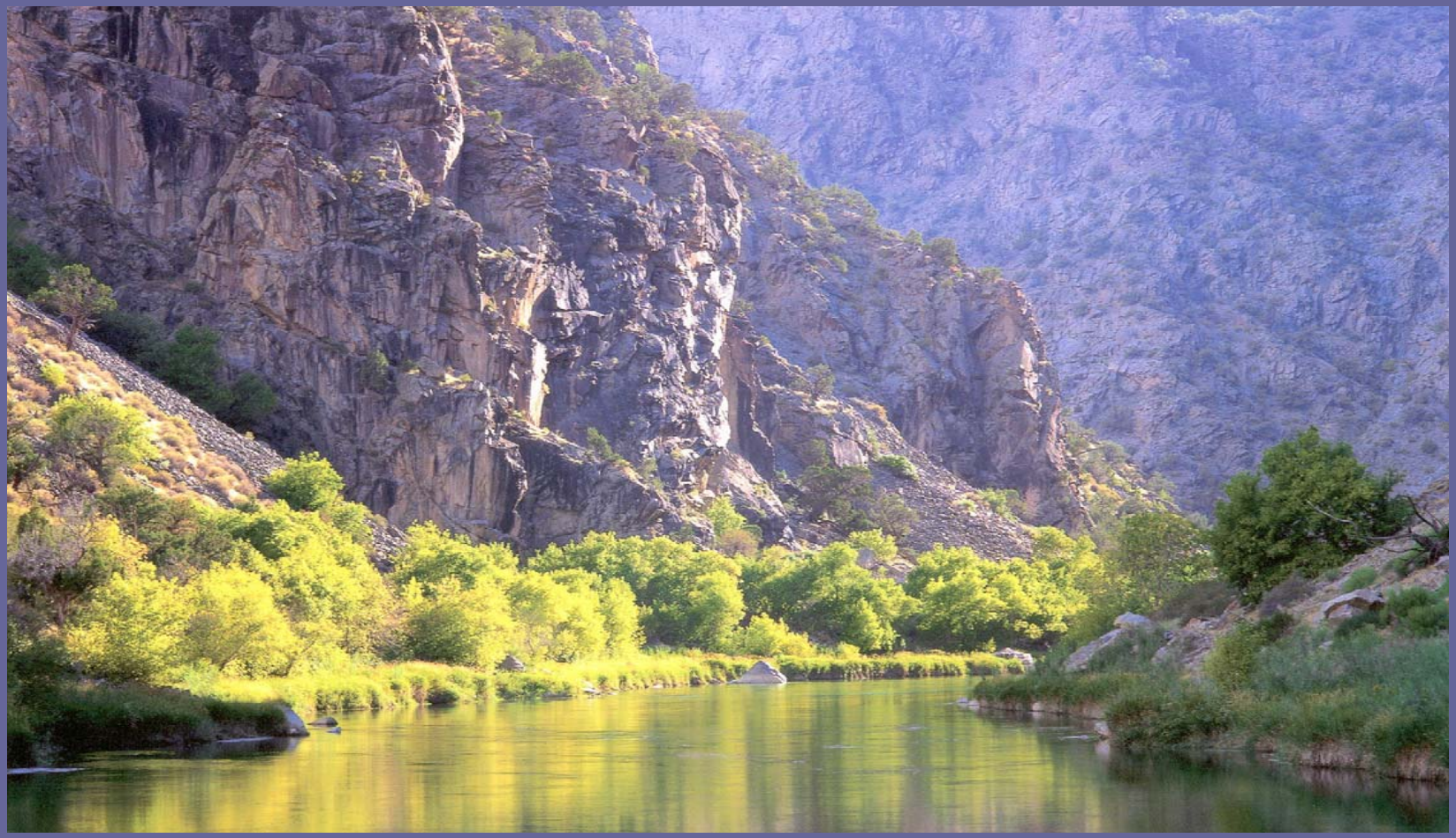
The Effects of Stream Flow on the Trout Populations of the Gunnison River



Dan Kowalski

Aquatic Biologist

Discussion Topics

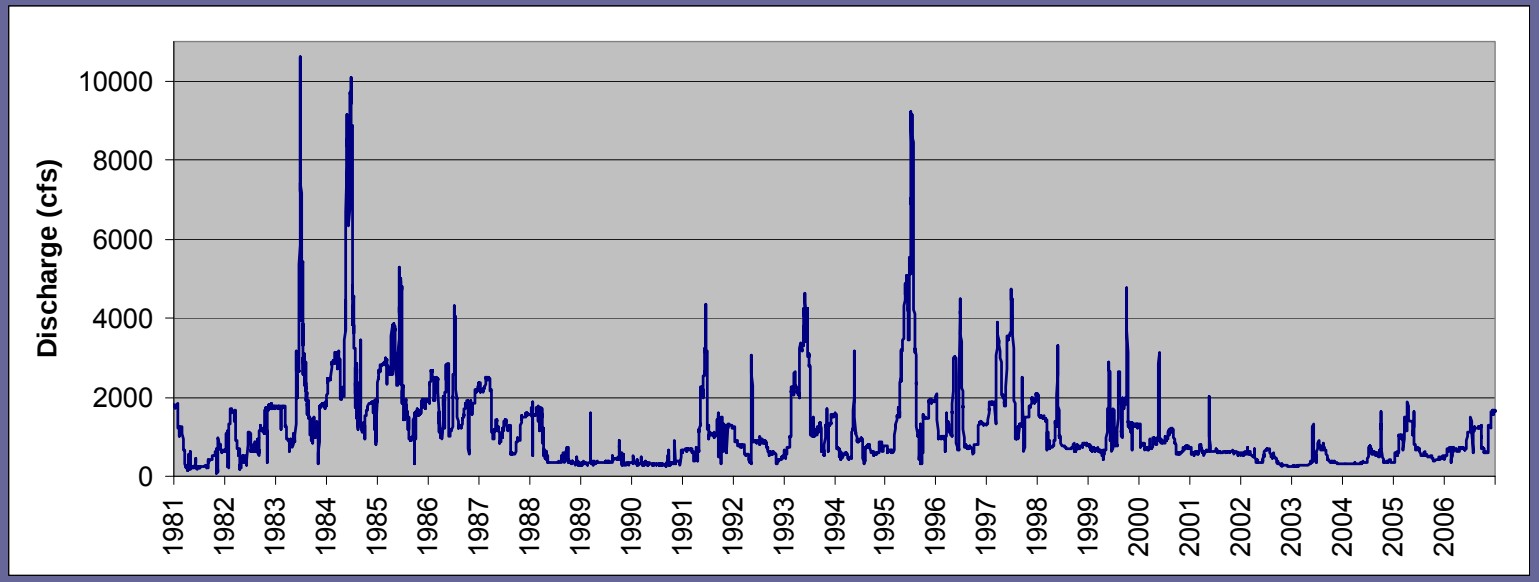
- History of Gunnison River Trout Fishery
- Research and Management Strategies
- Summary of Results
- Discussion and Comments

History of Gunnison Fishery

- Native Colorado River cutthroat trout prior to the 1880's
- Brook, rainbow, and brown trout introduced in late 1800's
- Wild rainbow and brown trout fishery ~ 1908
- 1900's – 1960's: Famous trout fishery above East Portal, native warmwater fish dominated the Black Canyon and Gunnison Gorge
- After Curecanti Unit was completed, stable trout populations established in Black Canyon and Gunnison Gorge
- Whirling Disease introduced below Crystal in 1993
  - Almost complete mortality of rainbow trout fry since 1994

Whirling Disease in the Gunnison River

- Unique environmental and geologic conditions in the Gunnison Gorge produce a severe WD infection
- Total trout biomass has not decreased, but rainbows now < 6%
- Rainbows are 2 to 3 times more “catchable” than brown trout and utilize different habitat & food
- Flow regimes that favor rainbow trout are more compatible with flow recommendations for downstream native fish
  - Re-establishing the rainbows would also reduce the chance of having several bad year classes impact overall trout populations


Discharge (cfs)
10000
8000
6000
4000
2000
0
1981
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006

The Affect of Steam Flows on Trout

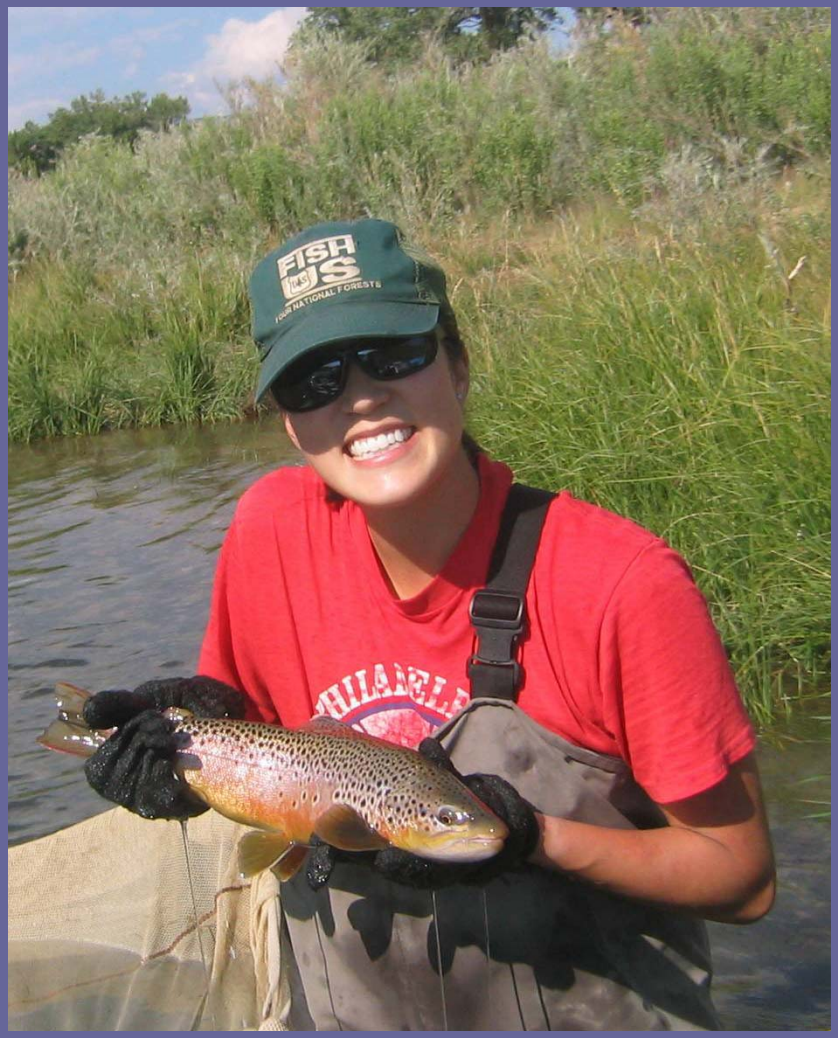
- Flows affect trout populations in many ways
  - Habitat Quantity
  - Habitat Quality
  - Spawning Habitat and Timing
  - Fry, Juvenile, Adult Survival
    - Trout select various habitats based on water velocity, water depth, substrate size, and cover availability
      - As stream discharge changes, all of these variables change
- Generally trout populations in Colorado are limited by three factors:
    - Fry Survival (Gunnison)
    - Winter Habitat (Uncompahgre)
    - Low Flows (North Fork)

Research and Management Strategies

Research and Management Strategies

Data Collected

- Adult Fish Population Estimates
  - 1981 to 2007 missing only 3 years
- Fry Estimates
  - 1992 to 2007 summer and fall
- IFIM and PHABSIM
  - Habitat modeling at two sites



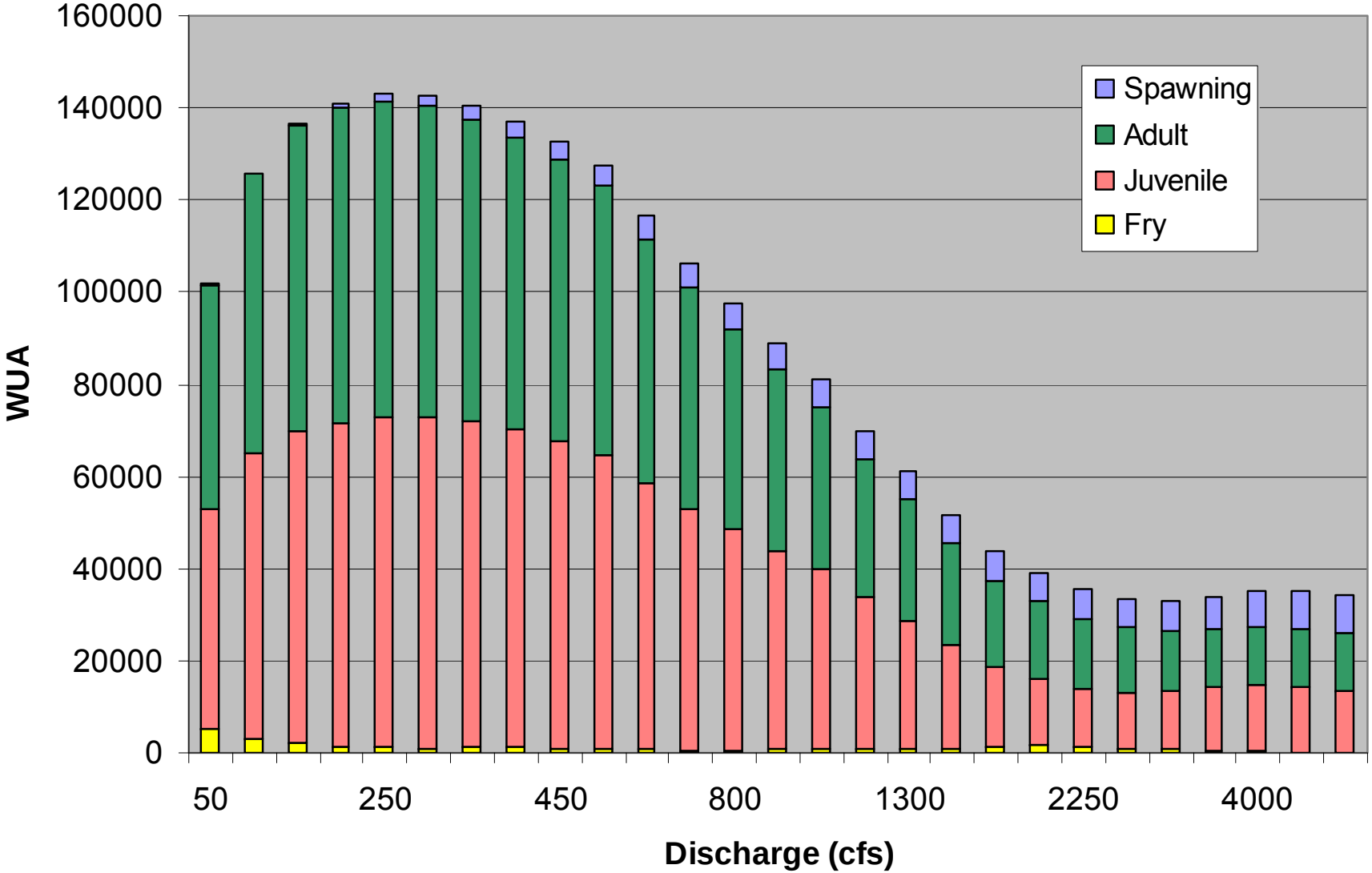
PHABSIM Habitat Modeling

- Combines physical measurements of river (velocity, depth, substrate) with habitat preference curves to estimate the amount of habitat available to fish at different flows

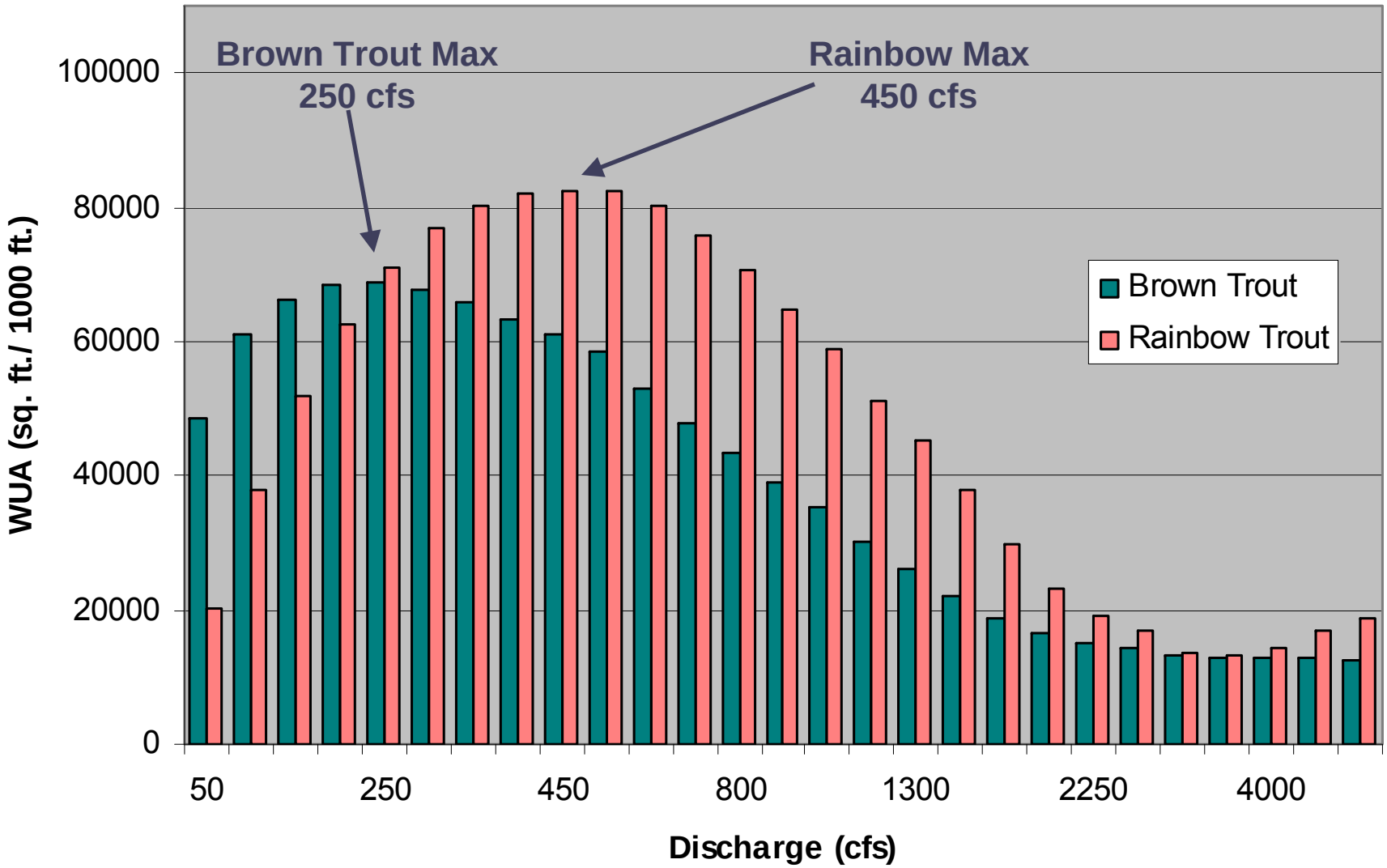
- Estimates habitat with Weighted Useable Area (WUA) or square feet of habitat per 1,000 ft of stream weighted by habitat preference curves.

PHABSIM Results

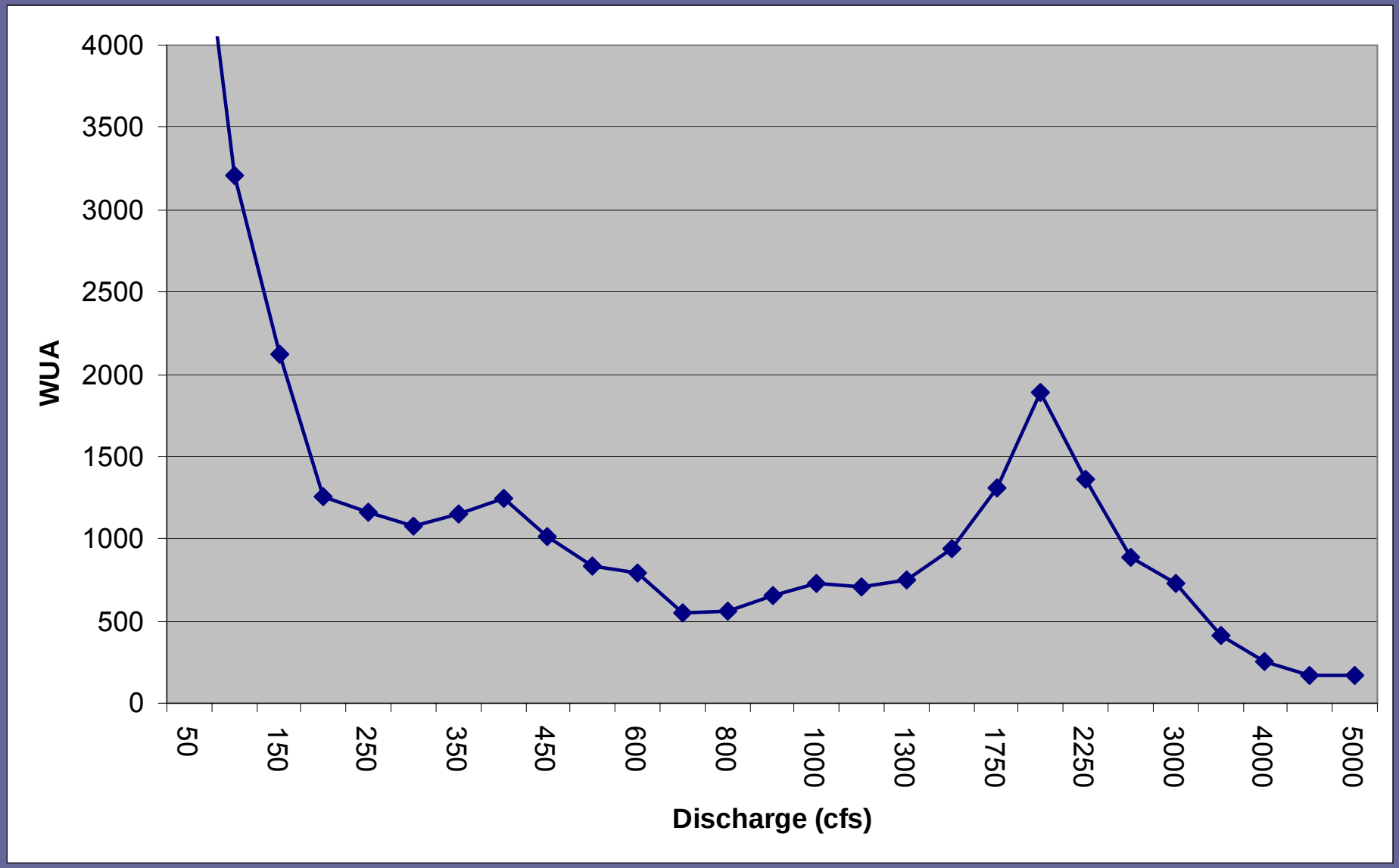
Brown Trout



Estimated Adult Fish Habitat



Estimated Brown Trout Fry Habitat



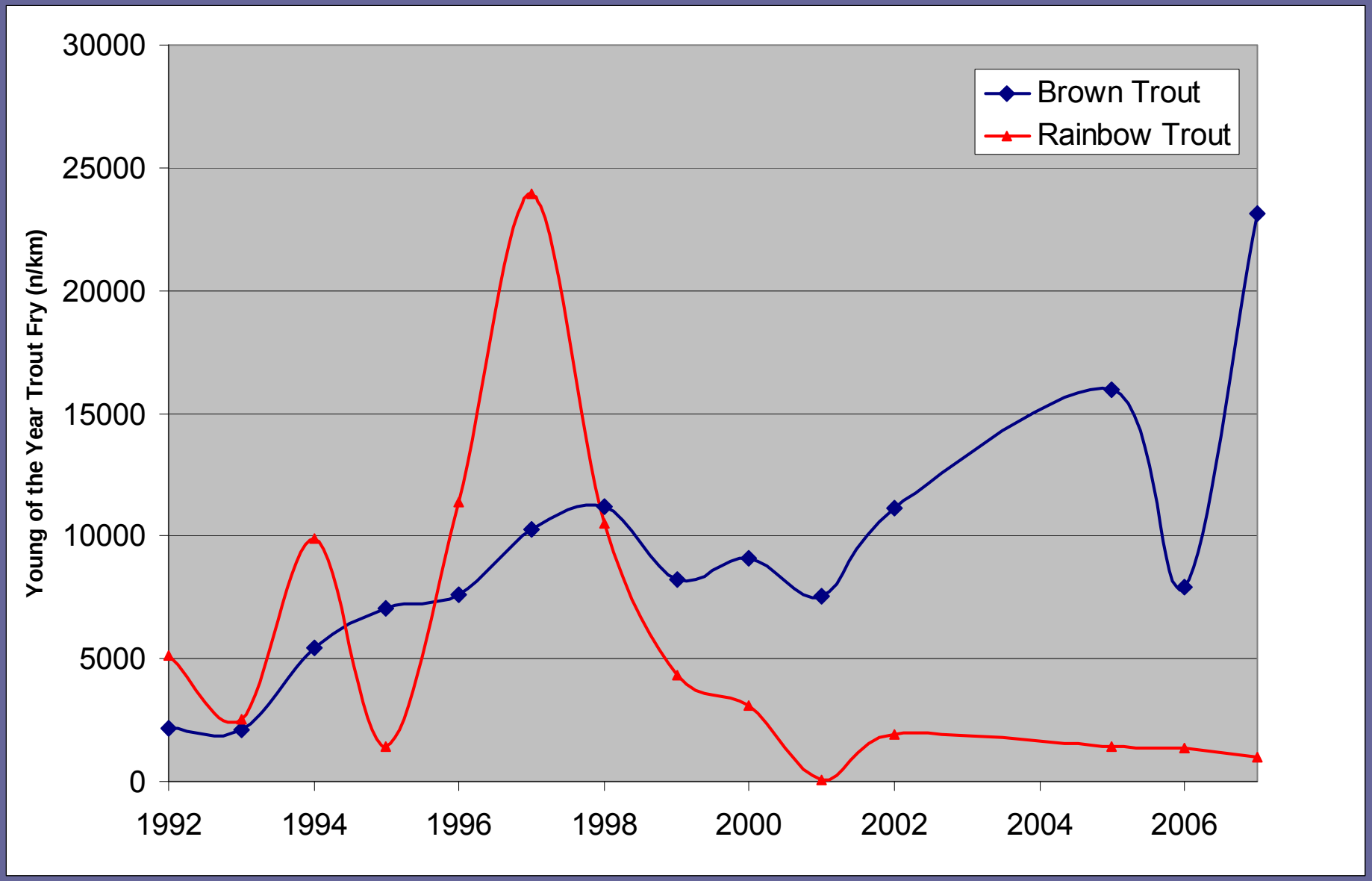
PHABSIM Habitat Modeling Summary

- Adult brown trout habitat maximized at 250 cfs, rainbow trout at 450 cfs, total habitat at 350 cfs
  - Low flows favor brown trout, higher flows favor rainbows
- Fry habitat and spawning habitat sufficient in moderate flow ranges 250 cfs to 3,000 cfs
  - Bankfull flow in Ute Park ~2,000 cfs: provides excellent fry habitat but very sensitive to fluctuations
  - Lower flows provide temperature benefits: fry growth better during drought years
    - High flows in June and July inhibit fry growth

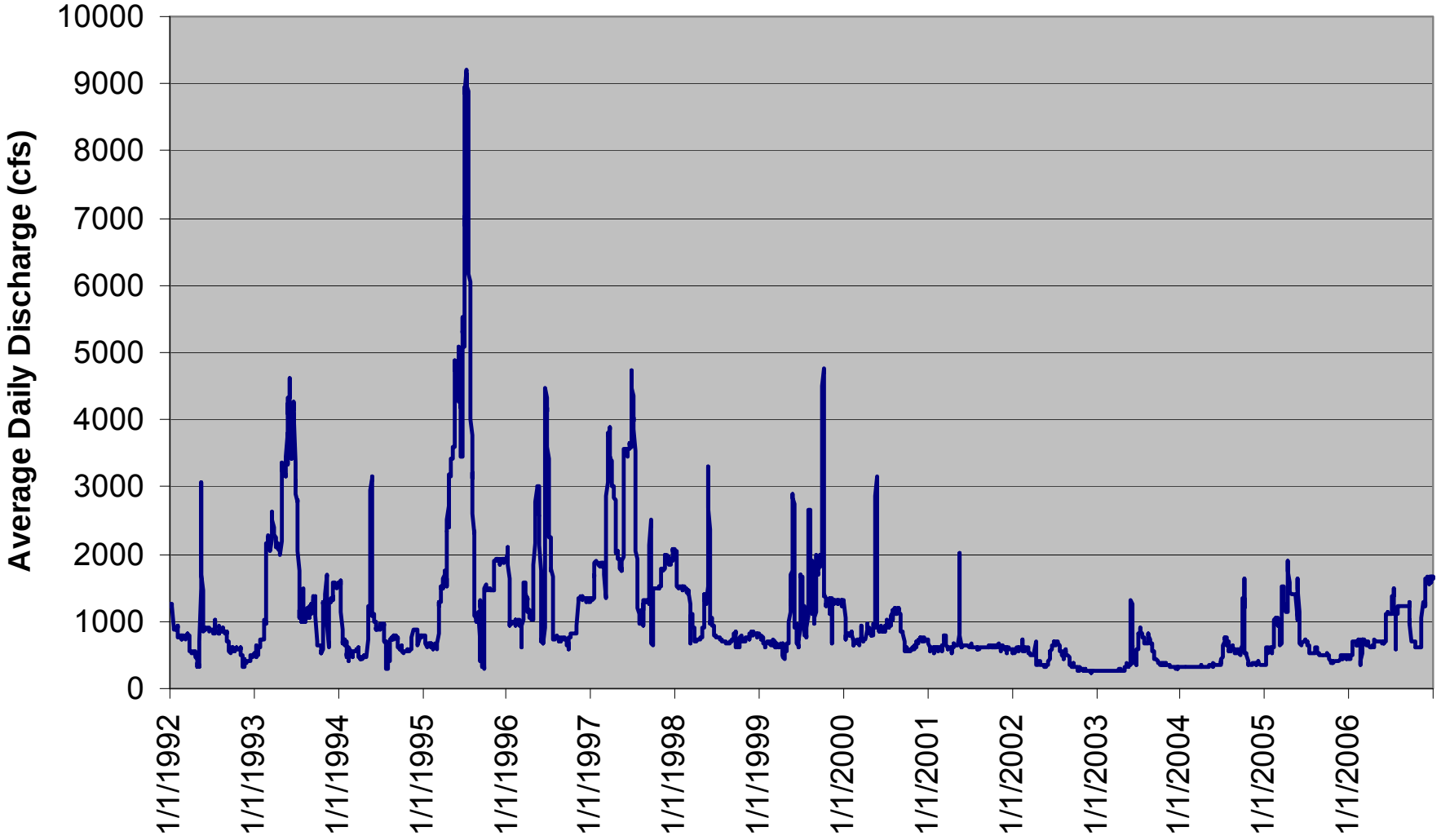
Reproductive Estimates (Fry Shocking)

- Conducted annually 1992 to 2007 in August and September, missing 2 years on fall estimate
- Multiple pass removal estimates of trout fry
  - 12 to 16 sites from Chukar trail to North Fork
- Critical in not only determining flow effects on year class strength but monitoring whirling disease infection

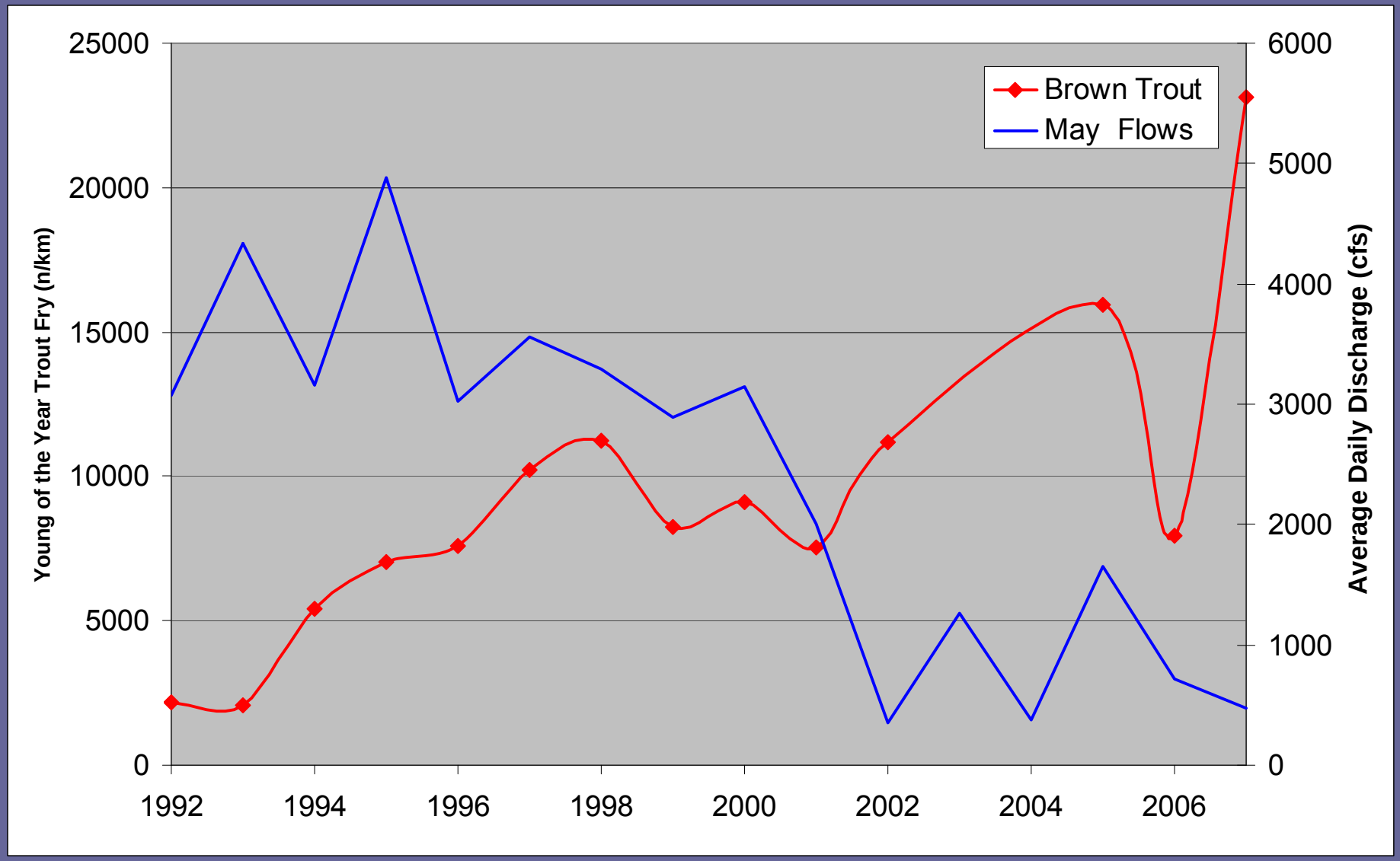
August Trout Fry Estimates 1992 - 2007



Gunnison Gorge Flows 1992 - 2007



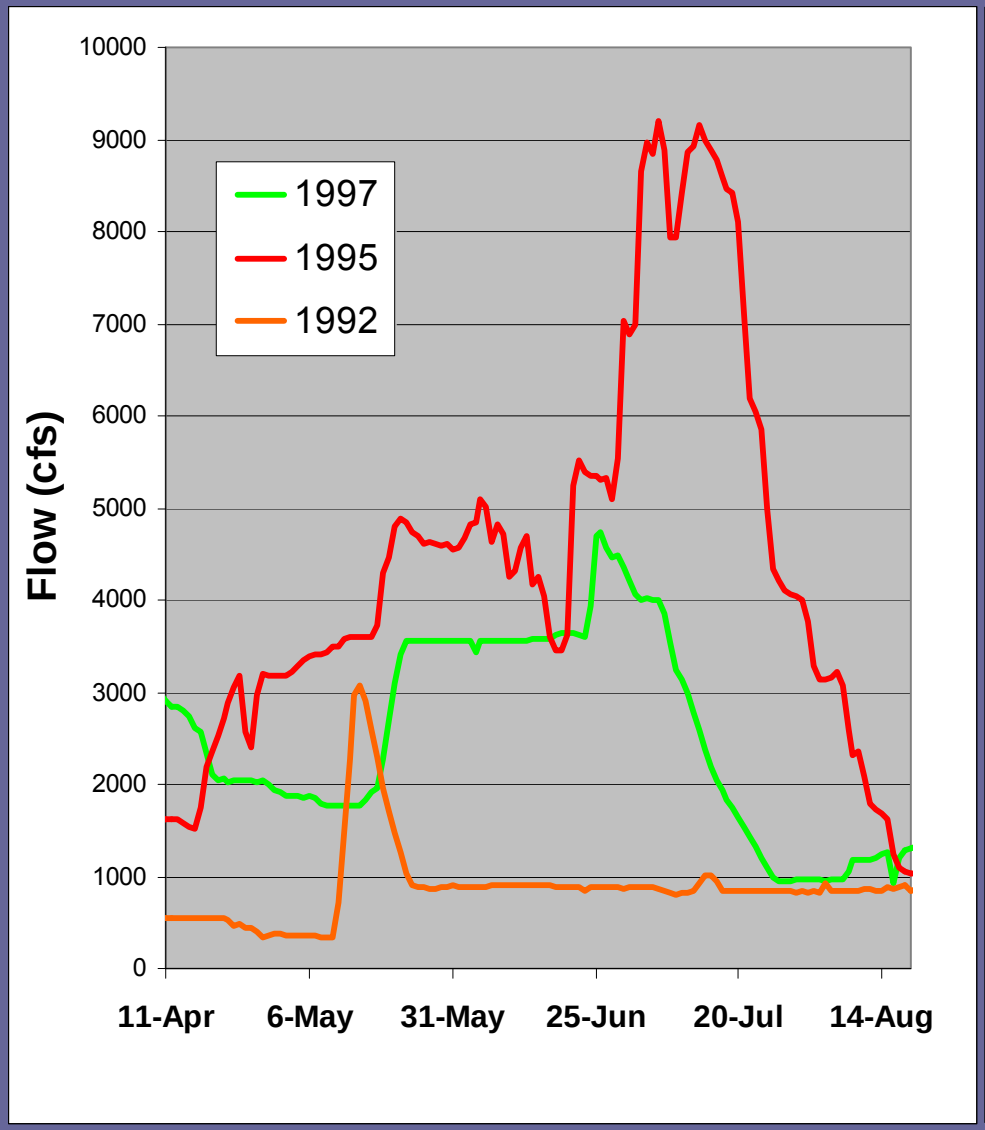
The Relationship Between May Discharge and Brown Trout Fry

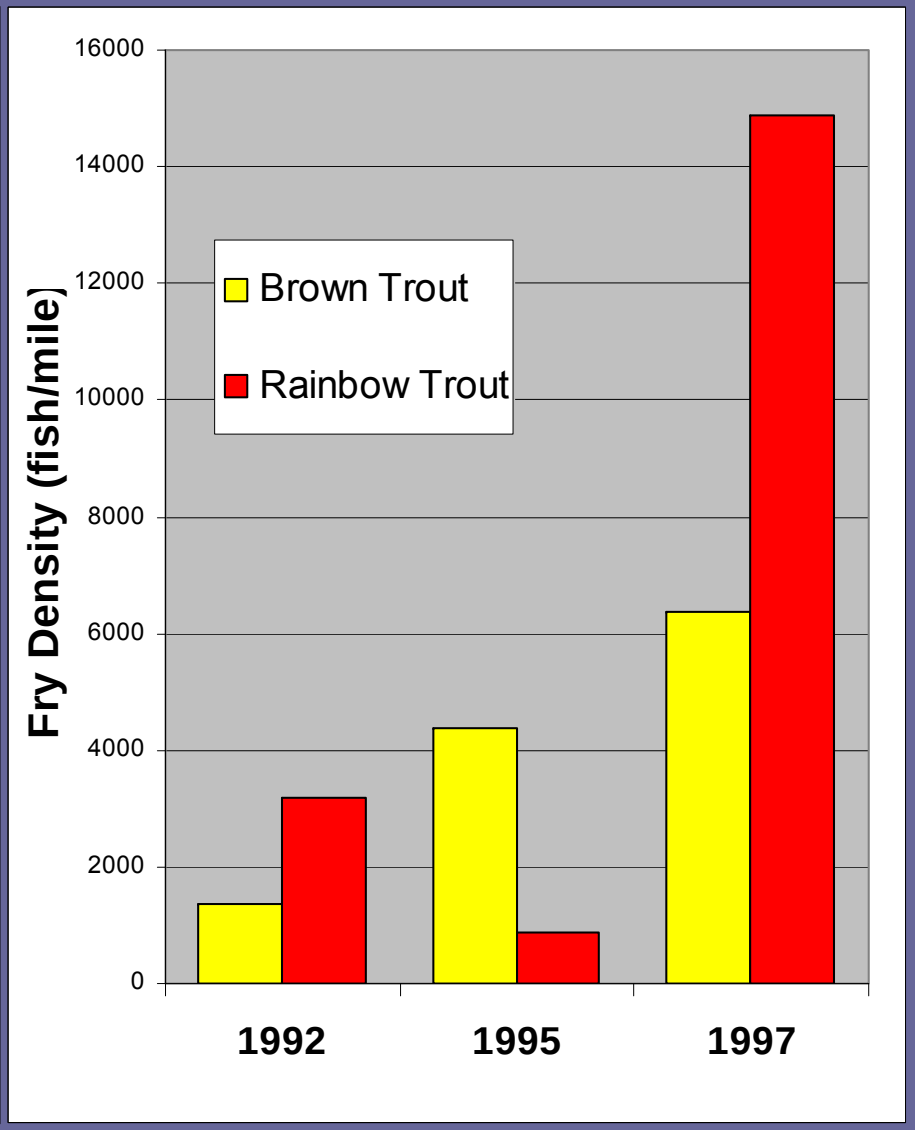


High Flows and Large Fluctuations Inhibit Fry Survival

- Brown trout fry emerge mid April through end of May
- Rainbow trout fry emerge from early June through July
  - High flows or large fluctuations in the first month post emergence can damage recruitment
  - Rainbow fry seem more susceptible than brown fry, possibly due to later emergence and smaller size
- Spring peak magnitude and timing is very critical in limiting trout populations in the Gunnison

Hydrograph Case Studies





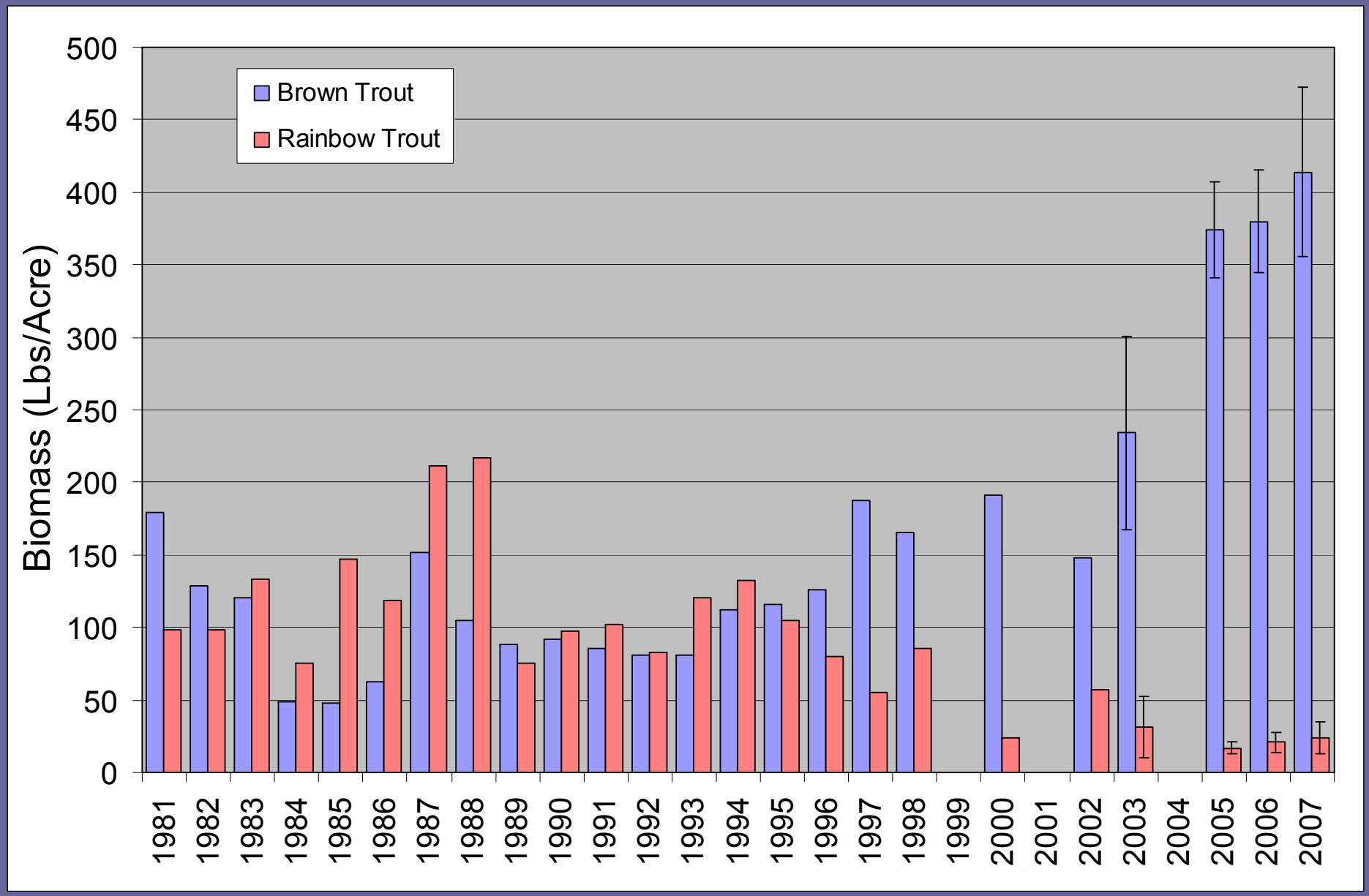
Trout Fry Sampling Summary

- High discharge is correlated with low fry survival
  - High flows (≥6,000 cfs) or large fluctuations during first month after fry emerge decreases survival
    - Corroborated by PHABSIM modeling: Fry habitat decreases quickly above 3,000
  - Peaks as low as 3,000 cfs have damaged recruitment without proper ramping (1992 browns)
  - High flows also inhibit fry growth
    - During recent drought we've observed excellent brown trout fry production and growth
- These observations are common in CO rivers not limited by summer base flows
  - Drought conditions can be good for trout fry!
  - Not intuitive, but true in many Colorado rivers (especially high elevation or rivers with a downstream senior water right)
    - Drought related sedimentation in Gunnison is not inhibiting trout reproduction, yet…
    - There is lower reproduction below the Smith Fork, but still sufficient to sustain population

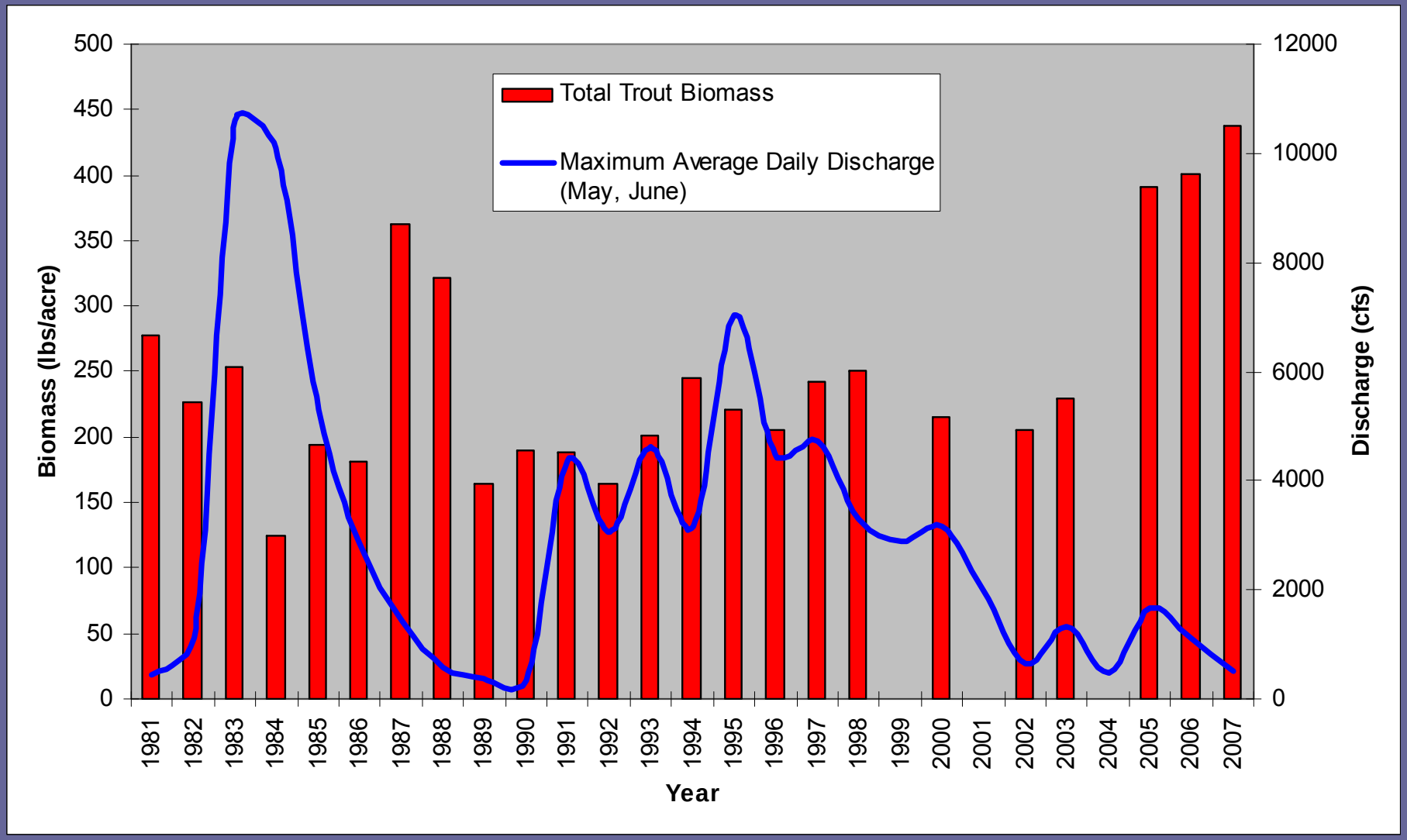
Adult Fish Population Sampling

- Sampling Site
  - 2 mile reach downstream from Duncan Trail
  - 4 mile reach downstream of Smith Fork
- Two Pass Mark Recapture Electrofishing
  - Mark fish with caudal punch
  - Recapture 48 hours later
  - Handle 20% - 30% of population
- Annual sampling since 1981 missing only 3 years

Gunnison Gorge Trout Population 1981 - 2007

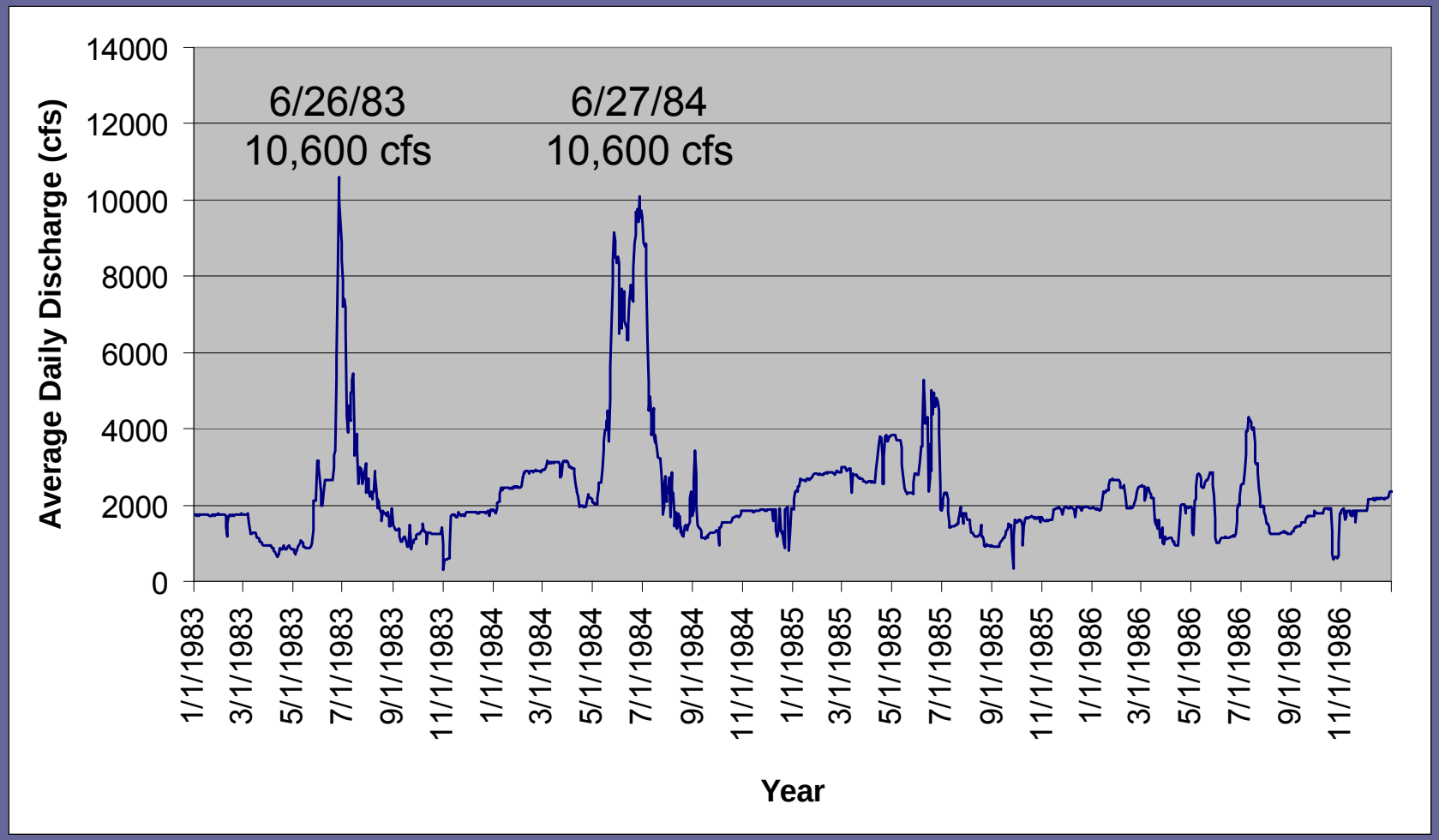


The Relationship of Spring Discharge Patterns to Trout Populations

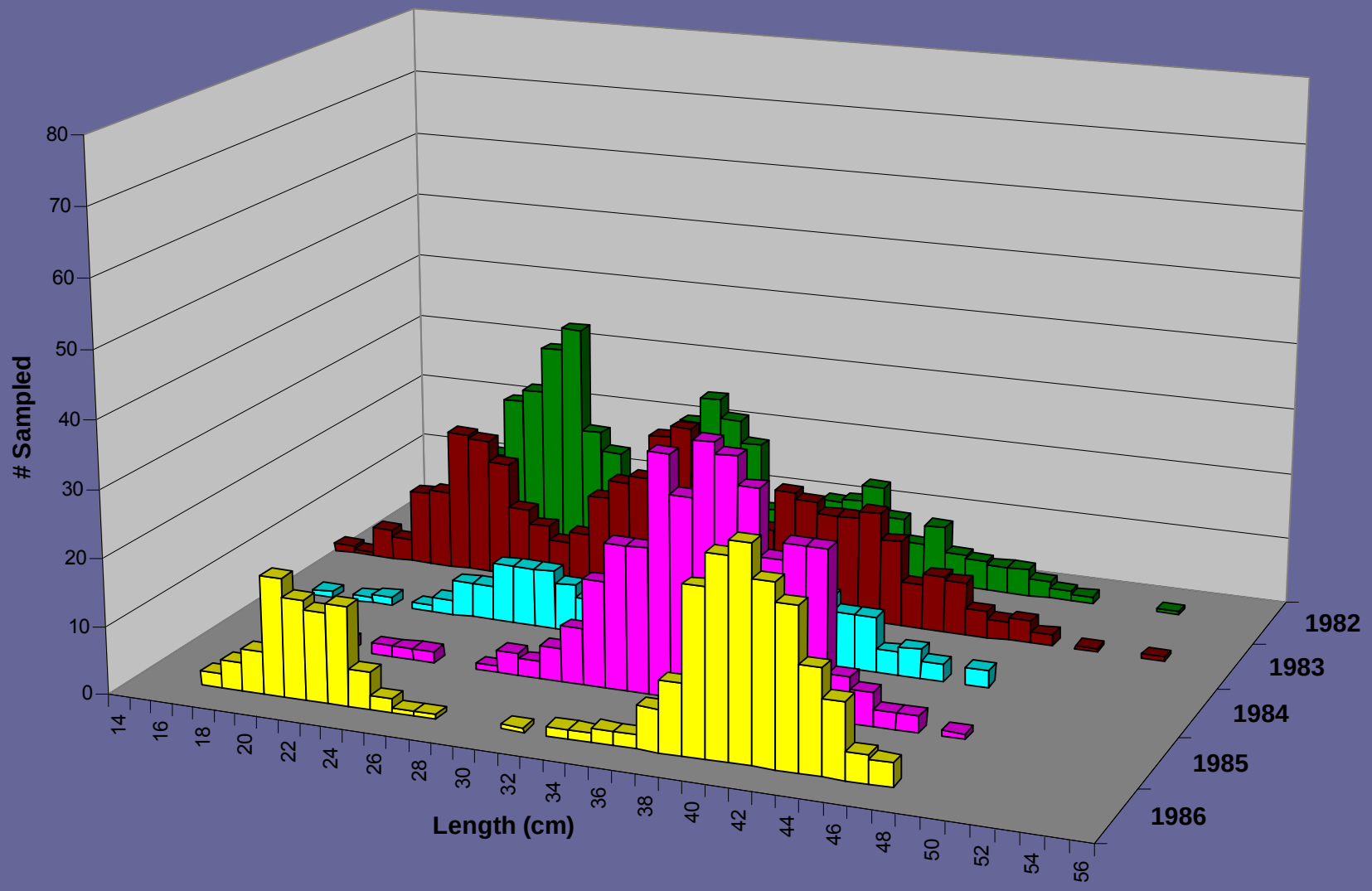


The Effects of High Flows on Adult and Juvenile Trout

Case Study: 1983-1986

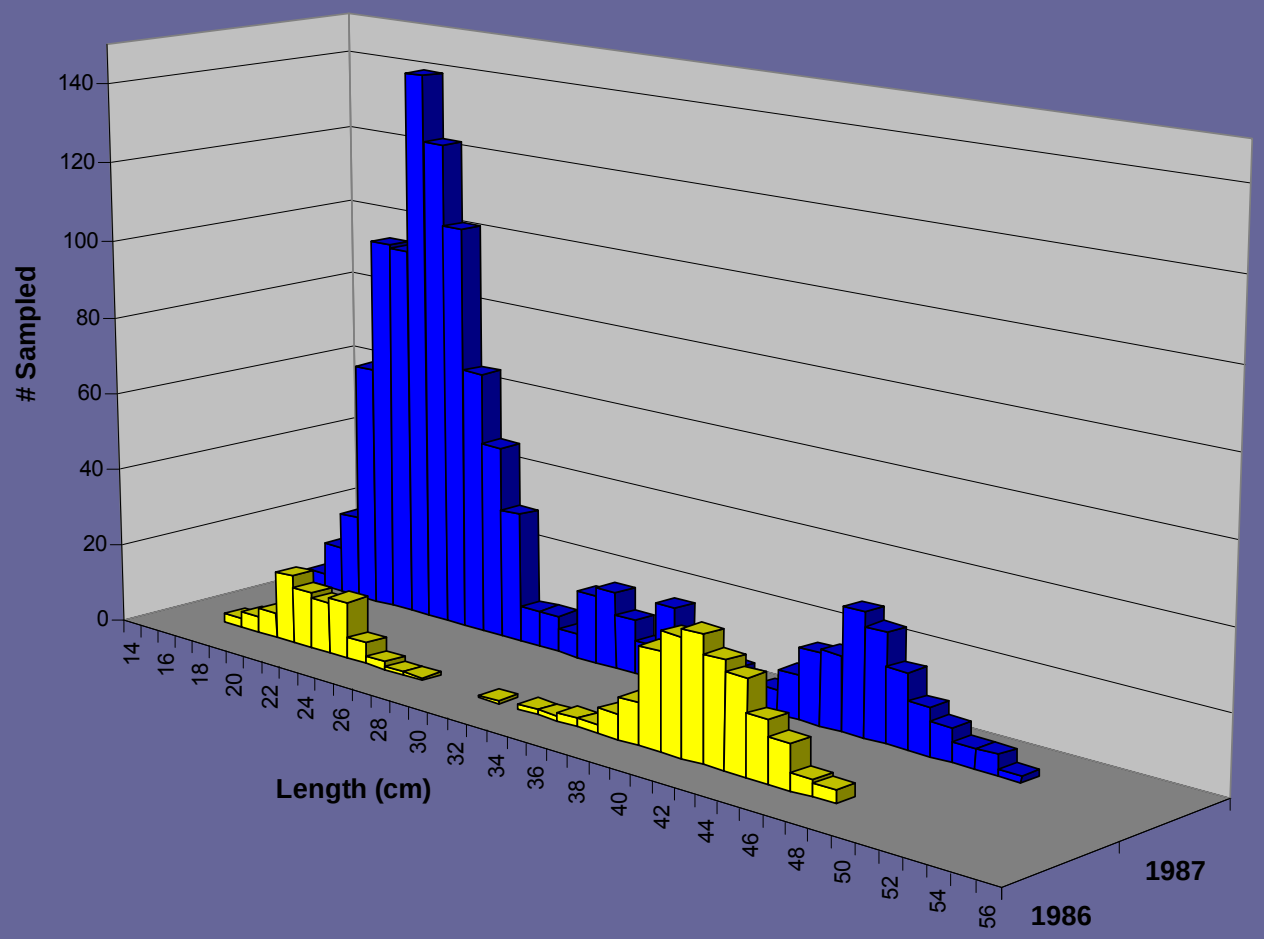


Rainbow Trout Length Frequency Histogram 1983-1986

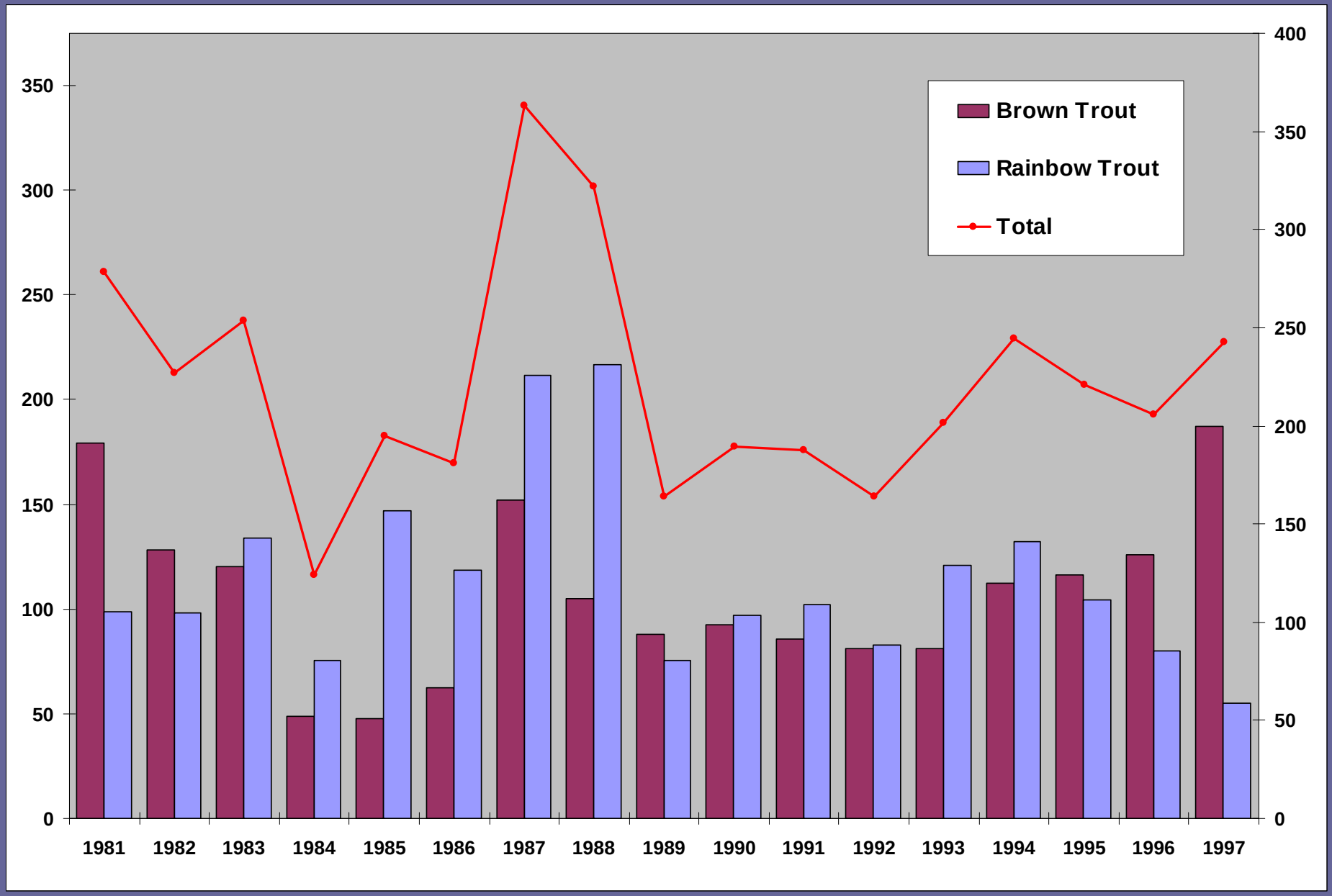


Case Study 1986

- After three consecutive year class failures due to high spring peaks, flows were carefully ramped on the descending limb from a peak of 4,300 cfs and produced one of the largest year classes of rainbow trout ever recorded



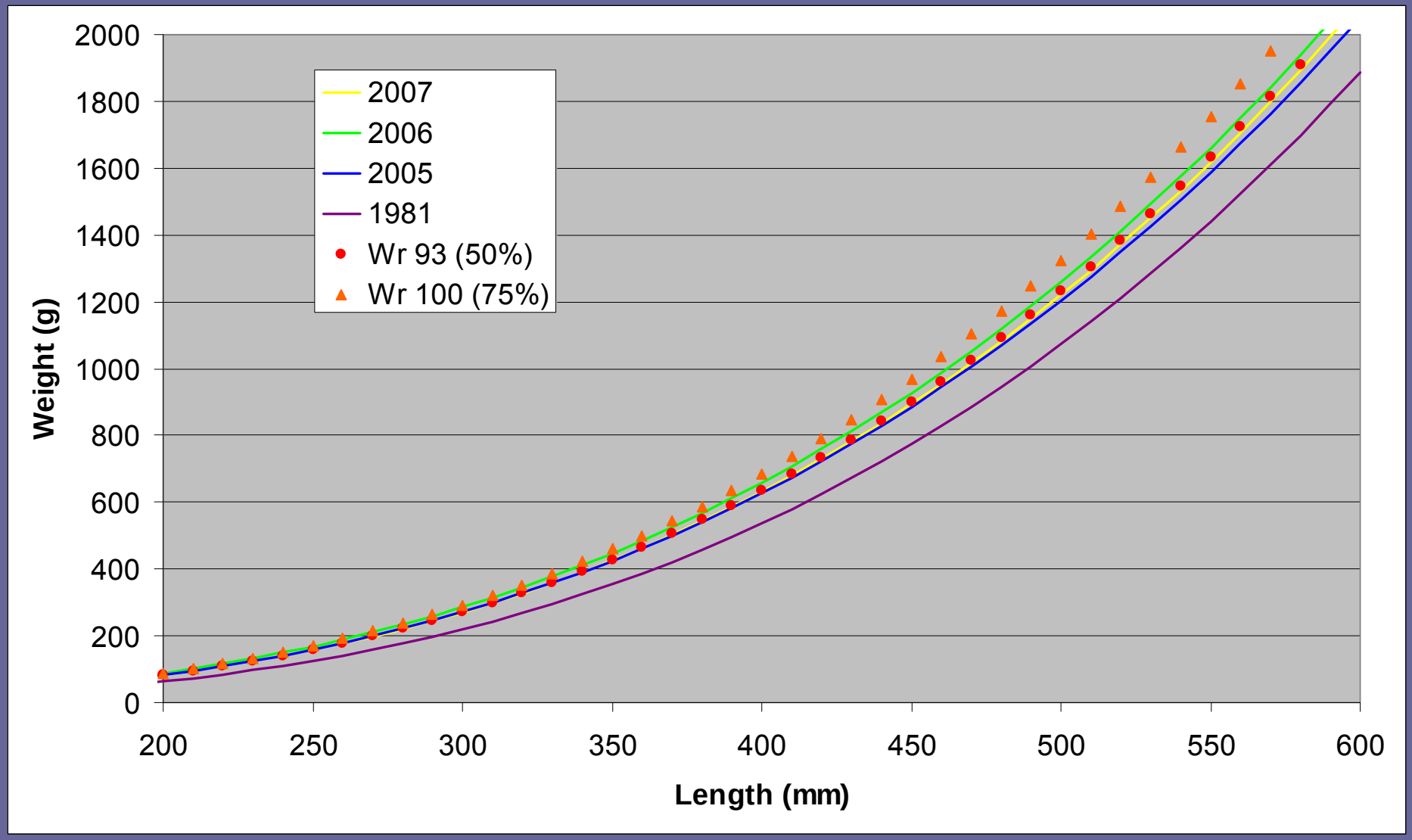
Gunnison Gorge Trout Population 1981 - 1997



Fish Population Data Summary

- The effects of flow on the trout population are evident in several areas:
  - Adult and juvenile mortality caused by extremely high flows (~10,000 cfs) i.e. 1983
  - Un-ramped peaks during fry emergence can cause subsequent weak or missing year classes
  - Conversely, moderate peaks ramped correctly can produce good year class survival i.e. 1986, 1997
- Flow patterns during drought (no spring peak, low base flows) are ideal for brown trout
  - Sedimentation has not impacted spawning success yet..
    - 2005 and 2007 highest fry estimates on record
    - 2007 Highest adult fish biomass observed in 27 years
    - Could be some effects starting to show below Smith Fork

Brown Trout Body Condition



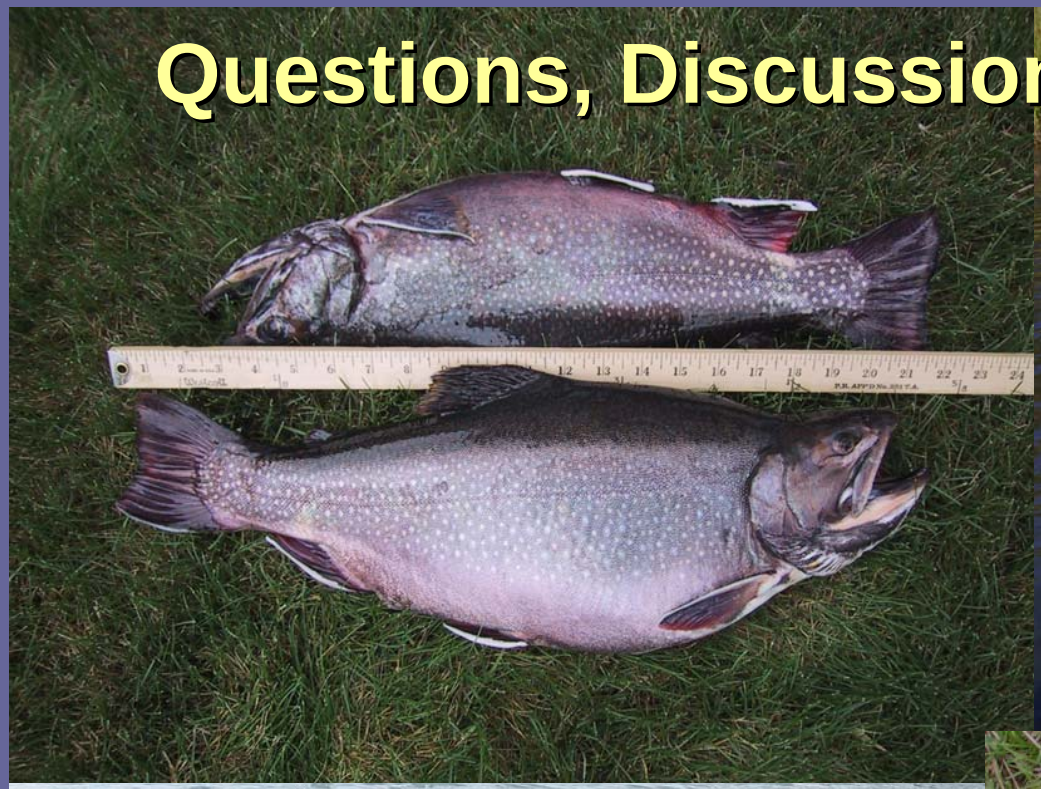
Trout Body Condition

- Body condition of trout has been near average during drought conditions
  - Could be better with few fish
- No documentation that increased sedimentation or woody vegetation encroachment is negatively affecting trout food sources
  - If it has, it is not yet affecting fish condition other than possibly age-1 brown trout in Ute Park

Gunnison River Trout Fishery Flow Recommendations

- Minimum flows of 350 cfs are appropriate biologically
  - Slightly higher base flows (450 cfs) would better accomplish our current fish management goals and benefit recreation
- Moderate peak flows (2,000 cfs to 6,000 cfs) if ramped correctly would not threaten the sport fishery
  - Peak timing is critical; May peak favors rainbows and downstream native fish (usually), June peak (or none) favors browns
  - Moderate sized May peak, matching hydrograph of North Fork, would be optimal for both sport and native fish
    - 2,000 to 6,000 cfs is high enough flow to mobilize fines, gravel, and cobble
- Ramping Rates
  - Above 2,500 cfs: 500 cfs/day in 2 steps (1,000 cfs Ramp Up)
  - Below 2,500 cfs: 250 cfs/day in 2 steps (500 cfs Ramp Up)

Conclusions

- Current operations are close to ideal for maximizing brown trout population
- Wetter climate conditions favor rainbow trout and native fish
  - Re-establishing the rainbow population is also important also to hedge our bets against year class loss
- Large peaks could damage the sport fishery
  - They are going to come weather we want them to or not
  - We are likely to see more frequent moderate peaks
    - To preserve the sport fishery and bring back rainbow trout these must be handled correctly
    - Ramping rates on descending limb are critical
- This has been a summary of what we know about the trout fishery only, native fish will definitely benefit from more natural hydrograph
- Take Home Message: Think Snow (and moderate peak flows in May with gradual descending limb)

Questions, Discussion, and Comments