Hydrologic Trends of Streamflow and Temperature in the Johnson Creek Watershed

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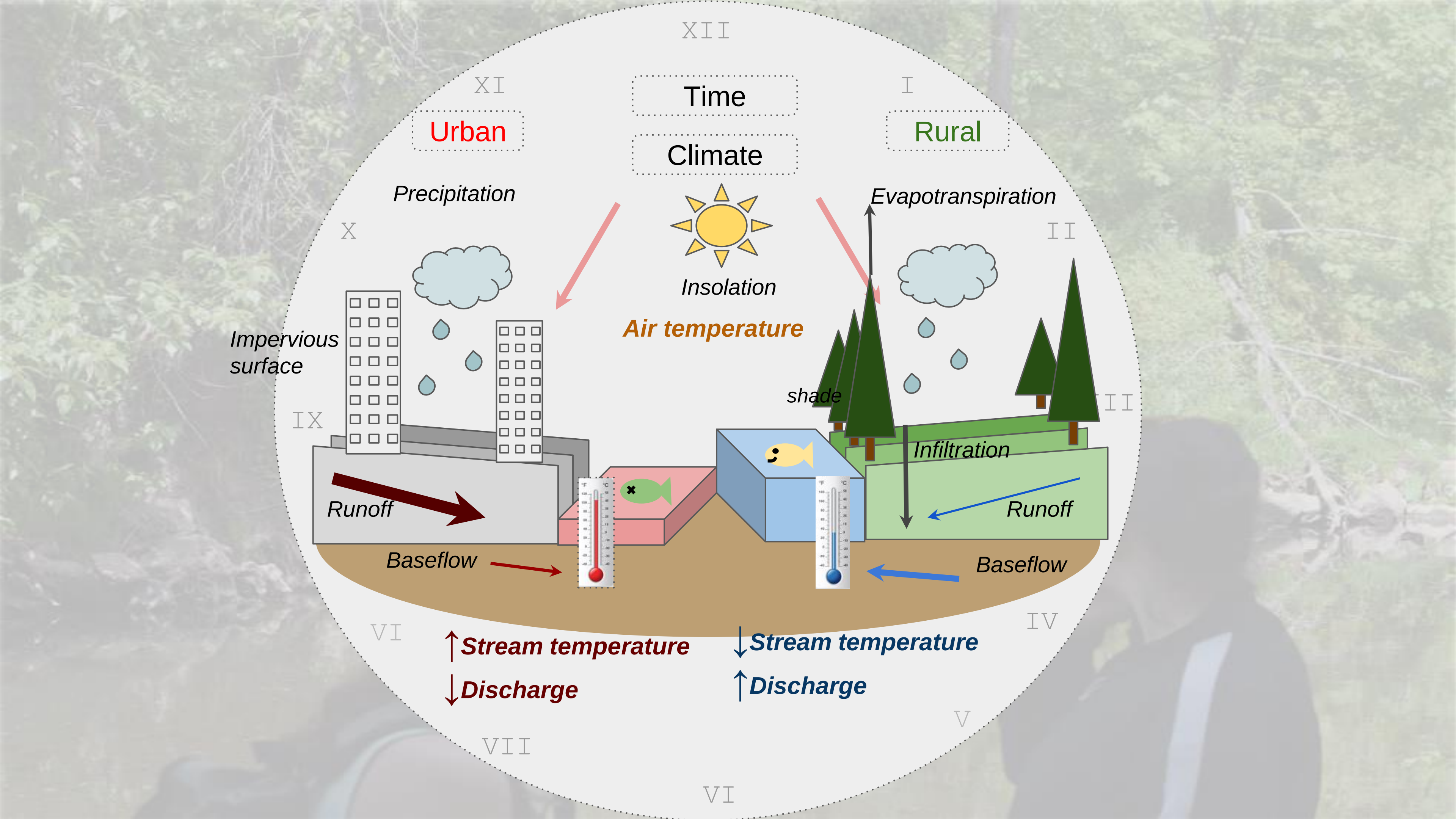
Why do we care about streamflow?

- Urbanization can alter stream hydrology→ urban hydrology [3, 10, 12, 23]
- Altered hydrology can change a streams geomorphology [13, 16]
- Urban flooding[14]
- Less baseflow and lower low flows=>less aquatic habitat [18, 22]

Why do we care about stream temperature?

- Urban heat island effect can increase water temperature [1, 7]
- Urbanized areas tend to have higher stream temperatures [12, 19, 26]
- High stream temperatures are not conducive for healthy habitat [1,2, 9,17,21]
  - i.e. plants, benthic macroinvertebrates, salmon
- Temperature and dissolved oxygen


XII
XI
I
Time
Urban
Climate
Rural
Precipitation
Evapotranspiration
X
II
Insolation
Impervious surface
Air temperature
shade
IX
Infiltration
Runoff
Runoff
Baseflow
Baseflow
IV
↑Stream temperature
↓Discharge
↓Stream temperature
↑Discharge
V
VII
VI

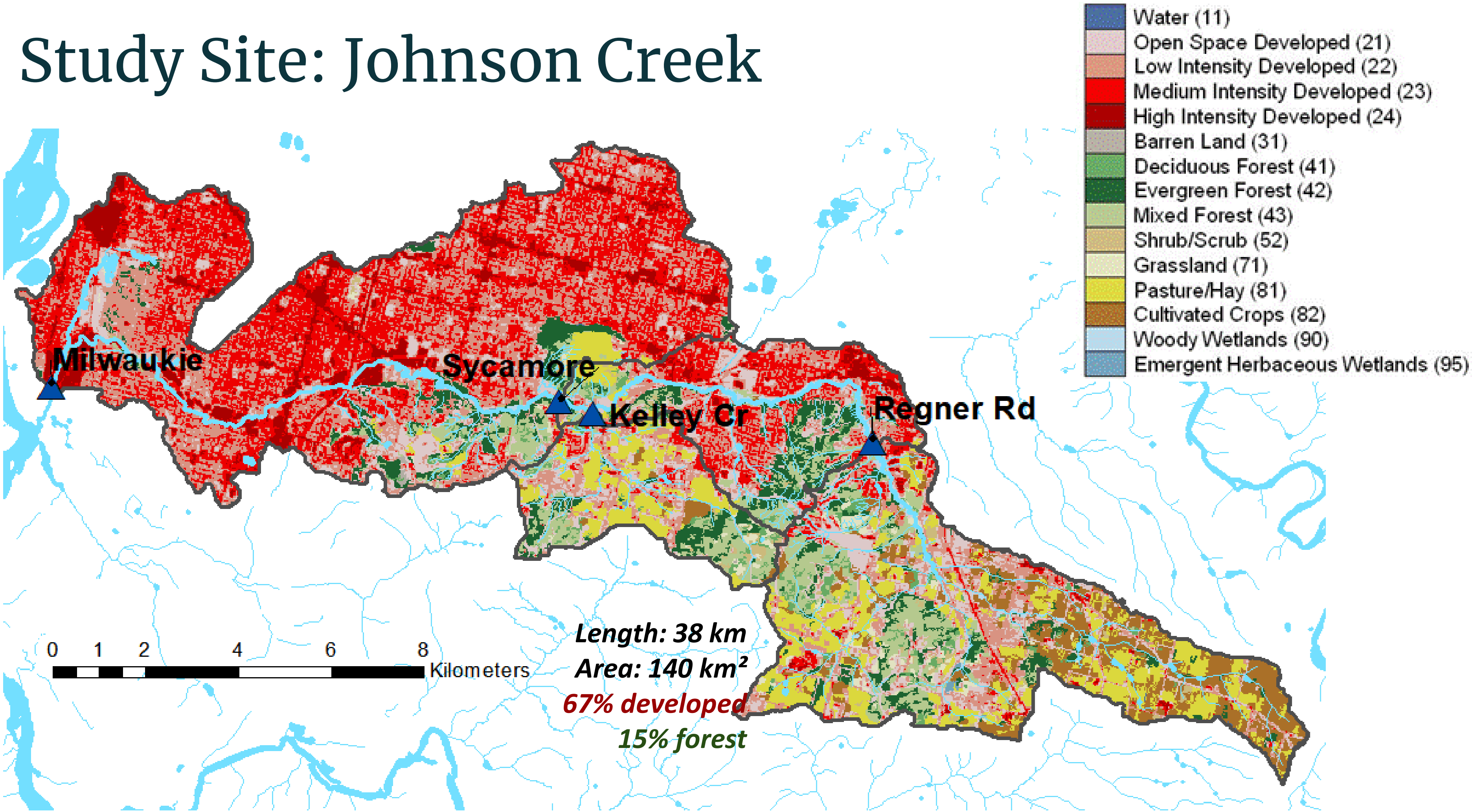
Research questions

1. Are there significant temporal trends of streamflow and stream temperature metrics in Johnson Creek, Oregon?

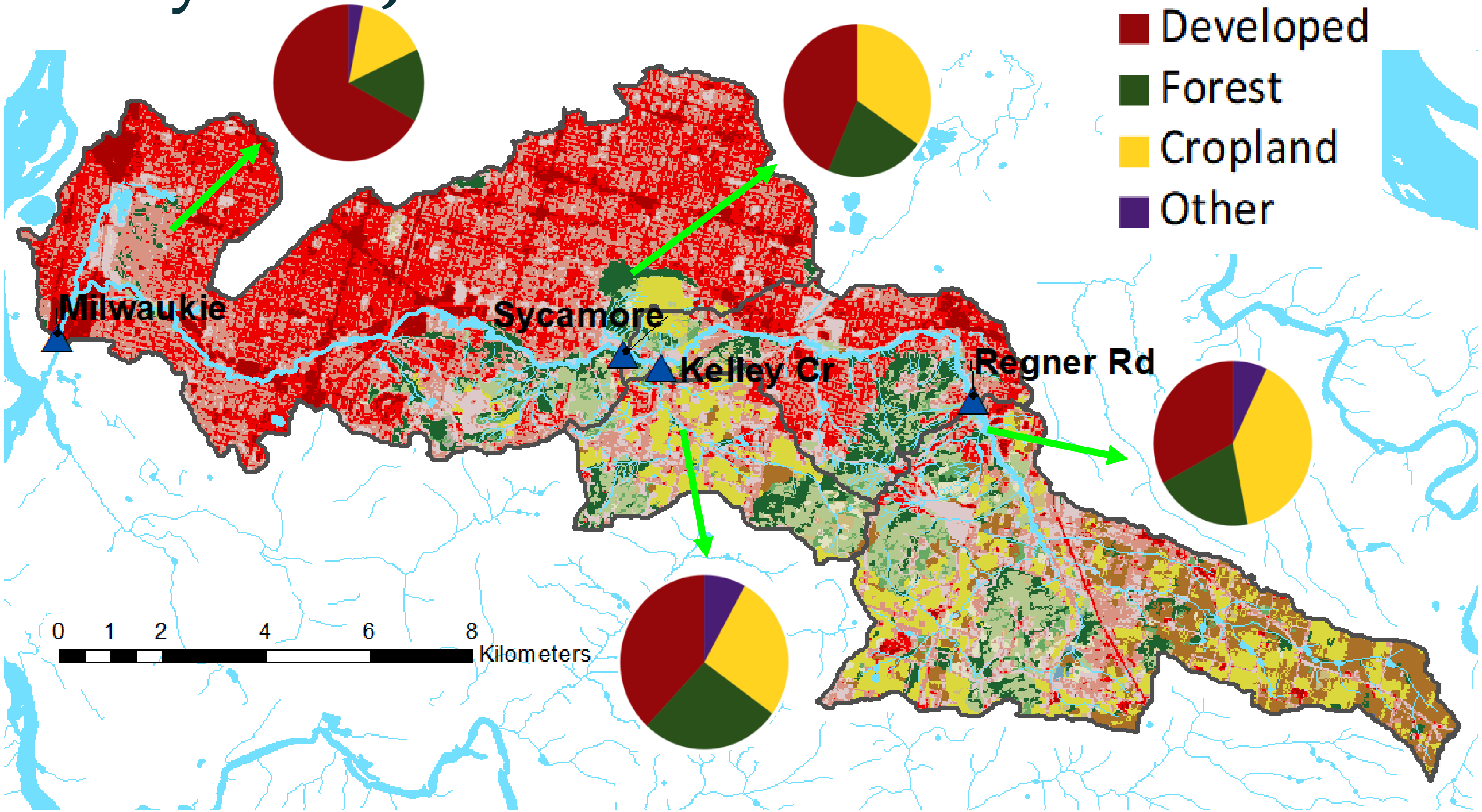
2. How do the trends vary at annual versus monthly scales?

3. How do they compare for the entire period of record versus the overlapping period of record for all four stations?

Study Site: Johnson Creek



Study Site: Johnson Creek



Data

Station ID	Station Name	Drainage area (km²)	Temperature record	Discharge record
14211550	Johnson Creek at Milwaukie	137.7	1998 - 2018	1989 - 2018
14211500	Johnson Creek at Sycamore	69.4	1998 - 2018	1940 - 2018
14211499	Kelley Creek at SE 159th	12.2	2000 - 2018	2000 - 2018
14211400	Johnson Creek at Regner Rd	39.8	1999 - 2018	1998 - 2018

Data

Dataset	Derived Metrics
Precipitation	Total daily precipitation
Discharge	Baseflow index Richards-Baker Flashiness index Mean runoff ratio TQmean
Stream Temperature	# of days exceeding 17.8 C 7-day moving average of daily maximum stream temperature 7-day moving average of daily minimum stream temperature Thermal flashiness

Mann-Kendall trend test: to detect monotonic trends in flow and temperature

Temperature 1998-present

Discharge 1989-present

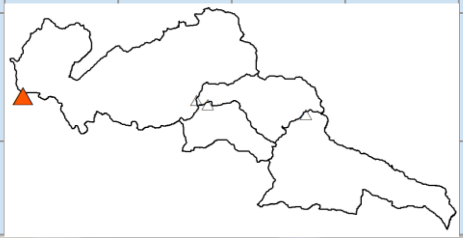
Milwaukie	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year
7DADTmax									○	○	○	○	○
7DADTmin									○	○	○	▲	○
Thermal Flashiness									▼	○	○	▼	○
# days >17.8℃									○	○	○	○	○
BFI									○	▲	○	○	○
RB Index	○	○	○	○	▼	○	○	○	○	○	○	○	○
Runoff Ratio	○	○	○	○	▼	○	○	○					○
TQmean	○	○	○	▼	○	○	○	○					○

Trend significant at:

Positive trend ▲ .01 ▲ .05 ▲ .10

Negative trend ▼ .01 ▼ .05 ▼ .10

○ No trend



Temperature 2000-present

Discharge 2000-present

Trend significant at:

Positive trend		Negative trend	
▲	.01	▼	.01
▲	.05	▼	.05
▲	.10	▼	.10

○ No trend

Milwaukie	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year
7DADTmax									○	○	▼	▼	▼
7DADTmin									○	○	○	○	○
Thermal Flashiness									▼	○	○	▼	○
# days >17.8℃									○	○	○	▼	○
BFI									▲	○	○	○	○
RB Index	▲	○	○	○	○	○	○	○	▼	○	○	○	○
Runoff Ratio	○	▲	○	○	○	○	○	○					○
TQmean	○	○	○	▼	○	○	○	○					○

Temperature 1998-present

Discharge 1940-present

Sycamore	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year
7DADTmax									▲	▲	▲	▲	▲
7DADTmin									○	▲	▲	▲	○
Thermal Flashiness									○	○	○	▼	○
# days >17.8℃									○	○	▲	▲	▲
BFI									○	○	○	▼	▲
RB Index	▲	▲	▲	○	○	▲	▲	▲	▲	▲	▲	▲	▲
Runoff Ratio	▲	○	○	○	○	○	○	○					○
TQmean	▲	○	○	○	▼	○	▲	○					○

Trend significant at:

Positive trend		Negative trend	
▲	.01	▼	.01
▲	.05	▼	.05
▲	.10	▼	.10

○ No trend

Temperature 2000-present

Discharge 2000-present

Sycamore	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year
7DADTmax									▲	▲	▲	▲	▲
7DADTmin									○	○	▲	▲	○
Thermal Flashiness									○	○	○	○	○
# days >17.8℃									○	○	▲	▲	▲
BFI									○	○	▲	○	○
RB Index	○	○	▲	○	○	○	○	○	▼	○	▼	○	○
Runoff Ratio	○	▲	○	○	○	○	▲	○					○
TQmean	○	▲	○	▼	○	○	○	○					○

Trend significant at:

Positive trend: ▲ .01 ▲ .05 ▲ .10

Negative trend: ▼ .01 ▼ .05 ▼ .10

○ No trend

Temperature 1999-present

Discharge 1998-present

Trend significant at:

Positive trend: ▲ .01, ▲ .05, ▲ .10

Negative trend: ▼ .01, ▼ .05, ▼ .10

○ No trend

Regner Rd	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year
7DADTmax									○	▲ .05	▲ .01	▲ .05	▲ .01
7DADTmin									○	▲ .10	▲ .10	▲ .10	○
Thermal Flashiness									○	○	○	○	○
# days >17.8°C									○	○	▲ .01	▲ .05	▲ .05
BFI									○	○	○	○	○
RB Index	○	○	▲ .05	▲ .10	○	○	○	○	○	○	○	○	▲ .01
Runoff Ratio	▲ .01	▲ .01	○	○	○	○	○	○					○
TQmean	▲ .01	▲ .10	○	▲ .01	○	○	○	○					○

Temperature 2000-present

Discharge 2000-present

Regner Rd	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year
7DADTmax									○	○	▲	○	▲
7DADTmin									○	▲	▲	▲	○
Thermal Flashiness									○	○	○	▼	○
# days >17.8℃									○	○	▲	▲	▲
BFI									○	○	○	○	○
RB Index	○	○	▲	○	○	○	○	○	▼	○	○	○	▲
Runoff Ratio	▲	▲	▲	○	○	○	○	○					○
TQmean	▲	▲	○	▼	○	○	○	○					○

Trend significant at:

Positive trend		Negative trend	
▲	.01	▼	.01
▲	.05	▼	.05
▲	.10	▼	.10

○ No trend

Temperature 2000-present

Discharge 2000-present

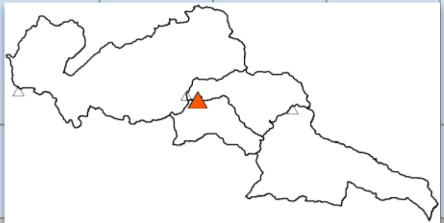
Kelley Cr	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Year
7DADTmax									○	○	○	○	○
7DADTmin									○	○	○	○	○
Thermal Flashiness									○	○	○	○	○
# days >17.8℃									○	○	○	○	○
BFI									○	○	○	○	○
RB Index	○	○	○	○	▼ .05	○	○	○	▼ .10	○	○	○	▼ .05
Runoff Ratio	▲ .10	▲ .05	○	○	○	○	▲ .05	○					○
TQmean	▲ .05	▲ .05	○	▼ .05	○	○	○	○					○

Trend significant at:

Positive trend ▲ .01 ▲ .05 ▲ .10

Negative trend ▼ .01 ▼ .05 ▼ .10

○ No trend



Conclusions

There are significant trends at all stations, on monthly and annual timescales, and for entire and overlapping period of record.

Depending on locations of stream gauge, different trends appear

→ Upstream stations show increases in stream temperature, while downstream station shows decreases in stream temperature in some months.

Differences in trends could be due to unique hydrogeology, land use characteristics, stormwater characteristics, stream restoration?

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