NSC 2020 Winter Conference:

How to Meet the Demands of our Changing Forests?

February 25-26, 2019

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Keeping the Mixedwoods: Is There Benefit?

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Pink Mountain, Buick Creek & Wonowon
British Columbia

Northern Silviculture Committee: Winter Workshop
Prince George, BC
February 26, 2020

Outline

- Northeast Climate
- Background
- Study
- Objectives
- Findings
- Take-home
  - Thoughts
  - Conclusions

Background

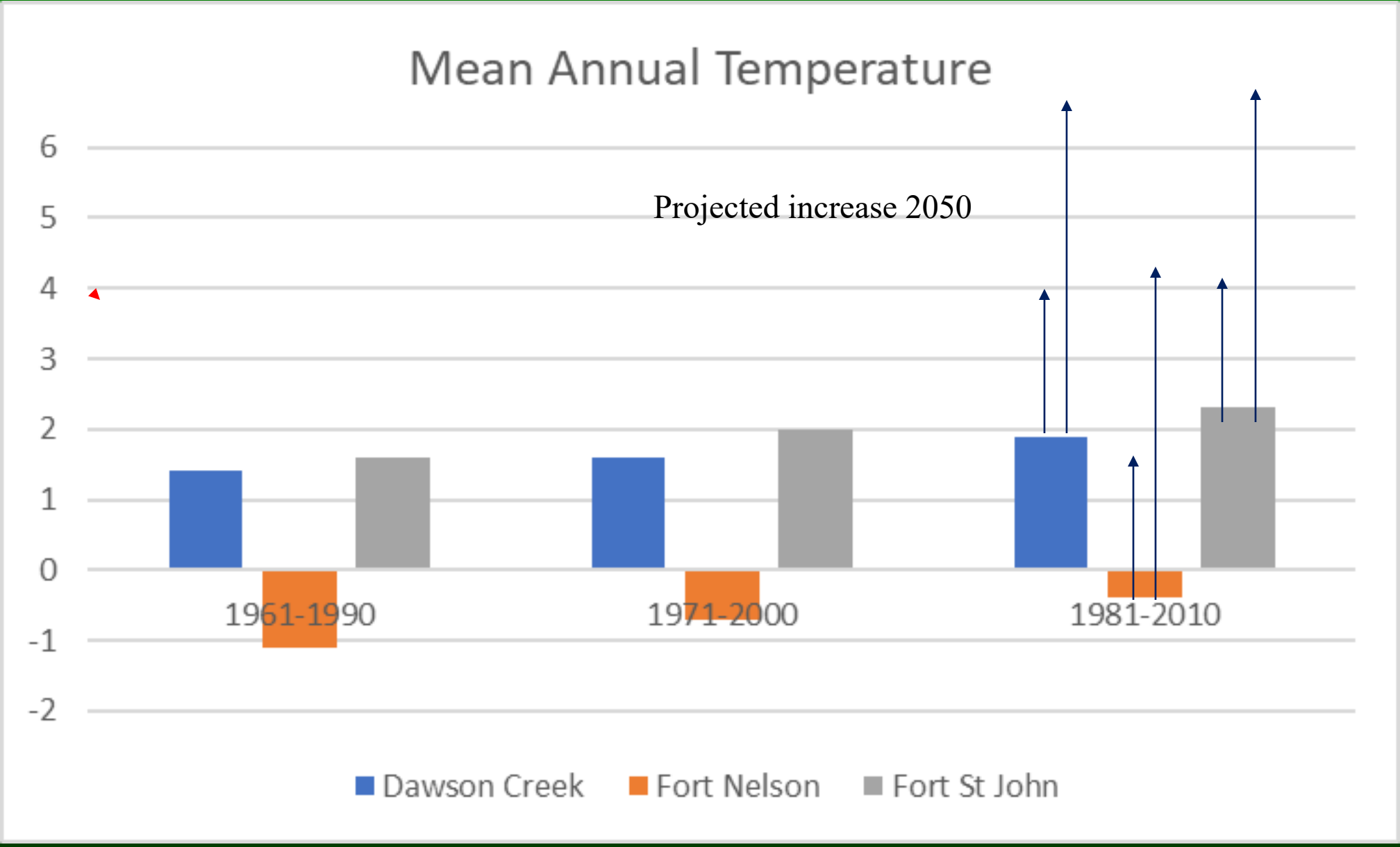
- Northeast BC
  - Complex (conifer – broadleaf) stands
  - BC forest management regulations ←→ economics
    - Drive management towards pure, even aged conifer stands
      - Assumed goal → maximize conifer productivity, economic return (conifer $ > deciduous $), maximize conifer AAC **not** site productivity.

Background

- Northeast BC
  - Complex (conifer – broadleaf) stands
  - BC forest regulations ←→ economics
    - Shortly after establishment
      - Broadleaves removed
        - » Pure conifer
      - A management contradiction results
        - » Other directives – maintain landscape level diversity
    - Reduced diversity (structural & species)
    - Potential threat to stand stability and resilience
      - (Gayer 1886)
    - More susceptible to fire

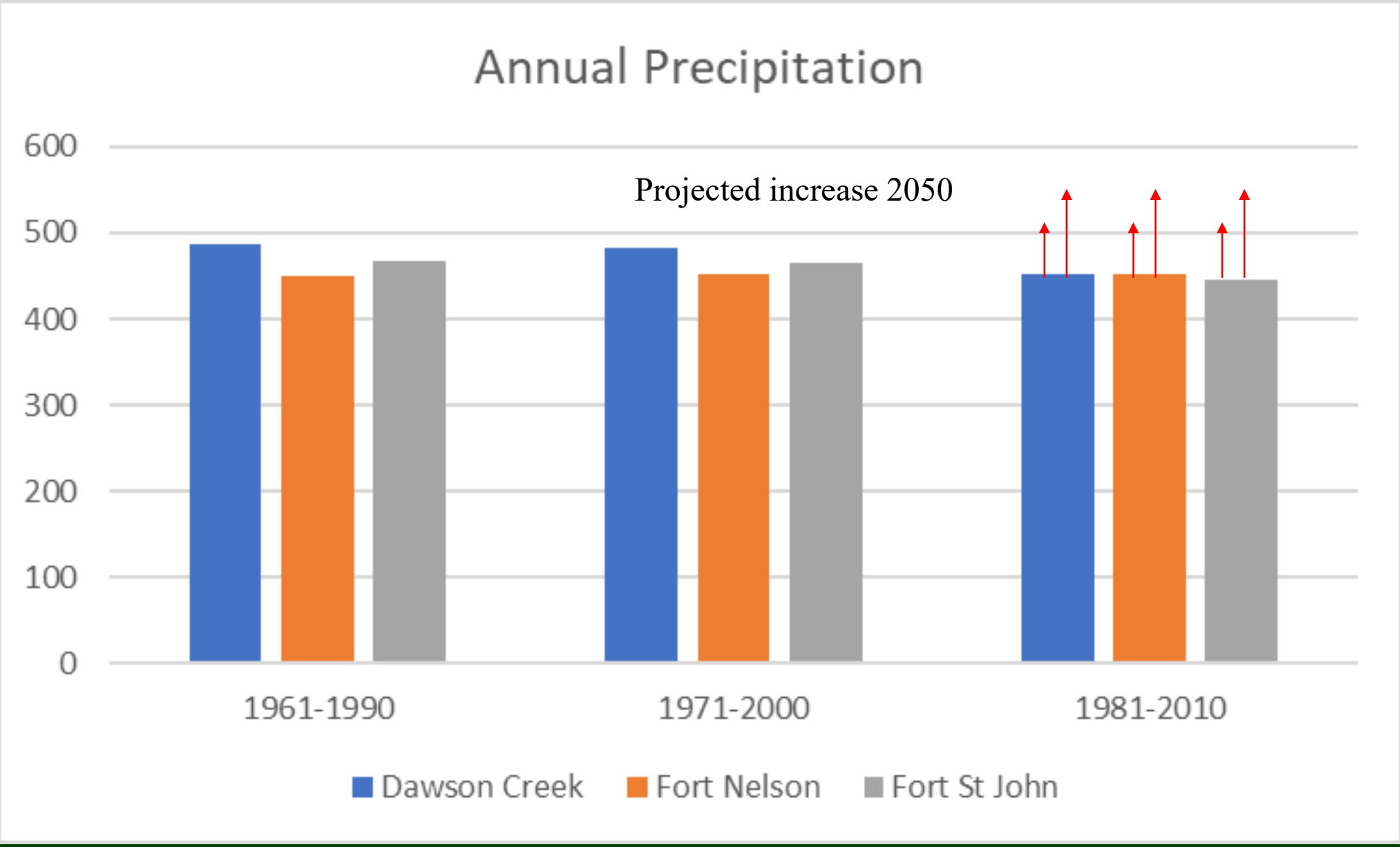
Background

- Changing climate, increases projected for Region
  - Mean annual temperature 1.9 → 4.7 C
    - Current -0.4 C in N → +3.0 C in S
    - Extremes -52 C → +36 C


Mean Annual Temperature
Projected increase 2050
6
5
4
3
2
1
0
-1
-2
1961-1990
1971-2000
1981-2010
Dawson Creek
Fort Nelson
Fort St John

Background

- Changing climate, increases projected for Region
  - Mean annual temperature 1.9 → 4.7 C
    - Current -0.4 C in N → +3.0 C in S
    - Extremes -52 C → +36 C
  - Annual precipitation 11 → 19 %
    - Current ~450 mm across region


Annual Precipitation
600
500
400
300
200
100
0
Projected increase 2050
1961-1990
1971-2000
1981-2010
Dawson Creek
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Background

- Changing climate, increases projected for Region
  - Mean annual temperature 1.9 → 4.7 C
  - Annual precipitation 11 → 19 %
  - Frost free days 25 → 40 days
    - Current 90 → 125 days (latitude independent)
      - Quesnel (118), Vanderhoof (129), Grand Forks (140), Castlegar (154)

Background

- Changing climate, increases projected for Region
  - Mean annual temperature 1.9 → 4.7 C
  - Annual precipitation 11 → 19 %
  - Frost free days 25 → 40 days
    - Current 90 → 125 days (latitude independent)
- Soils, can soil genesis keep pace with climate change?
  - Climate-induced macro changes slow
  - Current heavy clay soils not likely to soon support new species!
  - Future possible forest condition or …?

Background

- Little/no experience with complex stand management in BC
  - Literature suggests
    - (Man & Lieffers 1999, Simard et al. 2005, Kelty 2006)
    - Greater total yield
    - Provide stand level benefits
      - Maintain (enhance) biodiversity → resilience
      - Habitat
      - Pest and insect resistance
    - Greater wildfire protection
- The dilemma
  - On the ground mixedwood management poorly understood/implemented
  - Changing climate, limited knowledge, rate of soil genesis
  - Does this result in a change in forest composition/structure?

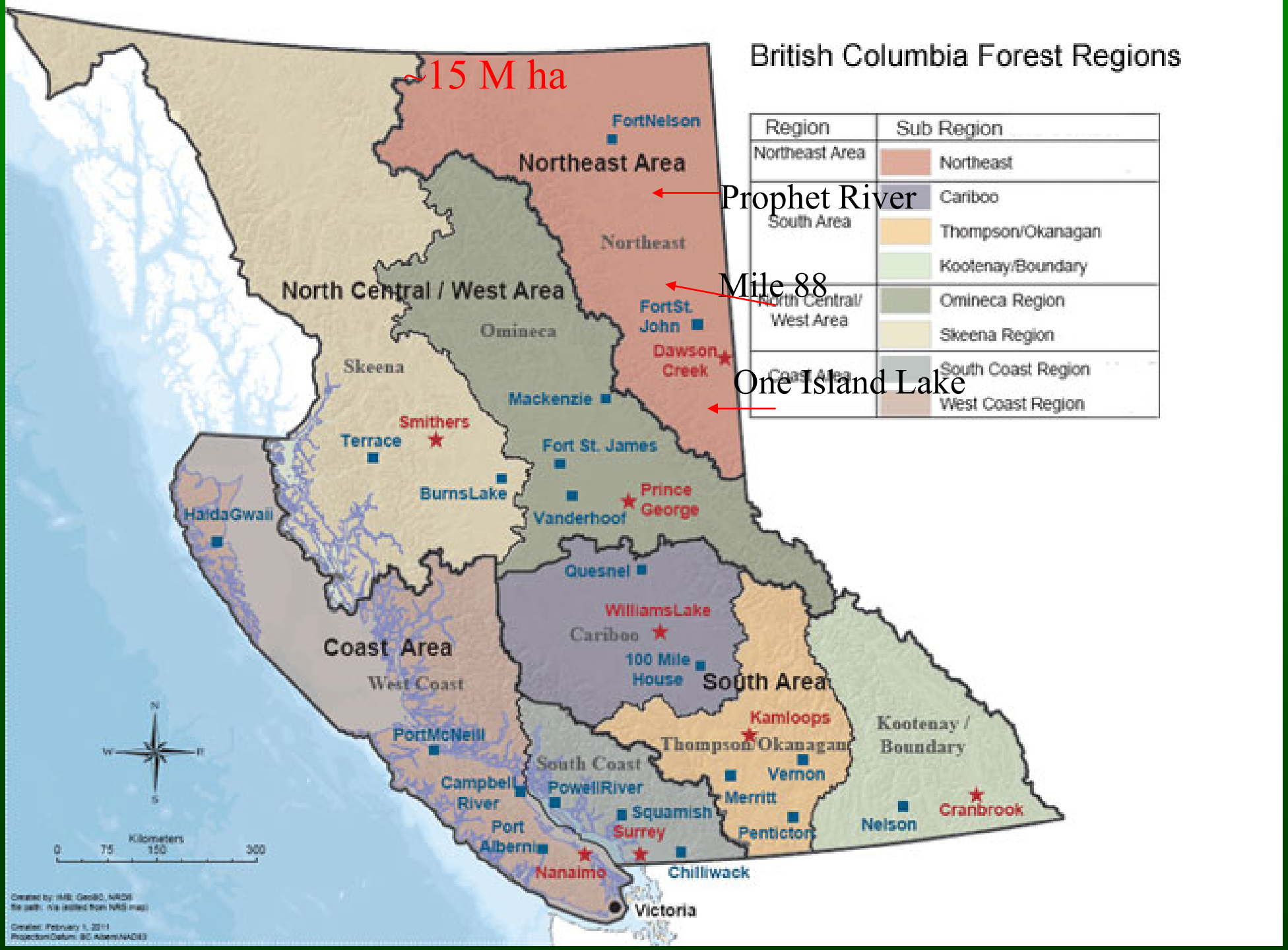
Objectives

- Effect of broadleaf competition on conifer growth
  - Range of stand ages across Northeast BC
  - Species mixtures
    - Populus tremuloides
    - Betula papyrifera
    - Picea glauca

    - Interspecific competition < intraspecific competition
      - *e.g., Betula – Picea* mixtures in Scandinavia

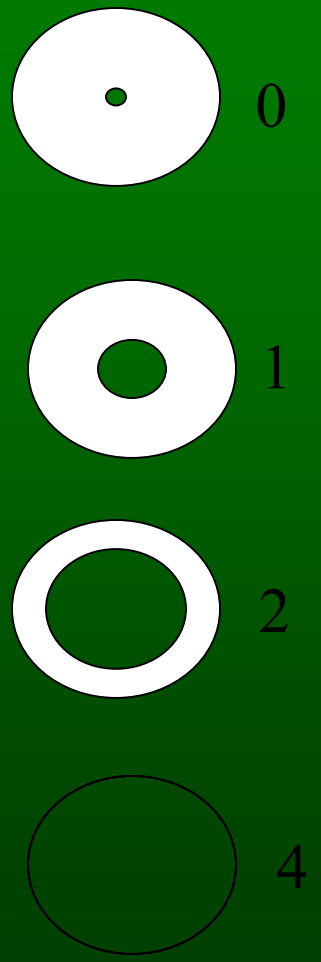
Objectives

- Two trial types established in region 12 – 15 years ago
  - 10 in northeast, 5 central interior (another story)
  - Mixedwood stands, 5 – 18 years old at establishment
  - Permanent plots (PSP)
    - Crop tree release
  - Temporary plots (TSP)
    - "Natural" stand development
- Today, 3 BWBS sites
  - One Island Lake (spruce – aspen)
  - Mile 88 (spruce – aspen)
  - Prophet River (spruce – birch)


~15 M ha
British Columbia Forest Regions
Region
Sub Region
Northeast Area
Northeast
South Area
Cariboo
Thompson/Okanagan
Kootenay/Boundary
North Central/ West Area
Omineca Region
Skeena Region
Coast Area
South Coast Region
West Coast Region
Prophet River
Mile 88
One Island Lake
FortNelson
Northeast Area
Northeast
North Central / West Area
Omineca
Skeena
FortSt. John
Dawson Creek
Mackenzie
Smithers
Terrace
Fort St. James
BurnsLake
Prince George
Vanderhoof
HaidaGwaii
Quesnel
WilliamsLake
Cariboo
Coast Area
West Coast
100 Mile House
South Area
Kamloops
Thompson/Okanagan
Kootenay / Boundary
PortMcNeill
South Coast
Vernon
Campbell River
PowellRiver
Merritt
Squamish
Cranbrook
Port Alberni
Surrey
Penticton
Nelson
Nanaimo
Chilliwack
Victoria
Kilometers
0 75 150 300

Release (PSP)

- Measure crop tree and competition at establishment
  - White spruce (*Picea glauca*)
  - Trembling aspen (*Populus tremuloides*) or
  - Paper birch *(Betula papyriferea)*



- 4 m radius single tree plots
  - Measure all trees in 4 m radius
  - Remove all broadleaves & conifers within radii of 0, 1, 2 or 4 m
    - ∞, 3183, 796, 199 equivalent sph

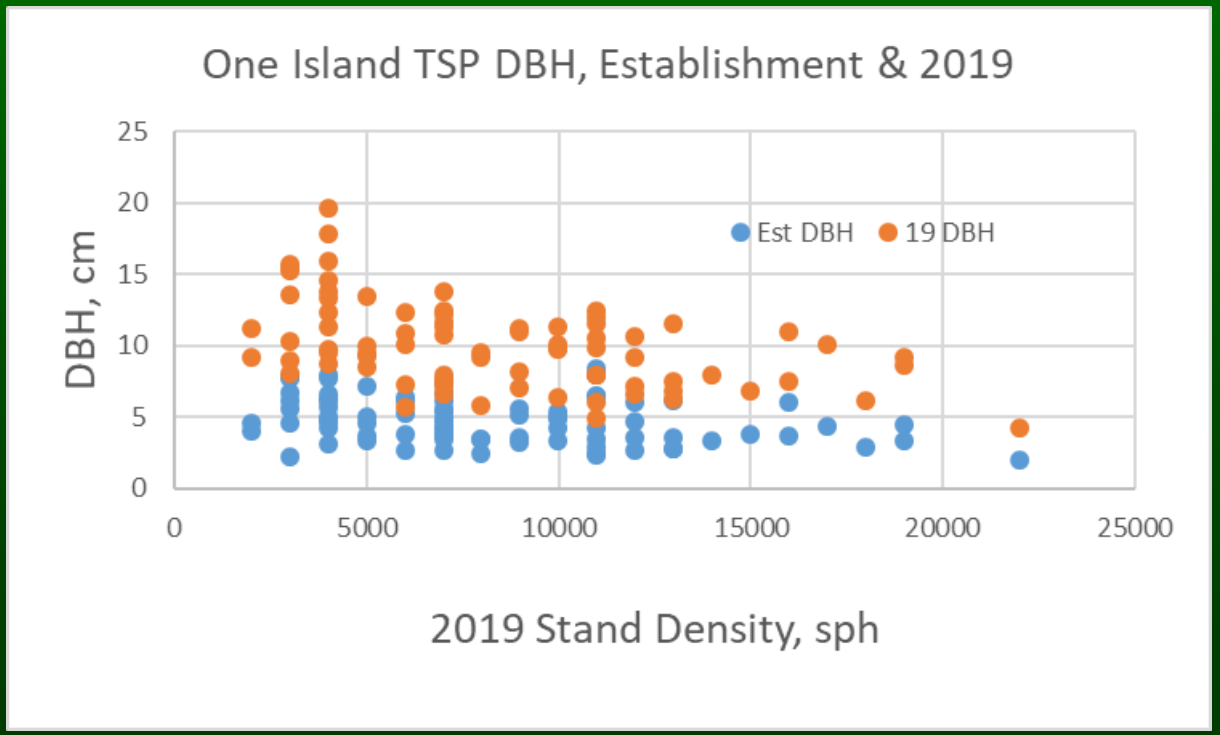
- Crop tree DBH metric of interest (responsive)

“Natural” stand development (TSP)

- Measure crop tree and competition metrics at establishment
  - White spruce
  - Trembling aspen or
  - Paper birch
- 1.78 m radius single crop tree (spruce) plots
  - Measure all trees in 1.78 m radius
  - Allow all trees to develop (no intervention)
  - Initial plan – mixedwood development up to establishment
- Crop tree DBH metric of interest

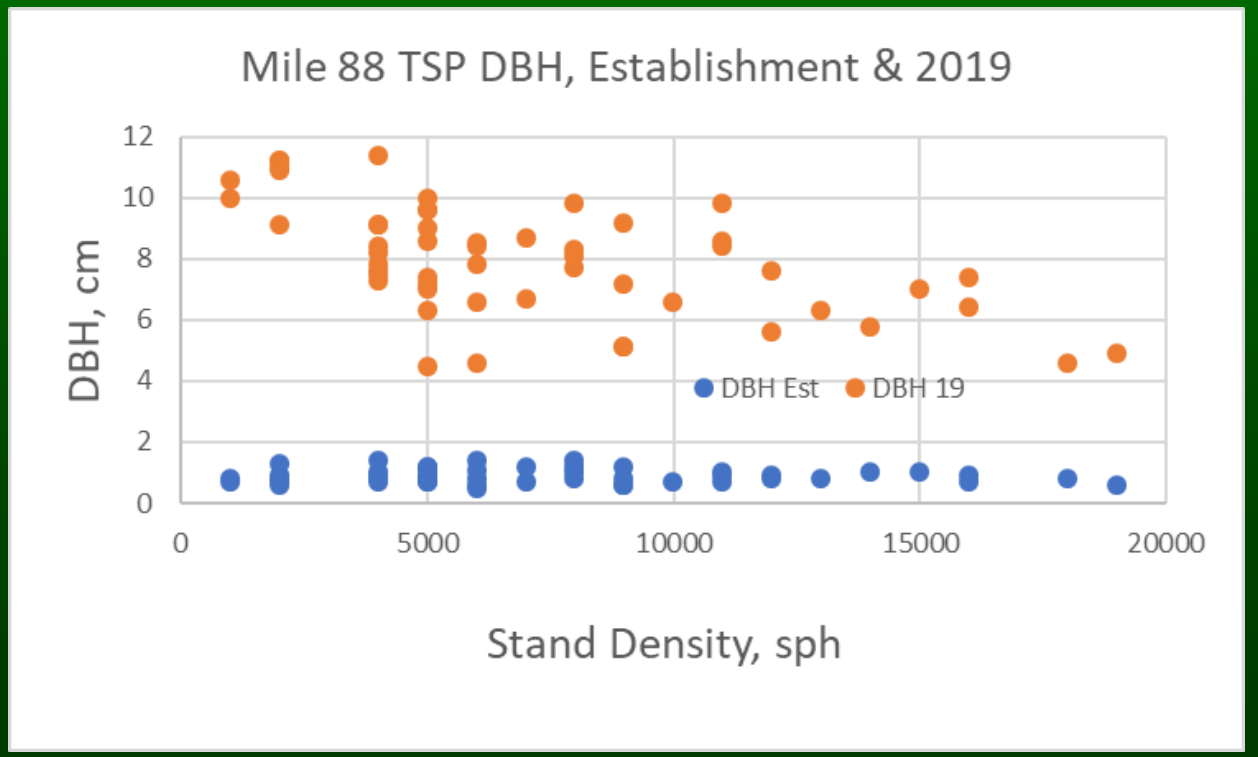
One Island (TSP) Established (winter 07-08)

- DBH vs competition (sph) at establishment and after 2019
  - Overall significant negative relationship
  - Threshold ~4,000 sph (n.s.d. relationship up to this point)



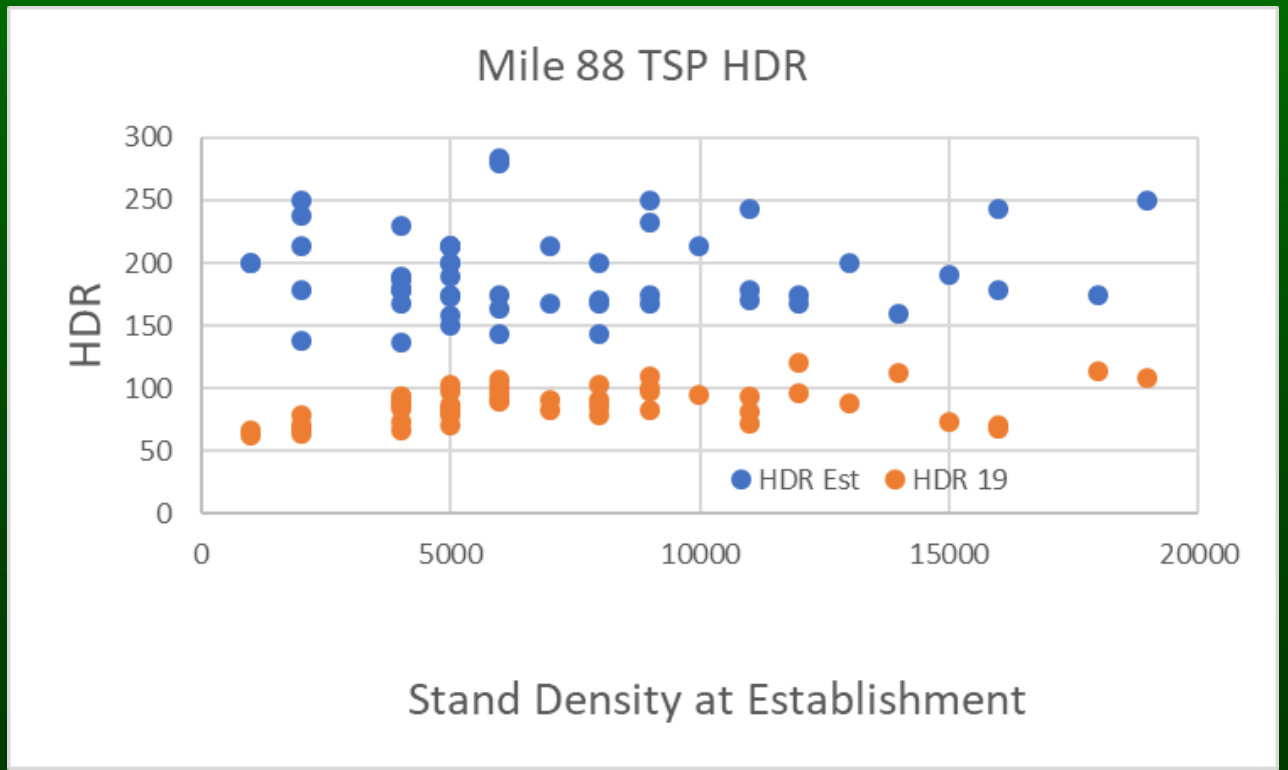
Mile 88 (TSP) Established (fall 09)

- DBH vs competition (sph) at establishment and after 2019
  - Overall significant negative relationship
  - Break ~10,000 sph (n.s.d. relationship up to this point)



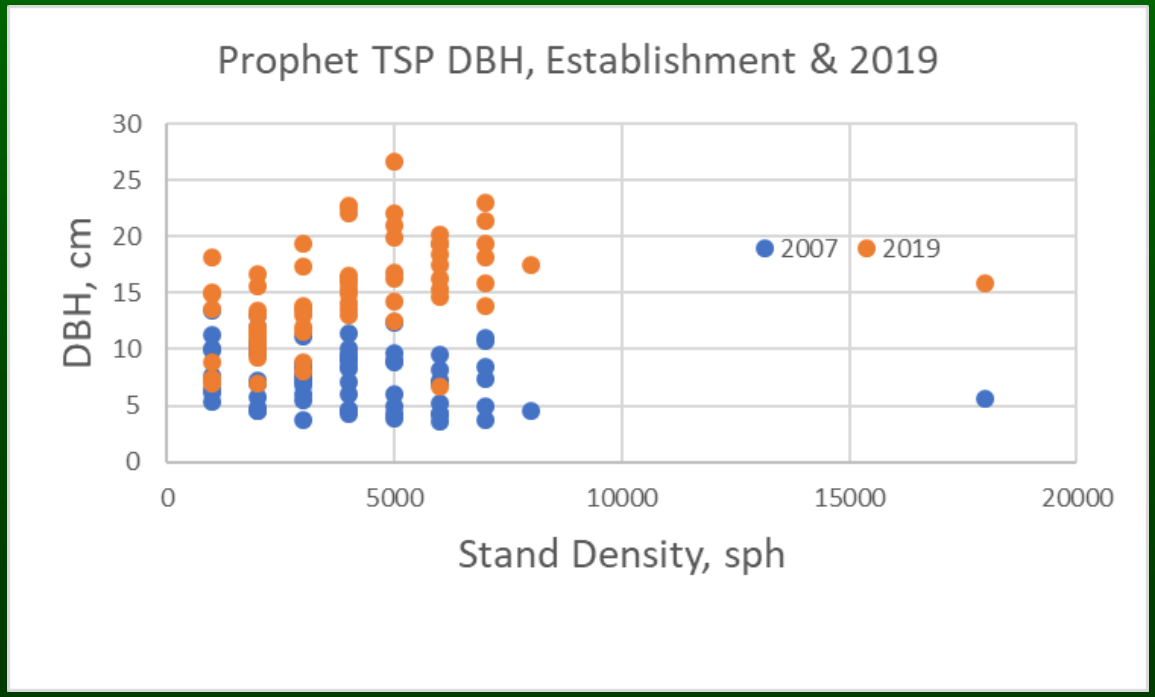
Mile 88 (TSP) Established (fall 09)

- HDR vs competition (sph) at establishment and after 2019
  - Large recovery regardless of density
  - Break ~5,000 sph (HDR ≤ 100 → height m = dbh cm)



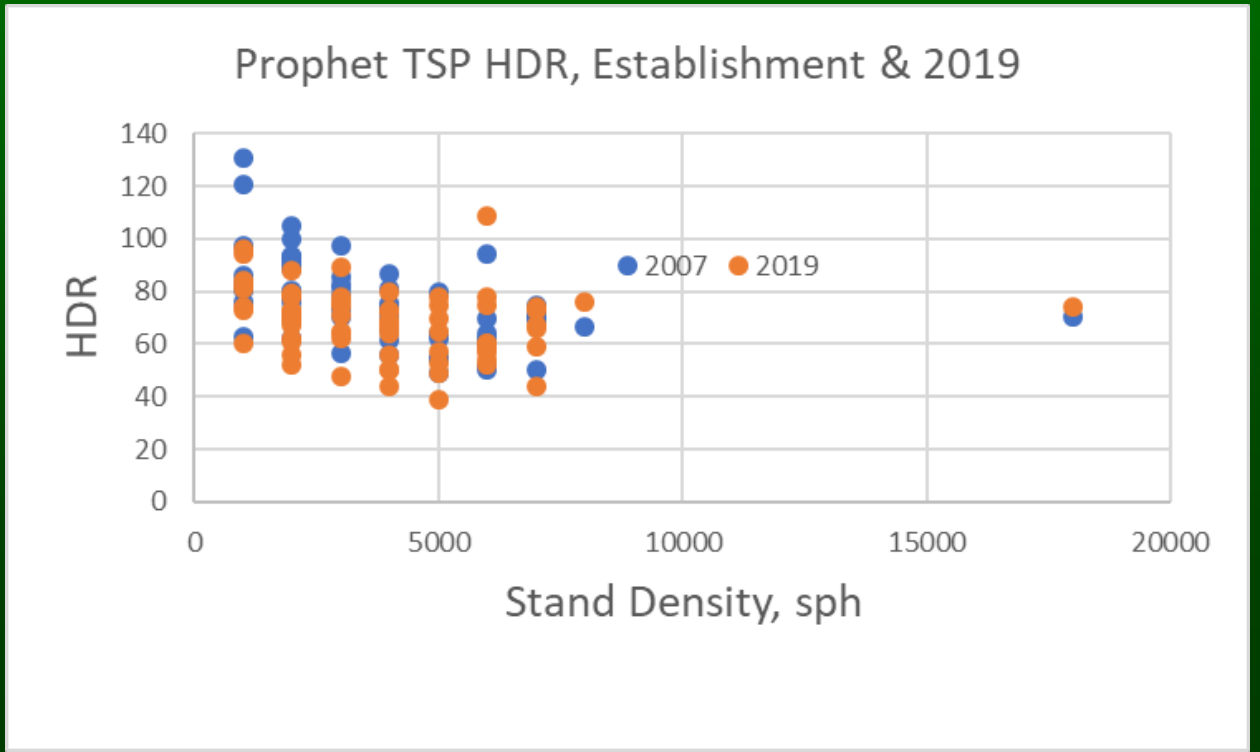
Prophet (TSP) Established (winter 07-08)

- DBH vs competition (sph) at establishment and after 2019**
  - Overall significant **negative** relationship in **2007** but **positive** in **2019**
  - Threshold ~5,000 sph in 2007 and none apparent in 2019
    - Competition is good?



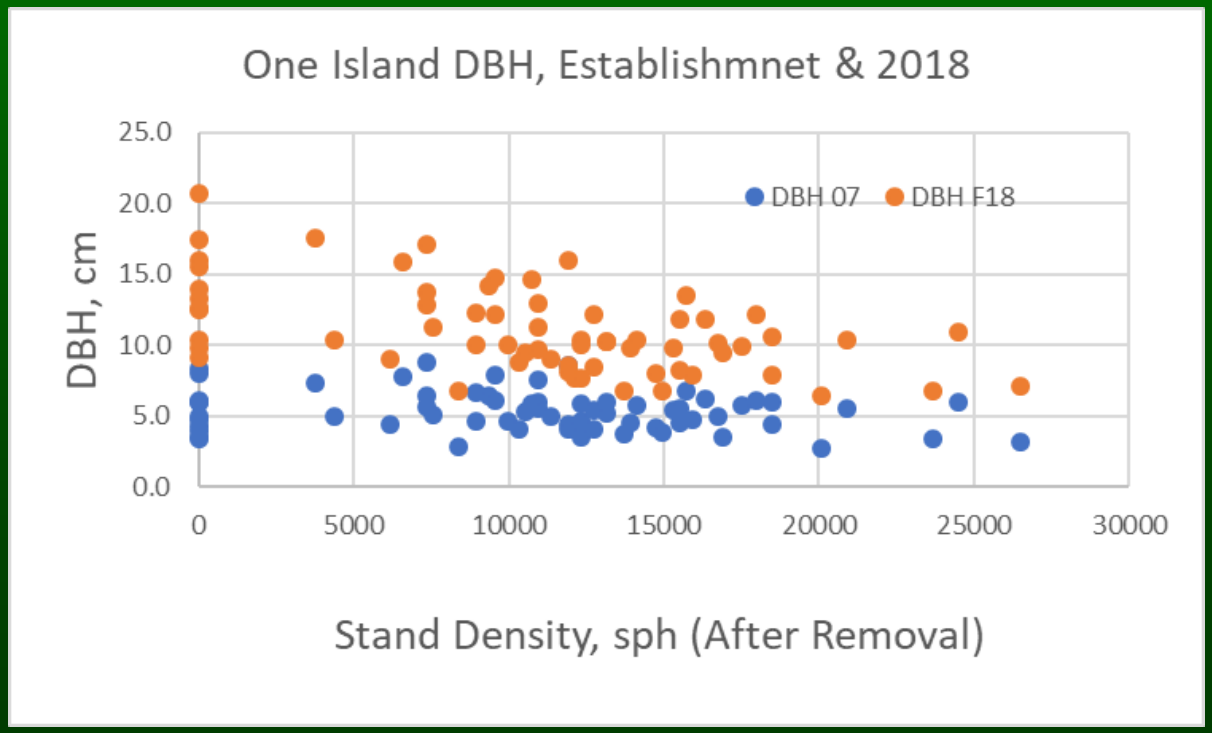
Prophet (TSP) Established (winter 07 – 08)

- HDR vs competition (sph) at establishment and after 2019
  - Small recovery over time regardless of density
  - 2019, most ≤ 80



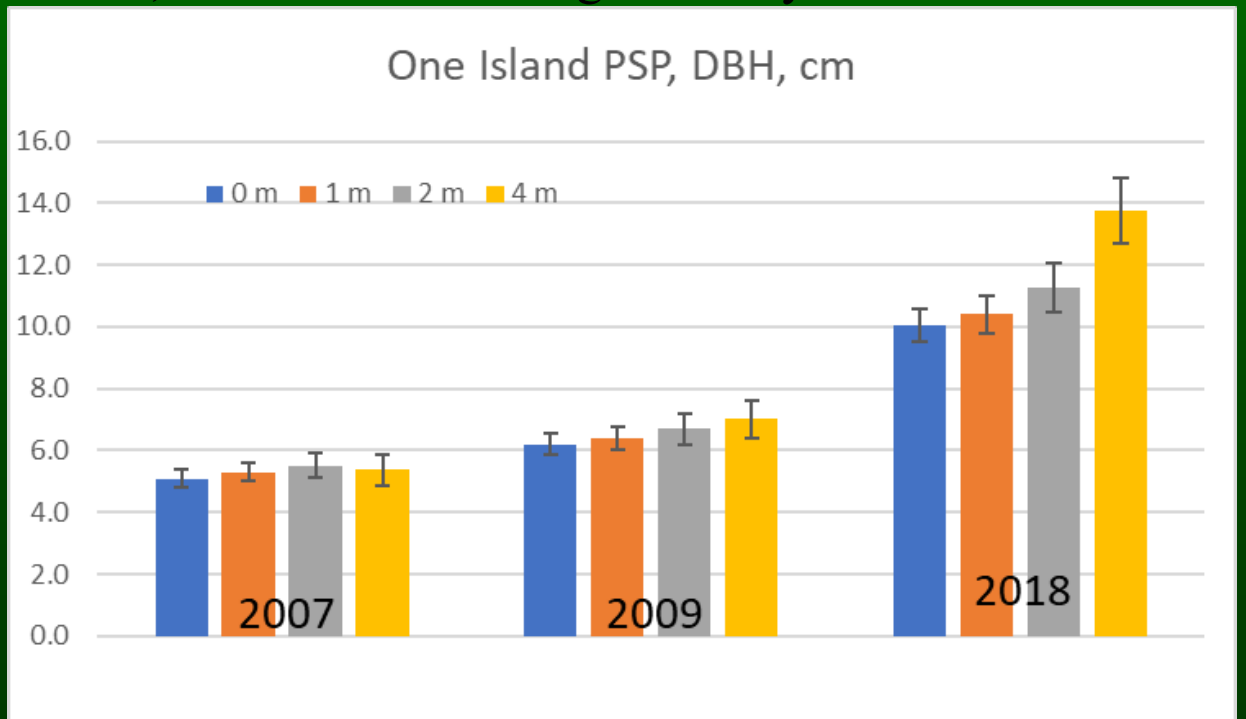
One Island (PSP) Established (winter 07-08)

- DBH vs competition (sph) at establishment and after 2018
  - Overall significant negative relationship
  - Break ~10,000 sph (n.s.d. relationship up to this point)



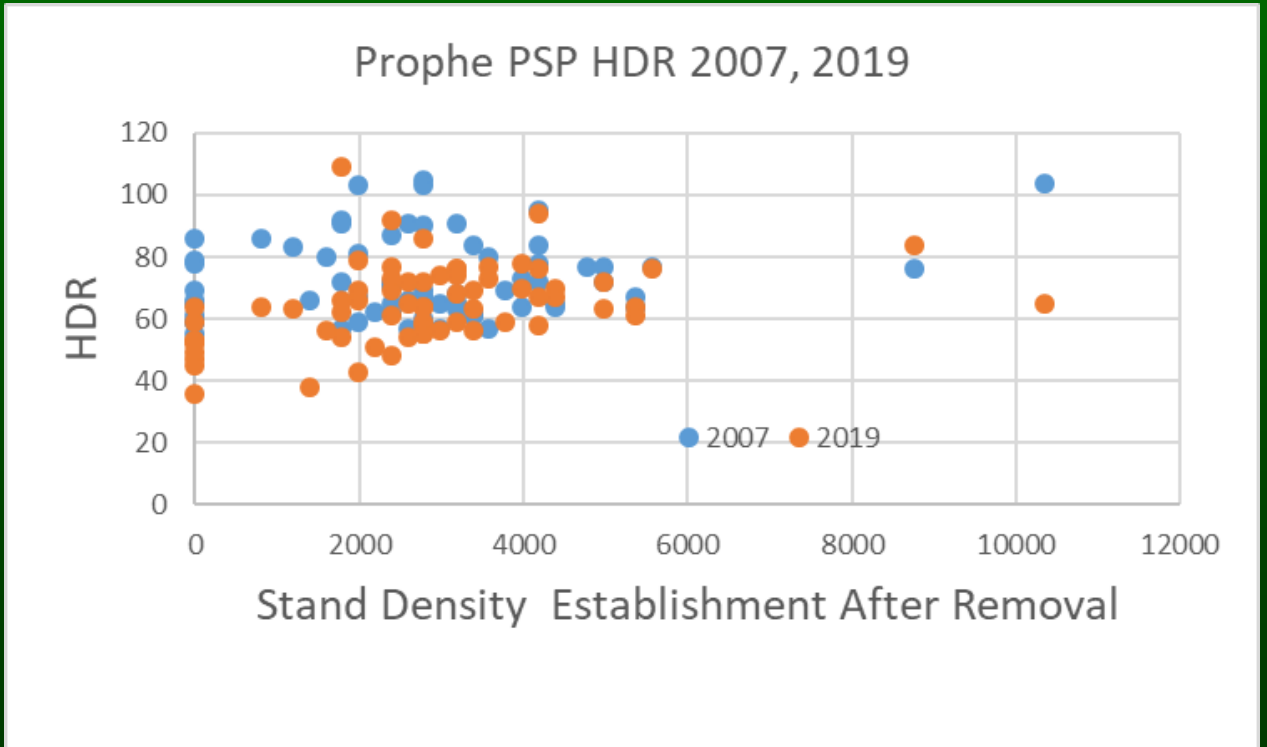
One Island (PSP) Established (winter 07-08)

- DBH vs brushing radii: establishment, 2009 and after 2018
  - At establishment, n.s.d. among radii
  - 2009, n.s.d. among radii
  - 2018, n.s.d. 0, 1 & 2 m but 4 m significantly > other 3 radii



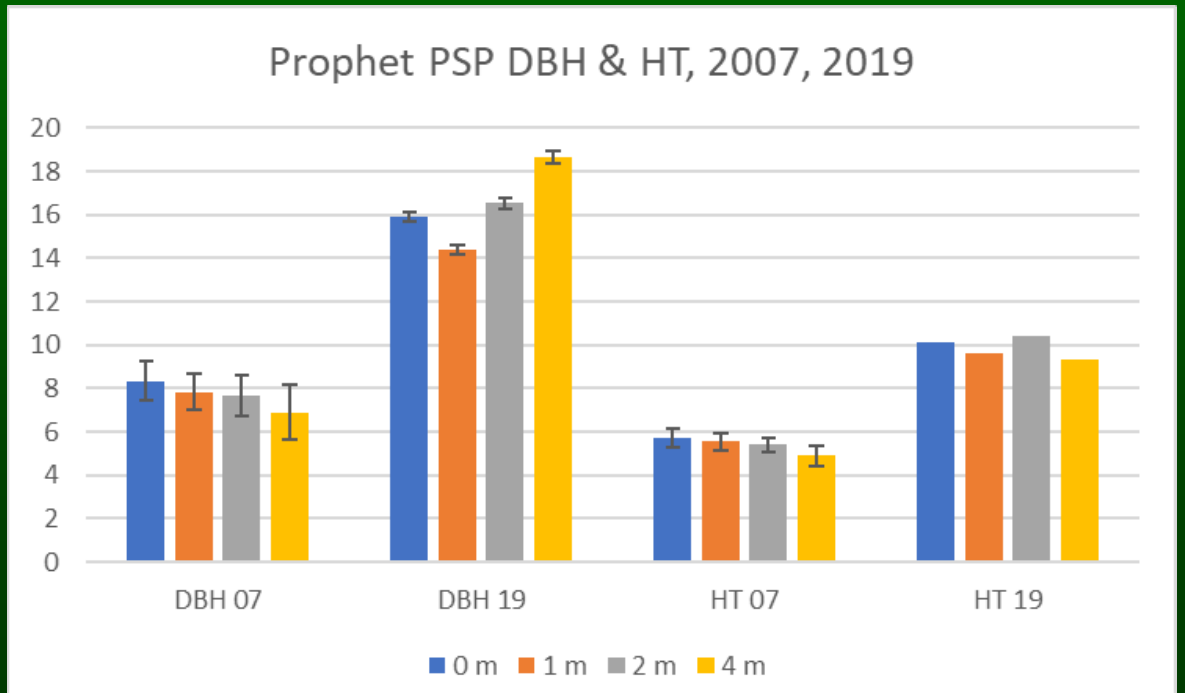
Prophet (PSP) Established (winter 07-08)

- HDR vs competition (sph) at establishment and after 2019
  - Recovery over time regardless of density with one exception
  - 2019, most HDR ≤ 80



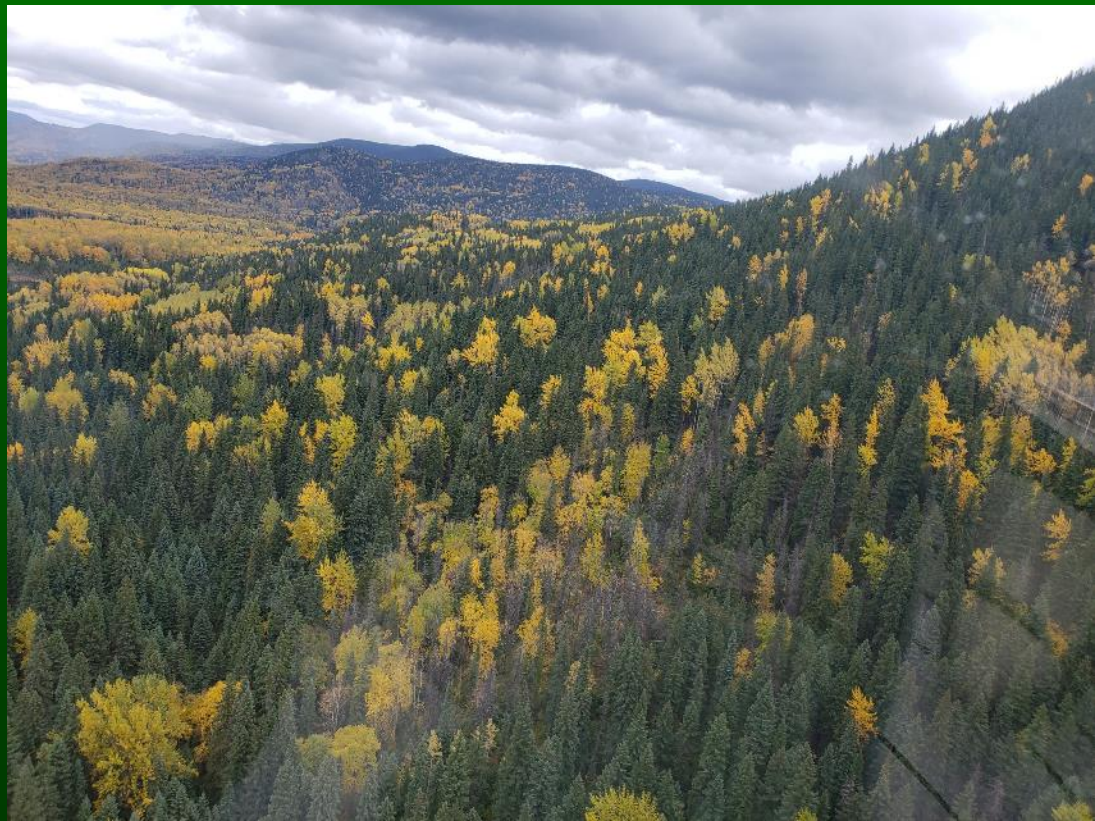
Prophet (PSP) Established (winter 07-08)

- DBH & Height vs brushing radii: establishment and after 2019
  - At establishment, n.s.d. among radii for DBH or height
  - 2009, n.s.d. among radii for height
  - 2019, n.s.d. 0, 2 m, 0 & 2 significantly > 1 m, 4 m signif. > other 3 radii



Thoughts

- From data there are competition thresholds
  - High by current thinking
    - 4,000 – 10,000 in TSP



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- HDR “recovers” over time
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- From data there are competition thresholds
  - High by current thinking
    - 4,000 – 10,000 in TSP
- HDR "recovers" over time
  - Competition not significantly affecting DBH growth
- Brushing (PSP) had **no** effect on height
- Long time for brushing to impact DBH
  - 10+ years
  - Very low stand densities

Thoughts

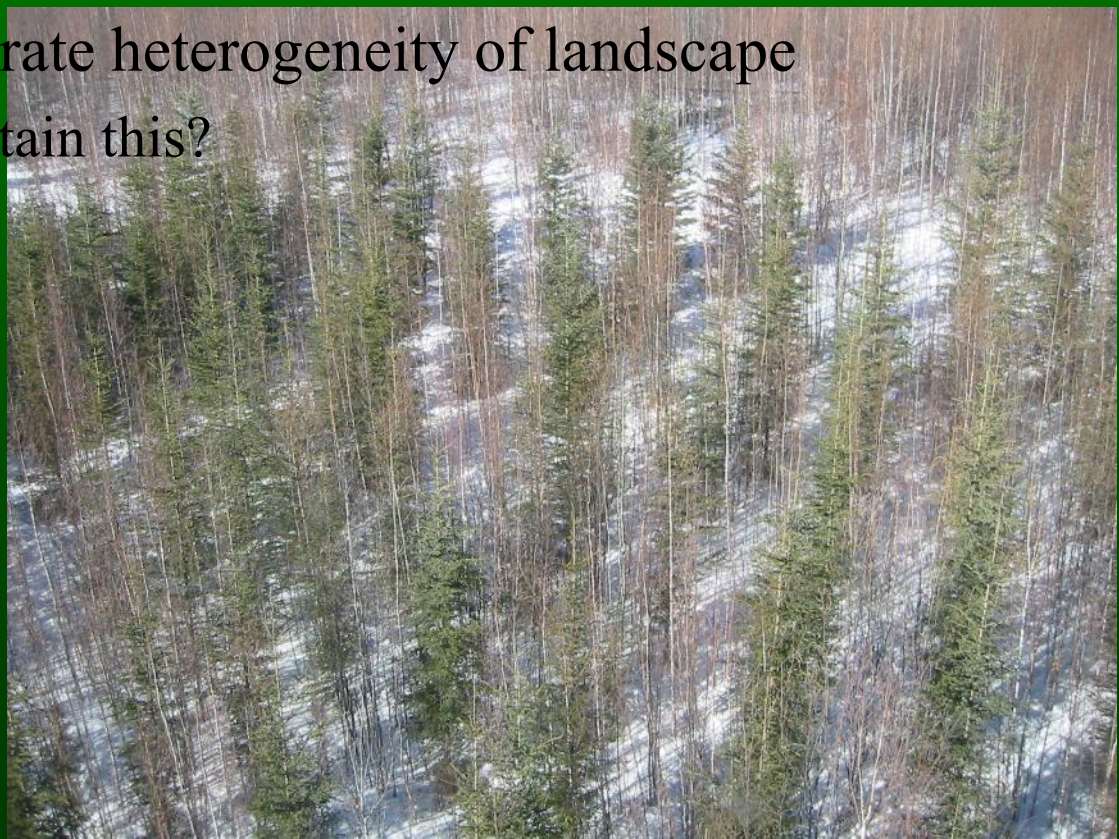
- Possible mechanisms for increased complex stand productivity
  - Facilitative interaction
    - Species benefits directly from another
      - N fixing tree species (alder – Douglas-fir)
      - Not the case here

Thoughts

- Possible mechanisms for increased complex stand productivity
  - Facilitative interaction
    - Species benefits directly from another
      - N fixing tree species (alder – Douglas-fir)
      - Not the case here
  - Complementary interactions (resource use)
    - Species differ in
      - Shade tolerance, height growth rates
      - Crown structure, phenology
      - Rooting depth
    - Interspecific < intraspecific competition
      - *Betula* – *Picea* mixtures in Scandinavia

Thoughts

- Similar observations from central BC interior sites
- Separation photos demonstrate heterogeneity of landscape
  - How do you manage to retain this?



Thoughts

- Similar observations from central BC interior sites
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  - How do you manage to retain this?
- Does **not** or will **not** apply or work everywhere!

Thoughts

- Similar observations from central BC interior sites
- Separation photos demonstrate heterogeneity of landscape
  - How do you manage to retain this on the landscape?
- Does **not** or will **not** apply or work everywhere!
- Need to understand dynamics of complex stands
  - Europeans are facing the same challenges
- Total productivity greater in complex stand (encourage?)

Conclusions

- **Competition removal can increase crop tree growth but**
  - **Not always a good investment**
    - **Economically or biologically**
- **Up to a high threshold competition density**
  - **DBH growth is not greatly (practically) affected by competition density**
- **With a changing climate**
  - **Broadcast brushing may not be a good investment under many conditions**
  - **Greater total yield (carbon storage) than pure spruce or broadleaf stand**
  - **Conversion to pure conifer stand reduces diversity**
    - **Species, structural and landscape levels**
  - **Likely reduces resilience too**
  - **Increases fire hazard**

Conclusions

- **Diversity in mixedwoods, where it occurs, is beneficial for**
  - **Forest health**
  - **Soil productivity**
  - **Diversity → resilience**
- **Retention of mixedwoods**
  - **Minimal impact of future fiber supplies**
  - **Greater options in the future**

- **To maximize overall long-term benefits**
  - **Educate & learn to manage and grow as a complex stand**
  - **Meet the challenge**

Acknowledgements

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  - Forest Science Program of British Columbia
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  - Peace Forest District
  - Adlard Environmental

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Questions?