Impacts of Climate Change and Variability in Stream Temperatures in Johnson Creek

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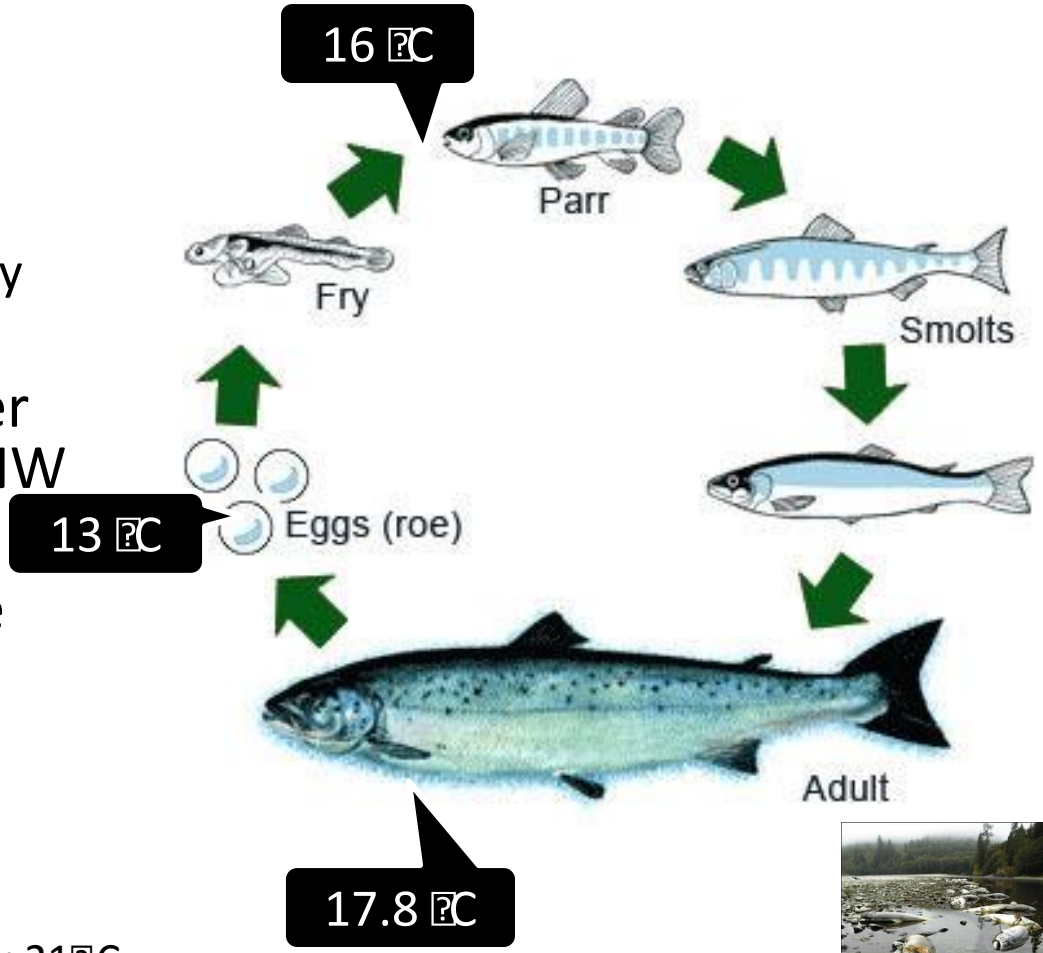
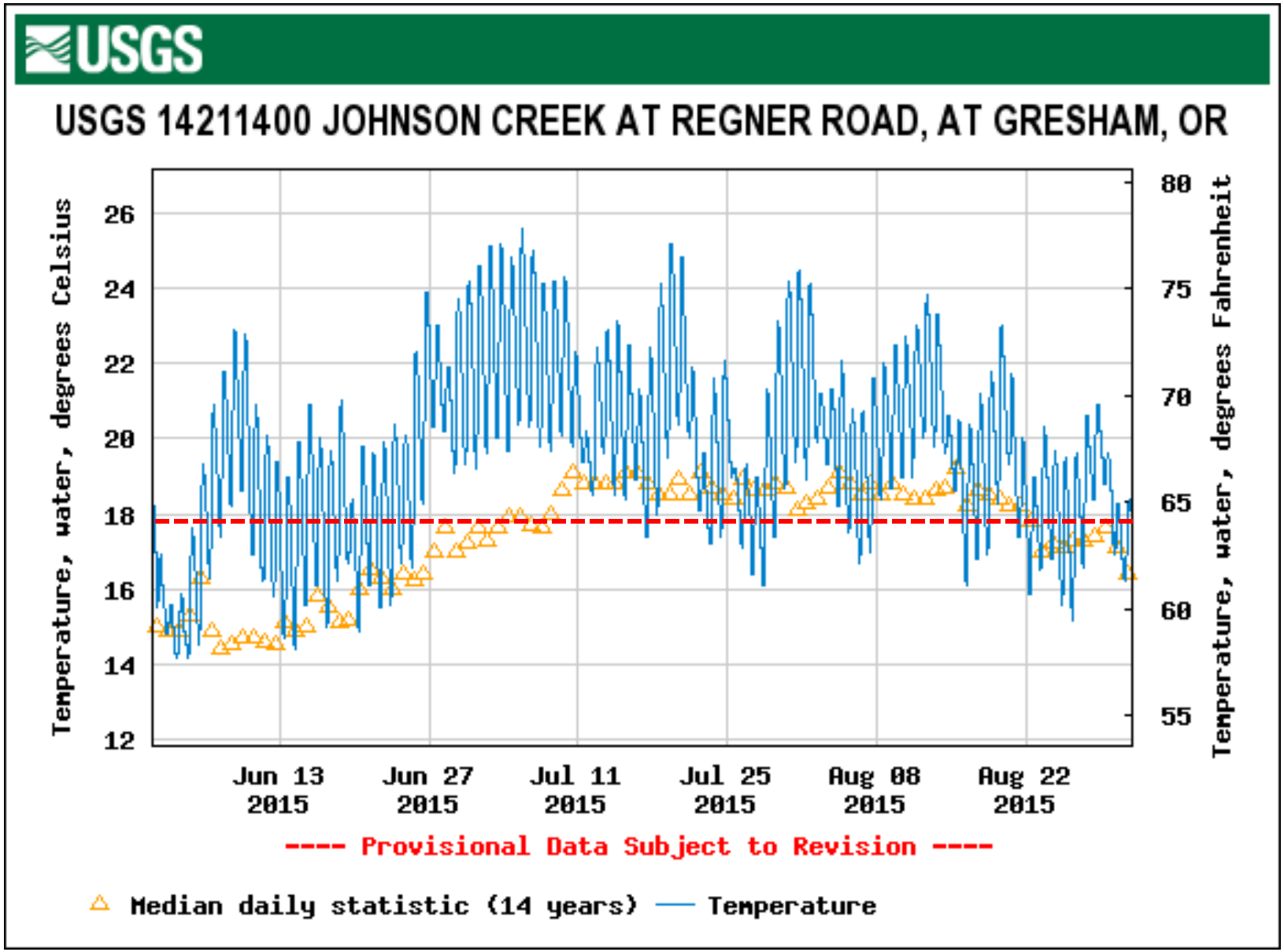
Why Stream Temperature?

- Water quality indicator
  - Dissolved Oxygen
  - Rates of chemical reactivity
- The most significant water quality problem in the PNW
- Salmon and Trout require specific ranges of water temperatures for :
  - Spawning: 13□C
  - Core cold water habitat: 16□C
  - Rearing and Migration: 17.8□C
  - Upper optimal limit for survival: 21□C

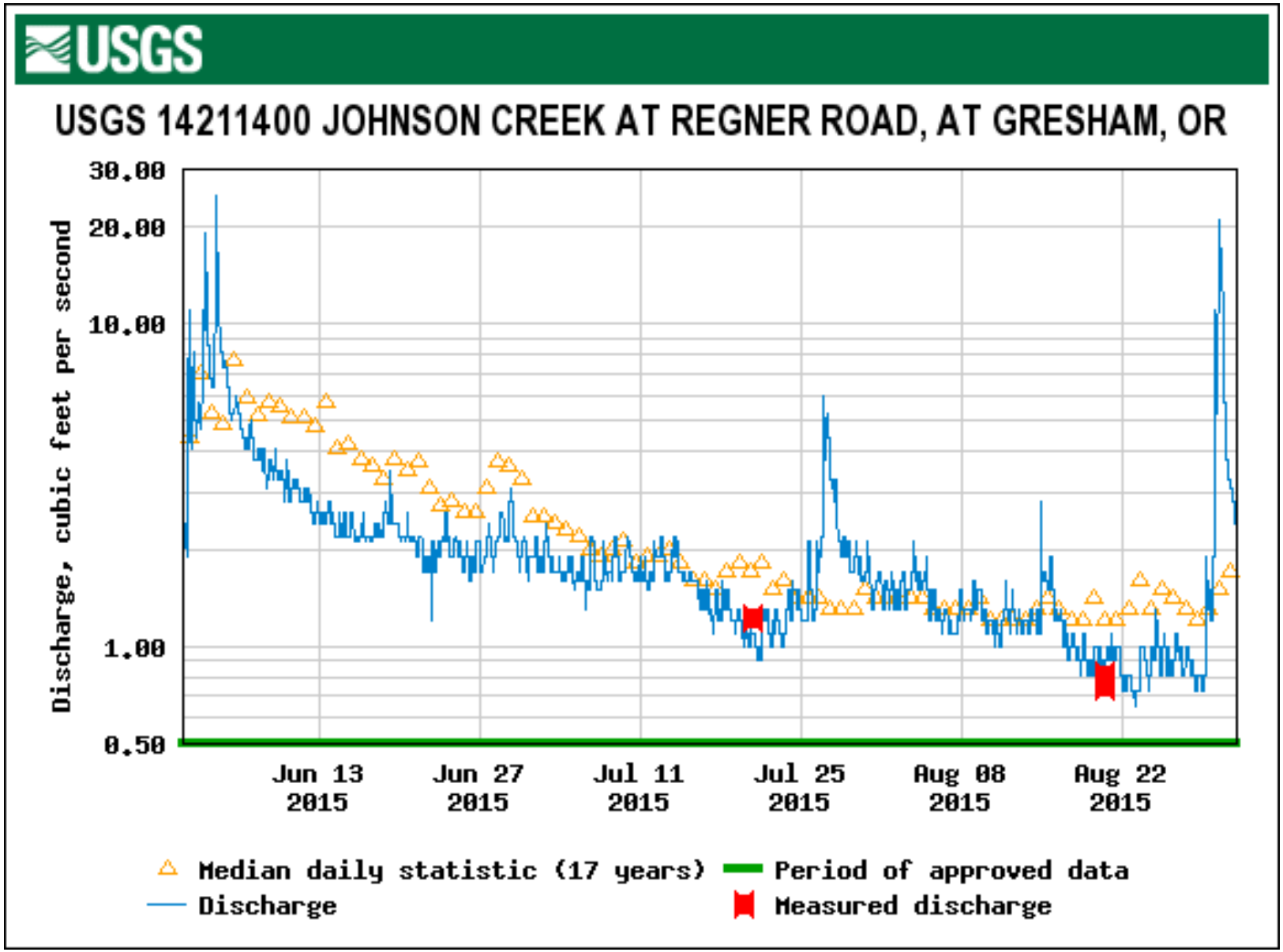
Source: ORDEQ



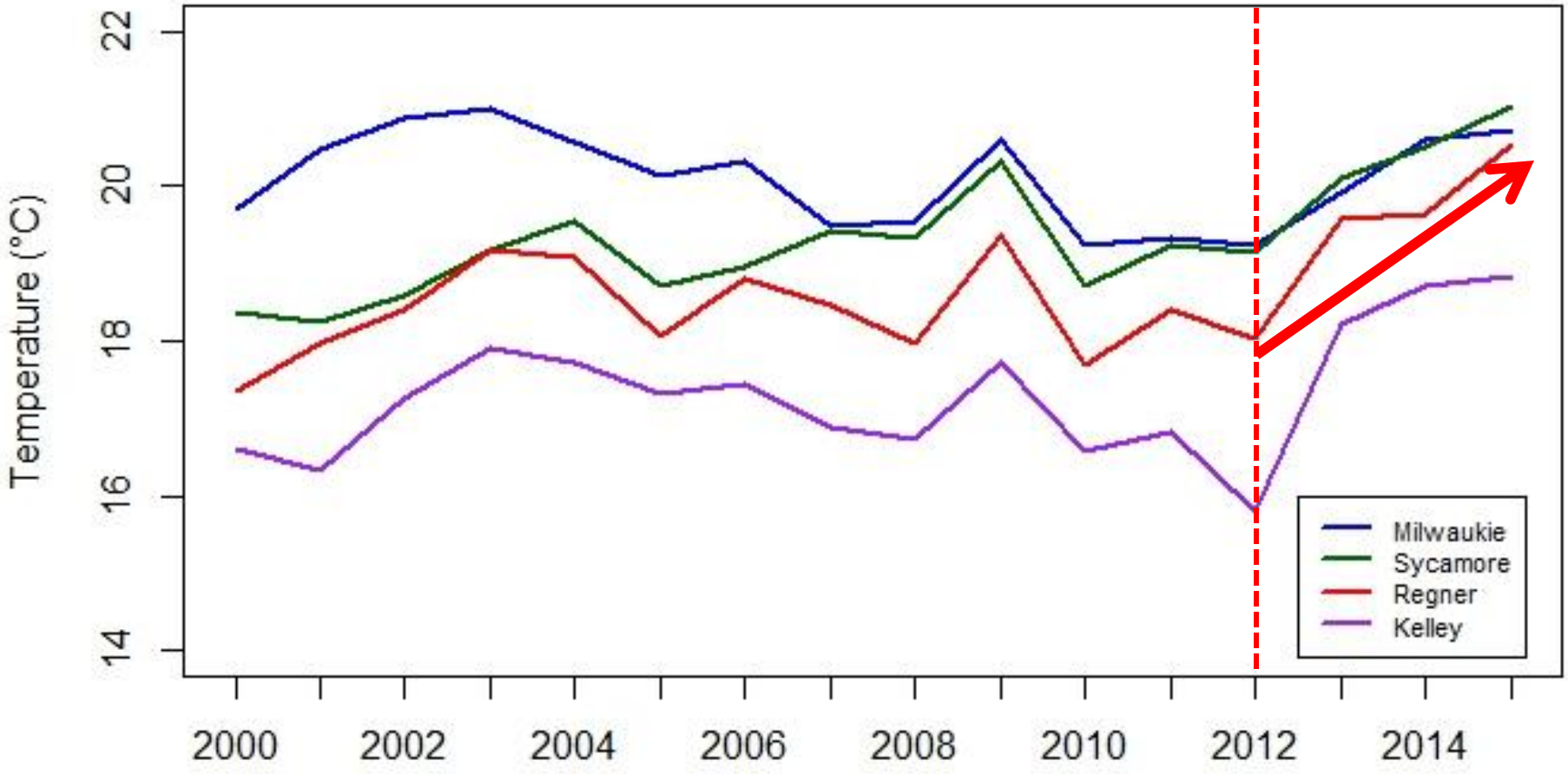
Stream temperature in 2015



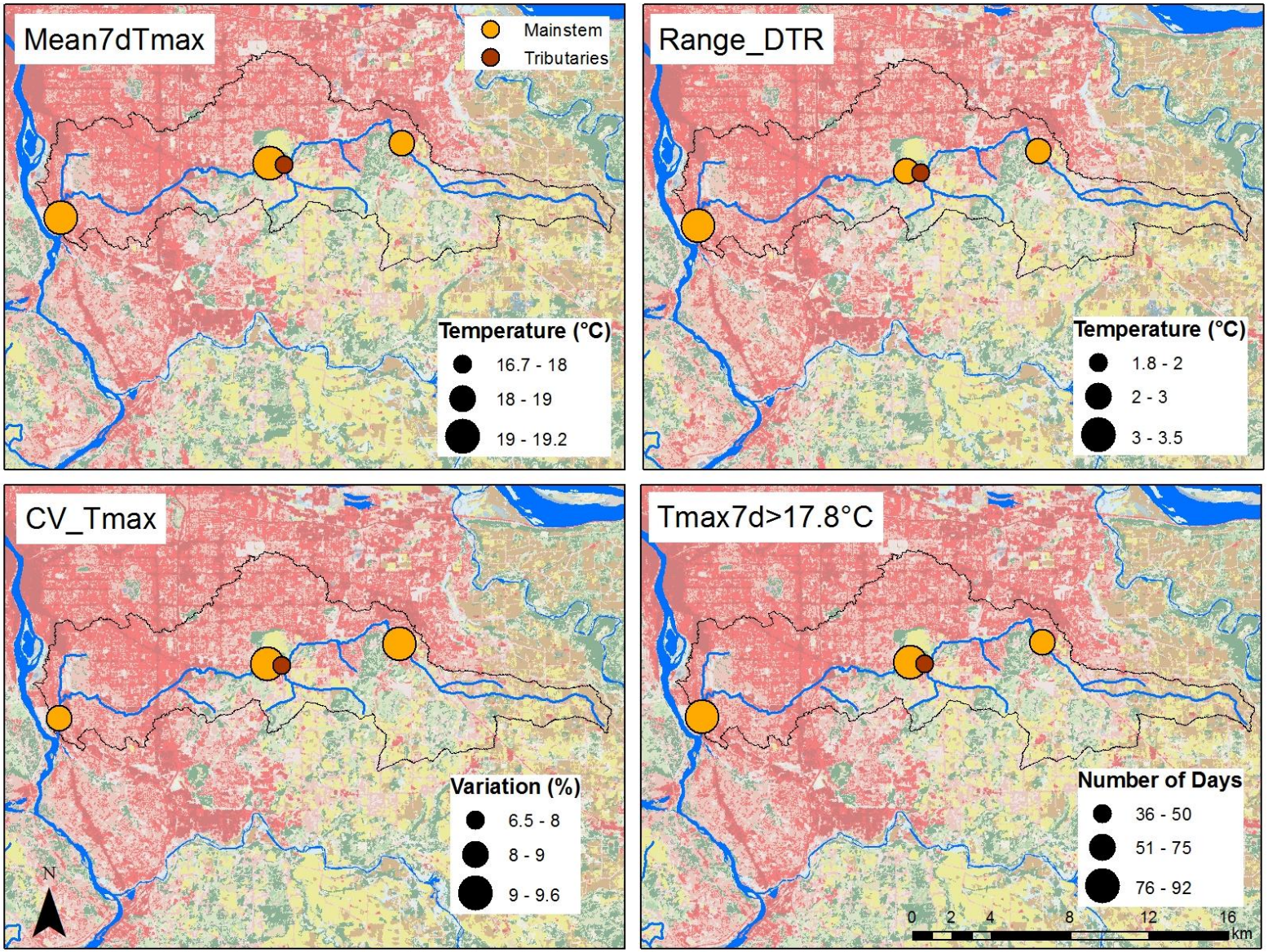
Streamflow in summer 2015



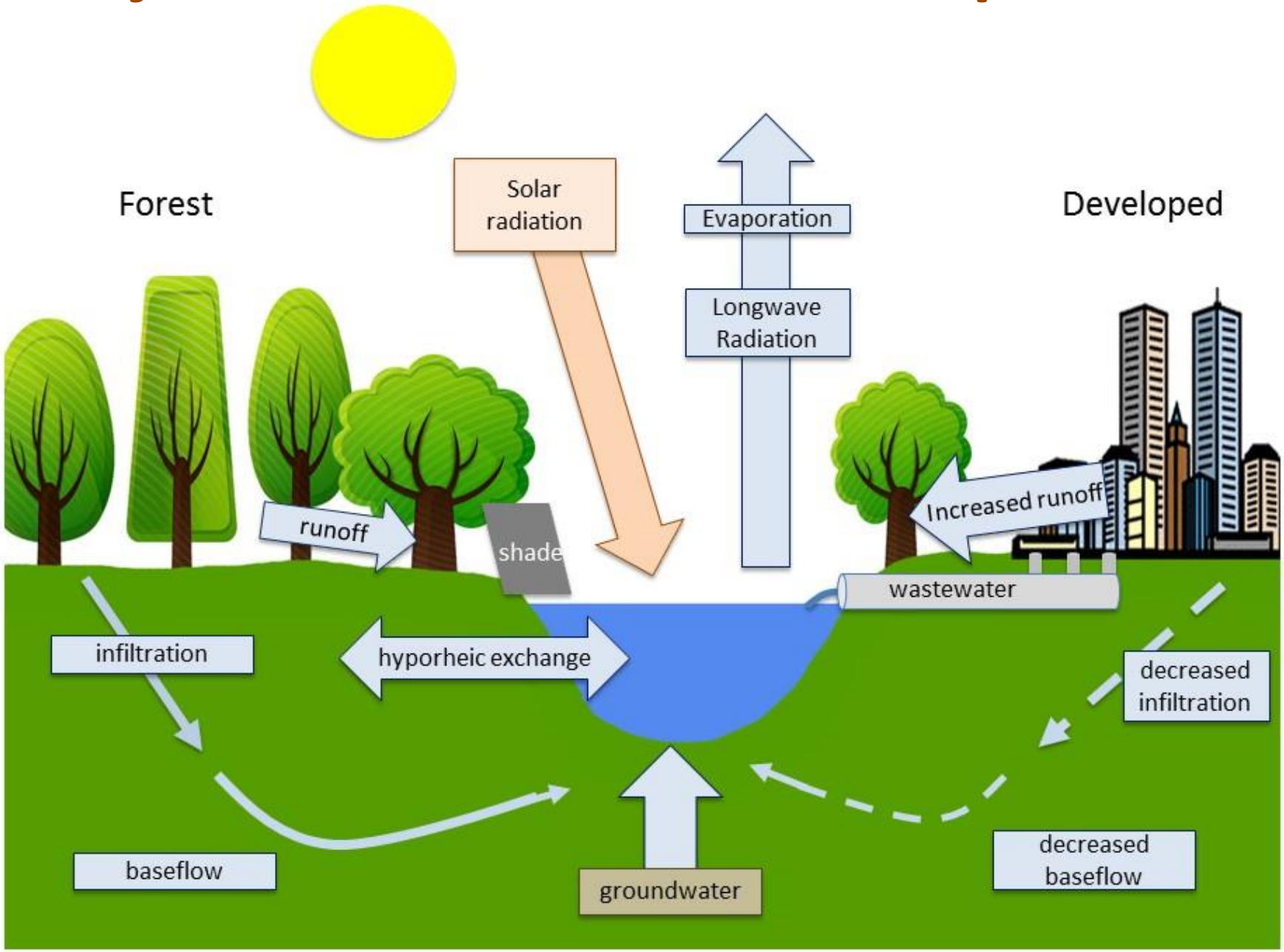
Trend in 7 day moving average of daily maximum temperature (7DADTmax), 2000-2015



Temperature metrics for summer 2011

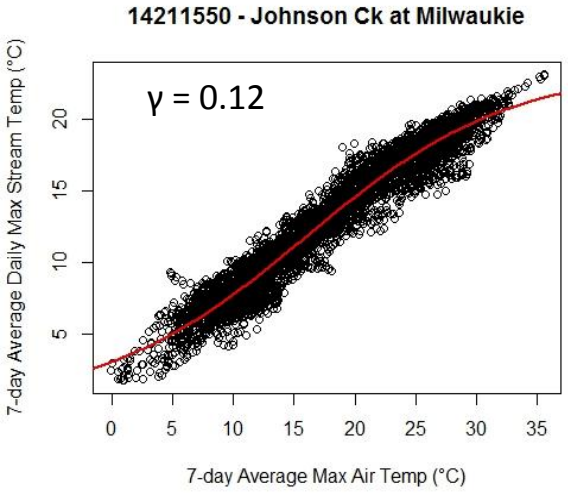


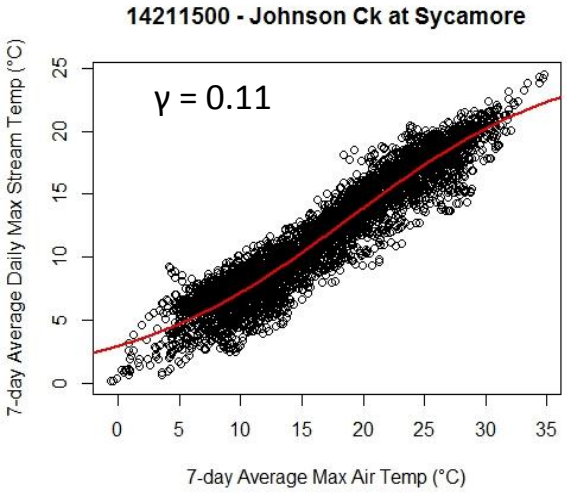
Major Drivers of Stream Temperature

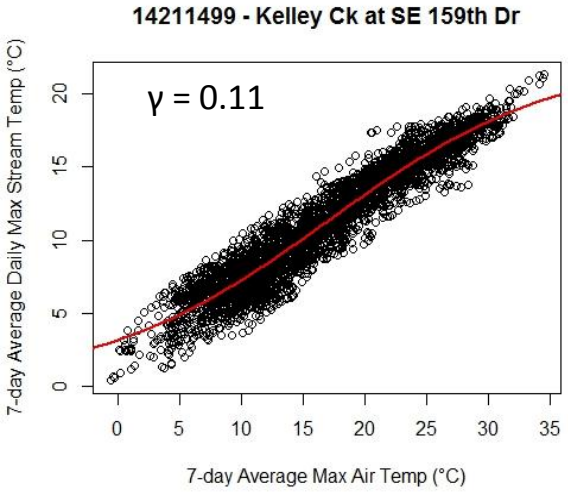


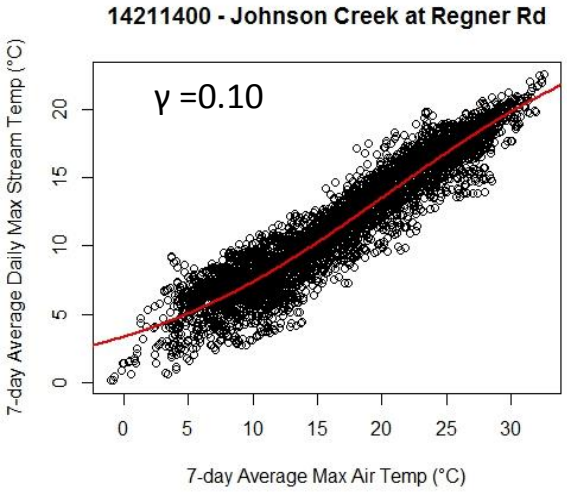
Stream temperature and air temperature for four stations

(following the Mohseni-model equation)









Ts = stream temperature

Ta = air temperature

$$Ts = \mu + \frac{\alpha - \mu}{1 + e^{\gamma(\beta - Ta)}}$$

μ= min stream temp
α = max stream temp
γ = steepest slope of the *Ts* function
B = air temperature at the inflection point

Framework of assessing climate change impacts on stream temperature and habit risk in the Willamette

Land cover data

Climate data: historical & future

INSIDE IDAHO

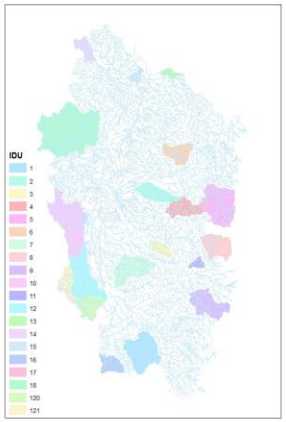
Daily max air temp
Daily min air temp
15 day average of daily Max air temp
15 day average of daily Min air temp

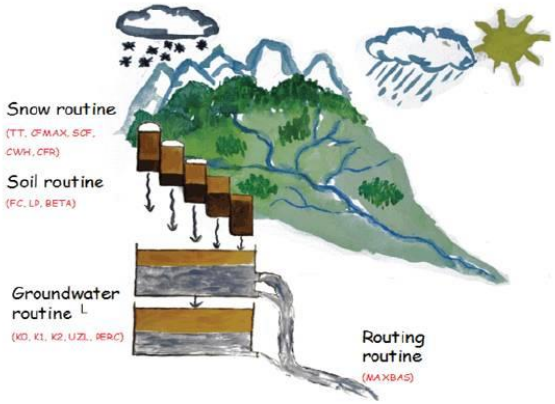
Willamette Hydrology Model (WHM)

Daily stream temperature

Temperature regression model

Daily streamflow





Daily streamflow
15 day streamflow

USGS science for a changing world

Daily max stream temp
7-day average of daily max stream temp (7DADM)

Probability of habitat Risk

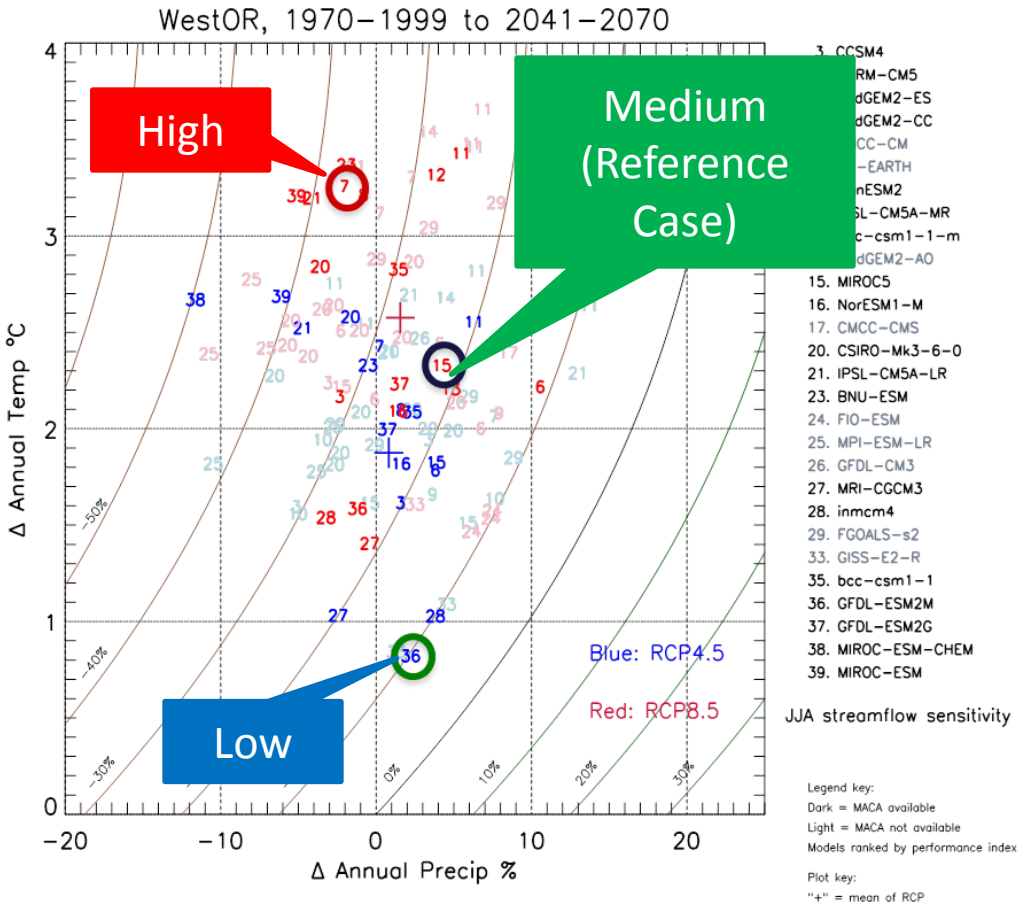
proportion of days annually that exceed the target temperatures (13, 16, 17.8, 21°C)

Climate Drivers

Three climate scenarios, representing a range of temperature and precipitation responses

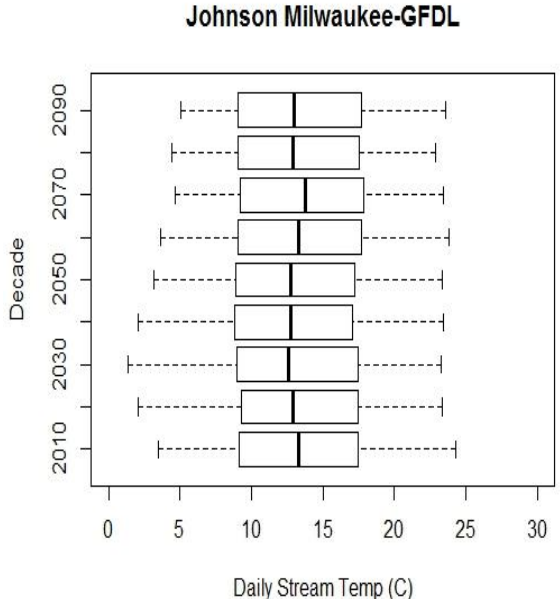
High: HadGEM2-ES RCP 8.5
Reference: MIROC5 RCP 8.5
Low: GFDL-ESM2M RCP 4.5

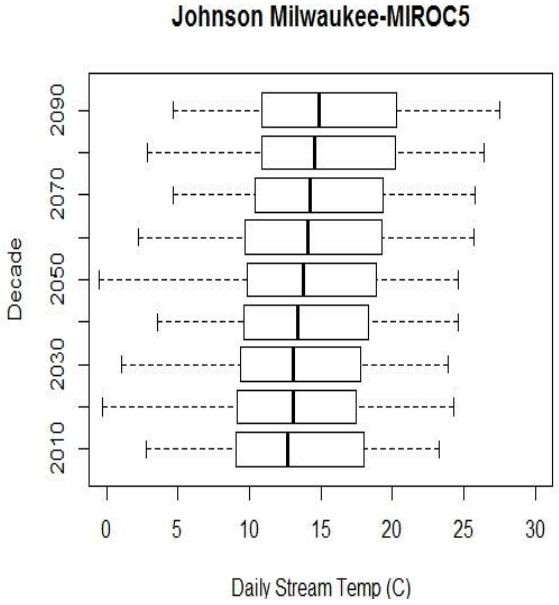
Reference Case scenario based on MIROC (Medium) climate change projection

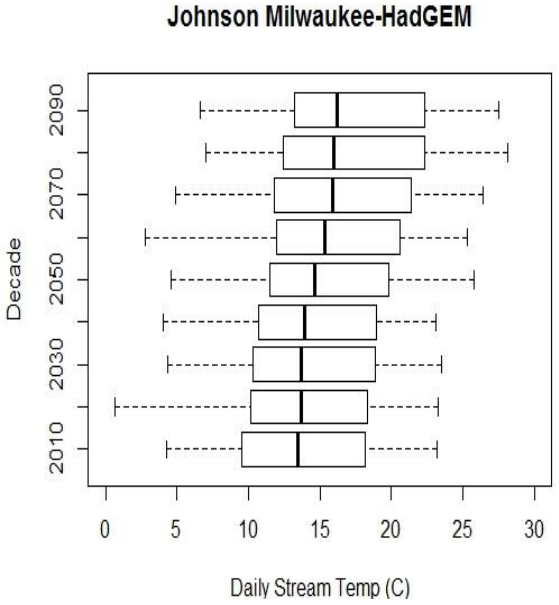


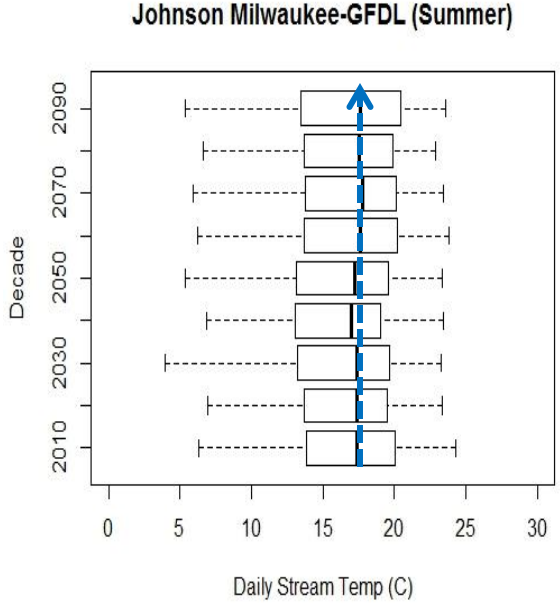
(Rupp, Mote et al.)

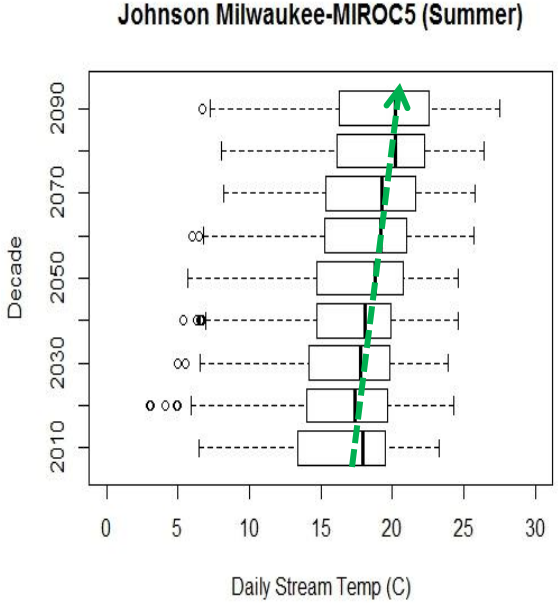
Change in annual and summer daily stream temperature, Johnson Creek, 2010-2099

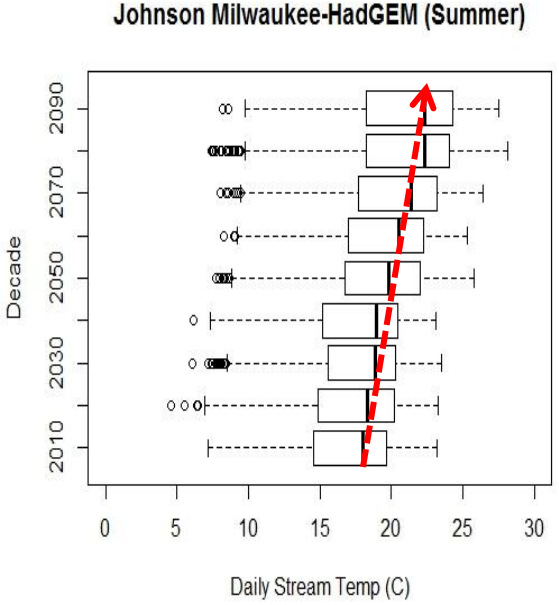






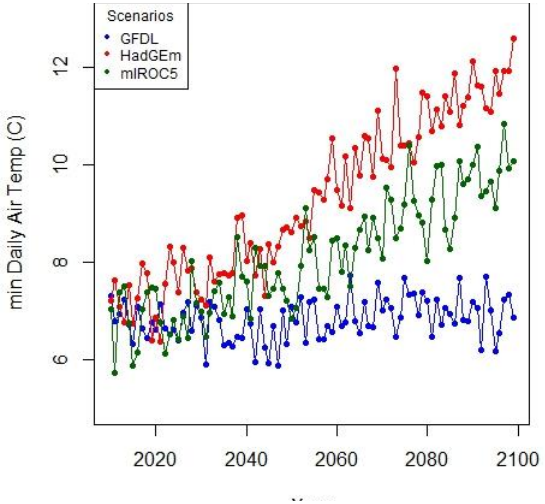




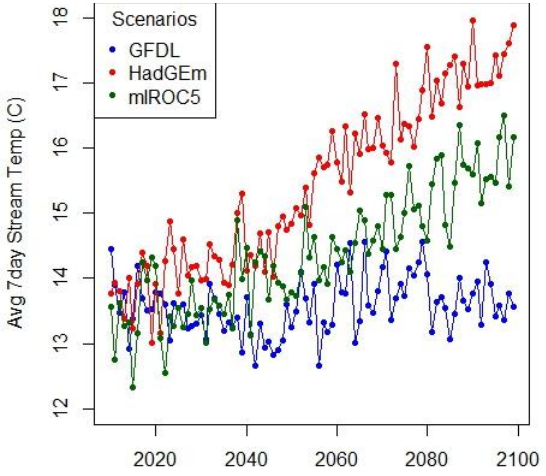


Change in air temperature, streamflow, and stream temperature, Johnson Creek

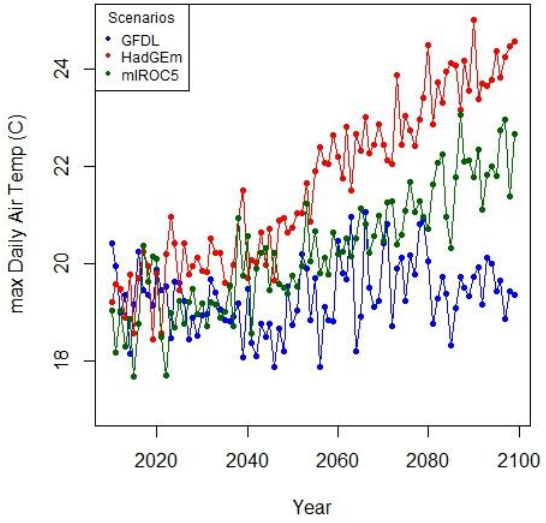
Air temp (min daily)



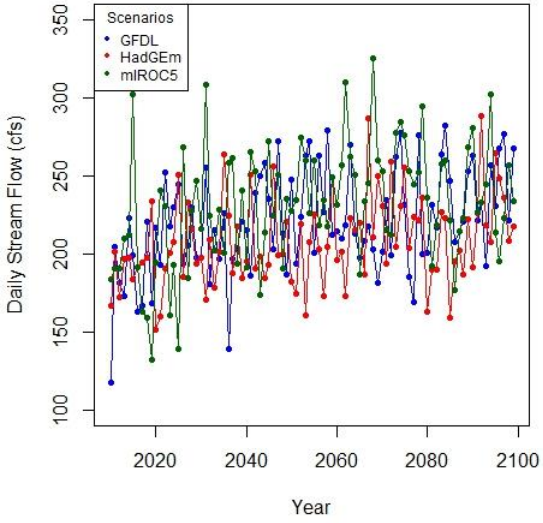
Stream temp (average 7DADM)



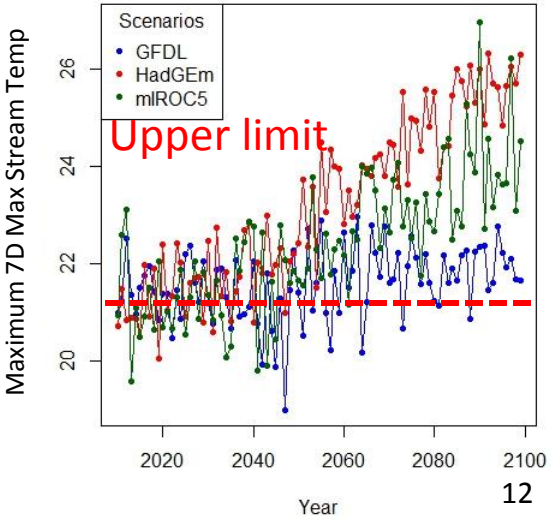
Air temp (max daily)



Streamflow



Stream temp (Max 7DADM)

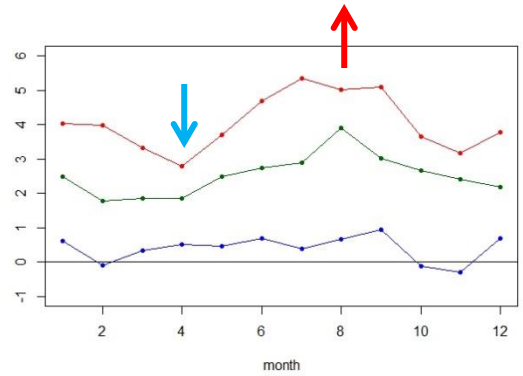


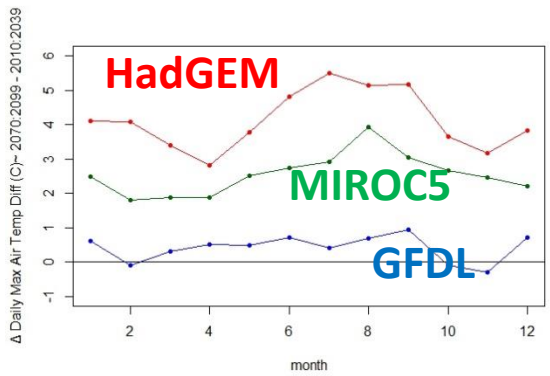
Milwaukie

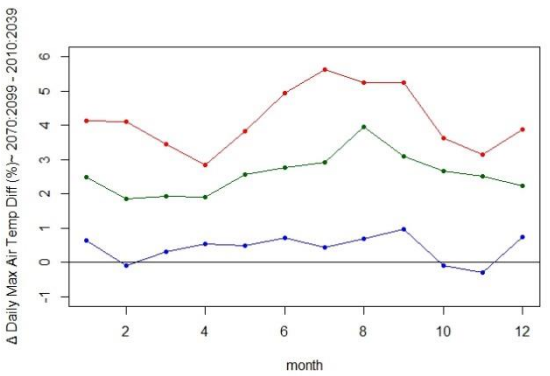
Sycamore

Regner

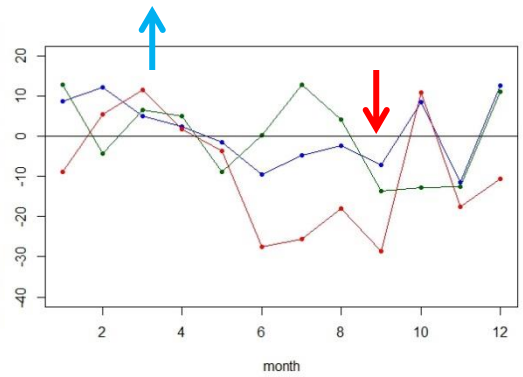
Δ in daily max air temp (C)

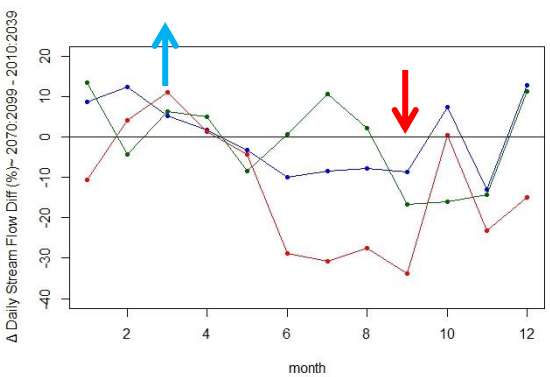


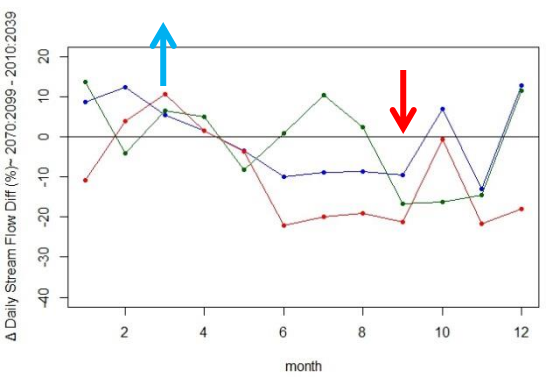




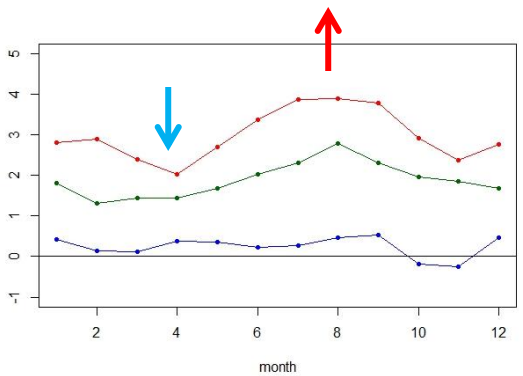
Δ in daily flow (%)

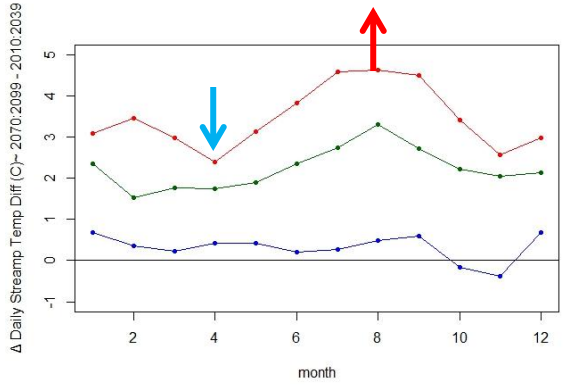


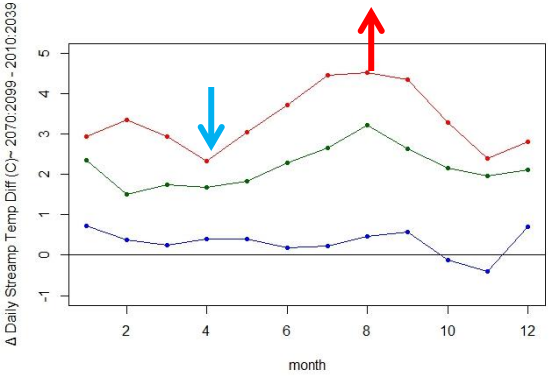




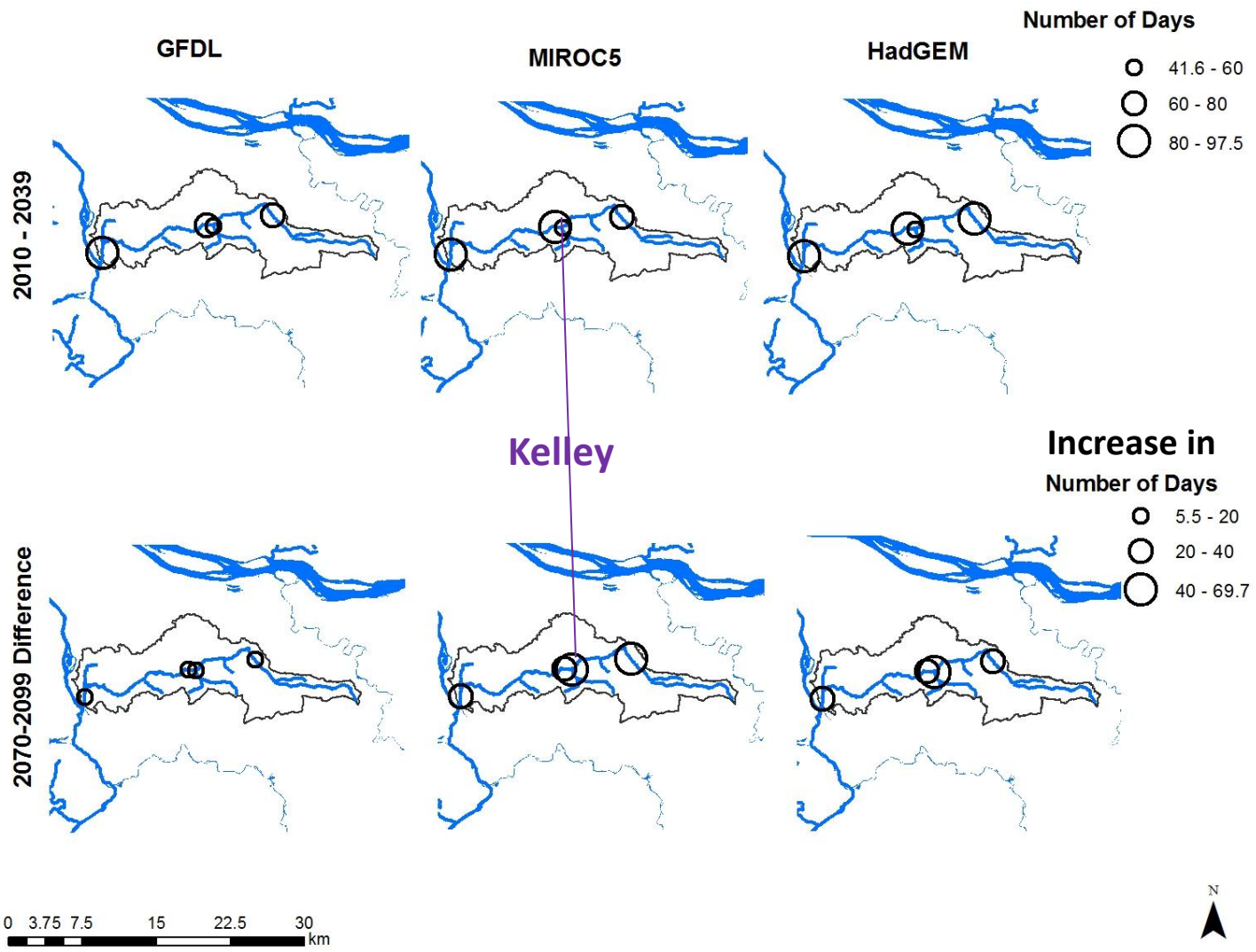
Δ in 7DADM stream (C)



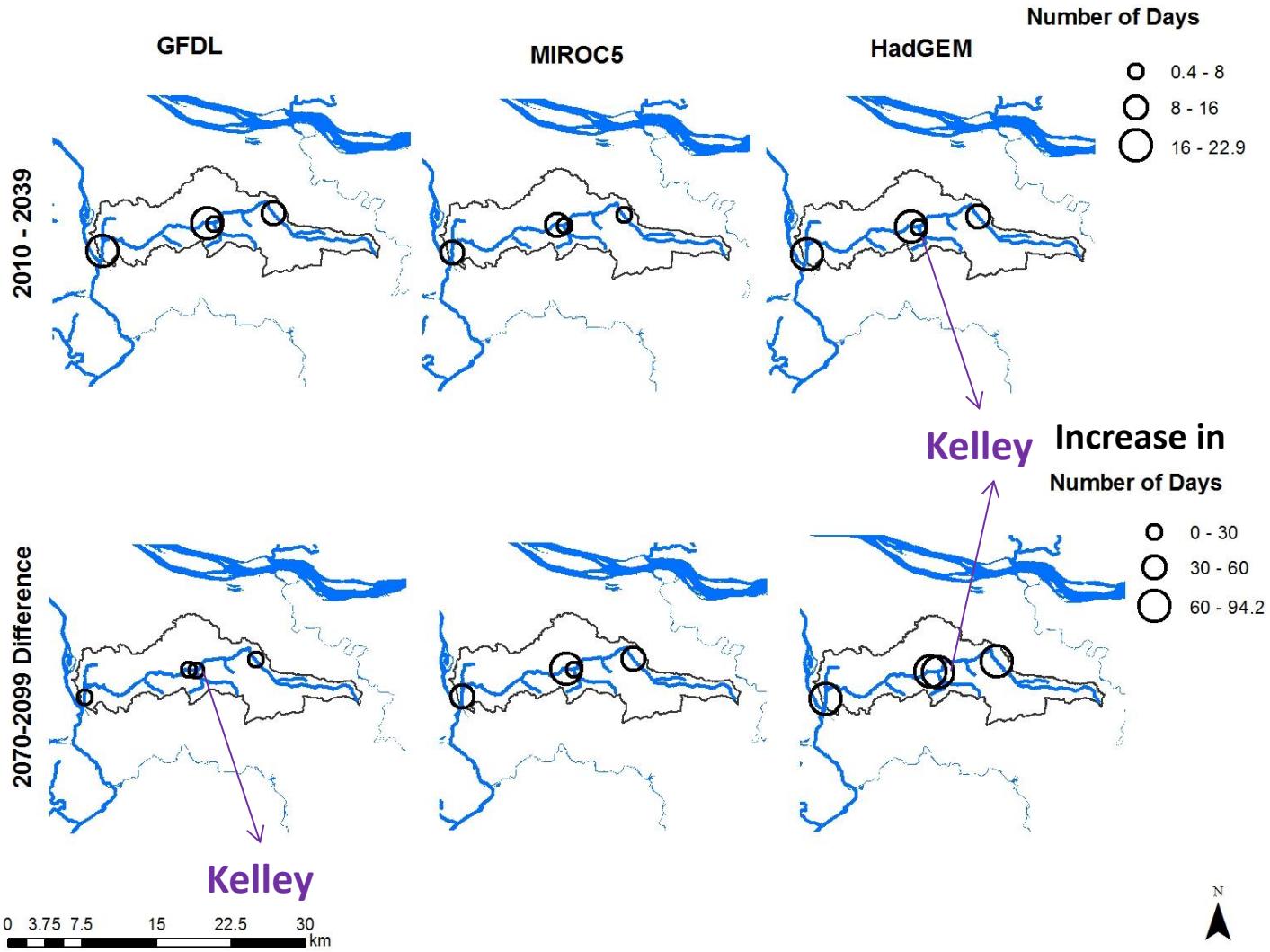




Number of days 7DADTmax > 17.8?C



Number of days 7DADTmax > 21?C



Summary

- Stream temperatures are increasing again in Johnson Creek since 2012.
- Stream temperature is projected to increase more in summer than in spring due to changes in air temperature and flow regime.
- Mid-sections of Johnson Creek respond to changes in climate more than downstream section.
- Temperatures in Johnson Creek will exceed optimum conditions for all life stages of salmon as soon as 2040.

Acknowledgements

Questions?
Contact Heejun Chang
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- Oregon Climate Change Research Institute
- University of Idaho
- Institute for Sustainable Solutions at PSU

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