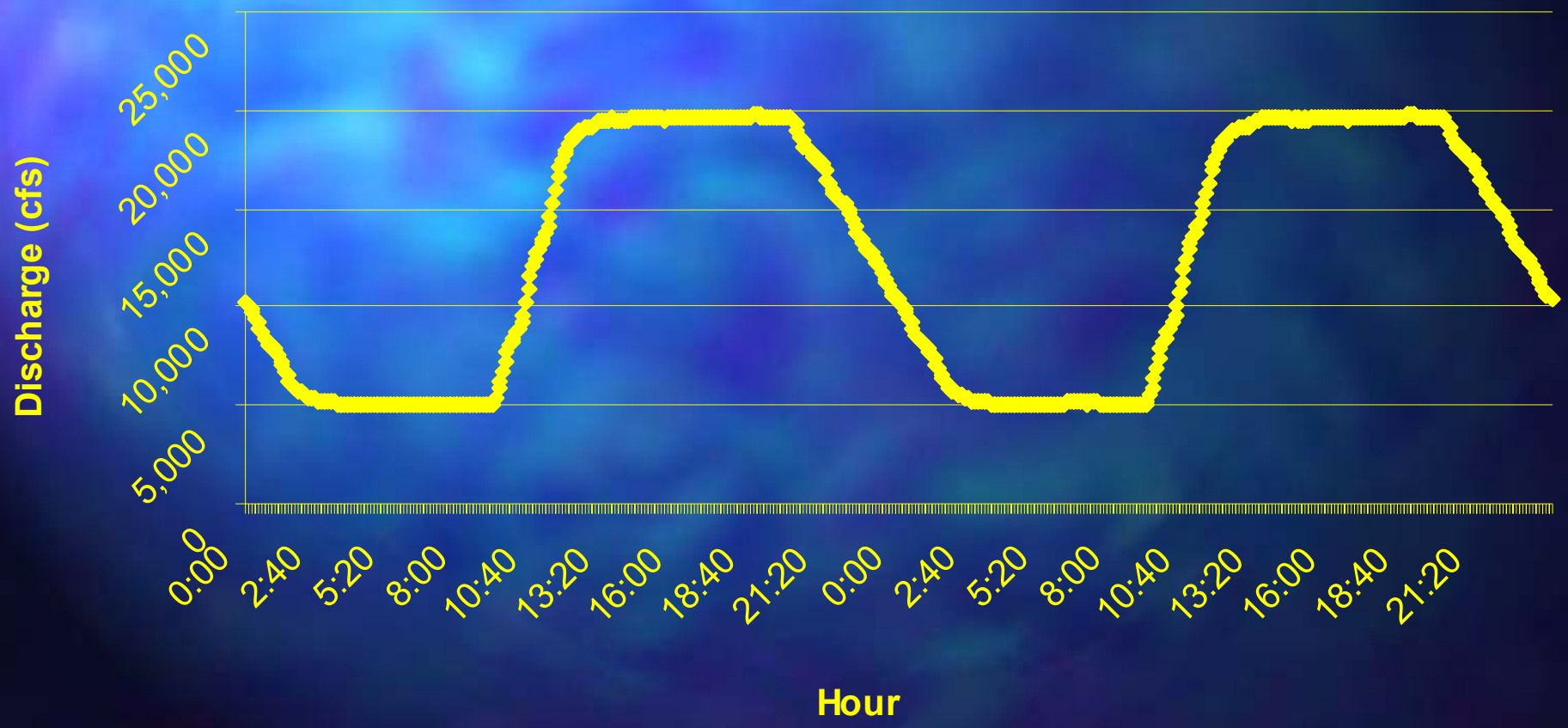
- Experimental flow regime commenced January 1, 2003 and continued through March 31, 2003.
- A daily high fluctuating flow element
  - a minimum of 5,000 cubic feet per second (cfs) beginning at 0100
  - a maximum of 20,000 cfs beginning at 1200

Various flow regime characteristics during the last 15 years

Flow regime	Minimum releases (cfs)	Maximum releases (cfs)	Allowable daily fluctuations (cfs)	Ramp rate (cfs/hr)
No Action Alternative/ Pre-EIS (normal flows)	1,000 Labor Day to Easter 3,000 Easter to Labor Day	31,500	30,500 Labor Day to Easter 28,500 Easter to Labor Day	Unrestricted; 4,000 up (70% of the time) 4,000 down (70% of the time)
Interim Flows/ROD Flows	8,000 day 5,000 night	25,000	5,000; 6,000; or 8,000	2,500 up 1,500 down
2003 Experimental Flows	5,000	20,000	15,000	5,000 up (0900 – 1200) 2,500 down (2100 – 0200)

(cfs = cubic feet per second)

Glen Canyon Dam Experimental Releases



Expected Results of Flow Fluctuations

- Benefit native fish
- Improve quality of Lee's Ferry rainbow trout fishery by reducing numbers of trout produced in the Lee's Ferry reach, resulting in larger fish
- Unintended stranding of adult trout in shallows

Previous Study

- Glen Canyon Dam and the Colorado River: Responses of the Aquatic Biota to Dam Operations, T.R. Angradi, R.W. Clarkson, D.A. Kinsolving, D.M. Kubly, and S.A. Morgensen. 1992

Differences between 1990 and 2003 Studies

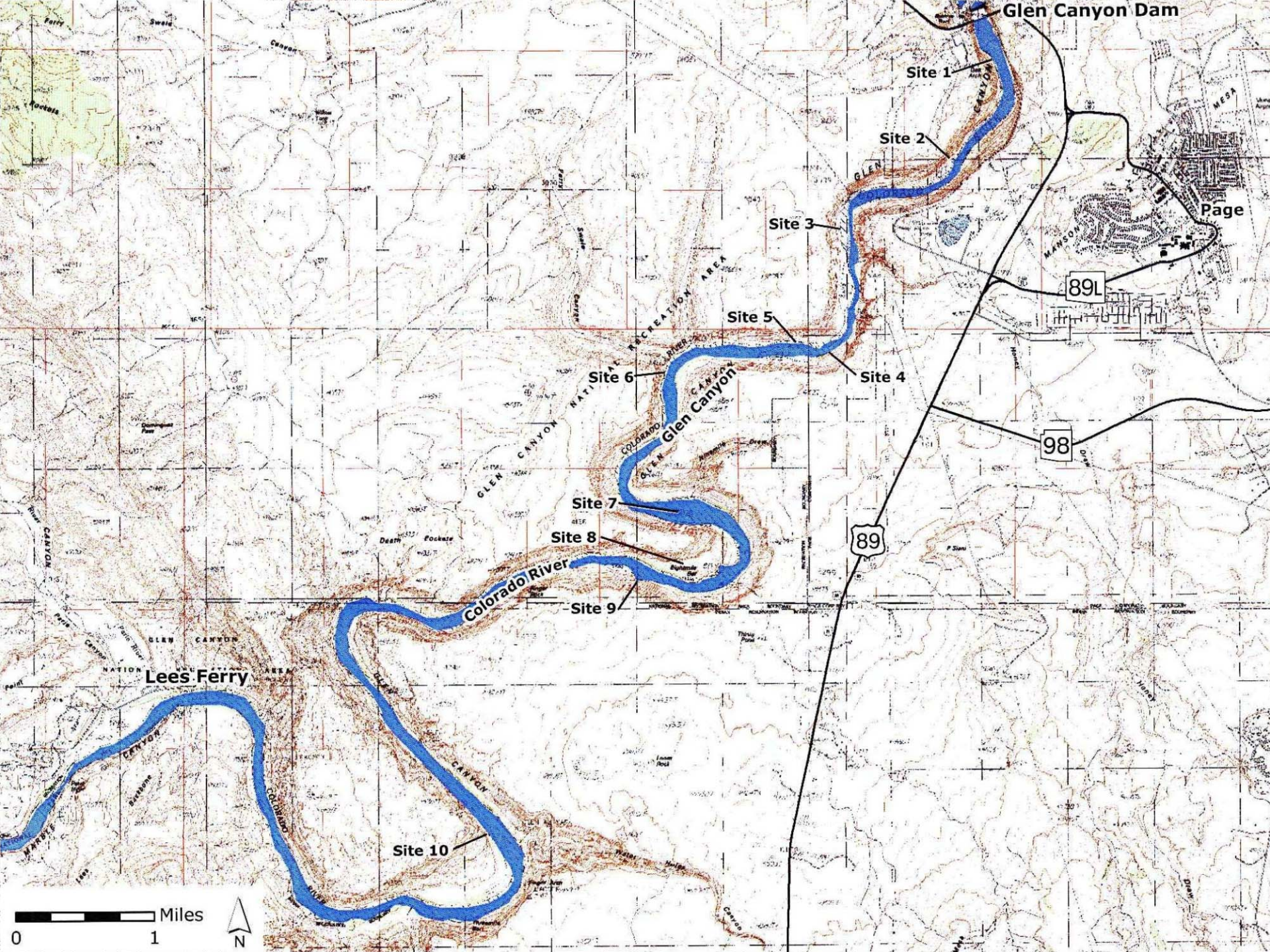
- Length of the study period (3 months vs. 18 months)
- Frequency (number) of surveys
- Flow conditions and ramping rates

Differences between 1990 and 2003 Studies

- Water temperatures in stranding pools
  - During the Angradi *et al.* 1992 study, high temperatures (up to 29 degrees Celsius) may have led to poor water quality and higher RBT mortality than seen in the 2003 experiment.

Stranding Sites

- Several aspects were taken into consideration to determine if the site should be classified as a potential stranding area:
  - previous findings (Angradi *et al.* 1992),
  - quality and quantity of spawning gravel,
  - recent observations of spawning activity relative to the site,
  - extent of stranding conditions, and
  - likelihood of stranding (e.g., morphometry of the site, seepage rates, etc.).


Glen Canyon Dam
Site 1
Site 2
Site 3
Site 4
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Site 7
Site 8
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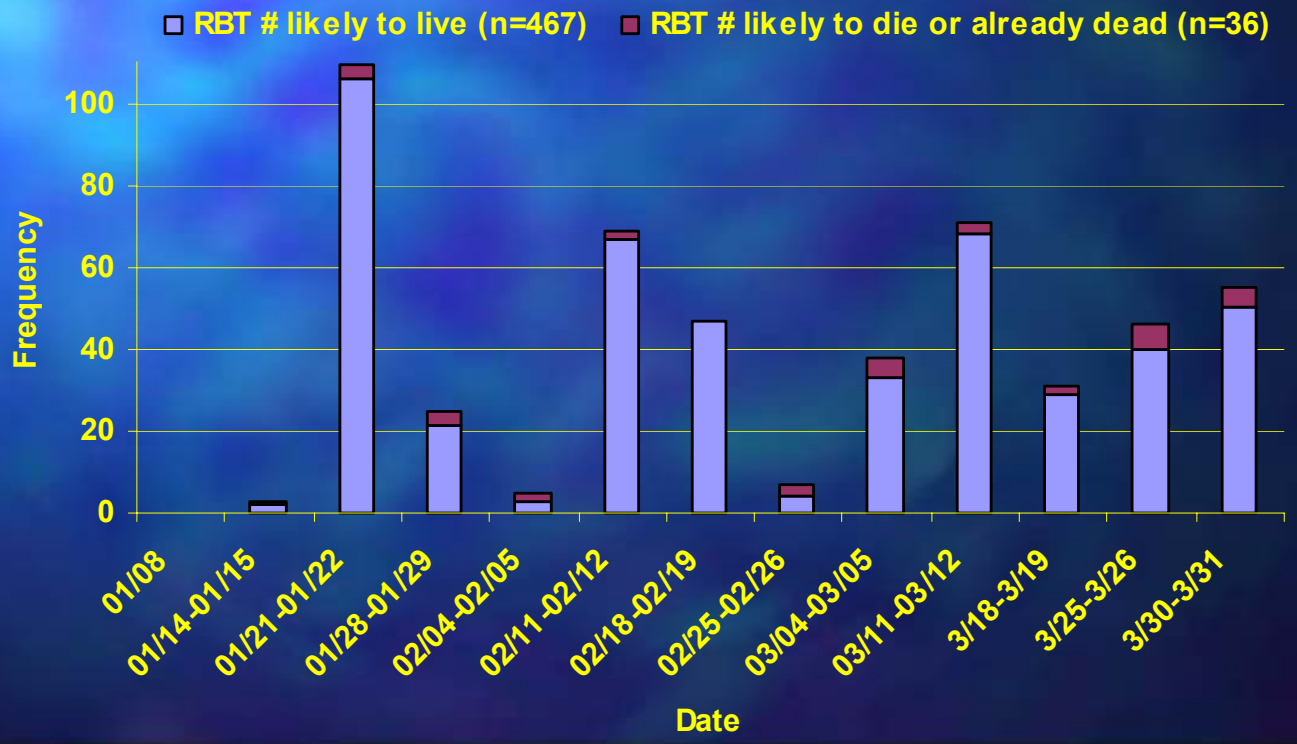
Stranded Fish

- A total of 503 adult fish were found stranded during this 3 month study.
- 7% (36 fish) of stranded fish were dead or dying.



Stranded Fish cont.

1990

- The mean TL of RBT (Angradi *et al*.) was 437 mm (SD = 53, n = 496).
- The mean TL of RBT (AGFD) in 1991 was 352 mm (SD = 117, n = 228).

2003

- Stranded fish (dead) ranged from 200 mm to 455 mm TL, with a mean of 378 mm (SD = 63, n = 36), and from 85 g to 1,200 g in weight
- The mean TL of RBT (AGFD) was 234 mm (SD = 88, n = 3409).

Predation on Stranded Fish

- 28% of the stranded fish, both alive and dead, showed indications of predation.
  - Fish that were still alive had talon marks along their flanks, while dead fish had wounds that varied from talon marks along the flanks to missing portions of their anatomy.

Predation on Stranded Fish cont.

- Stranded fish with talon marks present.

- Stranded fish that exhibits signs of predation.

Stranded Fish by Site

Site	RBT likely to live	RBT likely to die	RBT dead	Total	Percent dead and likely to die
Site 1	19	2	19	40	53
Site 2	2	0	0	2	0
Site 3	27	0	7	34	21
Site 4	30	0	2	32	6
Site 5	386	0	2	388	0.5
Site 6	0	0	0	0	0
Site 7	1	0	1	2	50
Site 8	0	0	0	0	0
Site 9	0	0	1	1	100
Site 10	2	1	1	4	50

Stranded Fish by Site cont.

Site 1

- High potential of stranding and mortality to fish
  - 40 fish were observed
  - 19 (48 %) of those fish were dead
  - 10 of the 19 (53 %) were found at the top of the stranding area

Stranded Fish by Site cont.

Site 1

5,000 cfs

20,000 cfs

Stranded Fish by Site cont.

Site 5

- 388 stranded fish observed
- 2 were dead

The difference between this site and Site 1, was the gravel sloped towards a 1.4 m deep pool, which enabled stranded RBT to survive until the water rose to a sufficient level where they could migrate out to the river.

Stranded Fish by Site cont.

Site 5

5,000 cfs

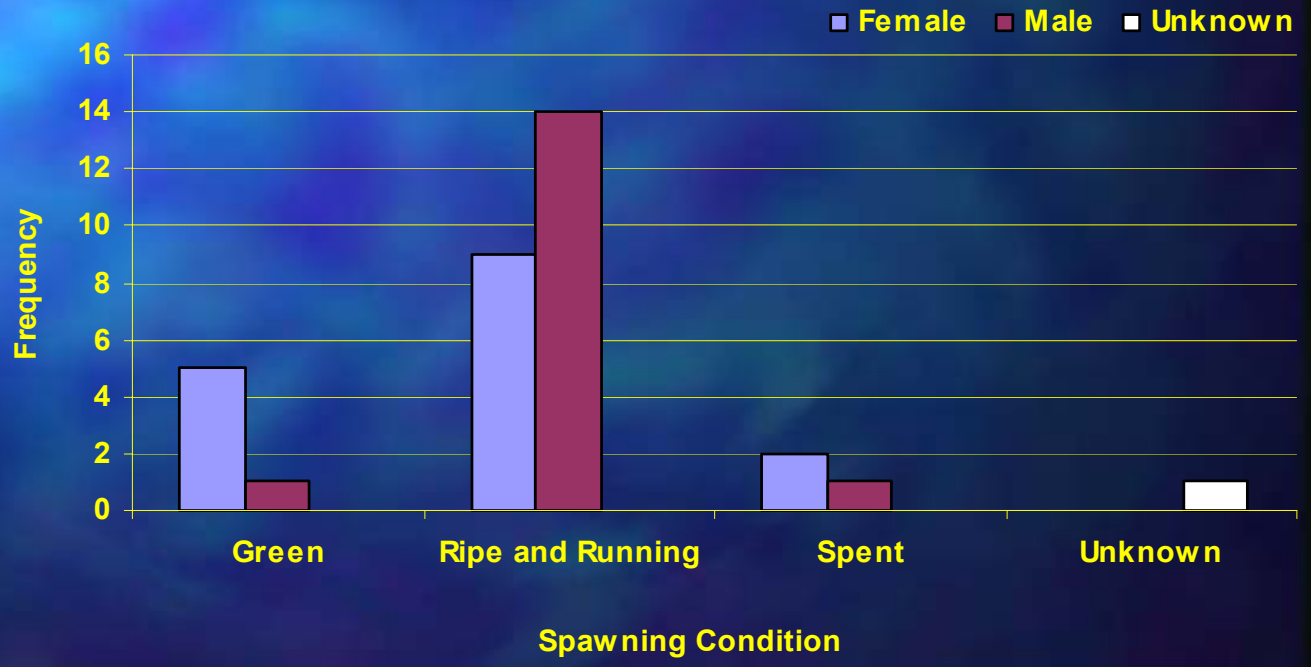
20,000 cfs

Conclusions

- Fish were stranded in select sites (not randomly).
- A lower percentage of stranded fish were found dead in this survey compared to the 1990 survey.
- Cool winter temperatures may have prevented further loss of stranded fish in pools.
- Predation on stranded fish appeared to be minimal.
- A low down ramp rate appears to be a possible factor in preventing stranding of fish.

Conclusions cont.

- Stranded fish apparently were substantially larger in size than the population norm.
- Male and female trout were equally susceptible to stranding.



Conclusions cont.

- Concerns of the angling public and guides regarding stranding in 2003 were not as prevalent as anticipated.
- Antecedent conditions may play a role in the degree of vulnerability of trout to stranding.

Acknowledgements

- Steve Gloss and other staff at Grand Canyon Monitoring and Research Center
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