

A Synthesis - What we have learned about rainbow trout movement, growth, survival over the study period that has implications to management



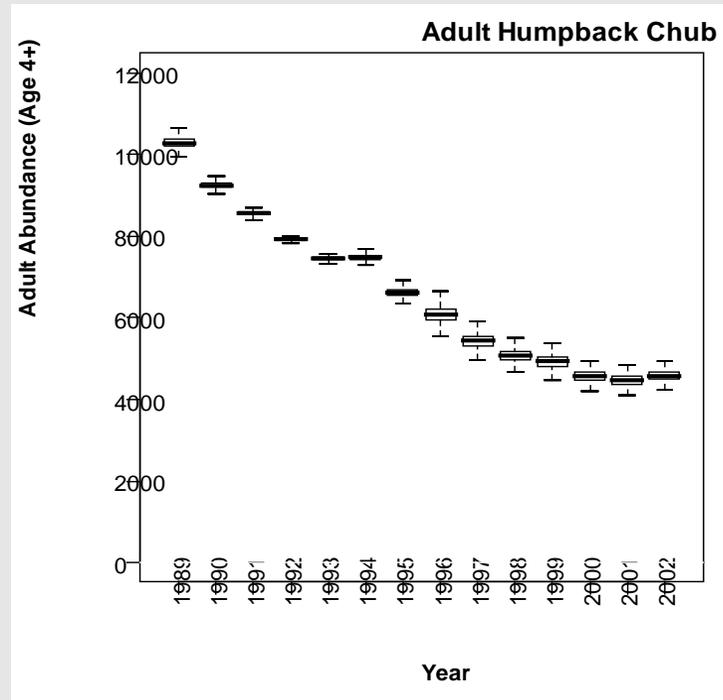
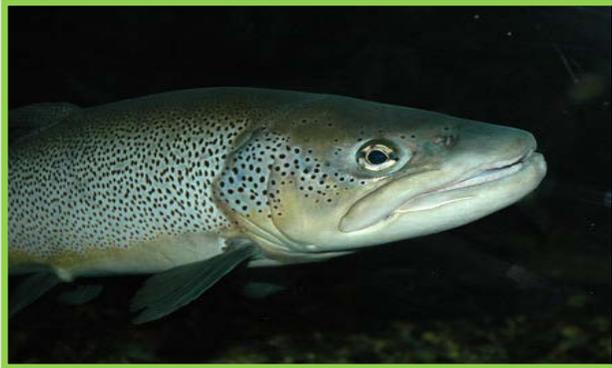
Michael D. Yard, GCMRC, Flagstaff, AZ

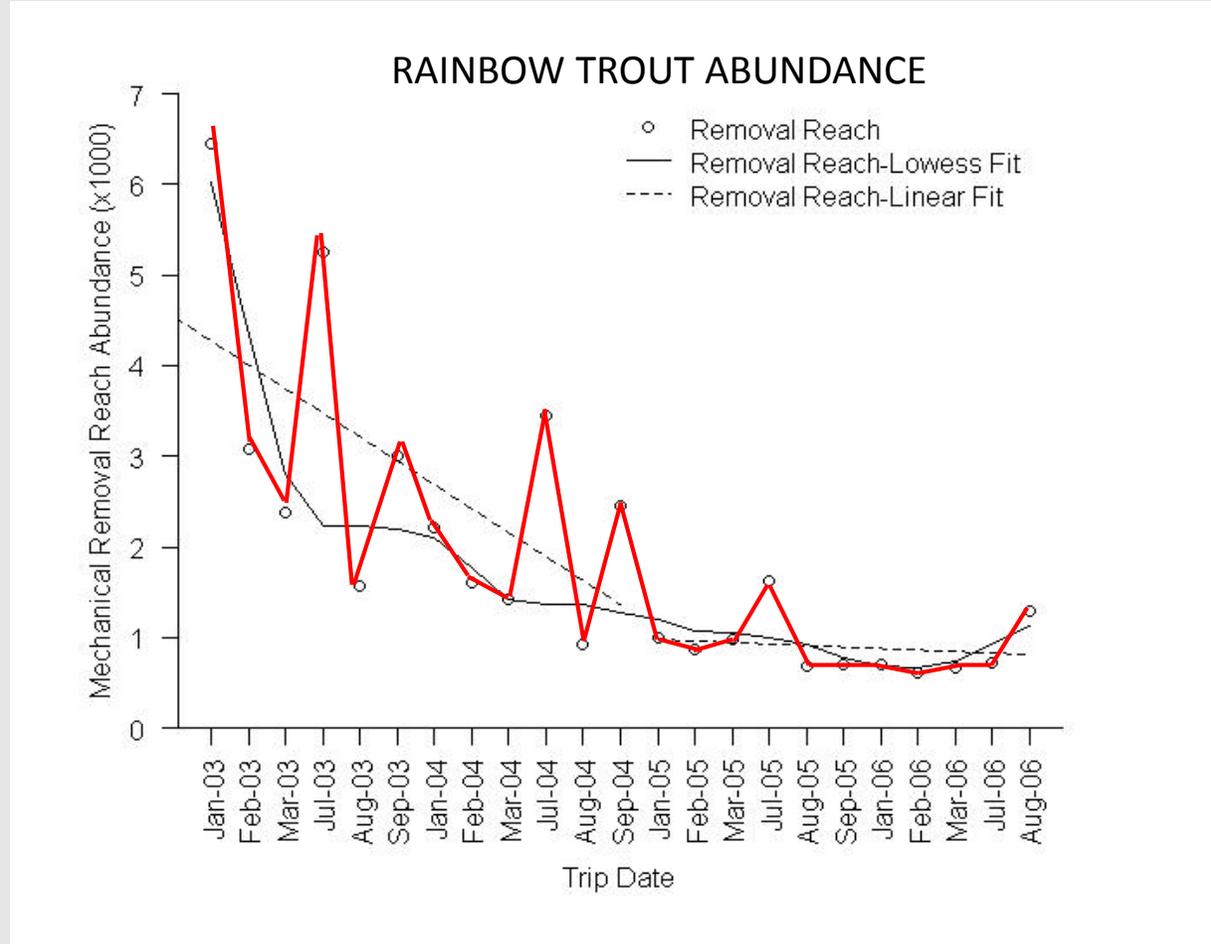
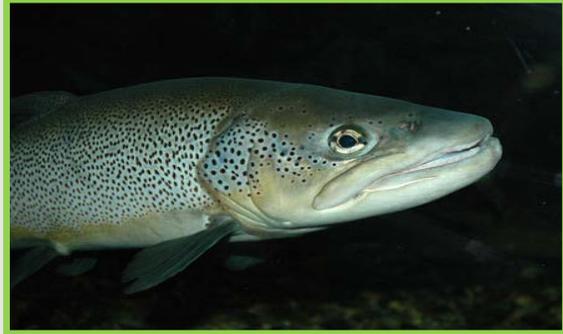
Josh Korman, Ecometric Research, Vancouver, BC

Natal Origin Project

GCDAMP - Annual Reporting Meeting
January 2017

Decline in adult Humpback chub





Findings:

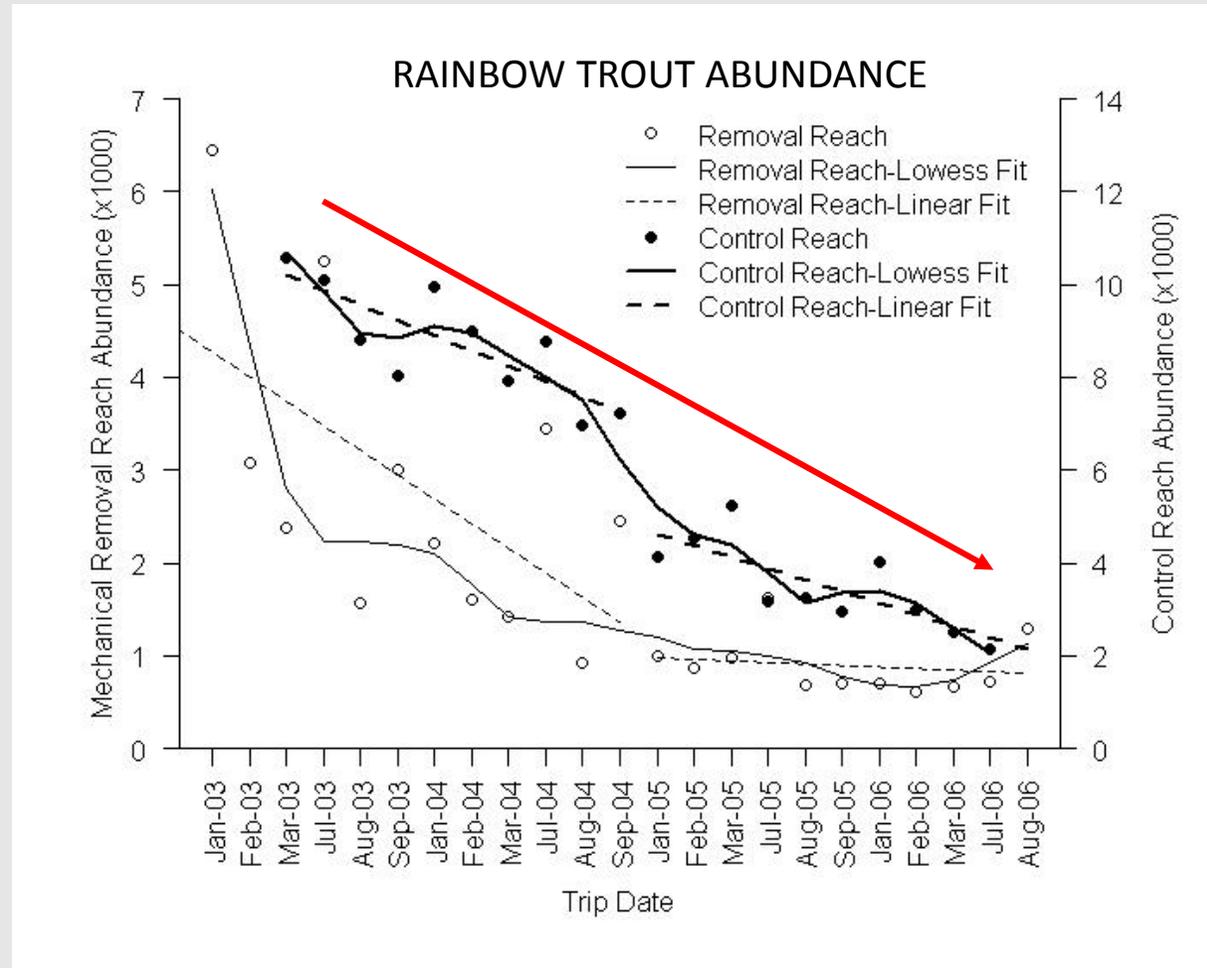
- Efficacy of Mechanical Removal
- RBT abundance was high and variable, partially offset by trout immigration
- BNT were more predaceous than RBT
- RBT were more numerous than BNT
- Predation risk is a function of both density & predatory behavior

Coggins et al. 2011
Yard et al. 2011

Questions:

- What controls trout abundance?
- Where were RBT migrants originating from?
- How many sub-adult HBC move into the mainstem?
- How variable was sub-adult HBC survival?
- Was there a relationship between HBC survival & RBT abundance?

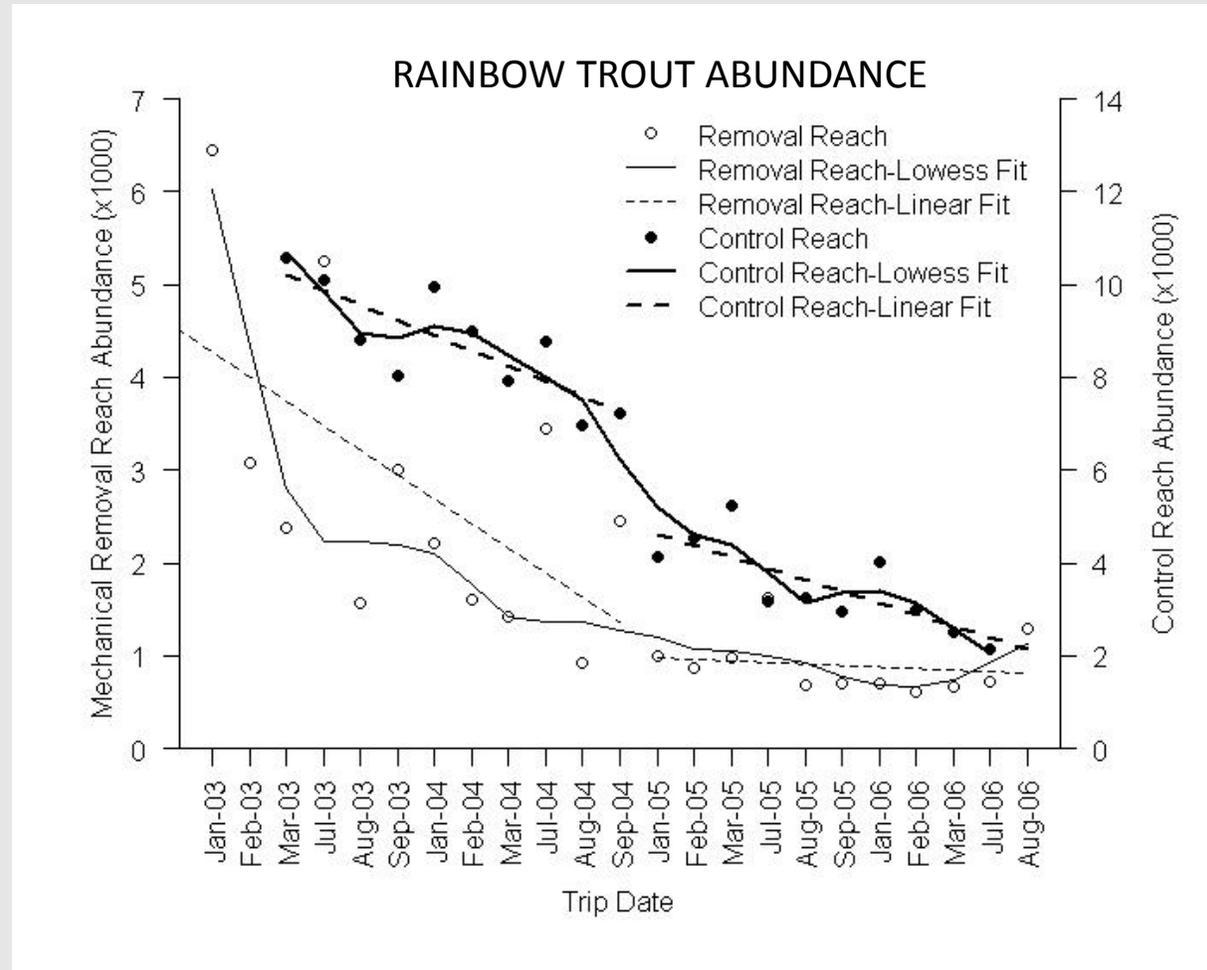
? Chub



- Trout were not removed from the control site
- 80% decline over 4 years
- Major truncation occurred between 2004 & 2005
- Similar to 2014 & 2015

Questions:

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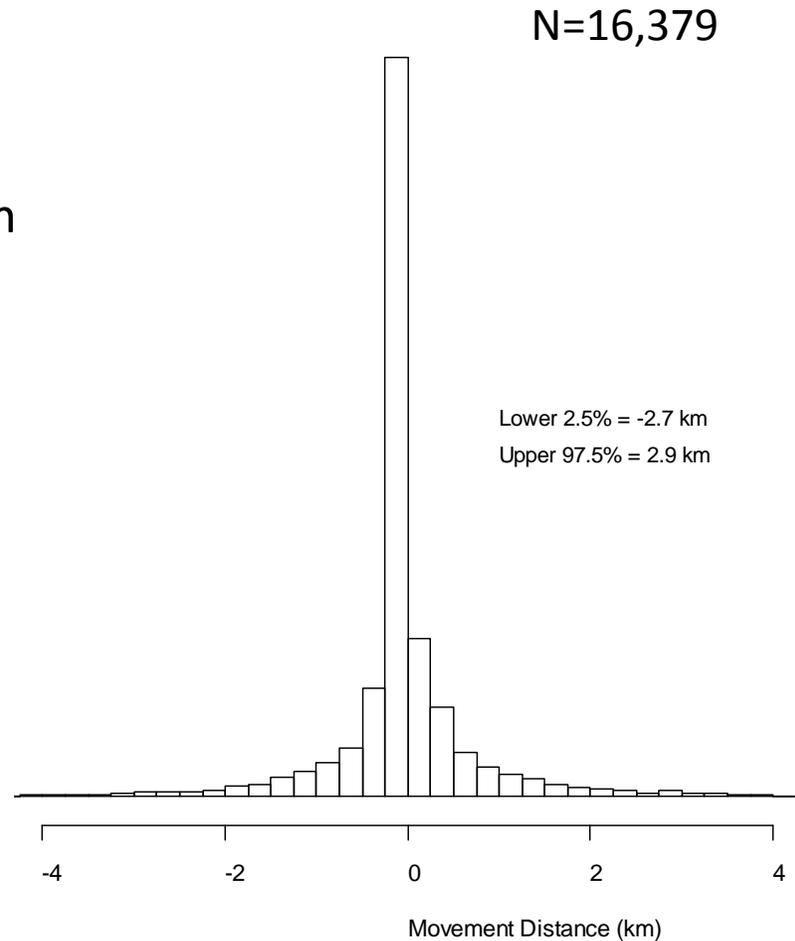


Outcome:

- Develop alternative sampling methods for determining:
 - Abundance
 - Vital rates
- Natal Origin Project
 - Movement
 - Trout dynamics
- NSE/JCM Projects
 - Juvenile HBC survival
 - Regulating factors

Movement Based on Tag Recoveries

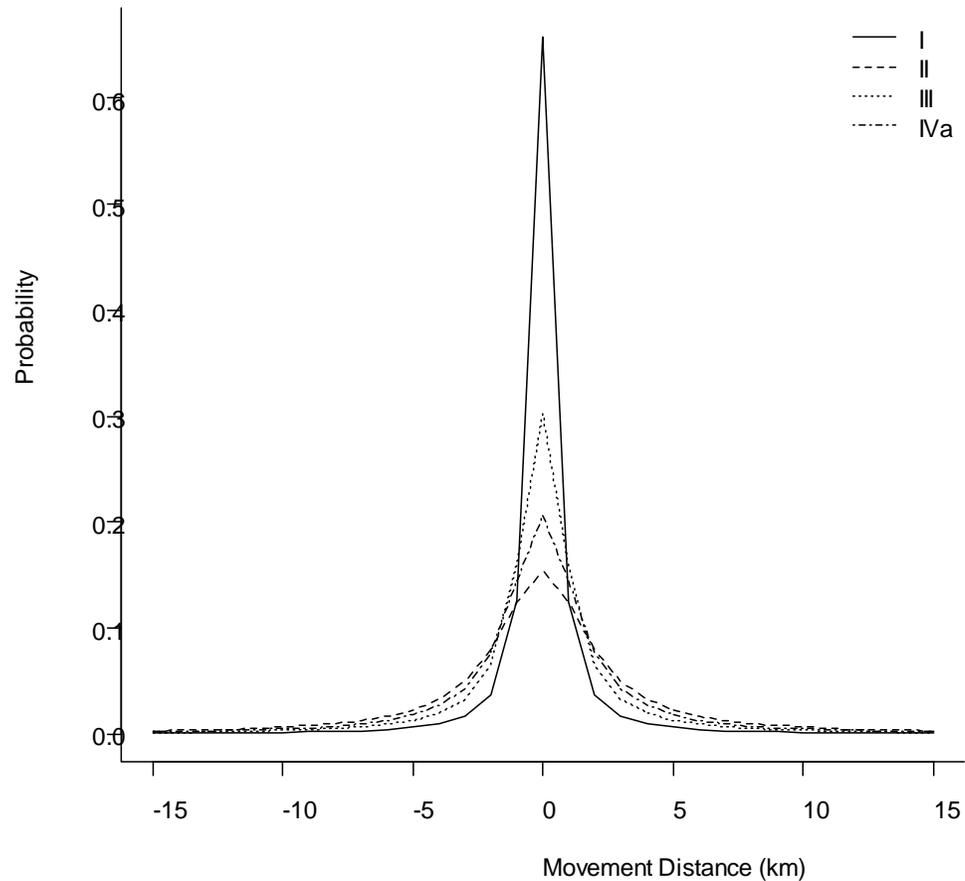
- Majority of rainbow trout exhibit limited movement based on differences between release and recapture locations.
- Taggable size is ≥ 75 mm FL
 - Moderate to large sizes
- 95% of recaps moved no more than
 - -2.7 km upstream
 - 2.9 km downstream



Upstream

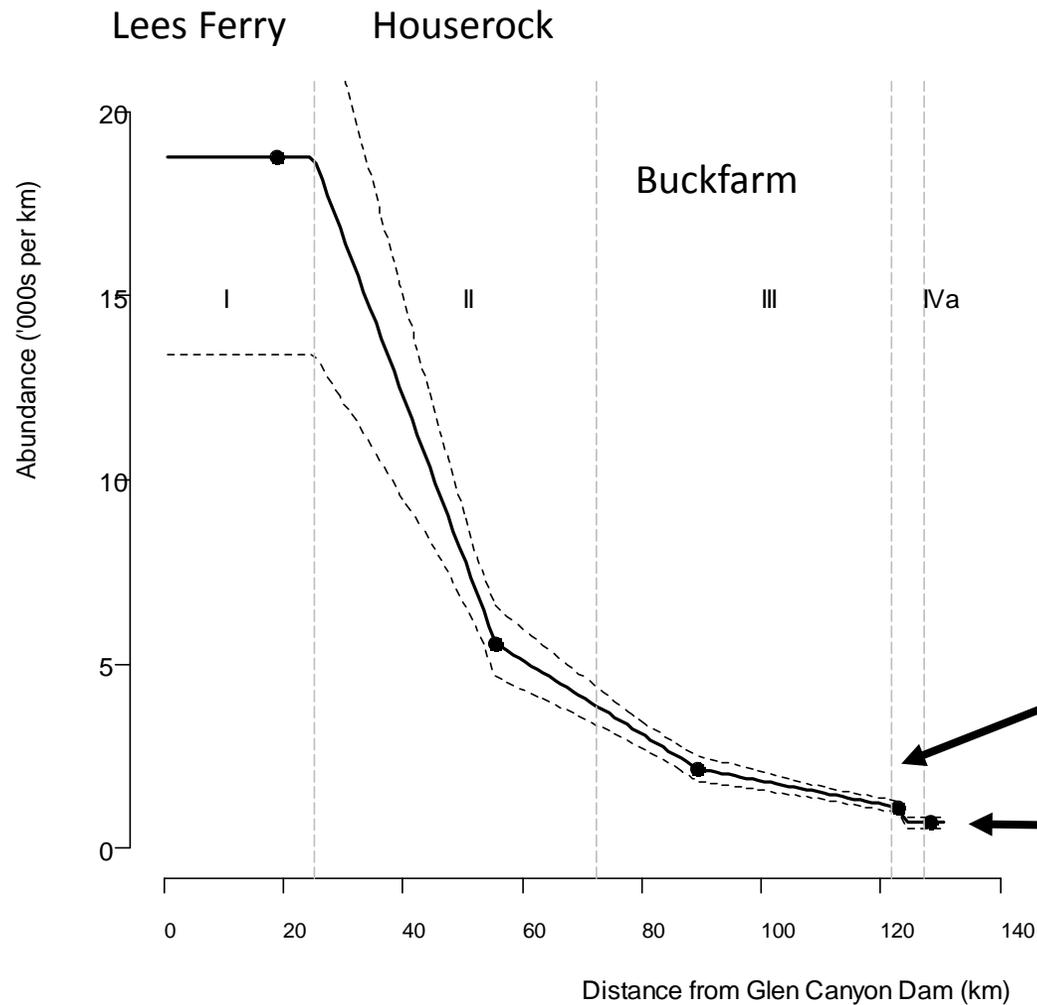
Downstream

Movement Probabilities



- There is a low probability for an individual fish to move large distances.
- More fish upstream – more fish will move downstream
- Abundance is a key factor

Reach-wide trout abundance and range: estimates between 2012-2014

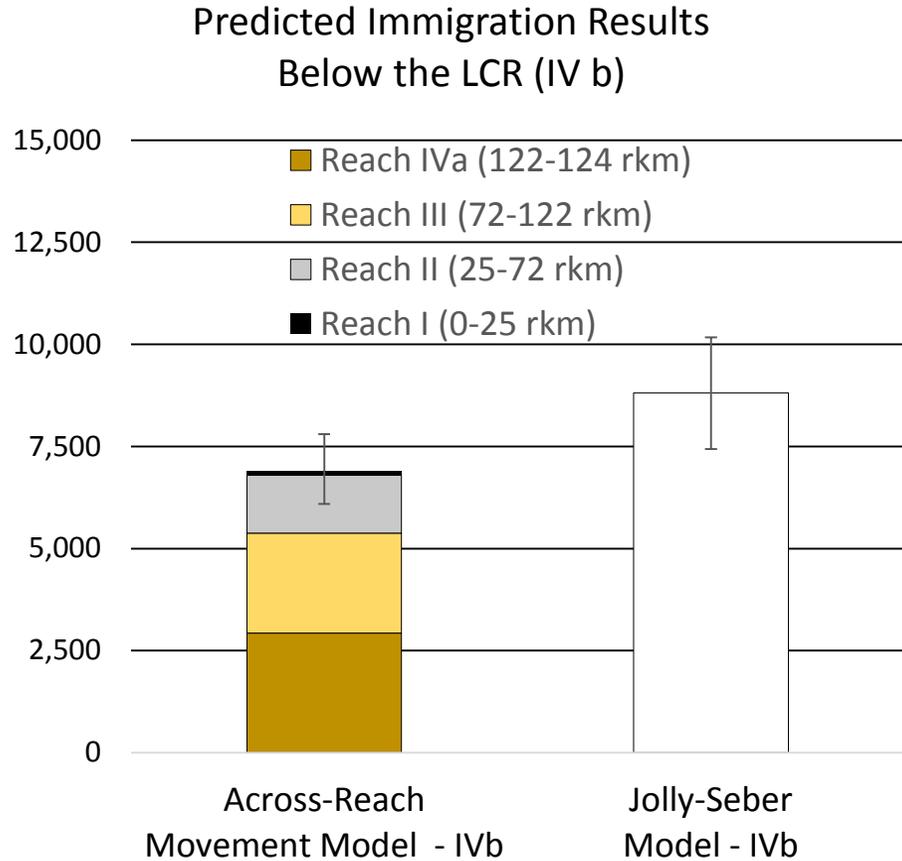


- Dispersal from upstream sources depends on the trout abundance(s) in each of the upstream reaches.
- The number of migrants decrease in relation to increasing distance from point of origination.

Above the LCR: IVa

Below the LCR: IVb

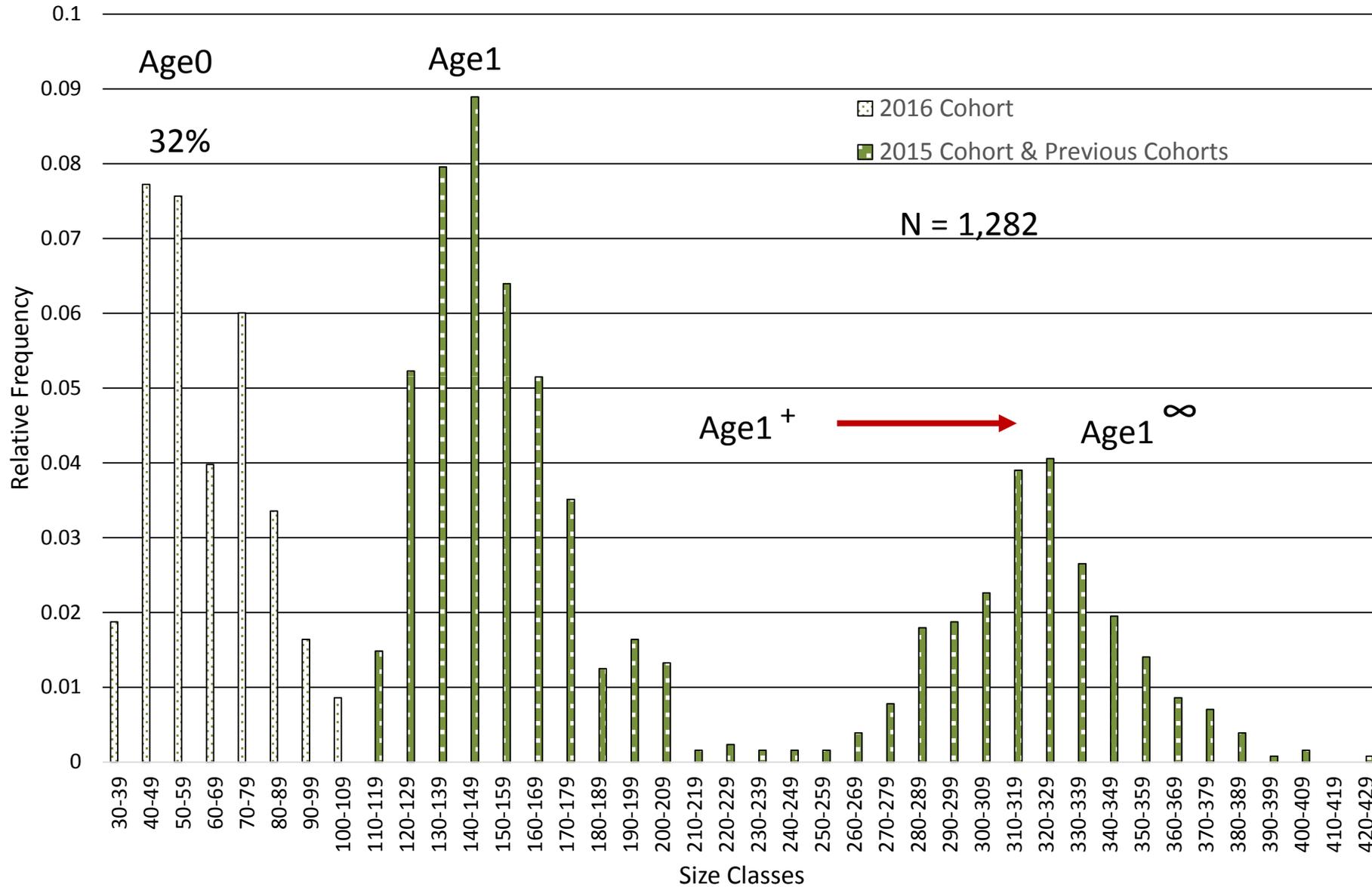
Modeled comparisons



- Equivalent results between two independent models
- Recruitment in the reach below the LCR can be accounted for solely by immigrants from upstream sources

Estimates reflect the reach below the LCR

July 2016 - Lees Ferry Size Distribution

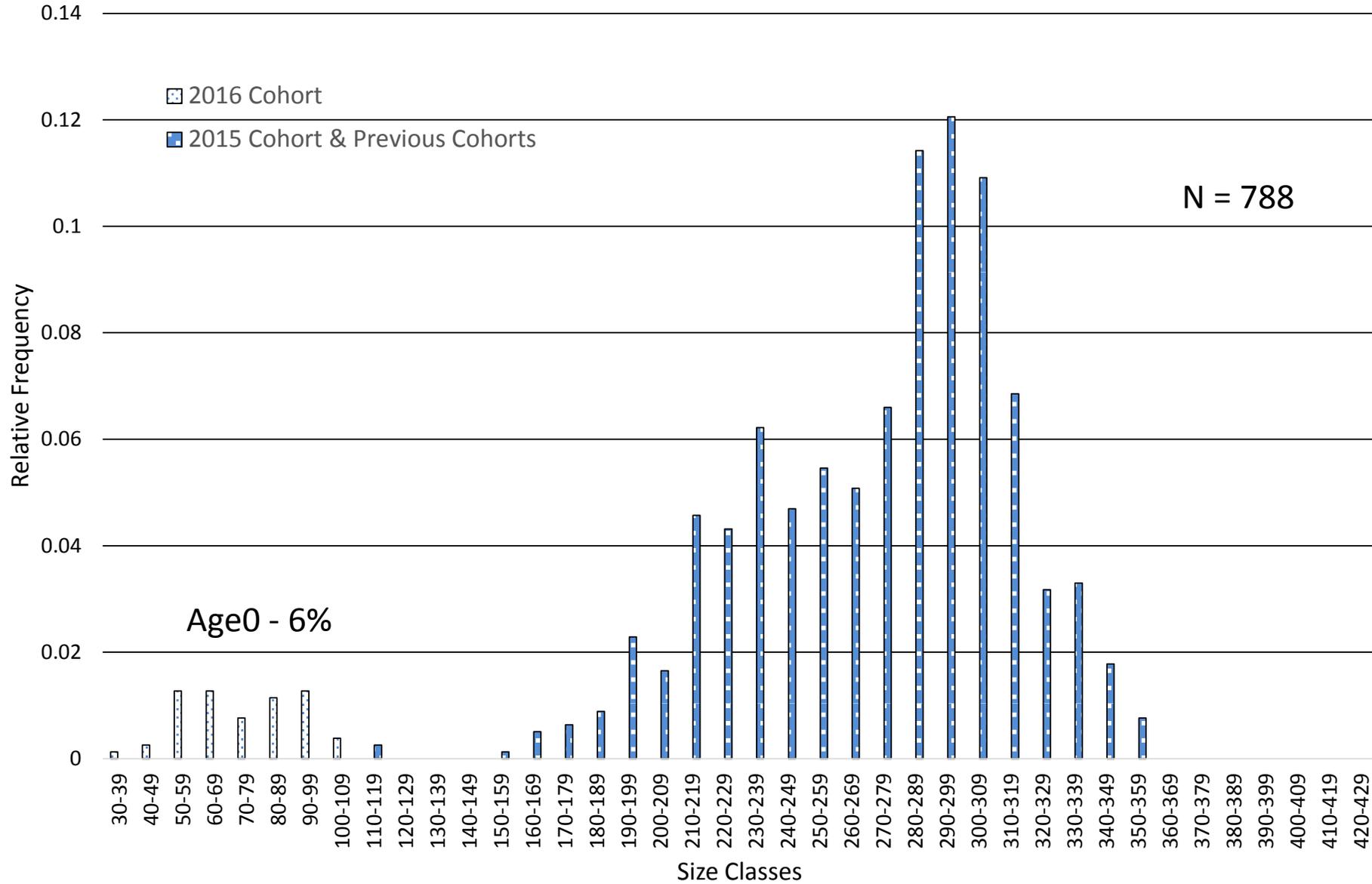


- July 2016 – Length frequency distribution
- Age0 comprised 32% of total catch
- Moderate recruitment event compared to previous years

Provisional data



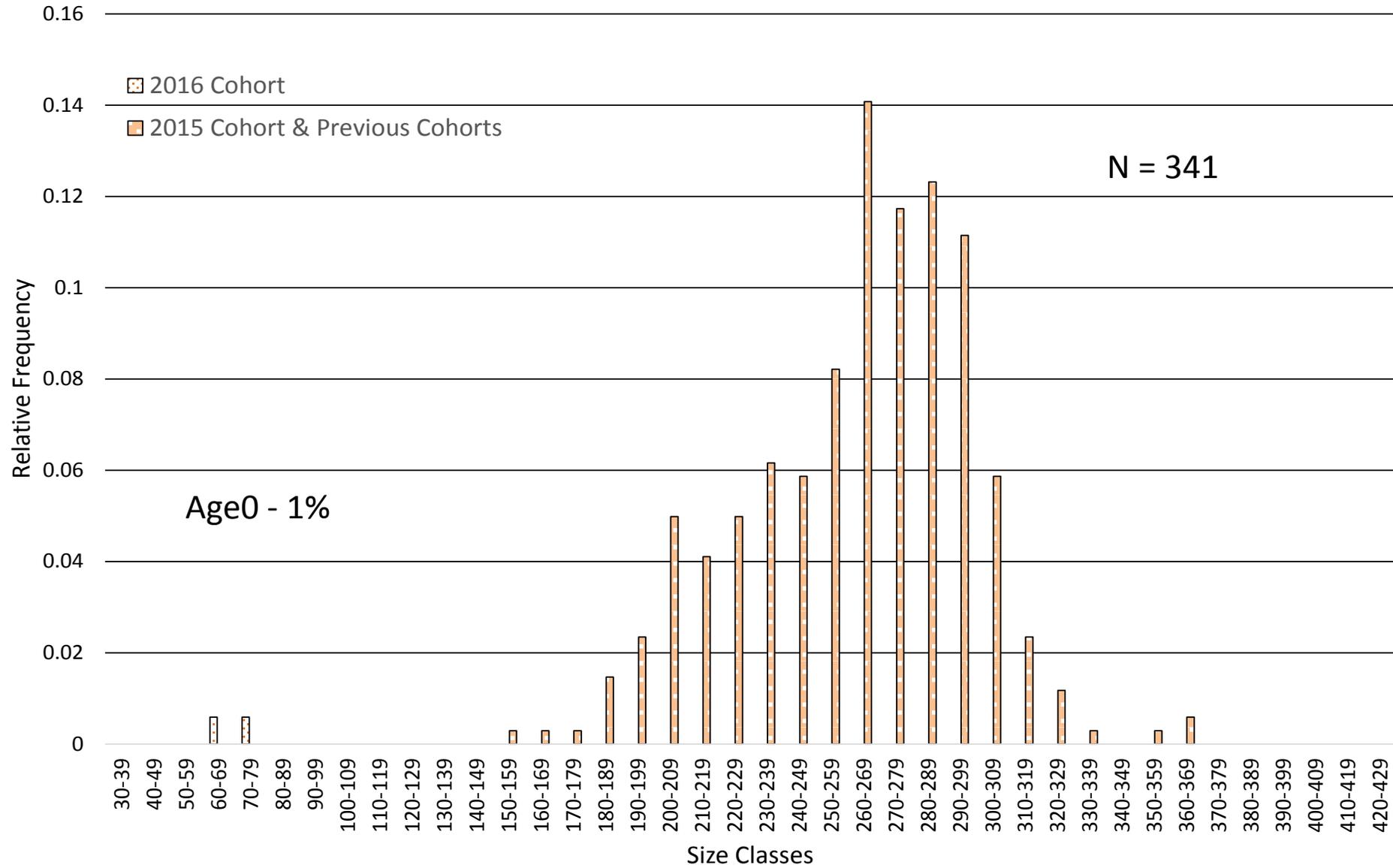
July 2016 - HouseRock Size Distribution



- Age0 comprise 6% of HouseRock's July 2016 catch
- Reach morphology and hydrology are not considered suitable for reproduction

Provisional data

July 2016 - Buckfarm Size Distribution

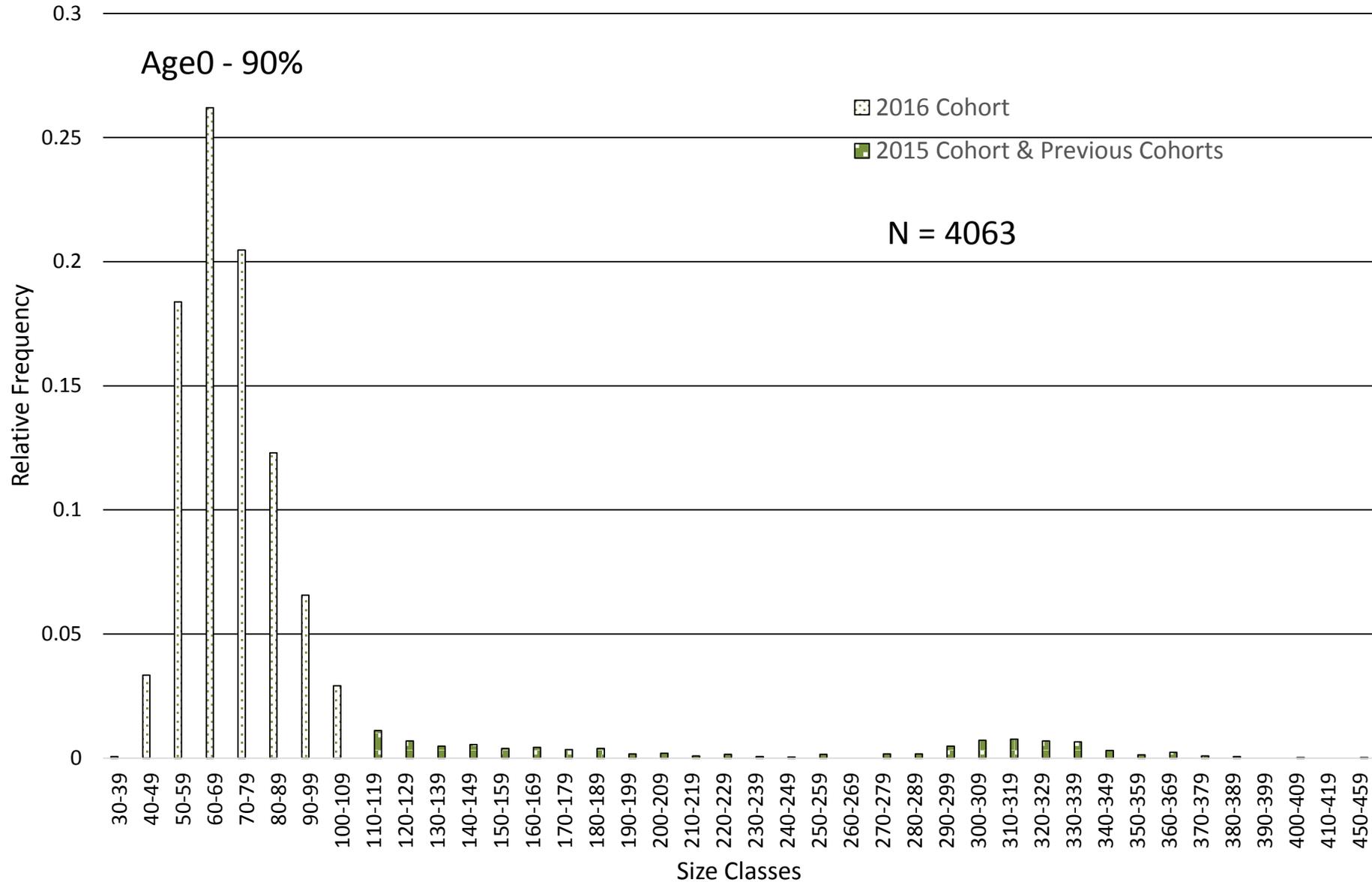


- July 2016 - Age0 comprise 1% of Buckfarm's catch

Preliminary data



September 2016 - Lees Ferry Size Distribution

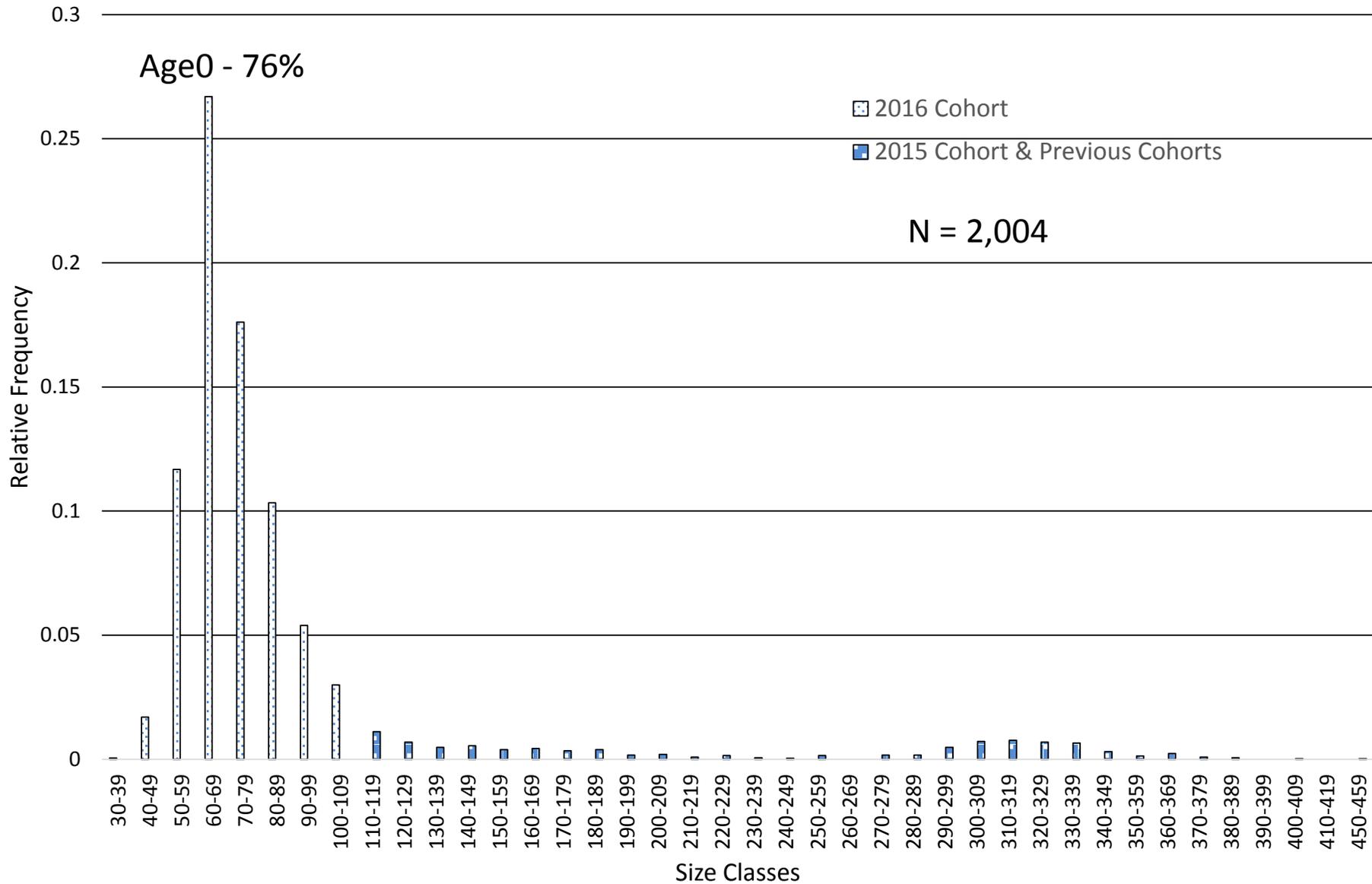


- Age0 comprise 90% of Lees Ferry's September 2016 catch
- In two months this size class dominated the total catch
- Total catch doubled
- **1st strong year class since 2011**

Provisional data



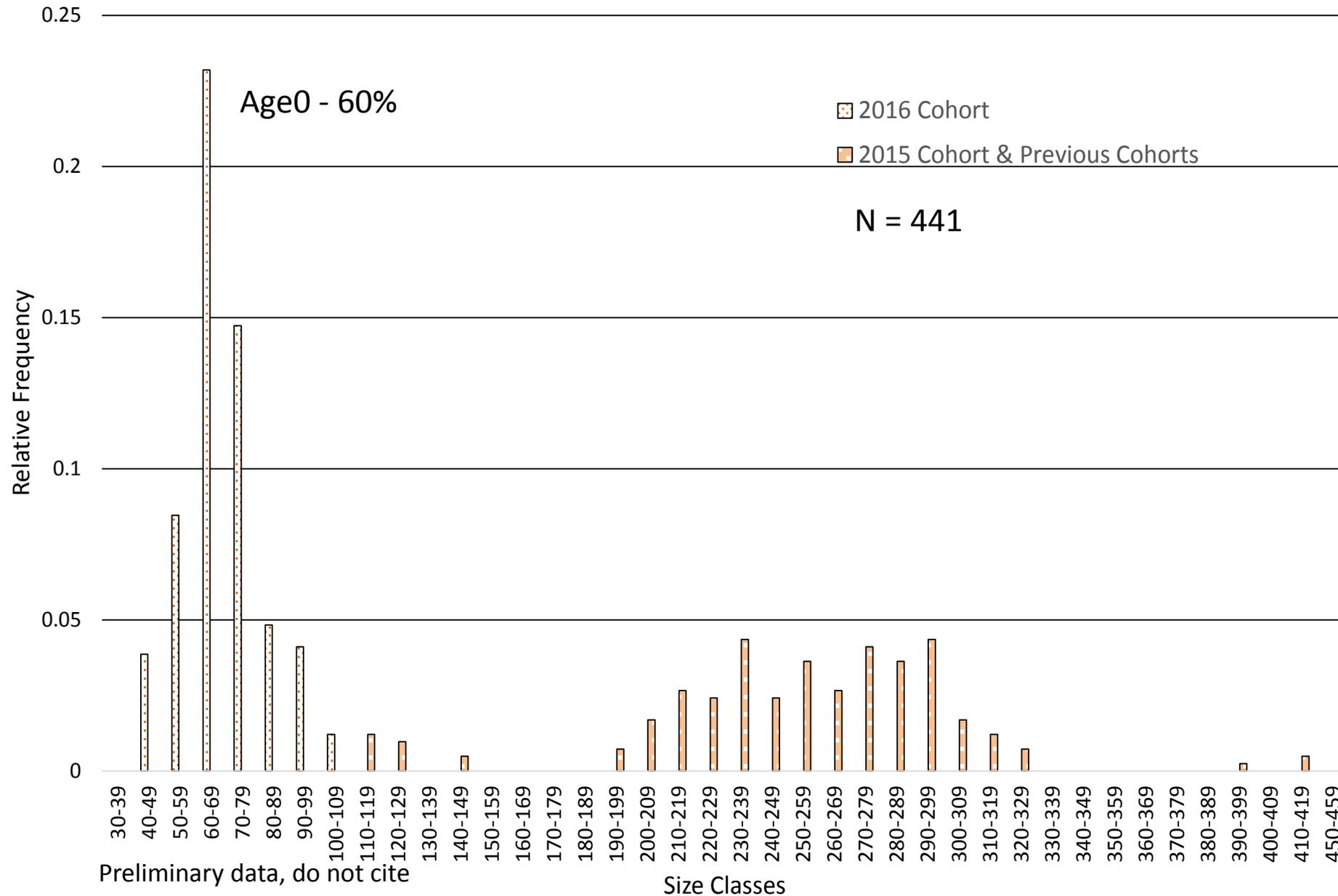
September 2016 - HouseRock Size Distribution



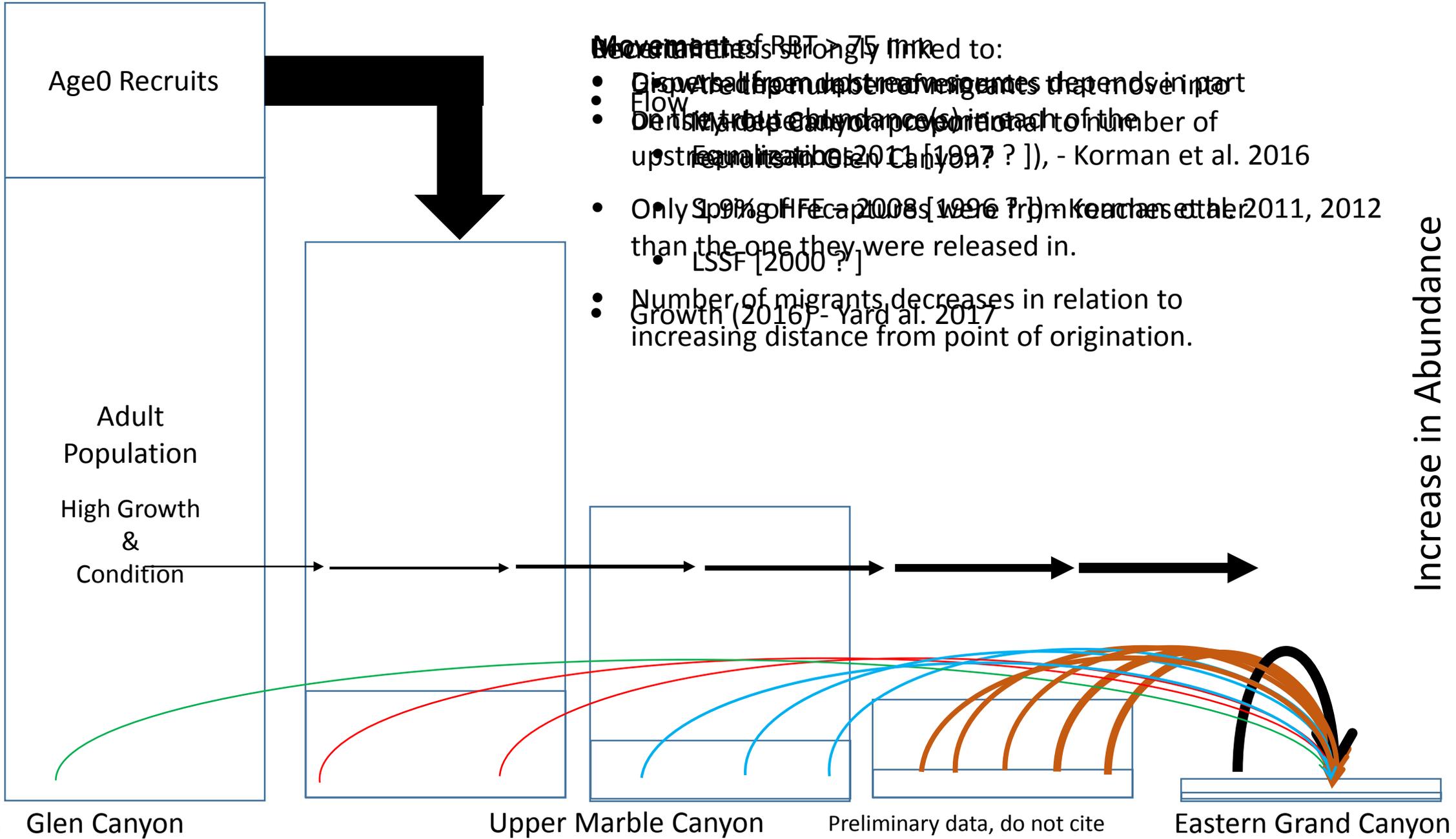
- House Rock Reach
- Unlike other downstream reaches, Age0 trout are rarely part of the catch
- Age0 catch proportion went up from 6% to 76%
- This reach rarely detects Age0 trout in EF catch

Preliminary data, do not cite

September 2016 - Buckfarm Size Distribution



- Age0 catch proportion went up from 1% to 60% of catch
- Why didn't we see a higher proportion of age0's in July?
- Length frequency comparisons made between Lees Ferry and all of the downstream reaches indicate similar size and likely hatch date.
- 2011 Age0 cohort was substantially larger than 2016 cohort
- **This strongly suggests that Lees Ferry Age0 recruits move downstream and repopulate Marble Canyon.**



Age 0 Recruits

Movement of RBT > 75 mm

- Dispersal from upstream originates that tends in part
- Flow
- Density-dependent dispersal (or in part to the number of upstream recruits [1997 ?]), - Korman et al. 2016
- Only 50% of Fecap (2008 [1996 ?]) from Korman et al. 2011, 2012 than the one they were released in.
 - LSSF [2000 ?]
- Number of migrants decreases in relation to increasing distance from point of origination.

Adult Population
High Growth & Condition

Increase in Abundance

Glen Canyon

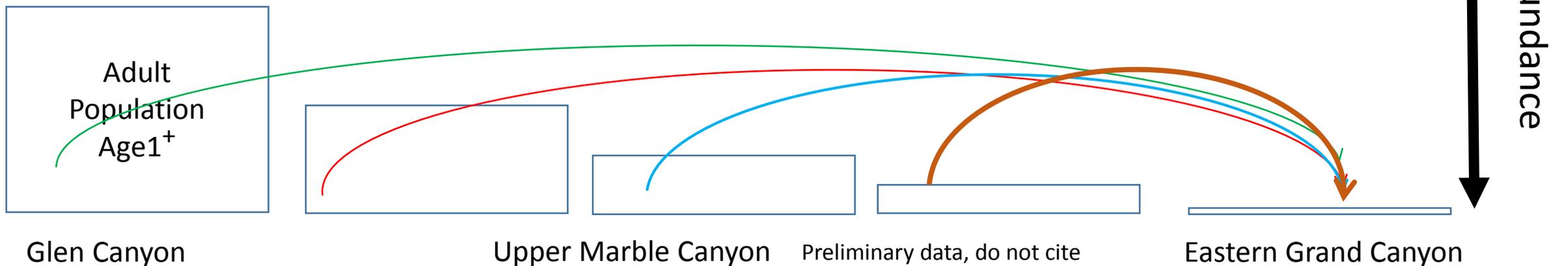
Upper Marble Canyon

Preliminary data, do not cite

Eastern Grand Canyon

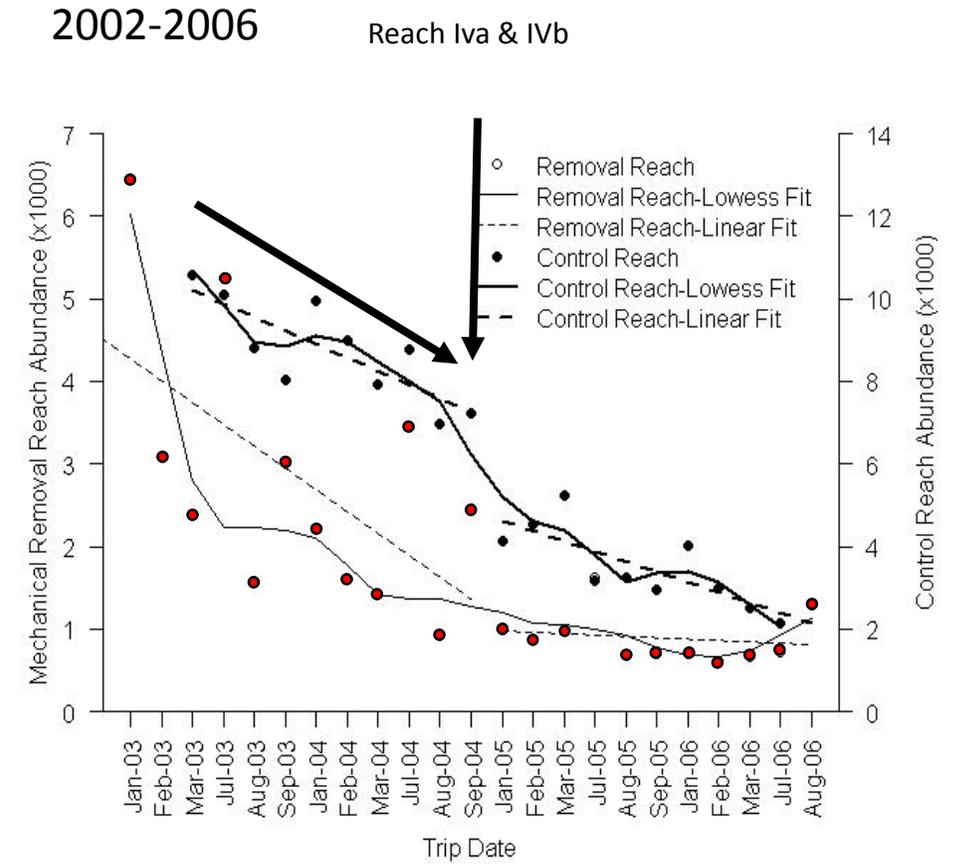
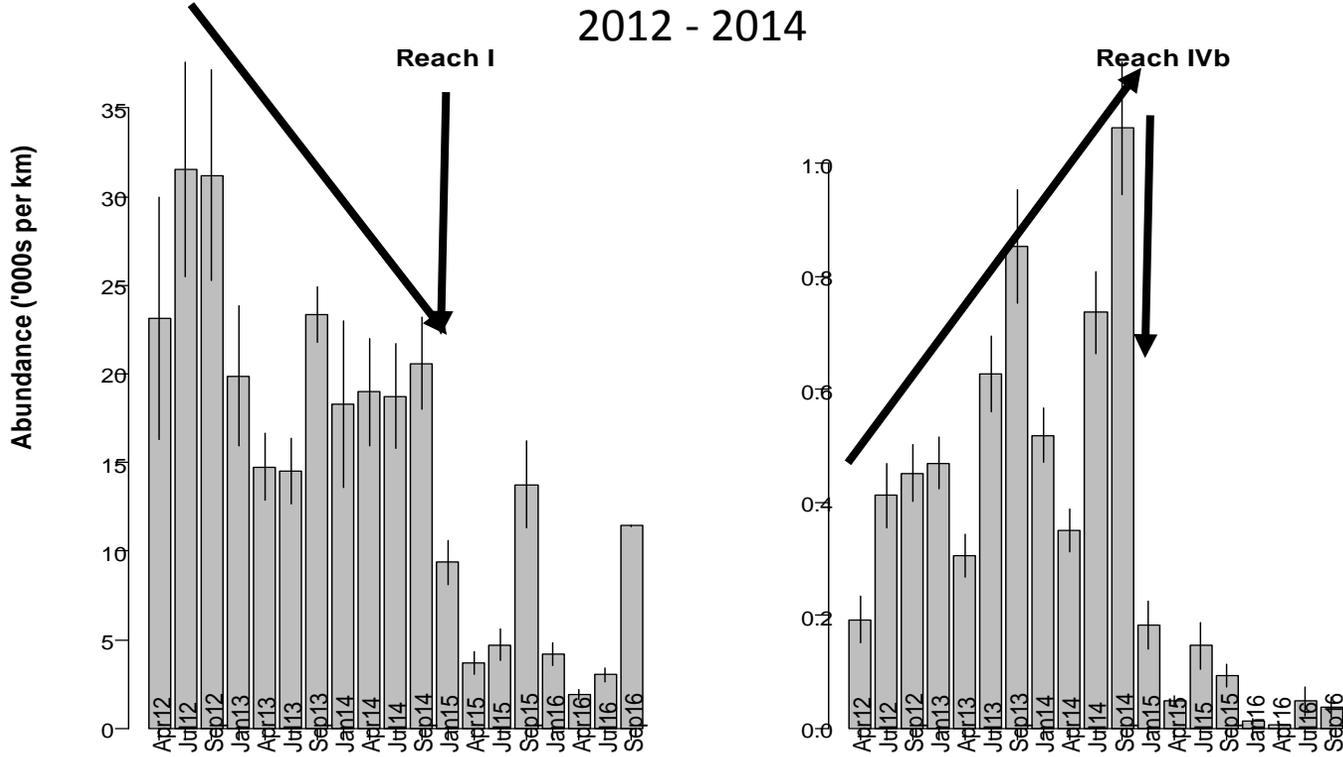
Movement of adult RBT (> 75 mm FL)

- Reduced abundance in upper reaches reduces the number of downstream movers
- Episodic movement occurs under periods of environmental stress (reduced growth & condition).
- Boom-bust cycle begins again



Trout abundance

- We have previously reported on substantial decreases in abundance over time on a system-wide scale between 2012-2015.
- Temporary increase above and below the LCR, due to influx of migrants
- It is likely, a system-wide collapse in trout occurred between 2002-2005.
 - Note the truncation, resulting from poor condition and low survival



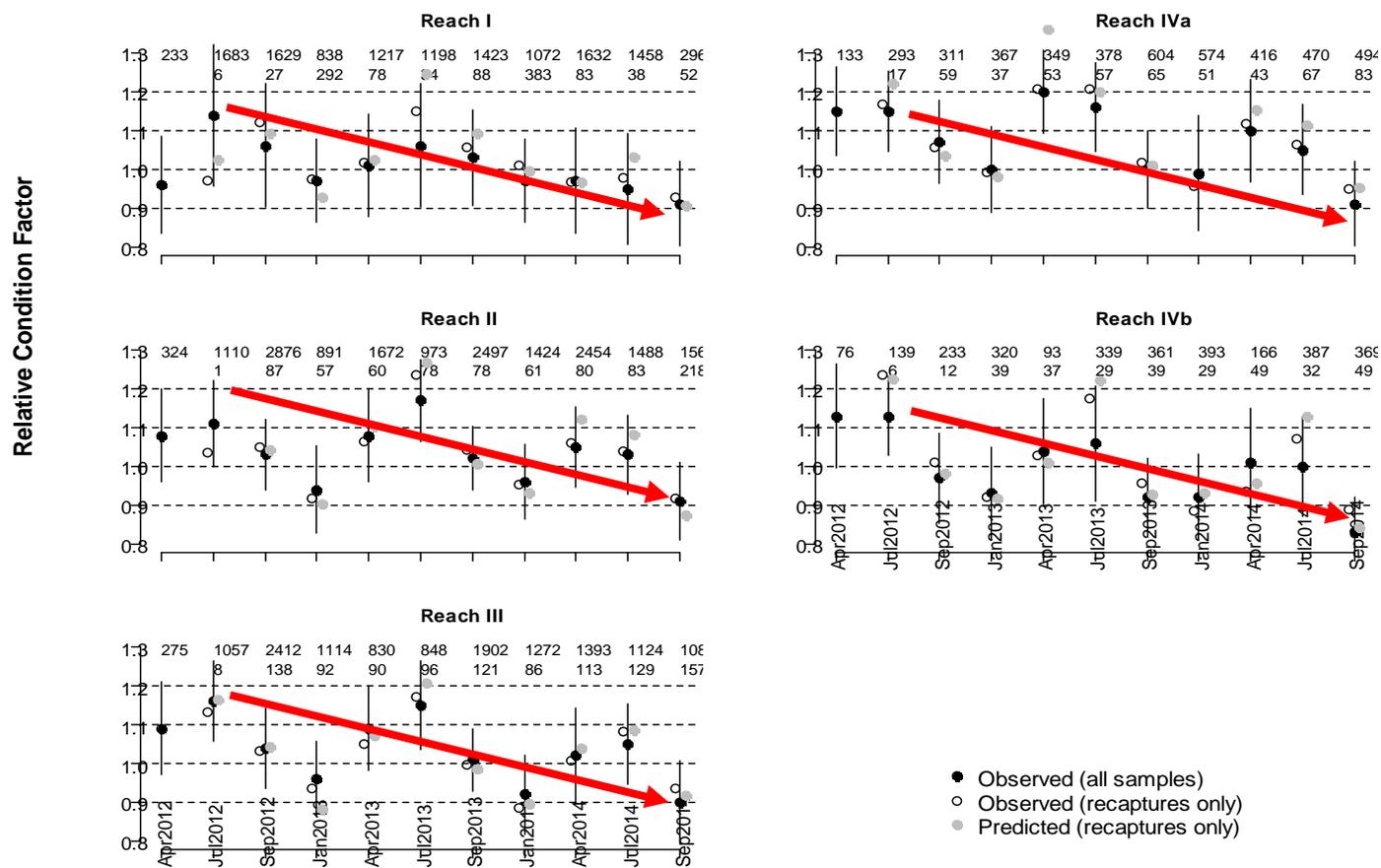
Korman et al. 2016
 Yard et al. 2016
 Korman et al. 2017

Preliminary data, do not cite

Coggins et al. 2011



Rainbow Trout Condition System-wide

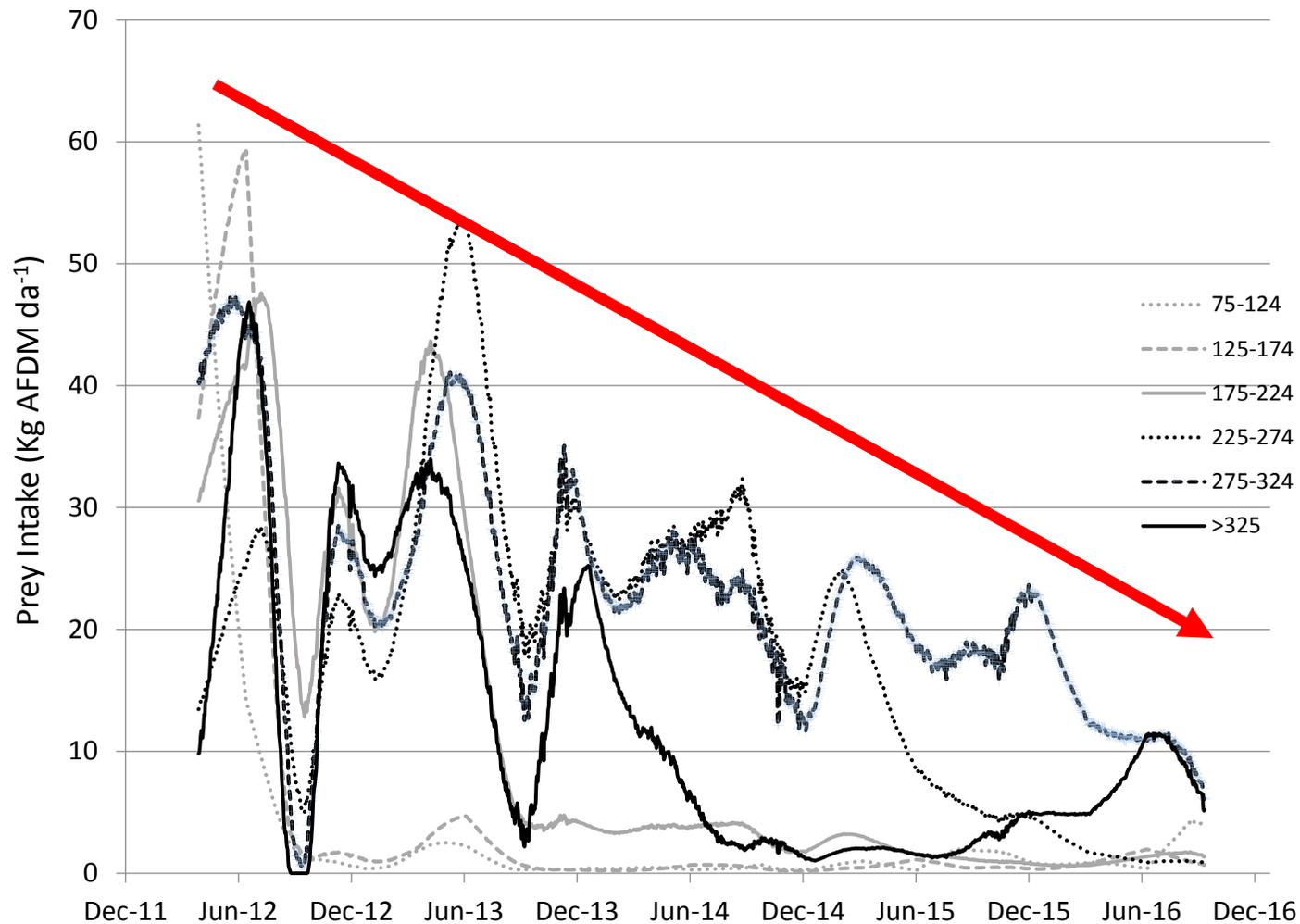


- We have reported on reduced trout growth, condition, and survival.
- This resulted in declining trout densities without sufficient recruitment to maintain trout abundance.

Preliminary data, do not cite



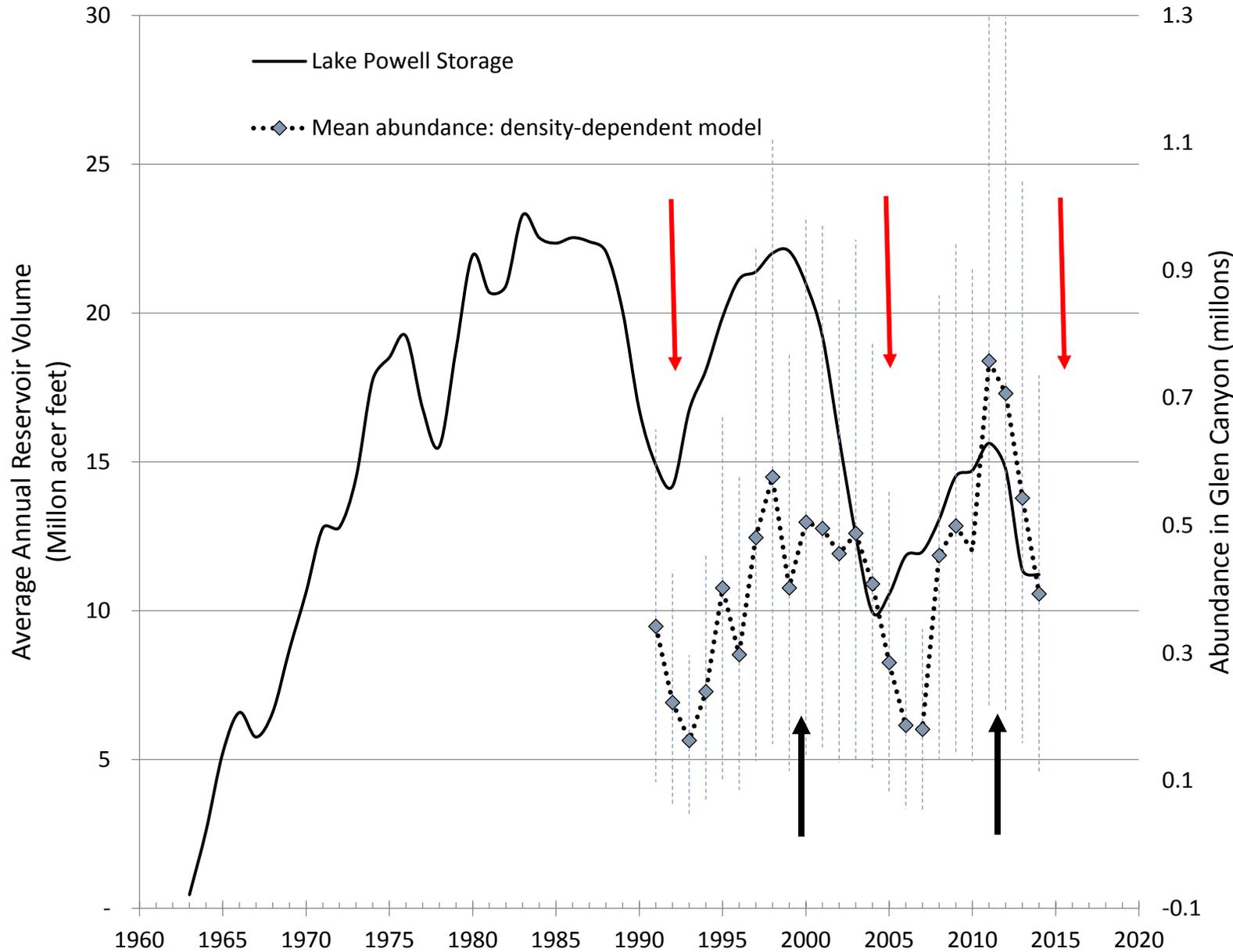
Lees Ferry Trout Fishery (2012 to 2016)



- Bioenergetic model estimated a large decline in prey consumption,
 - 92% reduction in the amount of invertebrate prey consumed
- This suggests a decline in the prey base and its availability
- Prey limitation lead to the collapse in the trout population, and by extension also likely happened in the downstream reaches.
- What might be responsible for the invertebrate prey decline?

Provisional analysis

Lees Ferry Trout Fishery & Lake Powell Storage



- Reconstructed abundance estimates from AGF monitoring data, with confidence levels based on a density-independent model (Korman et al. 2017)
- Lake Powell reservoir storage is correlated with the boom-bust cycles.
- Inflow hydrology and reservoir limnology likely govern the quality and quantity of nutrients supplied to the downstream river segments.
- Nutrient limitation is hypothesized as being the “BIG HAMMER” to the riverine ecosystem, which needs to be evaluated in greater detail in future research

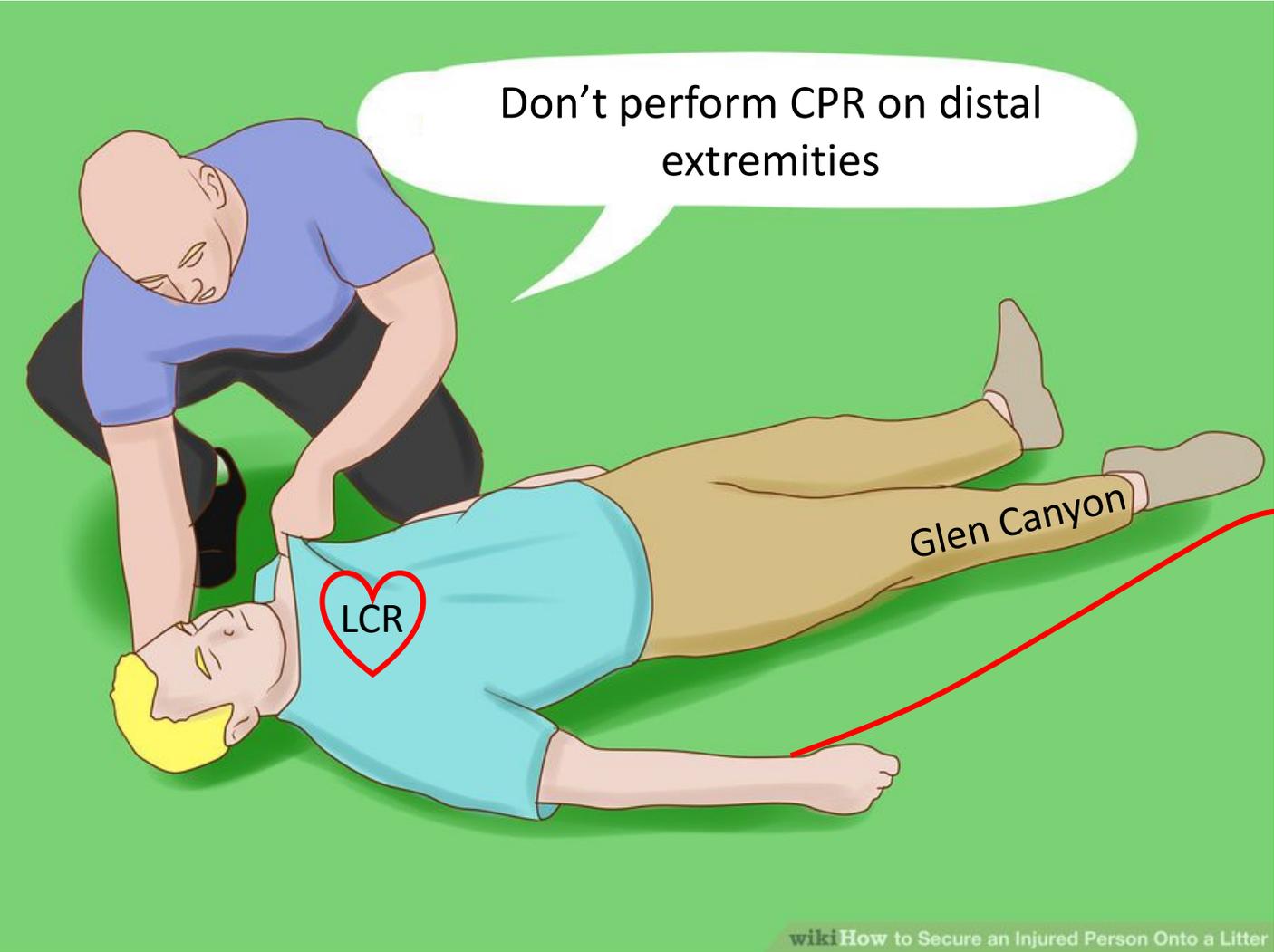
CONCLUSIONS

Trout Movement

- There is a relationship between the Lees Ferry sport fishery and LCR inflow area
- Recruitment is strongly linked to flow, and growth
- Out-migration is related to density- and growth-dependent conditions
- Migrants (Age-0, untaggable sized fish) repopulate upper Marble Canyon between July & September
 - Narrow window of time for conducting experimental TMF
- Trout density in upper reaches determines the number of larger migrants dispersing to the LCR
- Uncertainties –
 - Are the number of migrants that move into Marble Canyon proportional to number of recruits in Glen Canyon?
 - What causes Age0 movement out of Glen Canyon, growth or density?

Variability in fish abundance and vital rates

- Trout population dynamics appear to be driven by prey availability (bottom-up effects)
- Upper Basin inflow hydrology and reservoir limnology likely linked to trout boom-bust cycles.
- (Nutrients → Primary Producers → Secondary Producers → Fish Communities)
- FUTURE MONITORING and RESEARCH – Need to better understand the reservoir limnology and nutrient supply, delivery, and cycling in the river.



Don't perform CPR on distal extremities

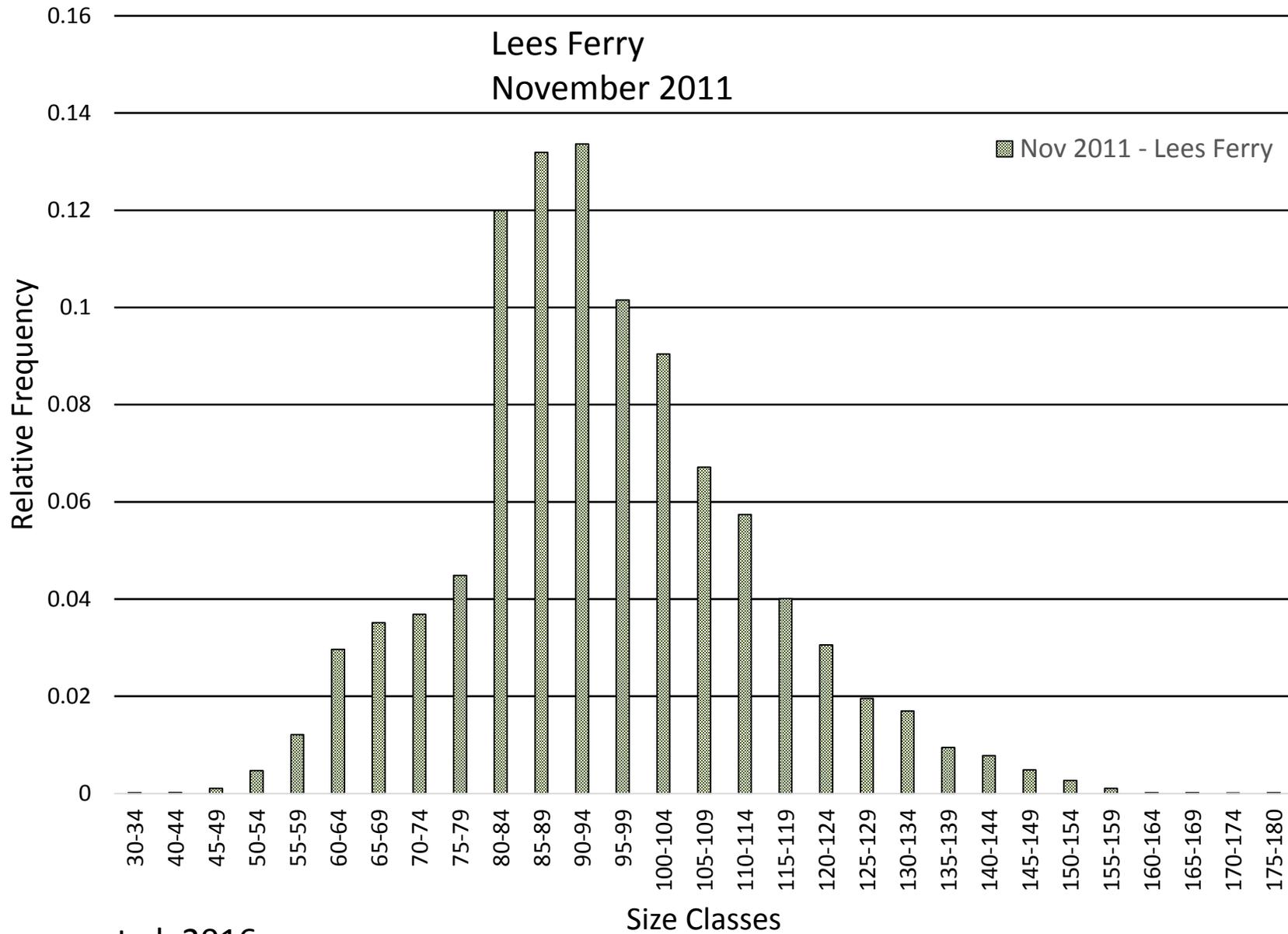
LCR

Glen Canyon

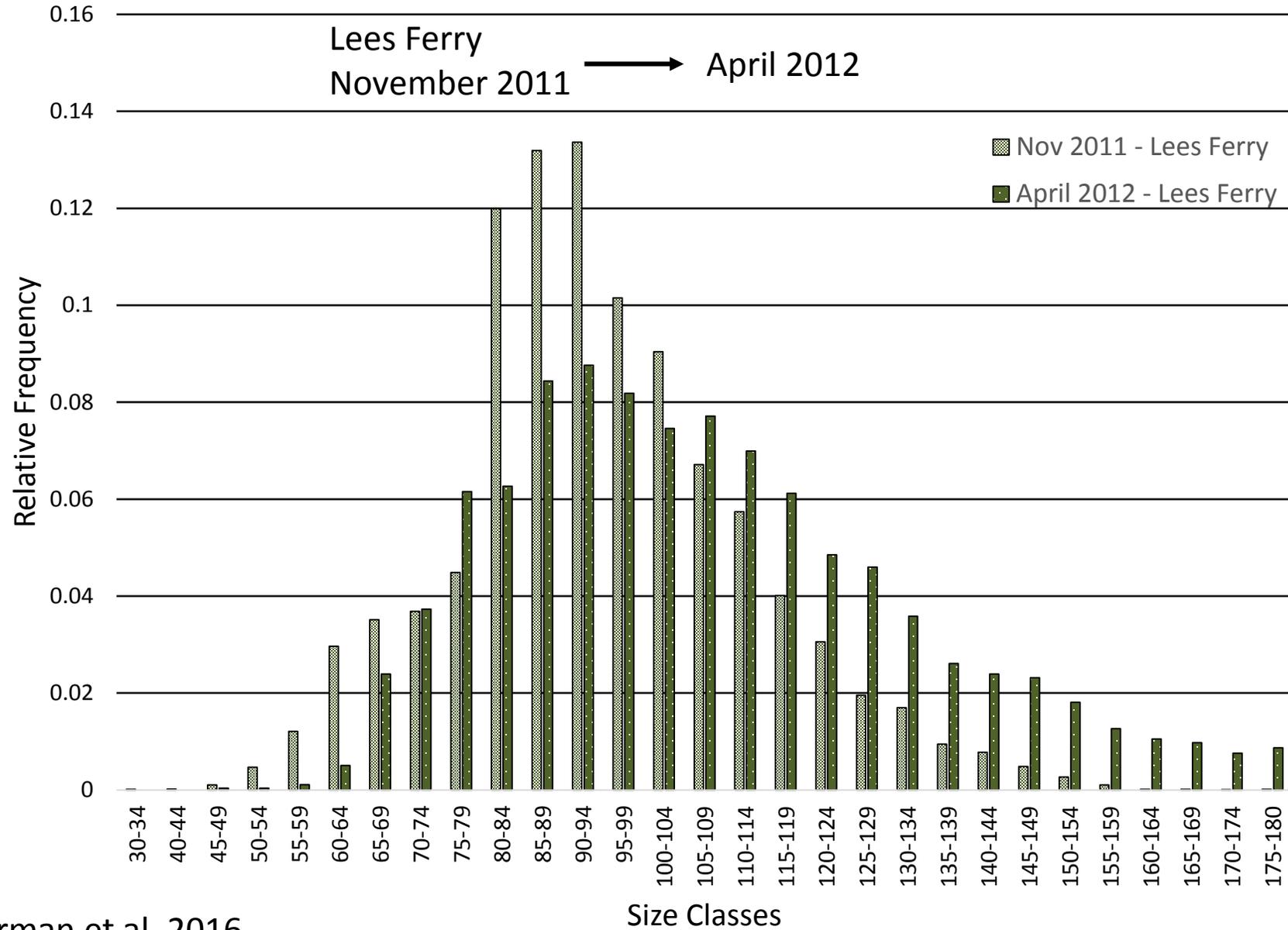
TMF transfusion



Size Distribution of 2011 Super-cohort

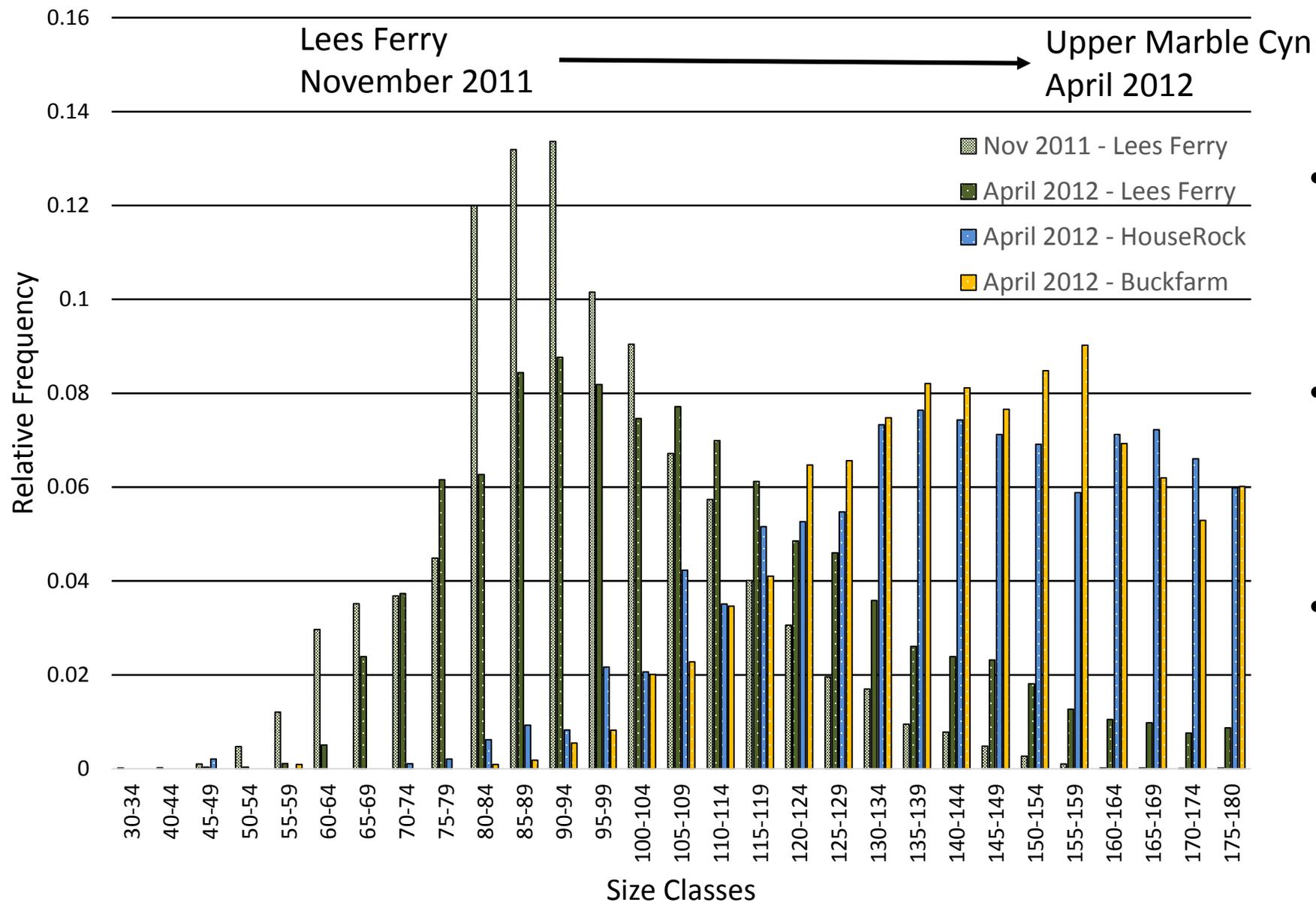


Size Distribution of 2011 Super-cohort



- Minimal growth over a 6 month period in Lees Ferry
- Differences in movement rates are often related to variation in energetic condition, essentially growth

Size Distribution of 2011 Super-cohort



- The 2011 cohort in Upper Marble Canyon grew substantially more than in Lees Ferry
- Minimal evidence of recruitment have been observed in subsequent years
- **It is likely this cohort migrated into Marble Canyon prior to initiating the NO study**