

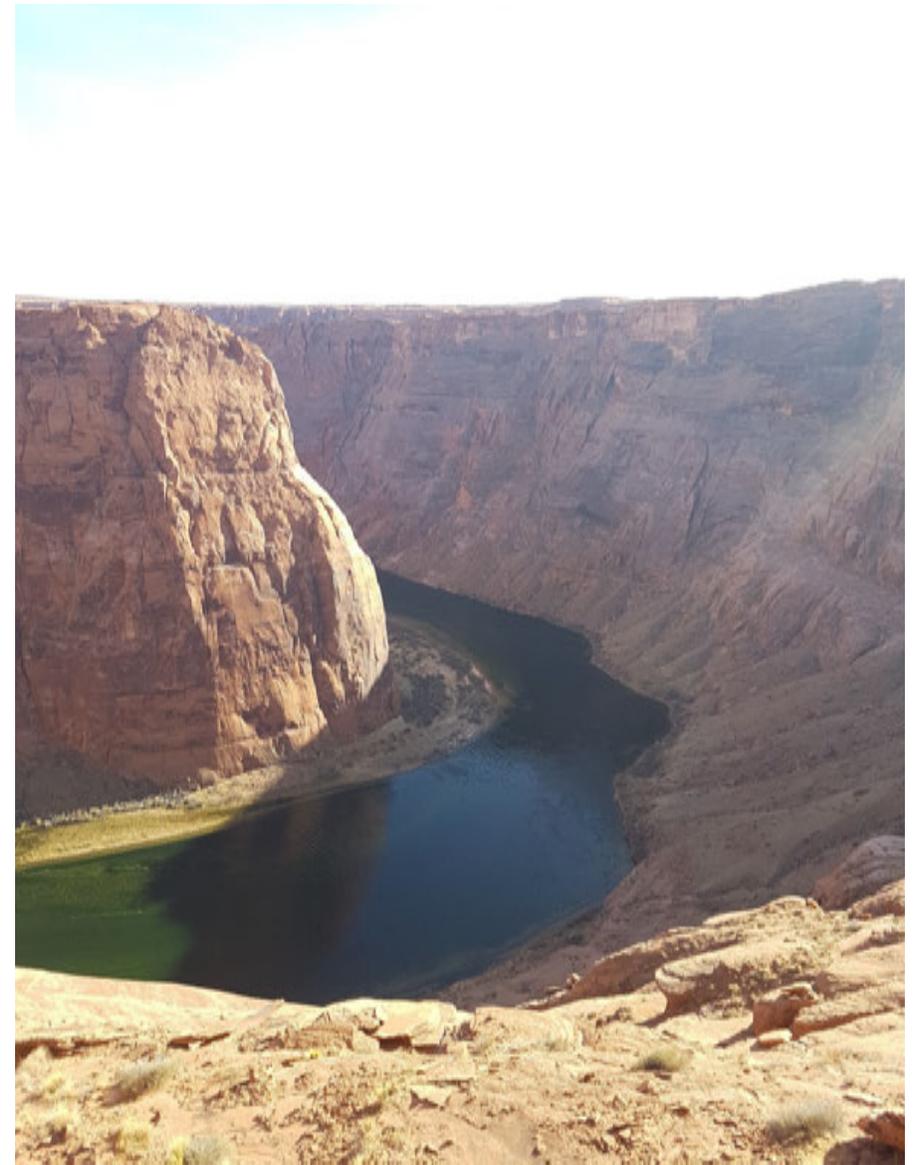
TRGD: Trout Recruitment, Growth and Population Dynamics

Project Element: H.1



Glen Canyon Dam Adaptive Management Program
Annual Reporting Meeting 2020

Tuesday, January 14, 2020



Michael Yard, USGS GCMRC

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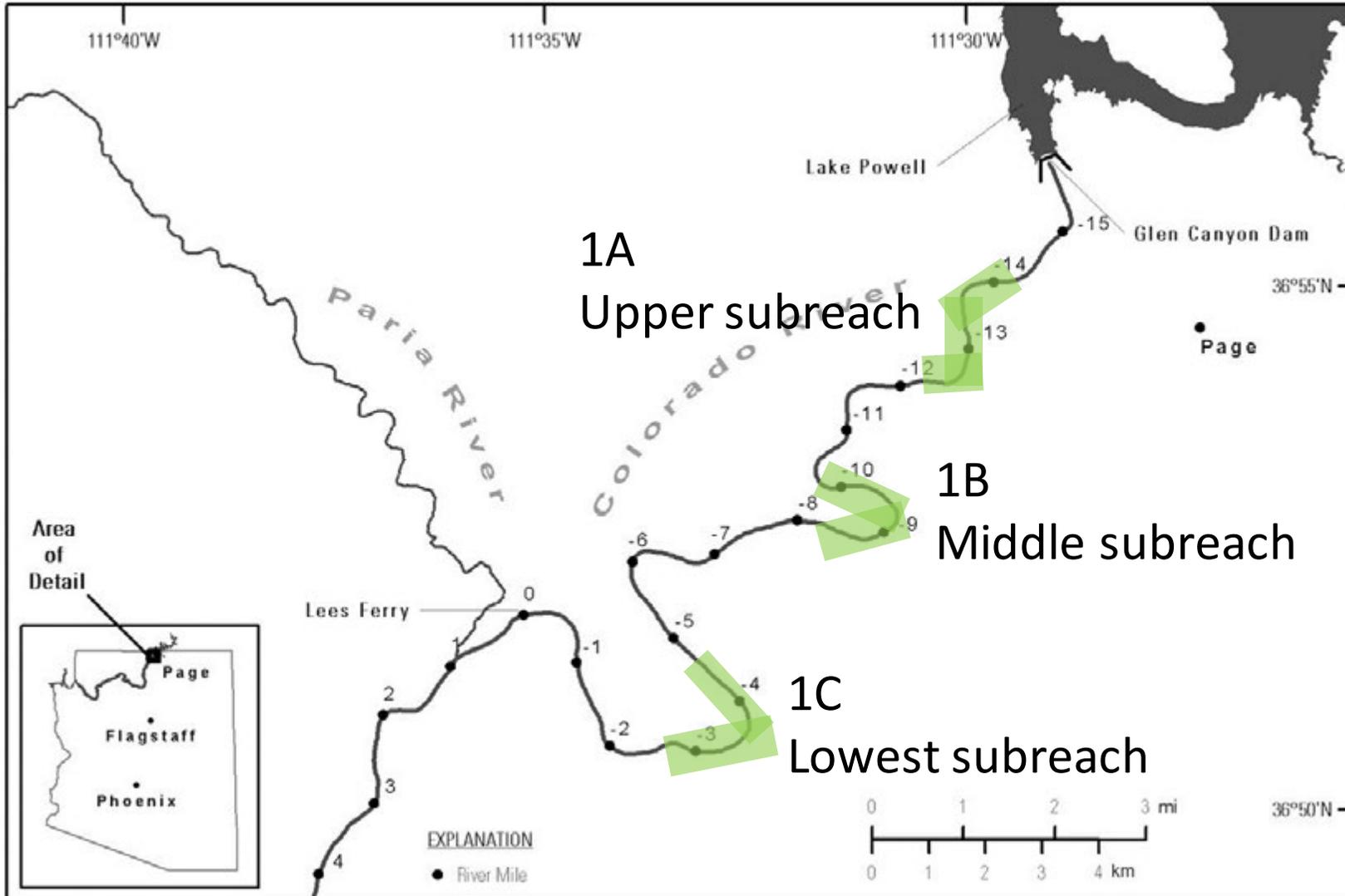
LTEMP Resource Goal:

- Achieve a healthy high-quality recreational rainbow trout fishery in GCNRA and reduce or eliminate downstream trout migration consistent with NPS fish management and ESA compliance.

Study Objectives:

- The data collection and analyses are intended to determine the effects of LTEMP ROD flows on the recruitment of young-of-year (YOY) rainbow and brown trout in Glen Canyon, the growth rate of juveniles and adults, and dispersal of YOY trout from Glen Canyon.
- The effects of higher and potentially more stable flows in spring and summer during equalization events on trout recruitment, growth, and dispersal.
- The effect of fall High Flow Experiments (HFEs) on recruitment of trout in Glen Canyon, measured either through direct effects on juvenile survival or through reduced egg deposition in later years driven by reduced growth of trout (which reduces fecundity and rates of sexual maturation).
- The effect of spring HFEs on trout recruitment, growth, and dispersal.
- The effect of Trout Management Flows (TMFs) on rainbow and brown trout recruitment and dispersal.

GLEN CANYON STUDY AREA, TRGD SAMPLING DESIGN

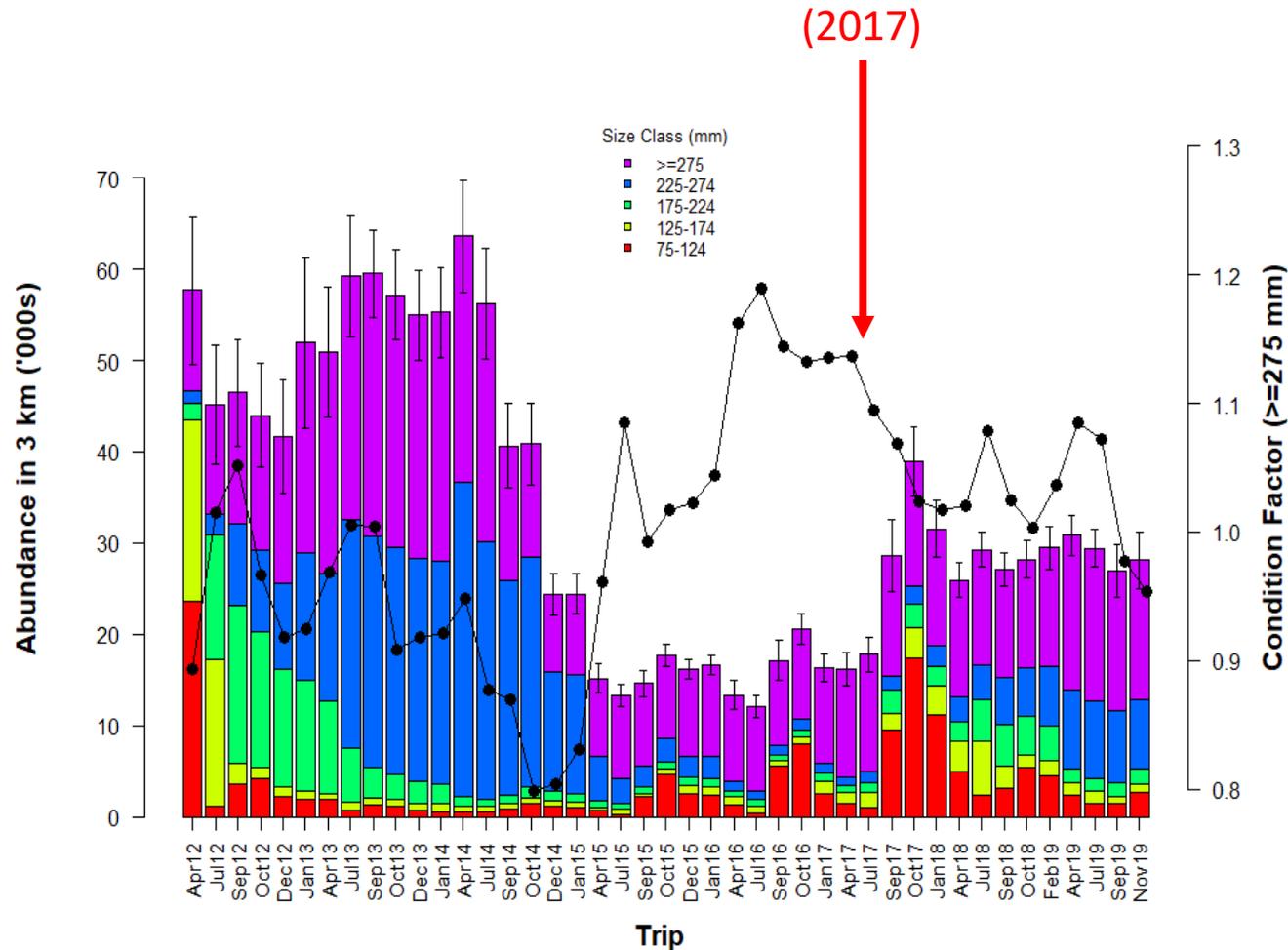


TRGD SAMPLING DESIGN

- Years 2017 – P
- 4 Full trips per year
- Trips: Jan, Apr, Sep, & Oct
- Sample 3 Subreaches
 - 6 Nights / trip of sampling
 - Subreach - 3 km
- 1 Single mid-summer trip
 - 1C Subreach
 - 2 passes (2 nights)
 - 3 km

RAINBOW TROUT ABUNDANCE AND CONDITION

1C - Subreach

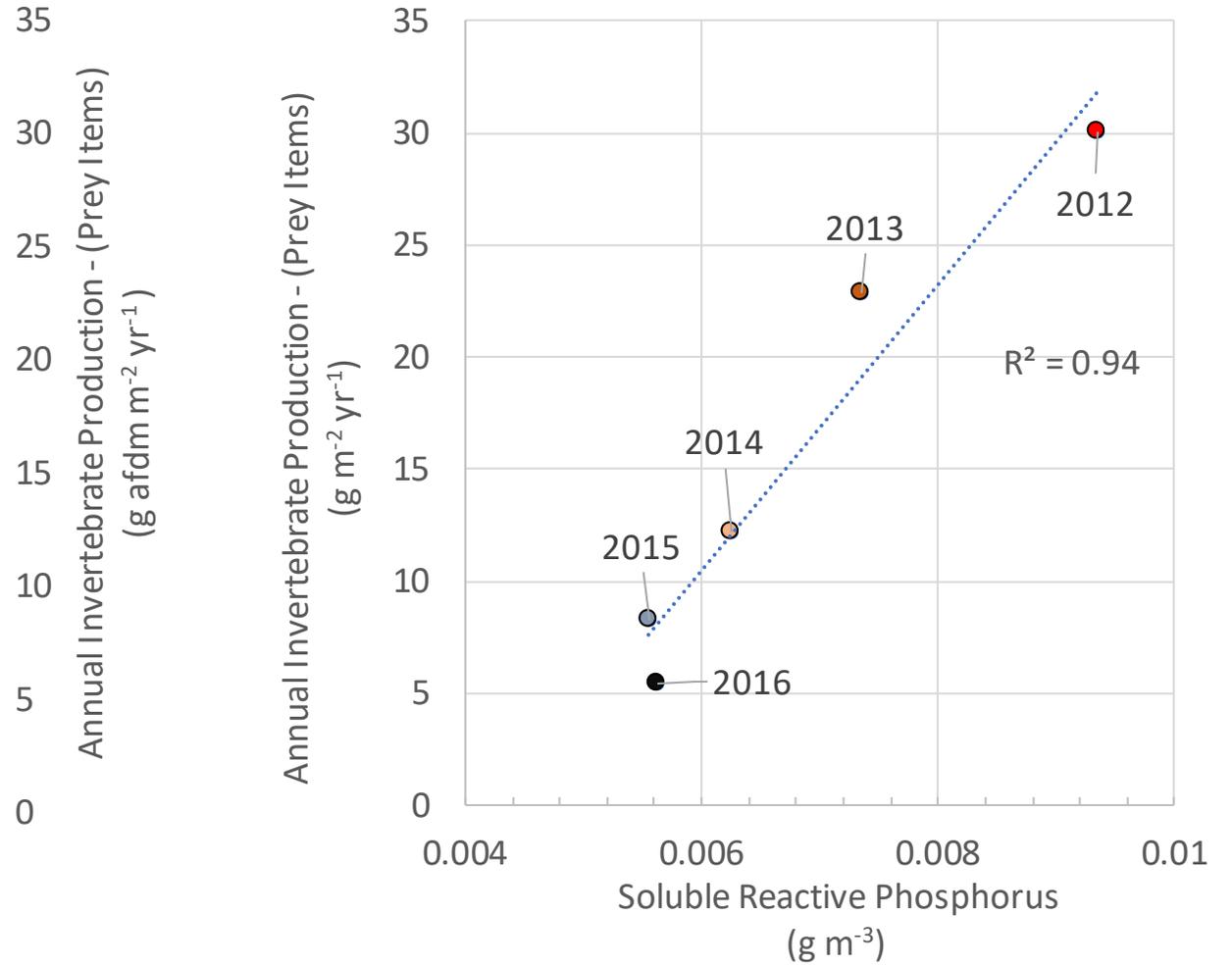
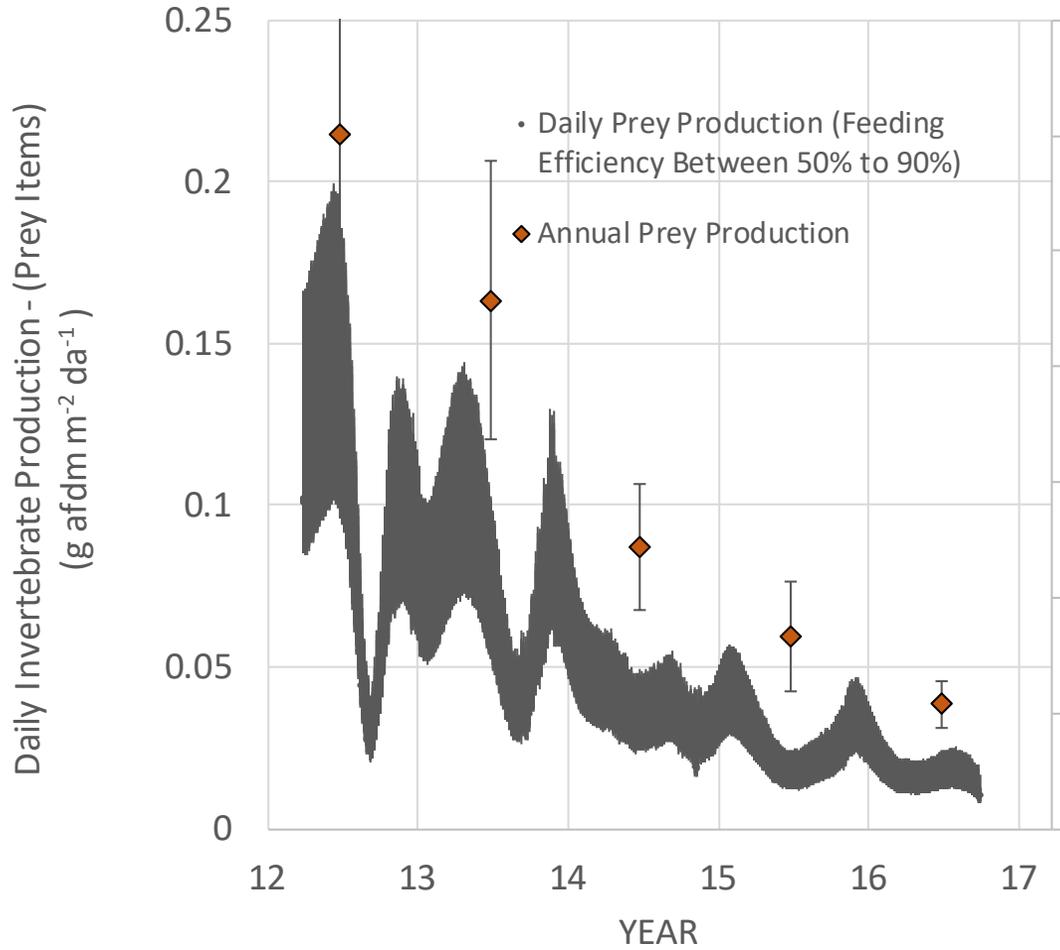


Overview: 2012 – 2019

- High abundance of juveniles in 2012 and 2013 due to large recruitment in 2011 from equalization flow
- Trout grew into catchable sizes (≥ 225 mm), which lead to very high catch rates in 2013 and early-2014.
- Prolonged and reduced growth and condition between 2013 & 2014 led to the collapse in rainbow trout fishery.
- Limited recruitment
- Post population collapse resulted in increased annual recruitment and growth
- Highest recruitment in 2017
- Abundance has increased and appears stable
- Condition is declining

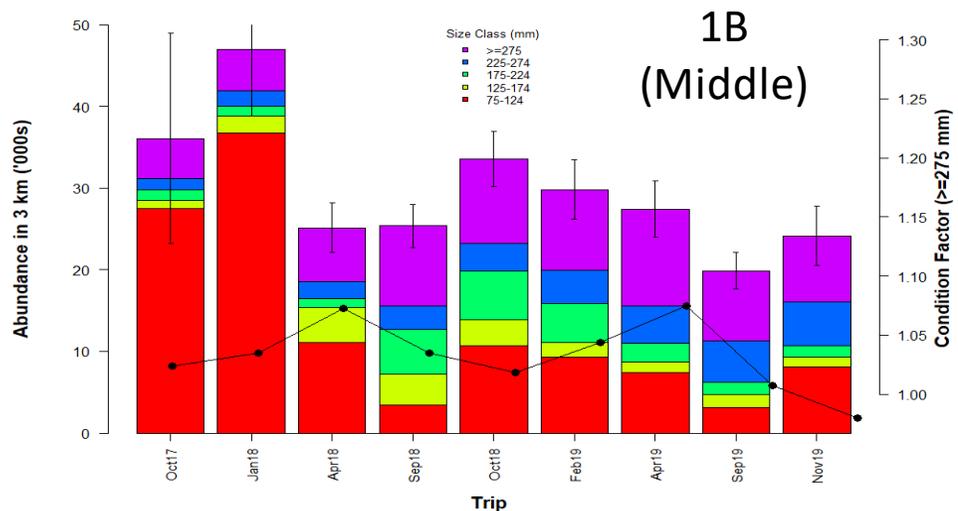
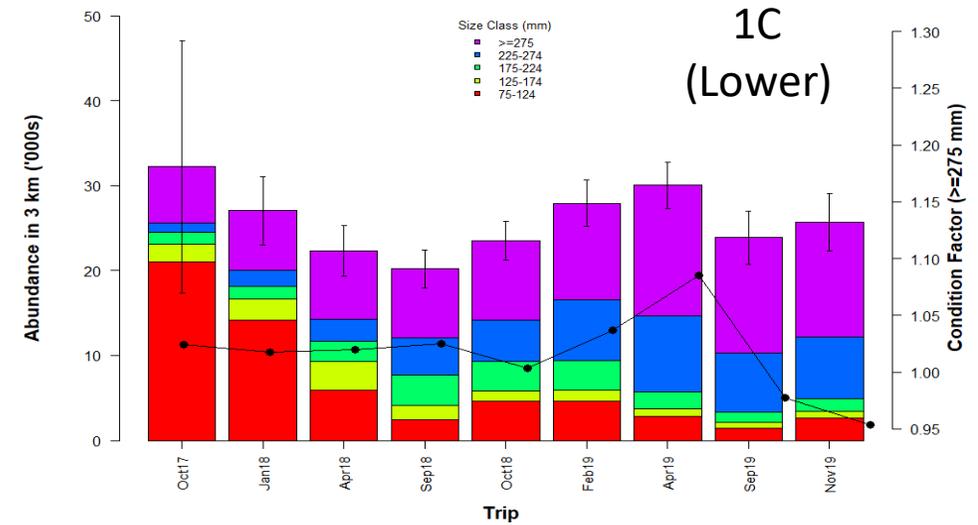
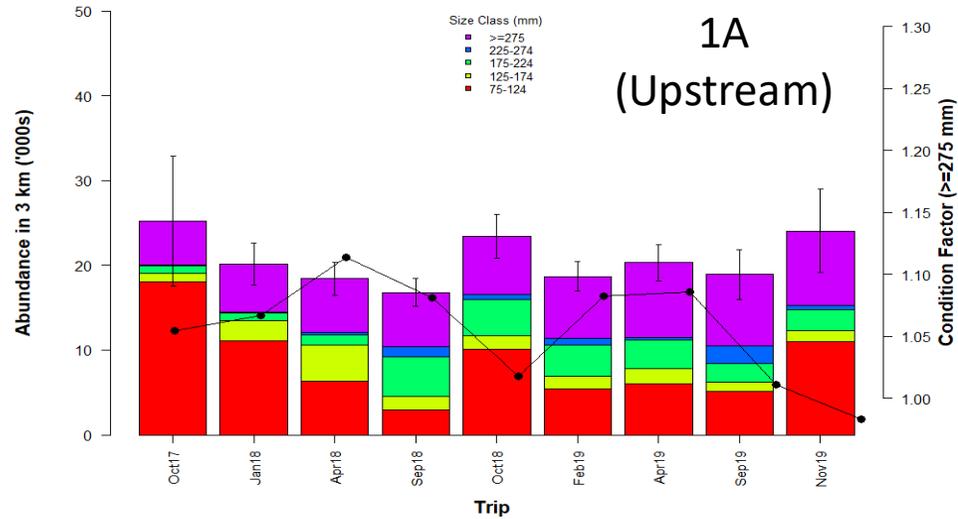
INVERTEBRATE PRODUCTION

(Prey: chironomids, gammarus, and simuliids)



Preliminary data, do not cite

RAINBOW TROUT ABUNDANCE



Overview: 2017 – 2019

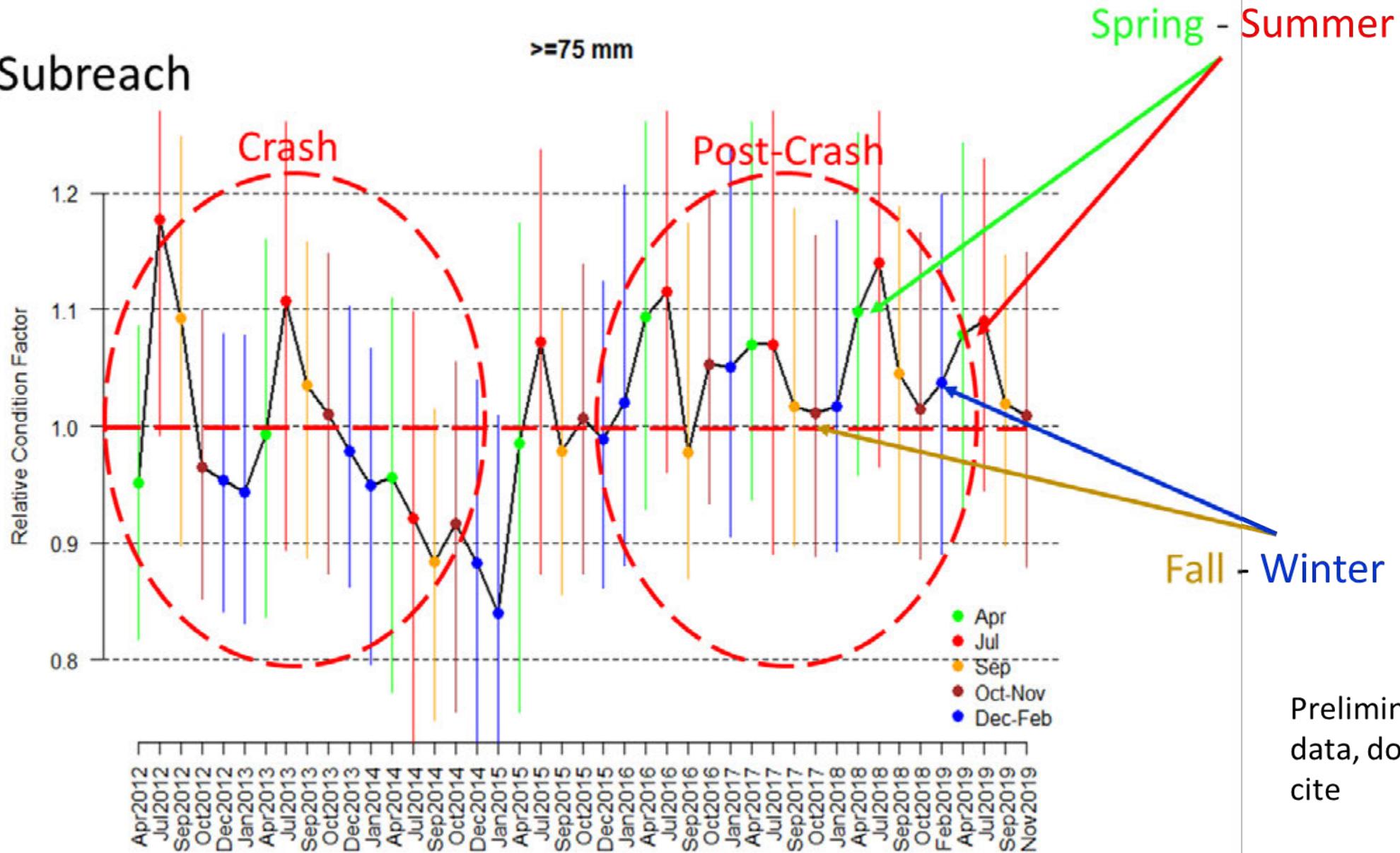
- Spatial variation in abundance
- Age-0 Recruits – higher abundance upstream (1A-1B)
- Catchable sized trout ($> 9''$) – higher abundance downstream (1C)
- Condition Factor higher upstream

Preliminary data, do not cite

SMALL RAINBOW TROUT

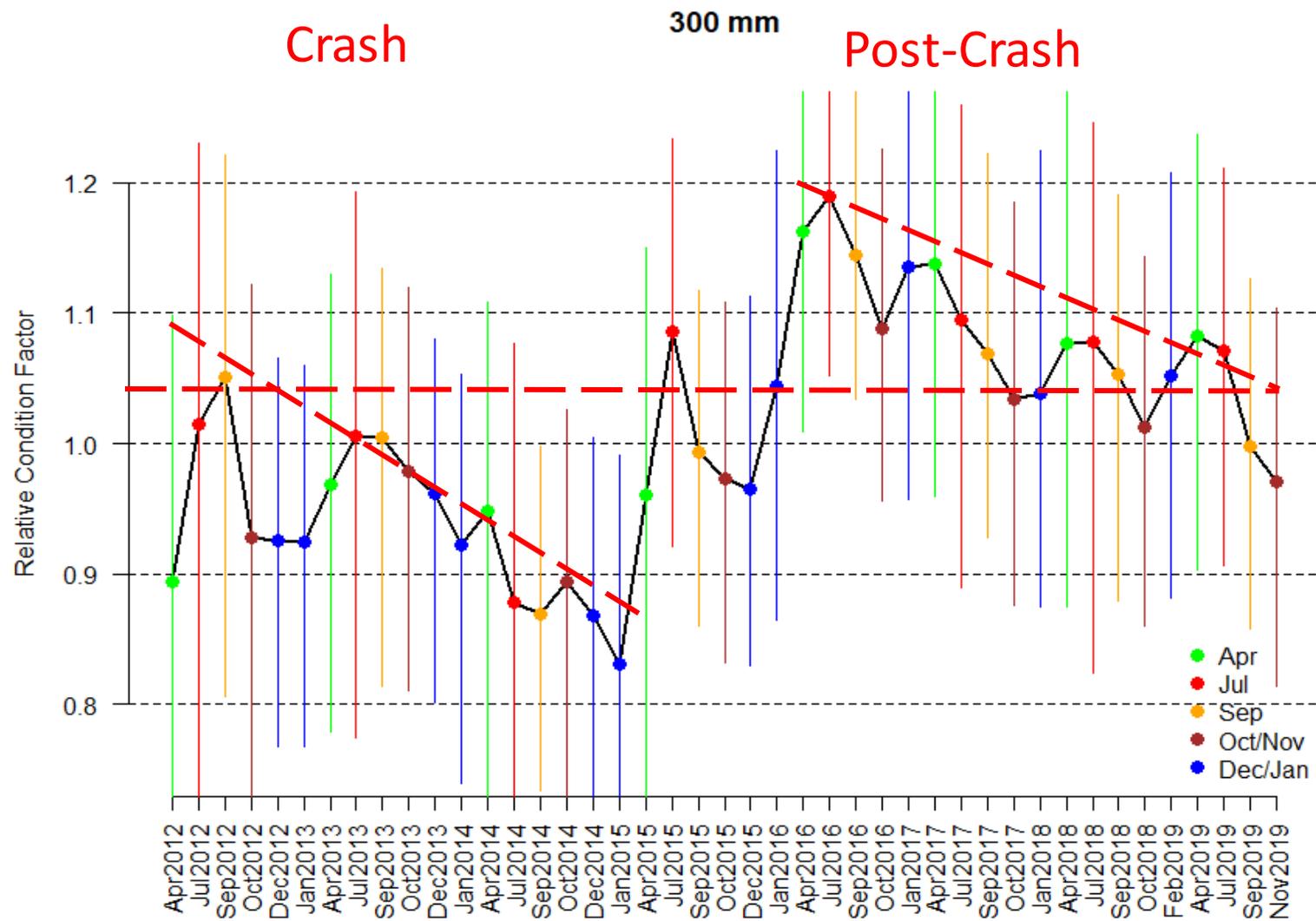
1C - Subreach

≥ 75 mm



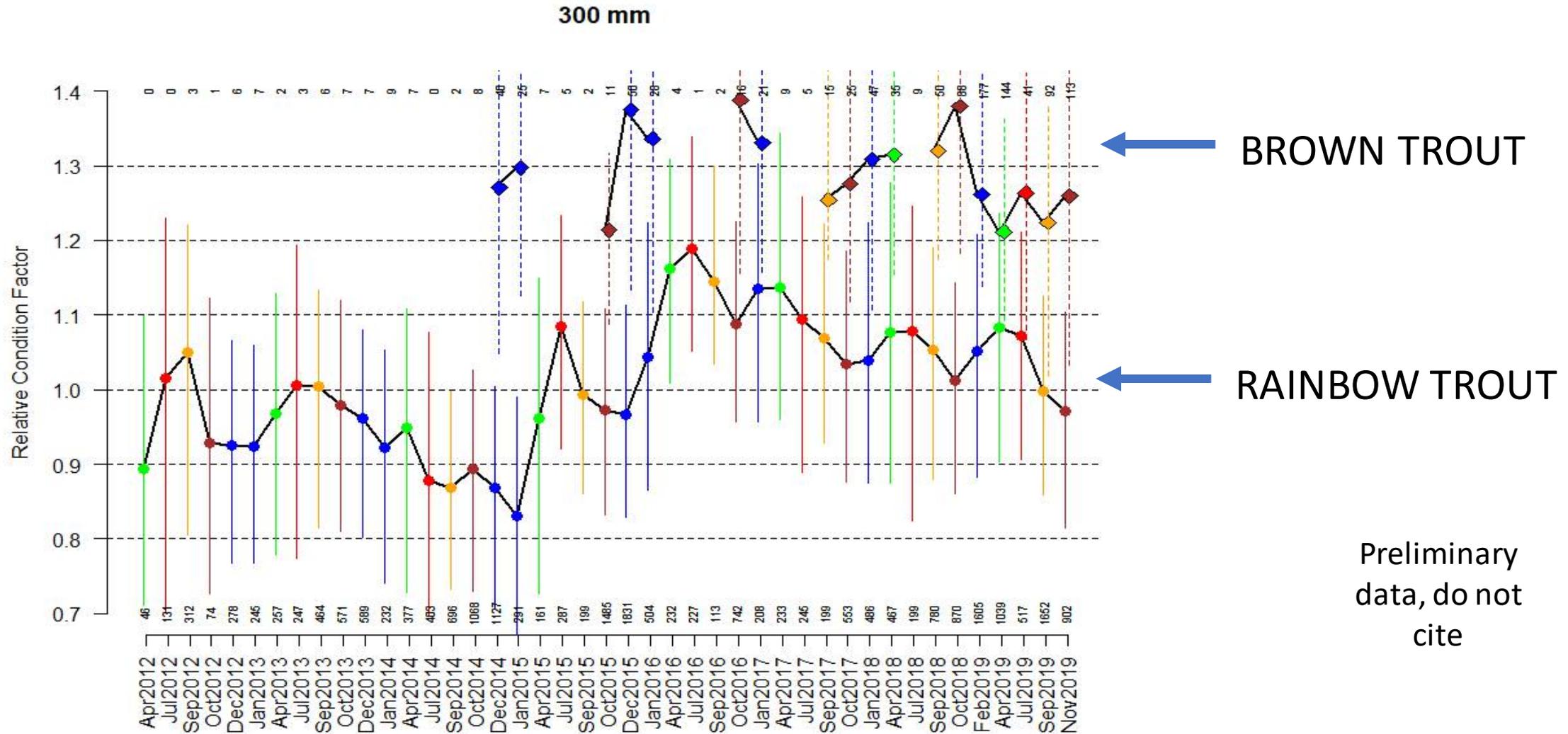
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LARGE RAINBOW TROUT

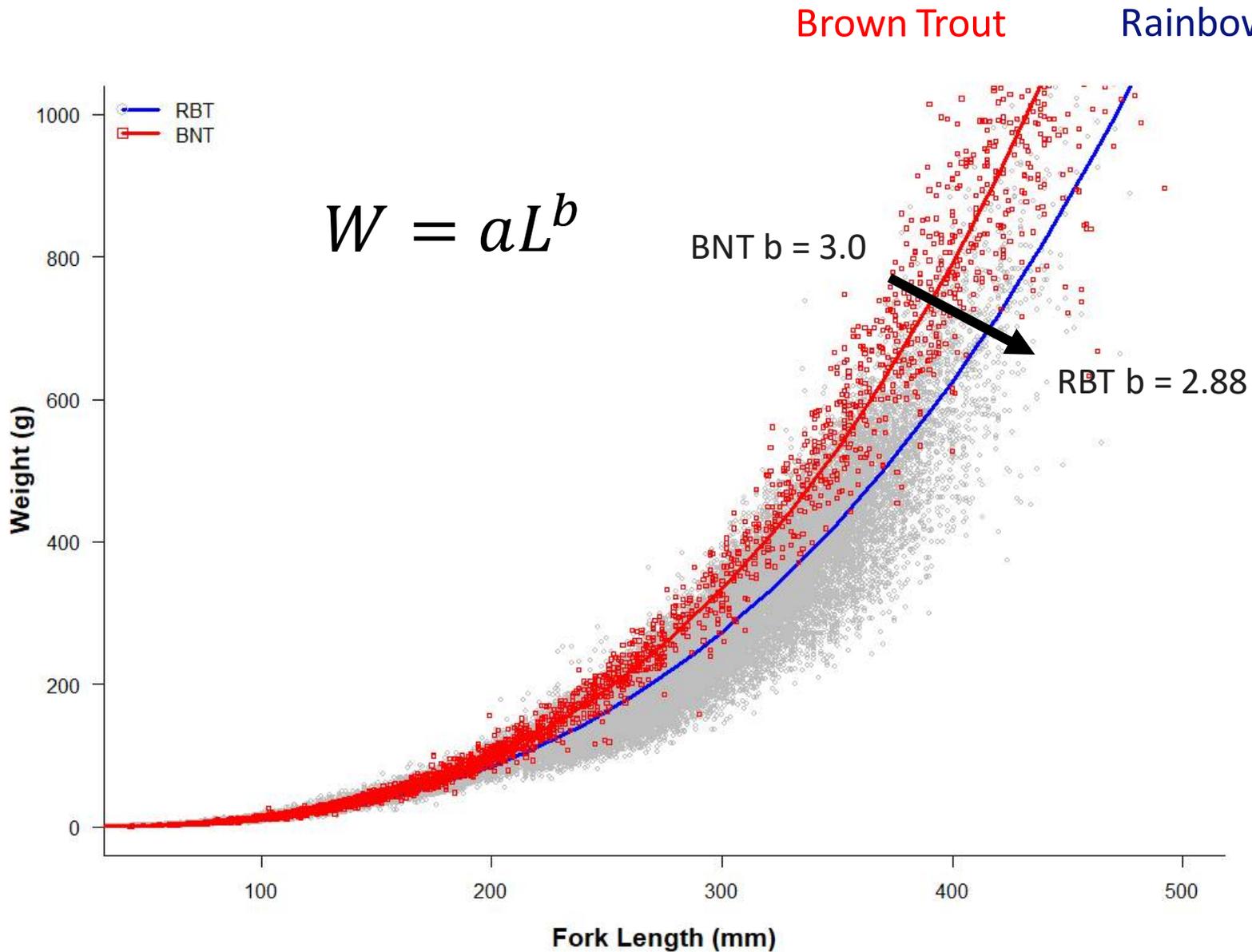


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COMPARISON BETWEEN RAINBOW TROUT AND BROWN TROUT



Preliminary data, do not cite



Length-weight Relationship

Sample Size

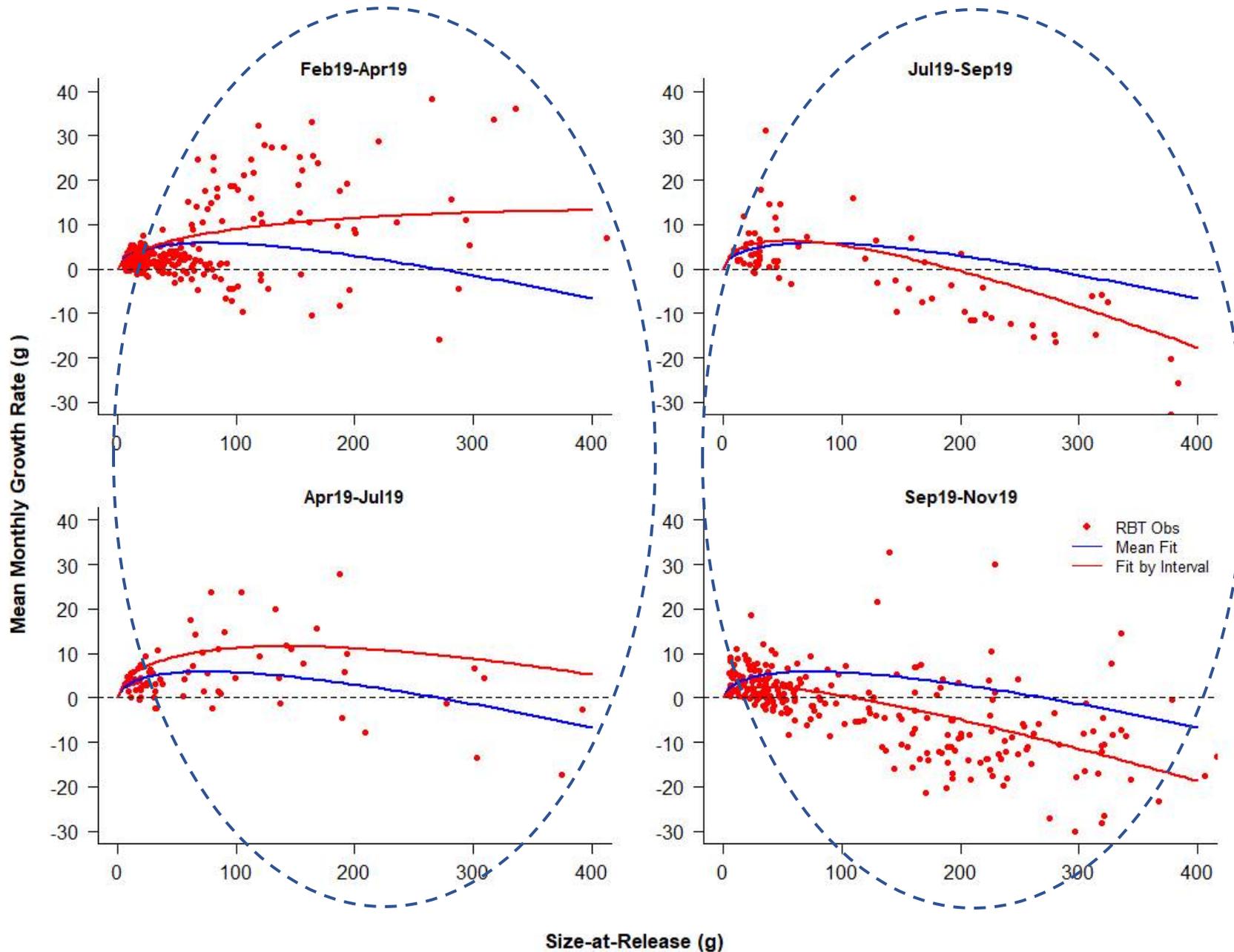
- RBT (n) = 101,989
- BNT (n) = 5,197

Growth Differences

- BNT are fatter than RBT.
- RBT display negative-allometric growth ($b < 3$)
- This indicates a decrease in growth or elongation in length without the commensurate increase in weight.

Preliminary data, do not cite

2019 - MONTHLY GROWTH RATES, slide 1

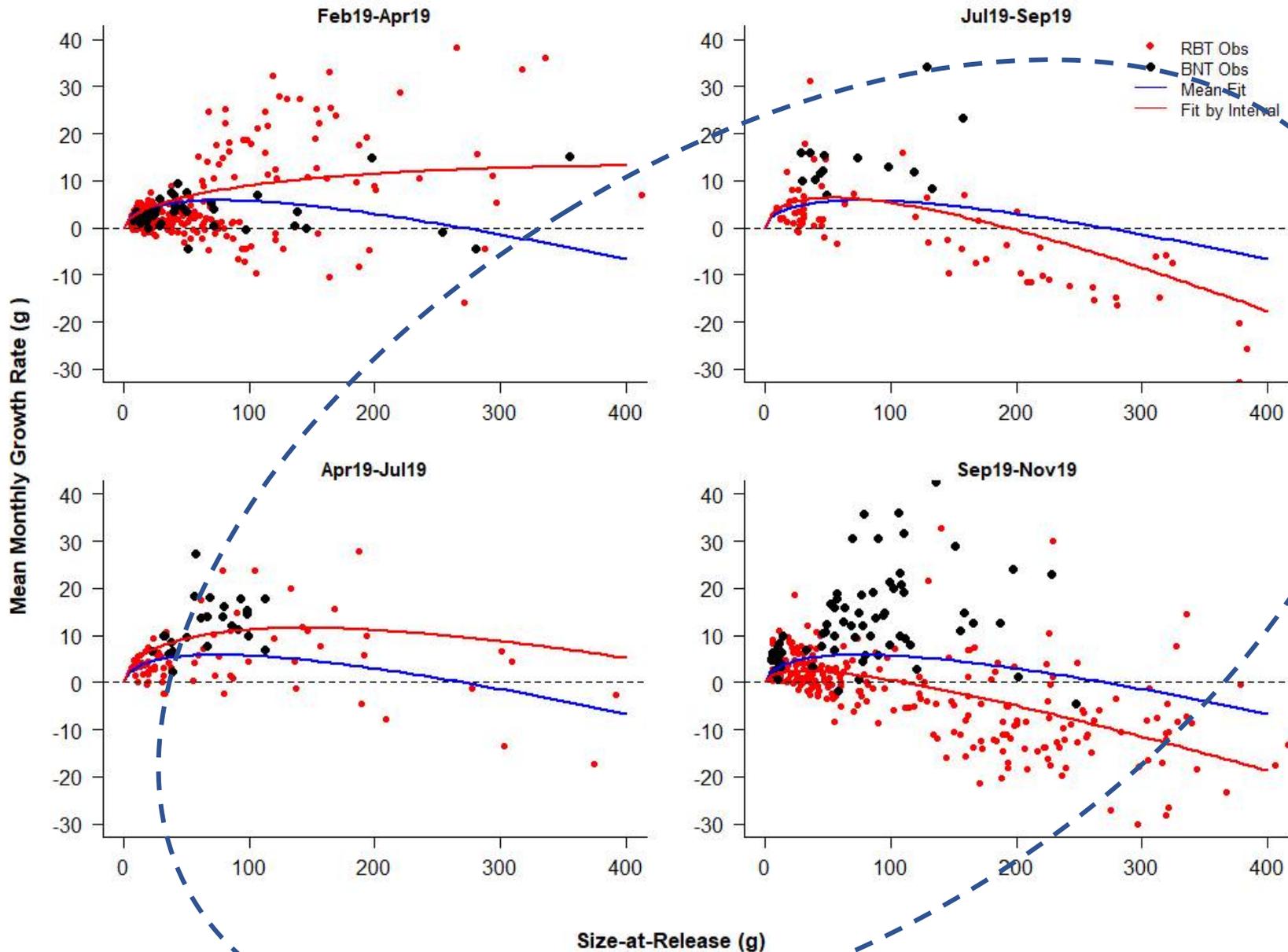


Mean Monthly Growth Rate (g/month) RAINBOW TROUT

- RBT growth higher in late-Winter/Spring and Summer
- RBT growth is more reduced in late-Summer/Fall and early-Winter

Preliminary data,
do not cite

2019 - MONTHLY GROWTH RATES, slide 2

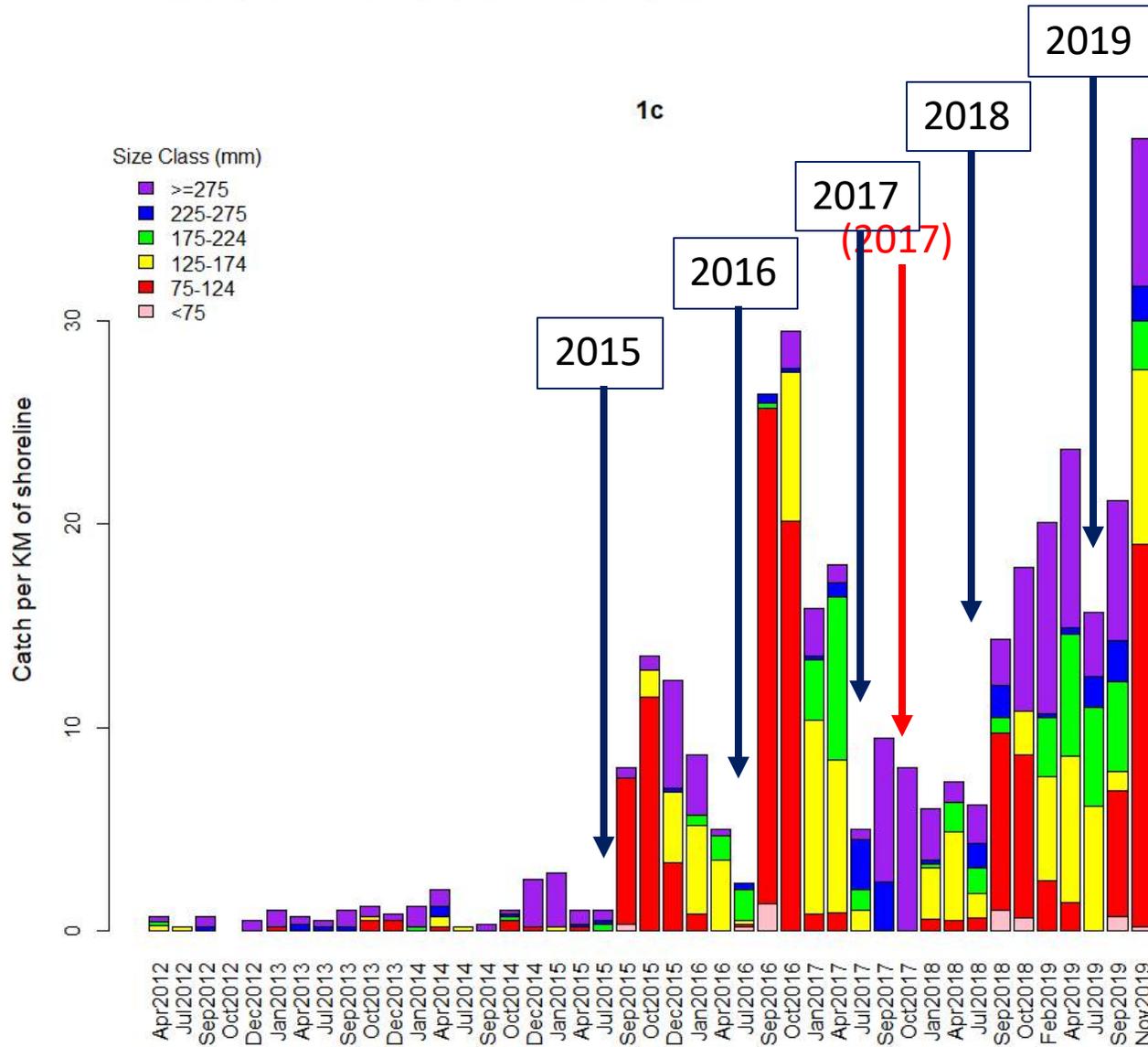


Mean Monthly Growth Rate (g/month) BROWN TROUT

- BNT Growth Rates Overlaid (black) onto RBT figure
- BNT growth is quite a bit higher than RBT.
- Increased BNT growth in weight occurs in Apr-Jul, Jul-Sep, and Sep-Nov 2019

Preliminary data, do not cite

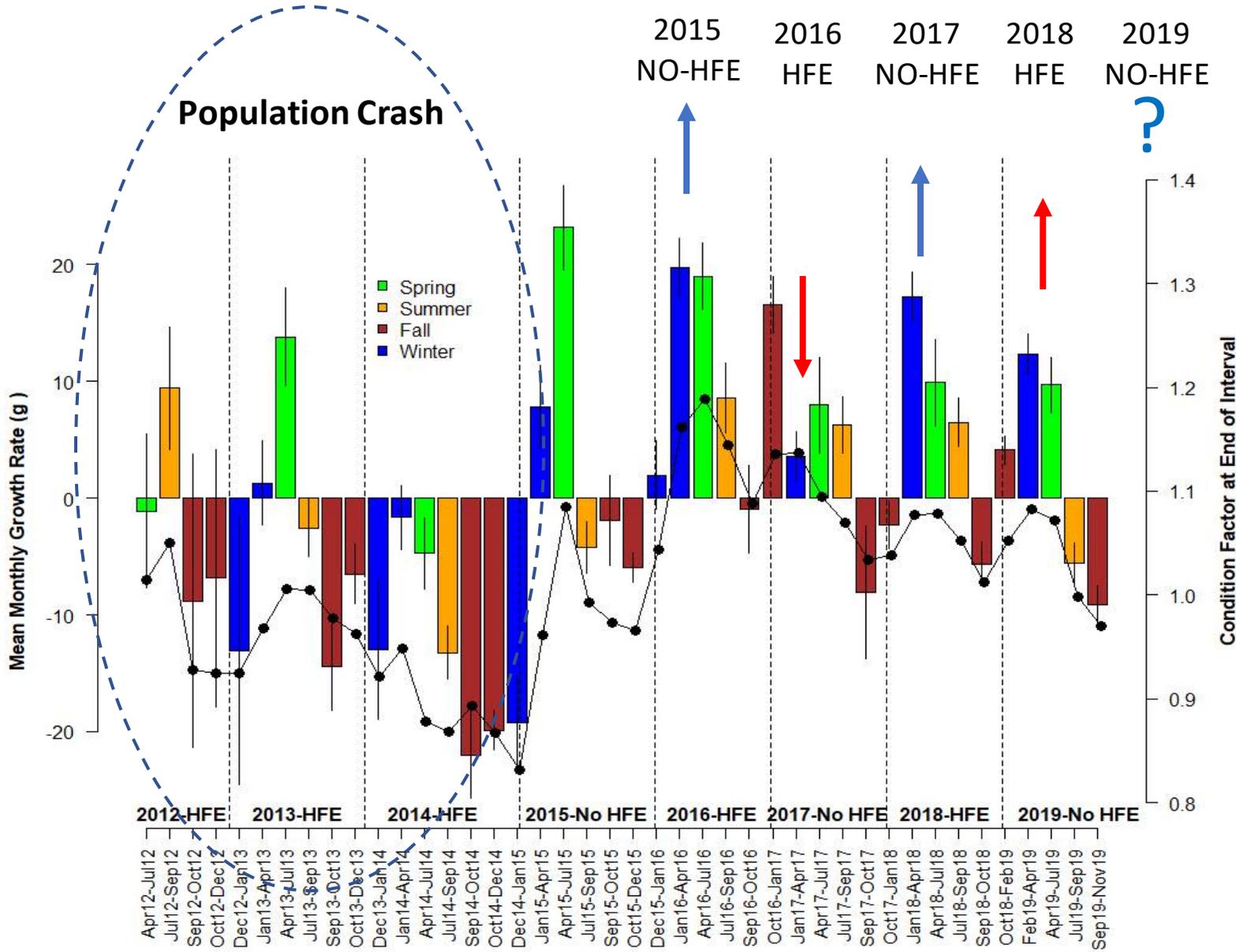
Brown Trout – CPUE



- Brown Trout (BNT) spawn between November-January, whereas, Rainbow Trout (RBT) around mid-March.
- We should expect to observe BNT in our electrofishing catch sooner than RBT
- Based on relative catch in the fall, BNT appear to be growing and surviving better than age-0 RBT.
- Why are BNT not as susceptible to capture by our sampling gear earlier in the year (April-July effort)?
 - Catch difference between the two trout species suggest that BNT are not occupying the near shoreline (wetted edge) when smaller in size.
 - If Age-0 BNT are utilizing different habitat at sizes <75 mm, then they are not as likely to be effected by TMFs in late Spring and Summer

Preliminary data, do not cite

Fall-High Flow Experiment -- Rainbow Trout

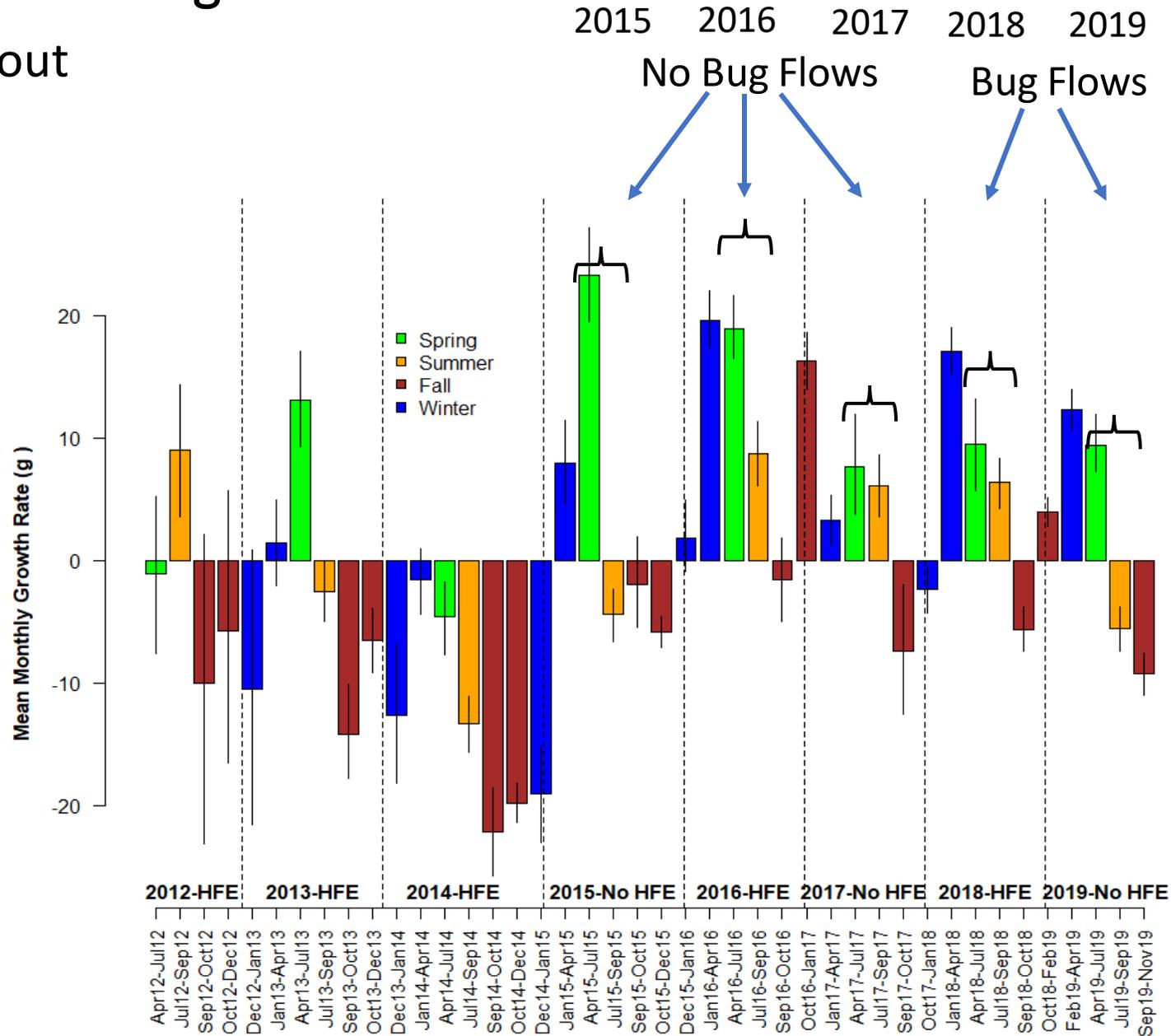


Mean growth for 266 g RBT (typical weight for a 300 mm fish)

Preliminary data, do not cite

Stable Flows – “Bug Flows”

Rainbow Trout

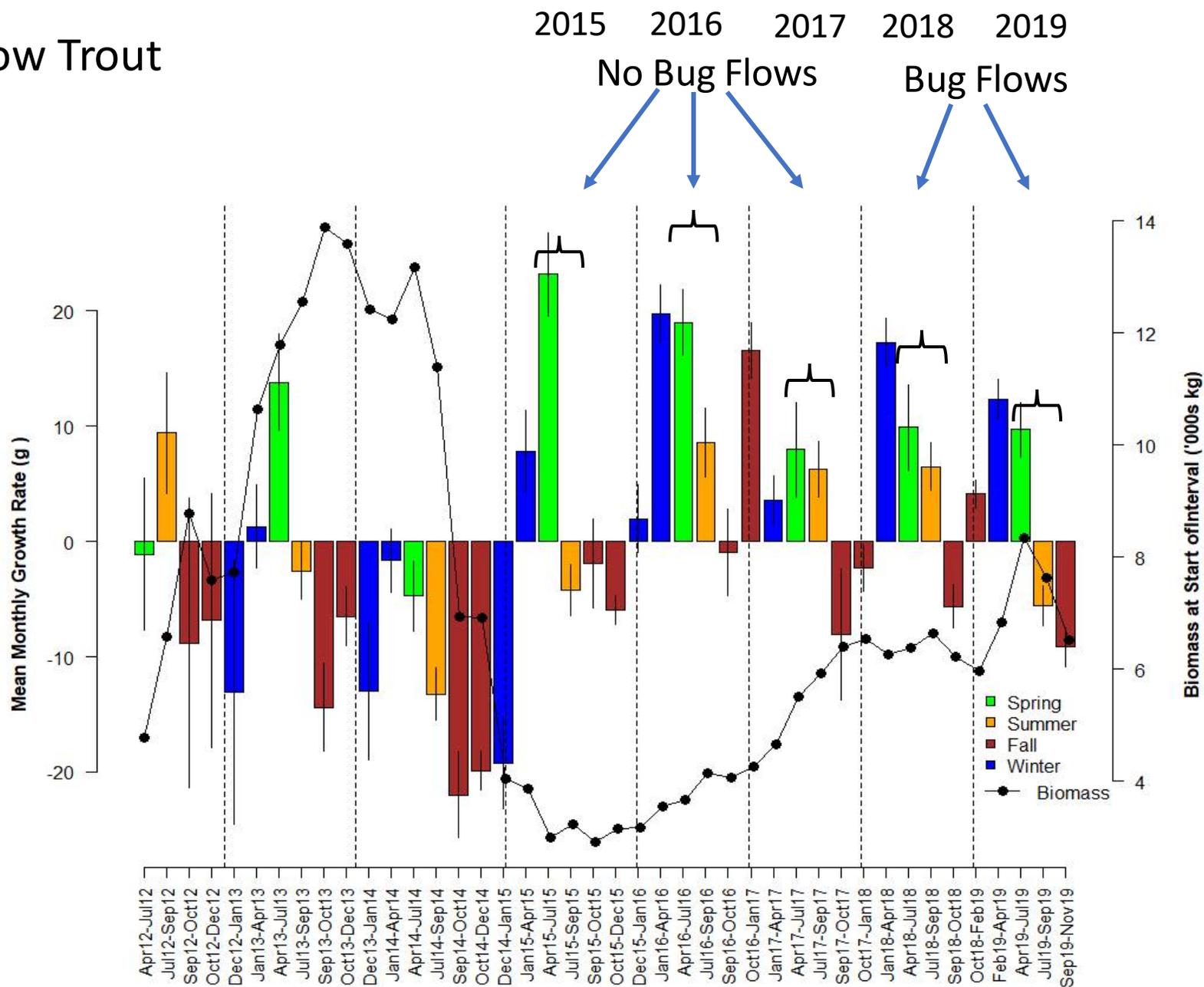


Mean growth for 266 g RBT (typical weight for a 300 mm fish)

Preliminary data, do not cite

Stable Bug-Flows

Rainbow Trout

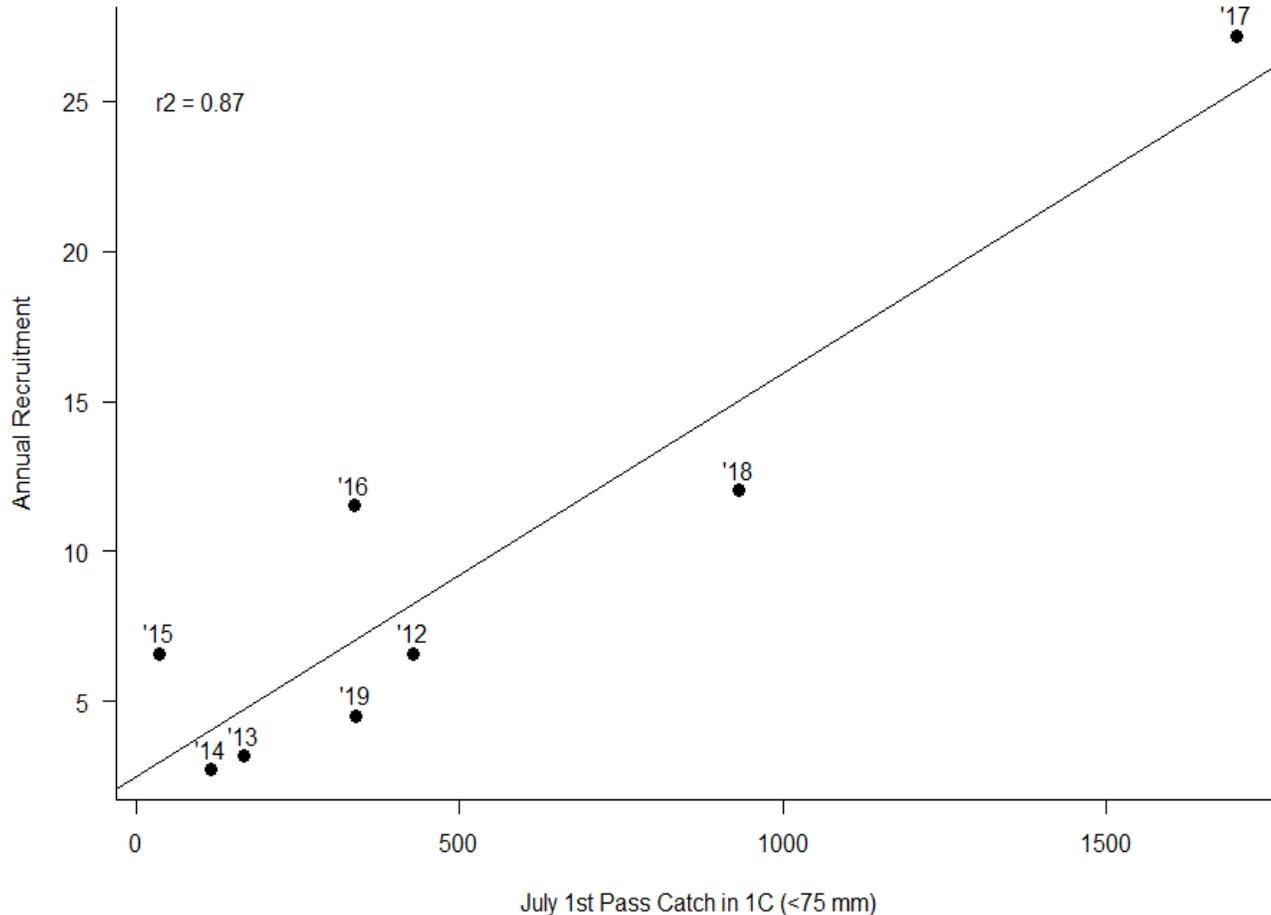


Mean growth for 266 g RBT (typical weight for a 300 mm fish)

- Growth differences between flow periods are inconclusive
- Other extrinsic factors like fish density and increasing biomass are likely influencing growth
- Flow effect is inconclusive

Preliminary data,
do not cite

Trout Management Flows, slide 1



Purpose of TMFs is to regulate large recruitment events (excess age-0 trout) to avoid downstream dispersal

Problems are:

- Uncertain about the overall efficacy of TMF's
- Negative effects to other resources
- Unable to forecast recruitment reliably until July.
- TMFs flow implementation is scheduled between May-July

Preliminary data, do not cite

Trout Management Flows, slide 2

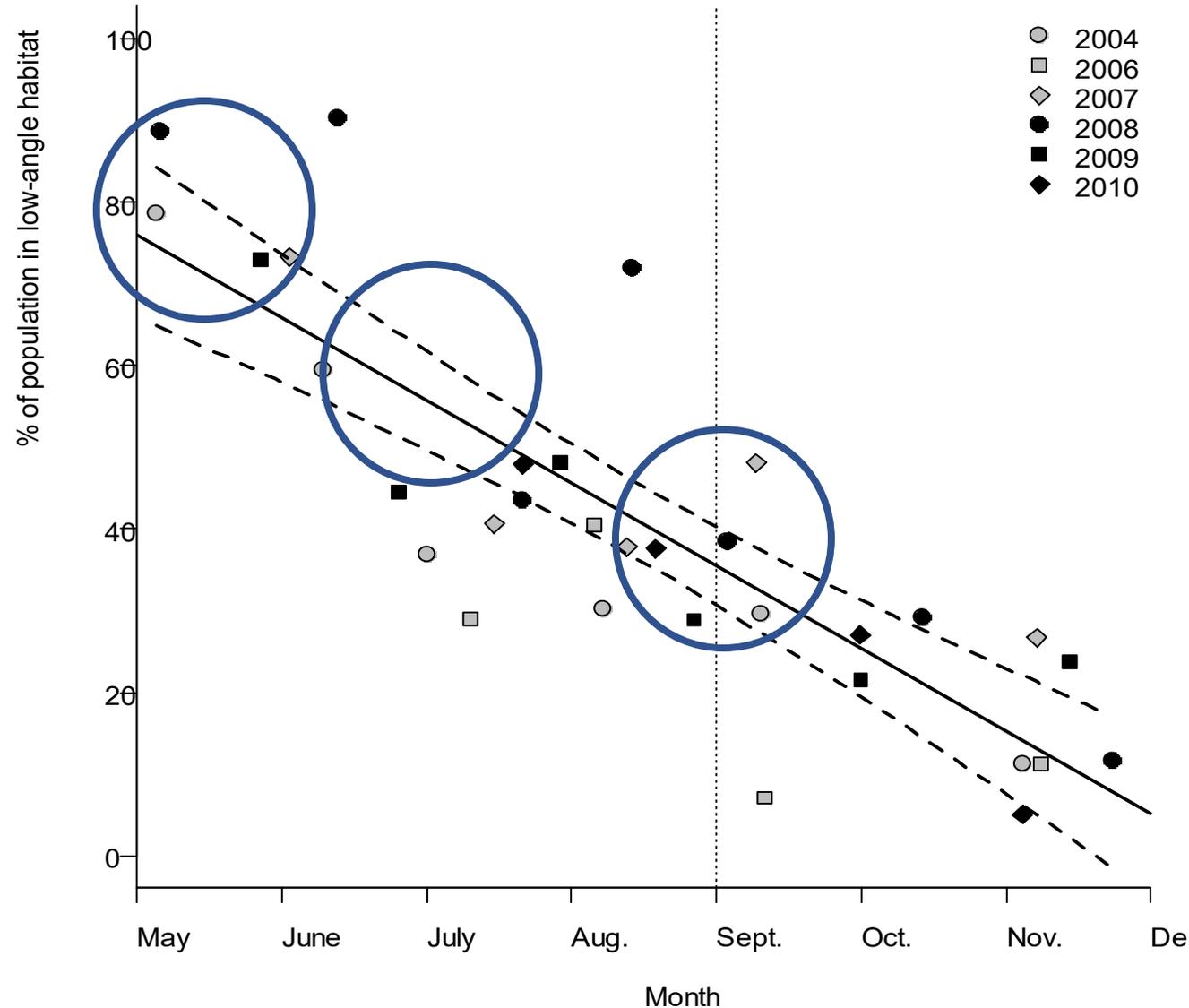
TMF's Assumptions:

We assume that recruits (Age-0, < 75 mm FL) are most vulnerable to stranding in low angle-habitat

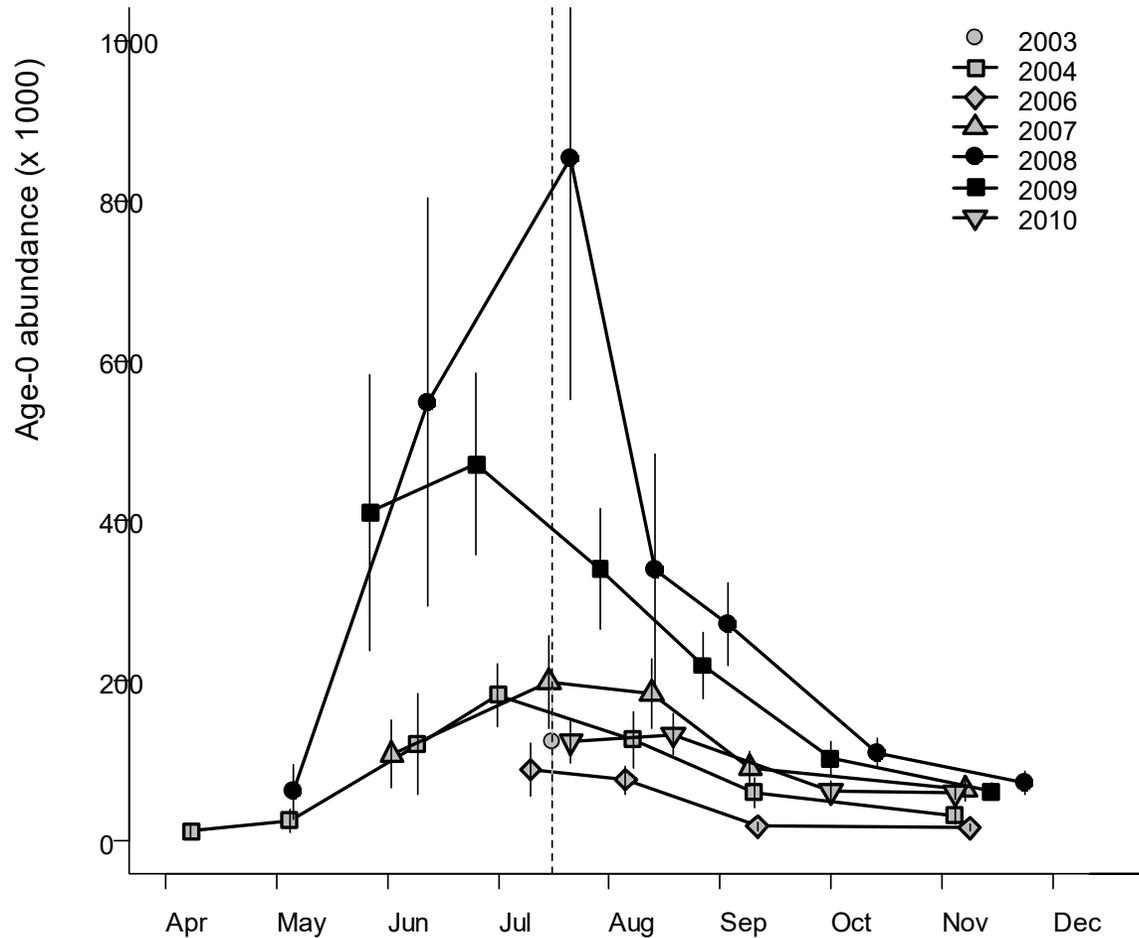
Based on RBT distribution RBT recruits would be most vulnerable to stranding in May-June.

Problems are:

1. Unable to forecast RBT recruitment until July
2. By July, only 50% of RBT recruits remain in low angle-habitat
3. BNT recruits don't appear to occupy wetted shoreline (low-angle or high-angle habitat) until September-October.
4. By September-October, BNT recruits are large in size, and not likely vulnerable to stranding



Trout Management Flows, slide 3

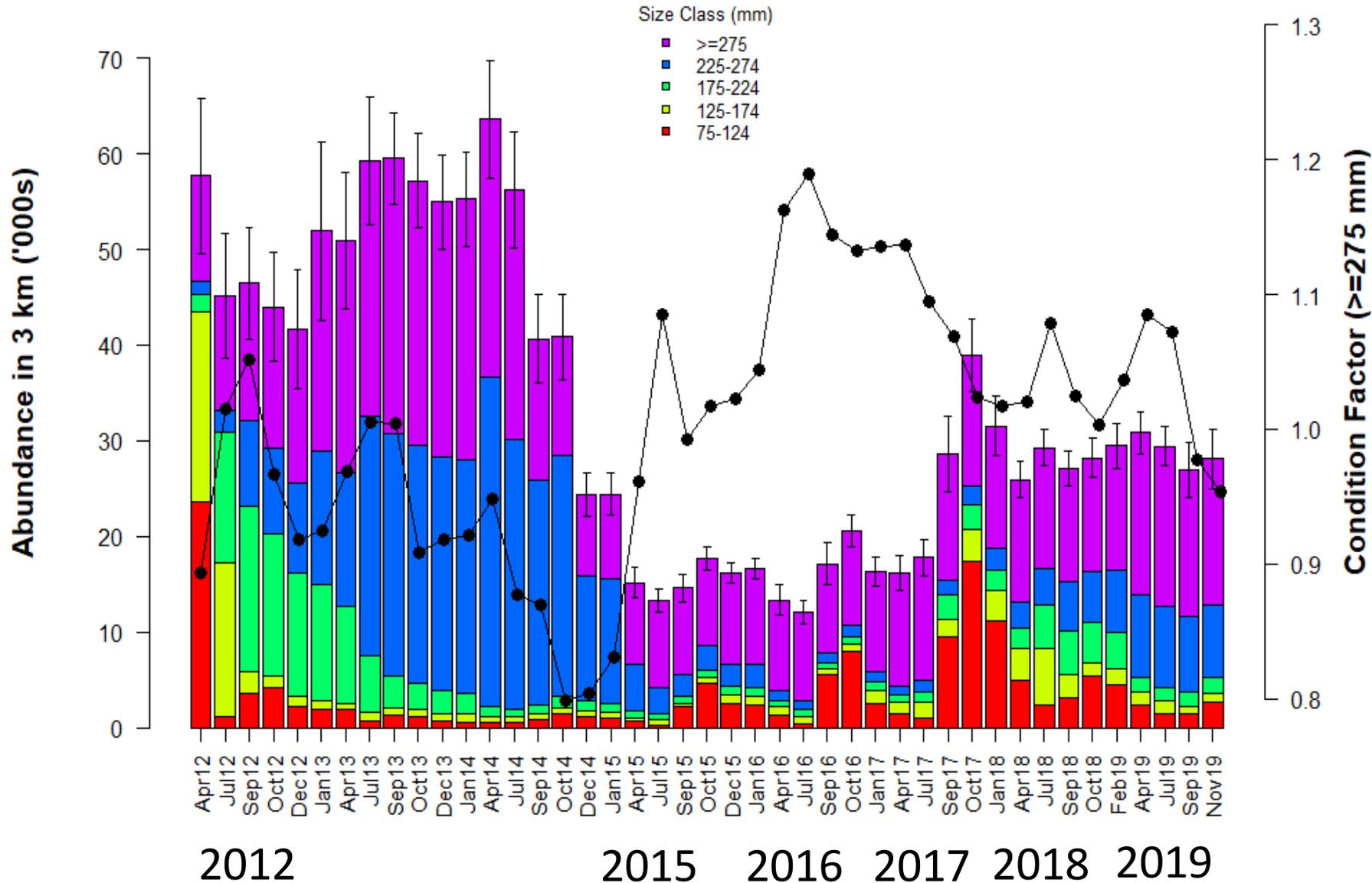


- **Purpose of TMFs is to regulate large recruitment events (excess age-0 trout) to avoid downstream dispersal**
- **Density dependent compensation**

Preliminary data, do not cite

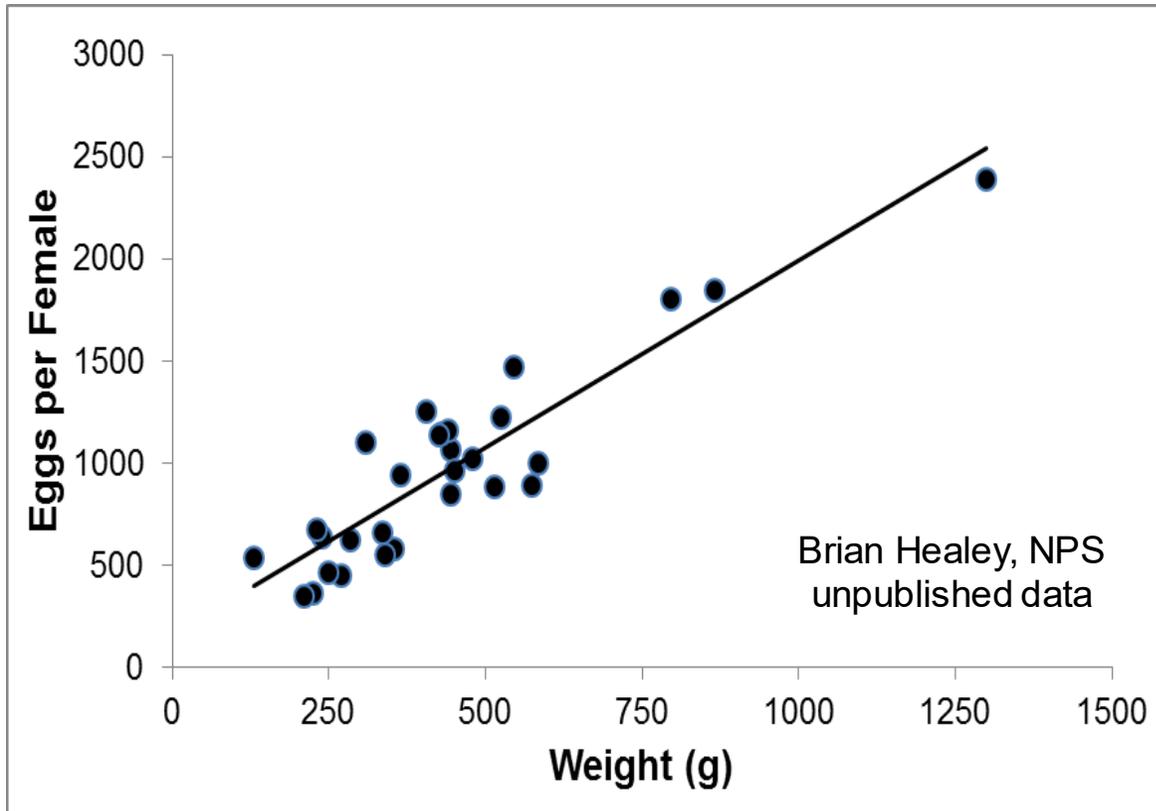
RAINBOW TROUT – ANNUAL RECRUITMENT

1C - Subreach

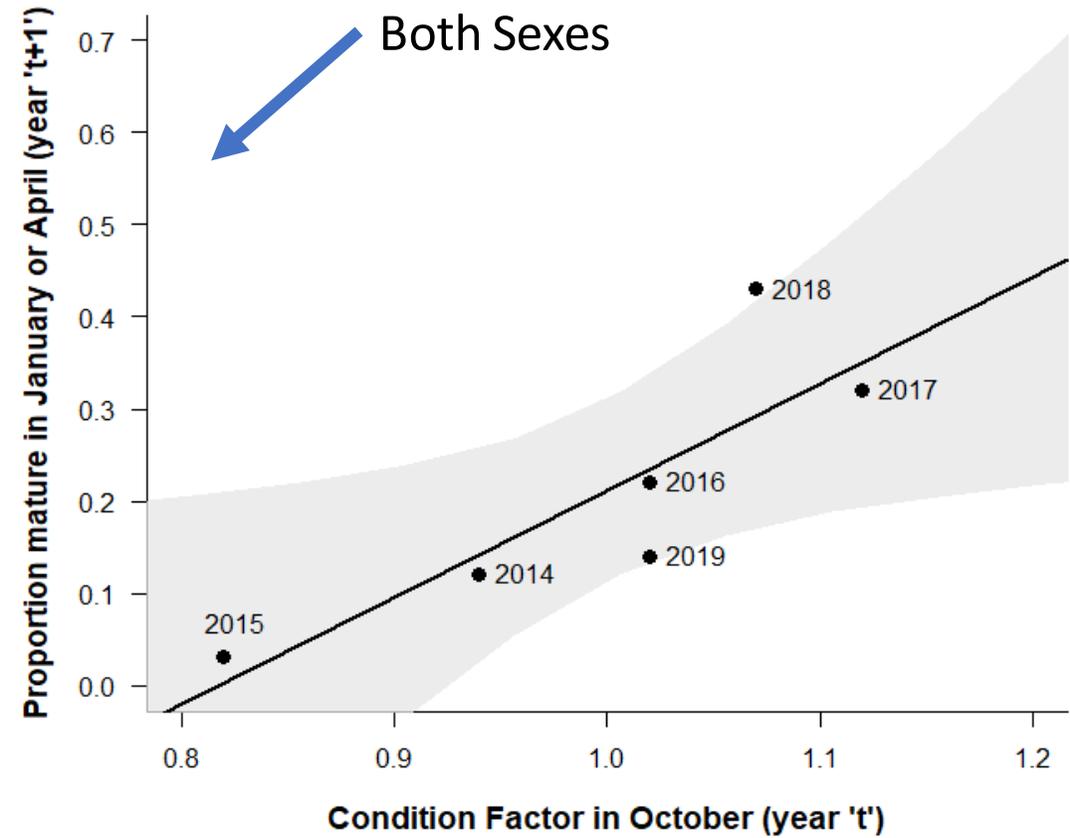


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Egg Production – Weight



Condition factor - Maturity



Preliminary data, do not cite

Conclusions

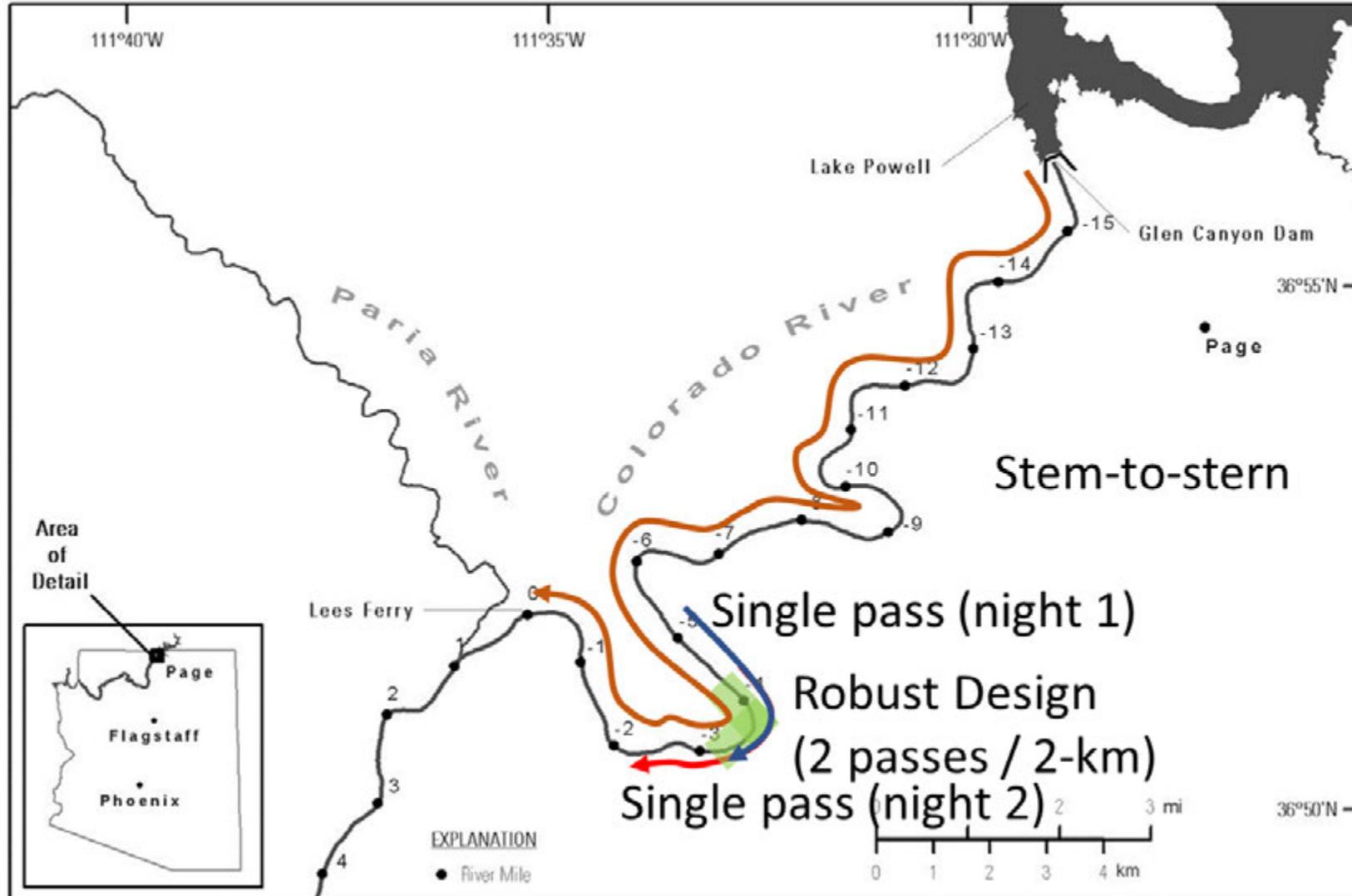
Population Status and Trends

- Rainbow trout abundance of catchable sized fish has increased and remained stable for the last 3-years.
- Since the RBT population crash, RBT relative condition is good, above 1.0
- 2017 was the last moderately large RBT recruitment (age-0) event.
- Since 2015, brown trout relative abundance (CPUE) has progressively increased.
- BNT relative condition and growth remains good and appears higher than RBT
- Since 2015, annual recruitment events for BNT have been relatively large with the exception of 2017 (i.e., the only year that RBT had a moderately large recruitment year since 2011)
- Difference in electrofishing catch between the two trout species suggest that BNT are not occupying the near shoreline (wetted edge) when smaller in size (i.e., vulnerable only during fall and winter)

Experimental Flow Status and Trends

- Reduction in invertebrate prey production/growth rates due to reservoir dynamics likely led to the RBT population crash (2014-2015).
- Fall High Flow Experiments may have an effect on trout growth and condition, but at this time the effect appears to be weak and inconclusive.
- Stable Summer Flows (“Bug Flows”) appears not to have had a positive effect on RBT growth and overall condition (i.e, other extrinsic factors).
- The implementation of Trout Management Flows is limited by researchers inability to forecast recruitment prior to, or during the ideal time period (specified by LTEMP design)

GLEN CANYON STUDY AREA, NATAL ORIGIN SAMPLING DESIGN



NATAL ORIGIN GLEN CANYON SAMPLING DESIGN

- Years 2012 – 2016
- 4 seasonal trips per year
- Trips: Jan, Apr, Jun/Jul, & Sep
- Sampled 1 Subreach (1C)
 - 2 nights per trip
 - 2 Single passes (4 km lengths)
 - 2 km overlap (Robust Design)
- Sampled all of Glen Canyon
 - 1 to 2 trips per year
 - 7 to 10 days per trip
 - Late-Oct/Nov & Dec/Jan
 - 25 km length