Effects of the 2003/2004 Experimental Increase in Daily Flow Fluctuations from Glen Canyon Dam on the Early Life History Stages of Rainbow Trout

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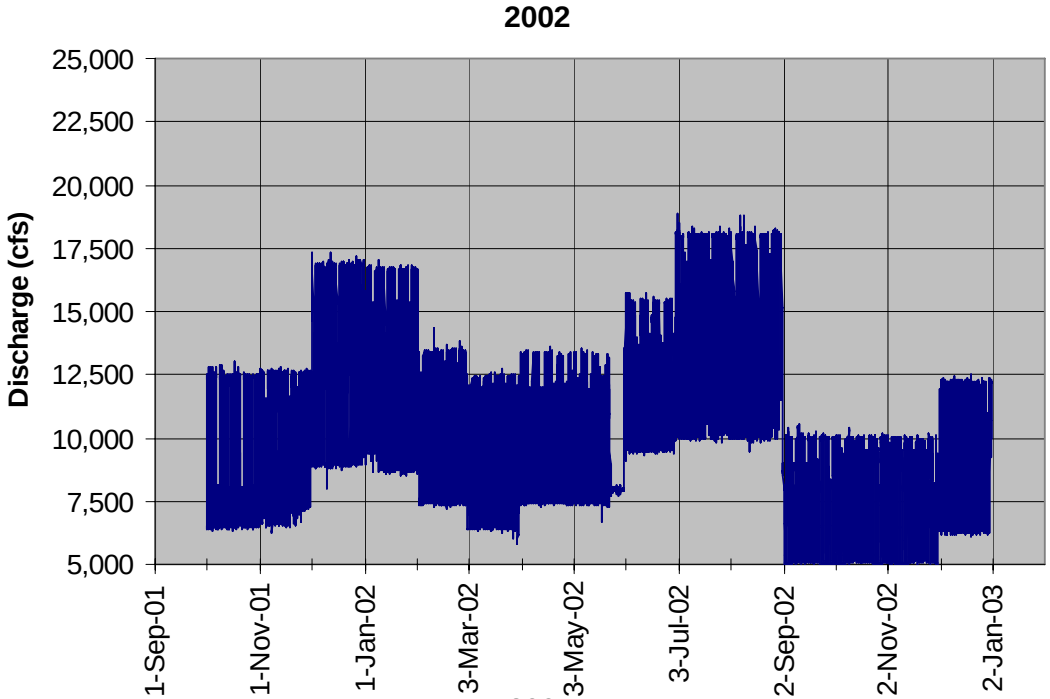
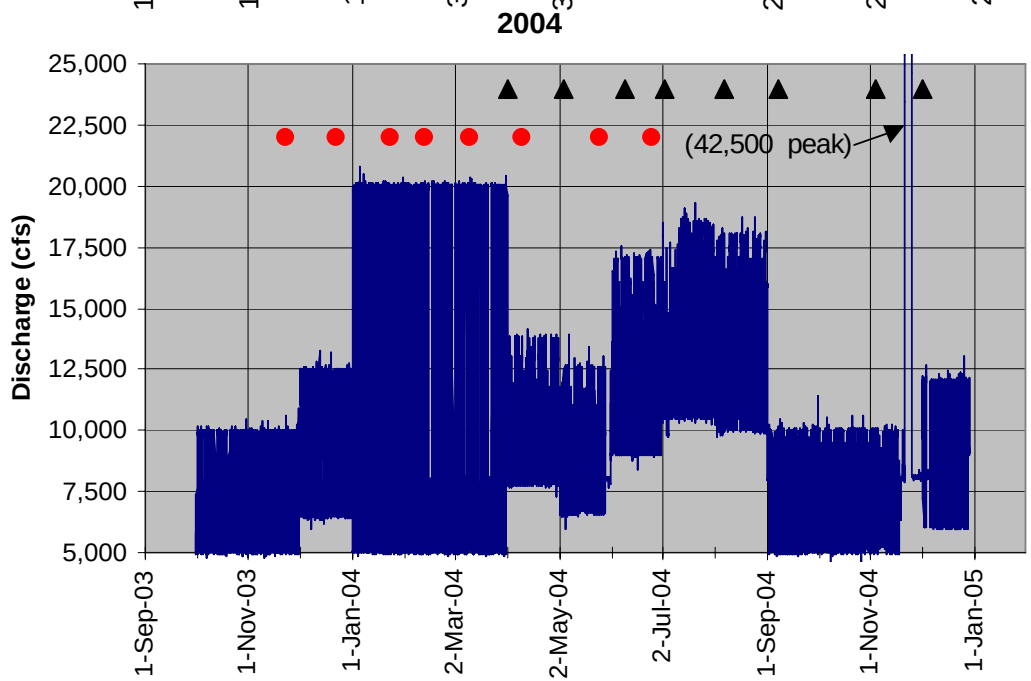
Funded from FY03/04 GCDAMP Experimental Flow Program

ROD vs. Experimental Hydrographs





Objectives of Project

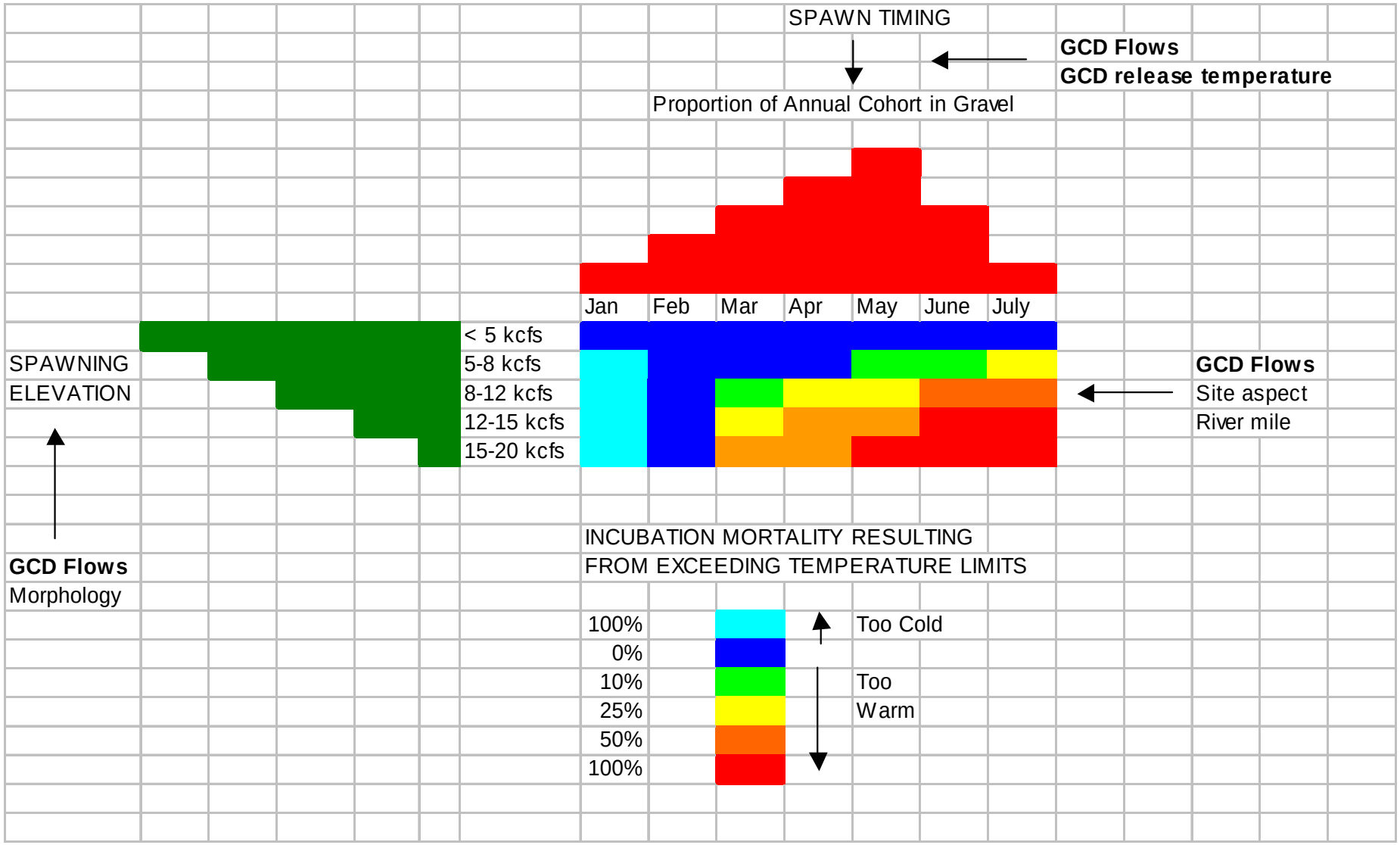
I. Estimate magnitude of incubation mortality (eggs and alevins) caused by Jan.-Mar. fluctuations and to predict effects of other flow regimes.

II. Estimate survival rate of young-of-year and processes (growth, habitat use, emergence timing) that influence survival.

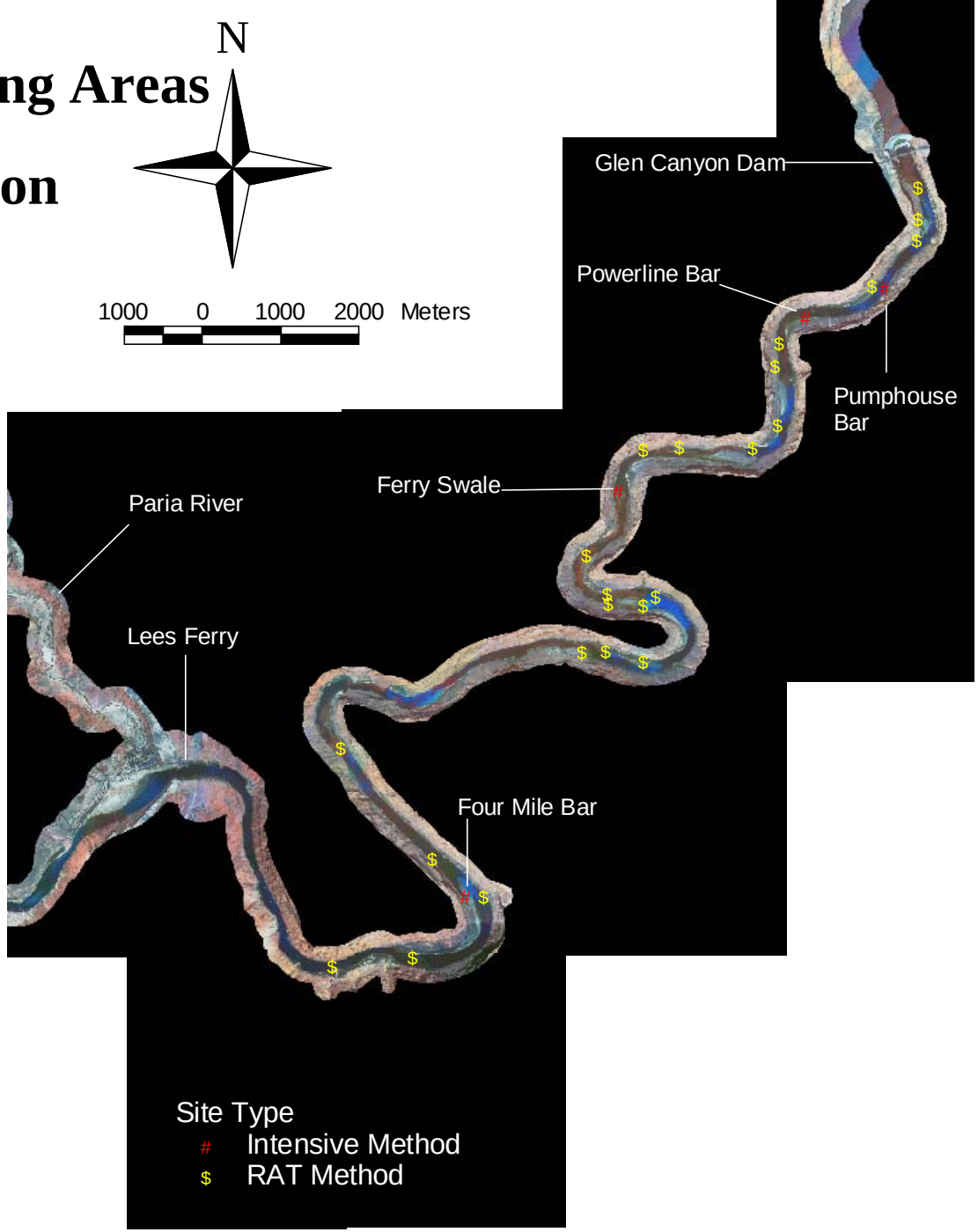
III. Evaluate the extent of successful reproduction by rainbow trout between Lee's Ferry and the LCR confluence

Part I:
Effects on Incubating Stages

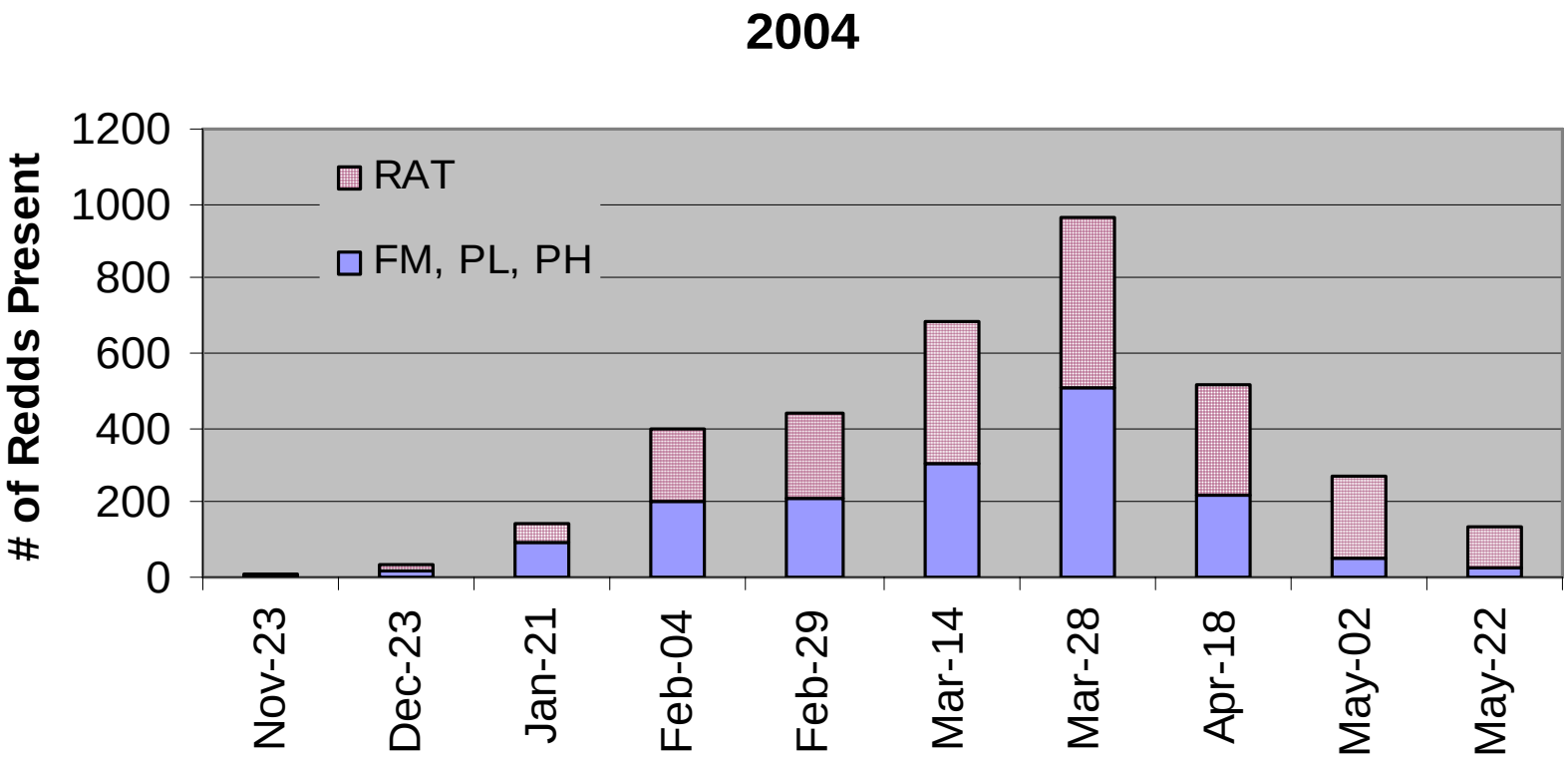
Dynamics of Incubation Mortality



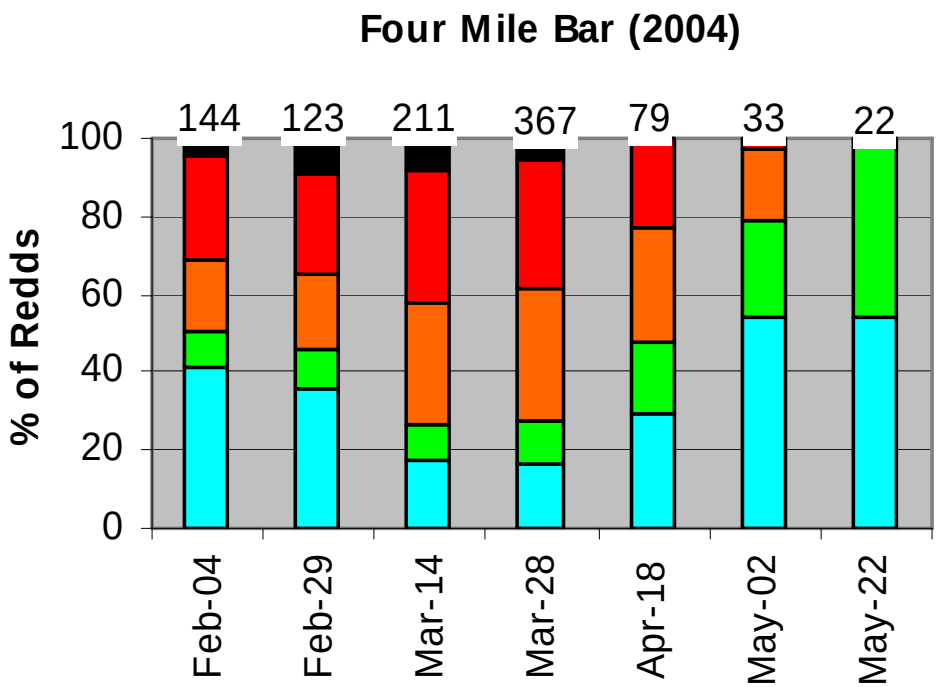
Location of Spawning Areas in Glen Canyon

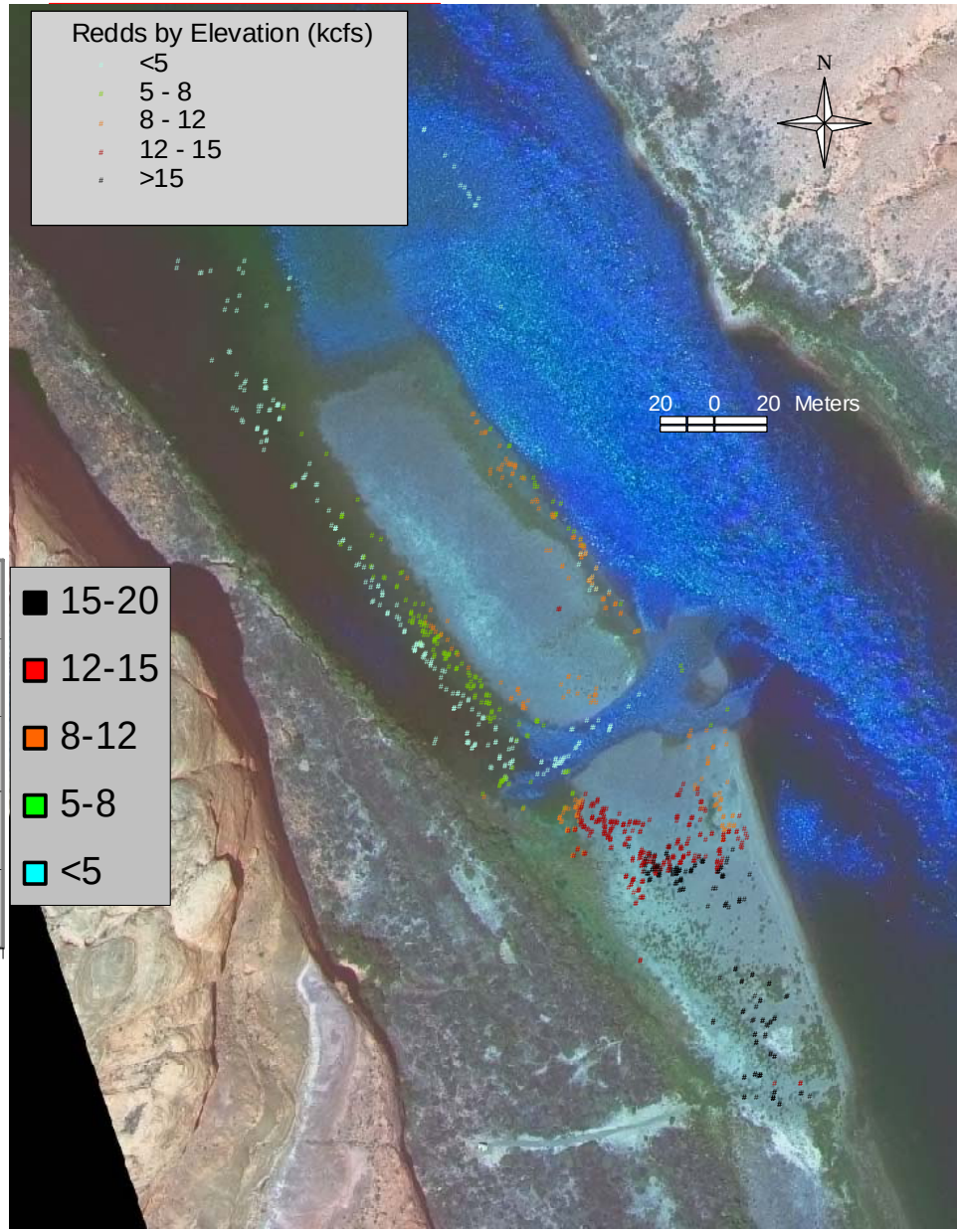


Redd Counts

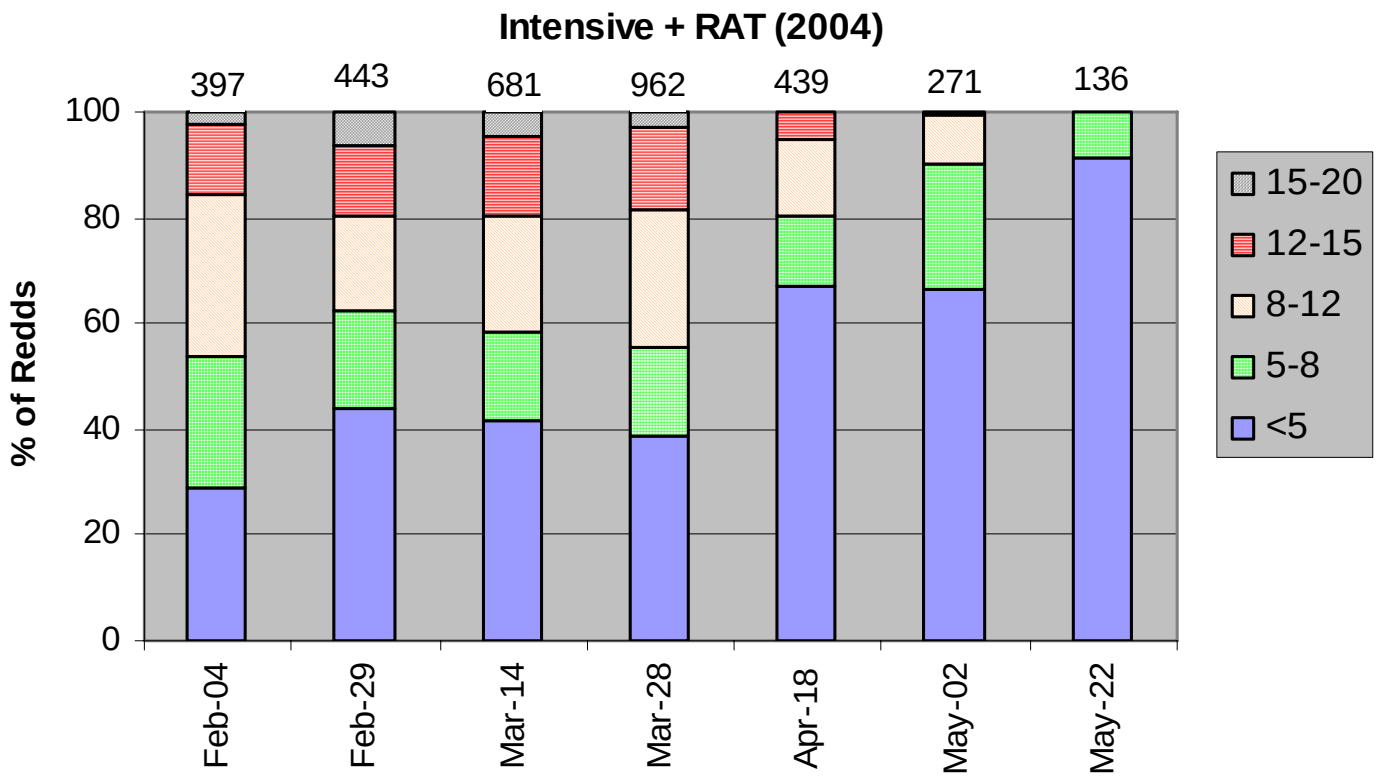

2004
# of Redds Present
1200
1000
800
600
400
200
0
RAT
FM, PL, PH
Nov-23
Dec-23
Jan-21
Feb-04
Feb-29
Mar-14
Mar-28
Apr-18
May-02
May-22

Redd Hypsometry

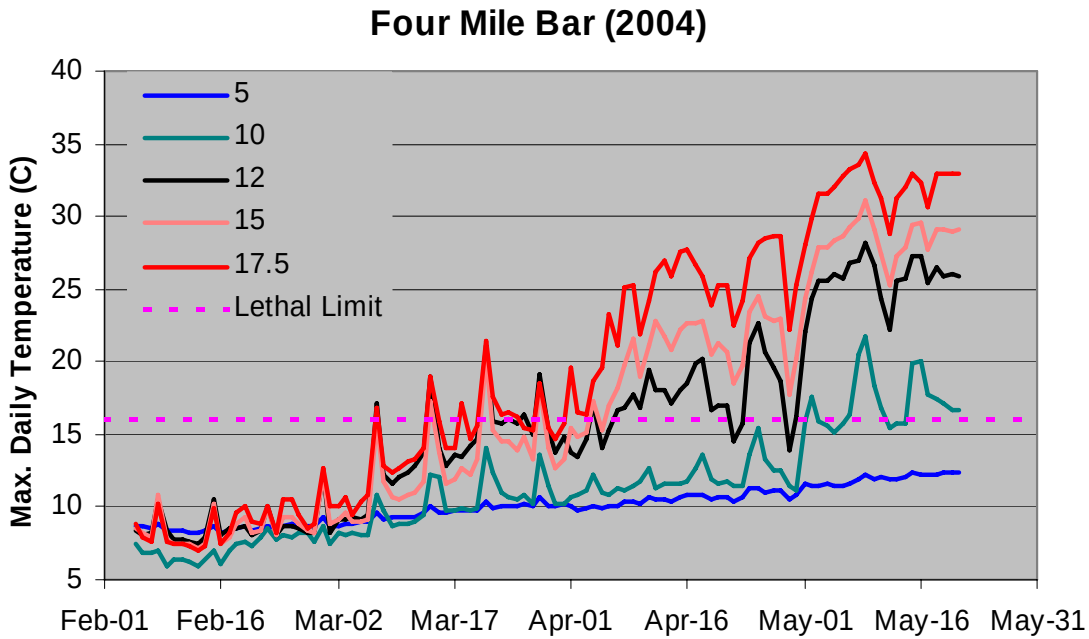


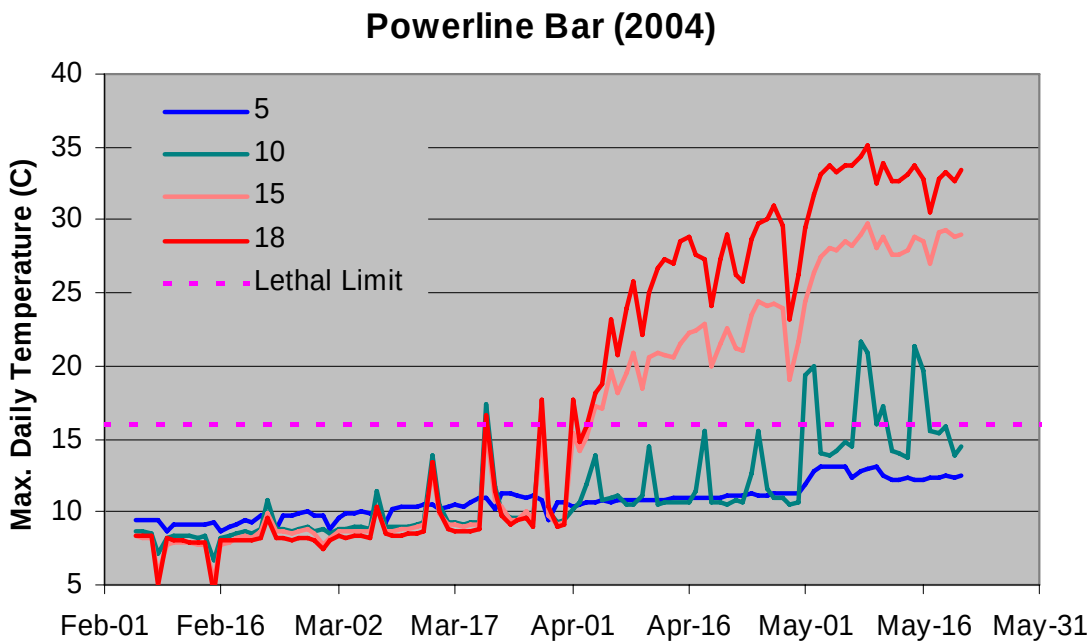


System-Wide Redd Hypsometry



Intergravel Water Temperatures

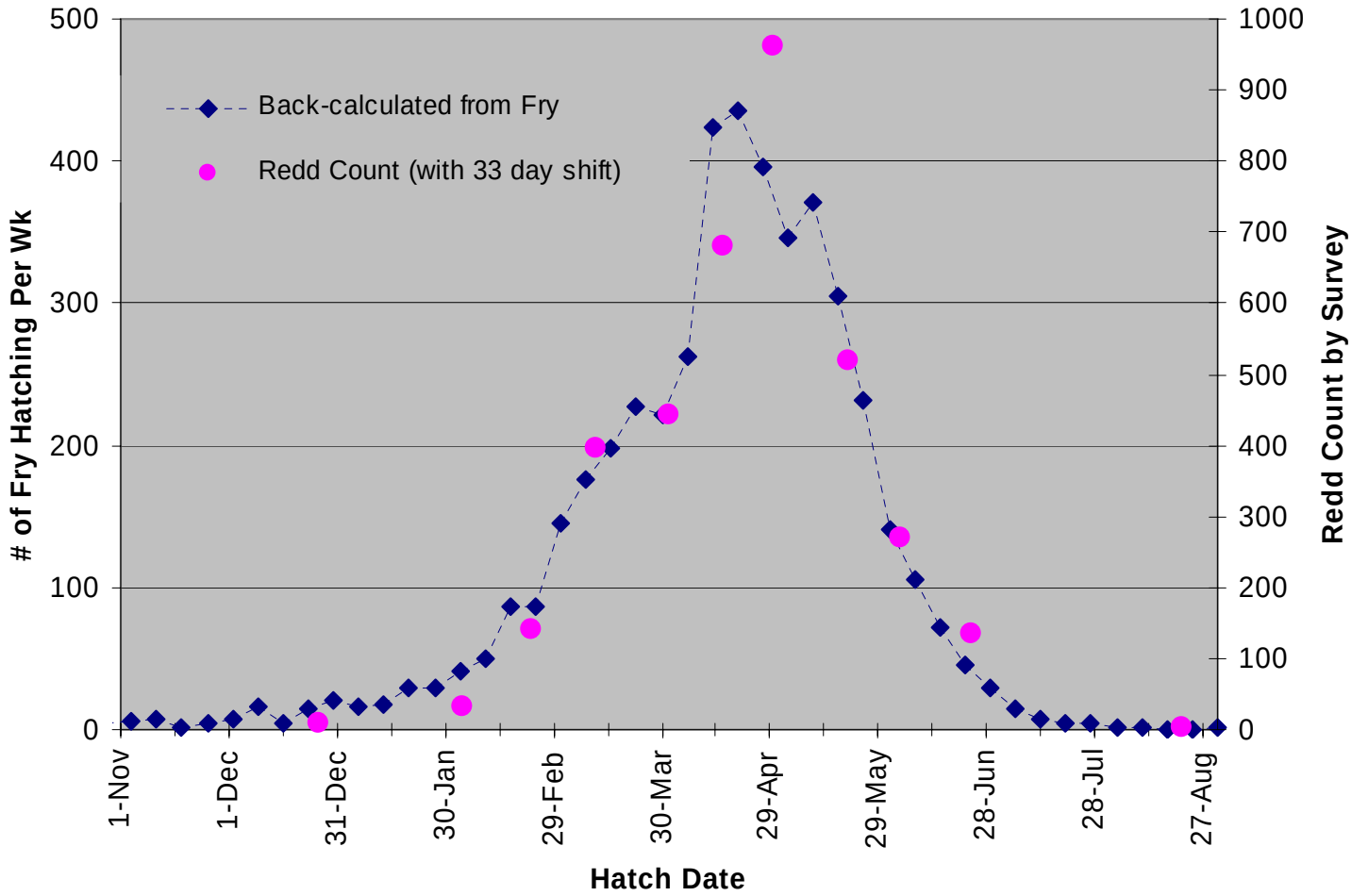




Incubation Loss Estimates

Scenario	% Redds Lost
2003	23
2004	33
2004 with ROD Flows	ca. 30
Jan: 12-20 with Sunday 12	14
Feb-Mar: 8/15 with Sunday 8	33
2004 + Sunday Steady Flow of 5 kcfs	49
Pre-ROD	ca. > 75

Annual Comparison of Observed Hatch vs. Redd Counts to Estimate Incubation Success (e.g. 2004 Expt. Flows vs. 2006 ROD Flows)



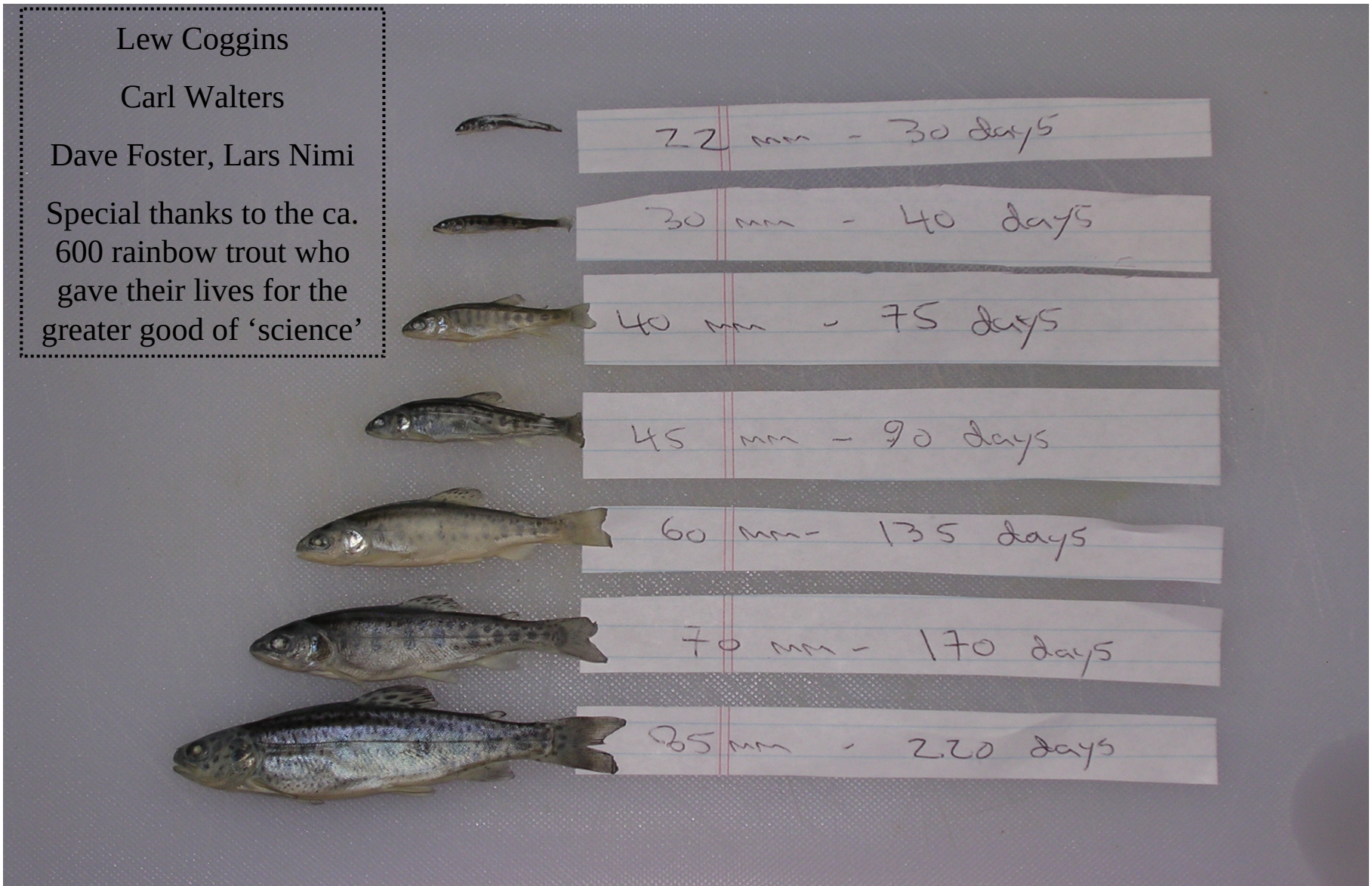
Part II: Effects of Flows on Growth, Habitat Use, and Survival of Young-of-Year in Glen Canyon

Lew Coggins

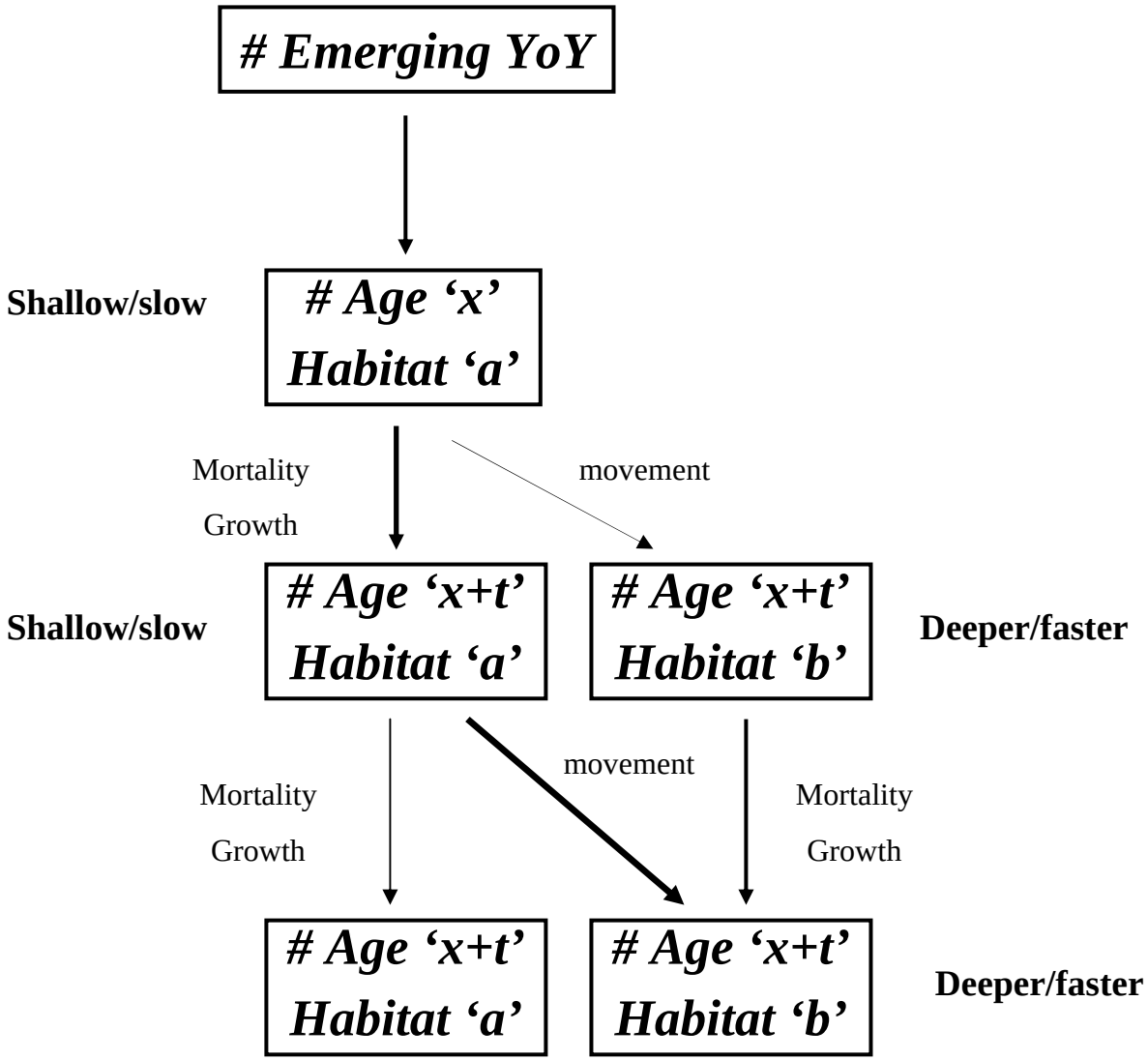
Carl Walters

Dave Foster, Lars Nimi

Special thanks to the ca. 600 rainbow trout who gave their lives for the greater good of ‘science’



Processes Determining Recruitment Rate to Age 1



Procedure

- Measure relative abundance of YoY at 2 habitat types every month for 8 months (Apr-Dec)
- Measure growth by determining daily age for a large subsample.
- Estimate emergence timing, survival, and movement parameters via statistical catch-at-age model (+ vulnerability 'nuisance' parameters)

Habitat Types

Low angle habitat

20-60 mm YoY

Debris fans, cobble and sand bars

50% of shoreline length Glen Canyon

20 sites/trip sampled by backpack electrofishing

600 m/trip sampled, or 2% of shoreline length of this type

Steep angle habitat

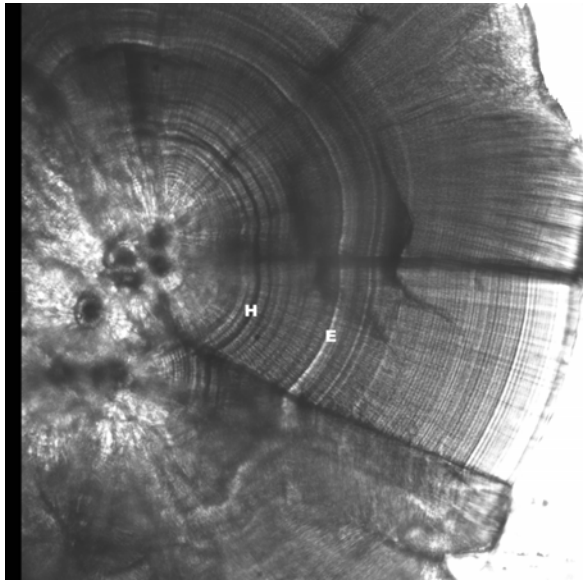
> 60 mm YoY

Talus slopes

40% of shoreline length in Glen Canyon

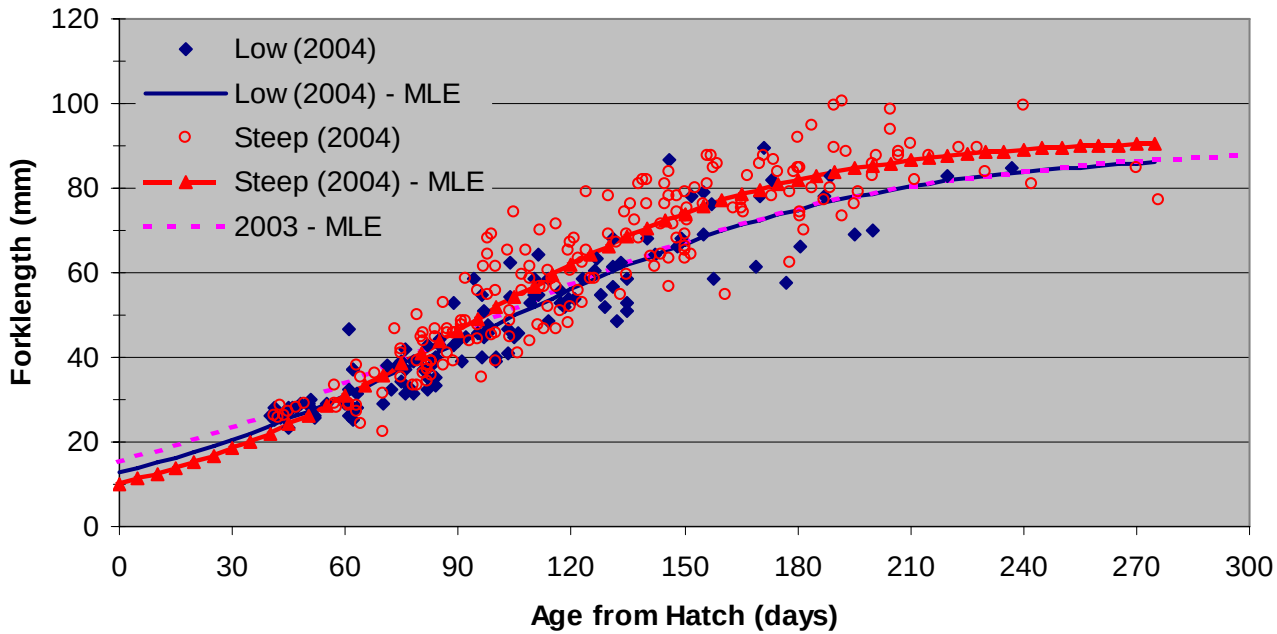
20 sites/month sampled by boat electrofishing

1000 m/trip sampled, or 5% of shoreline length of this type

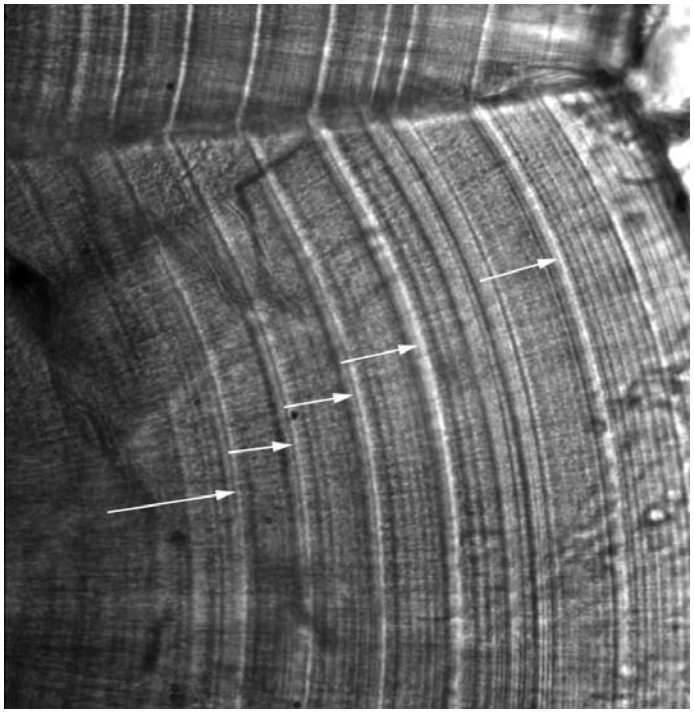


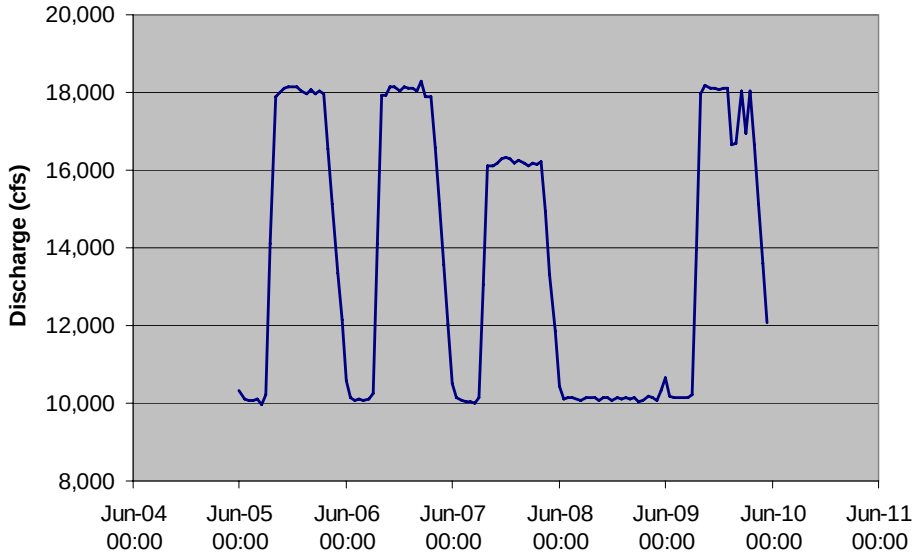
Length-at-Age from Otoliths

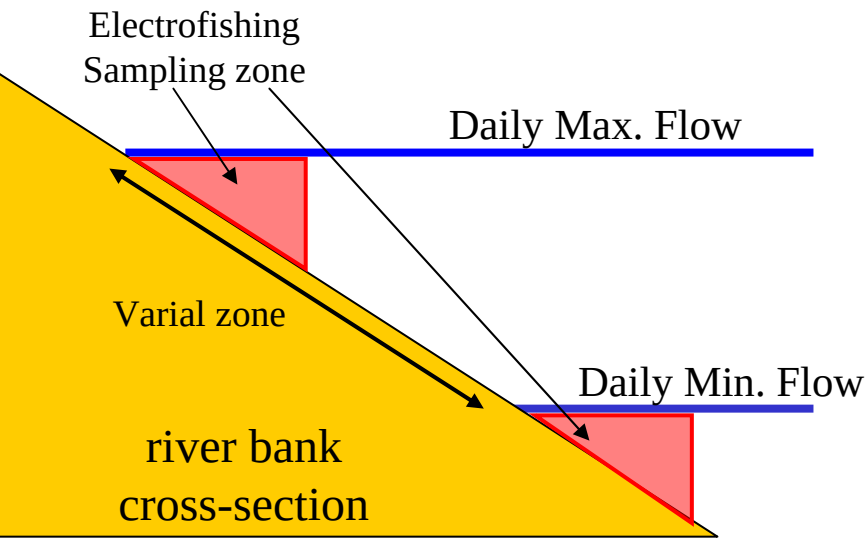
Dr. Steven Campana
Fisheries and Oceans Canada

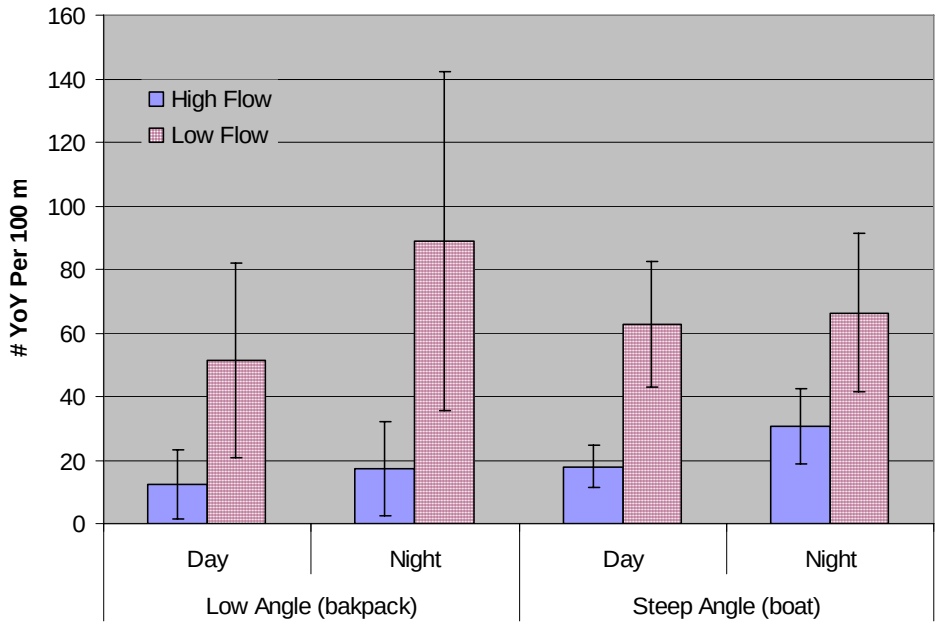


ENHANCED OTOLITH GROWTH ON SUNDAYS

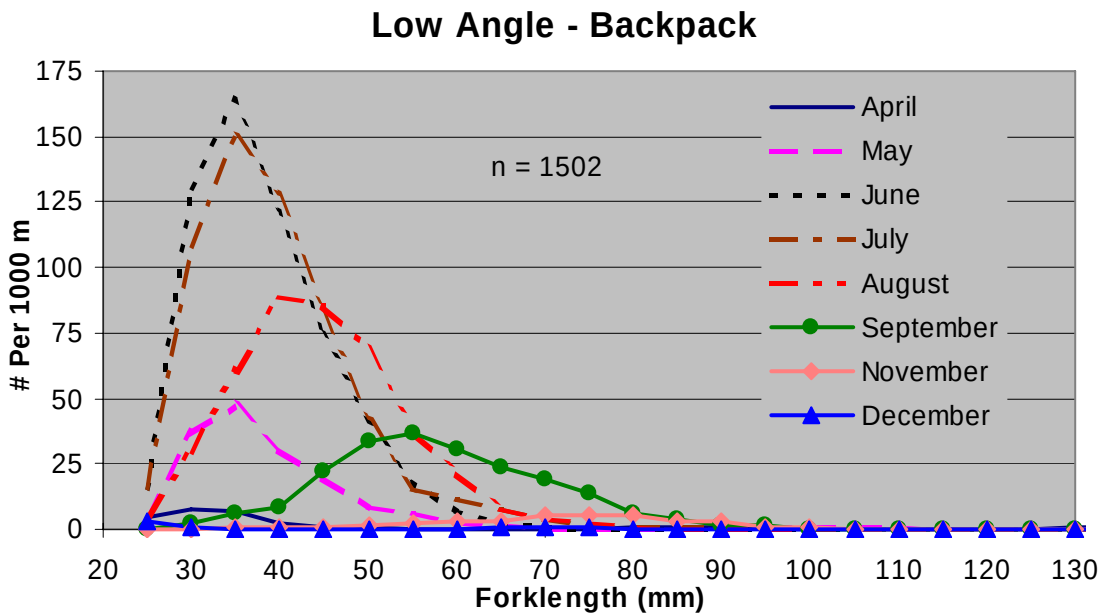


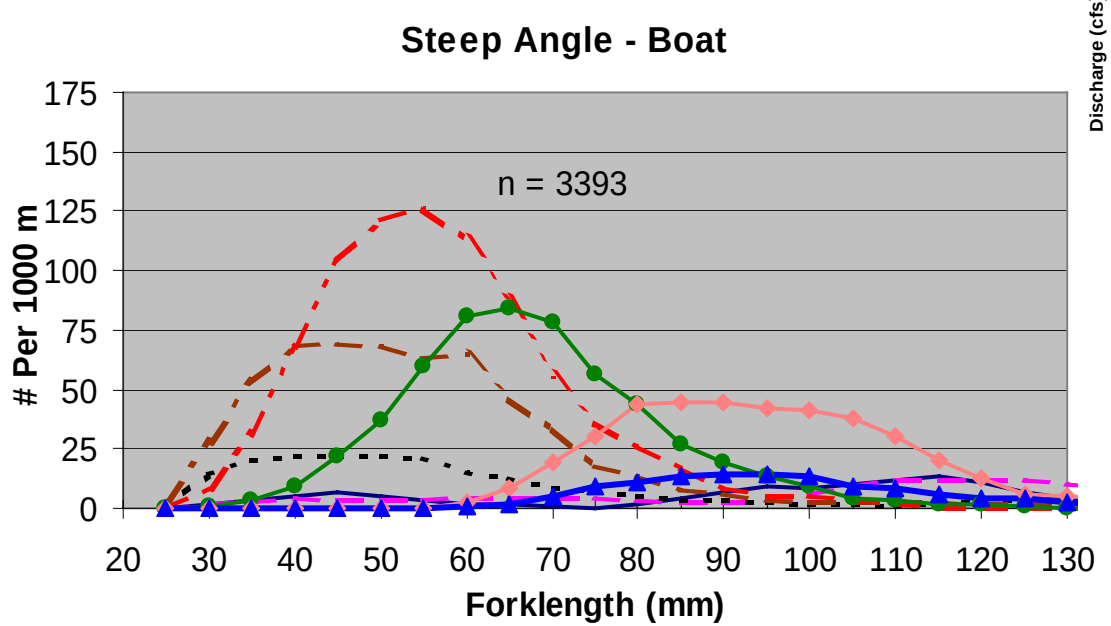


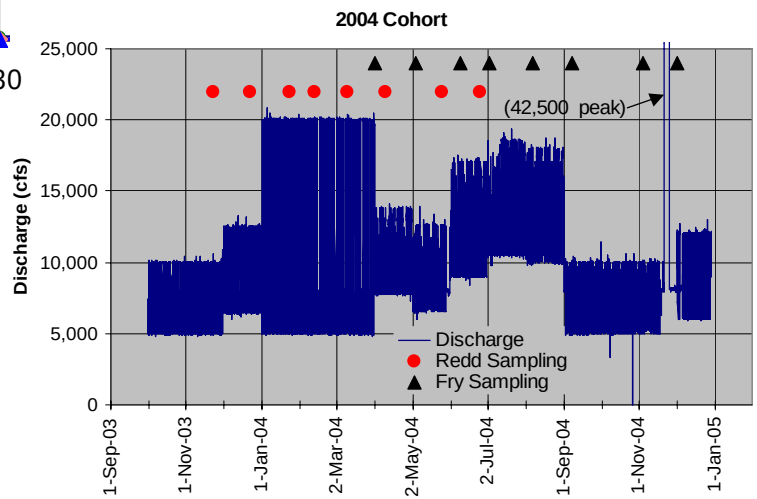


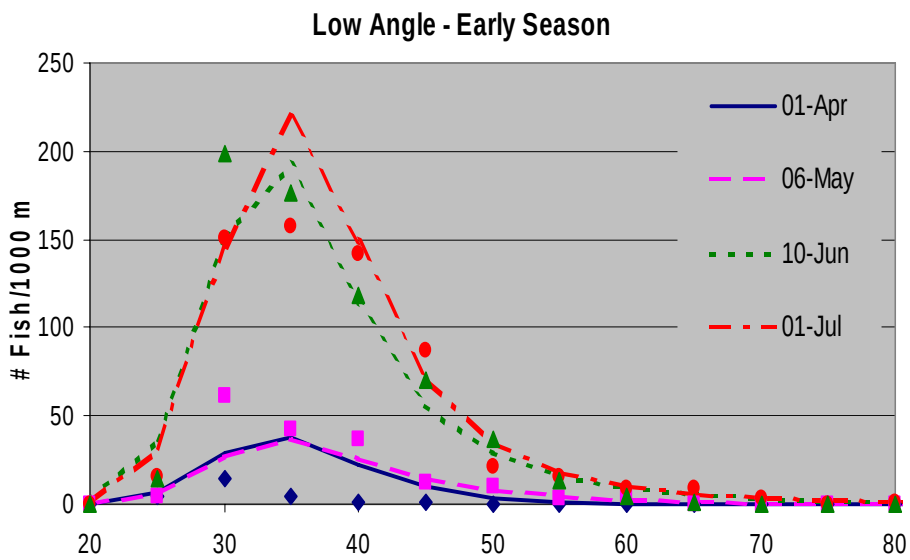


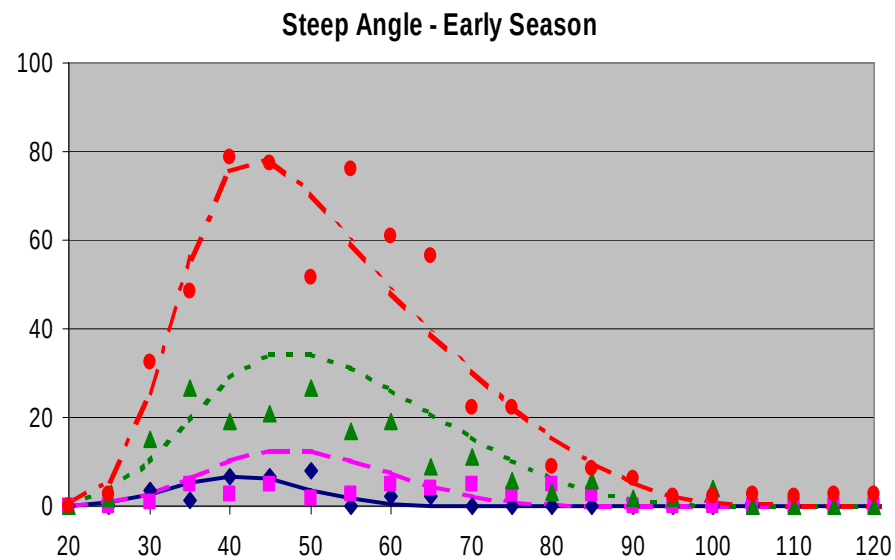
Observed Length-Frequencies

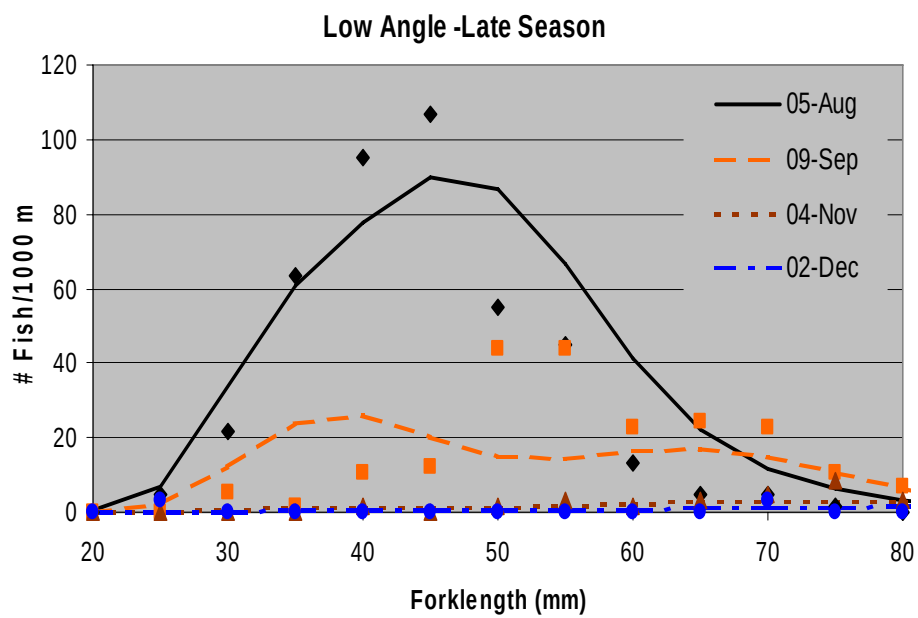


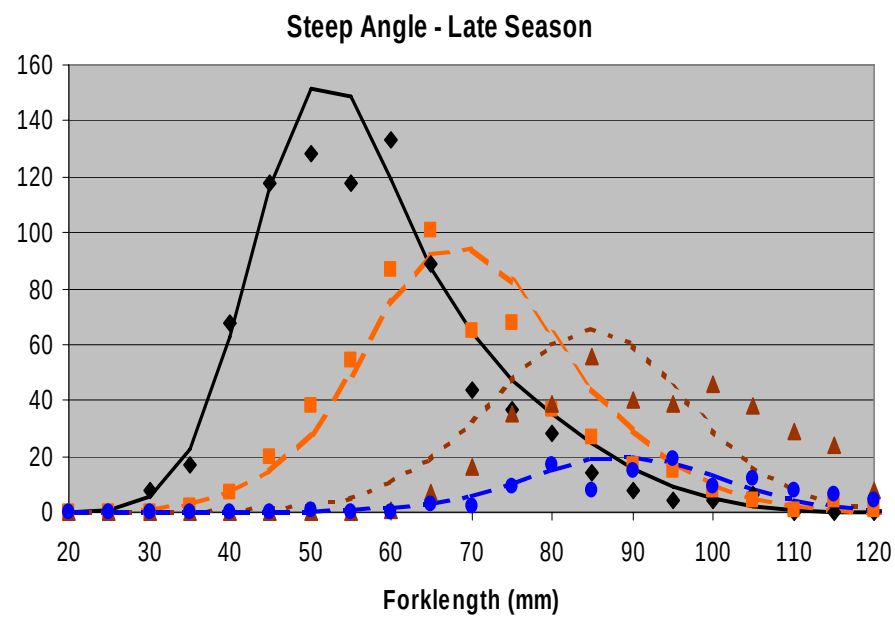




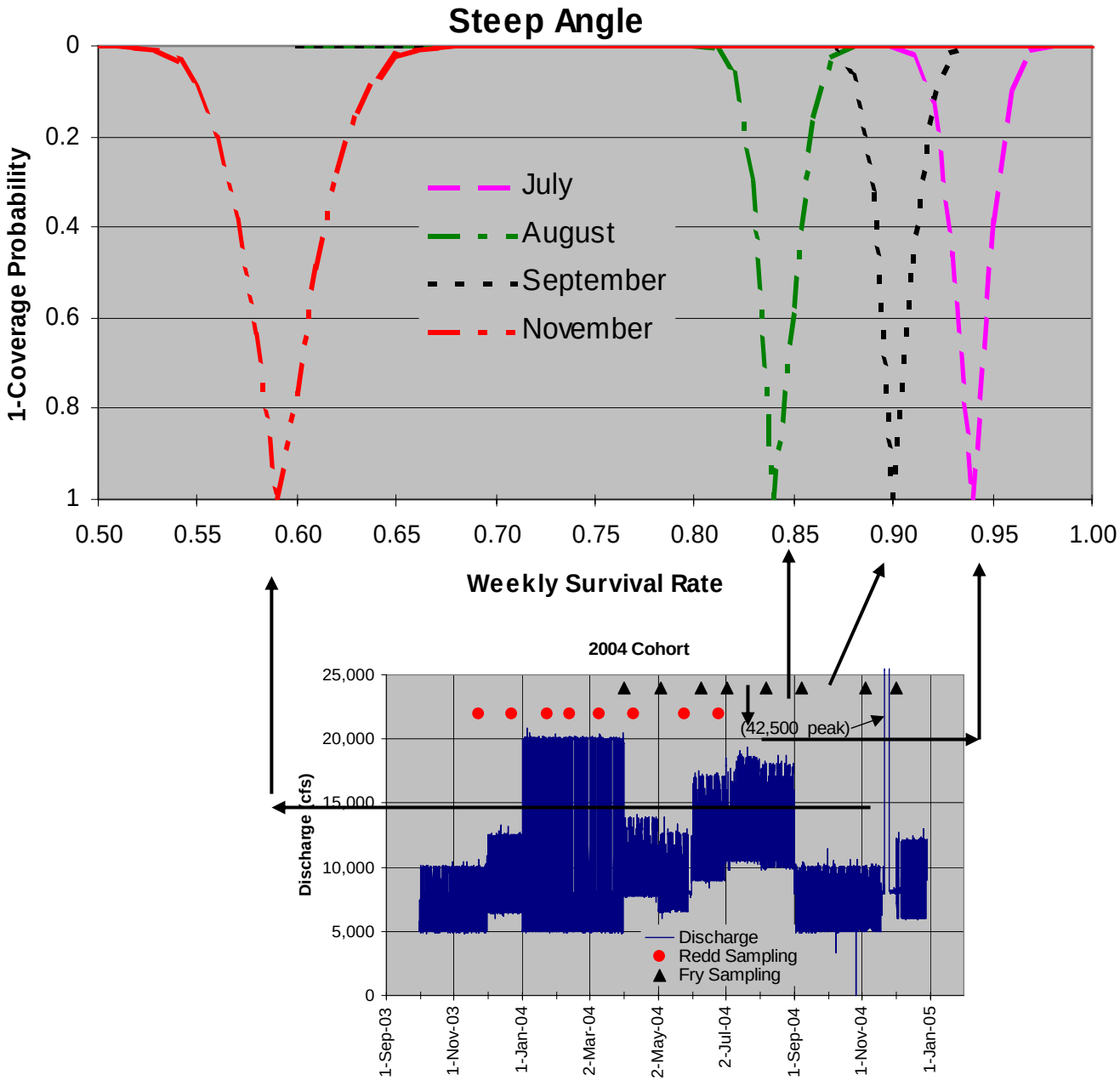

Low Angle - Early Season
Fish/1000 m
01-Apr
06-May
10-Jun
01-Jul


Steep Angle - Early Season


Low Angle -Late Season
Fish/1000 m
05-Aug
09-Sep
04-Nov
02-Dec
Forklength (mm)


Steep Angle - Late Season
Forklength (mm)

Comparison of Monthly Survival Rate Estimates



Conclusions from YoY Study

- Limit recruitment rate using ‘stranding flow’
  - 2-3 days at steady higher flow followed by quick reduction to low flow for 12 hrs.
  - Behaviour documented in otolith growth and high flow-low flow density differences.
  - Model suggests impact of Aug-Sep. flow change.
  - Much literature on fish movement/stranding.

- Redd and fry monitoring integrated in catch-at-age model useful for understanding impacts of GCD operations on trout recruitment.

Part III: Extent of Local Reproduction of Rainbow Trout in Marble Canyon

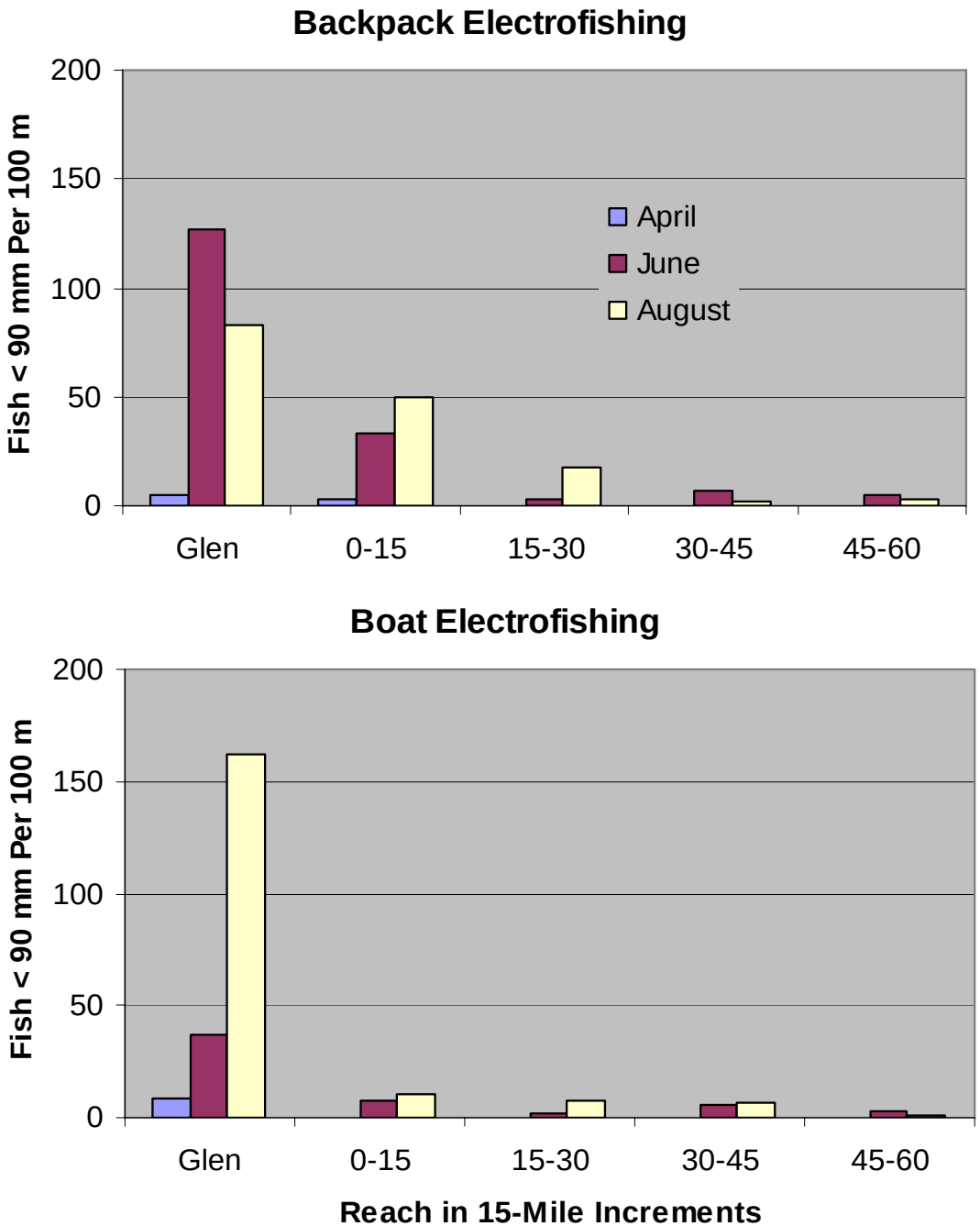
1) Is there substantial suitable spawning habitat in the mainstem? ***Very little compared to Glen Canyon***

2) Is there direct evidence of substantial spawning in the mainstem? ***Inconclusive due to turbidity on April survey but unlikely given 1).***

3) Are there Young-of-Year downstream of Lee's Ferry? ***Very few relative to the number of adults***

4) Is there suitable spawning habitat or direct evidence of spawning in Nankoweep Ck.? ***Yes, but very little evidence of successful reproduction in 2004 based on YoY densities.***

Young-of-Year downstream of Lee's Ferry



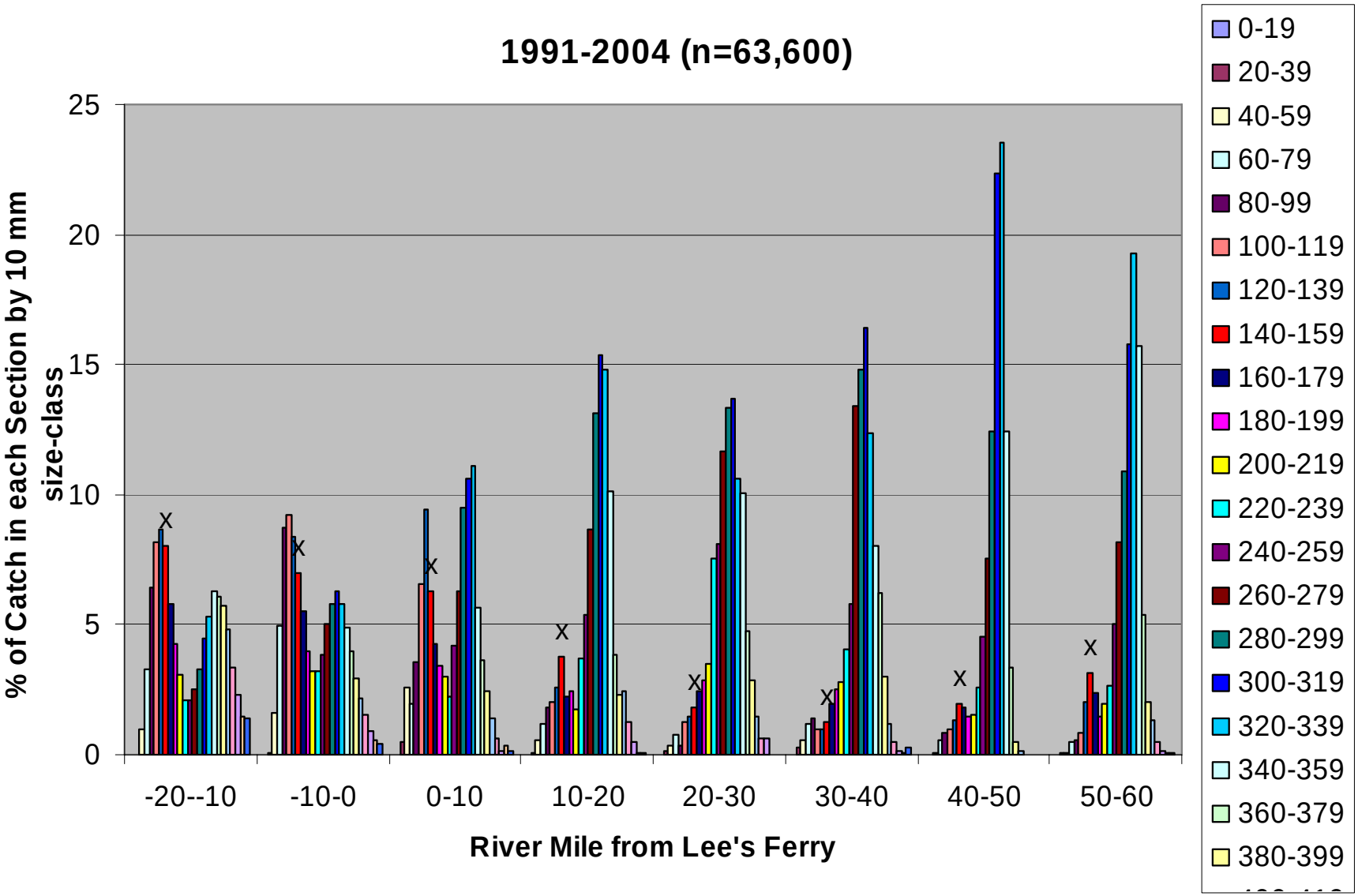
Yes, but very few.

Spatial and seasonal patterns in YoY abundance suggest that the majority of them probably came from Glen Canyon.

Growth rate and emergence timing for YoY in Marble Canyon identical to that from Glen Canyon.

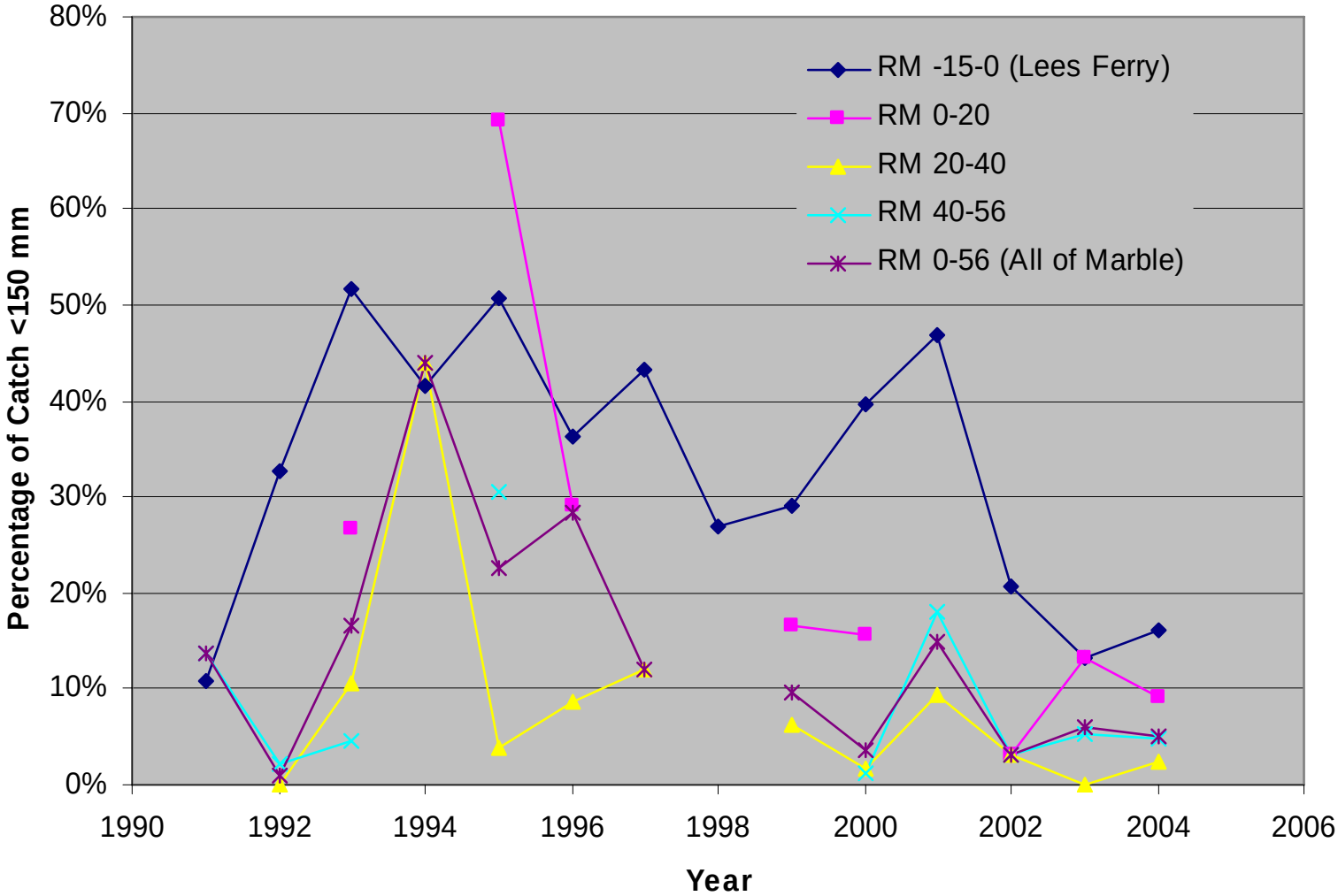
Much higher proportion of juveniles in Glen Canyon

Lew Coggins (GCMRC)/Bill Persons (AGF)

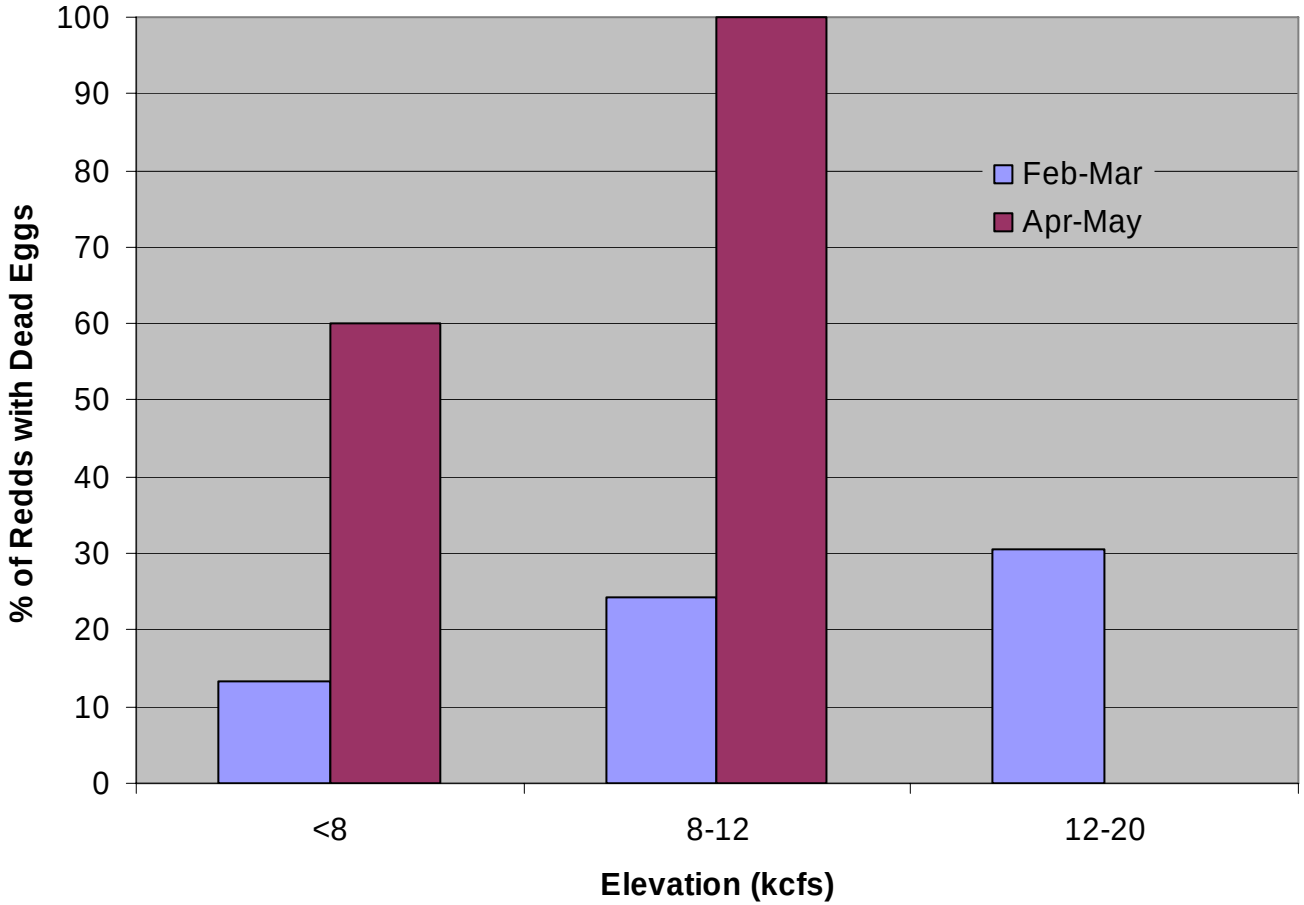


Relative abundance of juveniles is low in Marble Canyon, yet population has been growing or at least persisting.

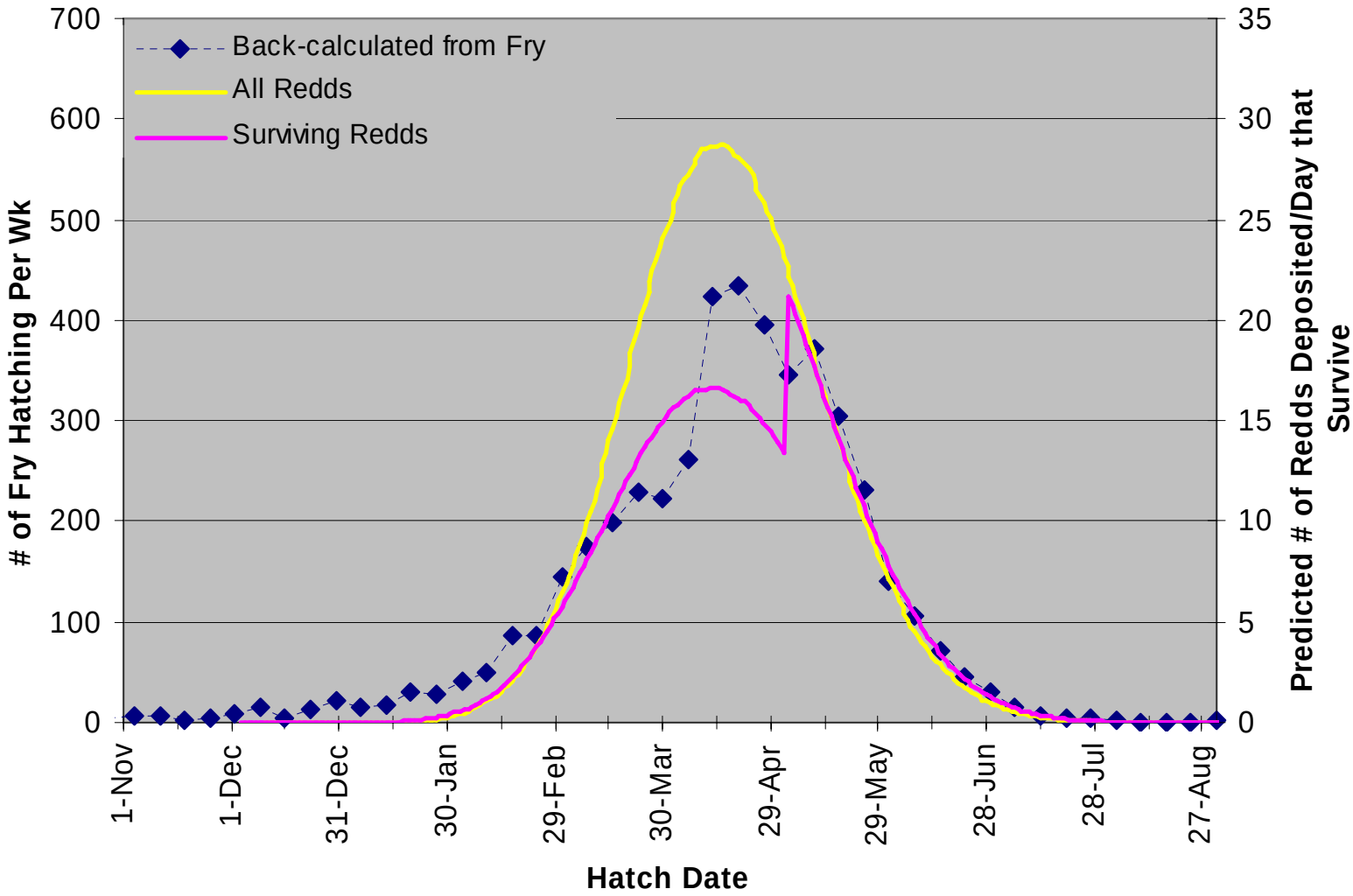
Lew Coggins (GCMRC) / Bill Persons (AGF)



125 Redds Examined, 80 Contained Eggs



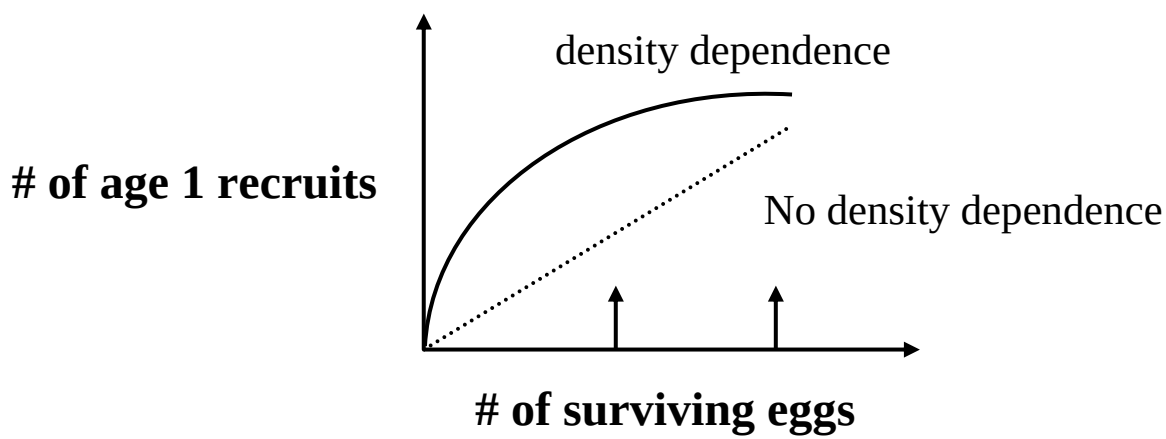
‘Observed’ (fry back-calculated) and Predicted Seasonal Trend in Incubation Survival



N 36 51.121
W111 36.417
Hdg: 235.3
Speed: 0.0
18:46:36
06-11-04

Conclusions from Redd Mortality Study

- Must validate model prediction with similar assessment in 2006 under ROD operations.

  H_0: incubation mortality in 2003/2004 = 2006

- Increased incubation mortality has highest probability of being corrected at a later stage through reduced density-dependent mortality.