Temperature Dependent Survival, Growth, and Physiology of Juvenile Snake River Fall Chinook Salmon

Jeff Yanke, Christine M. Moffitt, James L. Congleton

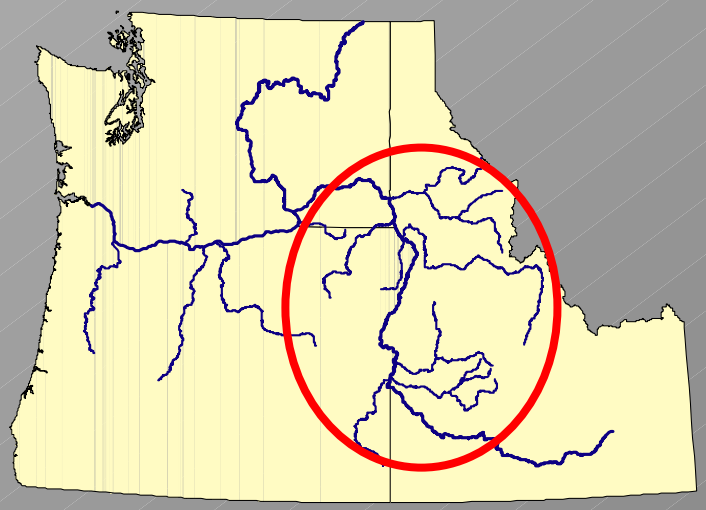
Idaho Cooperative Fisheries and Wildlife Research Unit

Dept. of Fish & Wildlife Resources - University of Idaho

Billy Connor

U.S. Fish and Wildlife Service – Idaho Fisheries Research Office

Historical and Current Spawning Areas



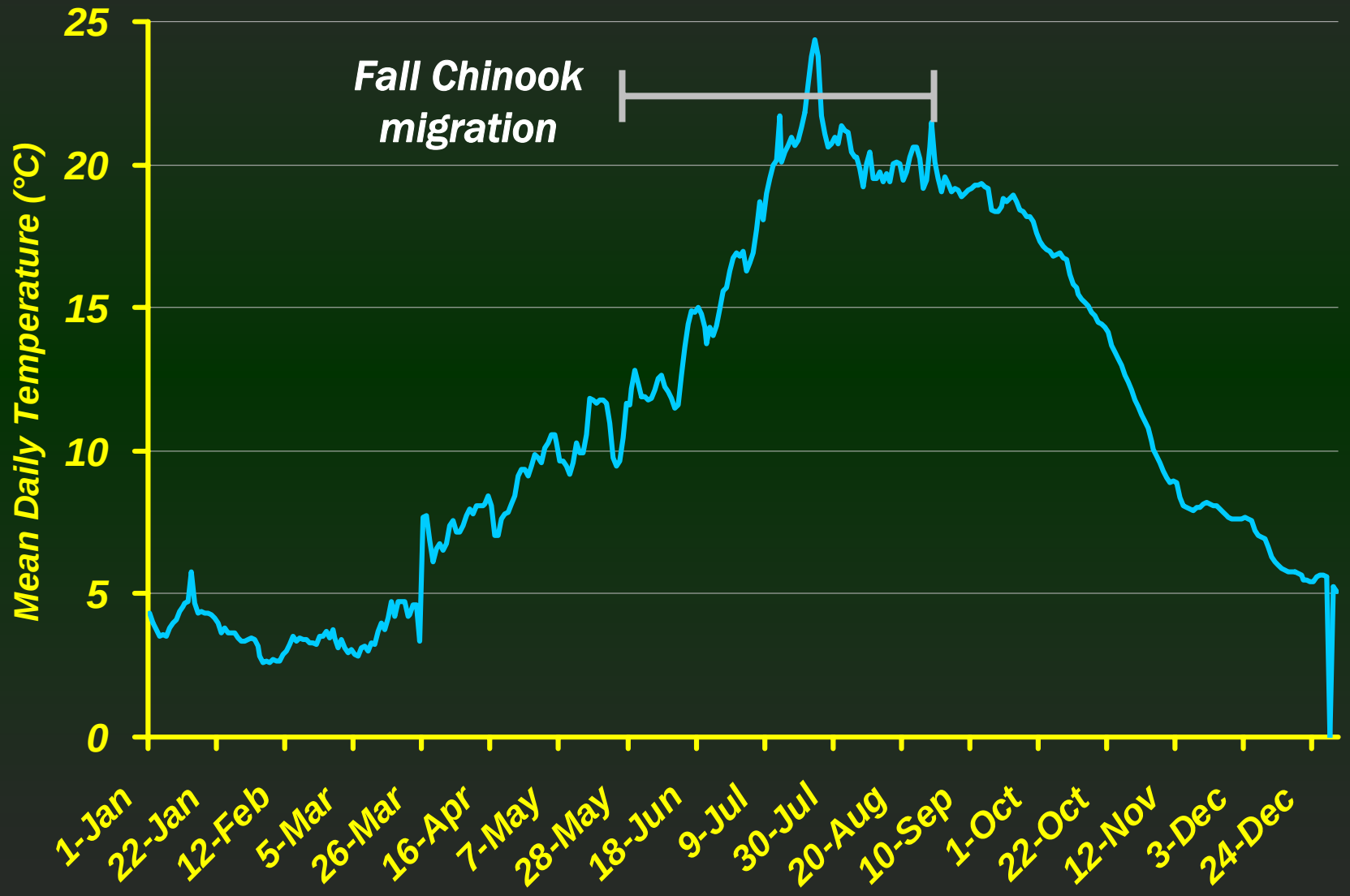
Delays in Life History Events

- Production has been shifted to margins of historical range
  - Areas of lower growth opportunity
  - Hells Canyon smolts typically migrate later than Marsing smolts

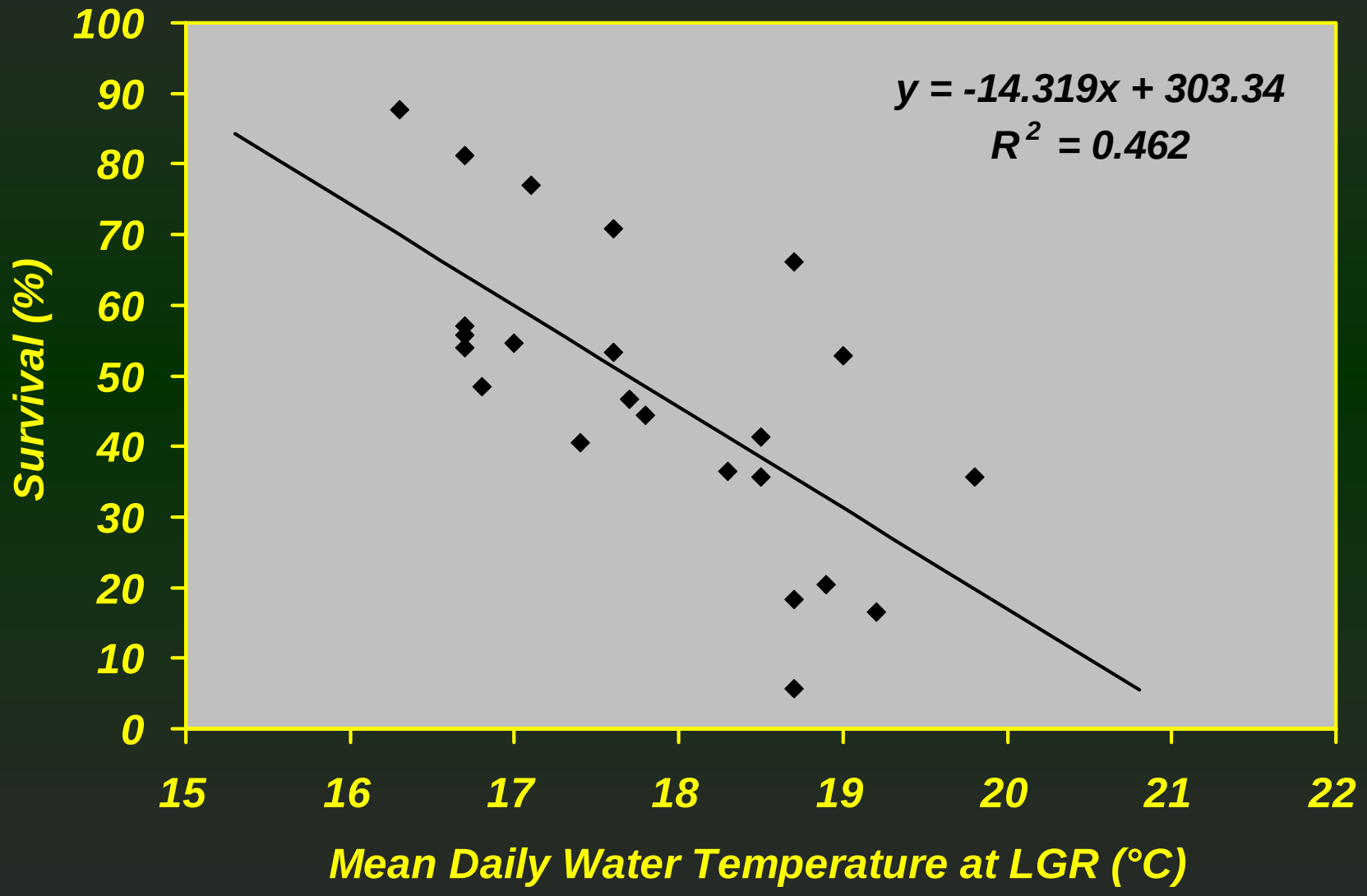
- Completion of the Lower Snake Dams
  - Reservoirs decrease rates of seaward migration
  - Environmental stressors prevalent in reservoirs
    - High temps, low flows, predators, etc.

Present day smolts migrate through reservoirs during high temperature and low flow conditions

2002 Lower Granite Forebay Temps



Juvenile Survival – 1998 to 2003



Primary Research Interest

- Evaluate temperature related effects on juvenile survival, growth, and physiology

- Simulate an array of possible temperature conditions during ocean-bound migration
  - Under controlled laboratory conditions

Experimental Design

- University of Idaho fisheries laboratory
  - 4 temperatures
    - (16, 20, 24, and 28°C)
    - 3 tanks per temperature
    - 180-240 fish per tank
  - Fed to Satiation twice daily
  - Lyons Ferry hatchery (WDFW) stock of fall Chinook
    - 2003 mean FL = **91mm**
    - 2004 mean FL = **72mm**

Sampling

- Temperature Acclimation
  - Reached experimental targets after 30d
- Experimental Samples
  - 2003: Bi-weekly following acclimation for 50d
  - 2004: Weekly for 42d *(sampled during acclimation)*
- Recorded and Examined Mortalities

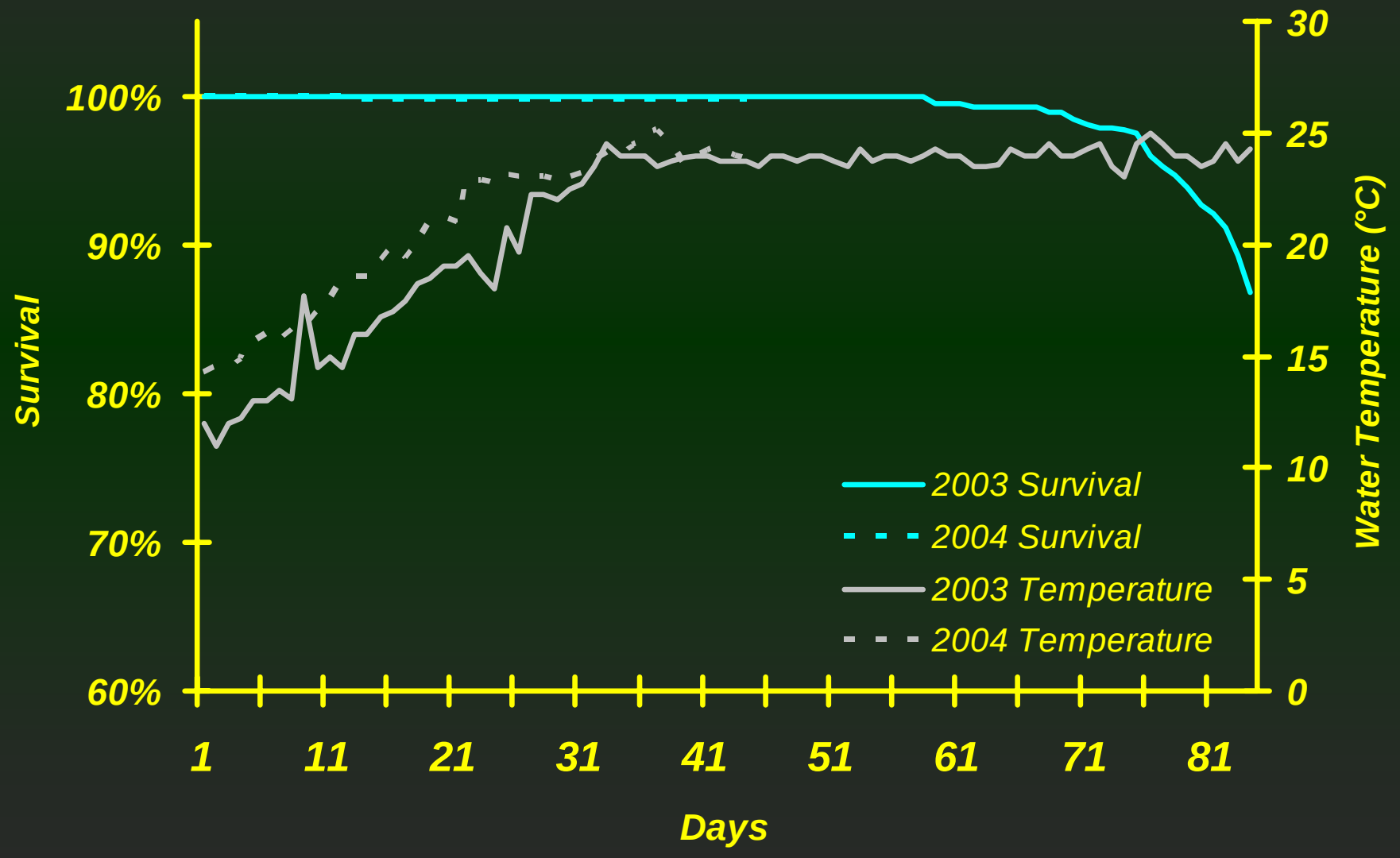
Methodology

- Random subset of fish removed from each tank
  - *Measured fork length (mm) and weight (g)*
- Each fish bled from caudal artery
  - *Blood centrifuged, plasma pooled at stored at -80°C*

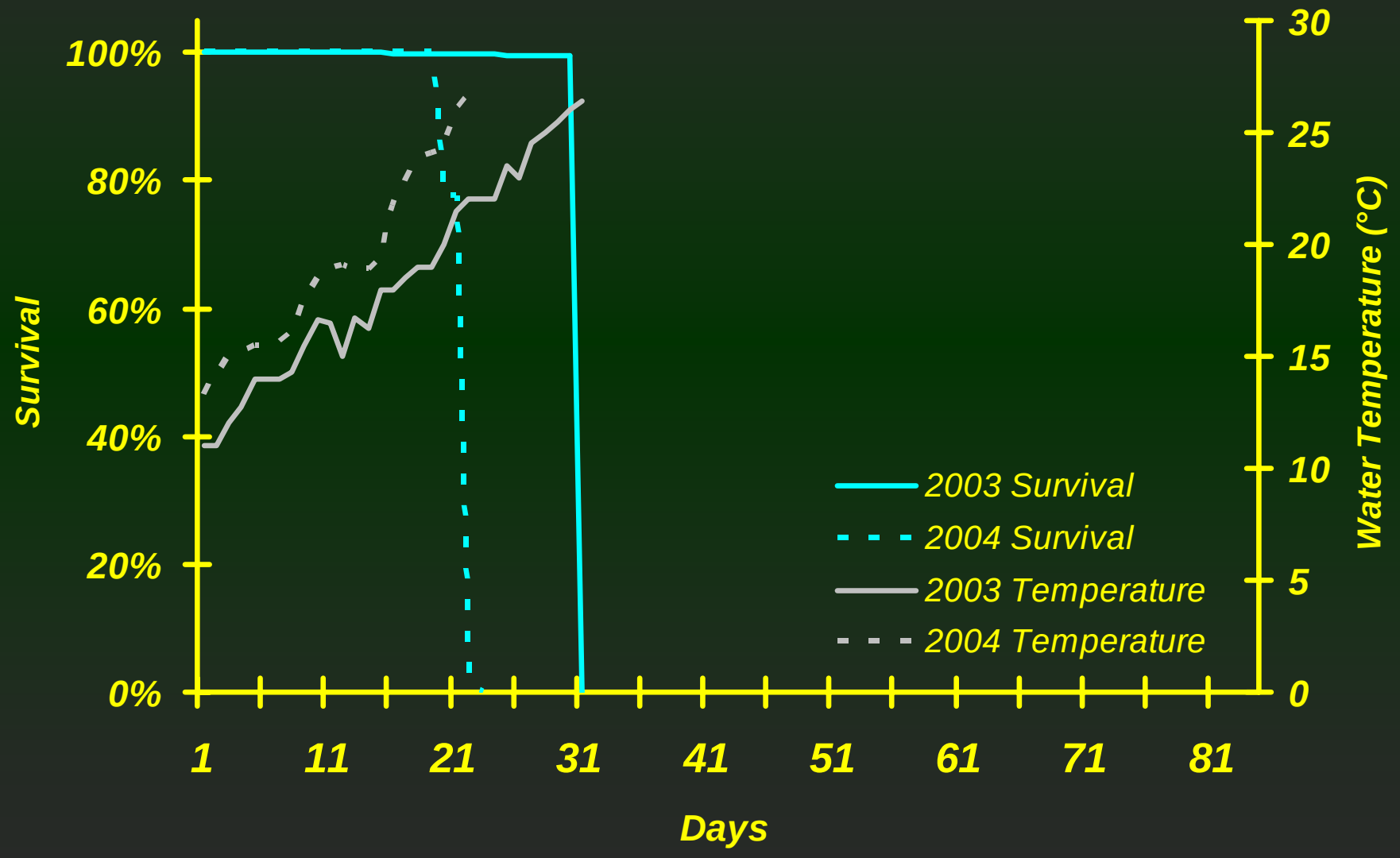
Survival at 16 and 20°C

- Greater than 99% in 2003 and 2004

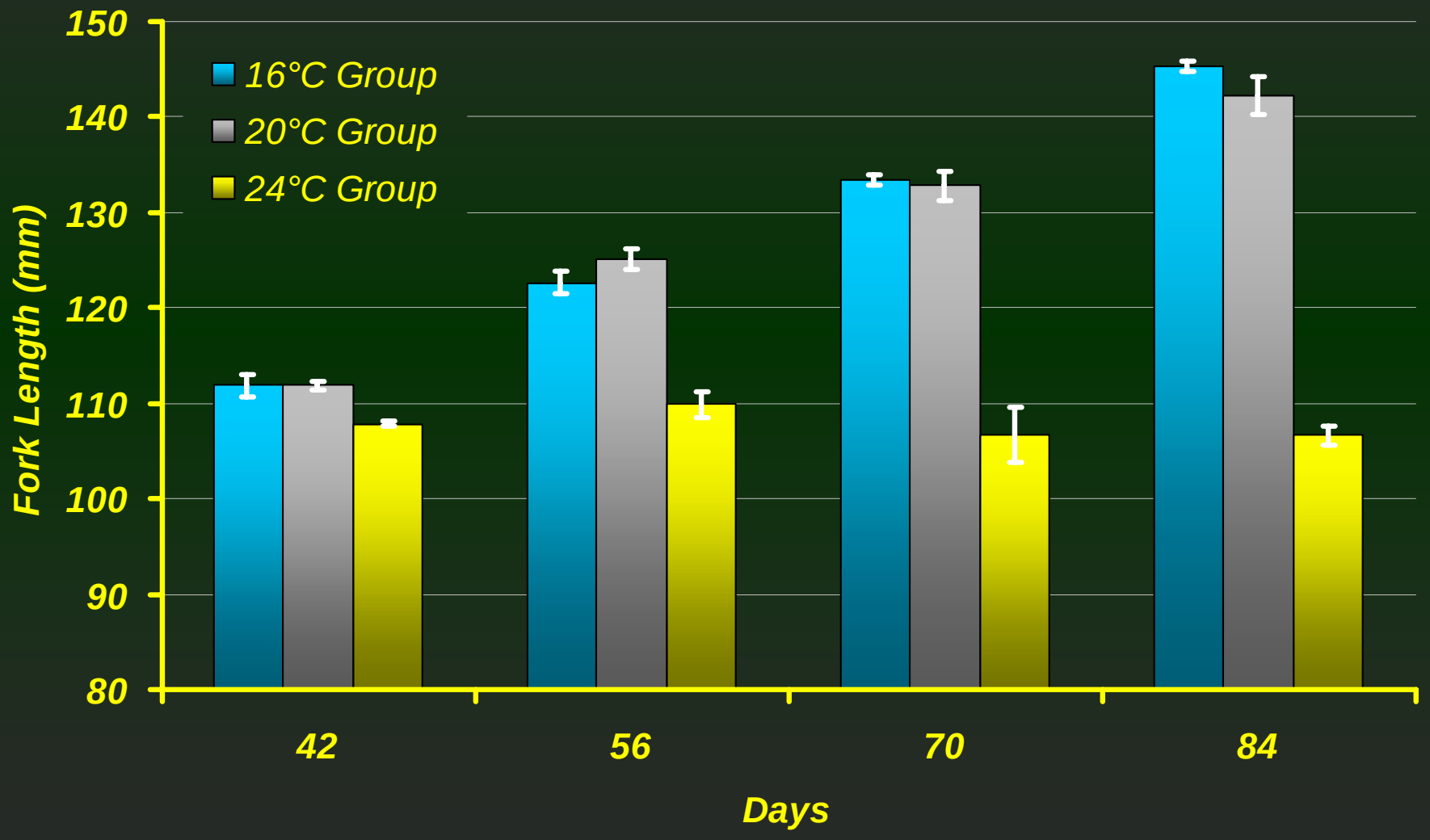
Survival at 24°C



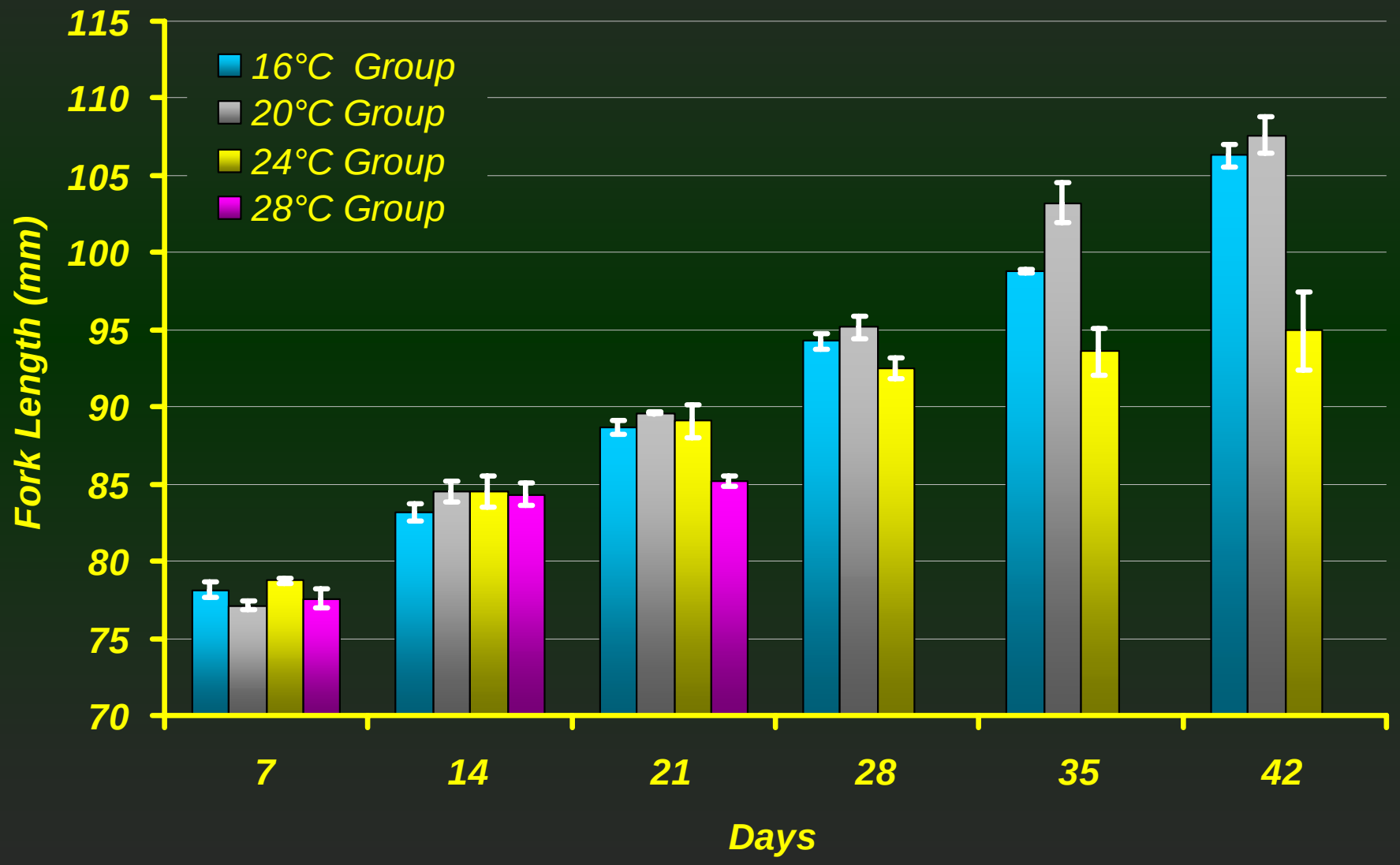
Survival at 28°C



2003 Fork Lengths



2004 Fork Lengths



Physiology - Blood Chemistry

- Blood plasma parameters
  - Surrogate for internal bodily functions
    - *Nutrition, Stress, Ion regulation, Tissue Damage*
- Analyzed with auto-analyzer at local hospital

- *Calcium*
- *Magnesium*
- *Lipase*
- *Sodium*
- *Potassium*
- *Chloride*
- *Carbon Dioxide*
- *Glucose*
- *Phosphorus*
- *Alanine Aminotransferase*
- *Alkaline Phosphatase*
- *Total Protein*
- *Cholesterol*
- *Triglycerides*
- *Lactic Dehydrogenase*
- *Aspartate Aminotransferase*
- *Amylase*
- *Creatine Kinase*

Factor Analysis

- Partitions highly correlated variables into smaller groupings – called ‘factors’
  - Provides insight into variable relationships

- Factor scores are created for quantitative analyses
  - Based on a function of correlation coefficients and number of variables in factor

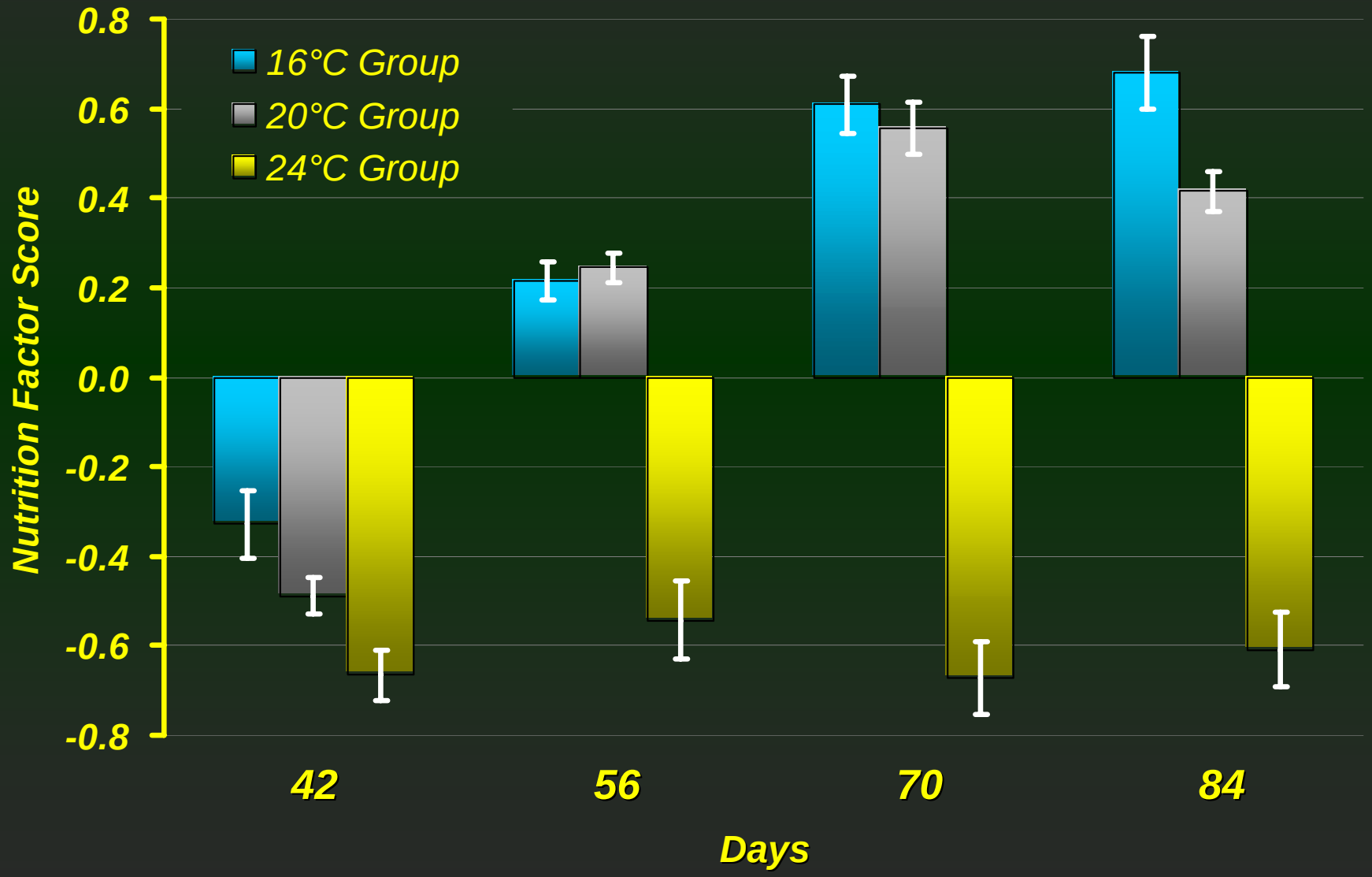
Factor 1

Cholesterol
Calcium
Total Protein
Alkaline Phosphatase
Amylase
Potassium

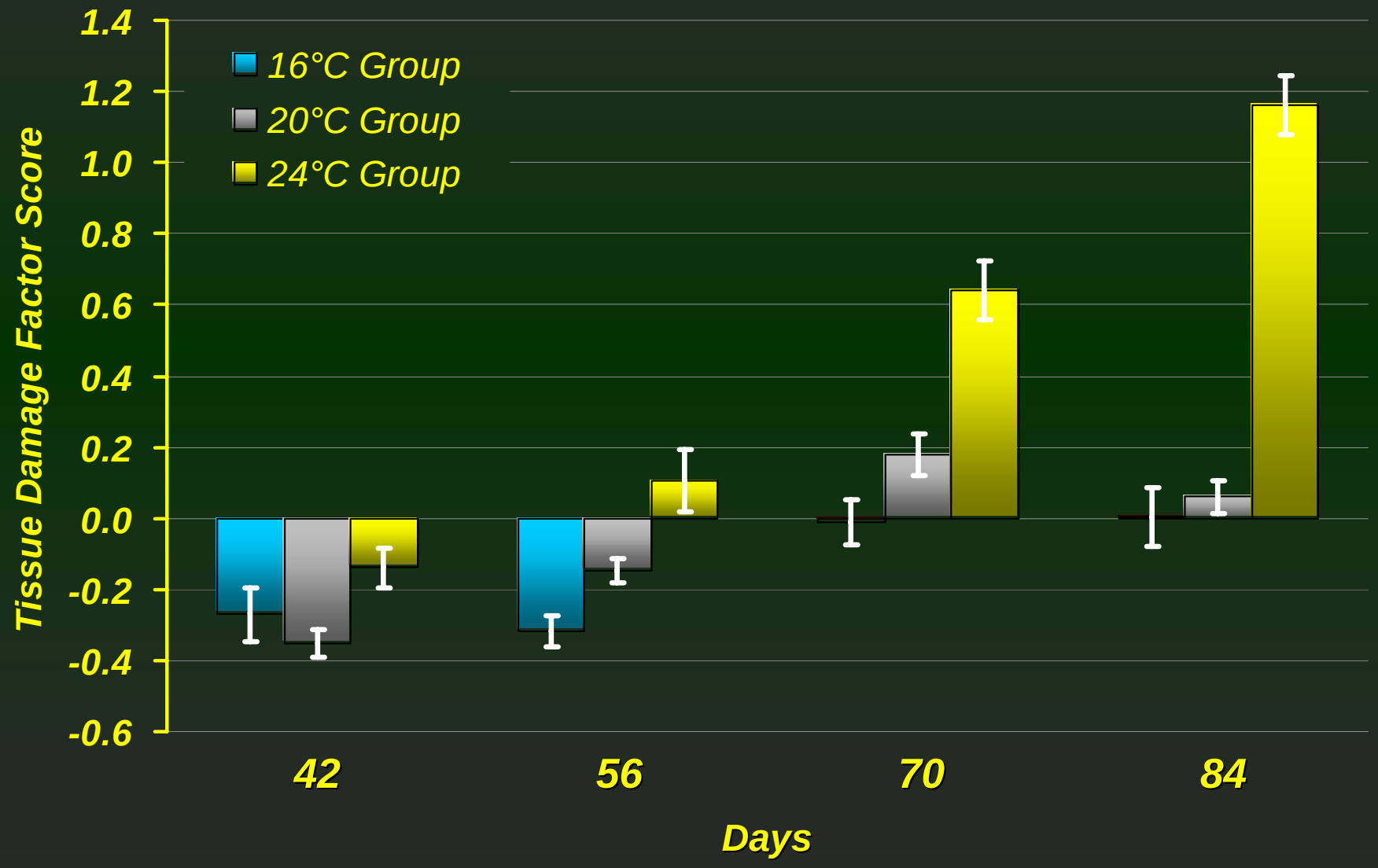
Factor 2

Creatine Kinase
Lactic Dehydrogenase
Alanine Aminotransferase
Aspartate Aminotransferase
Magnesium

Factor 1 – 'Nutritional Status'



Factor 2 – 'Tissue Damage'



Preliminary Conclusions

- Temperature effects on survival
  - 26/27°C lethal for juvenile fall Chinook
  - Prolonged exposure to ≥24°C detrimental to survival
  - So far, support the 19.8°C (67°F) objective at LGR

- Temperature effects on growth
  - Slowed growth at 24°C
  - Steady growth at 20°C up to 2 months

Preliminary Conclusions

- Factor Analysis
  - Useful for synthesizing large blood plasma datasets
  - Results supported by survival and growth metrics
- Temperature effects on Physiology
  - Depleted levels of nutritional indicators at 24°C
  - Elevated levels of plasma enzymes at 24°C
  - Indicates failure to convert food, energy reserves and potential tissue damage

Additional Research Objectives

- Investigate the impacts of previous temperature exposure on seawater adaptability
  - Seawater challenges
- Assess upper lethal temperature limits
  - Short-term exposure trials
- Analyze additional physiology data
  - Lipids, heat shock proteins, plasma cortisol

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