TRGD: Trout Recruitment, Growth and Population Dynamics

Project Element: H.1

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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.

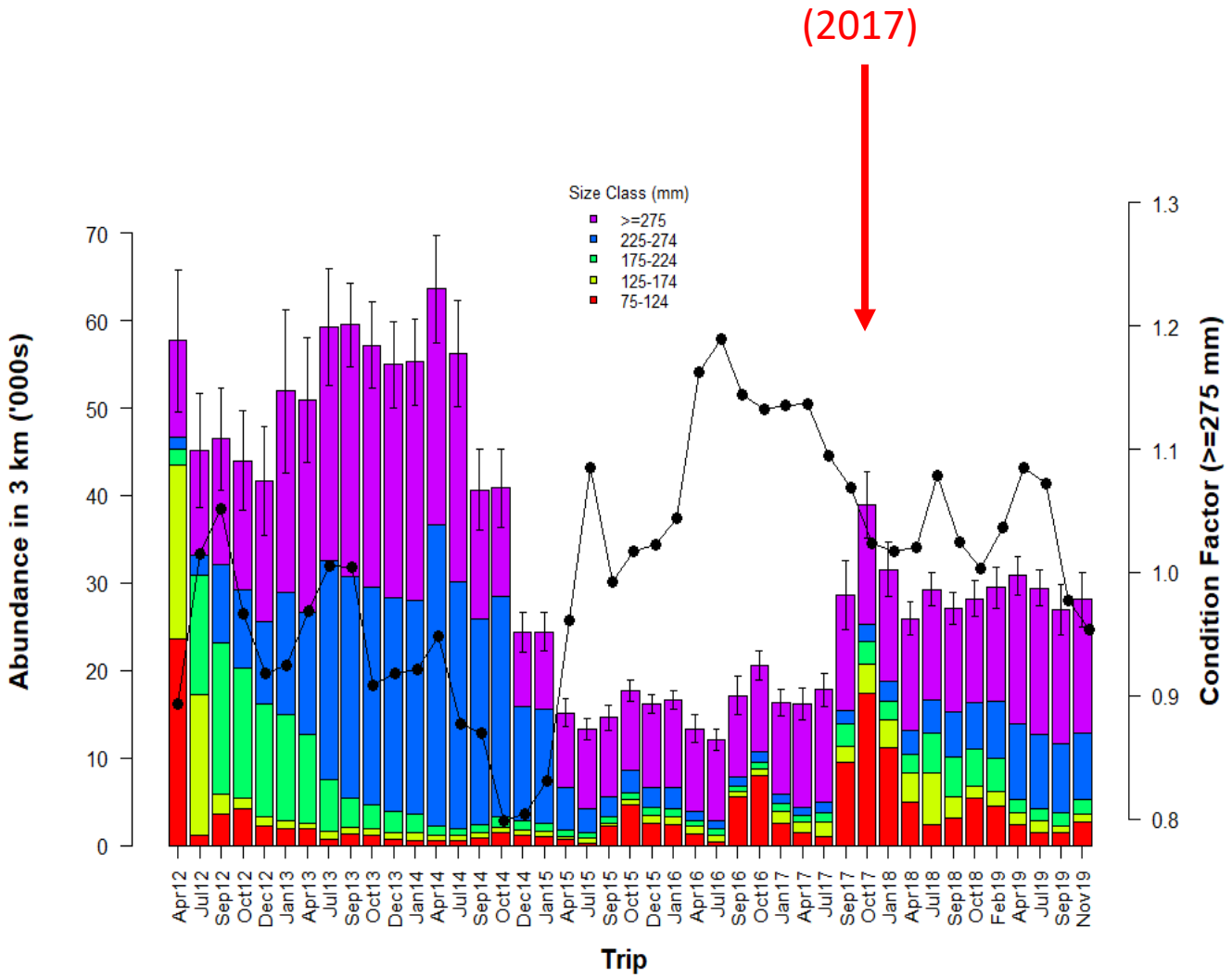
- The effect of fall High Flow Experiments (HFEs) on recruitment of trout in Glen Canyon, measured either through direct effects on juvenile survival or through reduced egg deposition in later years driven by reduced growth of trout (which reduces fecundity and rates of sexual maturation).

- 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.

RAINBOW TROUT ABUNDANCE AND CONDITION

1C - Subreach



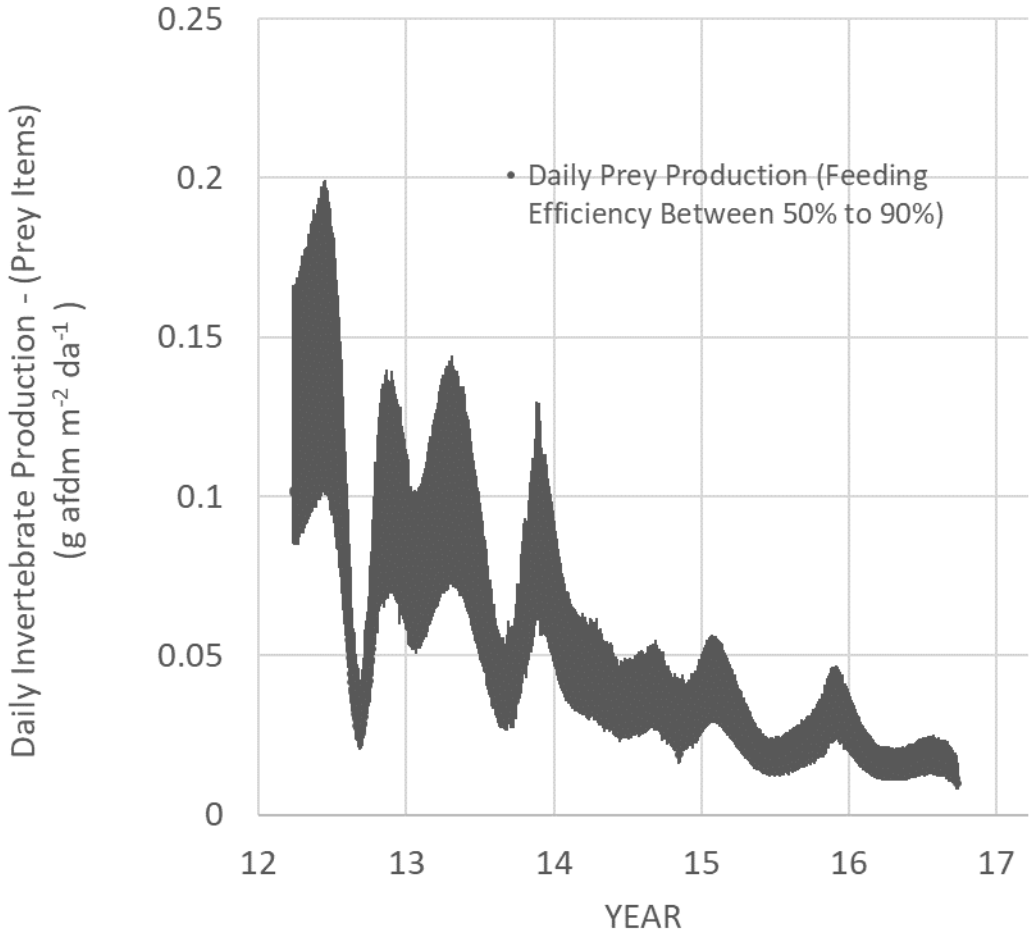
Preliminary data, do not cite

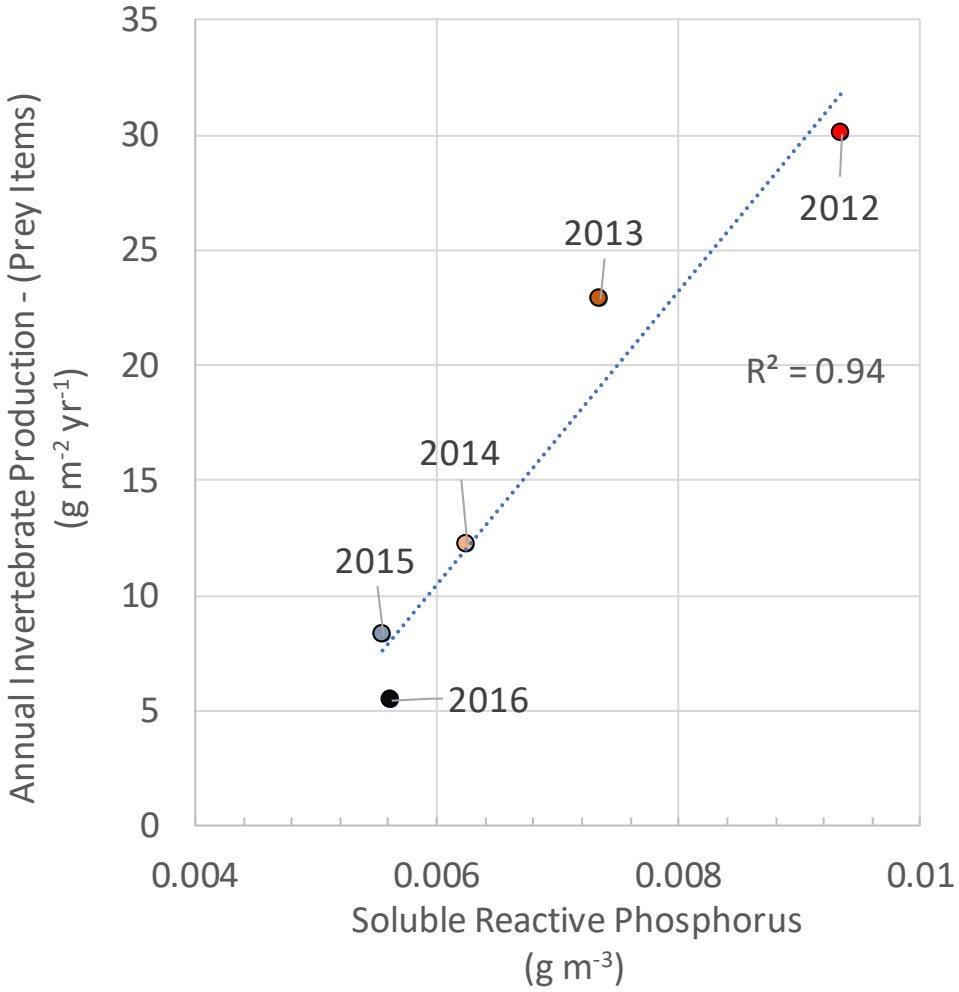
Overview: 2012 – 2019

- 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)





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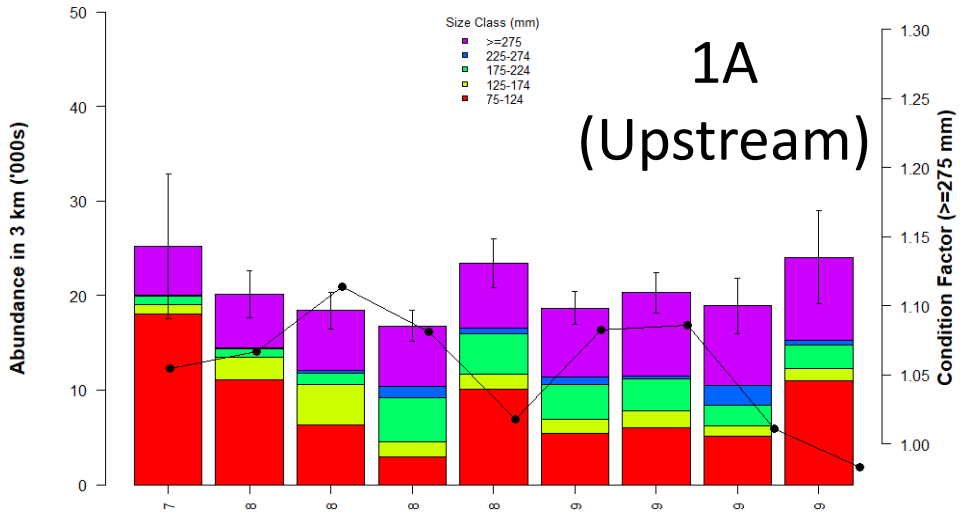
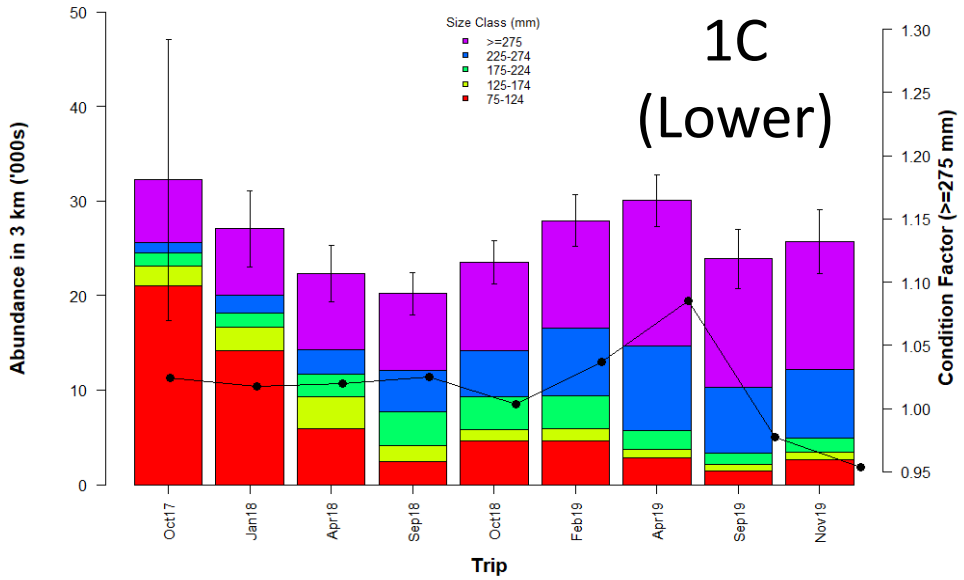
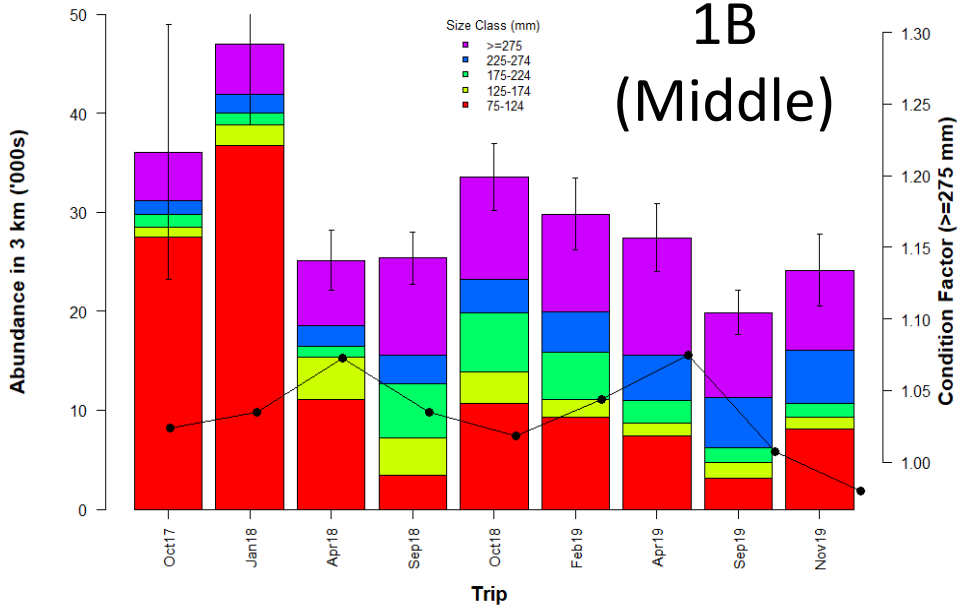
RAINBOW TROUT ABUNDANCE







Overview: 2017 – 2019

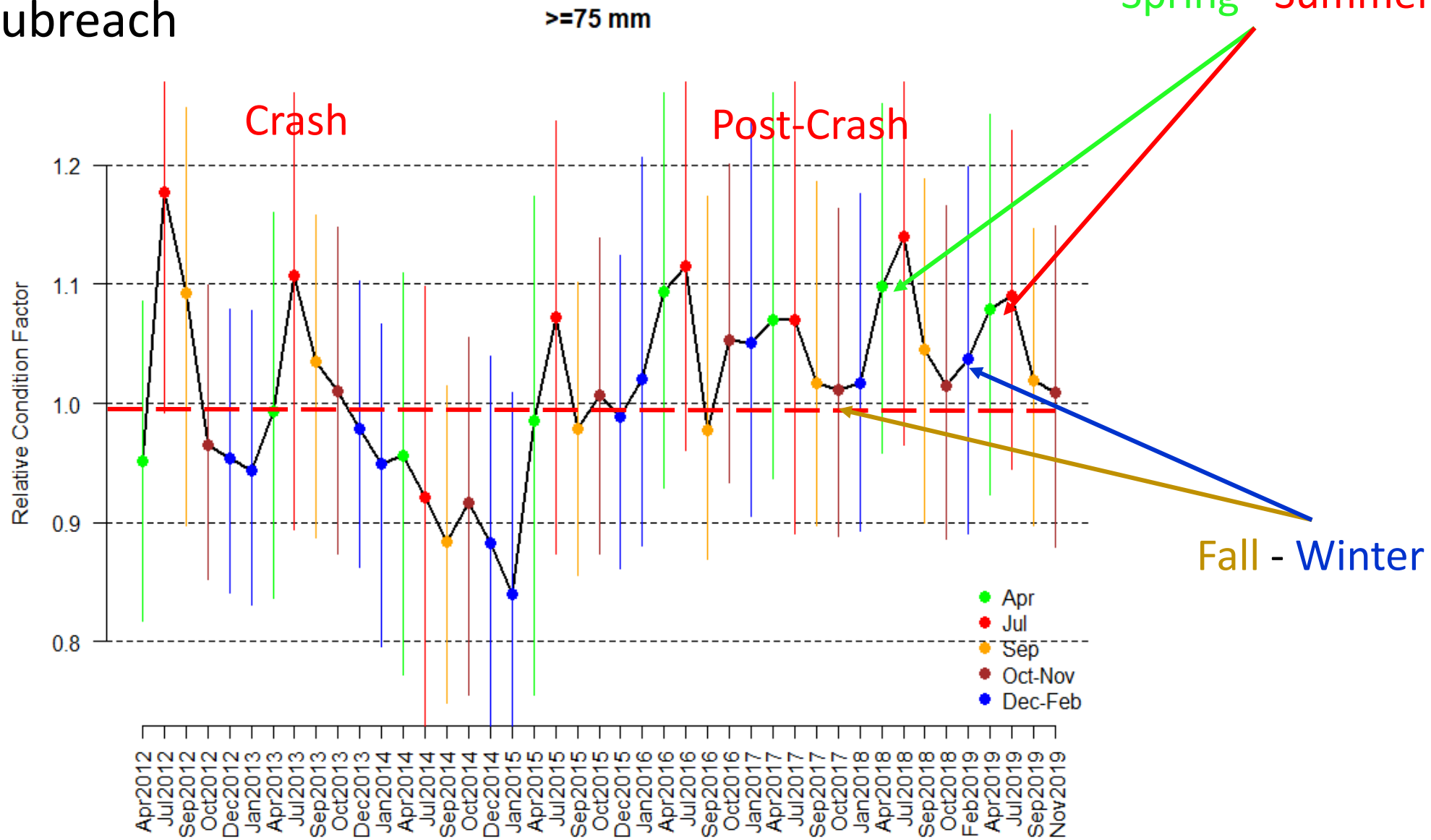
Spatial variation in abundance:

- 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



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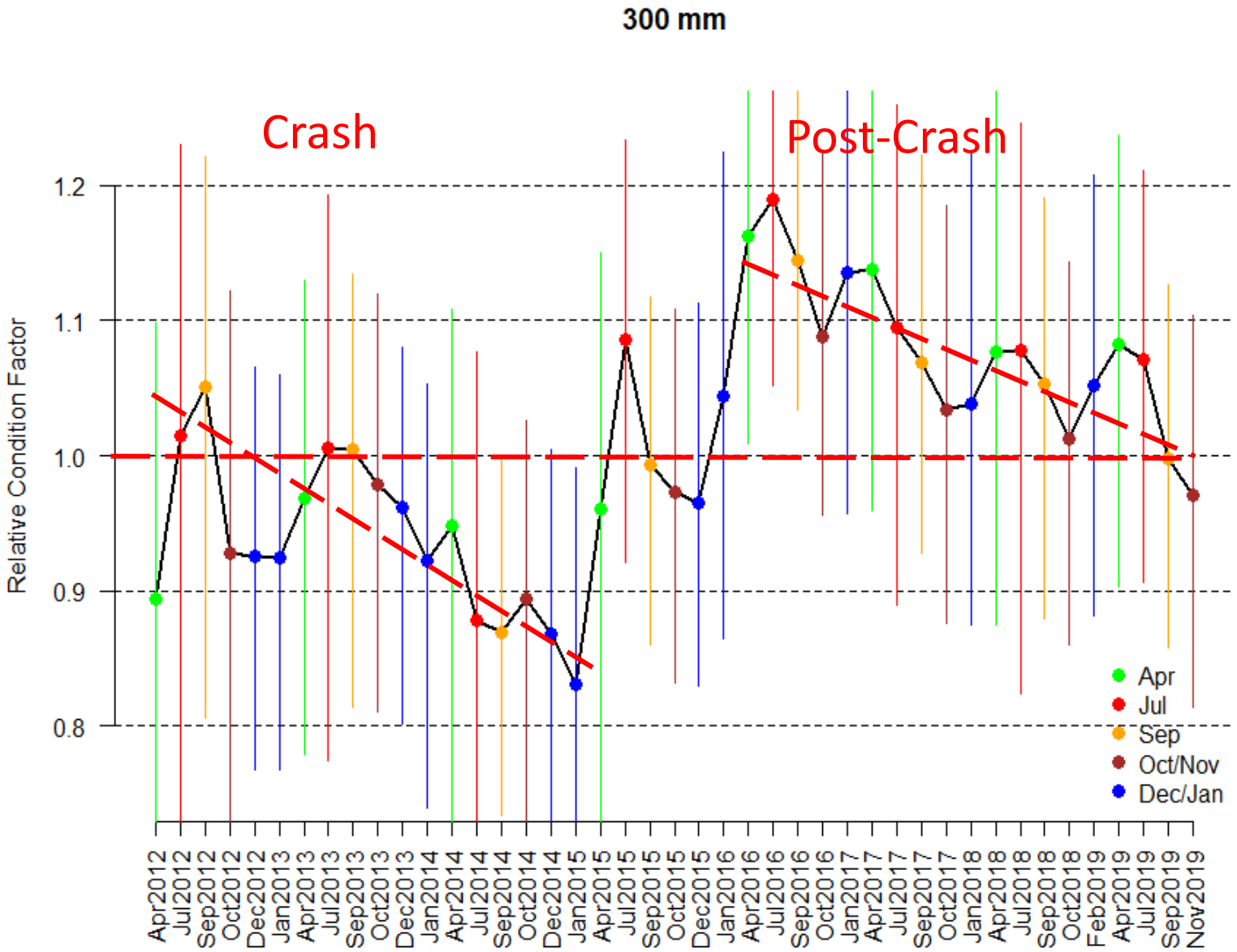
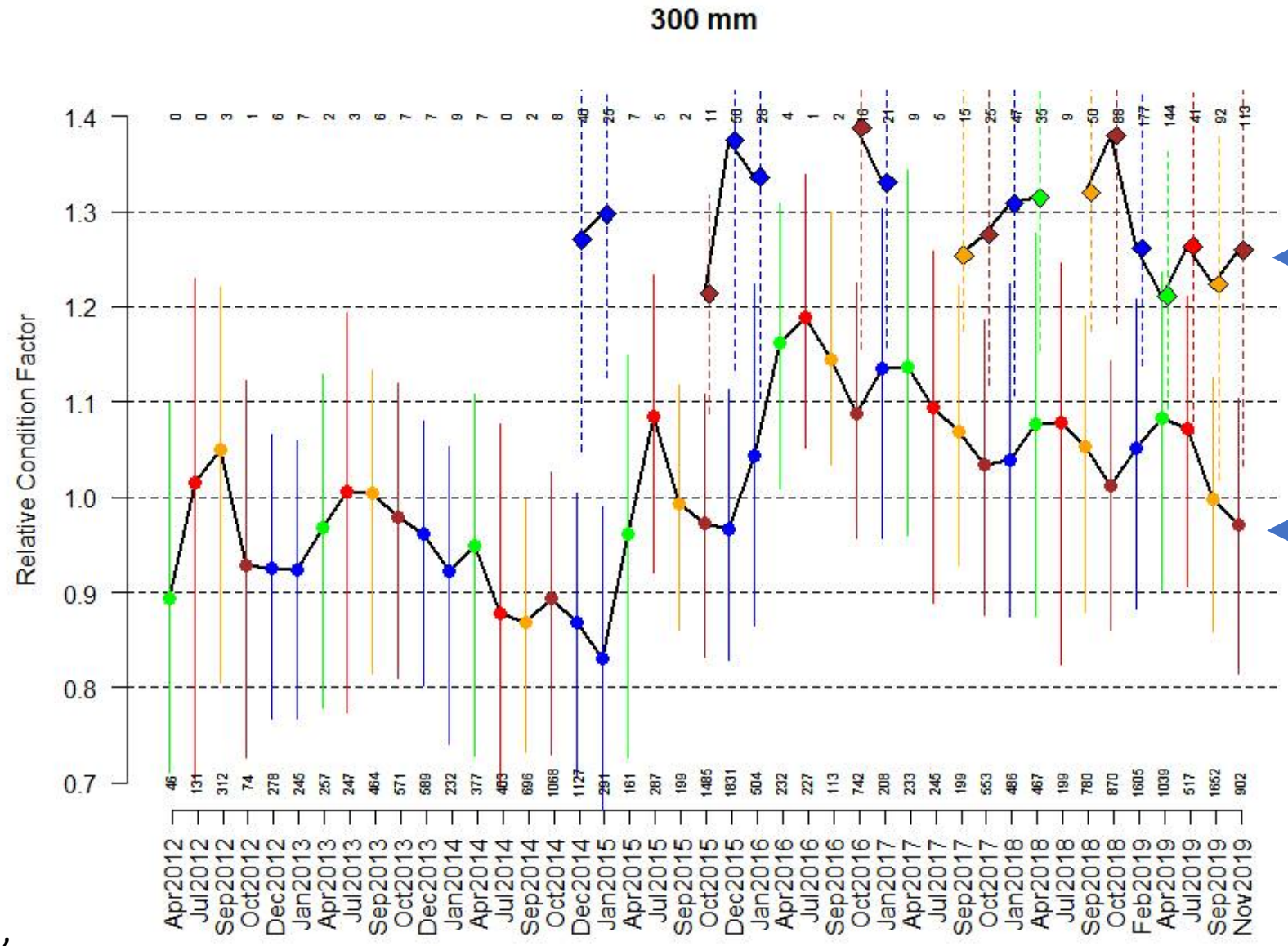
LARGE RAINBOW TROUT



Preliminary data,
do not cite

COMPARISON BETWEEN RAINBOW TROUT AND BROWN TROUT

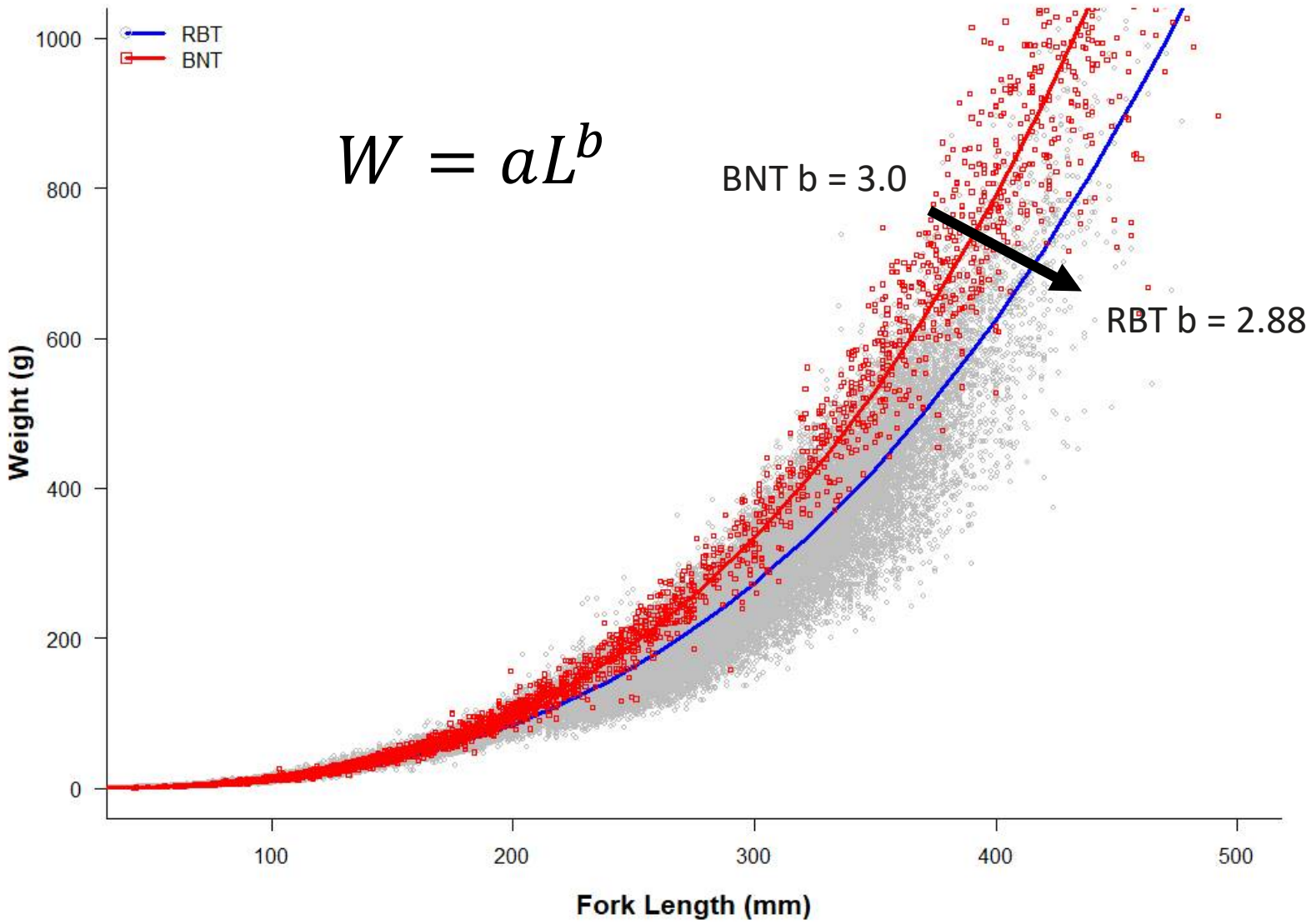


BROWN TROUT

RAINBOW TROUT

Preliminary data,
do not cite

Brown Trout **Rainbow Trout**



Length-weight Relationship

Sample Size:

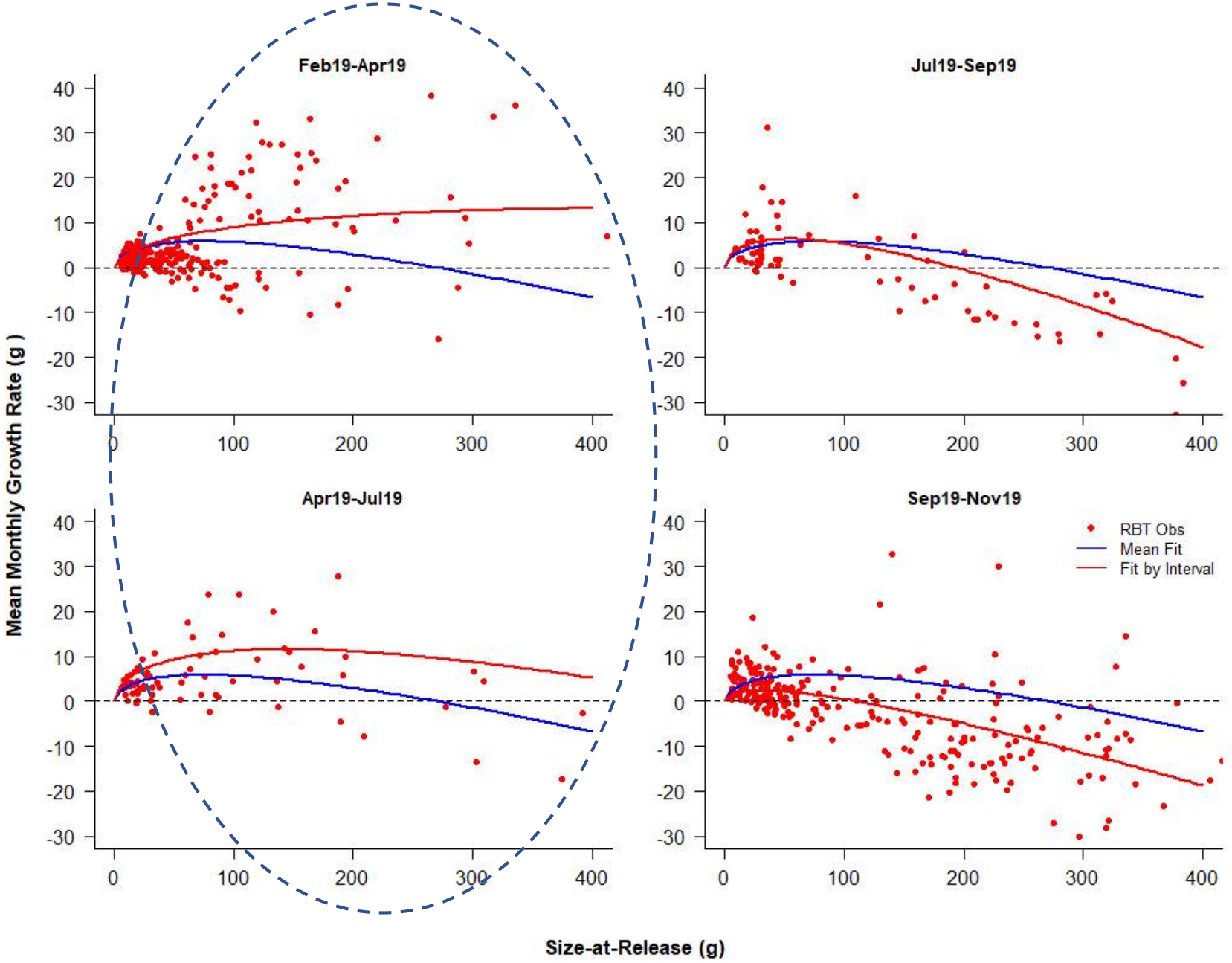
- RBT (n) = 101,989
- BNT (n) = 5,197

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 – RAINBOW TROUT MONTHLY GROWTH RATES

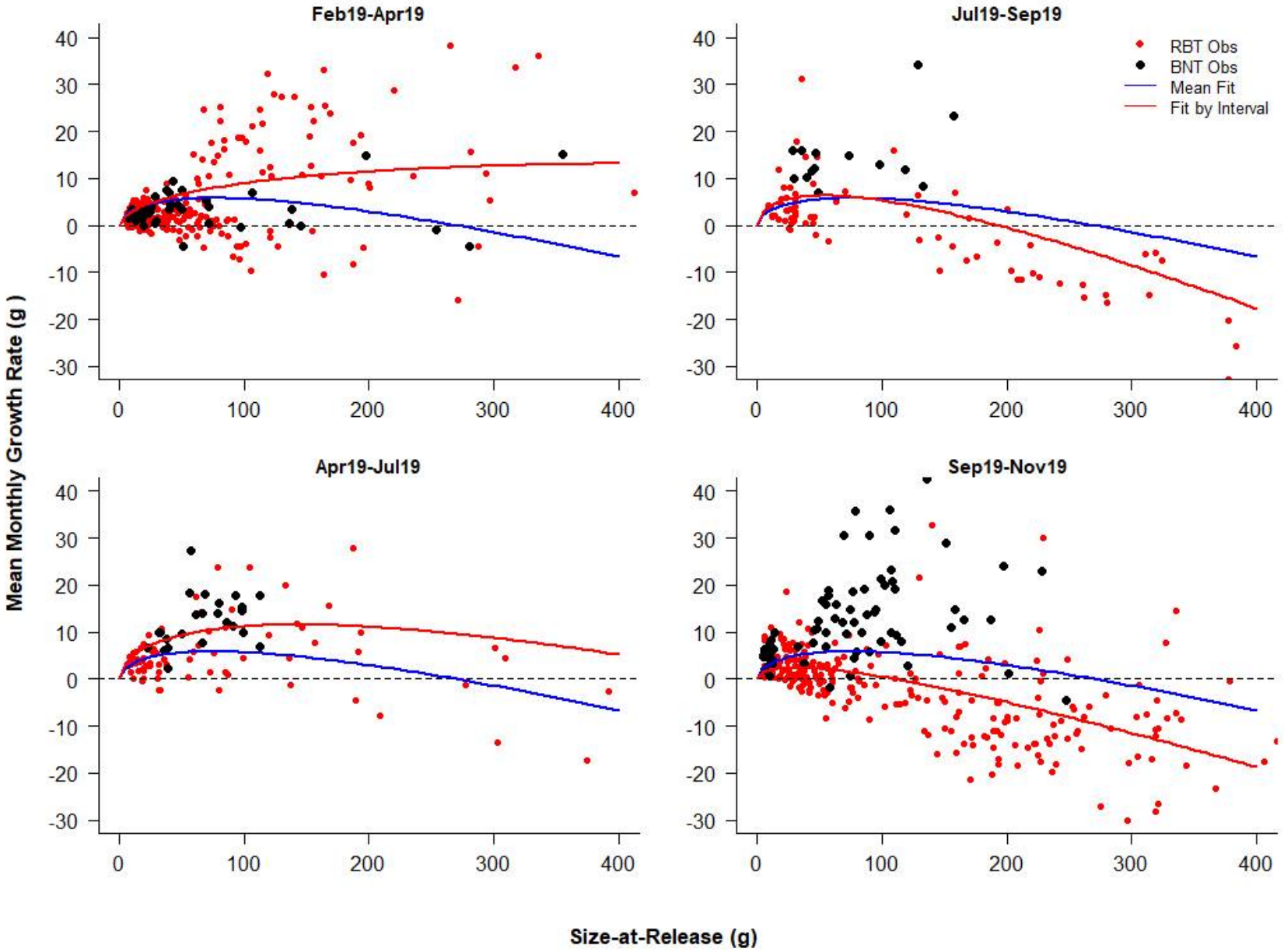


Rainbow Trout Mean Monthly Growth Rate (g/mo)

- 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 – BROWN TROUT MONTHLY GROWTH RATES

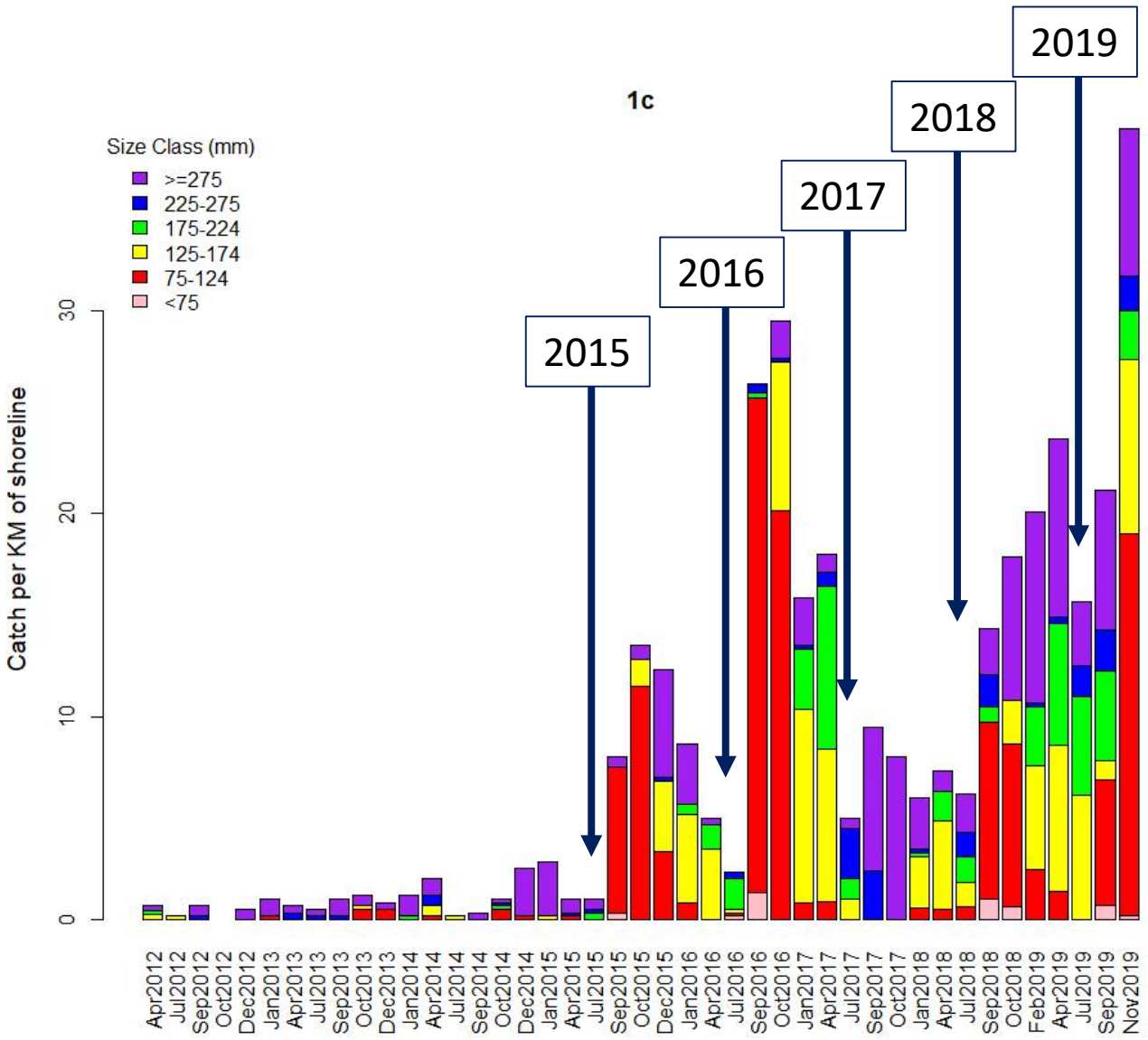


Brown Trout Mean Monthly Growth Rate (g/mo)

- 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



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Brown Trout (BNT) spawn between November-January, whereas, Rainbow Trout (RBT) around mid-March.

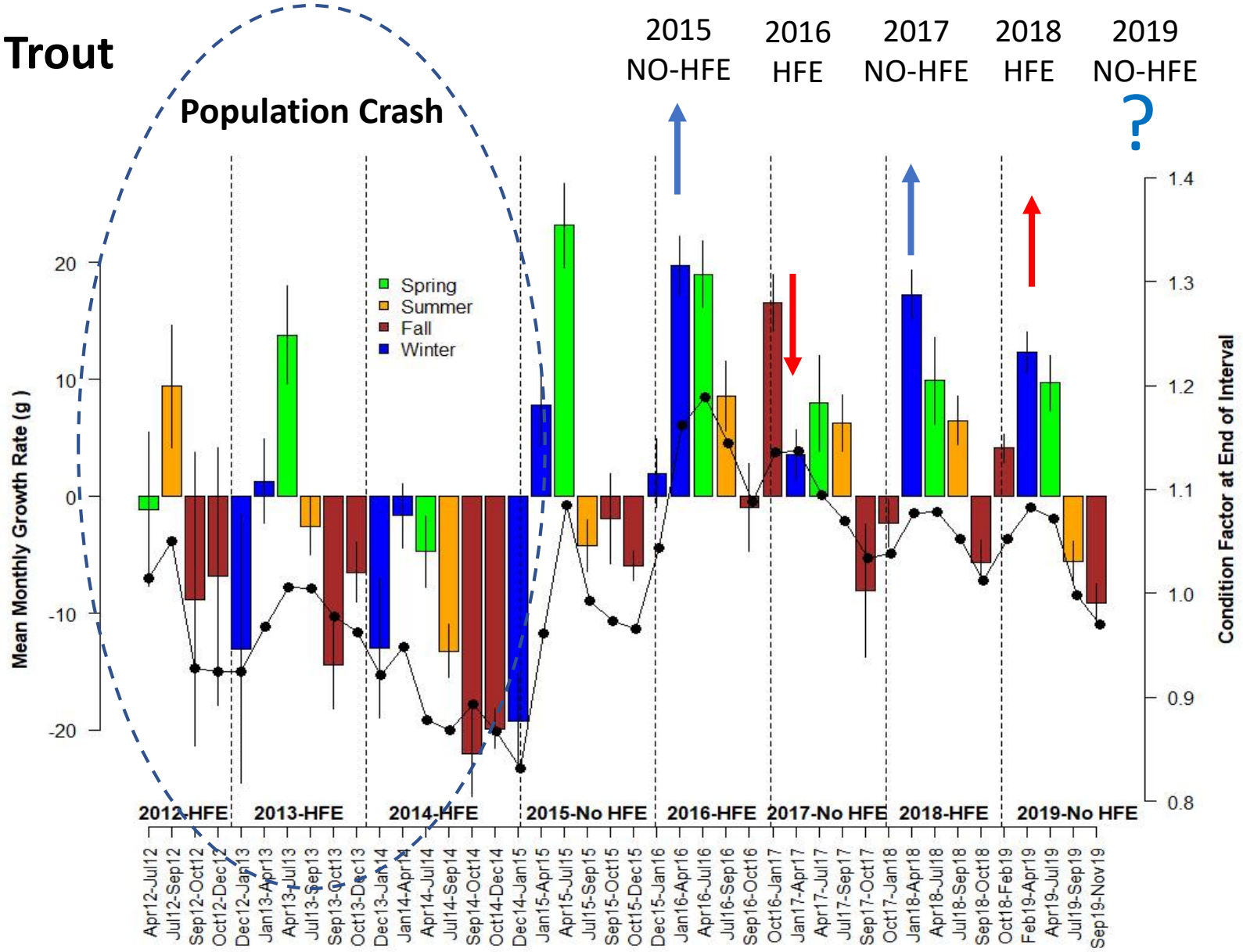
- We should expect to observe BNT in our electrofishing catch sooner than RBT.
- Based on relative catch in the fall, BNT appear to be growing and surviving better than age-0 RBT.

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 affected by TMFs in late Spring and Summer.

FALL HIGH-FLOW EXPERIMENT

Rainbow Trout

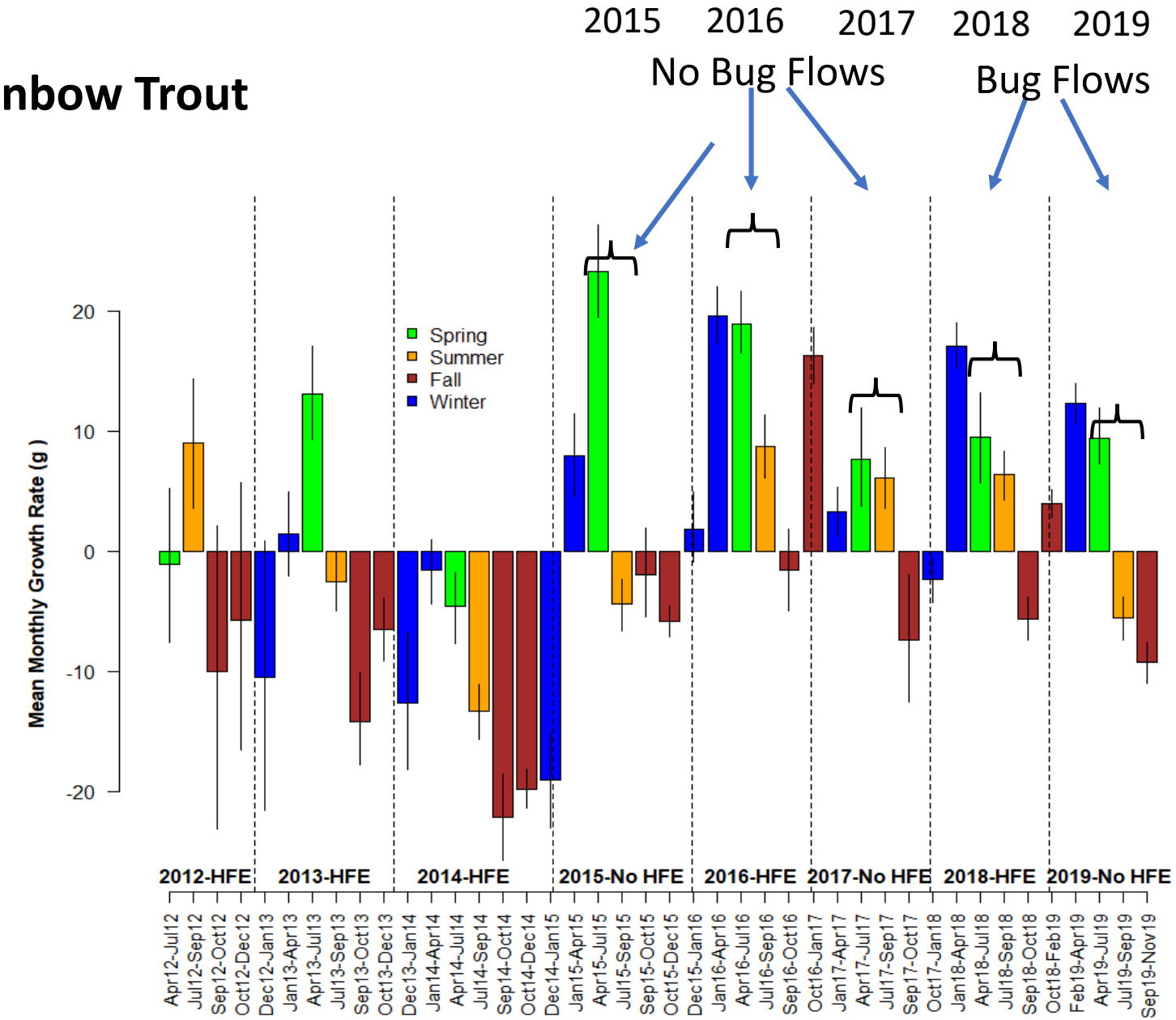


Mean growth for 266 g RBT (typical weight for a 300 mm fish).

Preliminary data, do not cite.

STABLE FLOWS – “BUG FLOWS”

Rainbow Trout

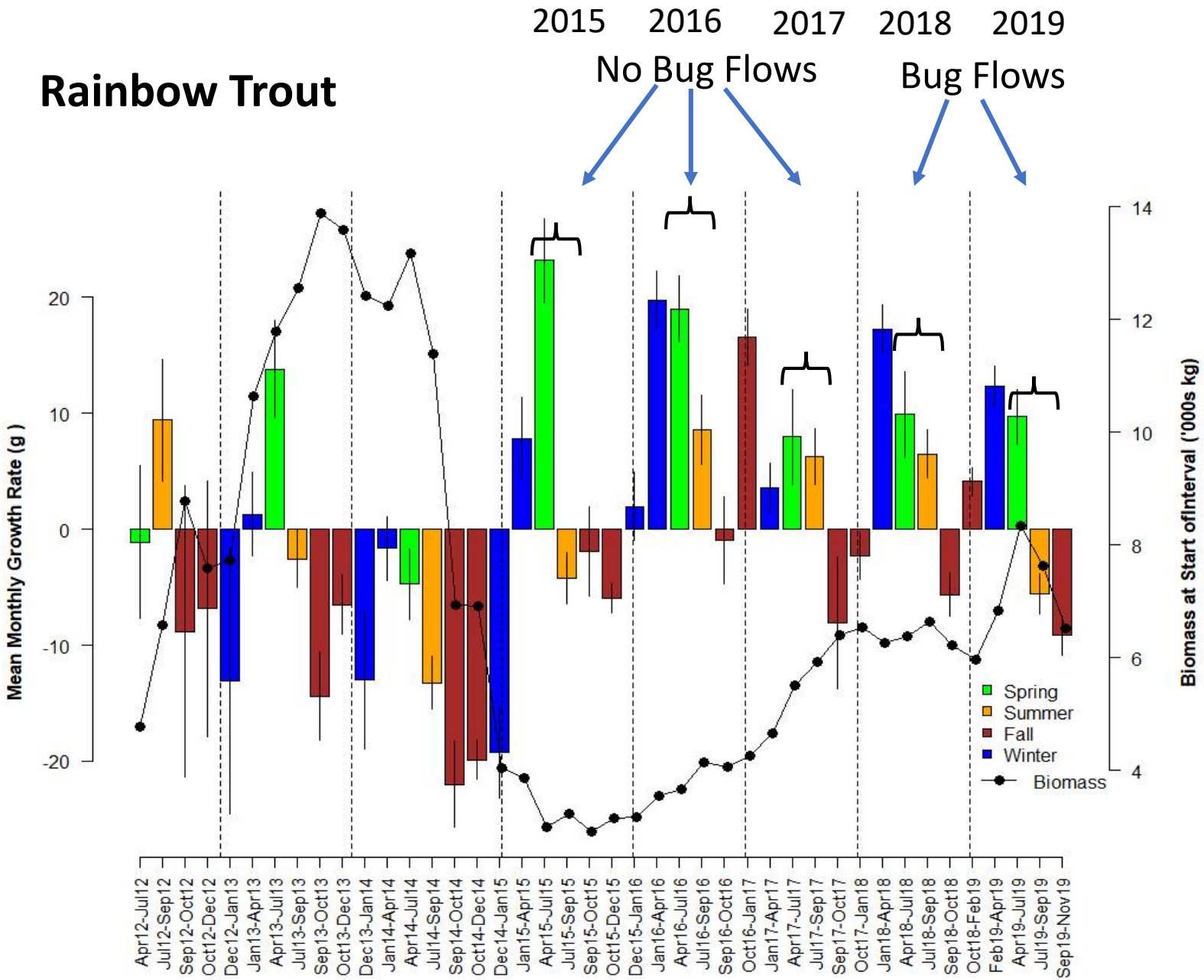


Mean growth for 266 g RBT (typical weight for a 300 mm fish)

Preliminary data, do not cite

STABLE “BUG-FLOWS”

Rainbow Trout



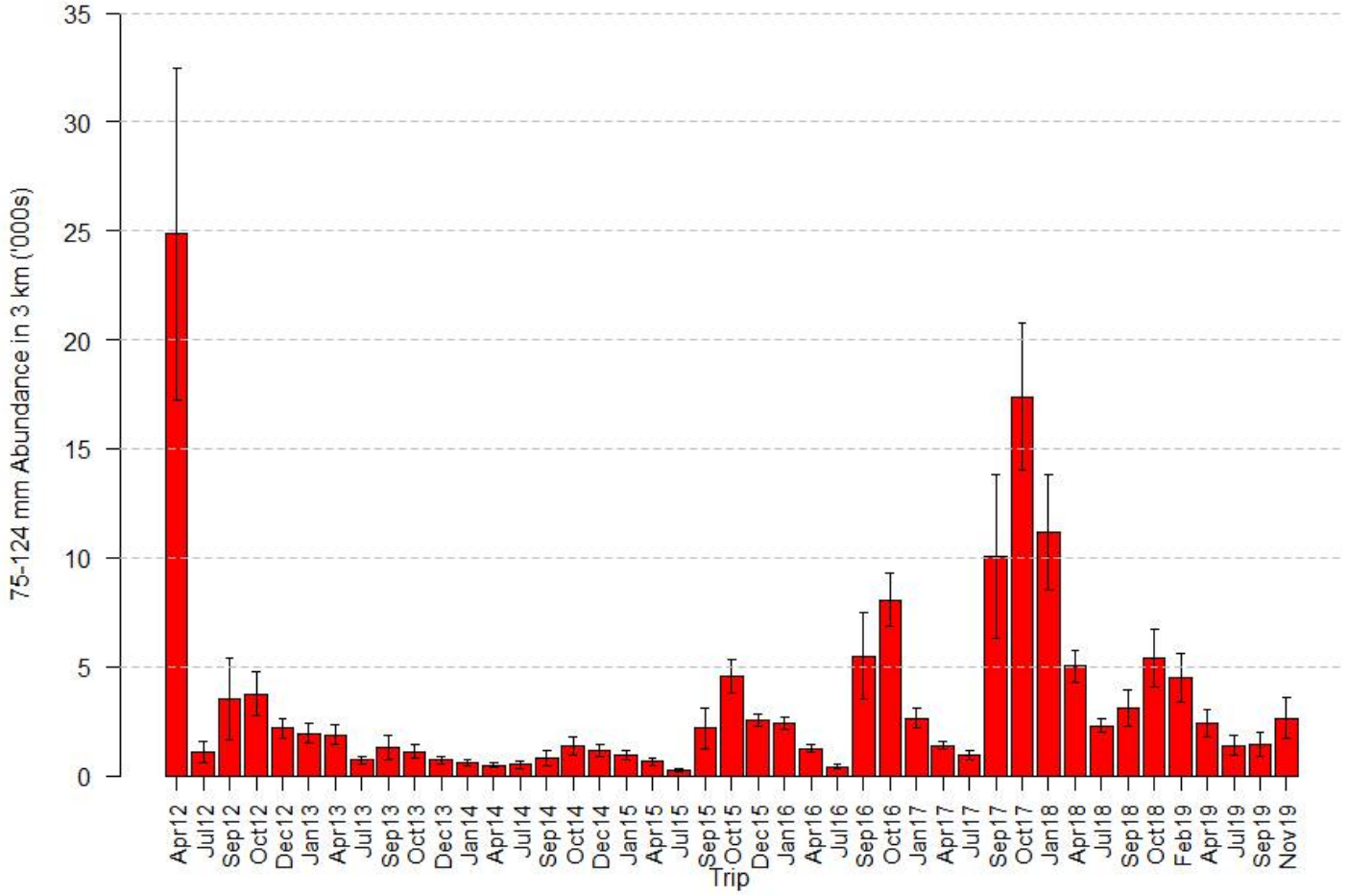
Mean growth for 266 g RBT (typical weight for a 300 mm fish).

- 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.

RAINBOW TROUT – ANNUAL RECRUITMENT

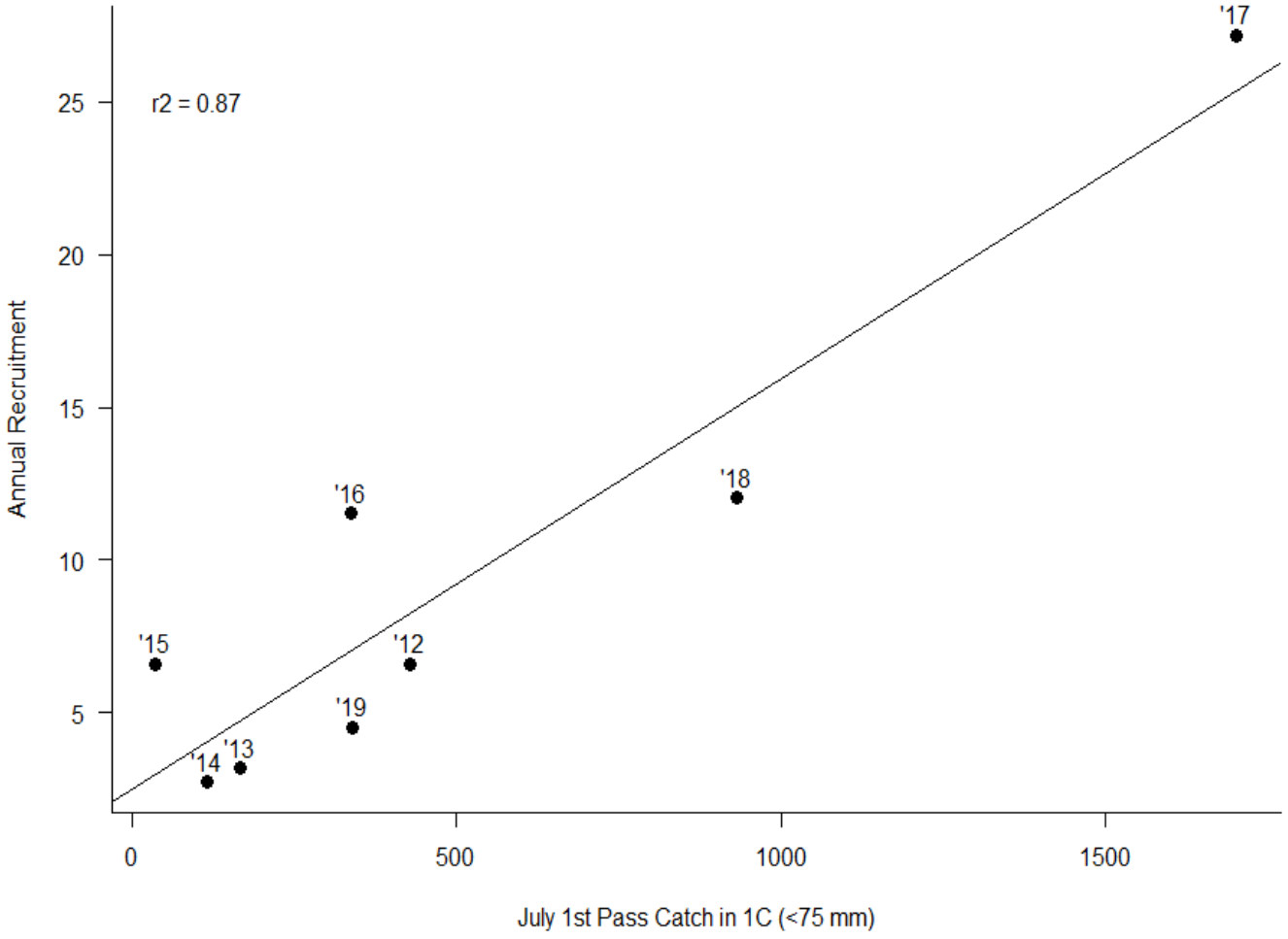
1C - Subreach



2012 2015 2016 2017 2018 2019

Preliminary data,
do not cite.

TROUT MANAGEMENT FLOWS



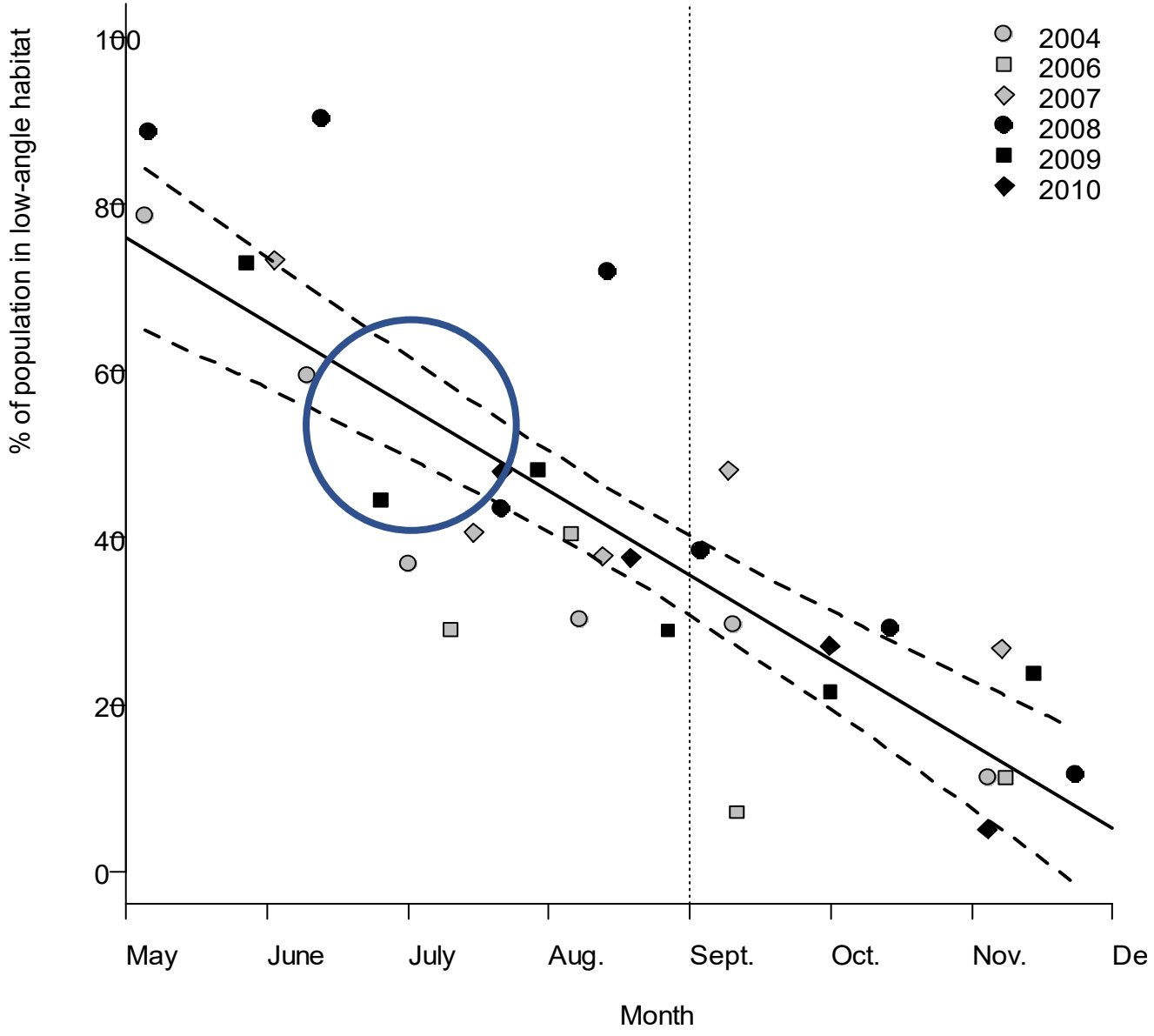
The purpose of TMFs is to regulate large recruitment events (excess age-0 trout) to avoid downstream dispersal.

Problems are:

- Uncertainty 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, cont.



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:

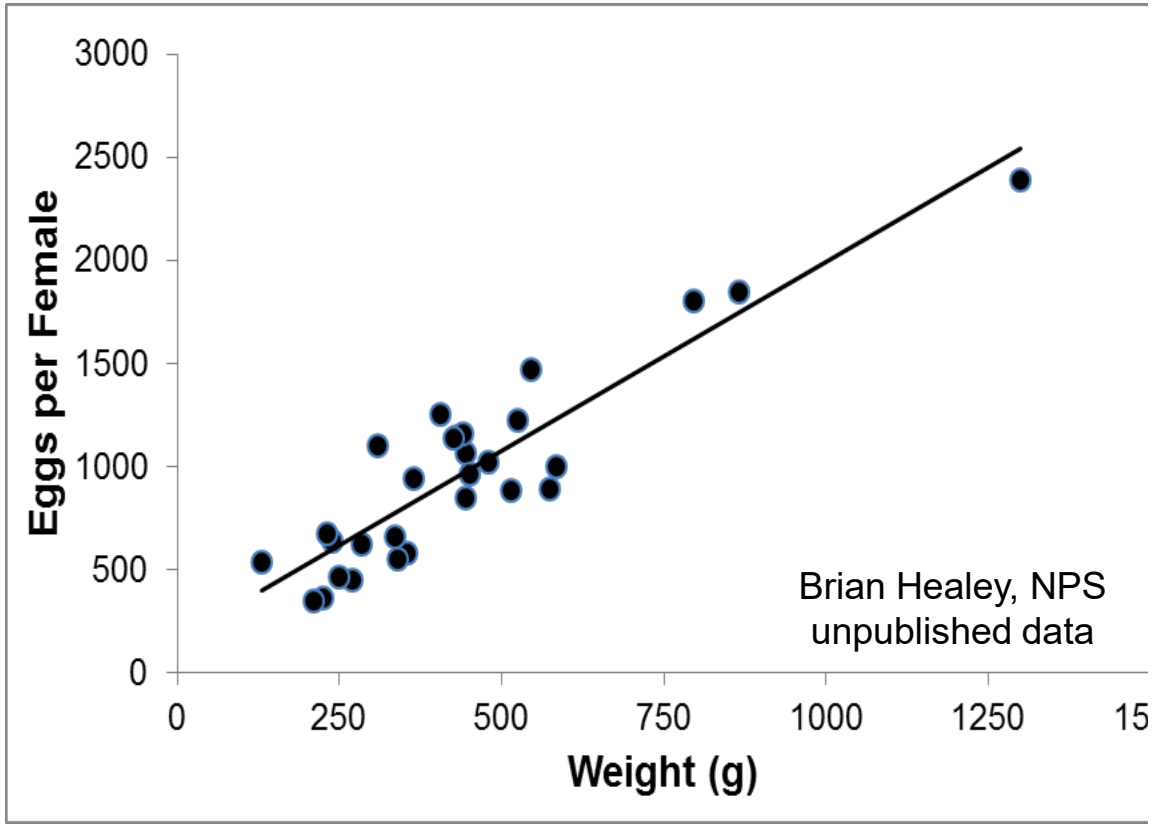
1) Unable to forecast RBT recruitment until July.
2) By July, only 50% of RBT recruits remain in low angle-habitat.
3) BNT recruits don't appear to occupy wetted shoreline (low-angle or high-angle habitat) until September-October.
4) By September-October, BNT recruits are large in size, and not likely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

Korman and others, 2011

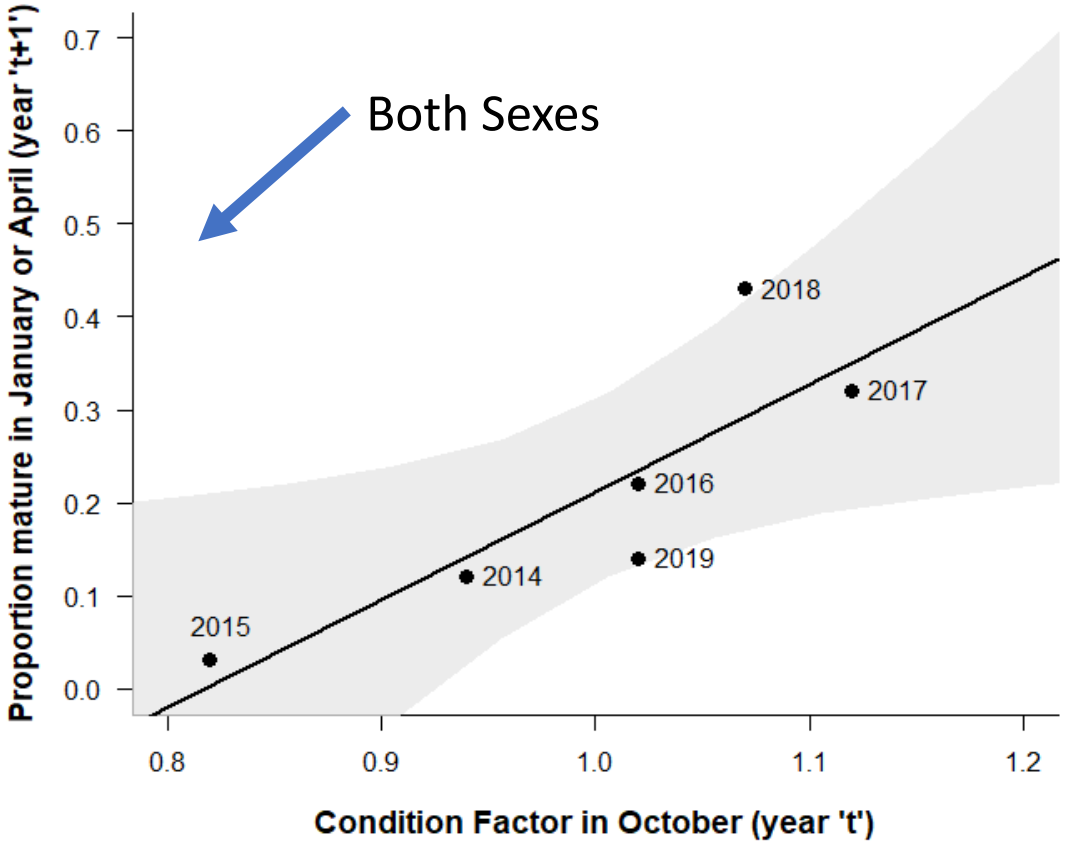
Preliminary data, do not cite

RELATIONSHIP BETWEEN CONDITION FACTOR AND MATURITY RATE

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 decreased SRP 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 - Researchers are currently limited in being able to forecast recruitment prior to, or during the ideal time period (specified by LTEMP design).

Preliminary data, do not cite

USGS