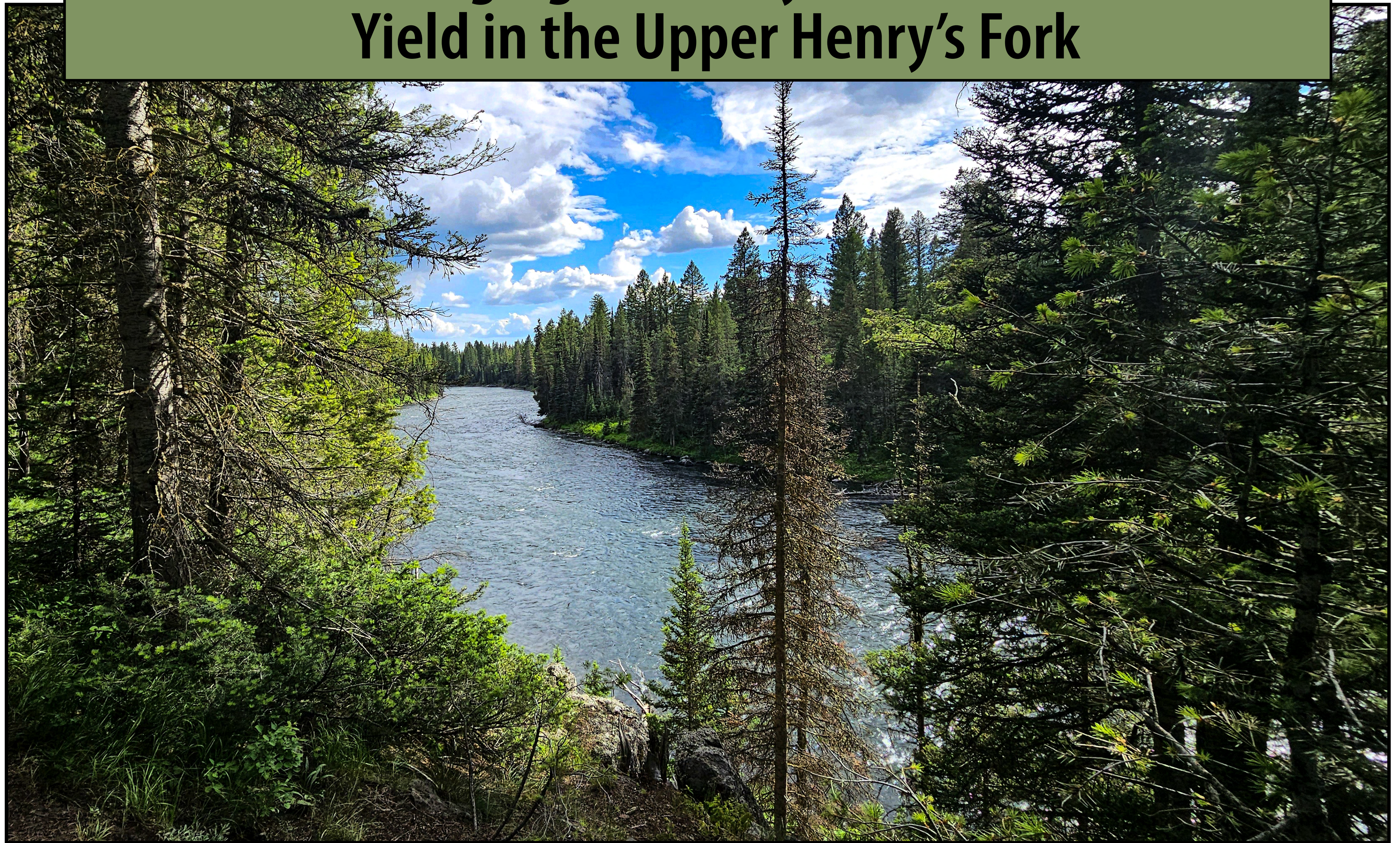


Effects of Changing Forest Dynamics on Watershed Yield in the Upper Henry's Fork



Sarah Newcomb

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Doctoral Researcher with Henry's Fork Foundation



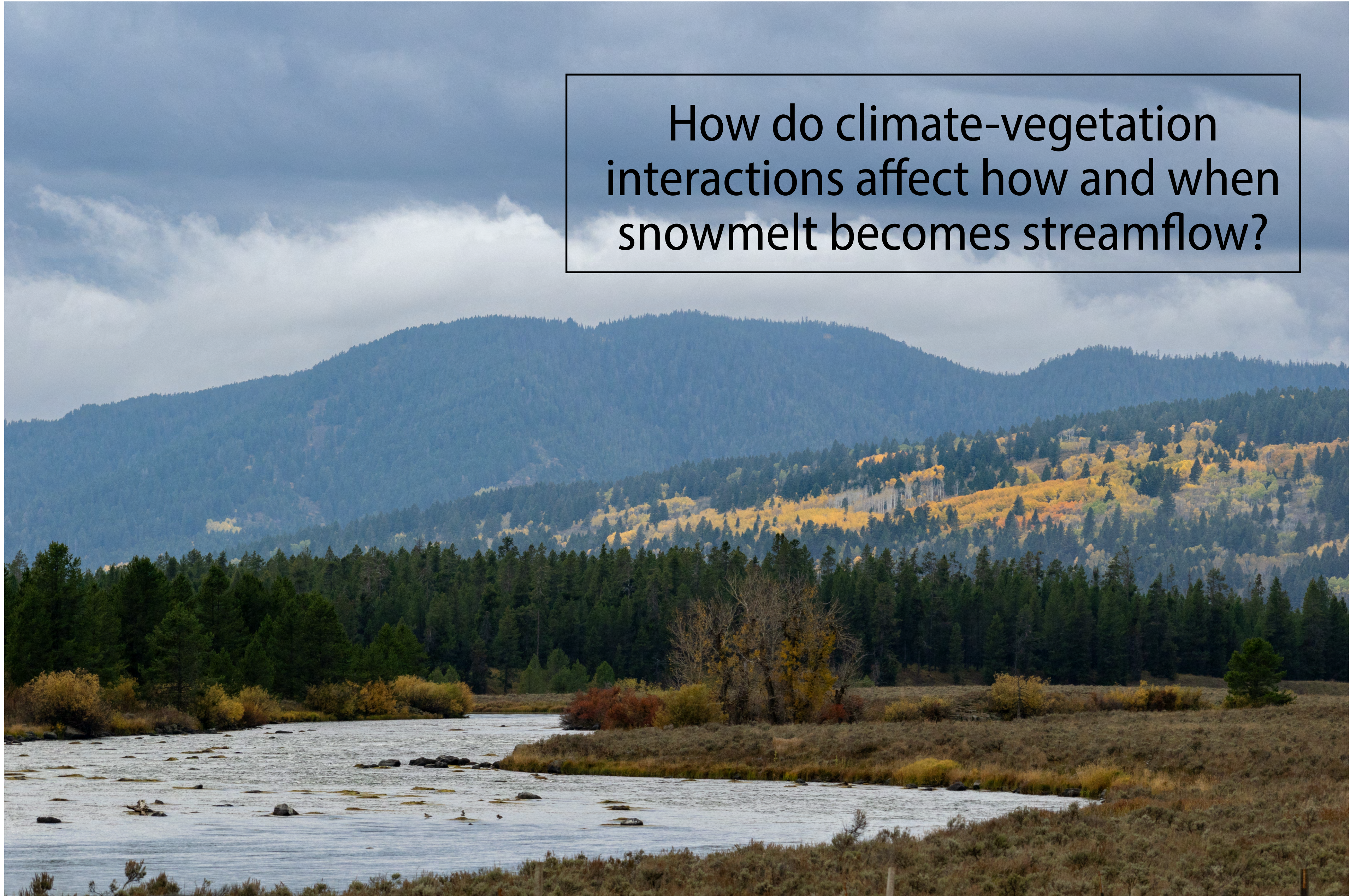
**Idaho State
University**
Geosciences



**How does rain
and snow that
falls in the
mountains
become
streamflow?**



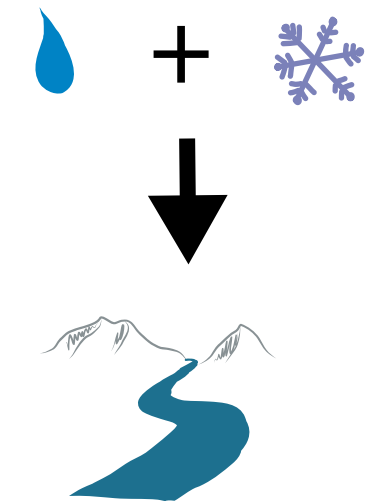
How do climate-vegetation interactions affect how and when snowmelt becomes streamflow?



How much precipitation becomes streamflow in the Henry's Fork?

$$\text{Runoff Ratio} = \frac{\text{Annual Streamflow (Q)}}{\text{Annual Precipitation (P)}}$$

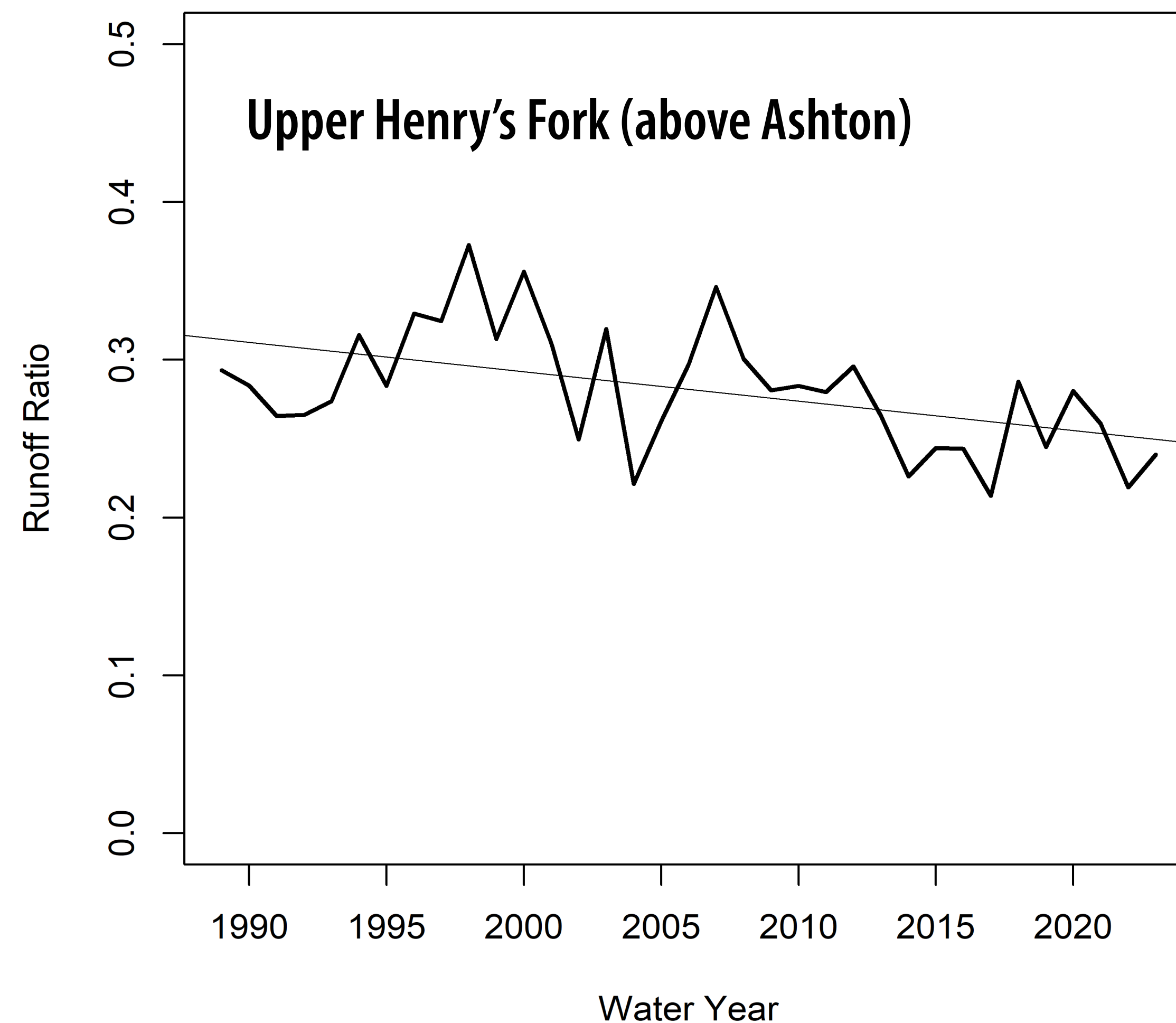
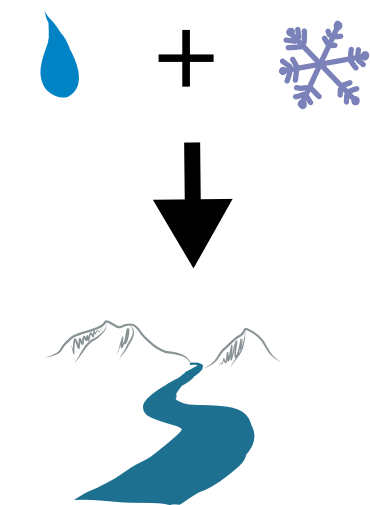
*AKA the portion of rain
and snowmelt that
becomes streamflow*



How much precipitation becomes streamflow in the Henry's Fork?

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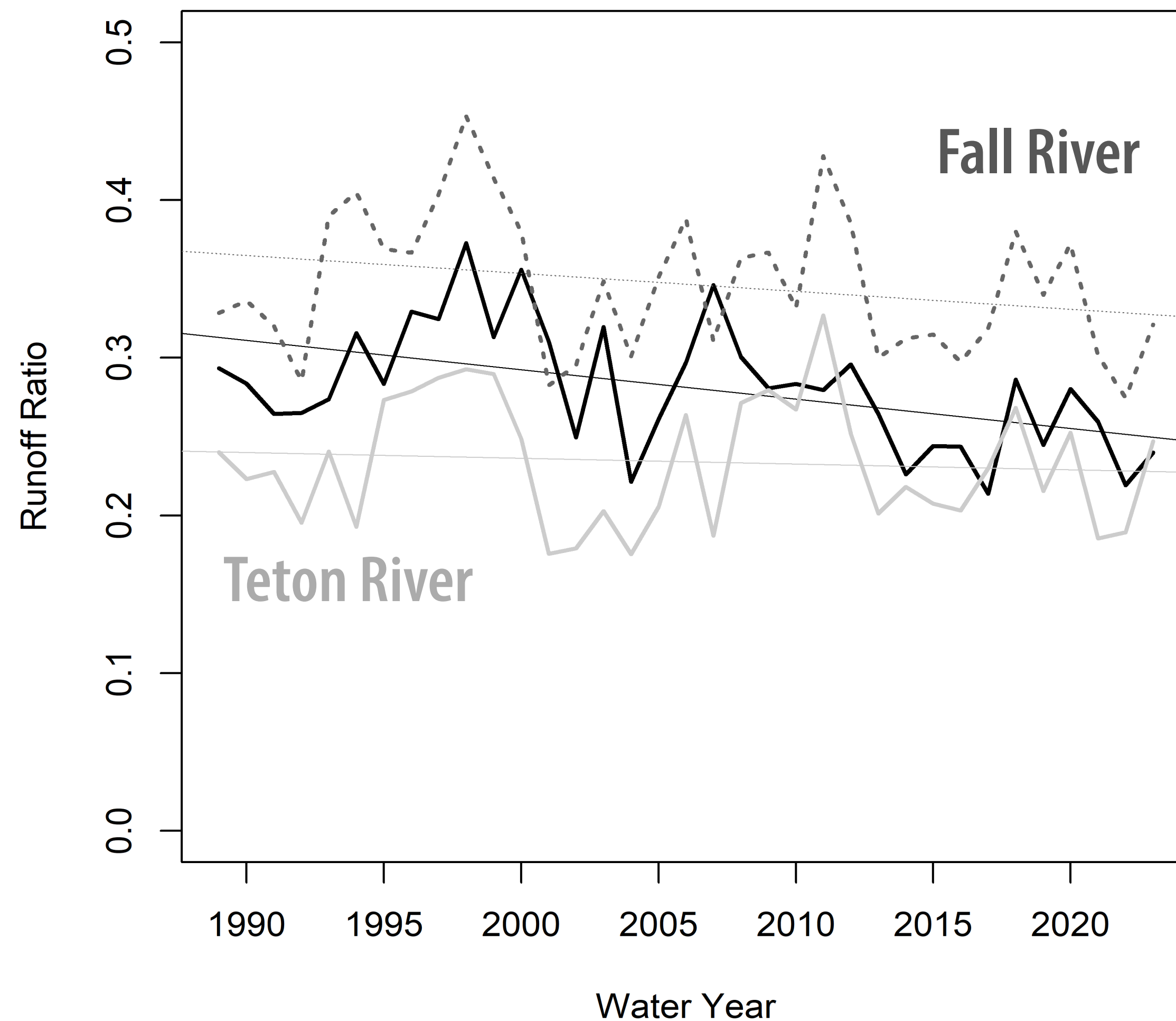
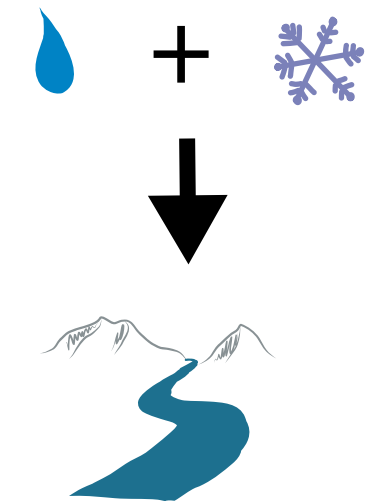
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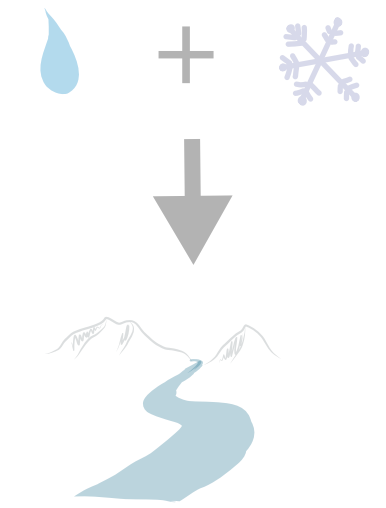
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and snowmelt the
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How much precipitation becomes streamflow in the Henry's Fork?

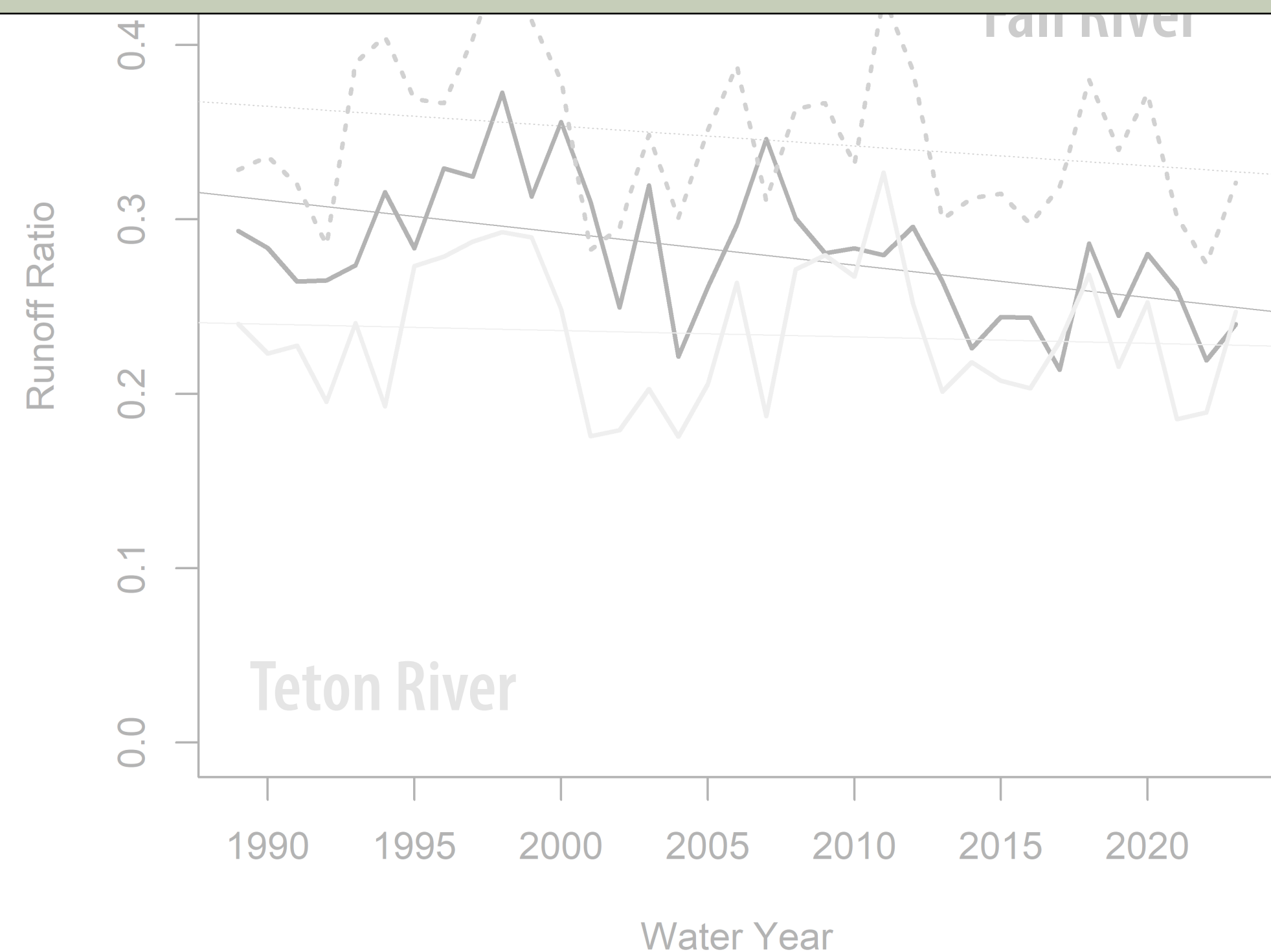
$$\text{Runoff Ratio} = \frac{\text{Annual Streamflow (Q)}}{\text{Annual Precipitation (P)}}$$

AKA the portion of rain and snowmelt that becomes streamflow

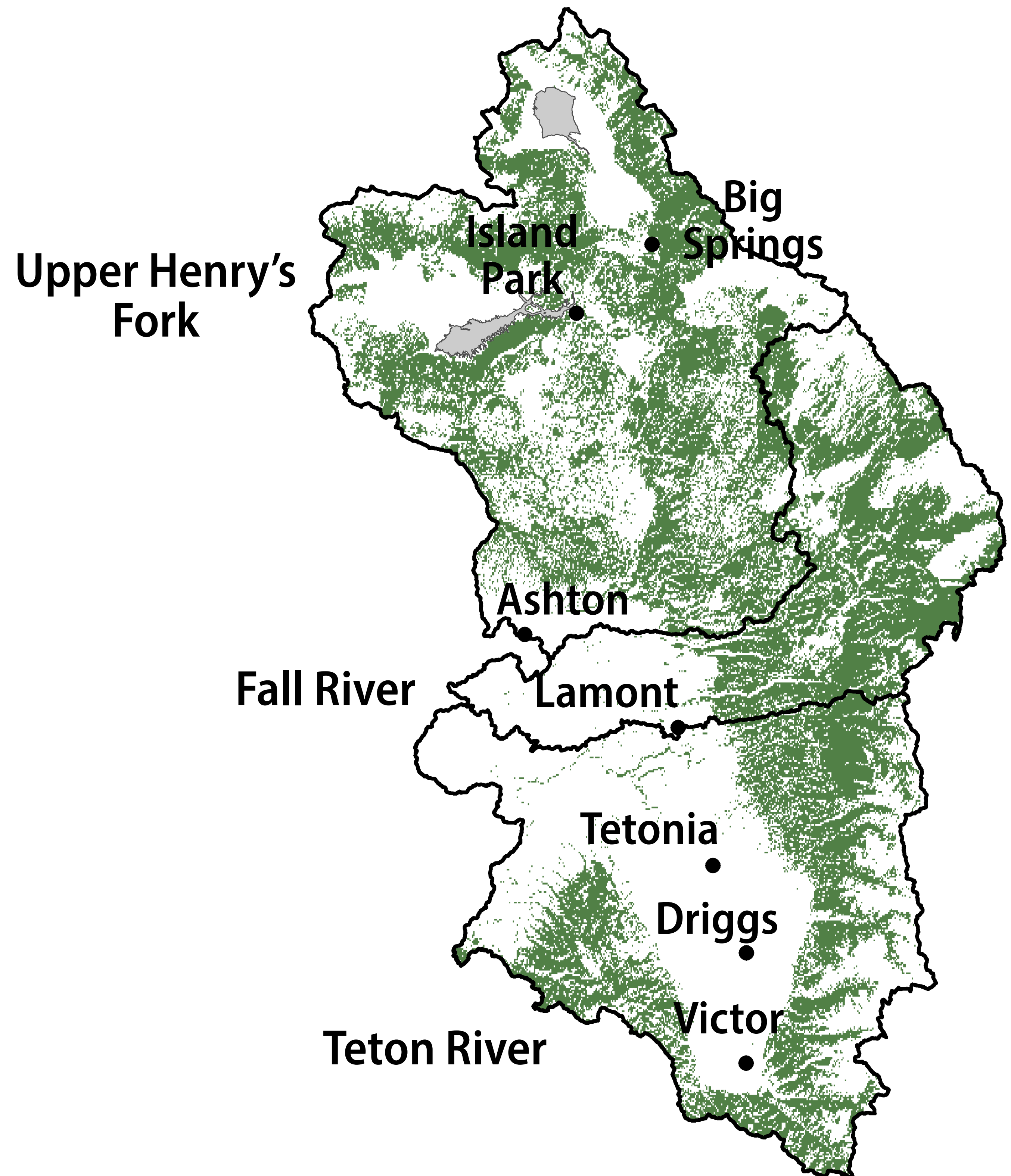


In 2023, less than 25% of the precipitation that fell in the Upper Henry's Fork became streamflow, so where did the rest go?

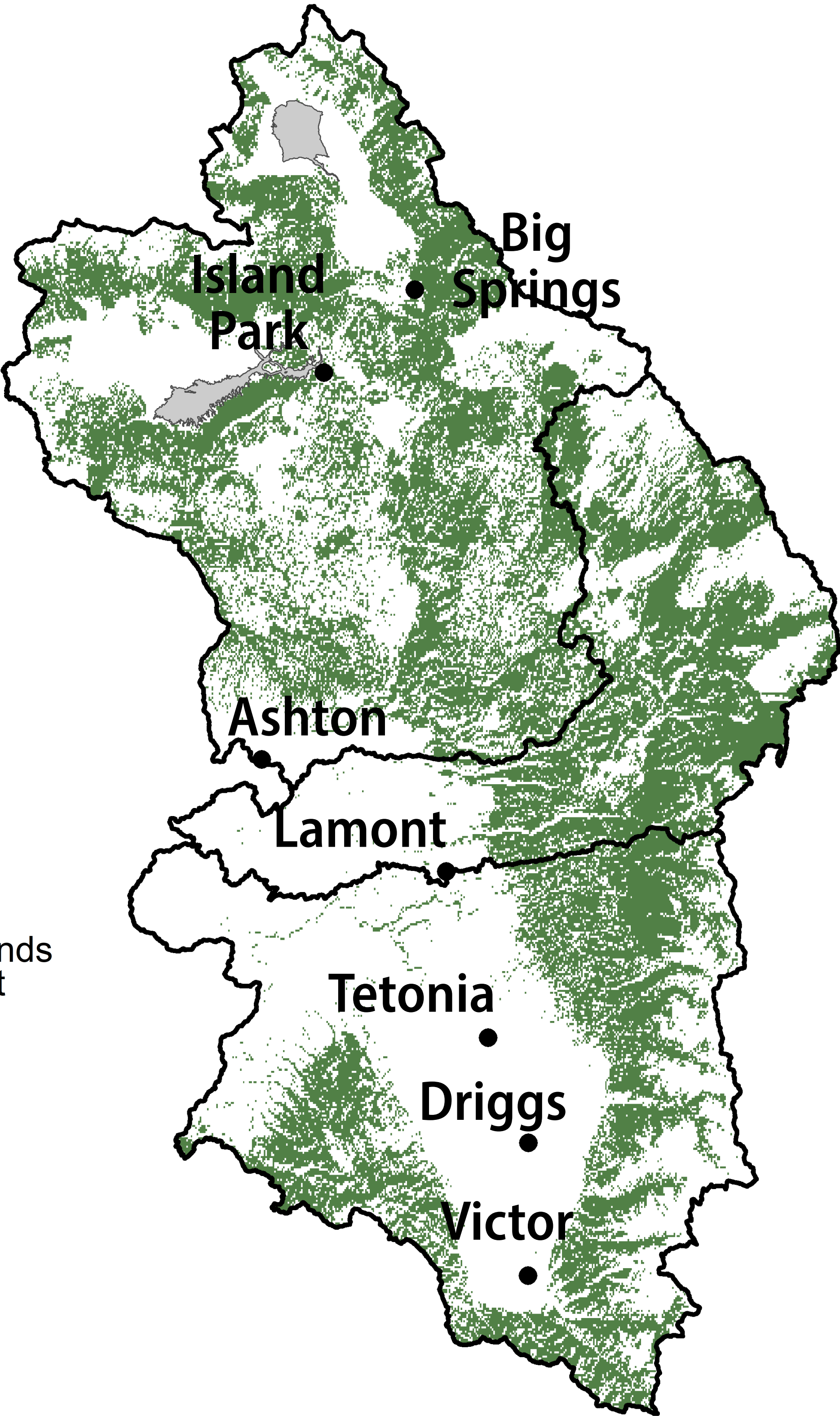
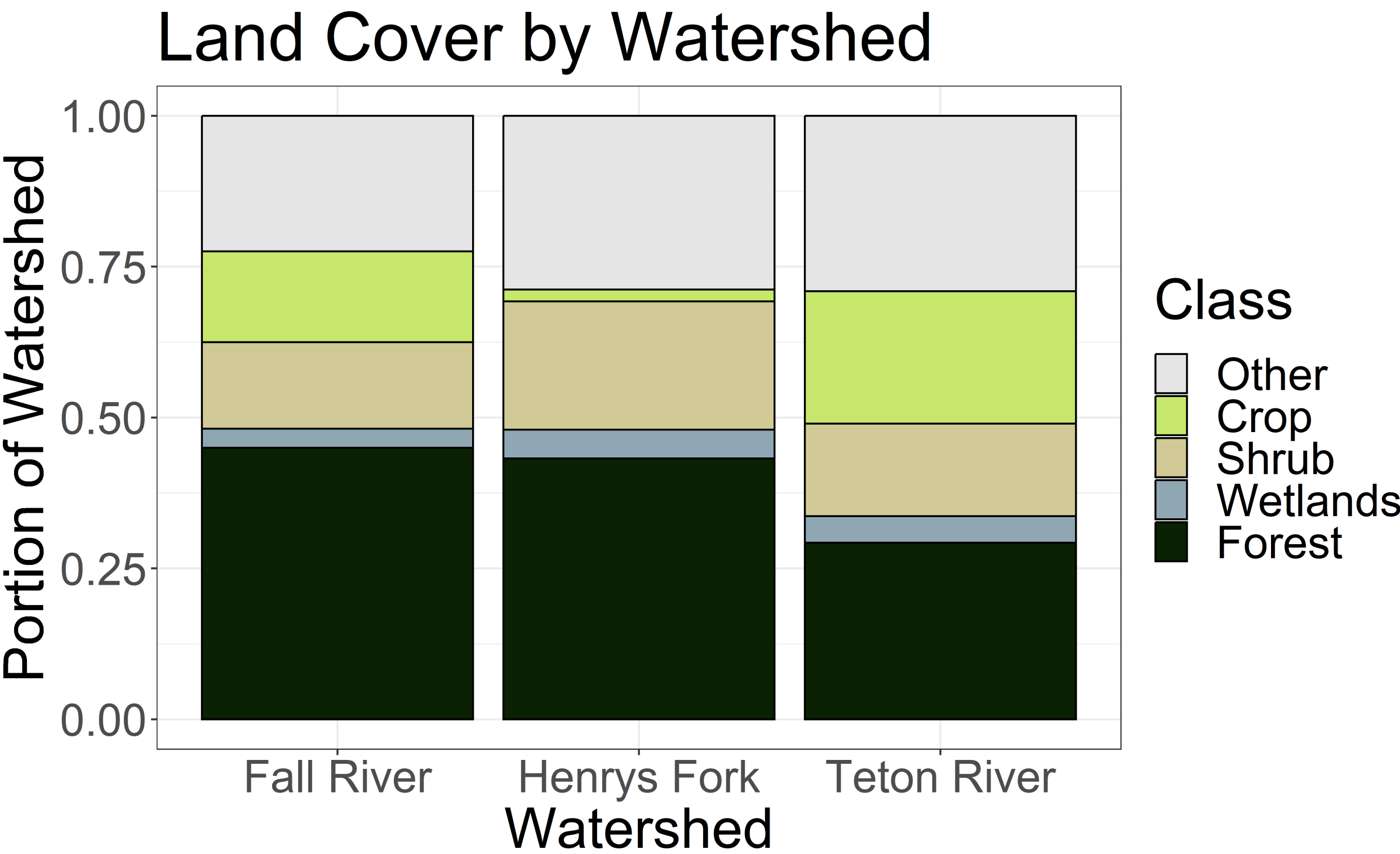
Over the same period we see smaller decreases in Fall River and Teton River.



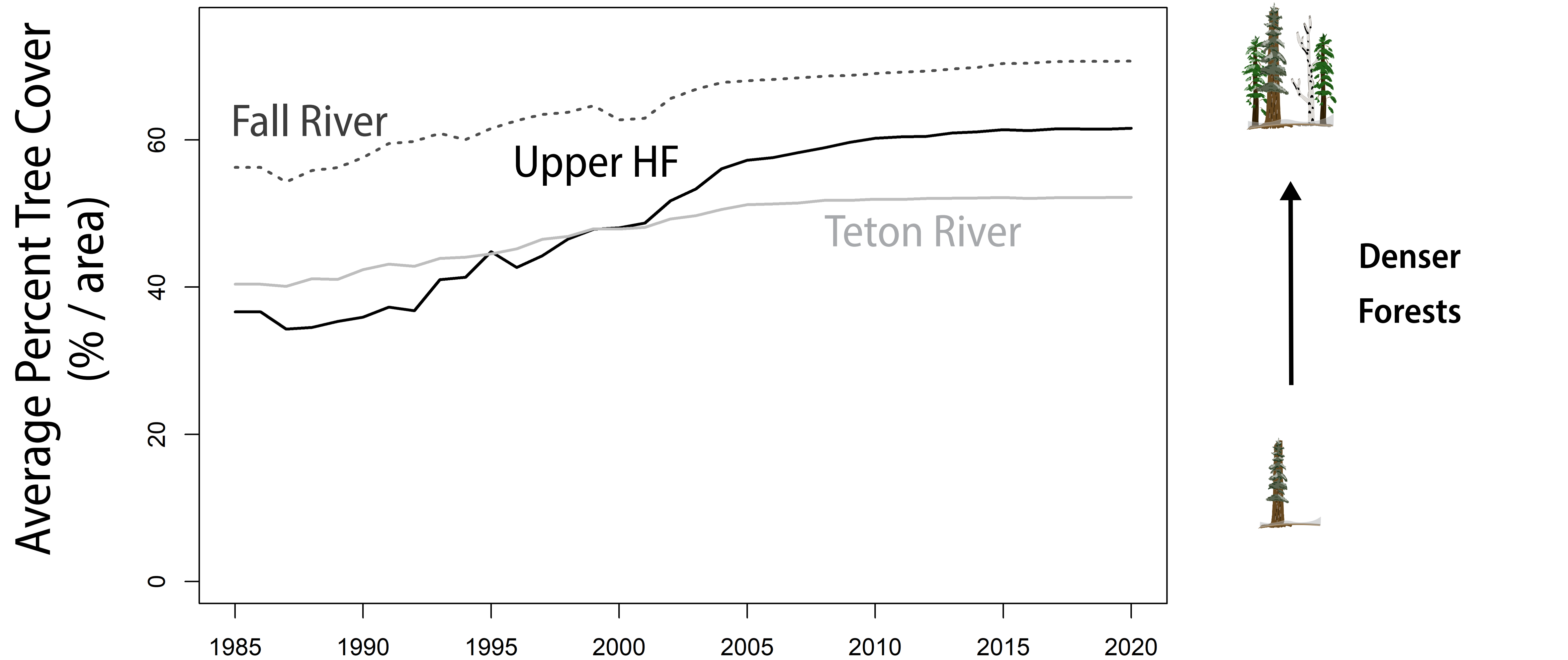
2020 Forest Cover

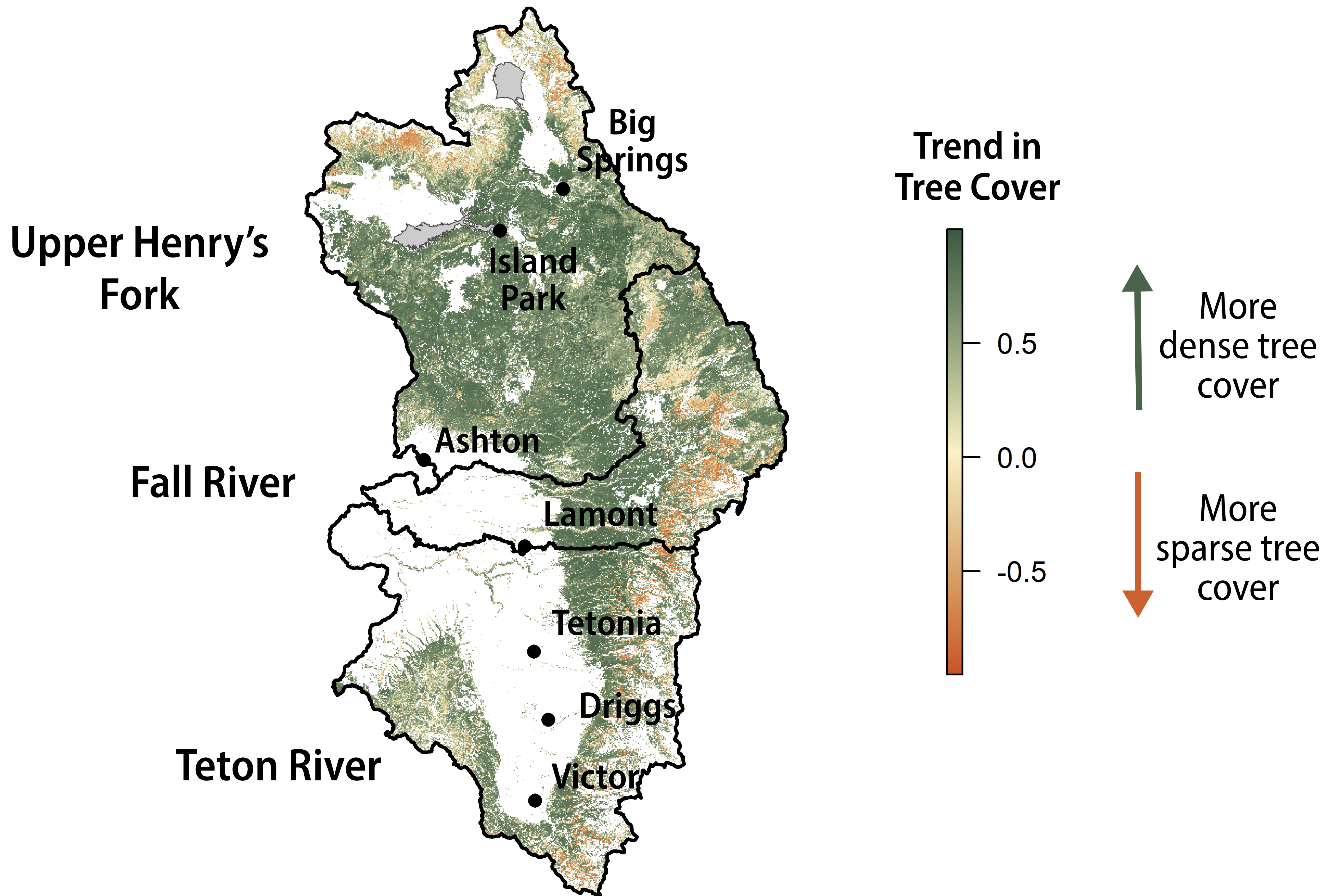


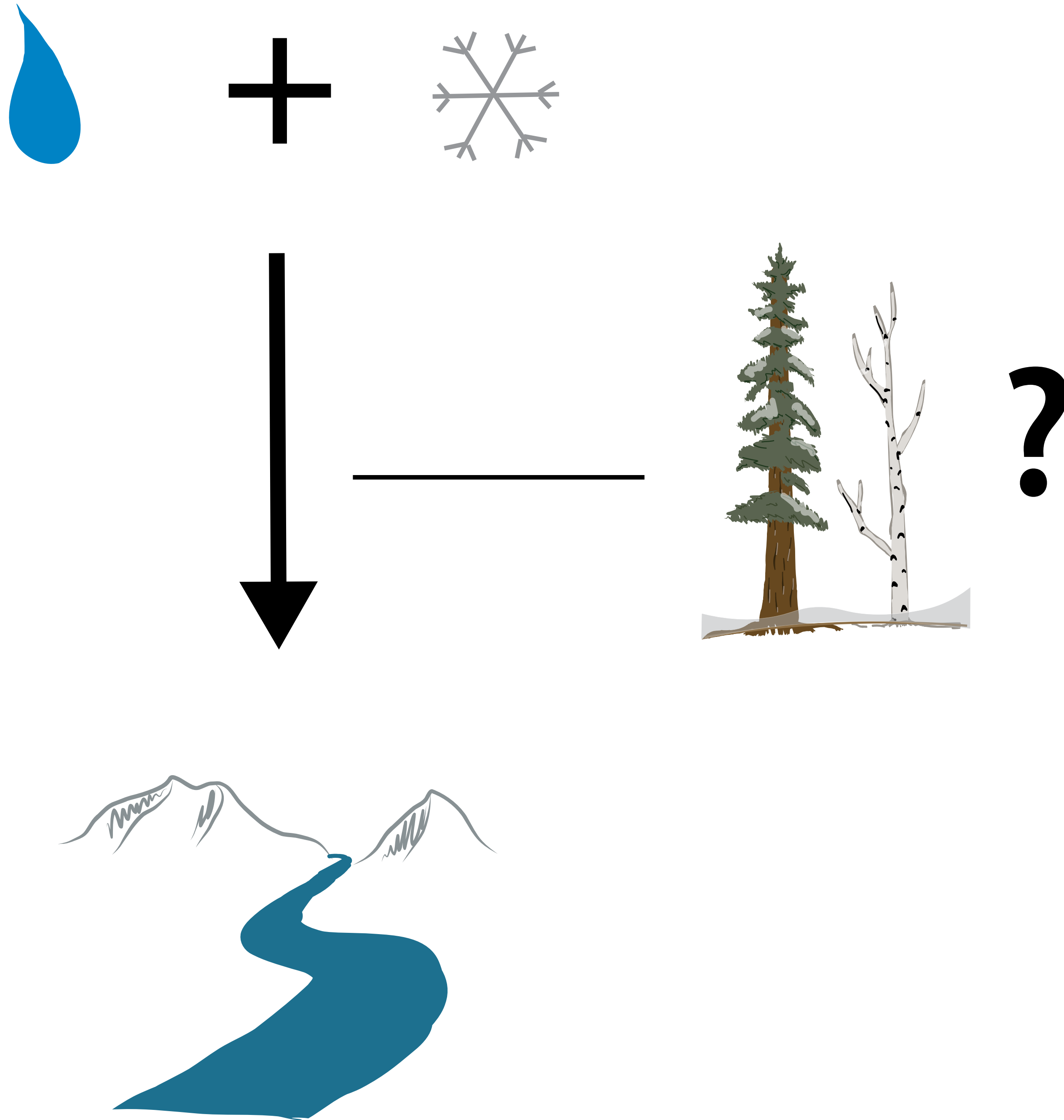
Upper HF and Fall River watersheds are more forested than Teton River



Since 1985, tree cover has become denser



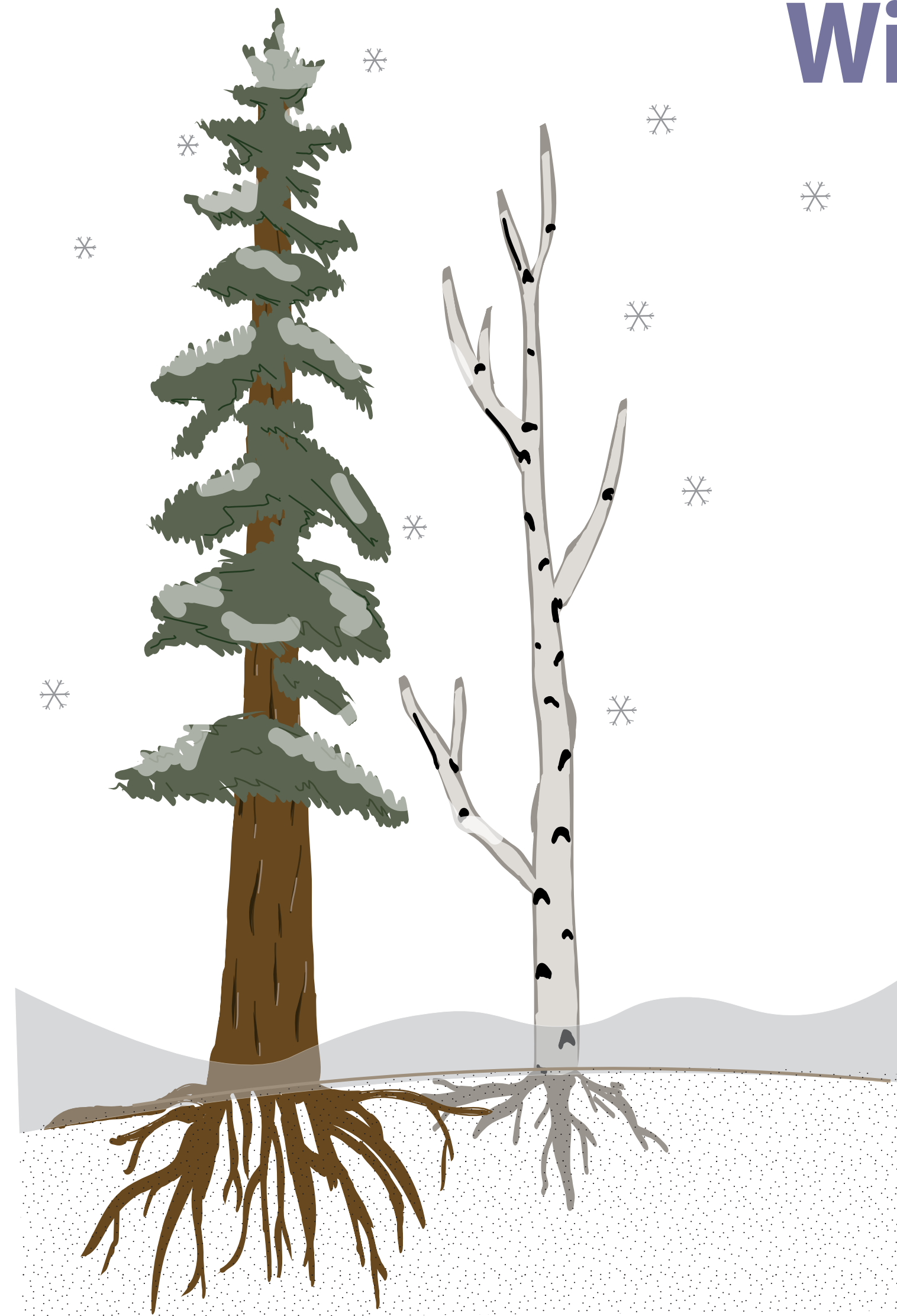




**How do forests
impact how
precipitation
becomes
streamflow?**

How forests impact hydrology

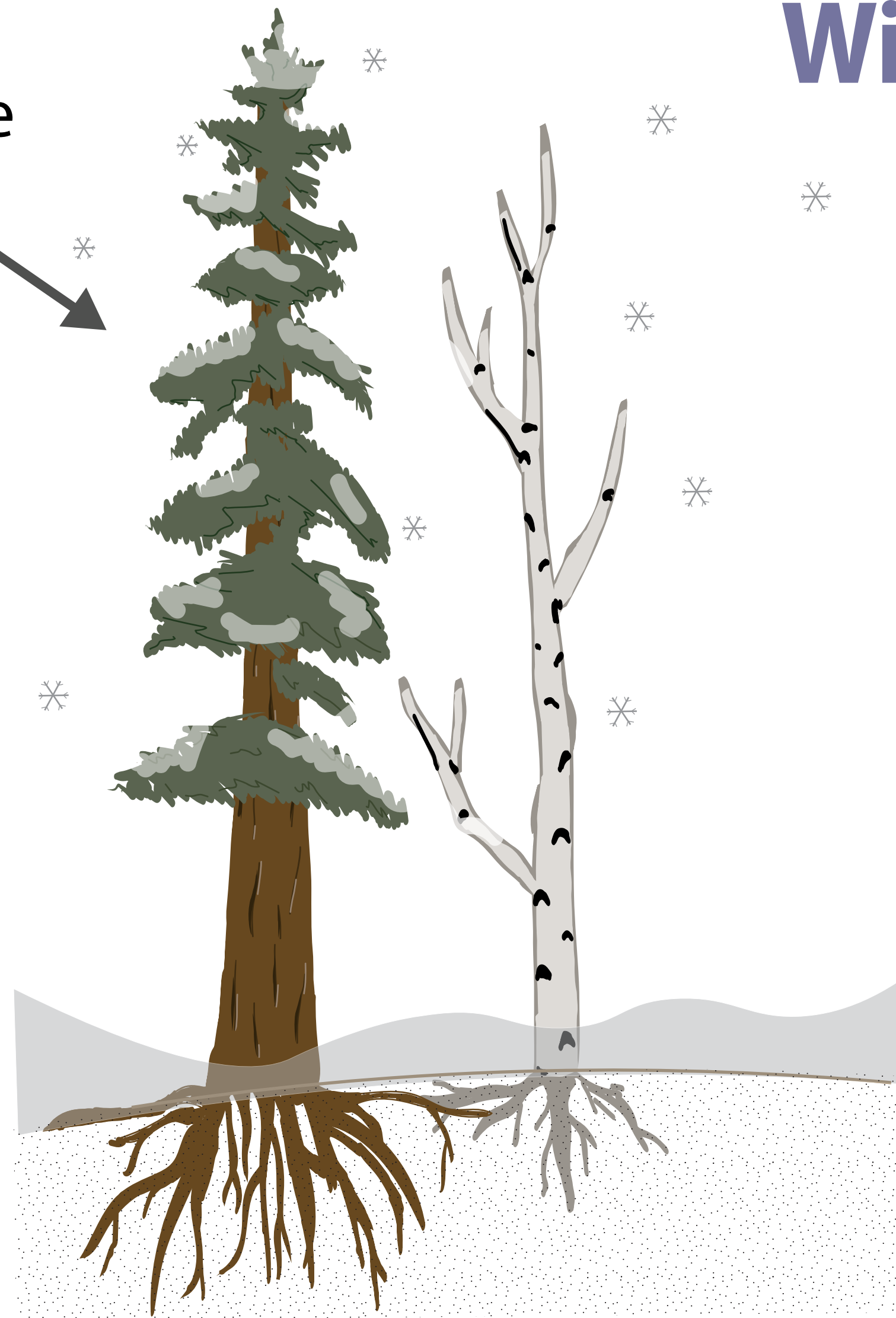
Winter



How forests impact hydrology

As snow falls, it is **intercepted** by tree branches

Winter



How forests impact hydrology

As snow falls, it is **intercepted** by tree branches

This is important because...

1. Intercepted snow is more likely to be returned to the atmosphere through **sublimation**.



How forests impact hydrology

As snow falls, it is **intercepted** by tree branches

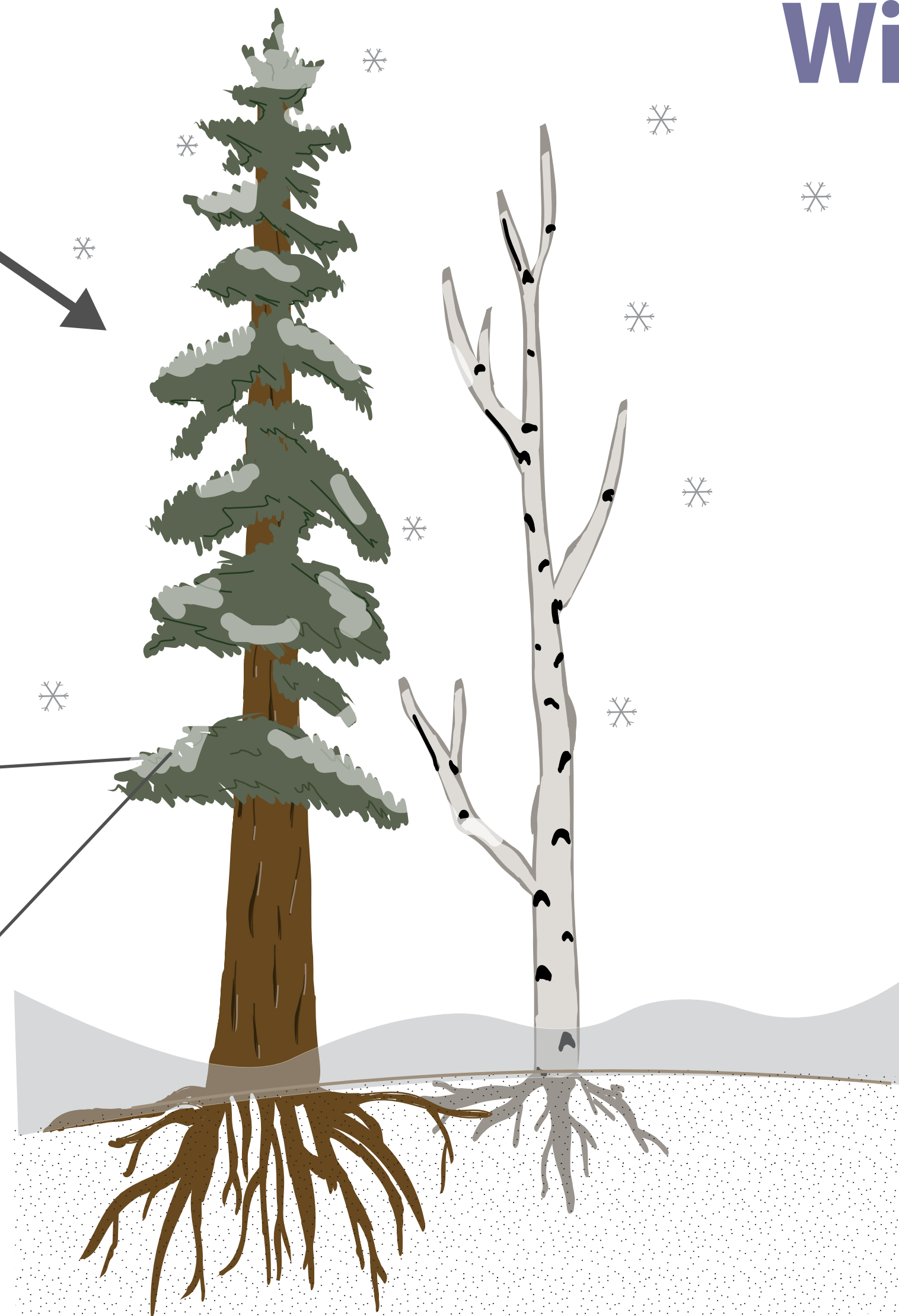
This is important because...

1. Intercepted snow is more likely to be returned to the atmosphere through **sublimation**.



20-40% of the annual snowfall can be sublimated

Winter



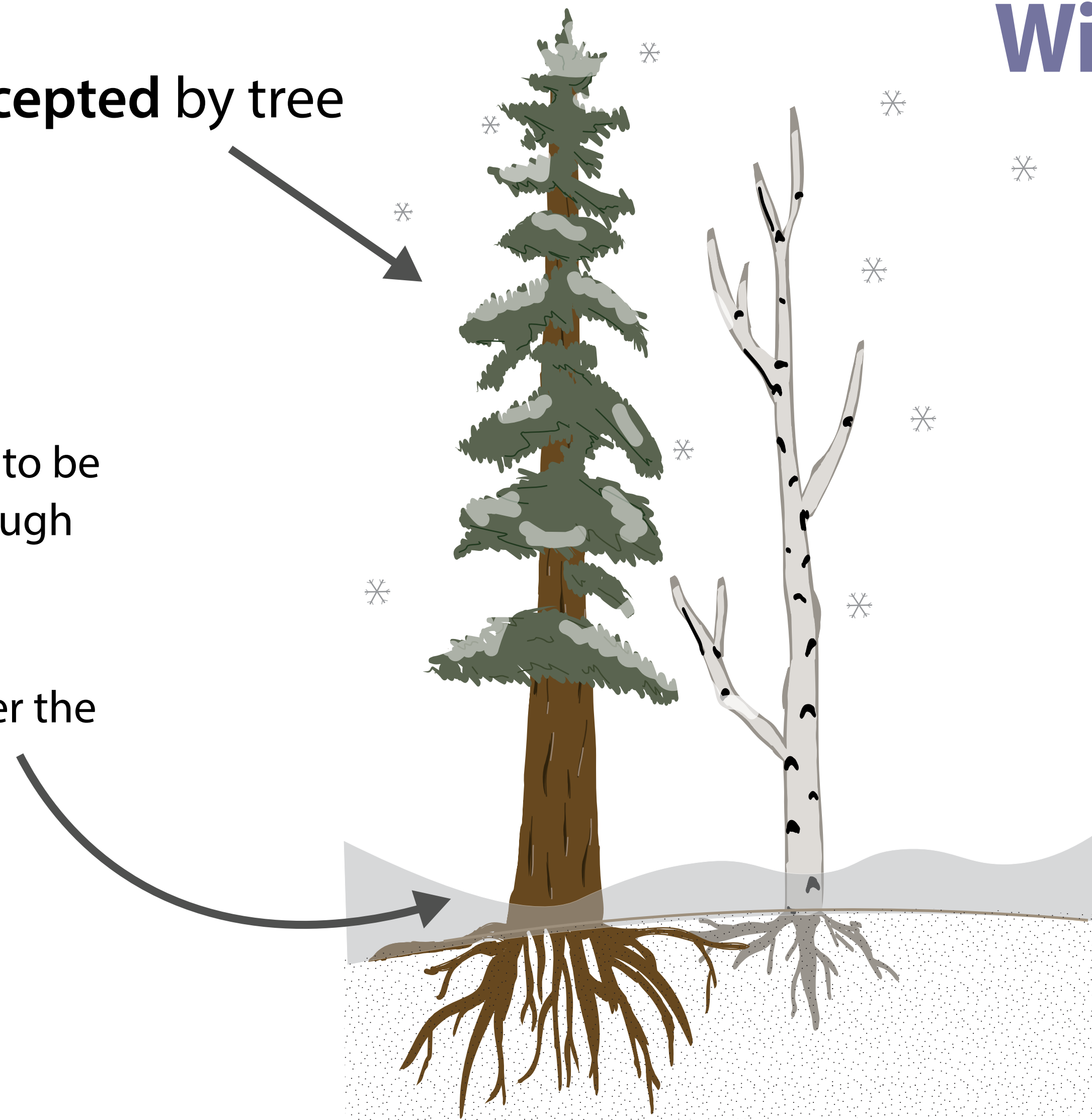
How forests impact hydrology

Winter

As snow falls, it is **intercepted** by tree branches

This is important because...

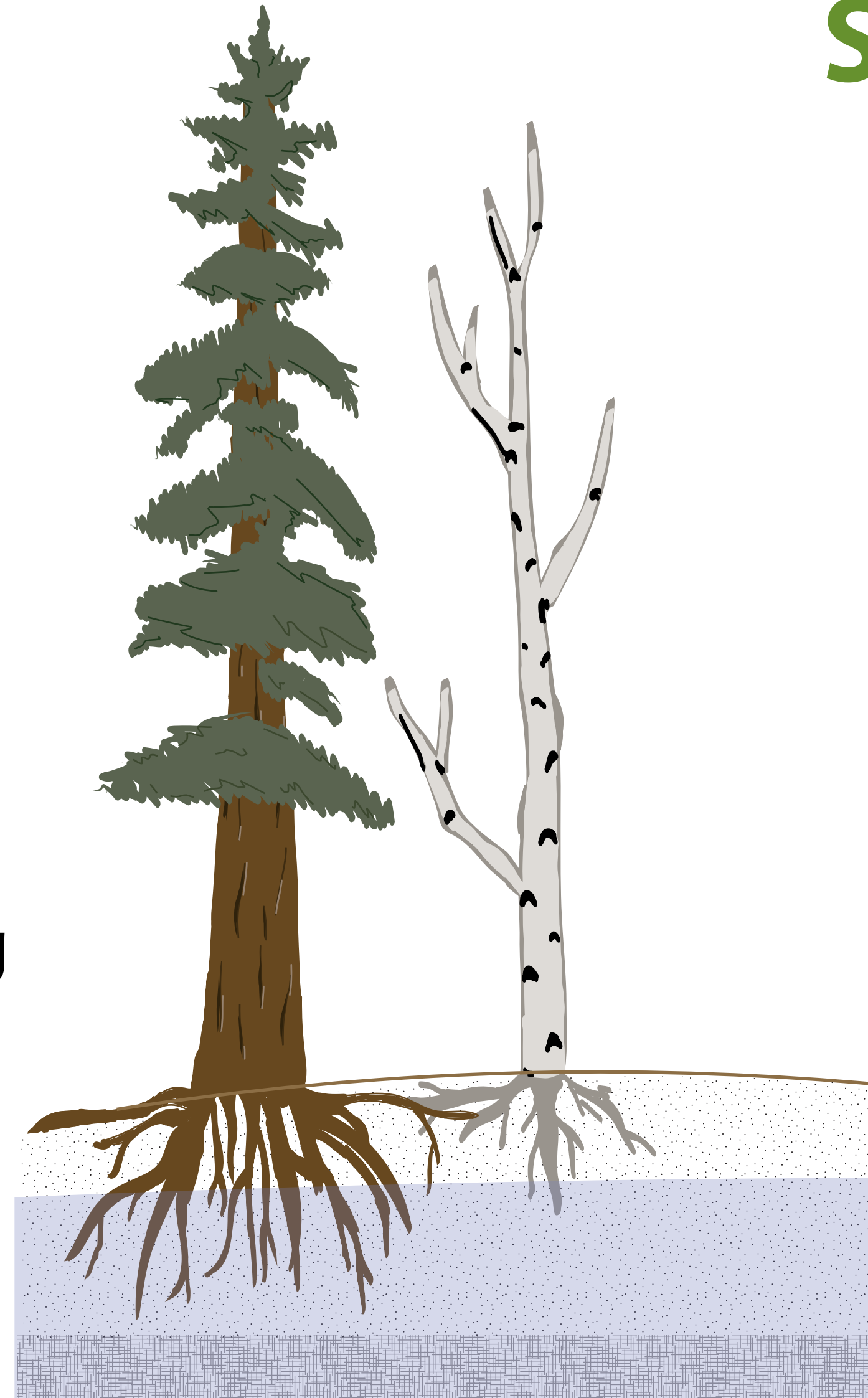
1. Intercepted snow is more likely to be returned to the atmosphere through **sublimation**.
2. Less snow will accumulate under the forest canopy



How forests impact hydrology

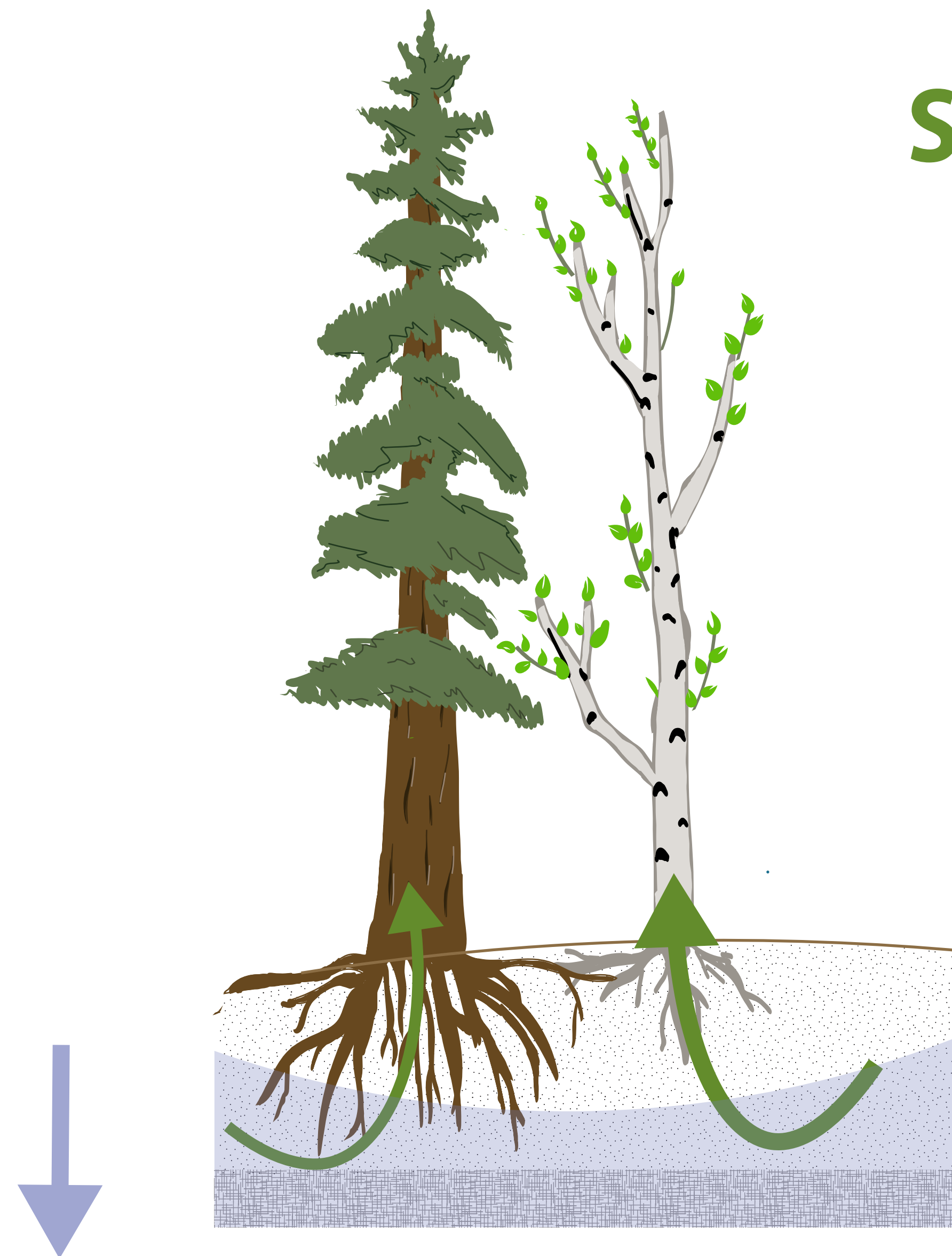
Spring

snowmelt
seeps into the
ground, replenishing
soil moisture



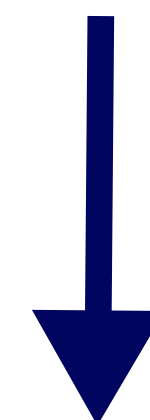
How forests impact hydrology

Spring



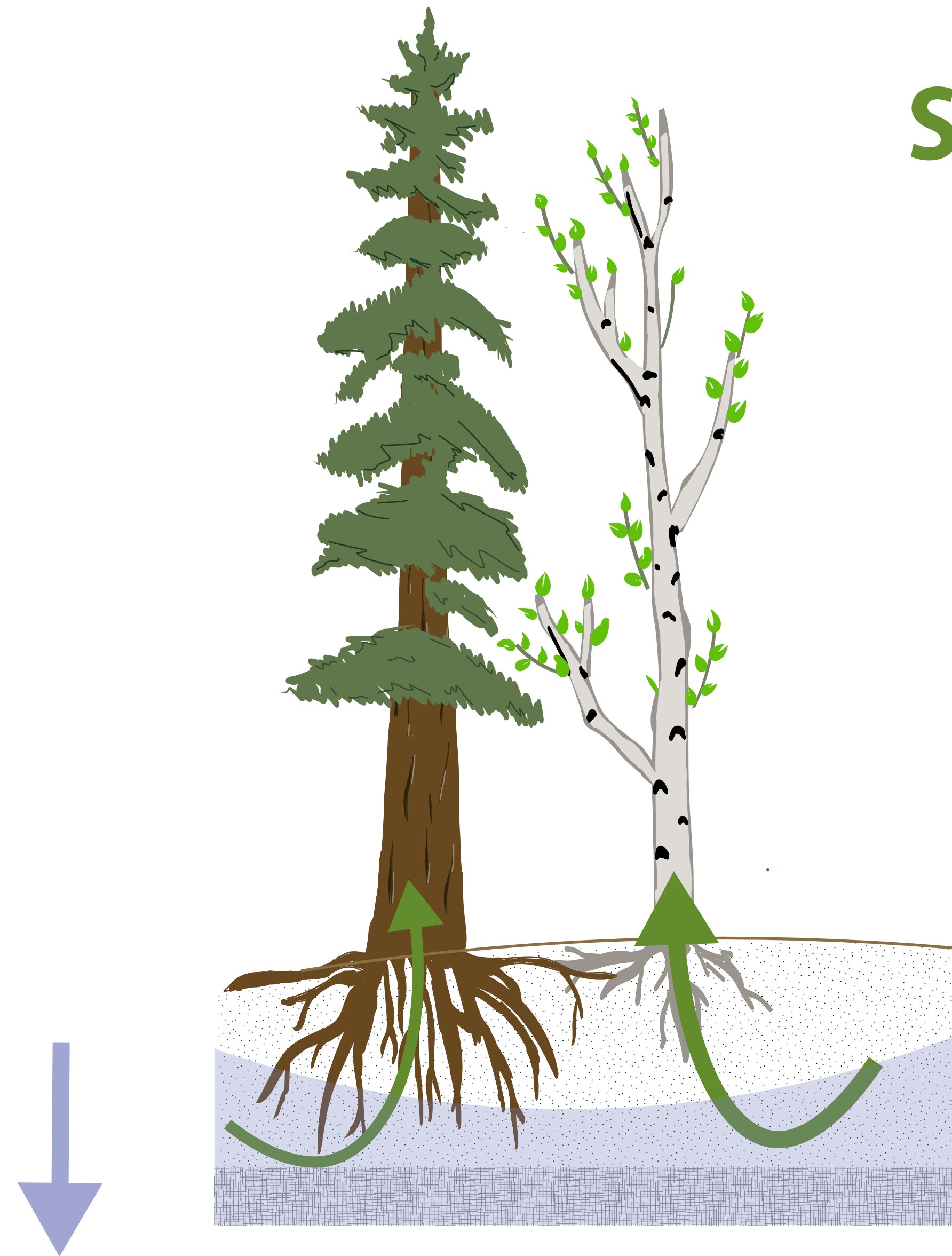
Plants begin taking up water

Snowmelt not taken up by plants produces streamflow and recharges groundwater



How forests impact hydrology

Spring

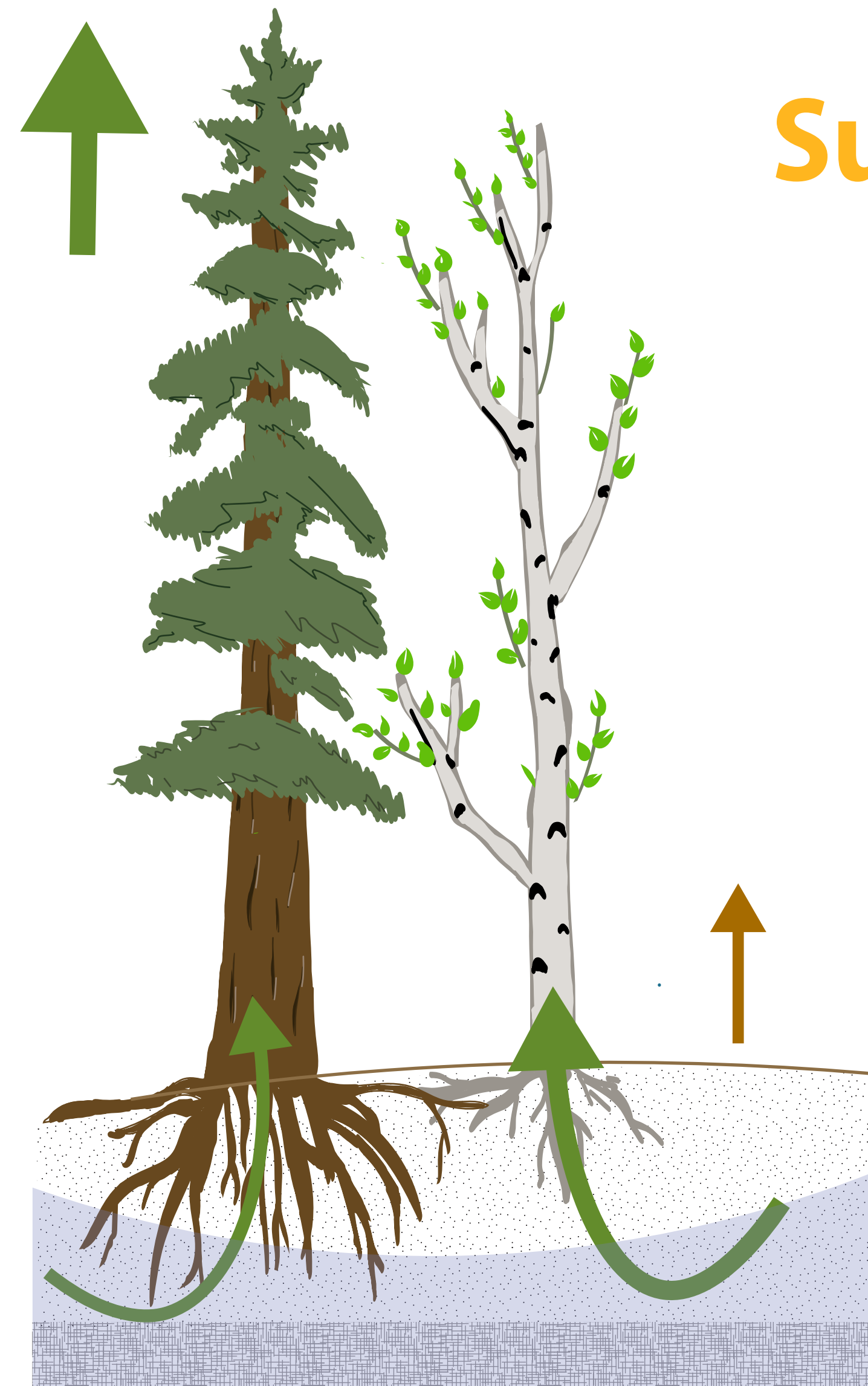


Snowmelt not taken by plants
produces streamflow and
recharges groundwater

This is determined by
spring temperatures, snow
melt rates, and timing of
growing season

How forests impact hydrology

Plants return water to the atmosphere via **transpiration** (greater in forests)



Summer

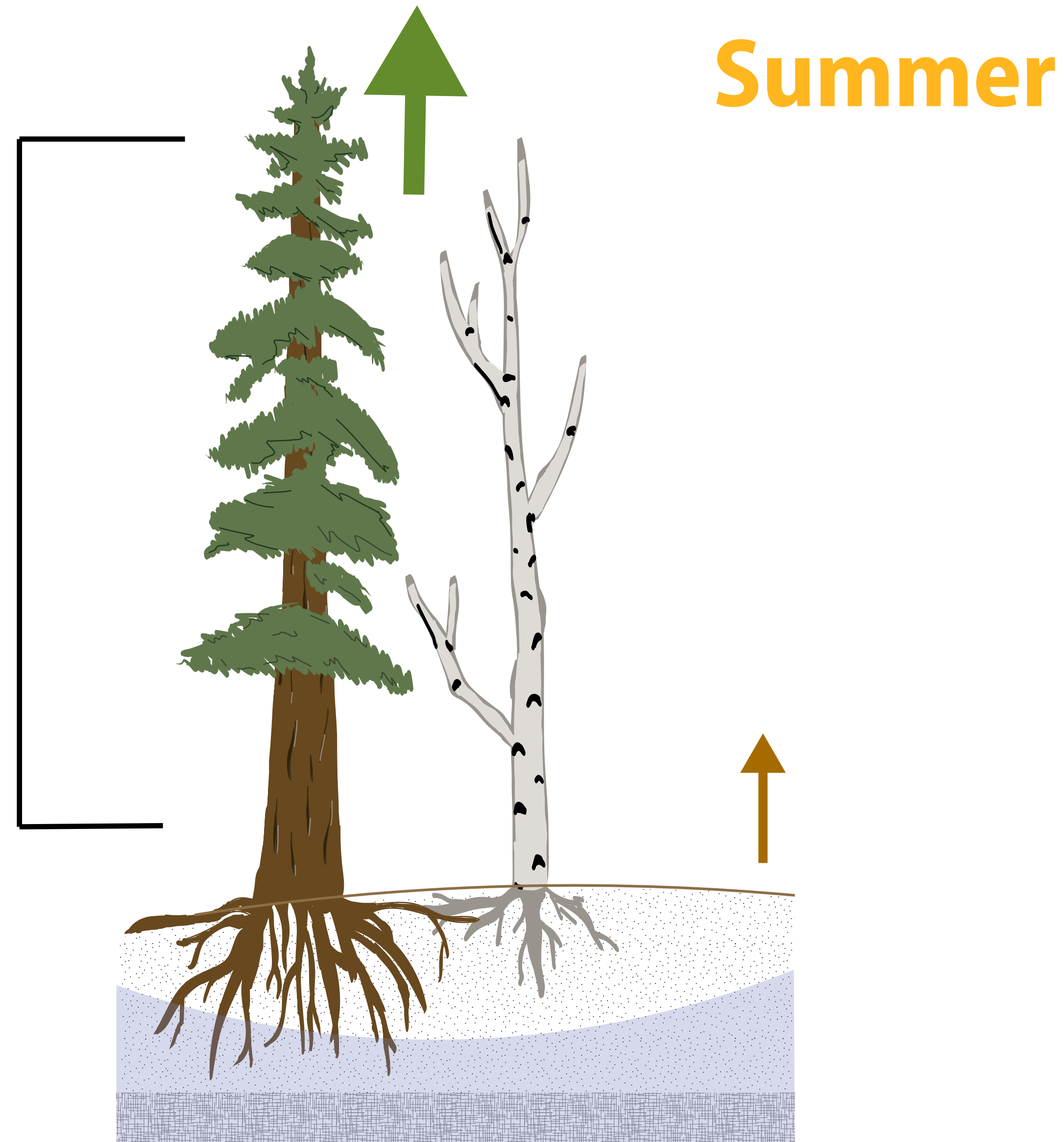
And water **evaporates** directly from the soil (less in forests)

How forests impact hydrology

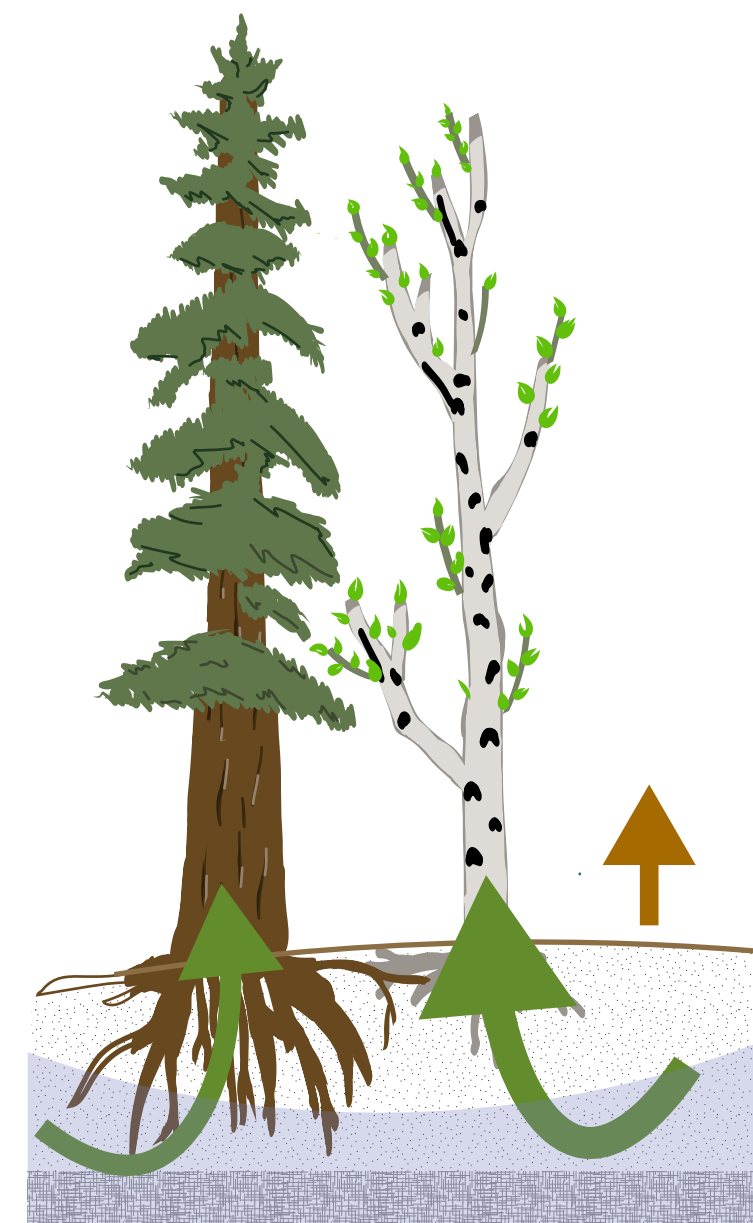
Evapotranspiration (ET)

75% Transpiration

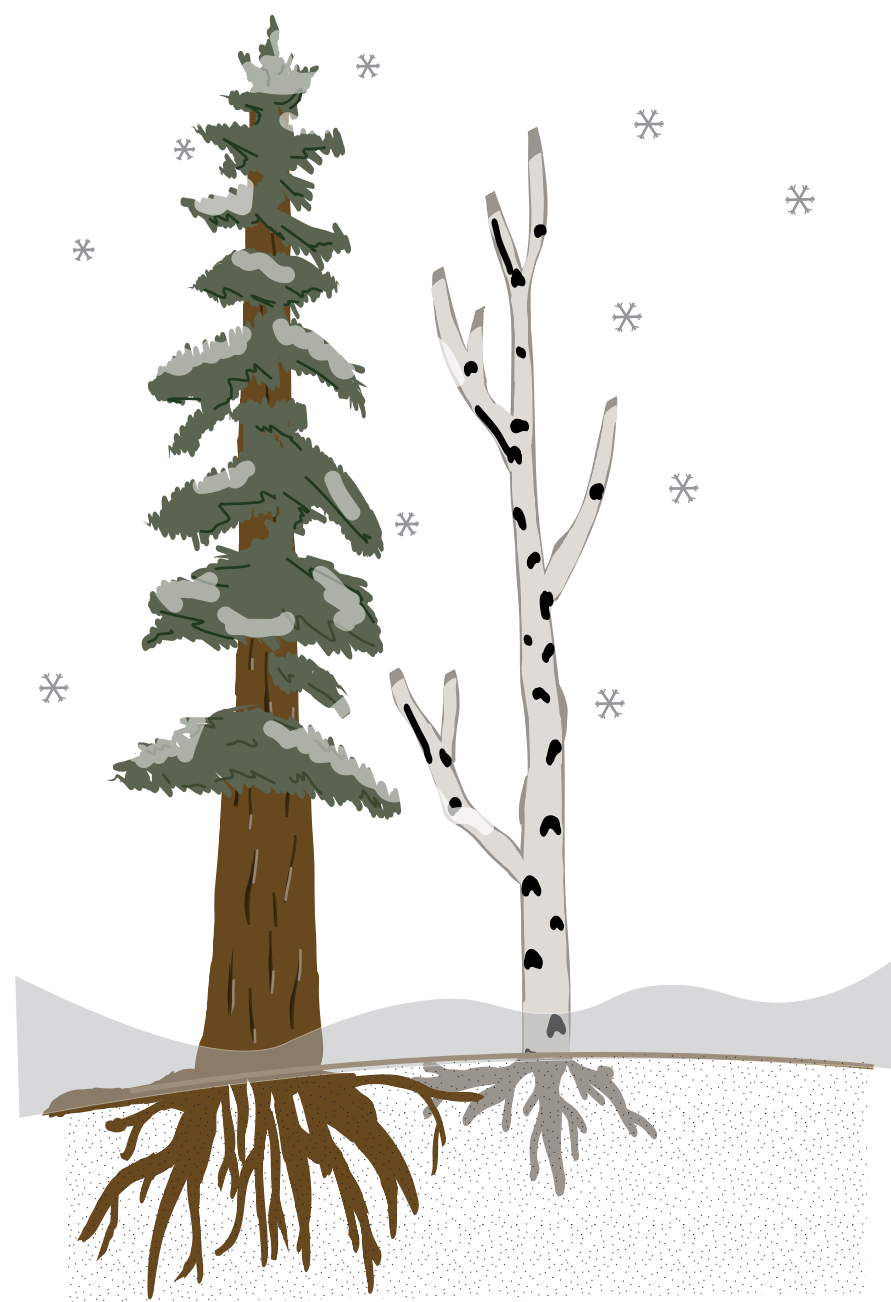
25% Evaporation



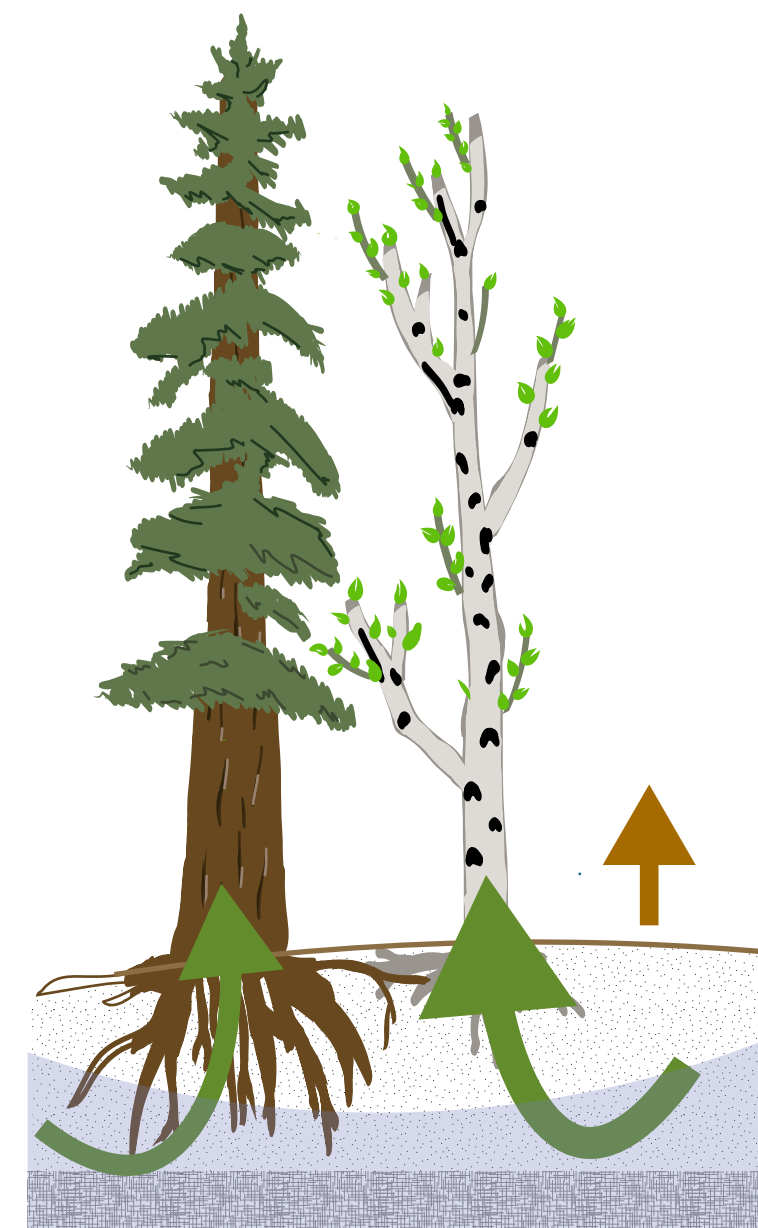
How do forests impact hydrology?



How do forests impact hydrology?

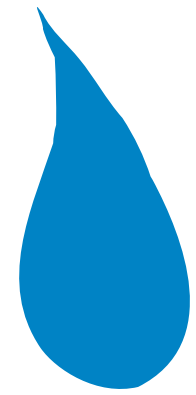


forests impact how
snow accumulates,
sublimates, and melts



forests influence
evapotranspiration
losses

'Recipe' for Transpiration



+



+

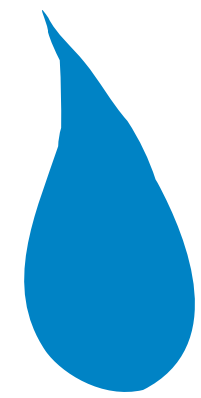


Plant available
water

Temperature/Climate

Vegetation/Tree Cover

'Recipe' for Transpiration



+



+

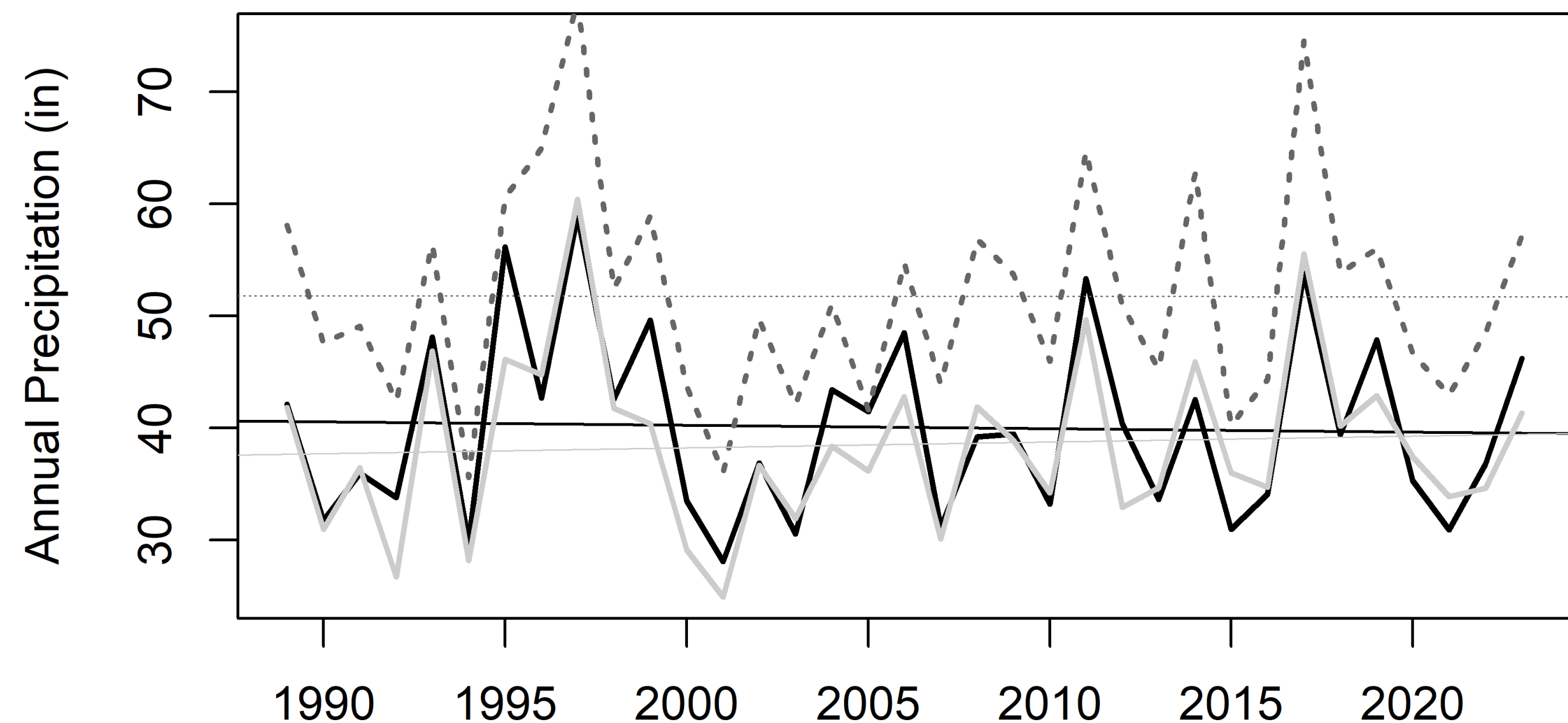


Plant available
water

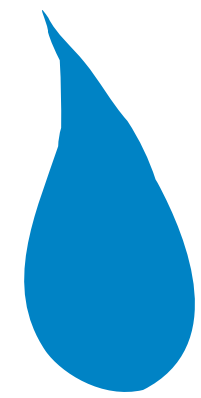
Temperature/Climate

Vegetation/Tree Cover

Annual precipitation has
not significantly changed
since 1989



'Recipe' for Transpiration



Plant available
water

+



Temperature/Climate

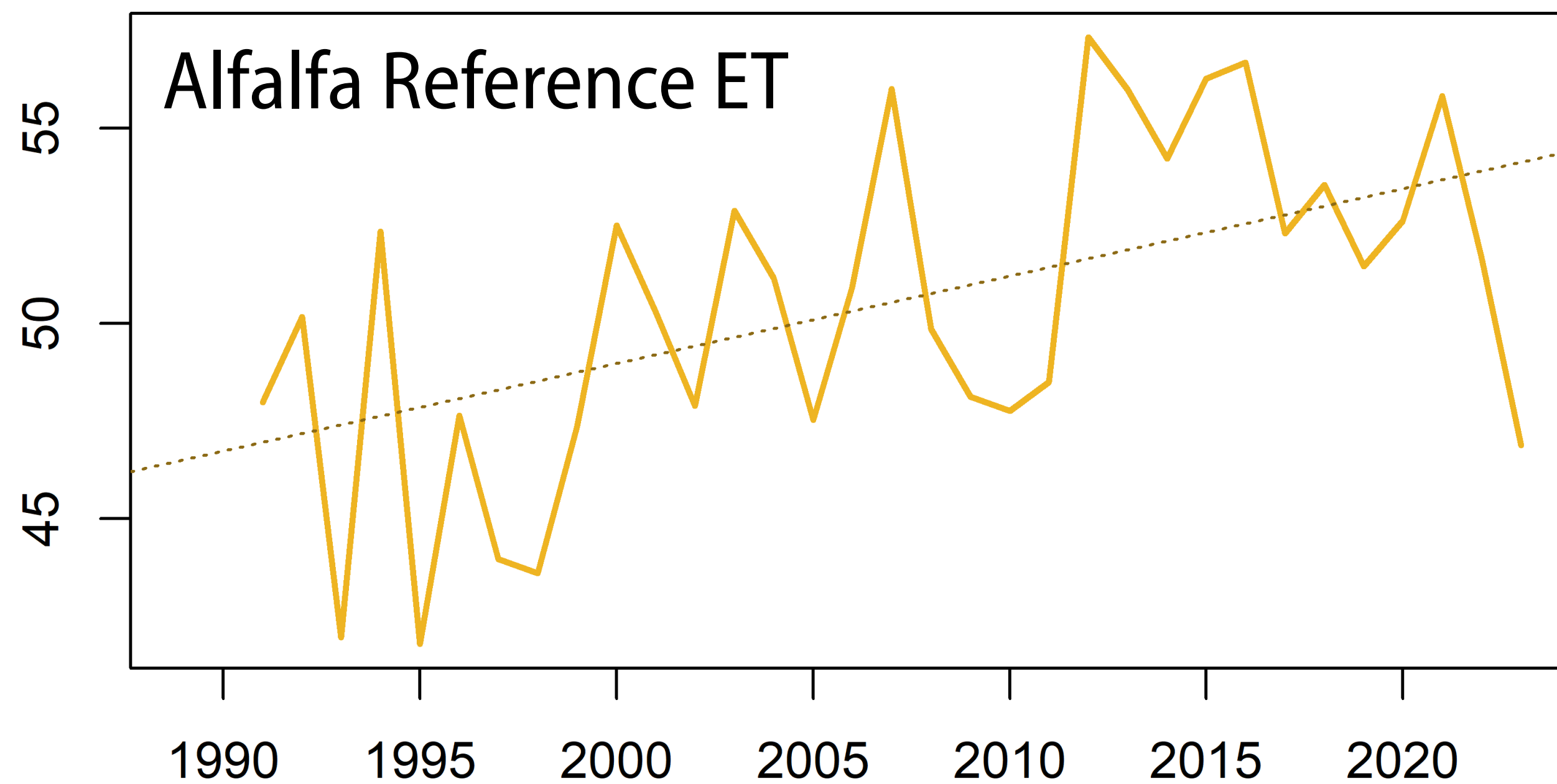
+



Vegetation/Tree Cover

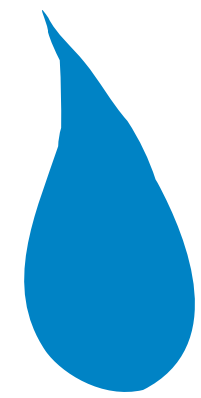
varies

Reference Evapotranspiration (in)



There is increasingly
more evaporative
demand.

'Recipe' for Transpiration



+



+



Plant available
water

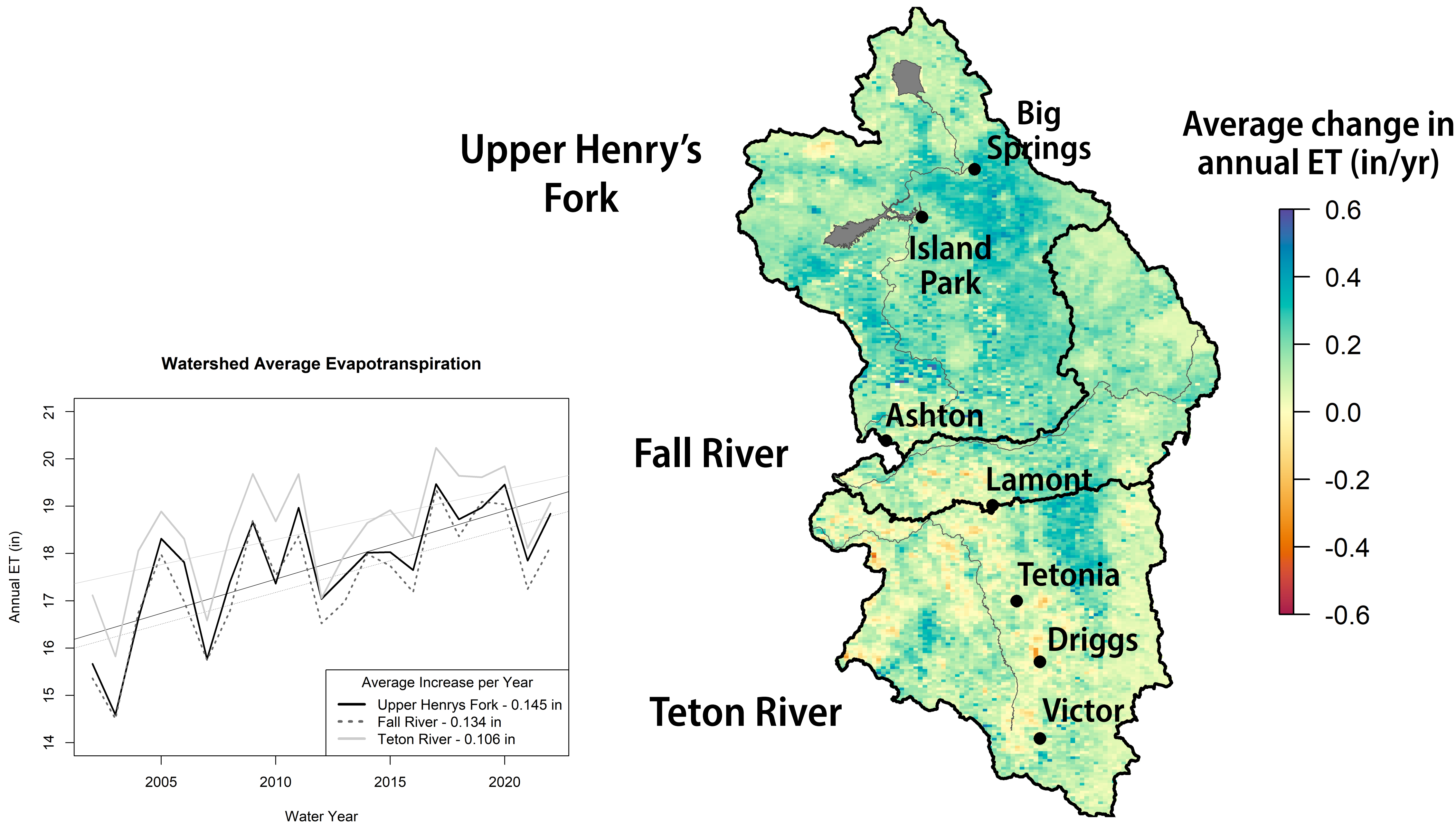
Temperature/Climate

Vegetation/Tree Cover

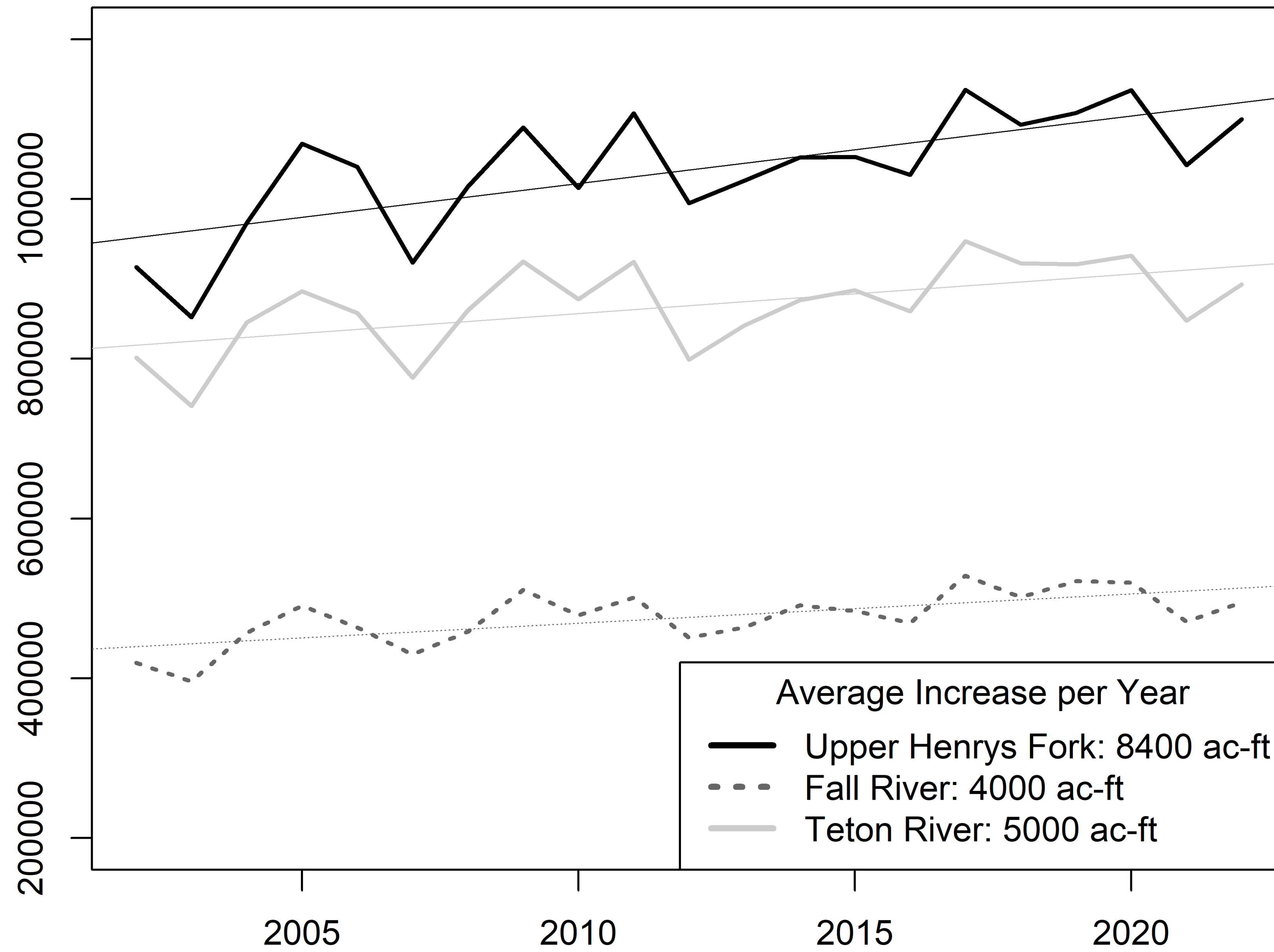
varies



Evapotranspiration has increased in all watersheds since 2002

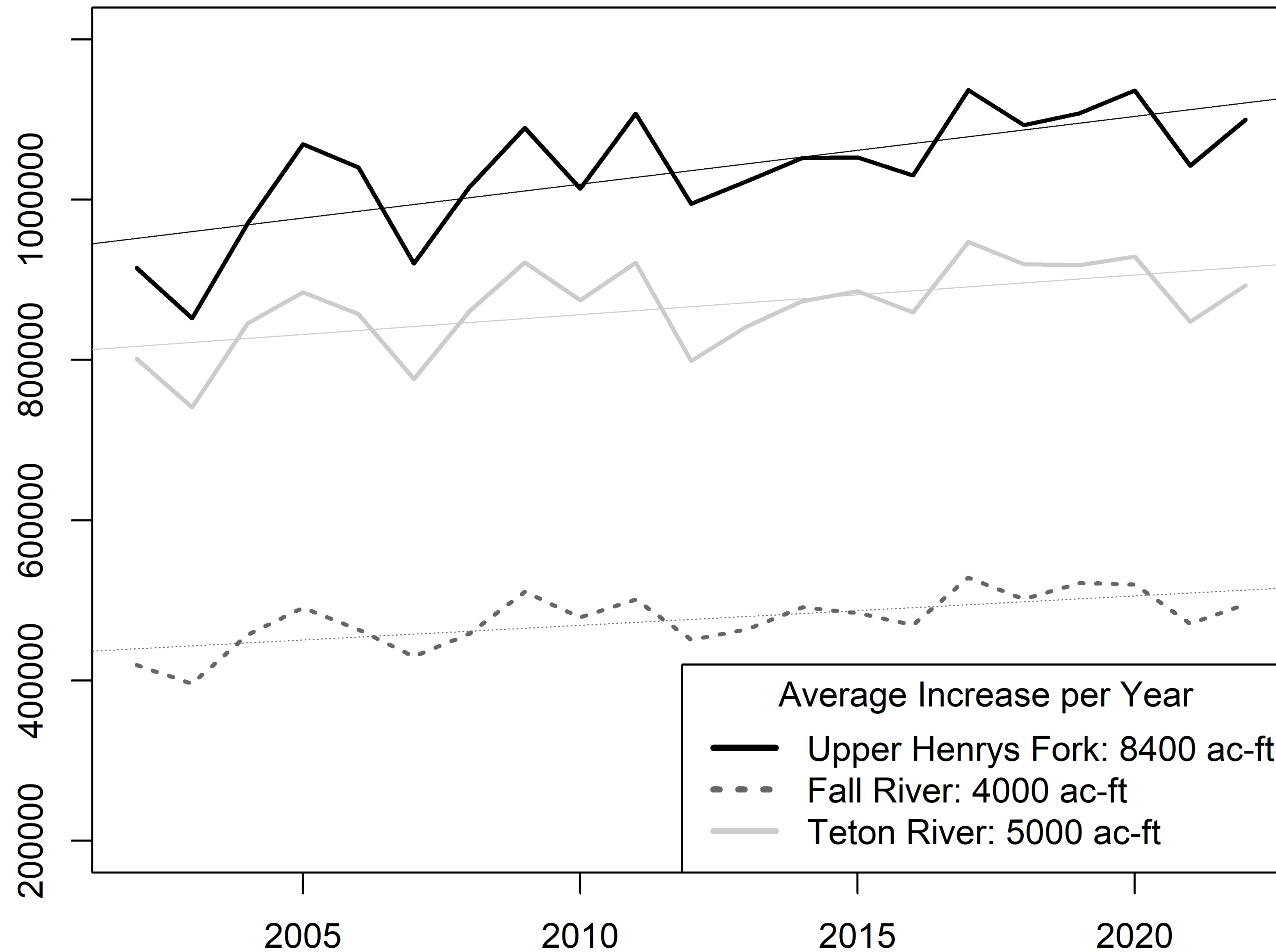


Average Watershed ET (ac-ft)

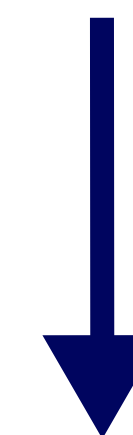


On average, ET is in increasing by 6-10k ac-ft a year in the Upper HF

Average Watershed ET (ac-ft)

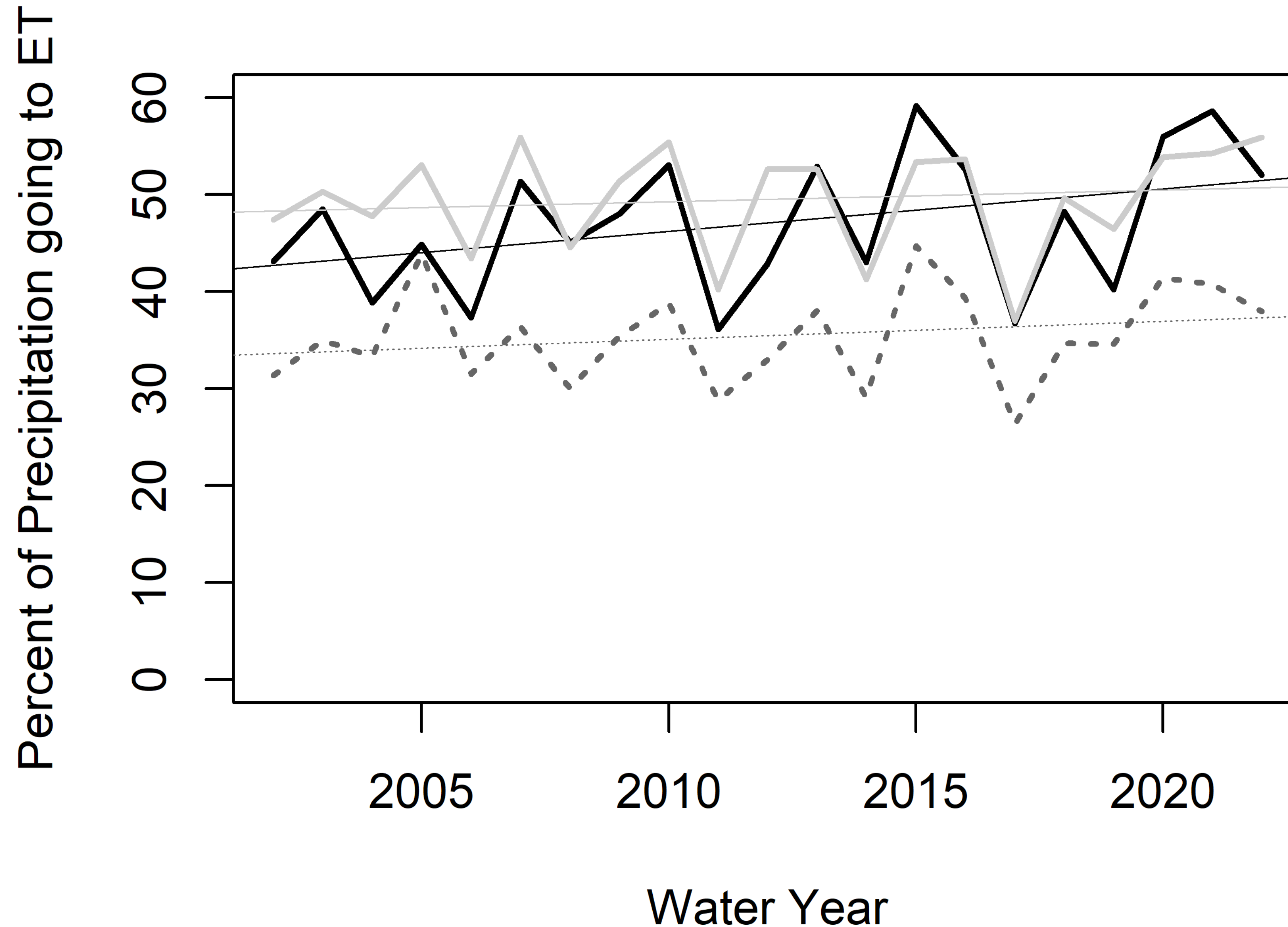


On average, ET is increasing by 6-10k ac-ft a year in the Upper HF

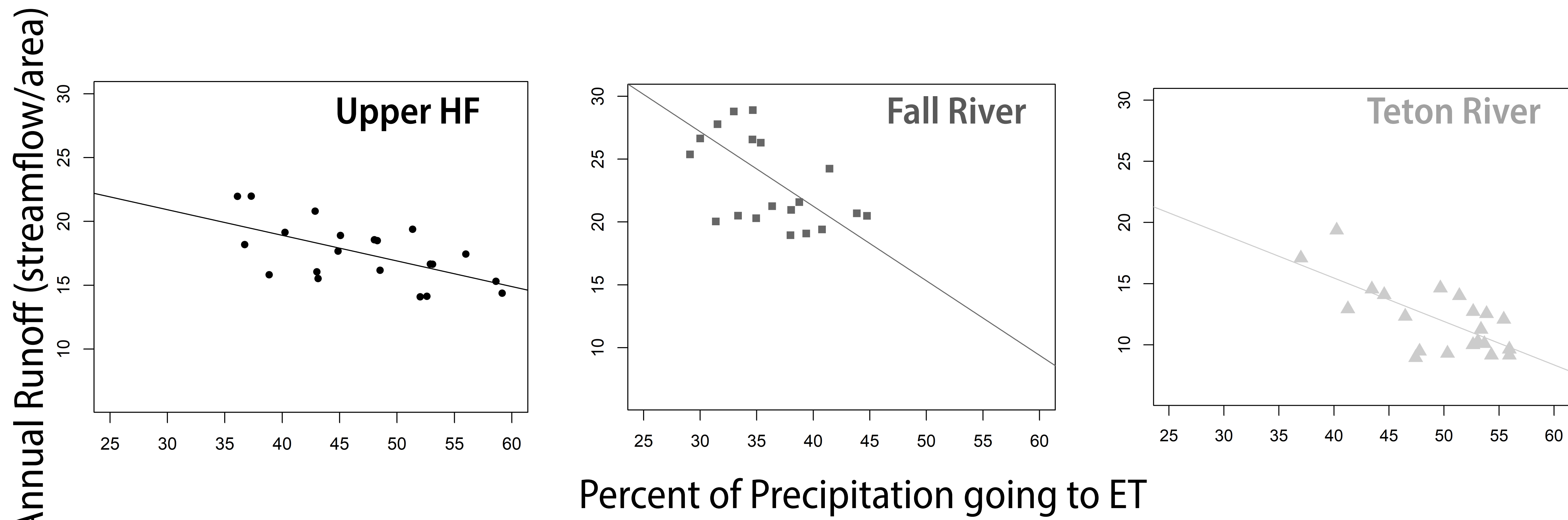


In 2022, ~160,000 more ac-ft of water was lost to ET than in 2002.

Since we haven't seen an increase in precipitation, this means
a larger portion of annual precipitation is lost to ET



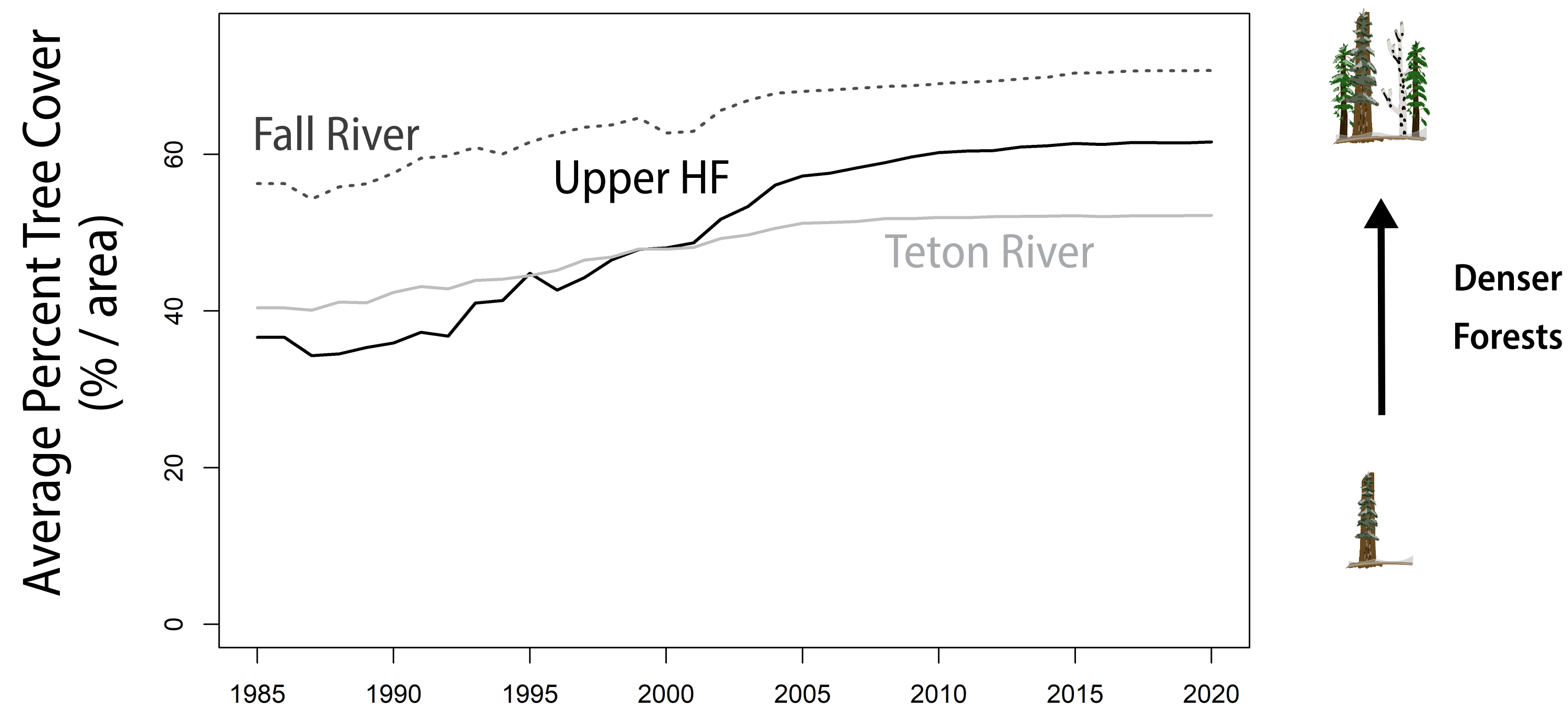
Annual watershed yield decreases as more precipitation goes towards ET



Why are we seeing more significant declines in Upper HF than Fall or Teton River?

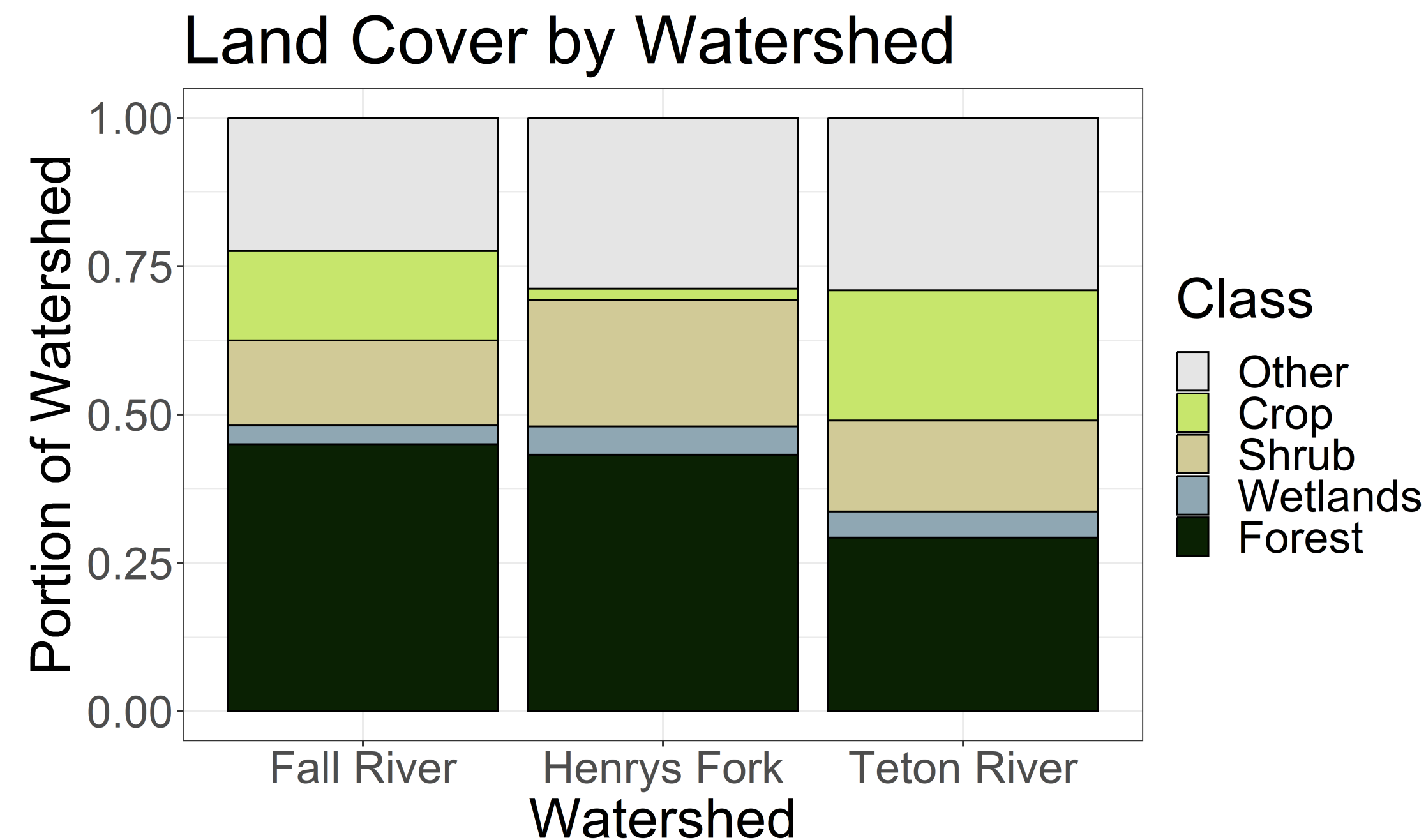
Why are we seeing more significant declines in Upper HF than Fall or Teton River?

1. Larger increase in tree cover



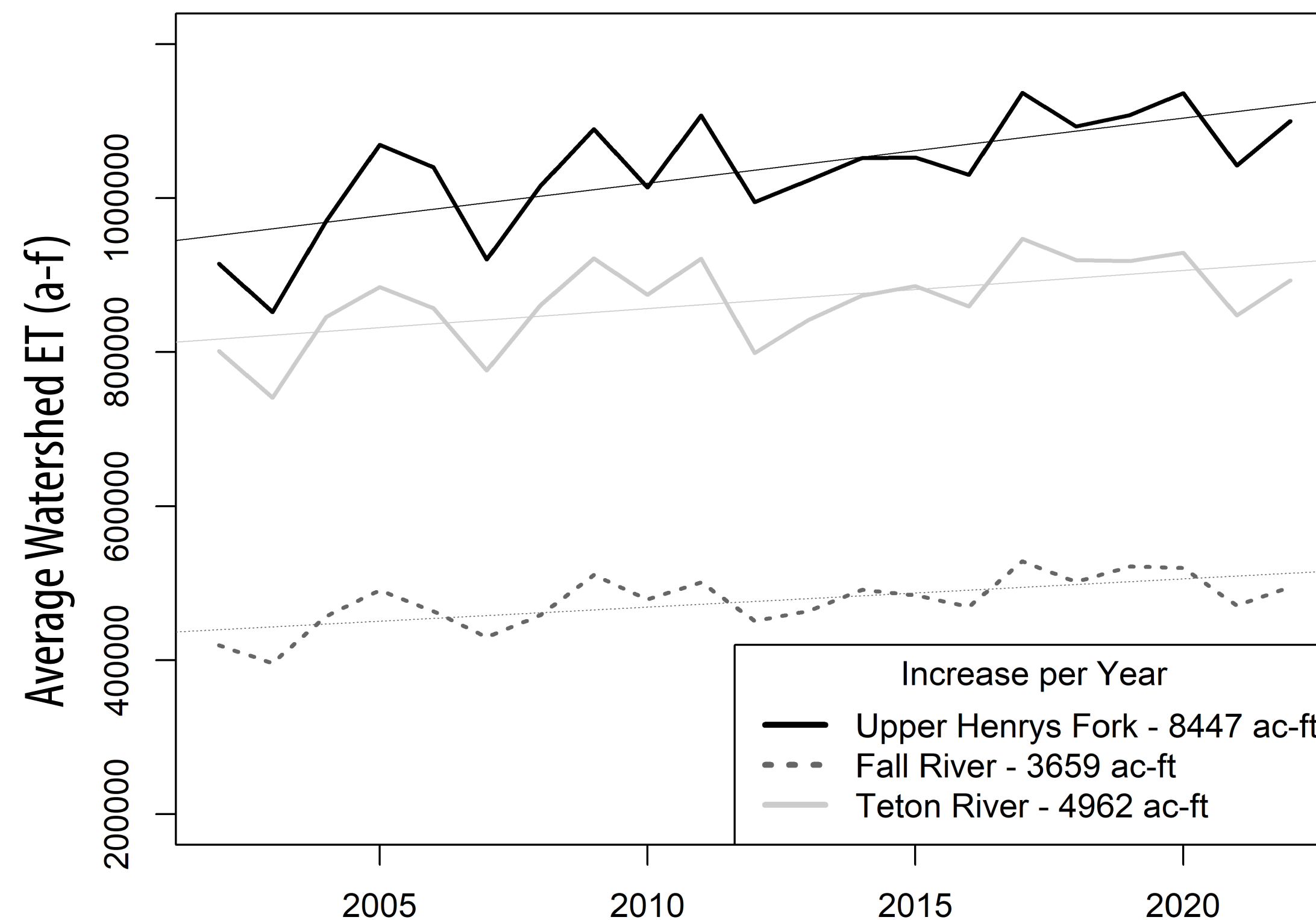
Why are we seeing more significant declines in Upper HF than Fall or Teton River?

1. Larger increase in tree cover
2. More acres of forested land (at lower elevations)



Why are we seeing more significant declines in Upper HF than Fall or Teton River?

1. Larger increase in tree cover
2. More acres of forested land (at lower elevations)
3. Greater annual ET losses



What can we do?

1. Collect data needed to calculate and model sublimation and ET.
2. Refine predictive models by accounting for changes in vegetation.
3. Forest management informed by best available science.

Questions?



contact: sarahnewcomb@isu.edu