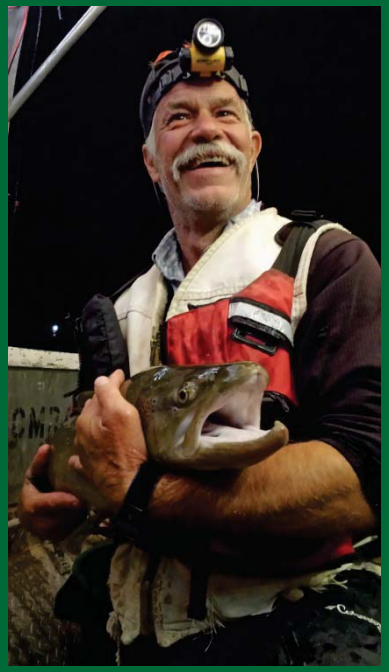
Boom-and-Bust Cycles in the Population of Rainbow Trout in Glen Canyon and Effects of Fall High Flow Experiments



Josh Korman, Ecometric Research, Vancouver, BC

Michael D. Yard, GCMRC, Flagstaff, AZ

January, 2016

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Objectives of Natal Origins (NO) Project

- Determine origin of rainbow trout near Little Colorado River (LCR)
  - Are trout at LCR coming from Glen Canyon?
  - Do actions that benefit tailwater fishery increase trout export with potential negative impacts on humpback chub near the LCR?
  - To address this question many trout were tagged in Glen Canyon

- NO sampling in Glen Canyon has provided many insights about the rainbow trout population and fishery
  - Dynamics and cause of boom-and-bust population cycles
  - Effect of Fall HFE's on growth
  - Movement (Yard, next talk)

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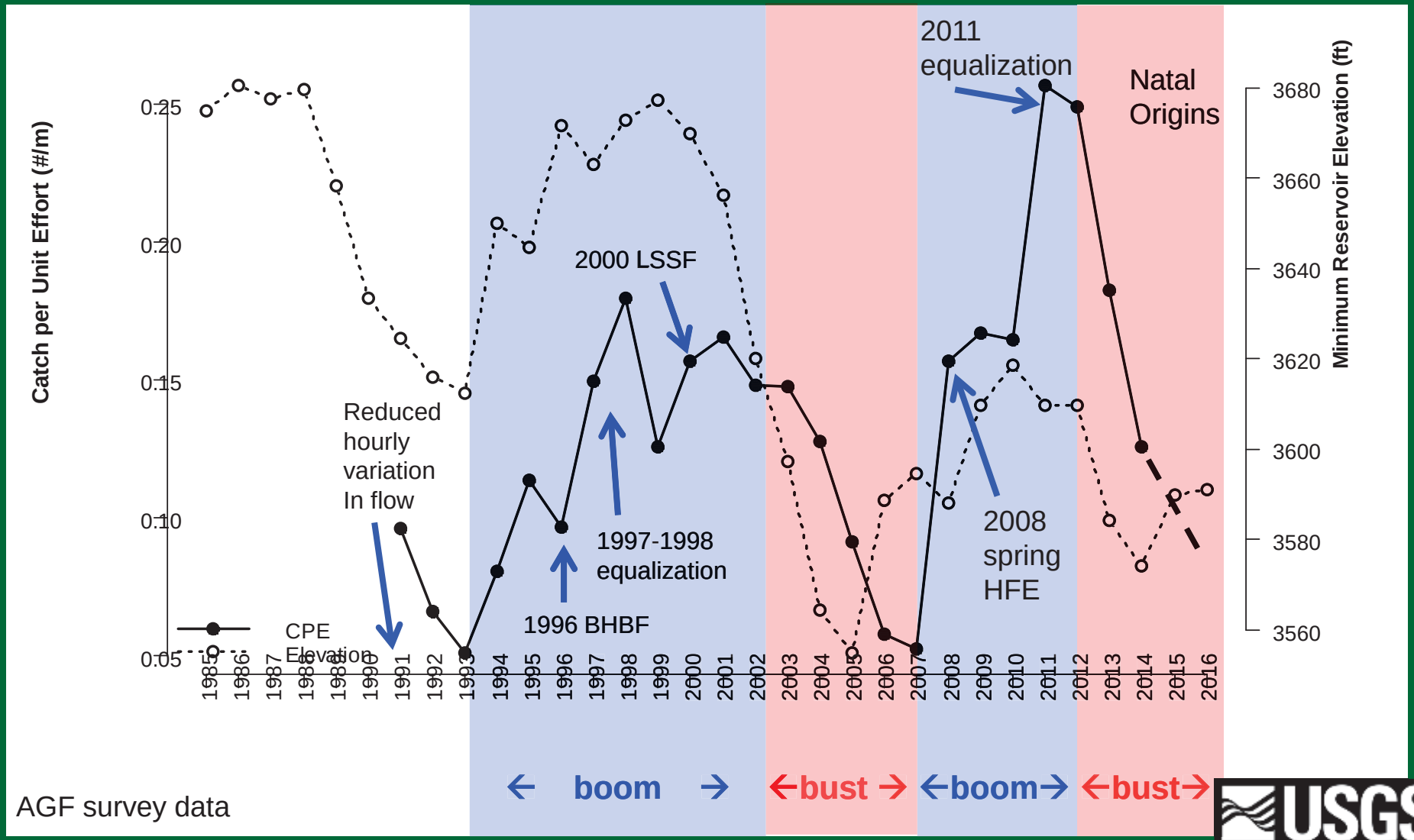
Boom-and-Bust Cycles in Abundance of Rainbow Trout in Glen Canyon



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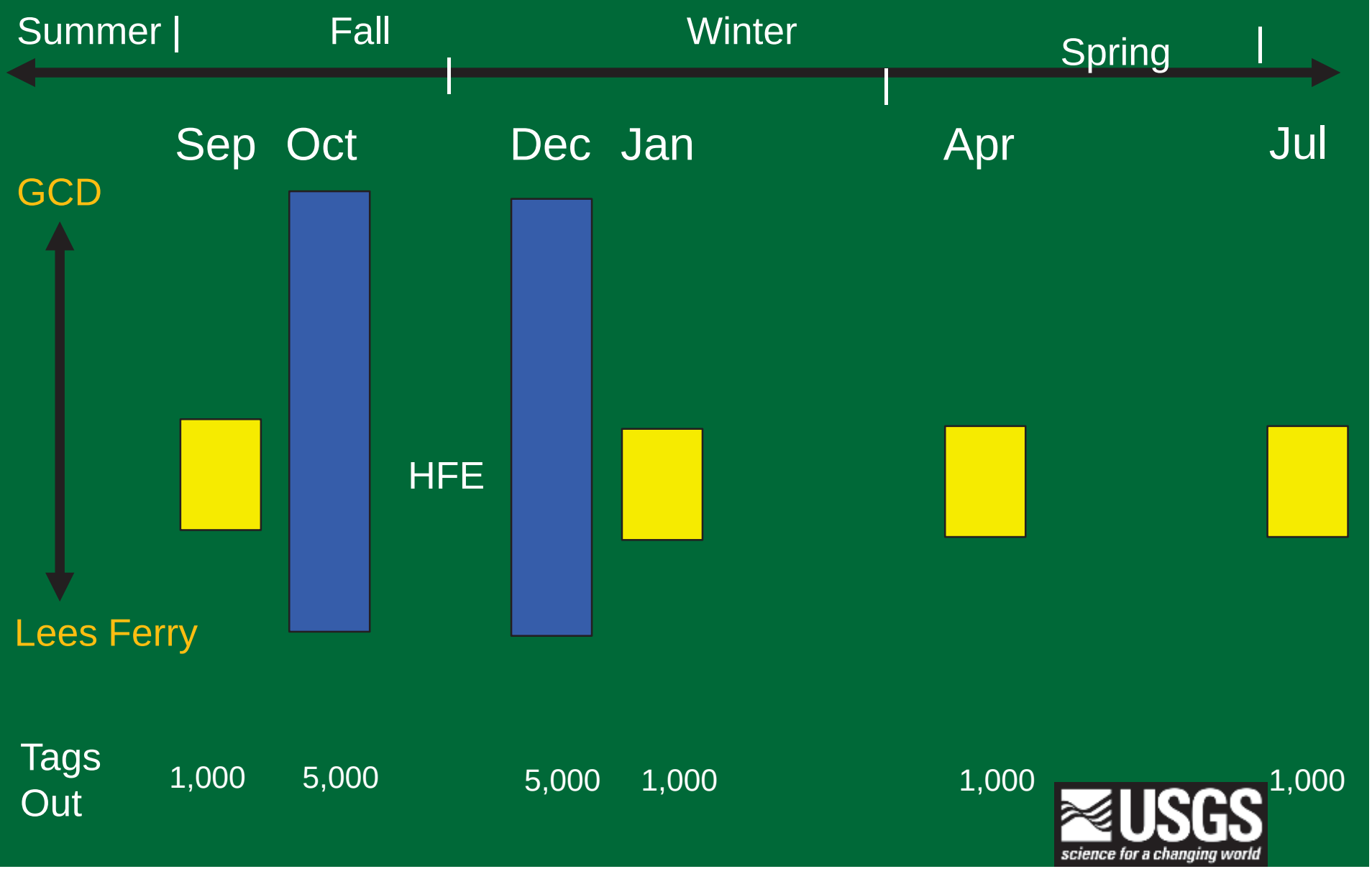
Natal Origins Sampling Design in Glen Canyon



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Summary of Catch and Tagging Data in Glen Canyon

Year	Number of Trips	Unmarked Catch	# of Trout Tagged	# of Tags Recaptured
2011	1	12,241	11,429	
2012	5	29,290	10,845	495
2013	6	27,092	13,644	1,112
2014	6	33,822	17,081	1,824
2015	6	26,108	17,682	2,133
2016	5	19,718	11,224	1,728
Total	29	148,271	81,905	7,292

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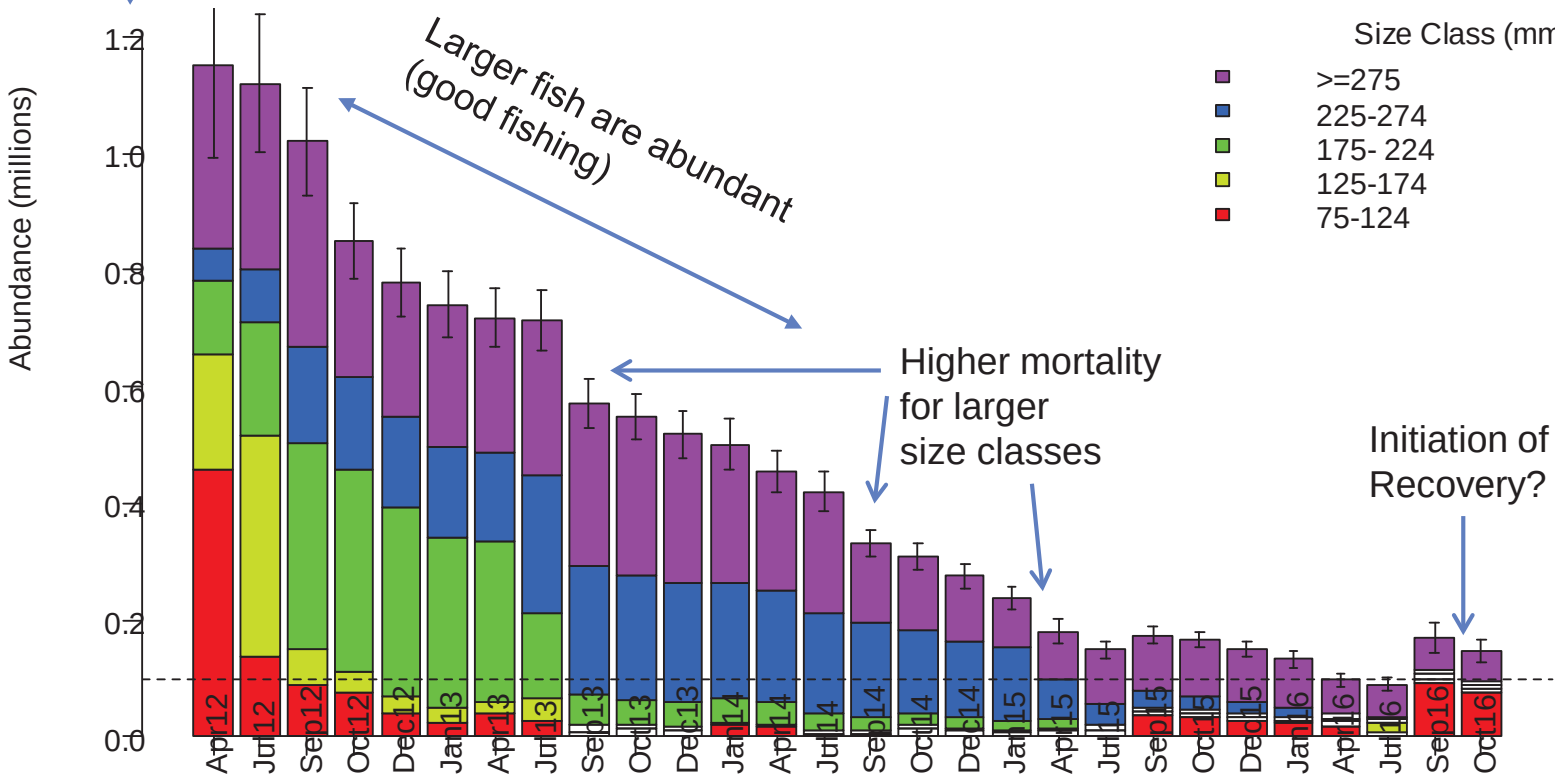
Preliminary data, do not cite

Anatomy of a Boom-and-Bust Cycle

High recruitment in 2011
due to equalization flows

$$N_{t+1} = N_t \cdot S_t + R_t$$



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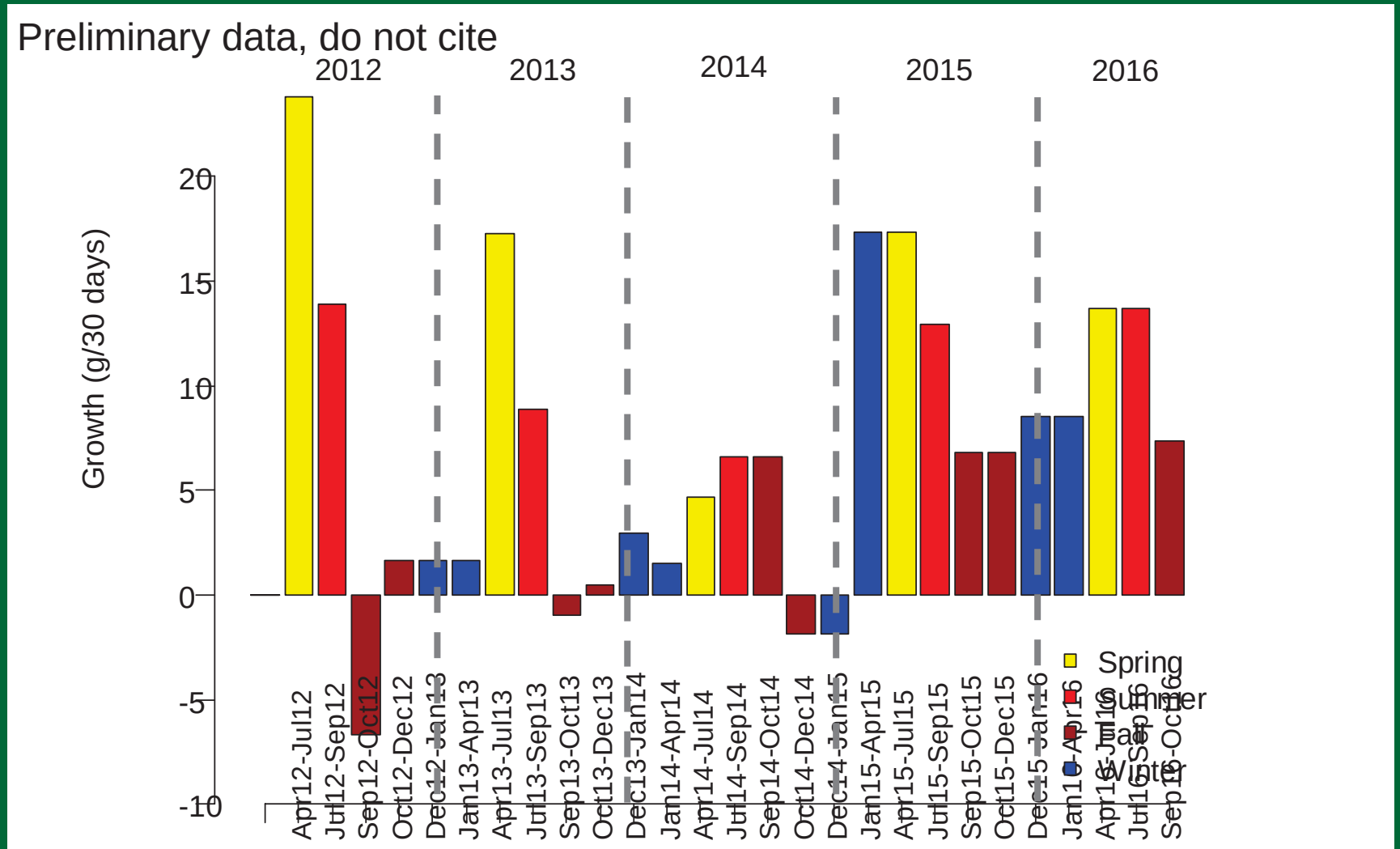
Annual and Season Variation in Trout Growth



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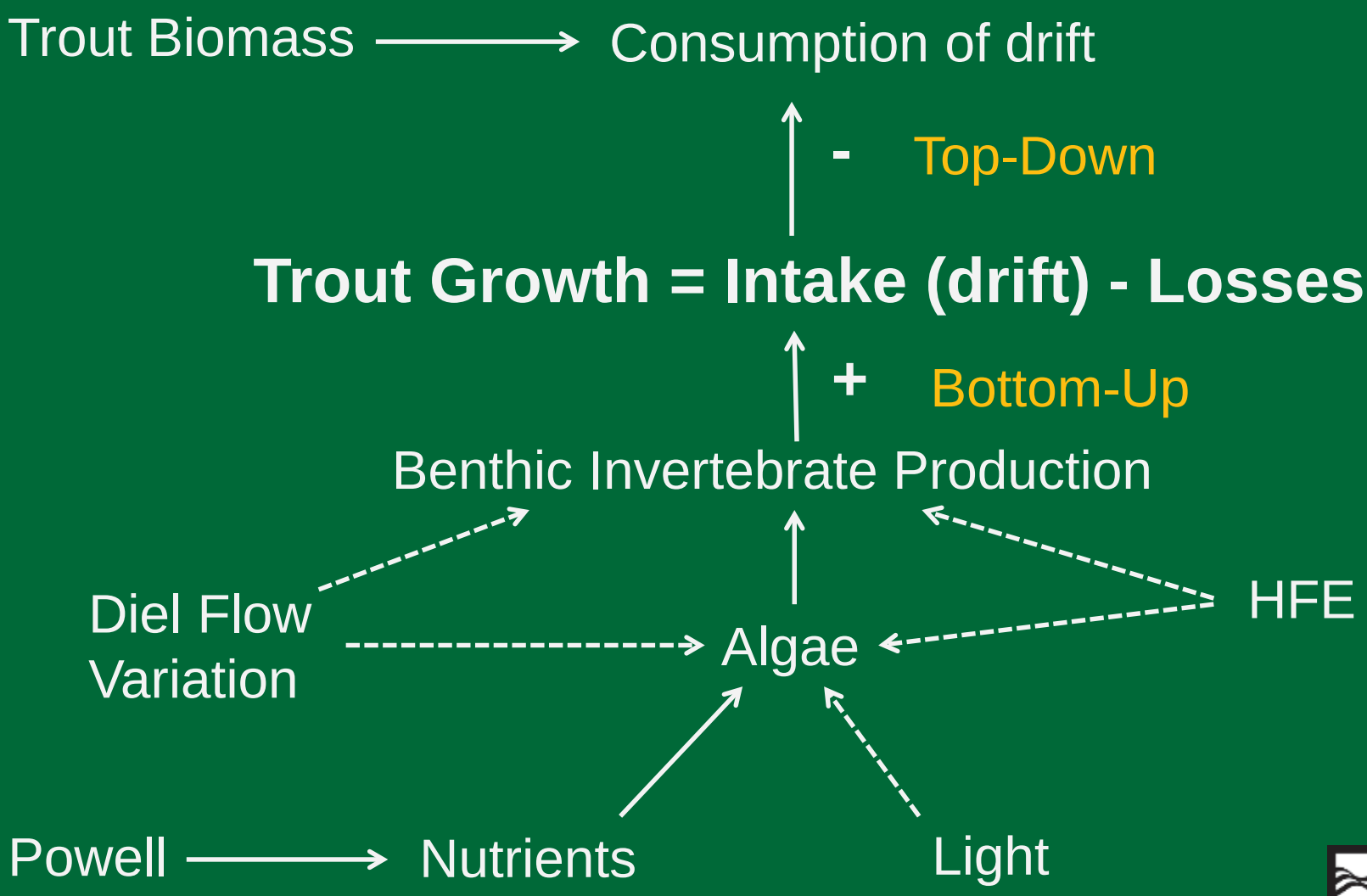
Bottom-Up Vs. Top-Down Control of Trout Growth



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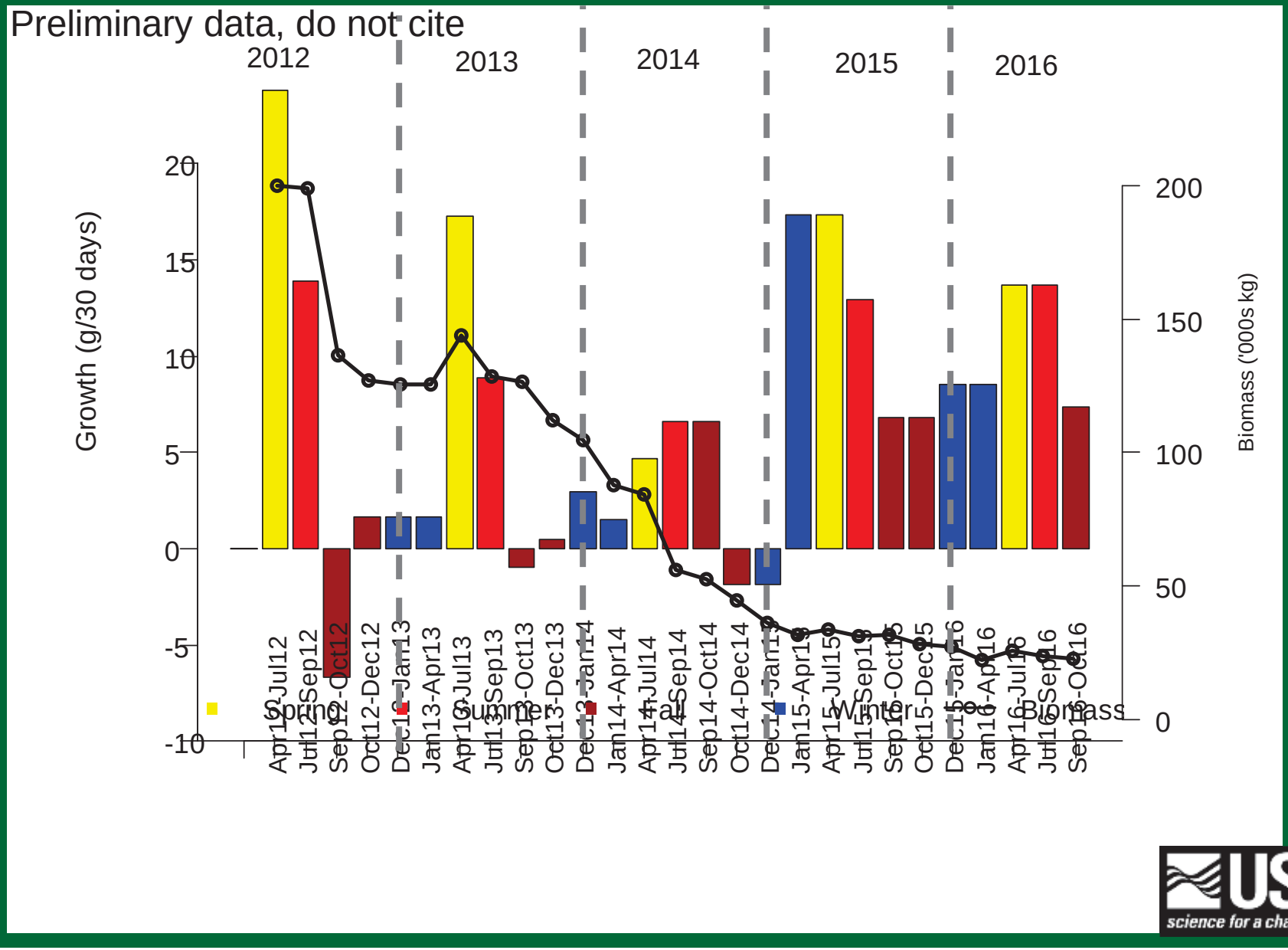
Trout Growth Controlled by Bottom-Up Variation in Prey Availability



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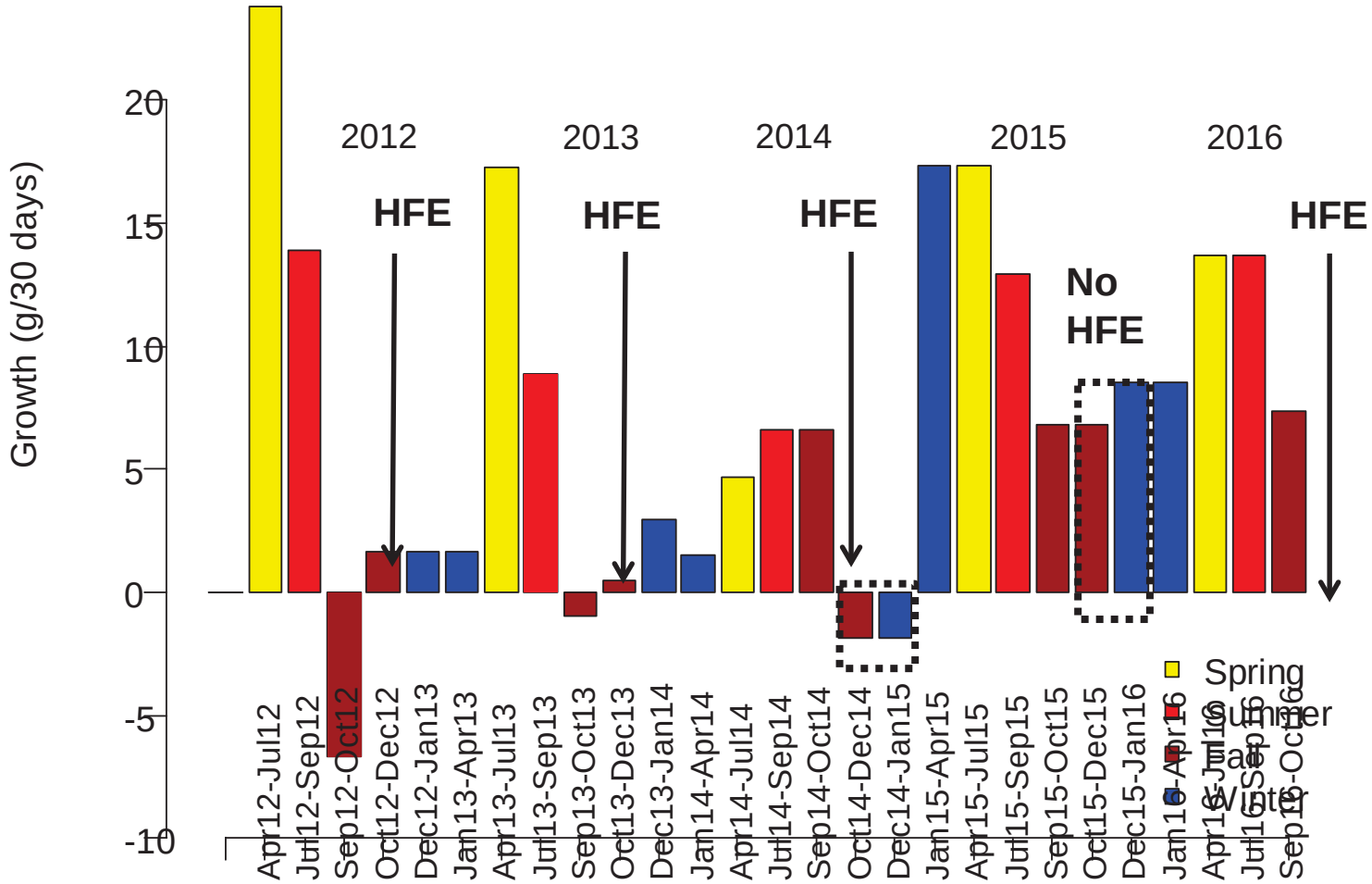
Effect of Fall HFEs on Growth (8” trout)

Preliminary data, do not cite



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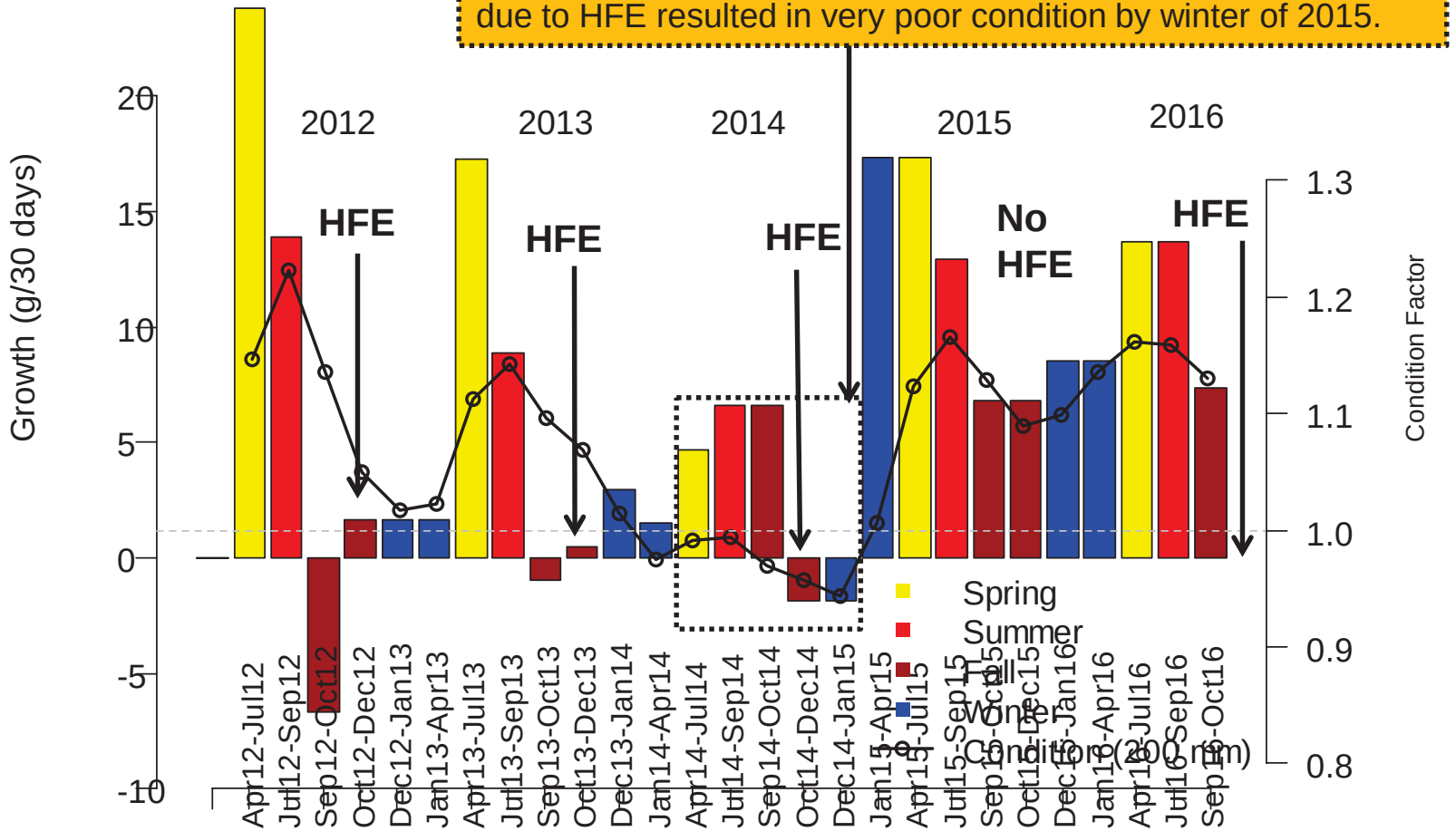
Effect of Fall HFEs on Condition (8” trout)

Preliminary data, do not cite

Poor growth in spring & summer due to lower nutrient levels in GCD discharge combined with poor growth during fall & winter due to HFE resulted in very poor condition by winter of 2015.



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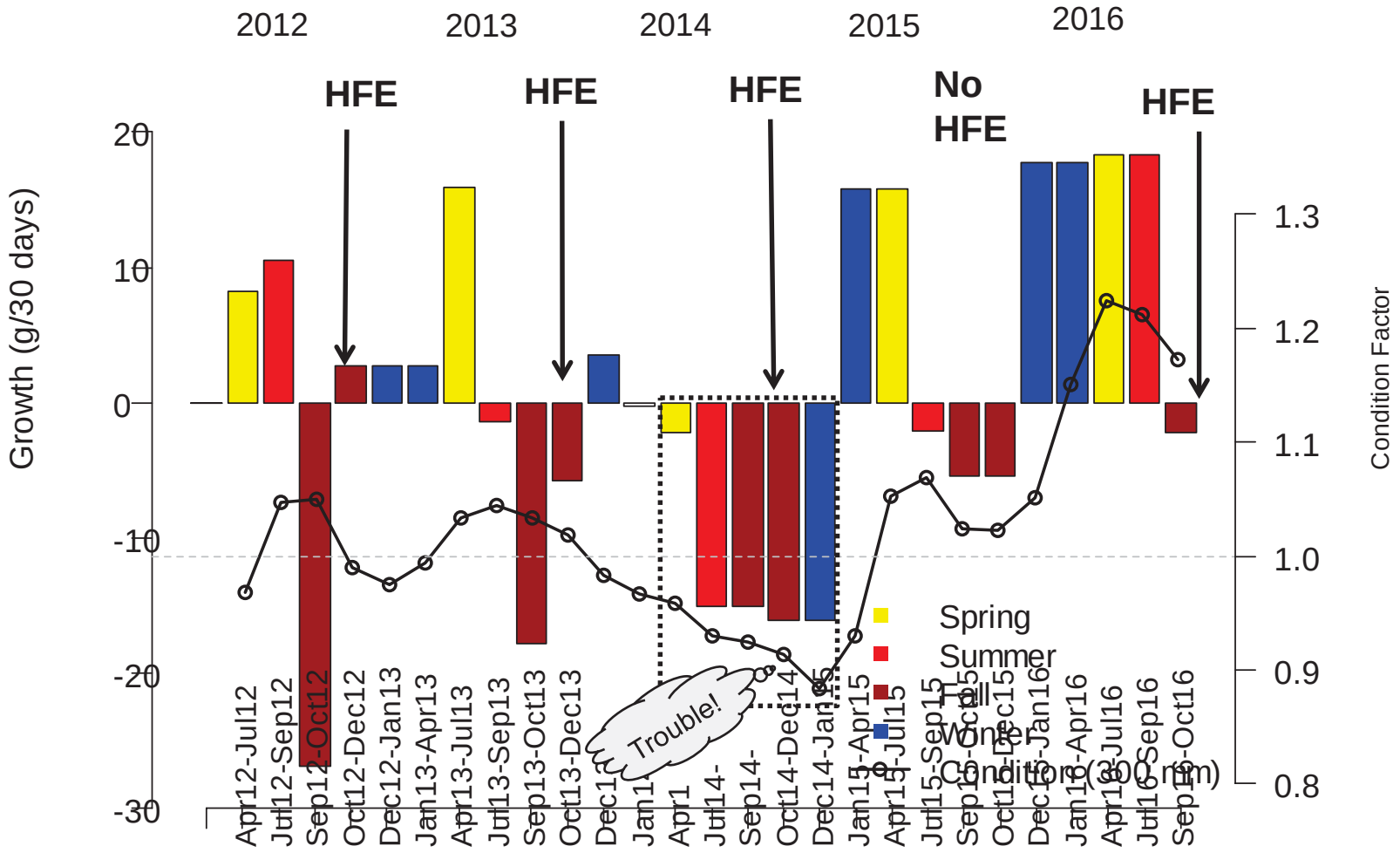
Effect of Fall HFEs on Condition (12” trout)

Preliminary data, do not cite



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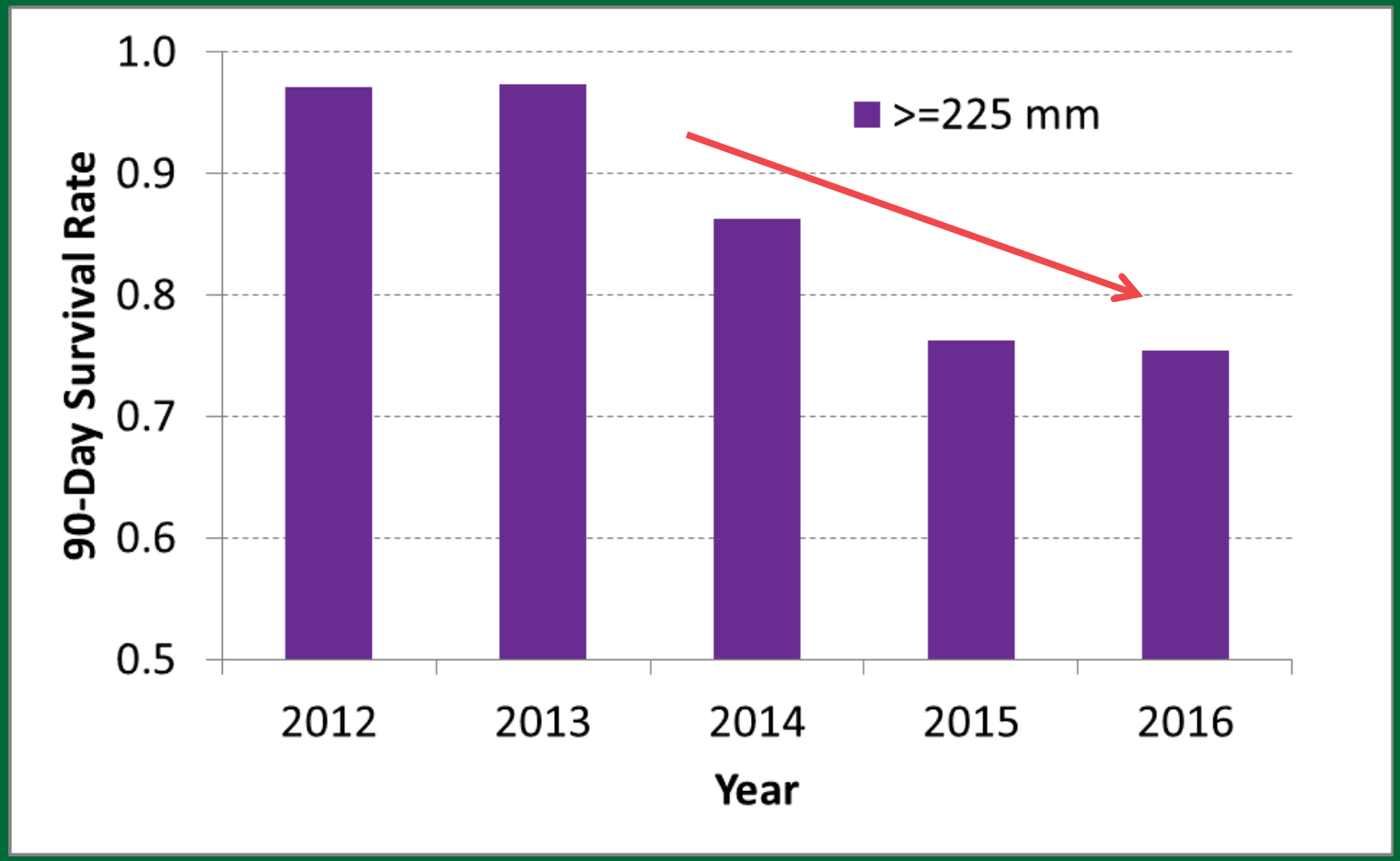
Effect of Growth on Survival



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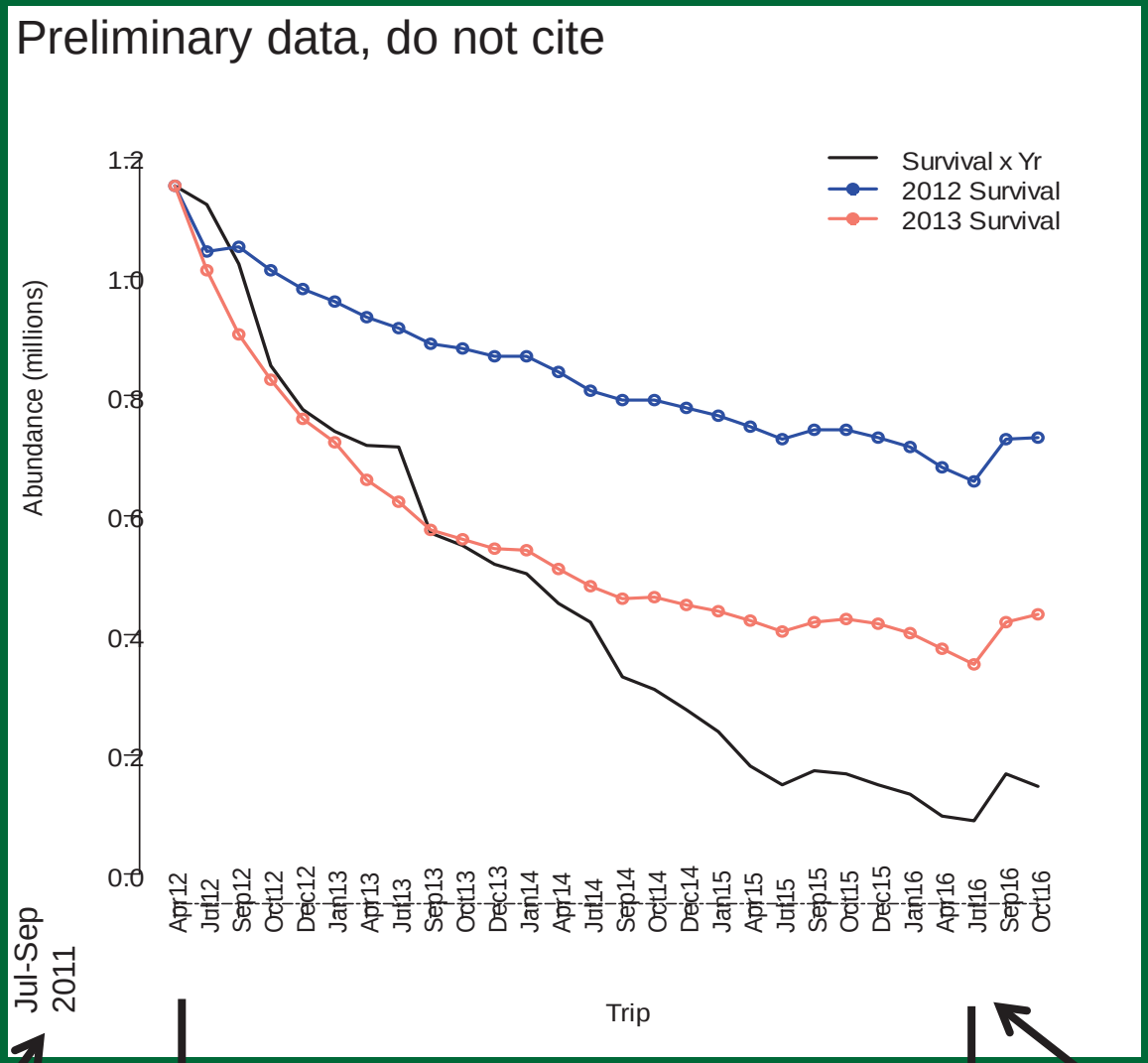
Preliminary data, do not cite

Effect of Survival on Abundance

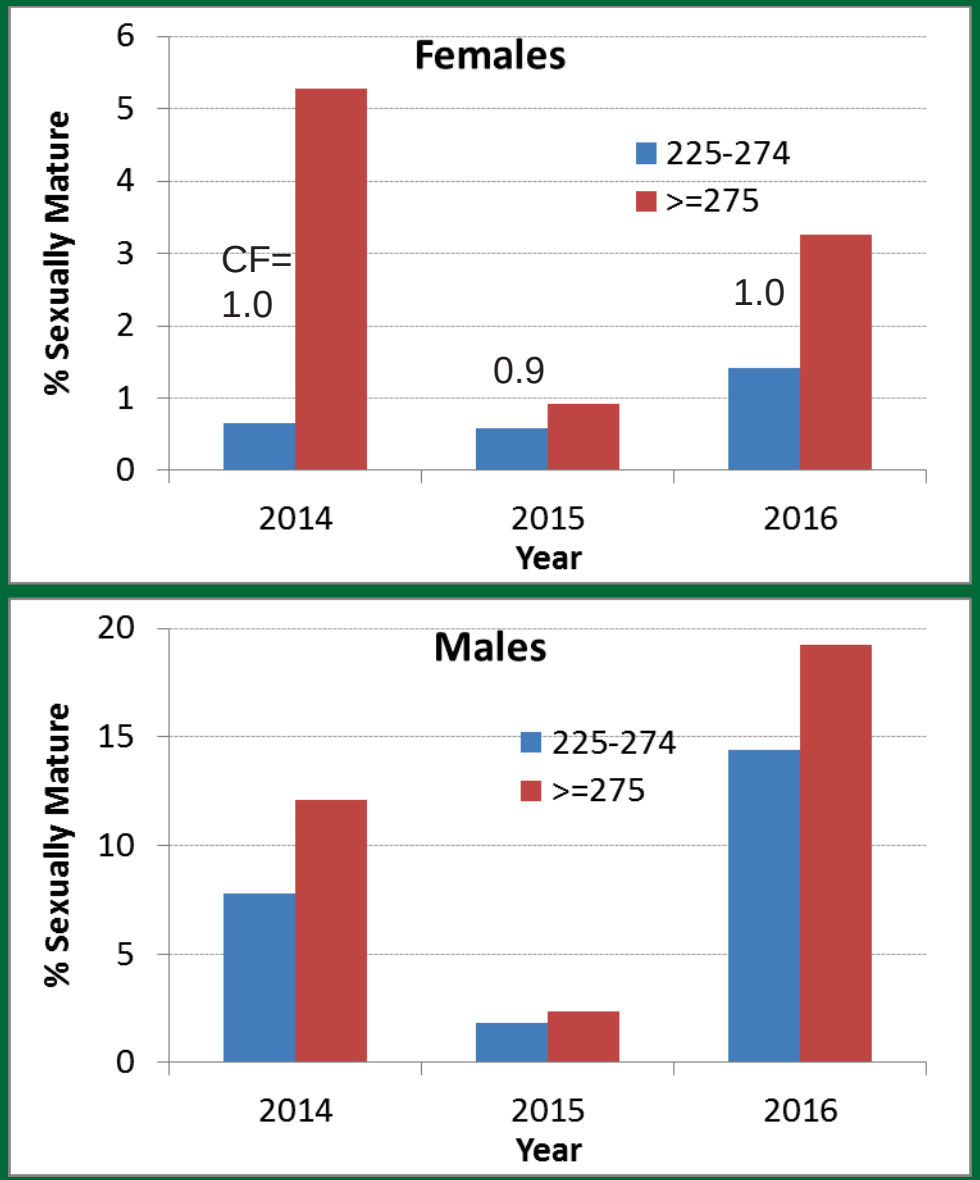


Large <75 mm export

Very limited < 75 mm export
Very few trout >75 mm move downstream

Moderate <75 mm export

Effects of Growth on Maturation



Preliminary data, do not cite

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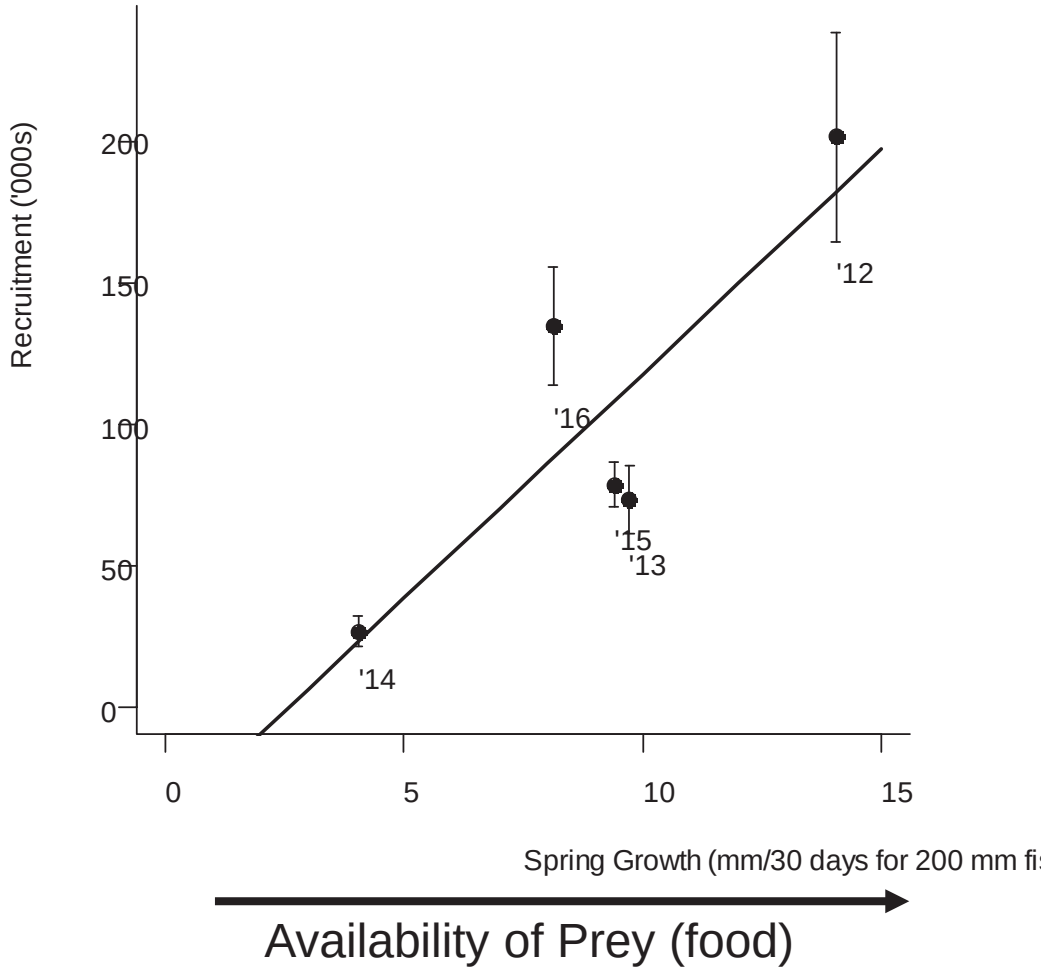
Effect of Growing Conditions on Recruitment

Preliminary data, do not cite



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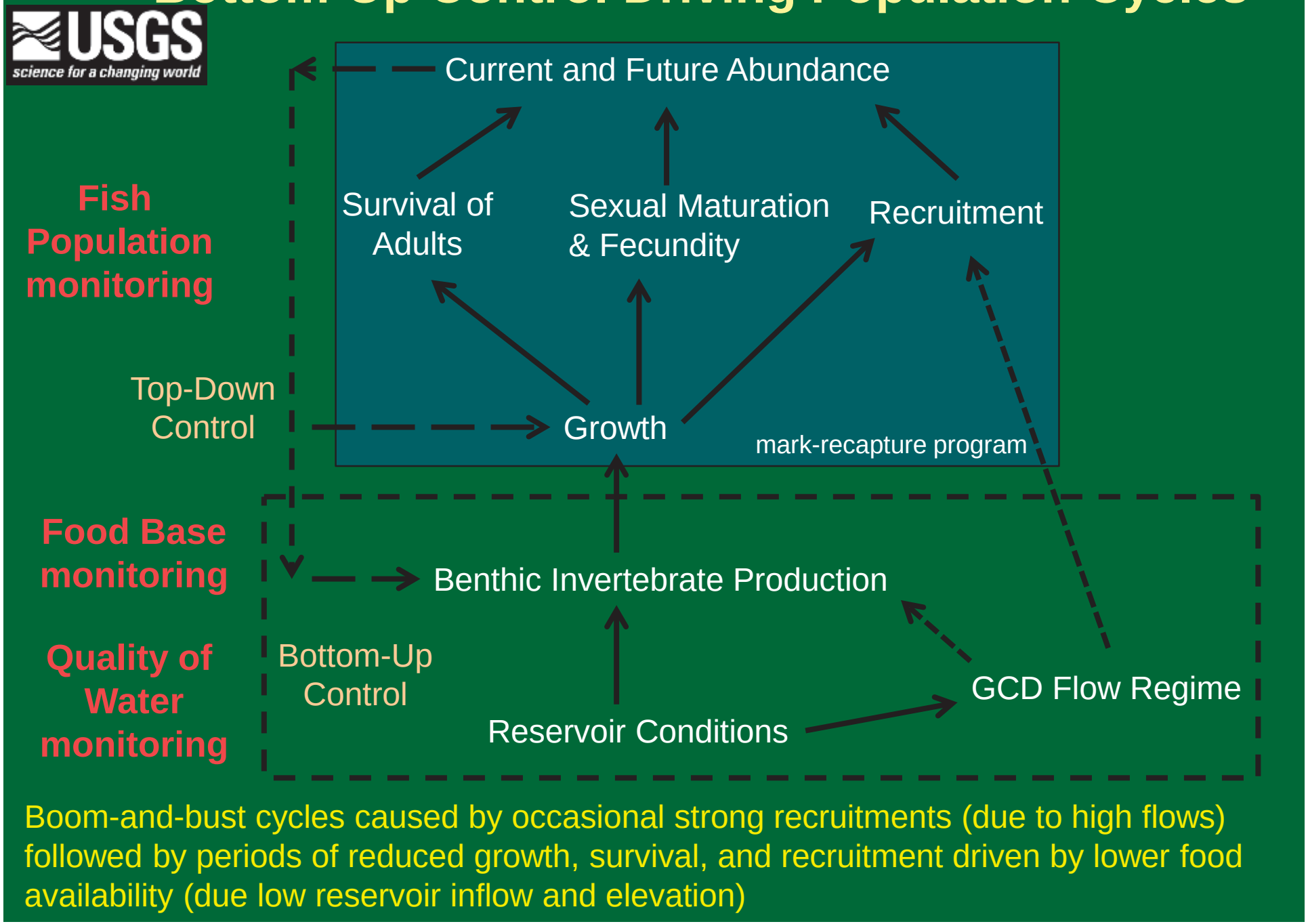
Bottom-Up Control Driving Population Cycles



Boom-and-bust cycles caused by occasional strong recruitments (due to high flows) followed by periods of reduced growth, survival, and recruitment driven by lower food availability (due low reservoir inflow and elevation)

Introducing the RBT-100 Food Intake Sampler

Trout Growth = Intake (drift) - Losses

Intake = Trout Growth + Losses

Operating Instructions for RBT-100

1. Catch trout, measure, weigh, tag and record information
2. Deploy RBT-100 instrument into environment (or -101 or -300, etc.)
3. Return to office and go about your daily business, allowing RBT-100 to sample over desired interval (integrated food availability)
4. Retrieve RBT-100. Scan, measure, weigh, record and re-deploy!
5. >16,000 RBT-xxx's recovered to date. Also see HBC-100.

Caution. Some work at night may be required

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Potential Policy Implications

- Avoid boom-and-bust cycles to reduce trout export to LCR and maintai consistent catch rates and larger trout in the fishery:
  - Enhance food supply via 'bug flows' or fertilization (add liquid nitrogen & phosphorous) as a mitigation for fluctuating flows and low reservoir elevation
  - Limit recruitment via Trout Management Flows (TMFs)
  - Do not implement fall HFEs in years when trout are in poor condition
  - Fertilize prior to conducting an HFE to mitigate negative effects
- Critical uncertainties
  - Will TMFs be implemented & work? What years to implement (e.g., 2016)?
  - Will bug flows or fertilization increase food supply?
  - Does enhanced food supply increase or decrease extent of trout export?

Future Monitoring in Glen Canyon

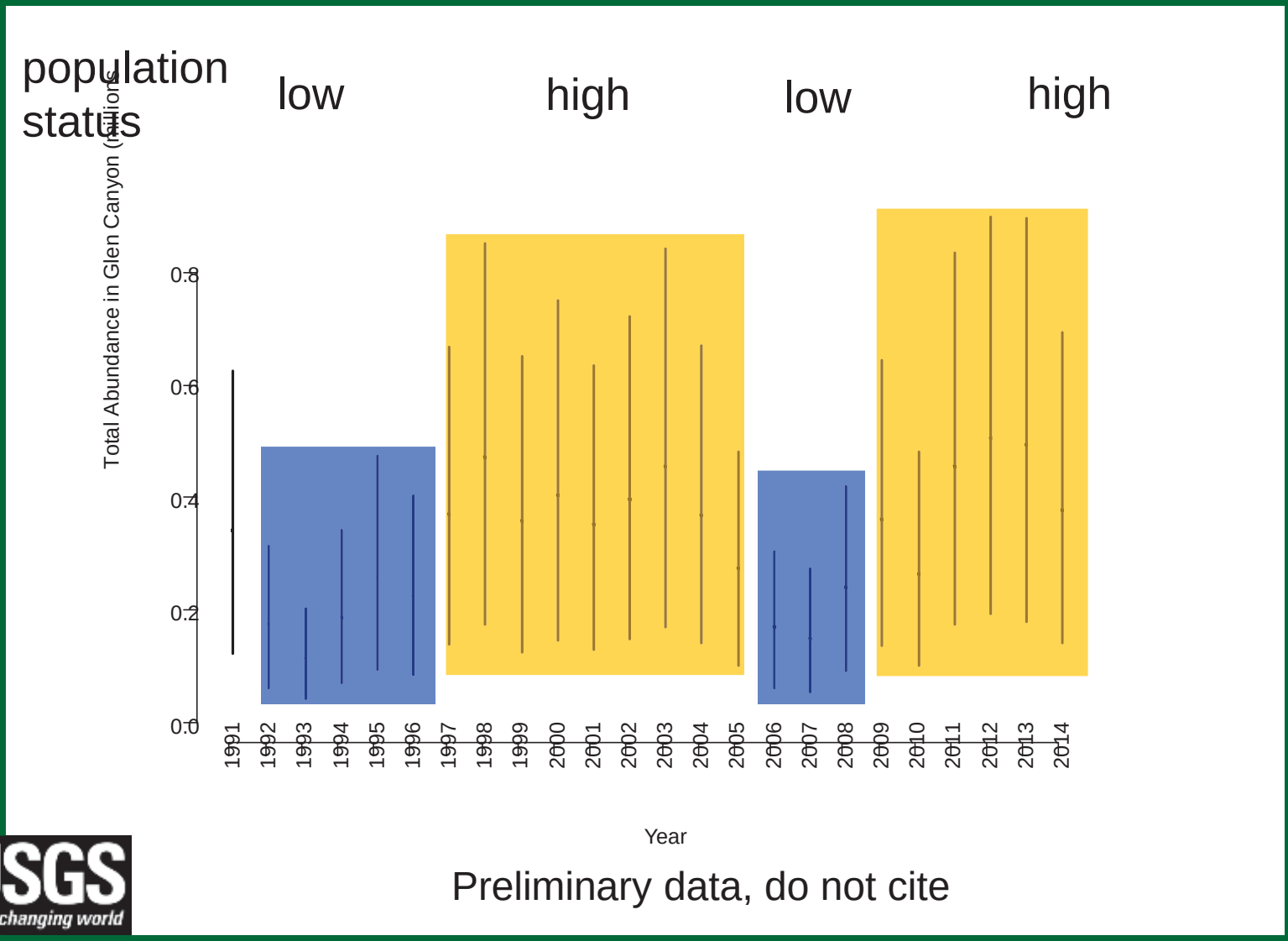
- STAY ON THE ROAD TO LEARNING: Estimate growth, survival, recruitment, and abundance by mark-recapture at time- scale that is fine enough to address GCD AMP questions.
  - Response of recruitment to a particular flow in one year (e.g. spring HFE, 2011 equalization)
  - Seasonal effects of fall HFEs on growth
  - "Identify approaches to determine the root cause(s) of the unstable trout population in Lees Ferry" (#1 question)
  - Measure export of trout from Glen Canyon to upper Marble Canyon (tagging not needed)
- The current Catch-Per-Effort survey provides imprecise indices of recruitment and abundance.
  - Useful for assessing trends in population over longer blocks of time (e.g. 5 yrs), but not for tracking annual changes needed to address management questions
  - Growth is not estimated from CPE surveys but is needed to understand why recruitment and abundance are changing, and effects of fall HFEs.
- Two choices for TWG:

A. Keep asking current management questions and therefore continue with mark-recapture program that can address these questions.

B. Ask much simpler questions restricted to long-term trends in status which can be addressed from current CPE program.

What Catch-per-Effort Surveys (CpE) Tells Us

N = CpE/q (q=proportion of population captured)



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