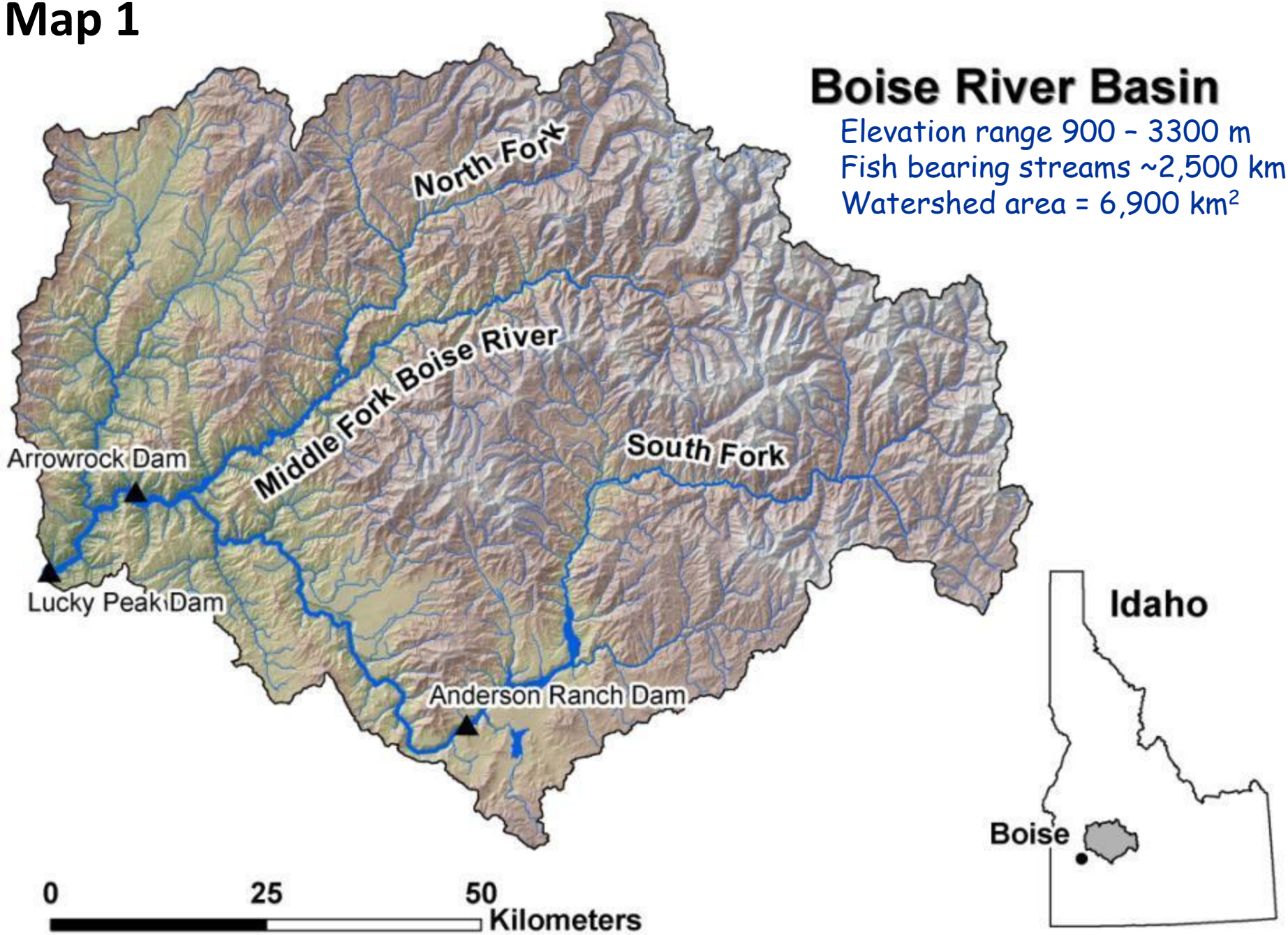
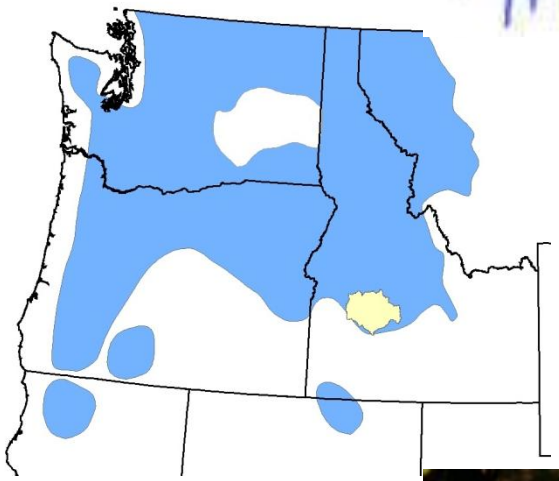
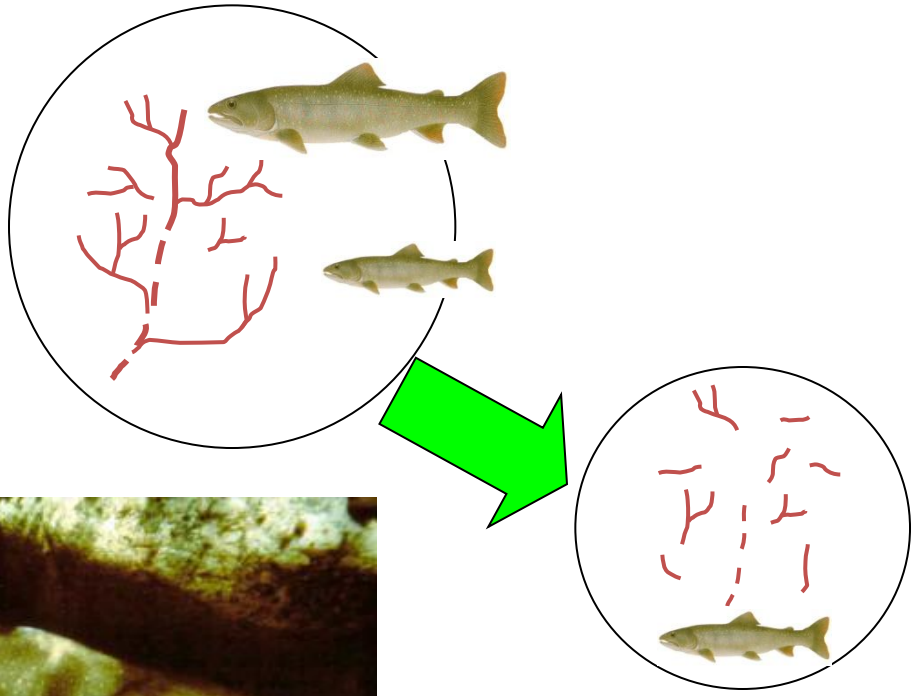
Map 1

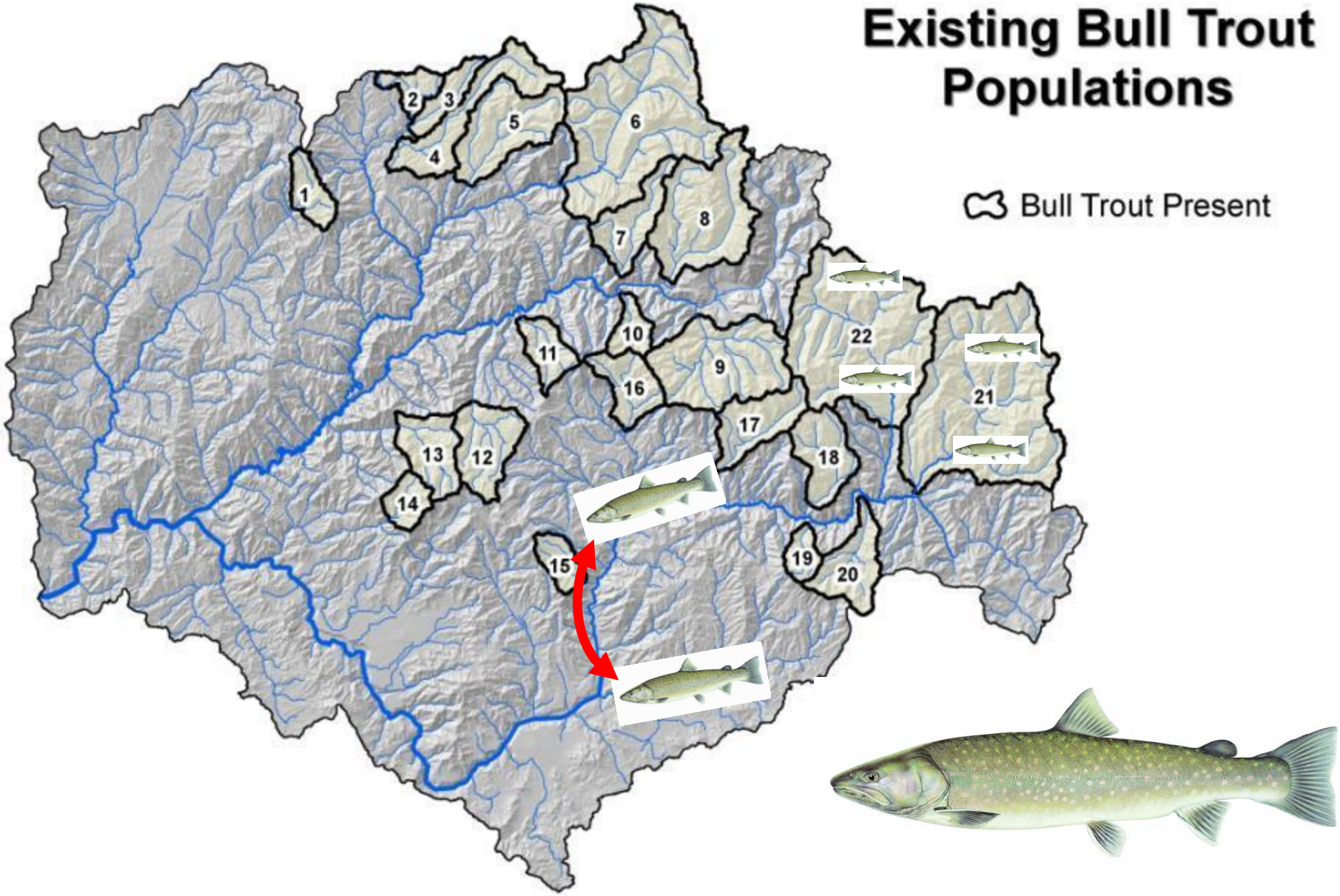

Boise River Basin
Elevation range 900 – 3300 m
Fish bearing streams ~2,500 km
Watershed area = 6,900 km²
North Fork
Middle Fork Boise River
South Fork
Arrowrock Dam
Lucky Peak Dam
Anderson Ranch Dam
0
25
50
Kilometers
Idaho
Boise

Bull Trout as a Climate "Canary"





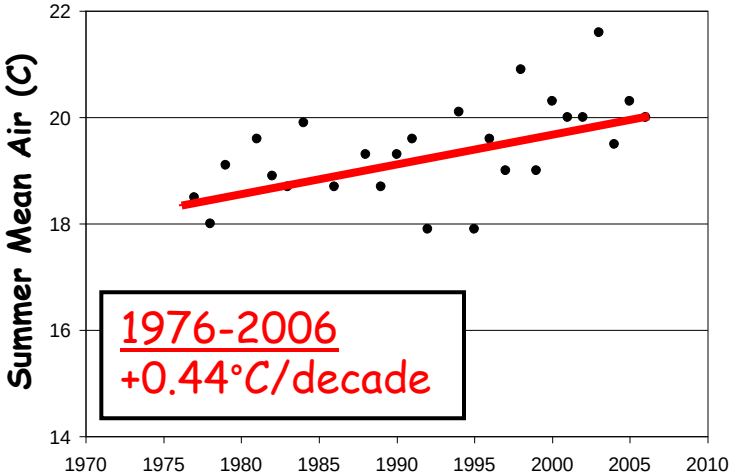
Map 2

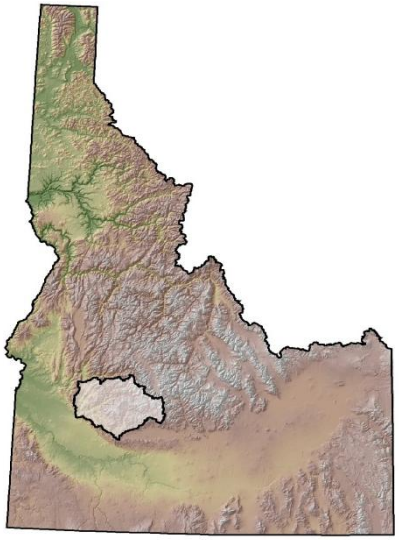


Bull Trout Populations - Watersheds currently occupied by locally reproducing populations of bull trout. Occurrence determined through extensive field sampling.

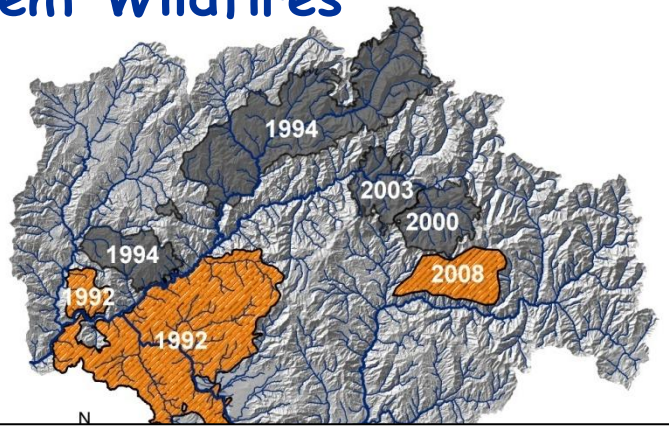
Environmental Trends in the Boise River Basin

Summer Air Temperature



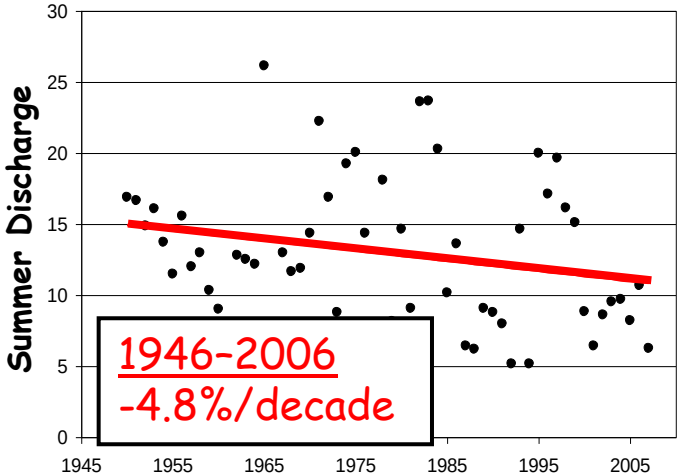


Recent Wildfires



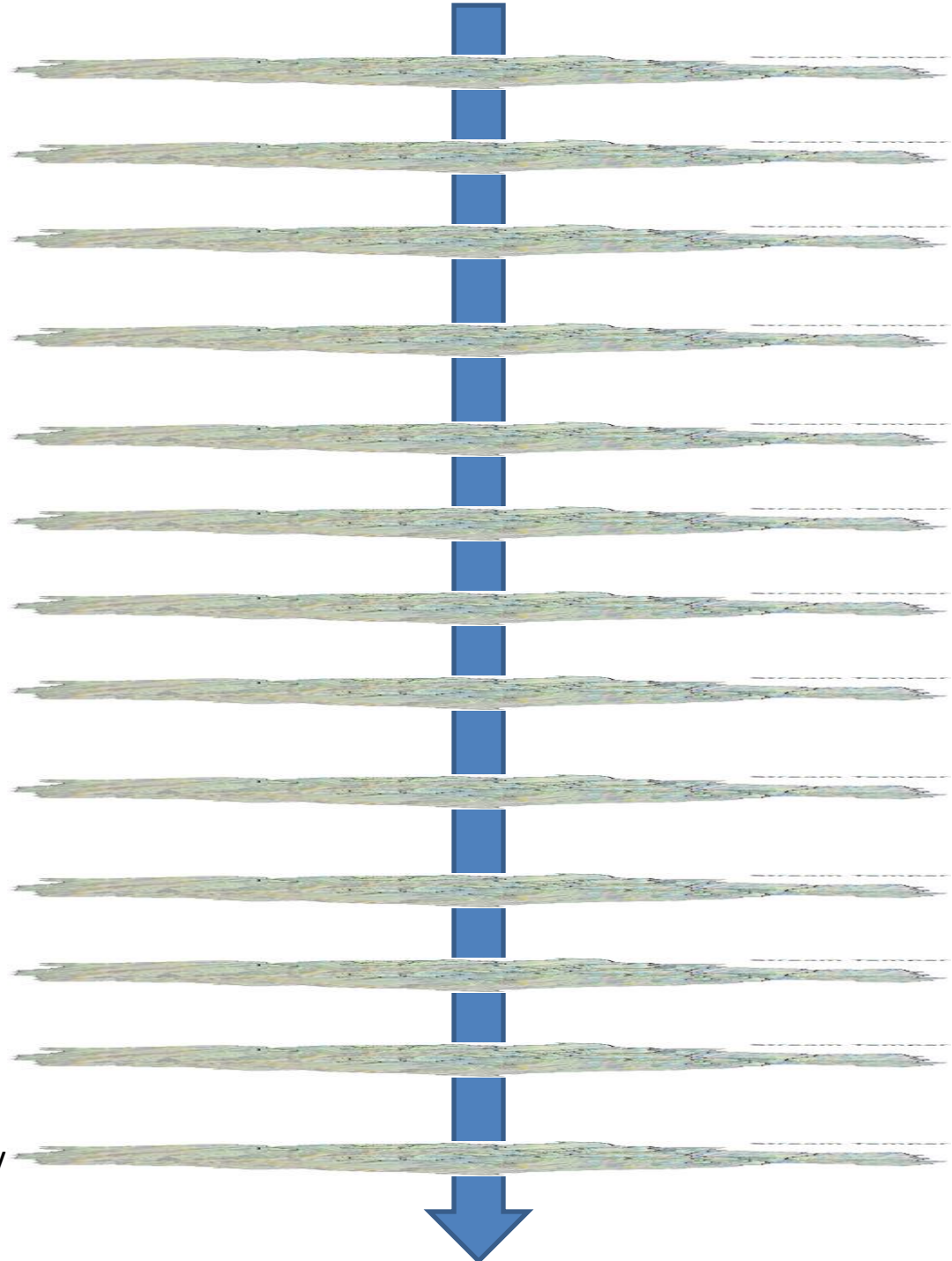
14% burned during 93–06 study period
30% burned from 92-08

Summer Stream Flow

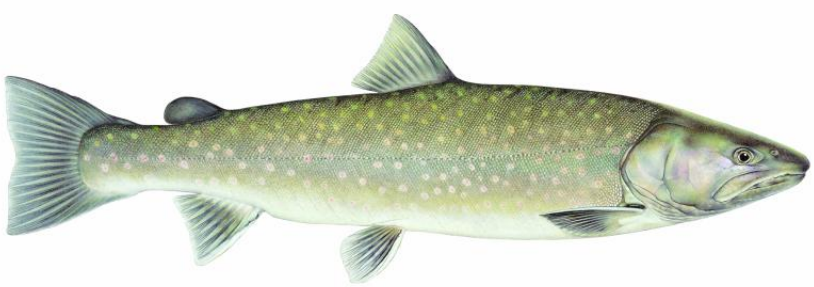


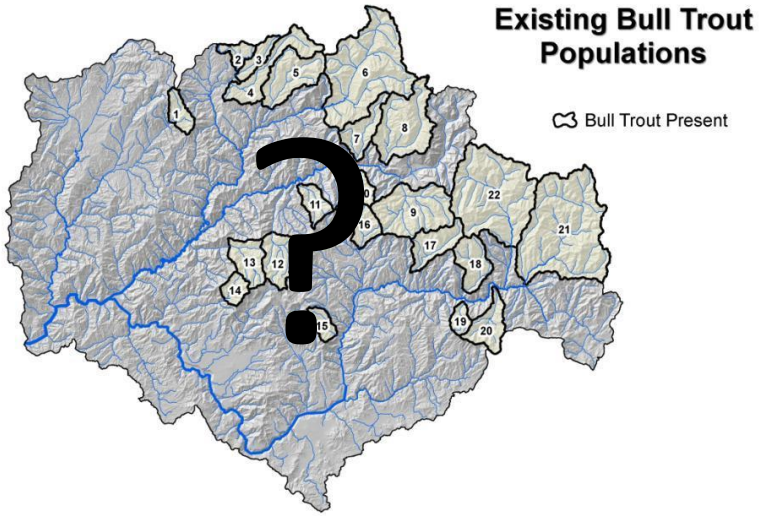
Spatial data layers

1) Boise Basin Topography
2) Land ownership
3) Roads
4) Fish barriers from road culverts
5) Recent wildfire perimeters
6) Crown fire potential
7) Stream gradient
8) Unconfined valley bottoms
9) Extant bull trout populations
10) Brook trout occurrence
11) Historic & future summer temperatures
12) Historic & future summer stream flow
13) Historic & future winter flood frequency

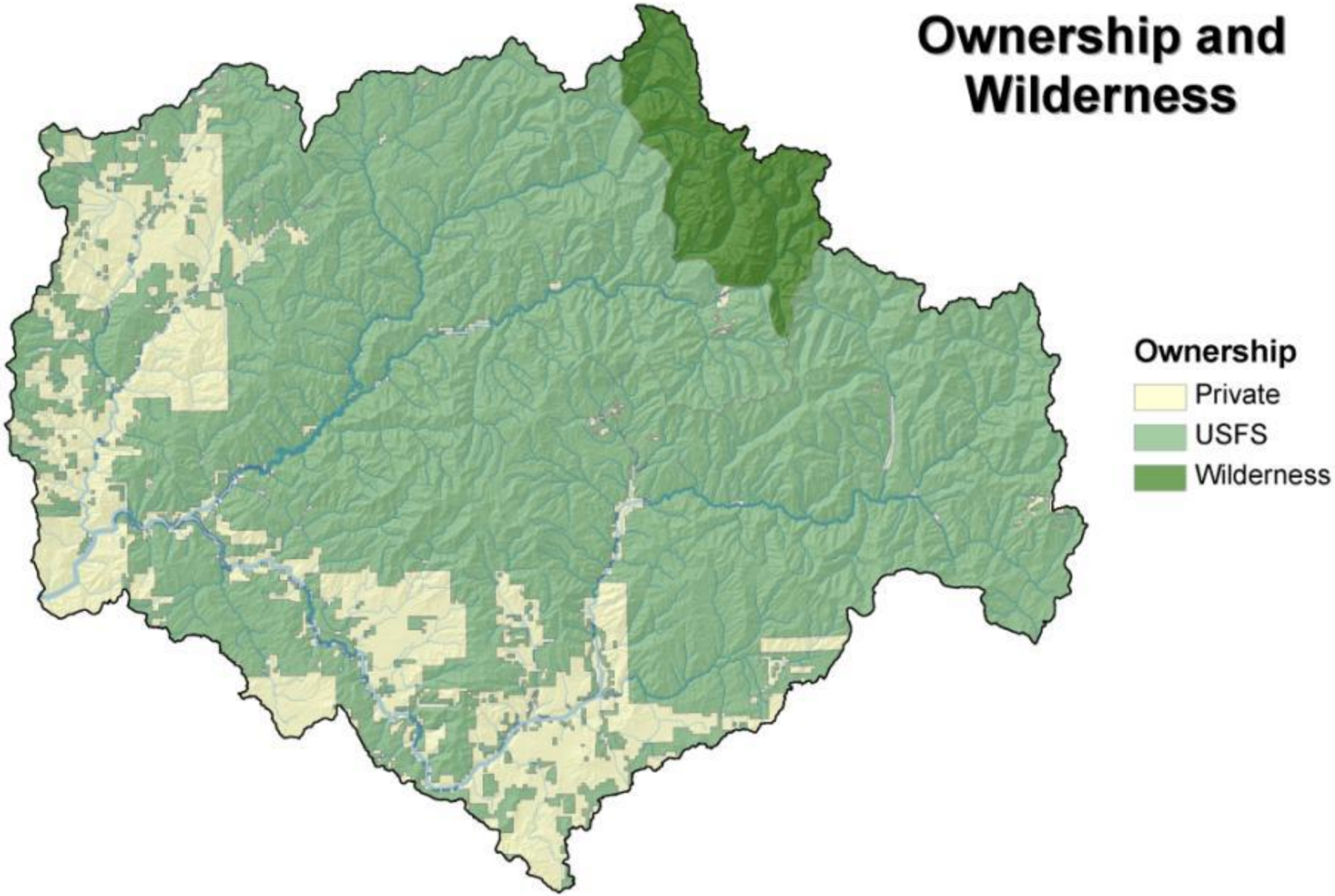


Day 1 task: Using the spatial data for the Boise, you will be asked to rank from 1 to 5 (1 = highest priority) the populations where your budget will be spent to help bull trout adapt to climate change and maximize their chances of long-term persistence in the Boise basin.



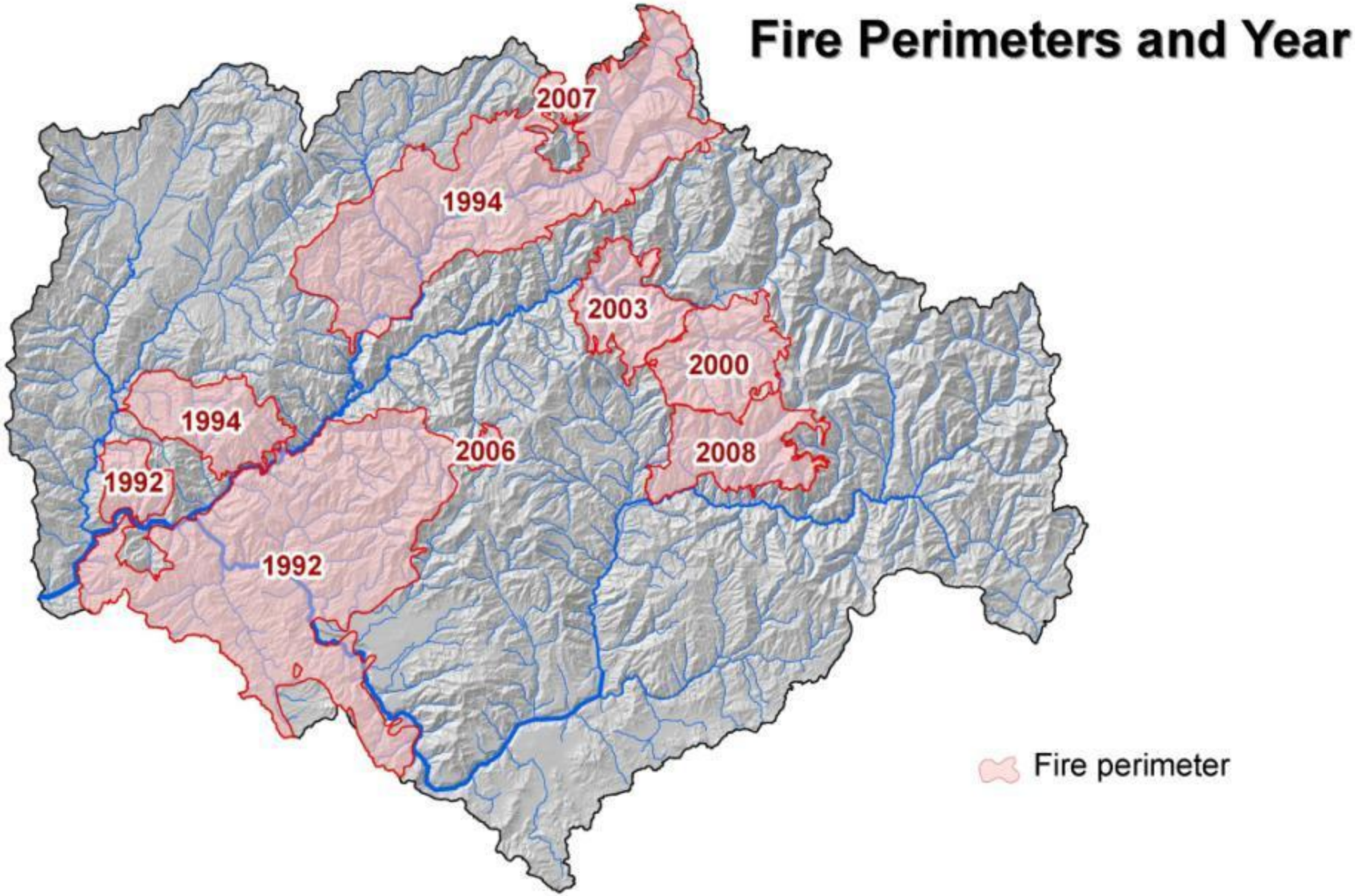


Map 3



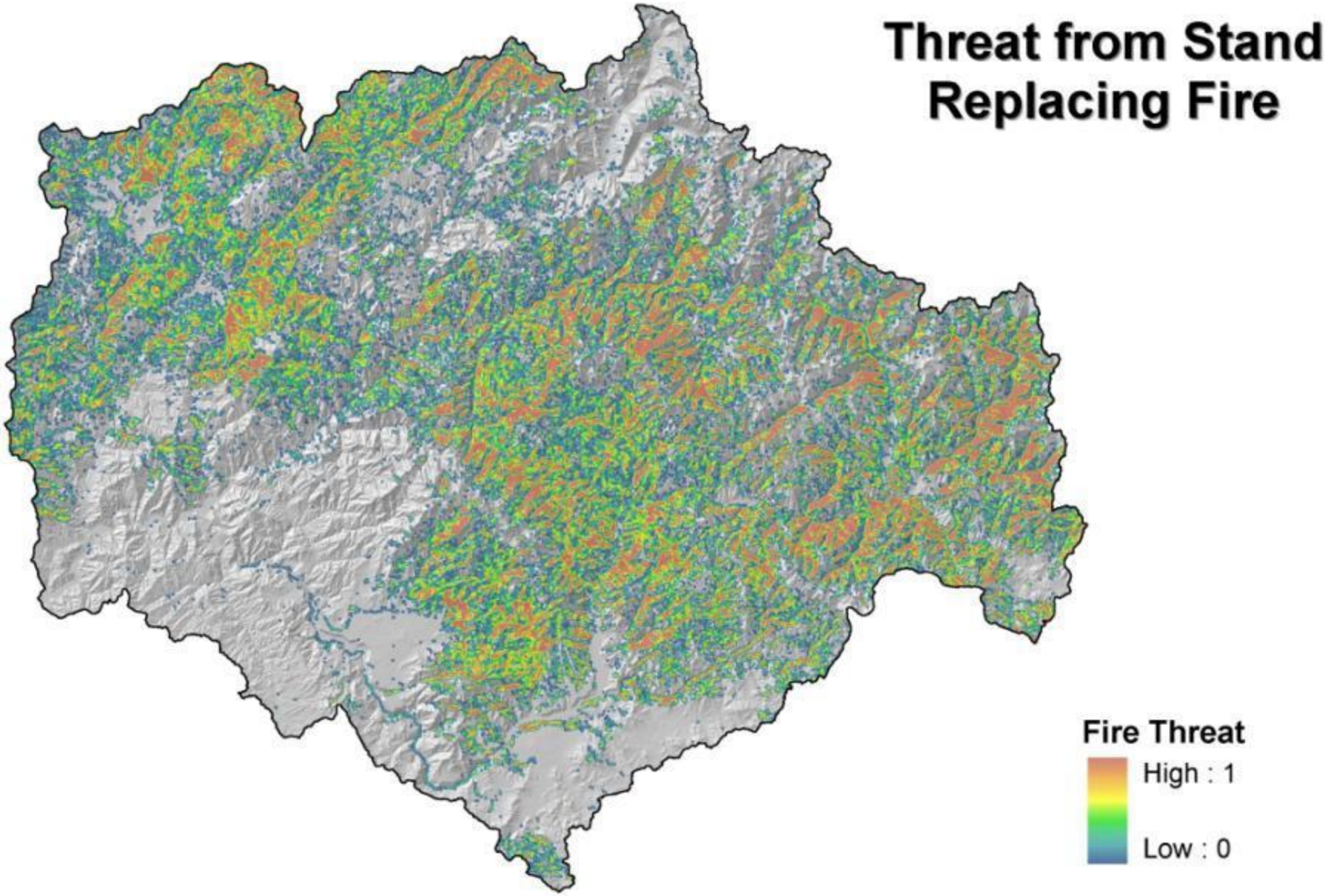
Ownership - Public and privately held land within the basin.

Map 4



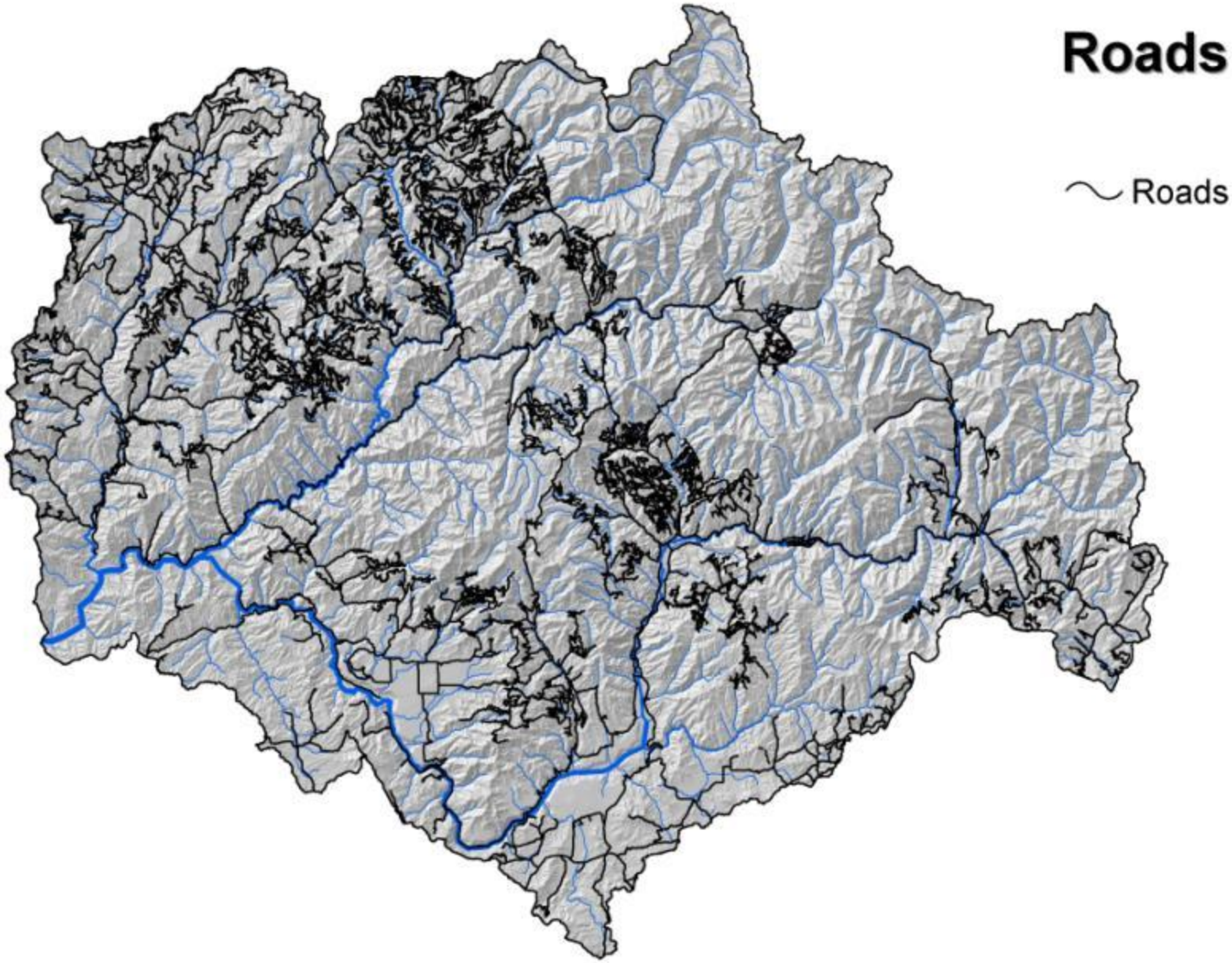
Fire Perimeter - Extent of major fires within the basin since 1992.

Map 5



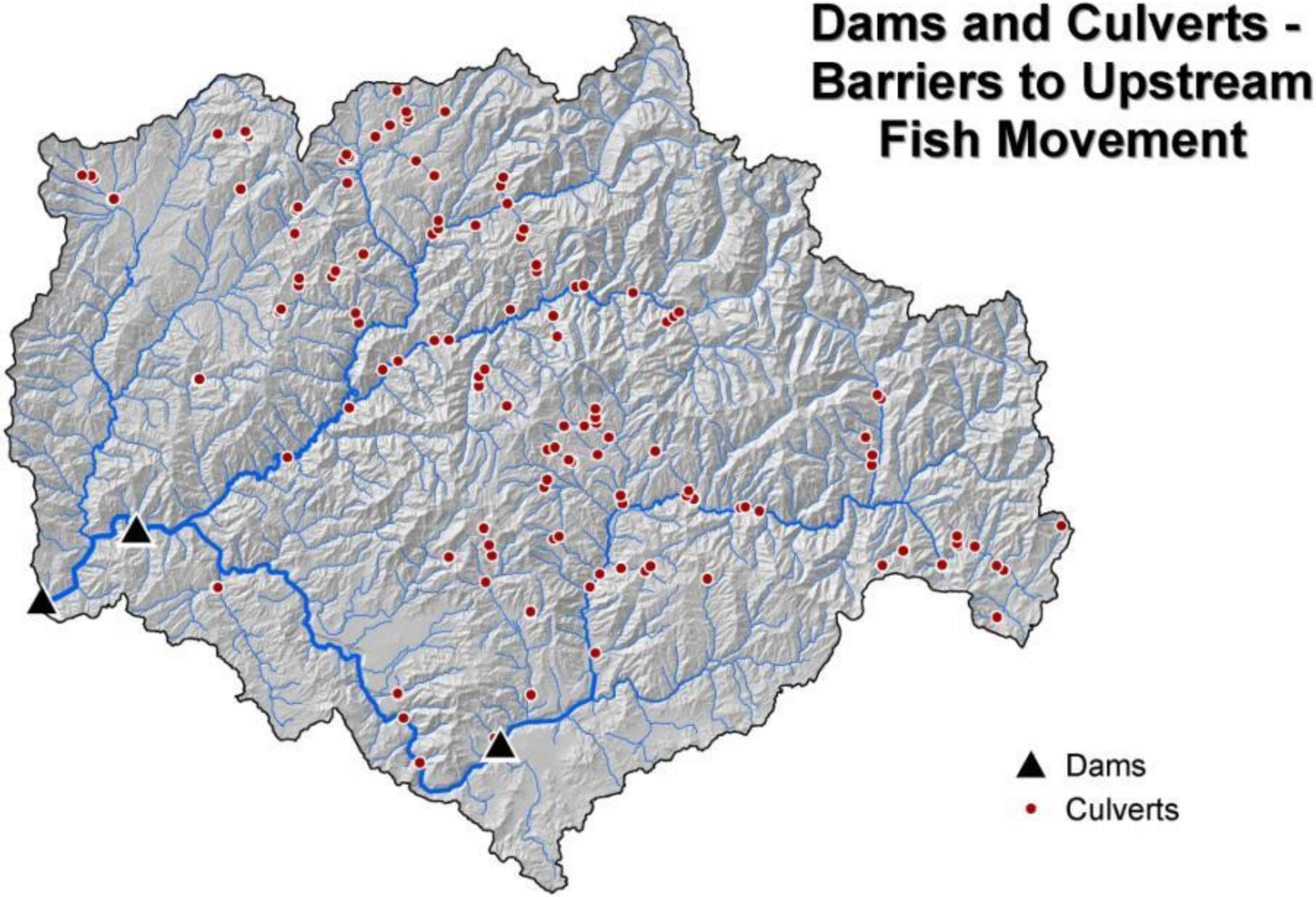
Fire Threat - Estimated threat of stand replacing fire derived from canopy closure estimates.

Map 6

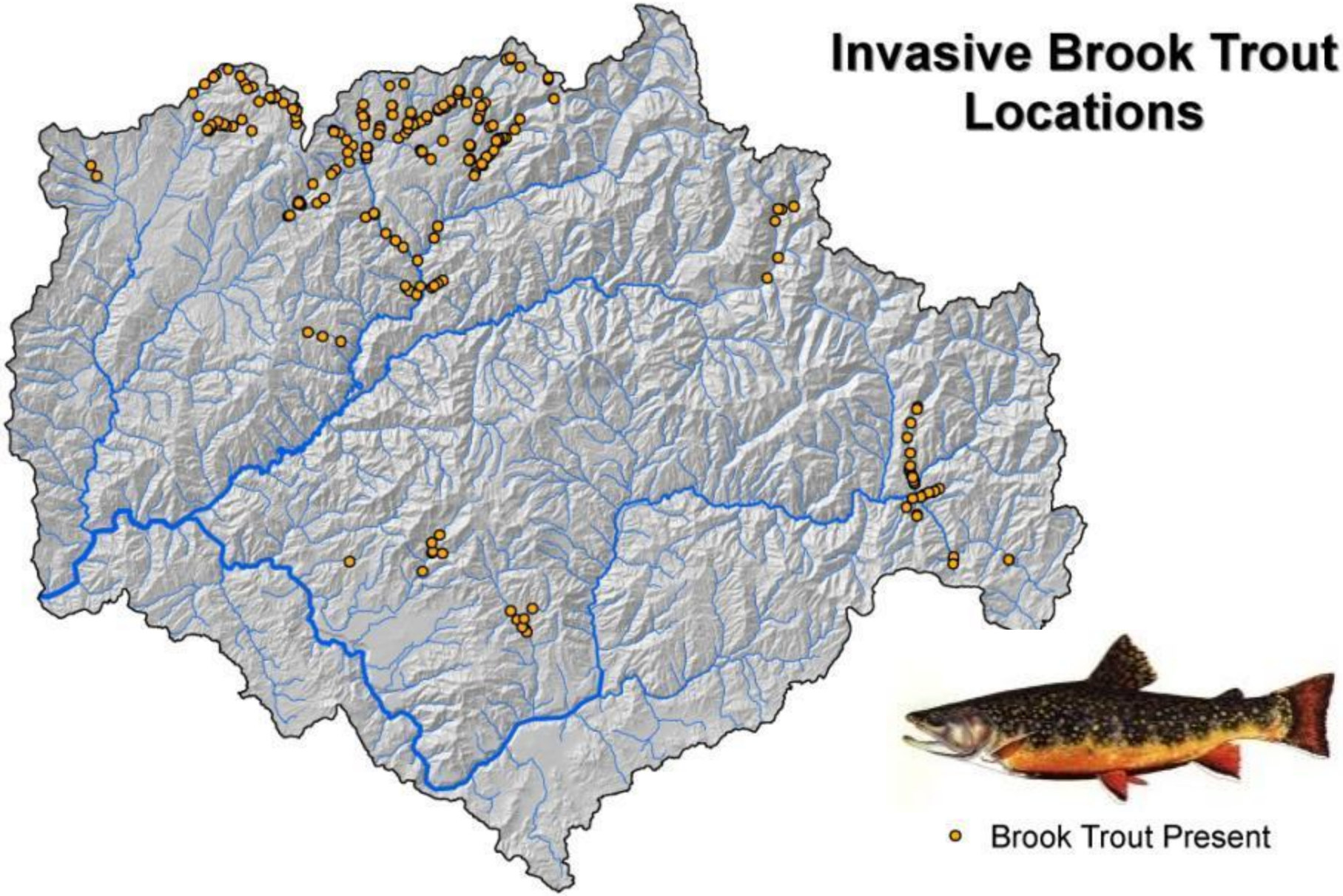


Roads - Paved and unpaved travel routes on private and National Forest lands.

Map 7

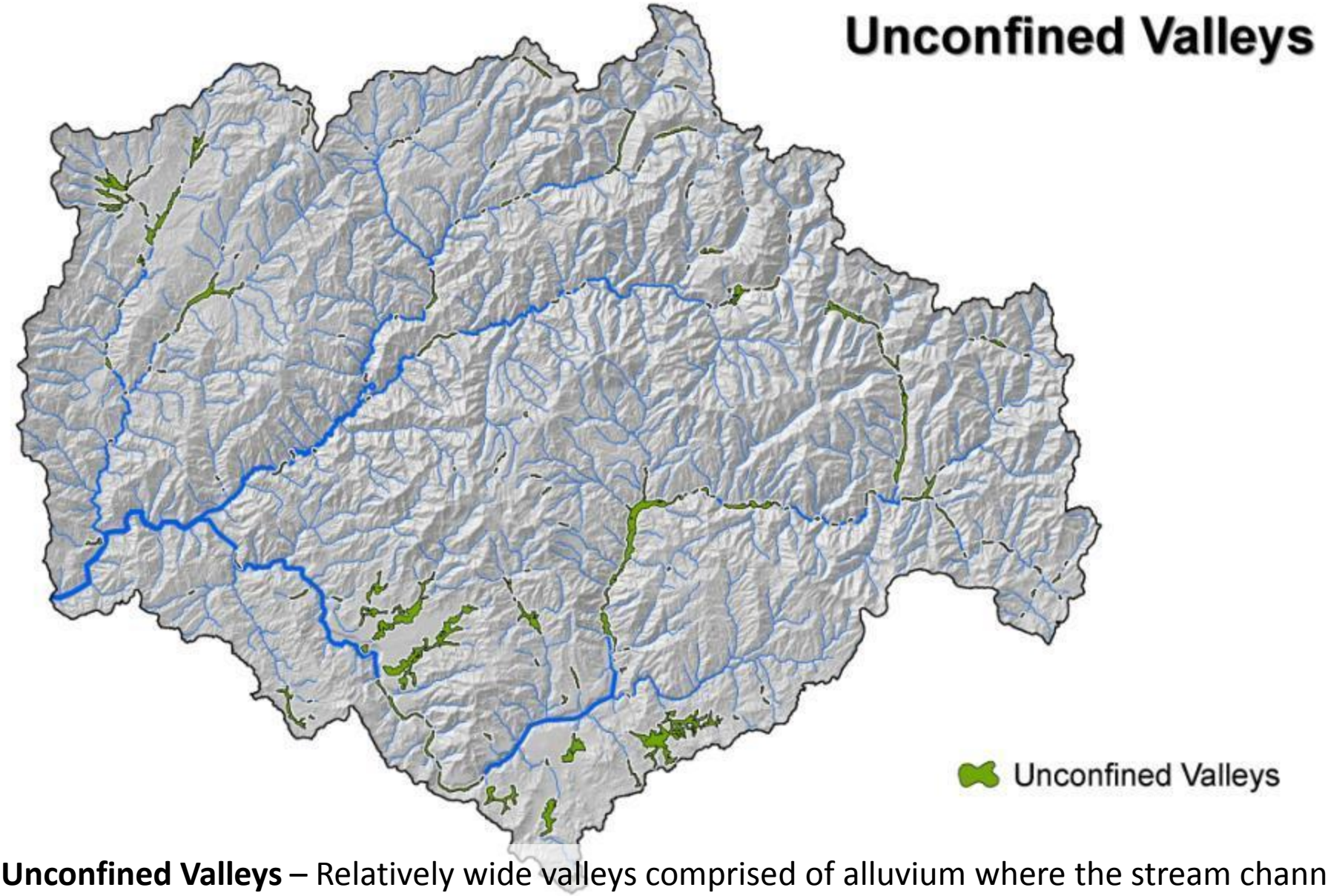

Dams and Culverts - Barriers to Upstream Fish Movement
Dams
Culverts

Map 8



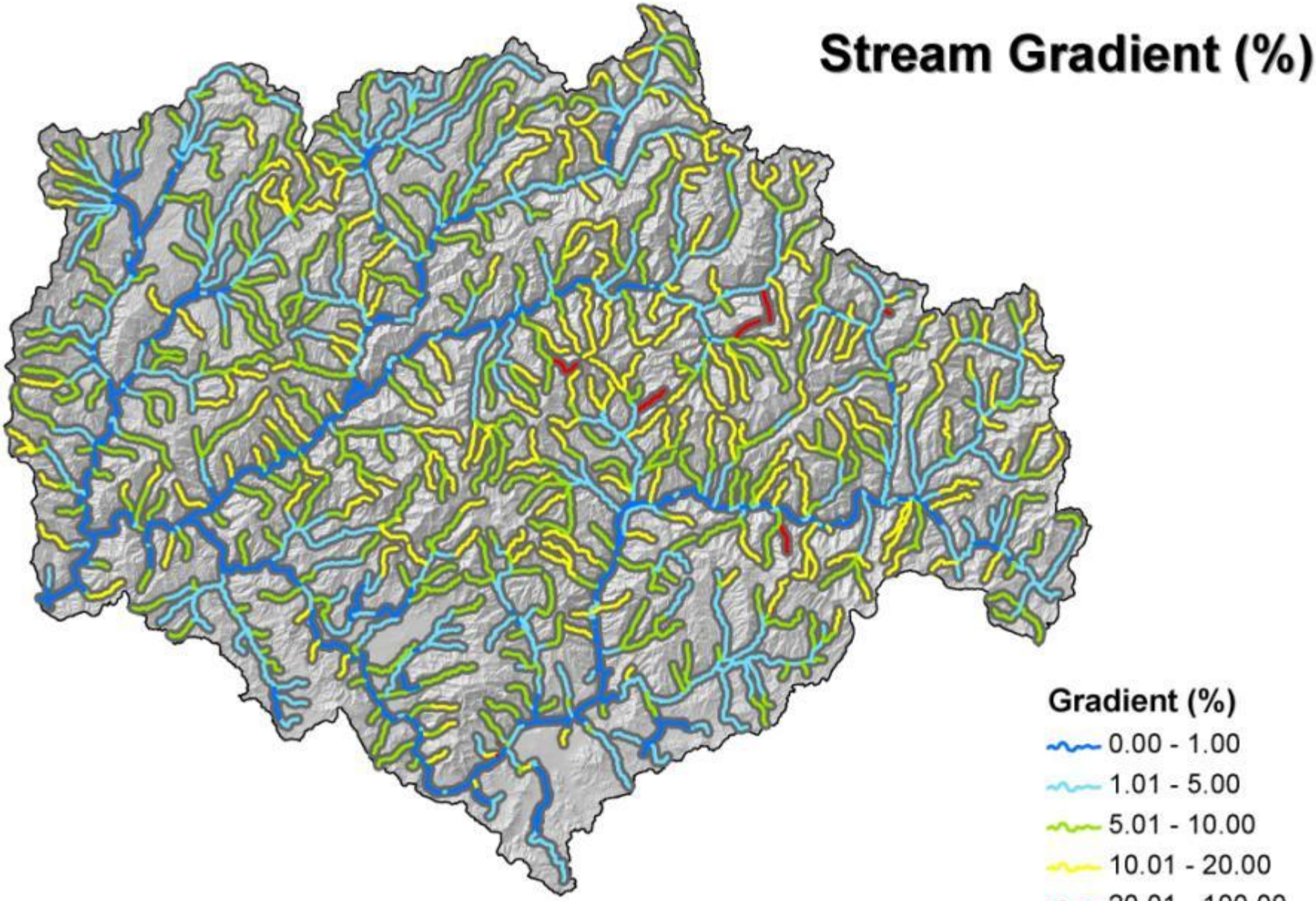
Brook Trout Locations – Sites where invasive brook trout have been sampled during extensive field sampling.

Map 9



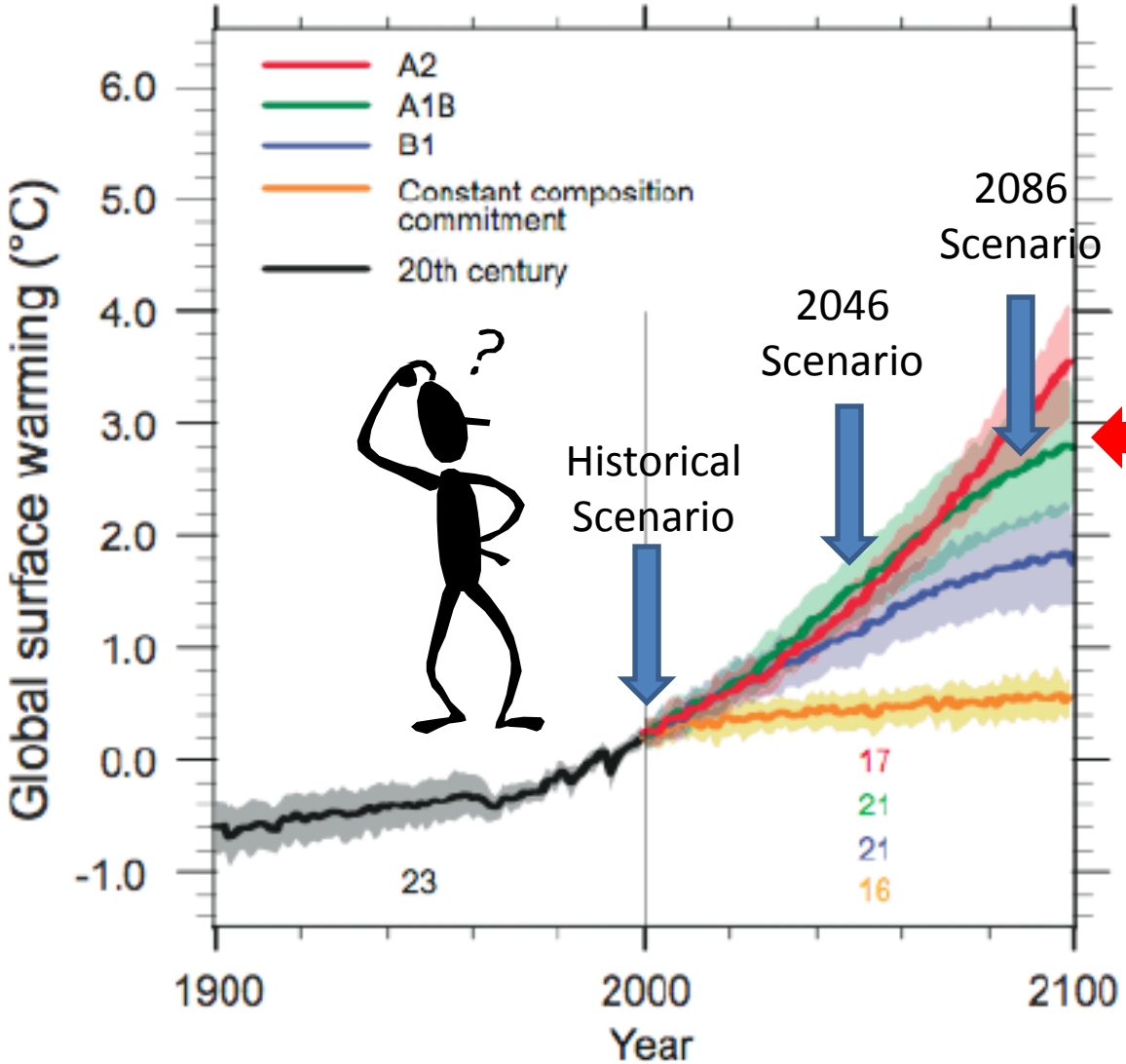
Unconfined Valleys – Relatively wide valleys comprised of alluvium where the stream channel meanders and is not confined by narrow valley walls. These valleys often constitute high quality habitat for invasive brook trout.

Map 10



Stream Gradient - Stream channel gradient computed between tributary junctions on the NHD+ hydrology layer.

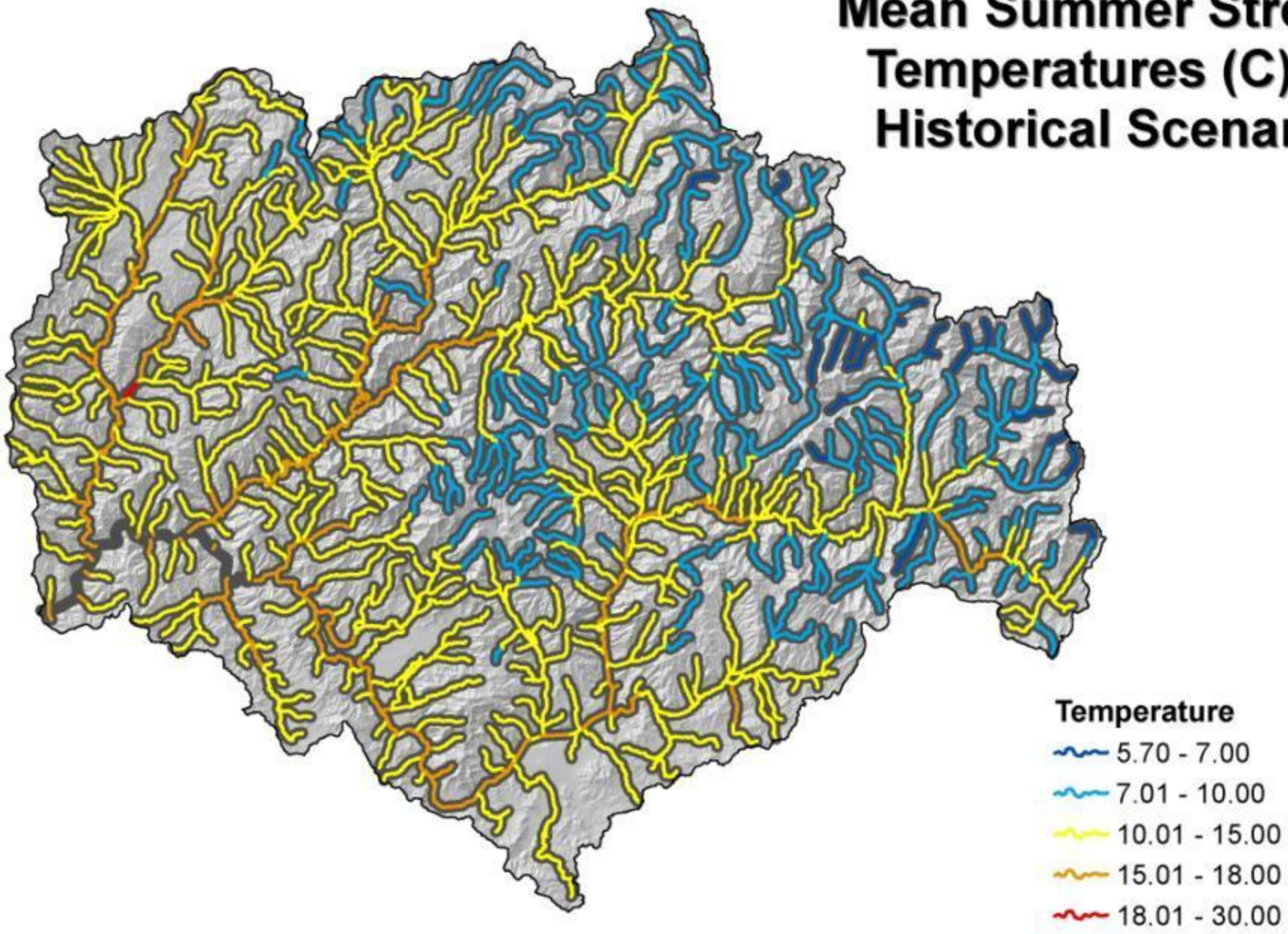
Boise Basin Climate Scenarios



A1B warming trajectory for the example

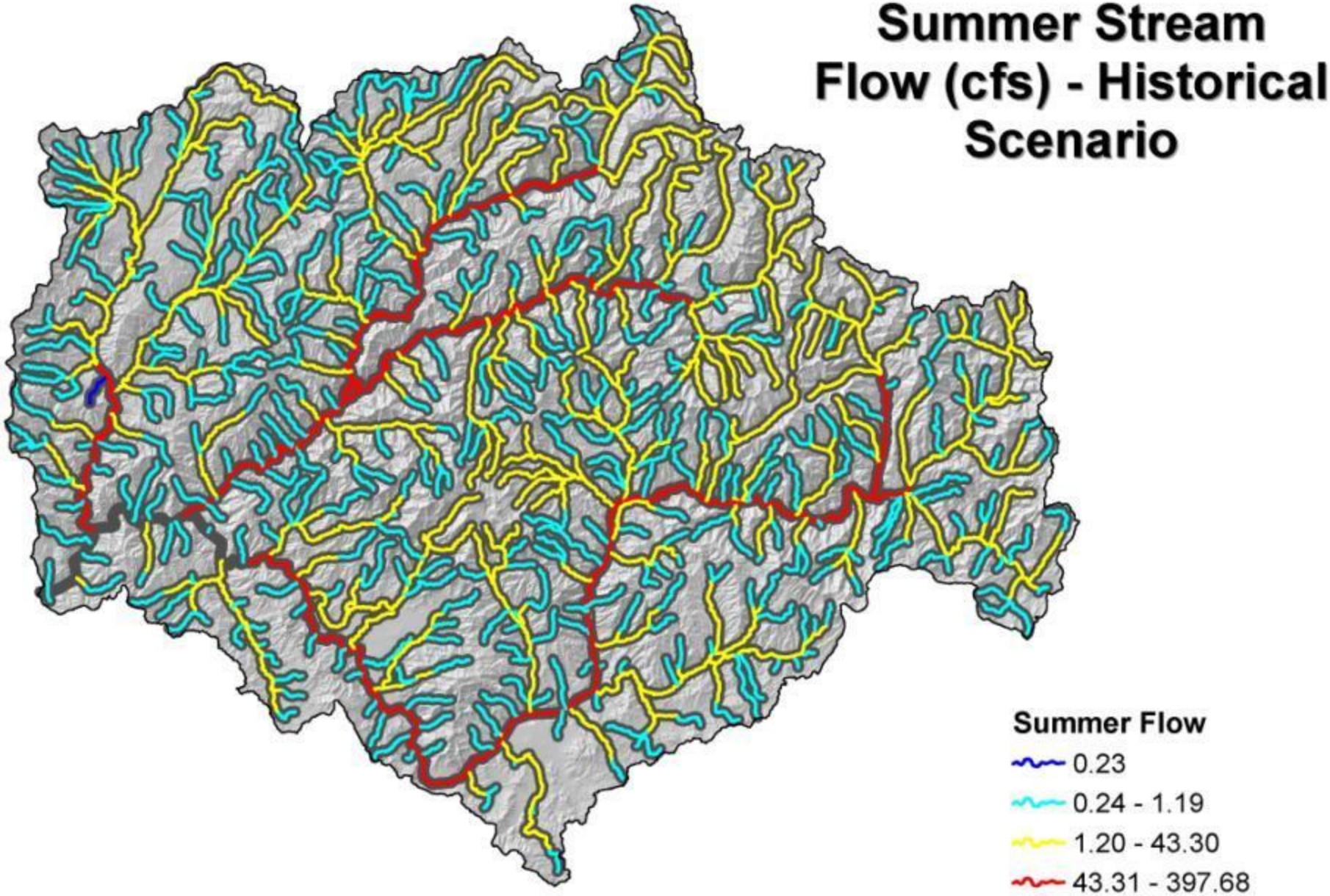
Historical Scenario

Map 11



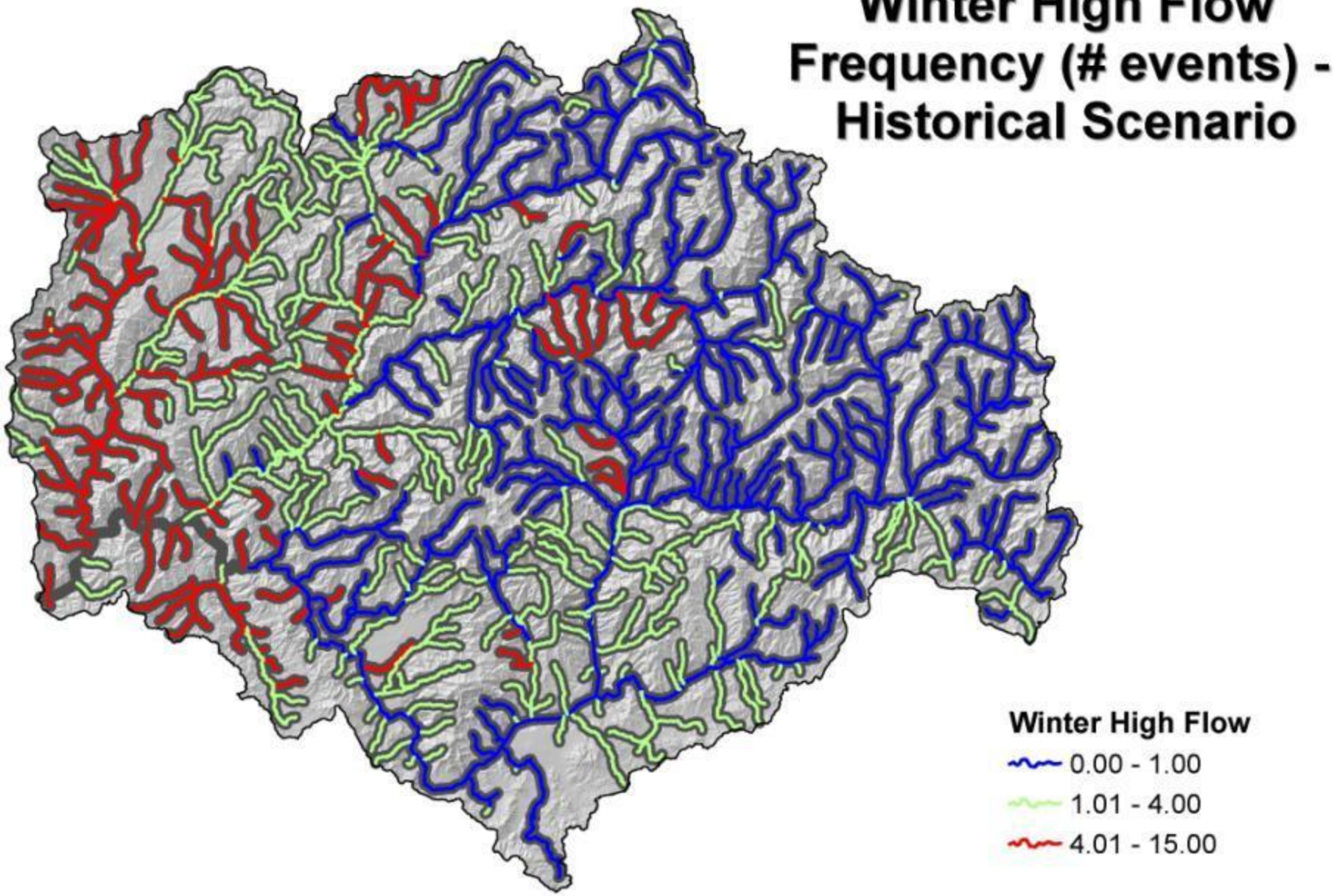
Stream temperatures based on models developed in Isaak et al. 2010. *Ecological Applications* 20:1353-1371.

Map 12



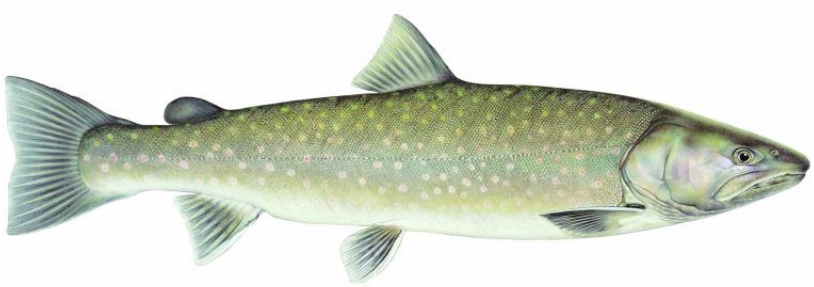
Stream flows based on VIC model outputs & methods described in Wenger et al. 2010. *Water Resources Research* doi:10.1029/2009WR008839

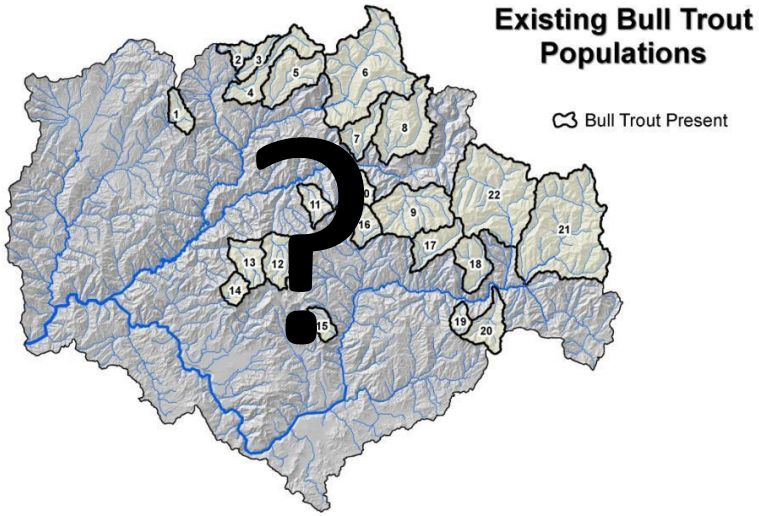
Map 13



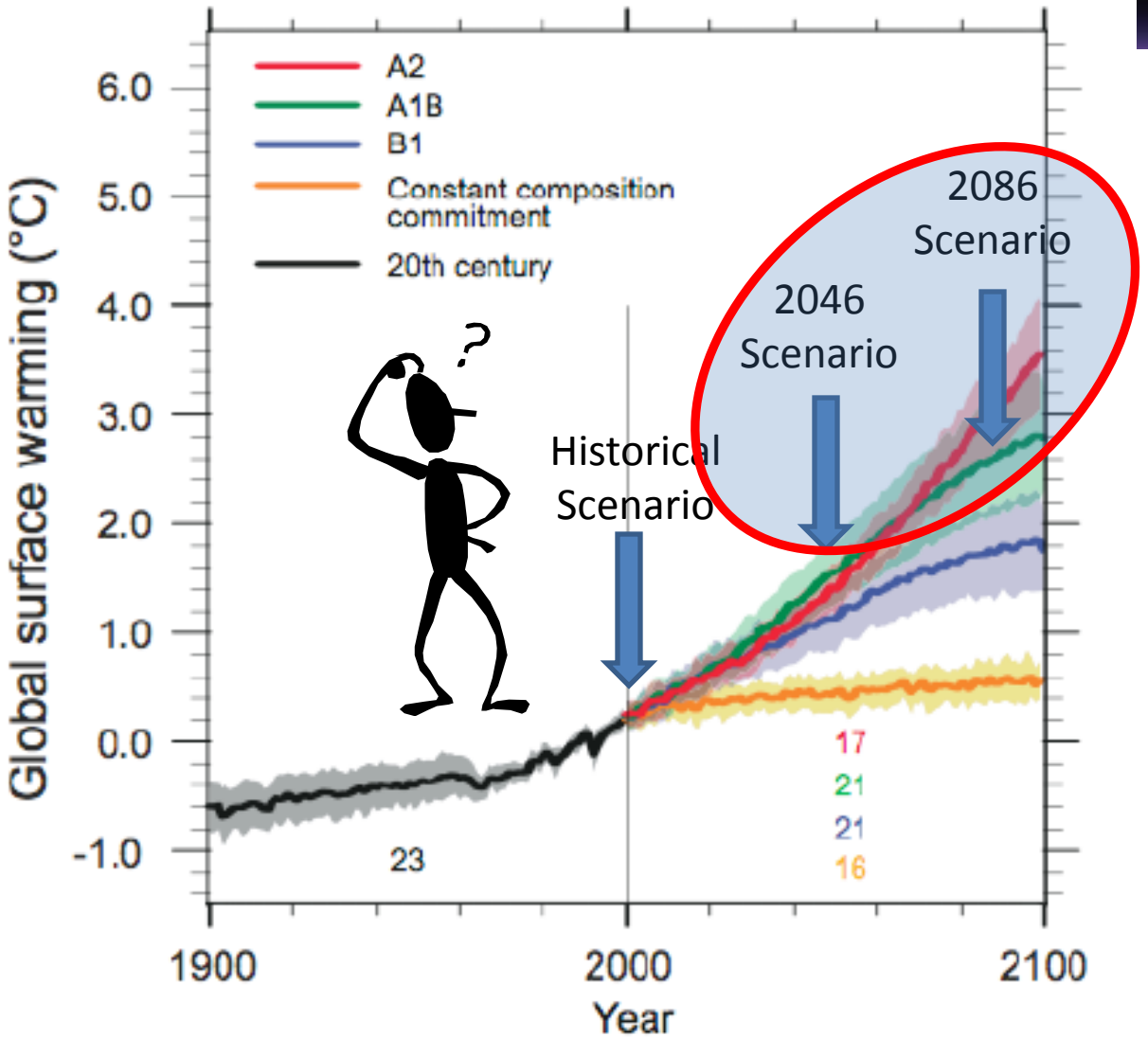
Stream flows based on VIC model outputs & methods described in Wenger et al. 2010. *Water Resources Research* doi:10.1029/2009WR008839

Day 1 task: Using the data now at your disposal, and assuming a limited budget, rank from 1 to 5 (1 = highest priority) the populations where your budget will be spent to help bull trout adapt to climate change and maximize their chances of long-term persistence in the Boise basin. Why did you rank the populations the way you did?



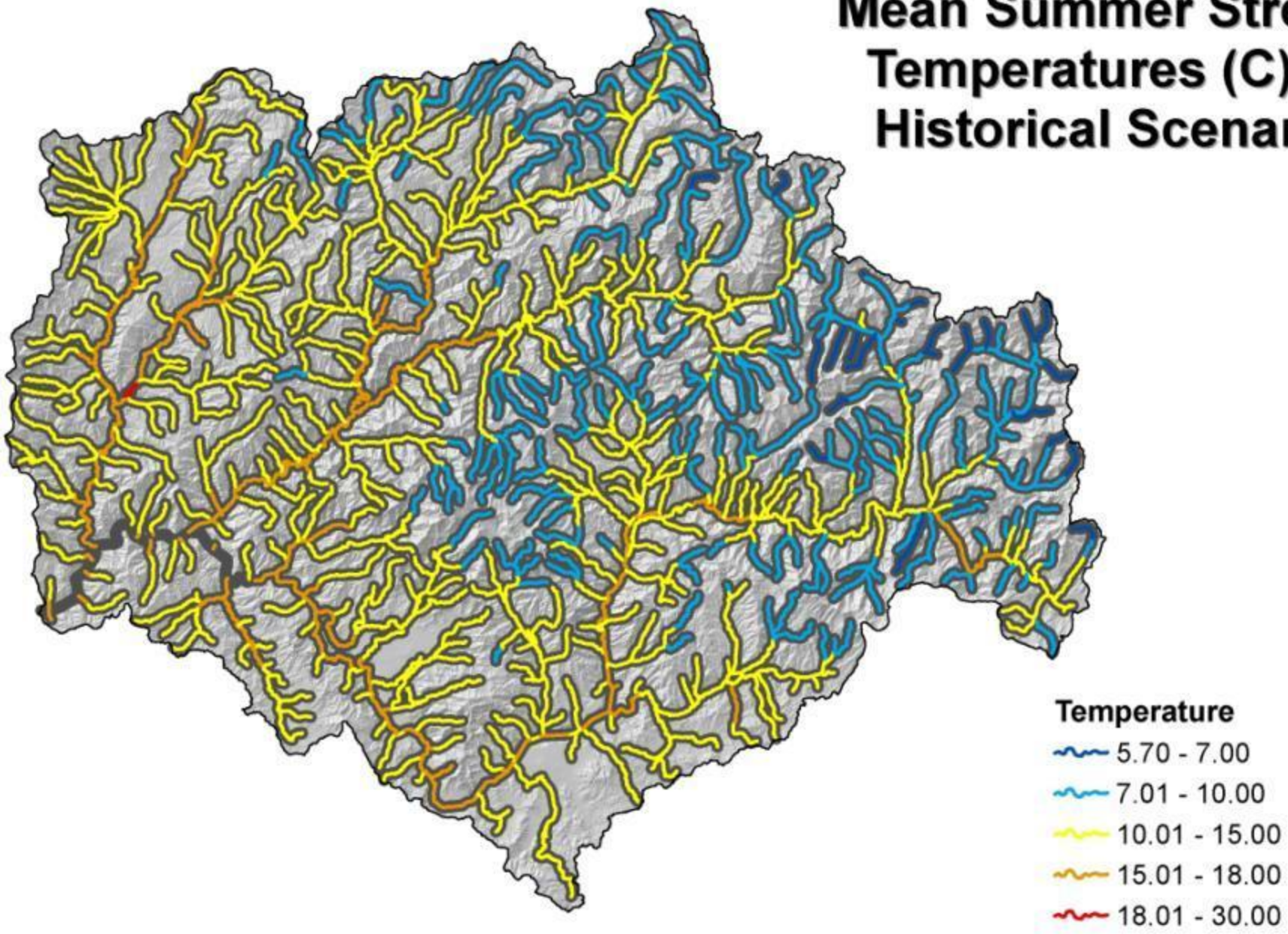


Boise Basin Climate Scenarios



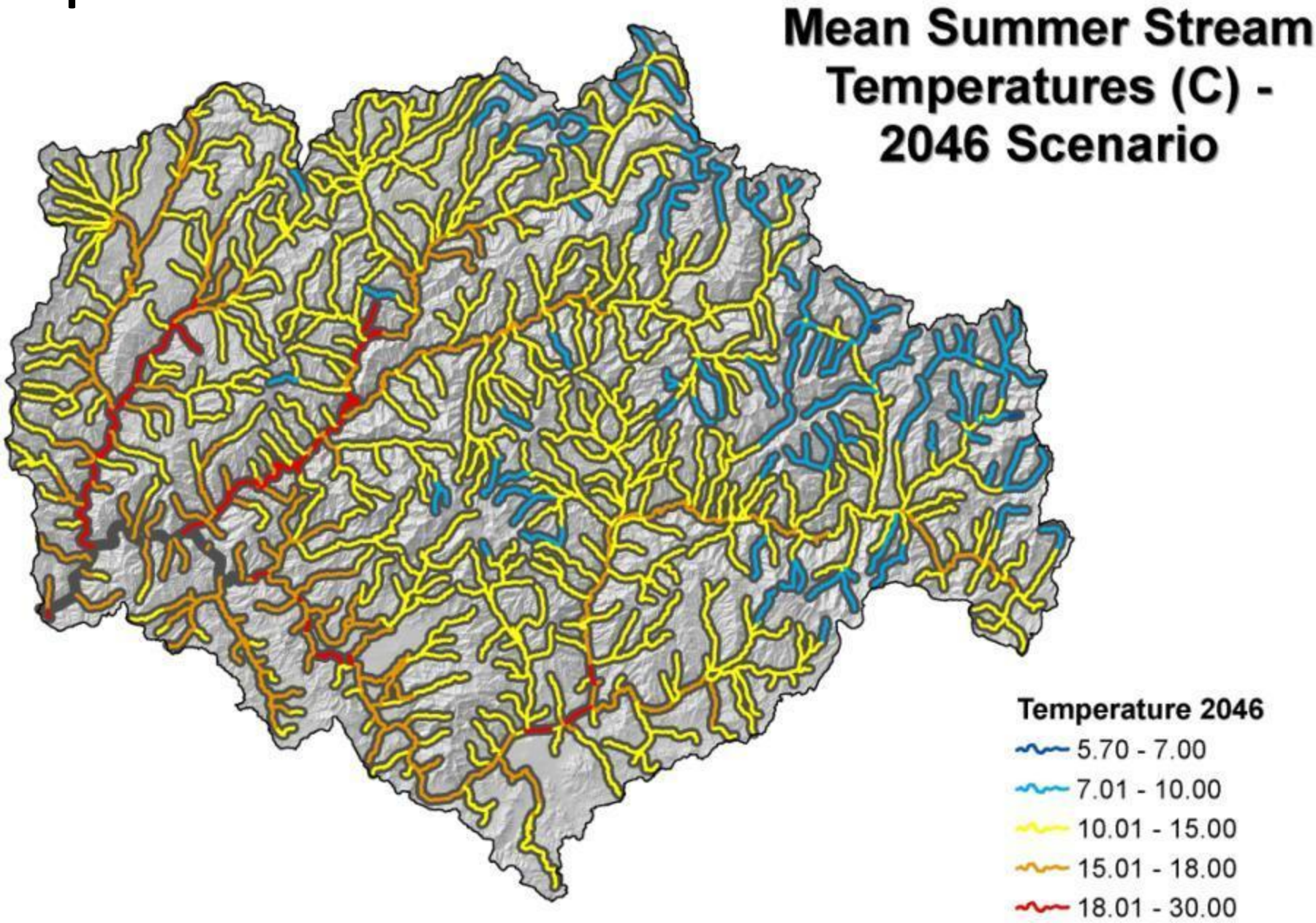
Historical & Future Climate Scenarios

Map 11



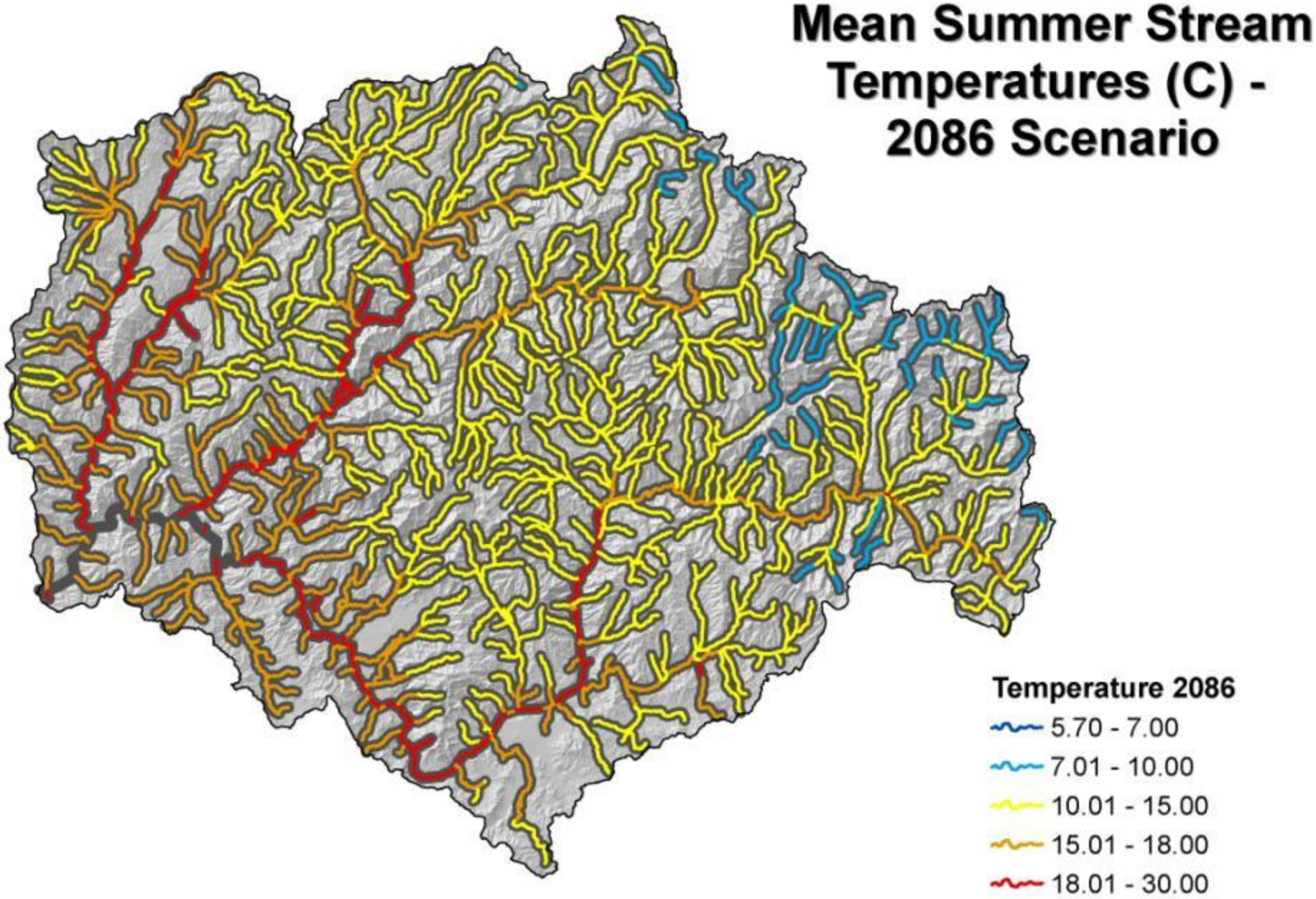
Stream temperatures based on models developed in Isaak et al. 2010. *Ecological Applications* 20:1353-1371.

Map 15



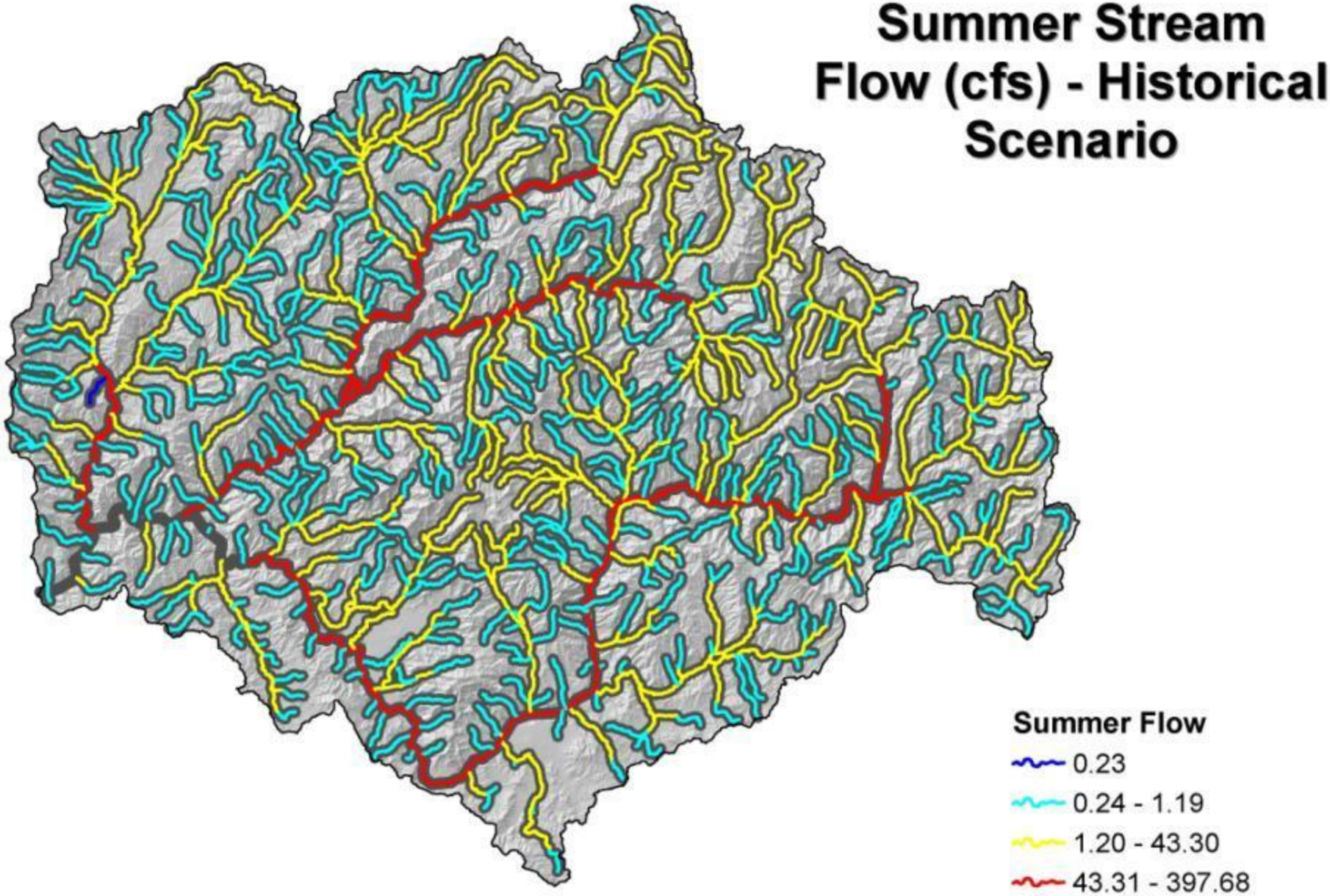
Stream temperatures based on models developed in Isaak et al. 2010. *Ecological Applications* 20:1353-1371.

Map 16



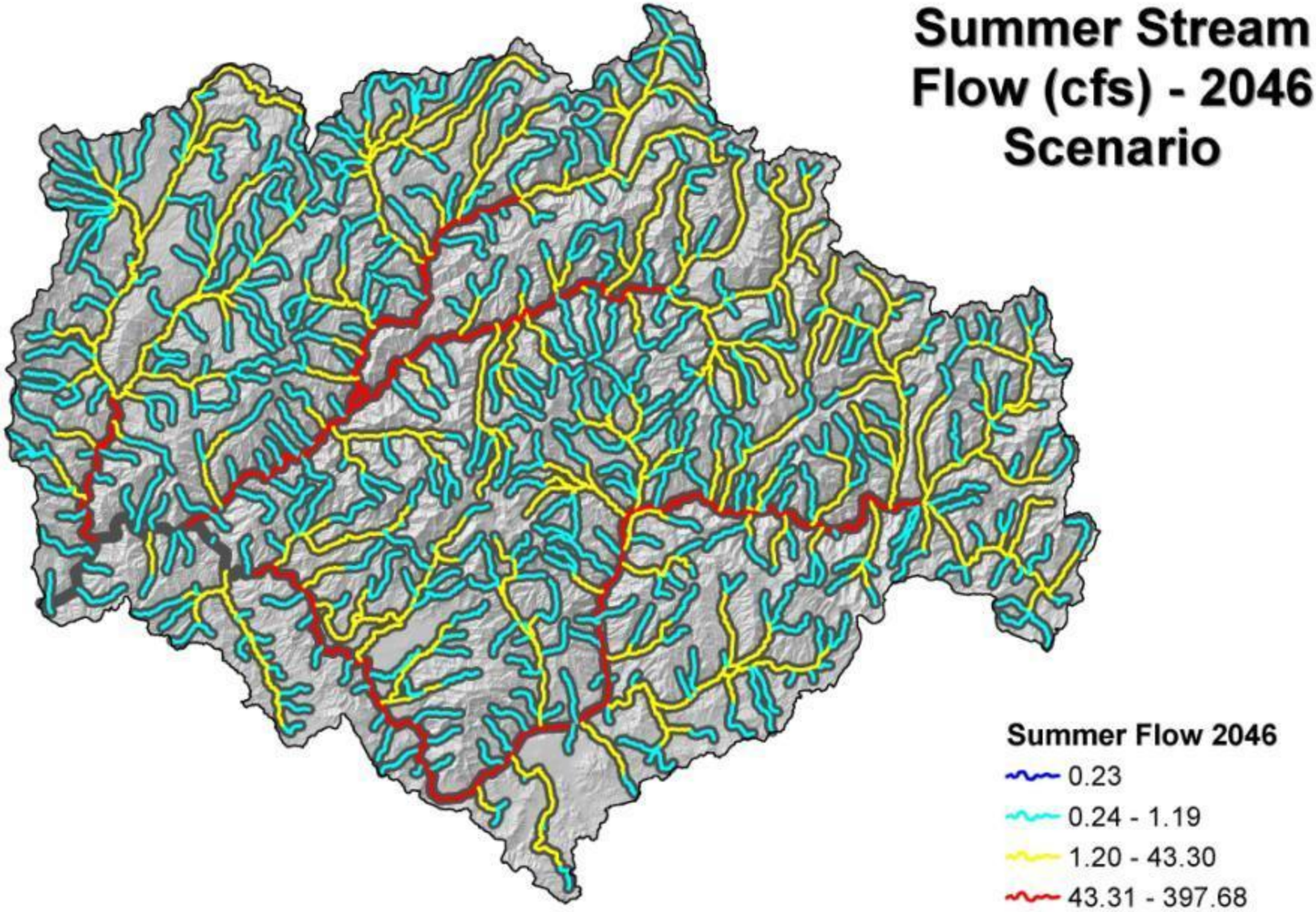
Stream temperatures based on models developed in Isaak et al. 2010. *Ecological Applications* 20:1353-1371.

Map 12



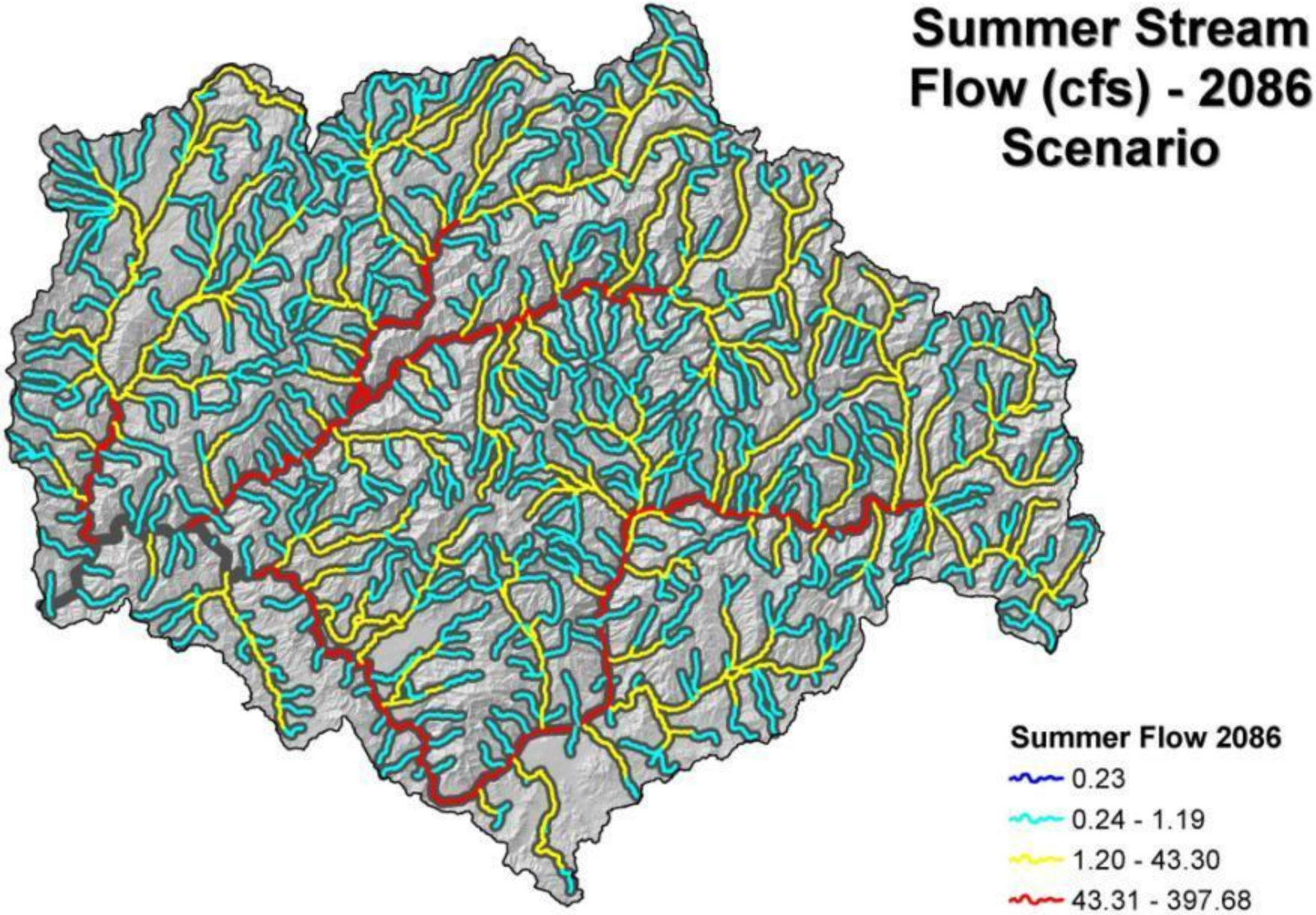
Stream flows based on VIC model outputs & methods described in Wenger et al. 2010. *Water Resources Research* doi:10.1029/2009WR008839

Map 17



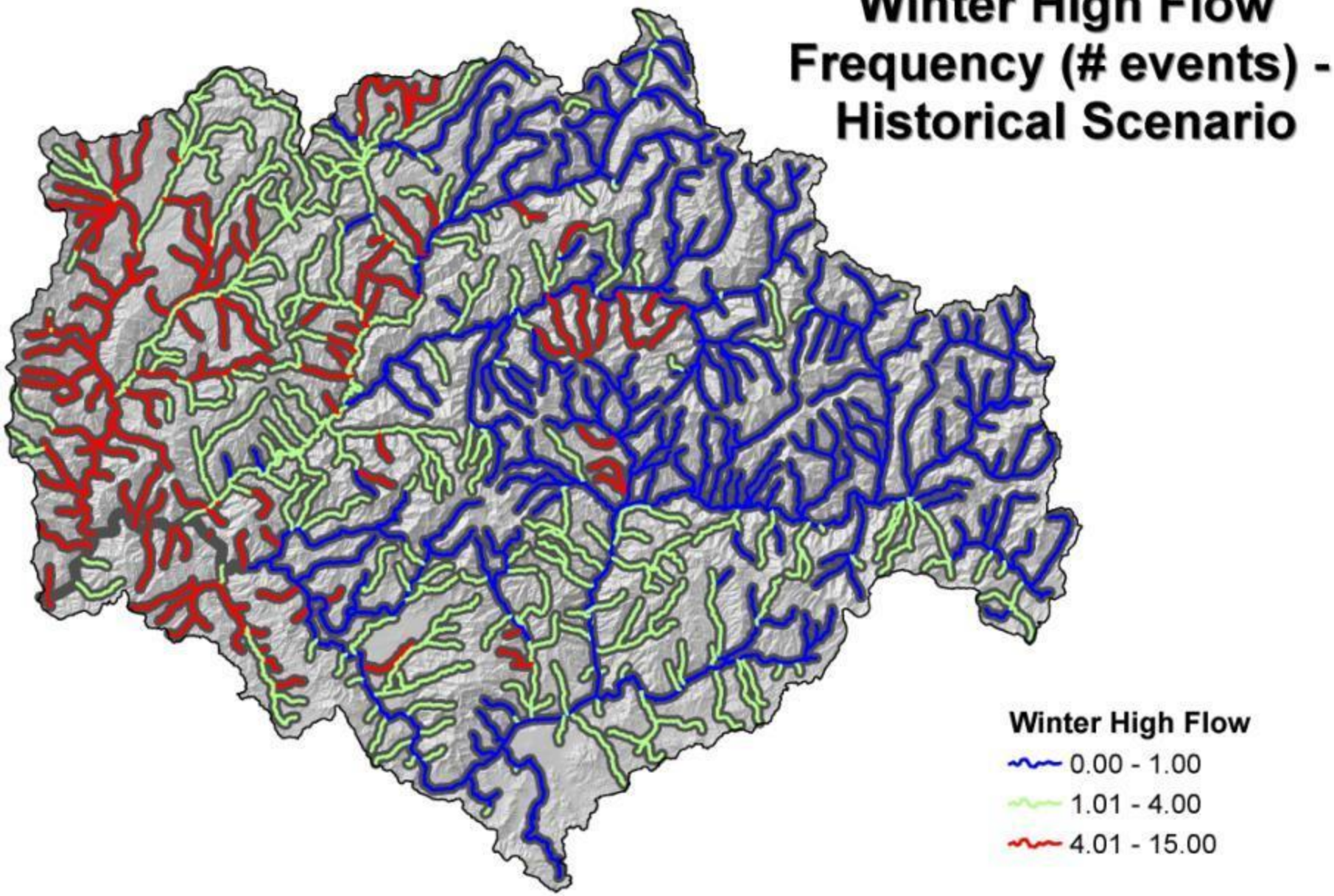
Stream flows based on VIC model outputs & methods described in Wenger et al. 2010. *Water Resources Research* doi:10.1029/2009WR008839

Map 18



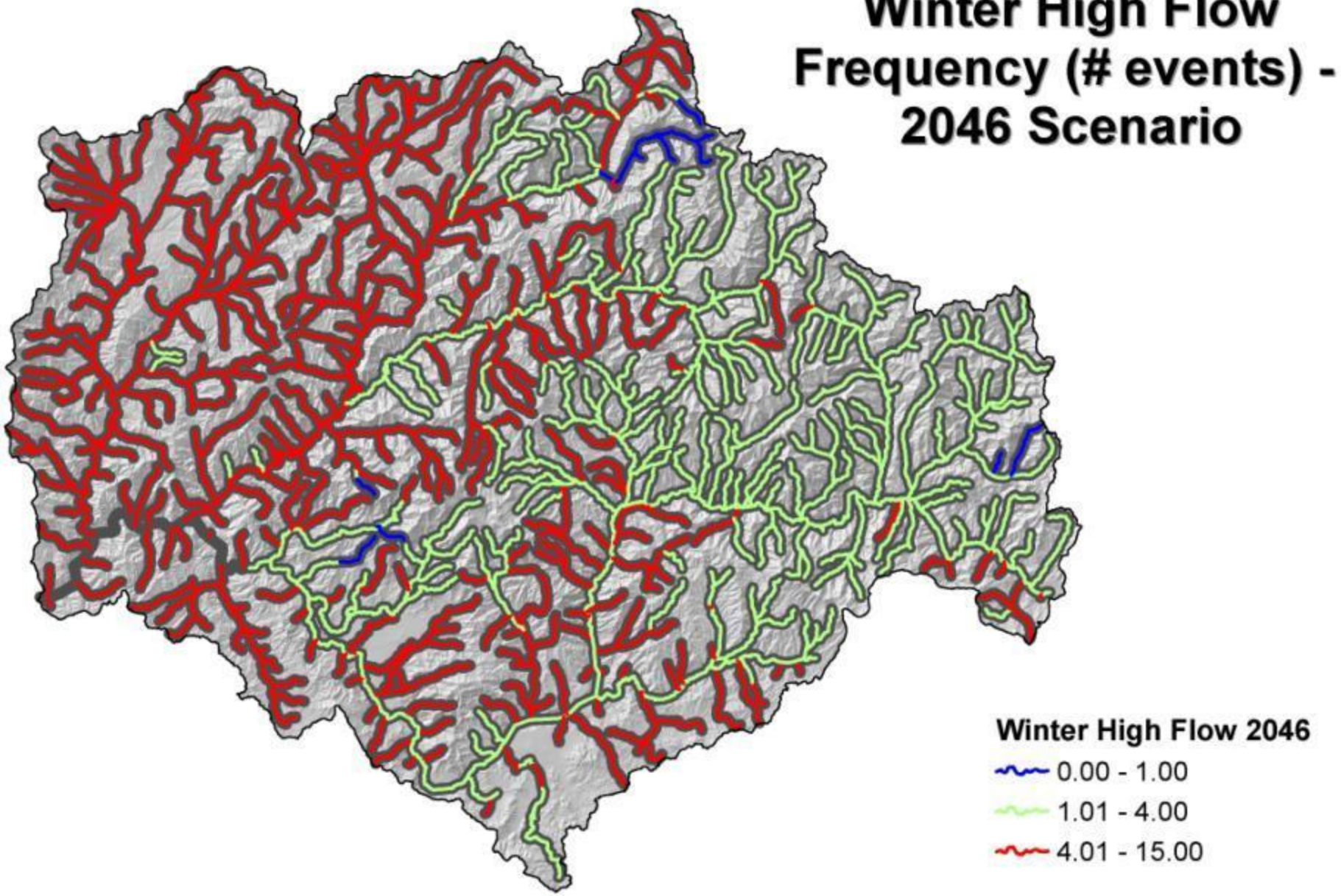
Stream flows based on VIC model outputs & methods described in Wenger et al. 2010. *Water Resources Research* doi:10.1029/2009WR008839

Map 13



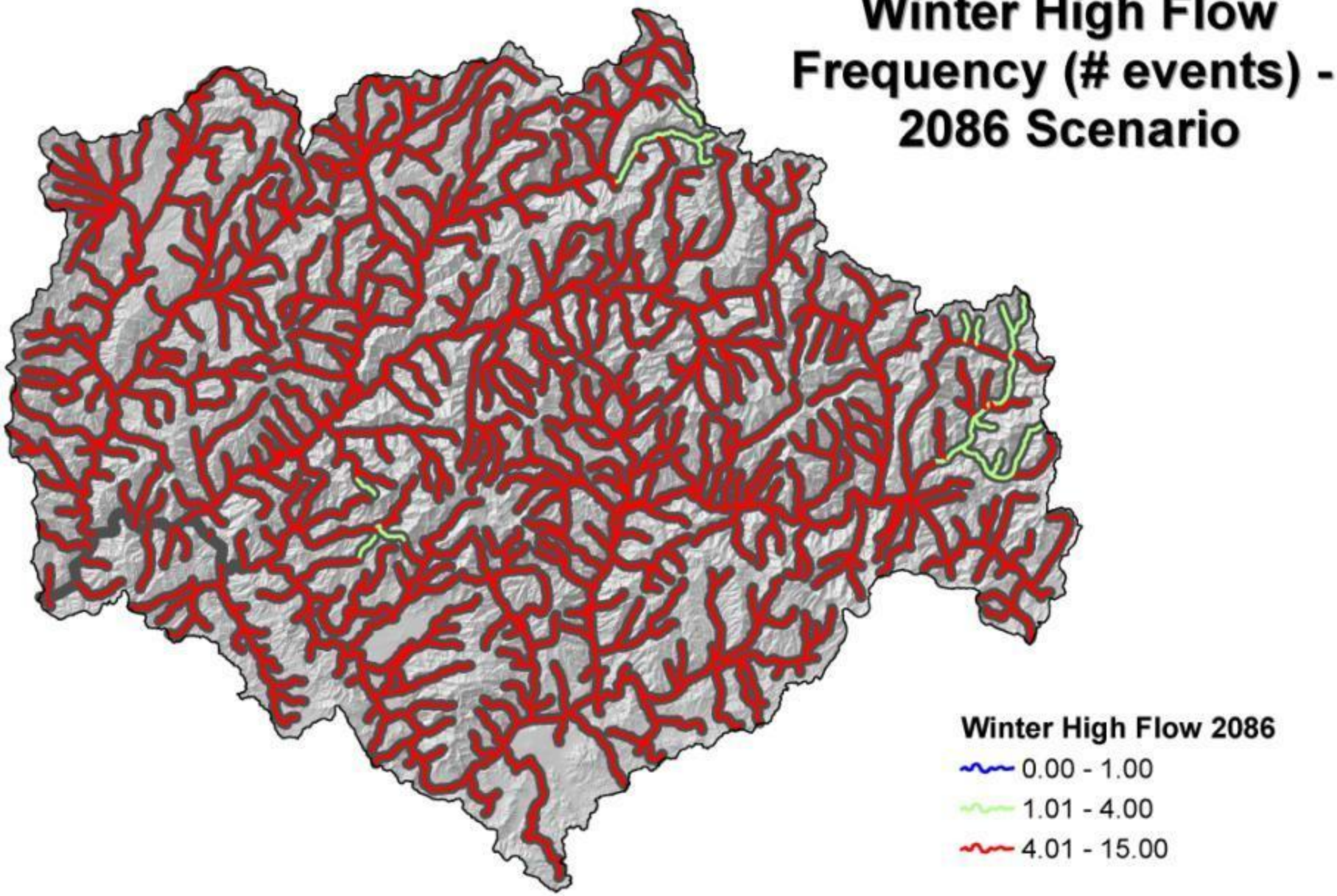
Stream flows based on VIC model outputs & methods described in Wenger et al. 2010. *Water Resources Research* doi:10.1029/2009WR008839

Map 19



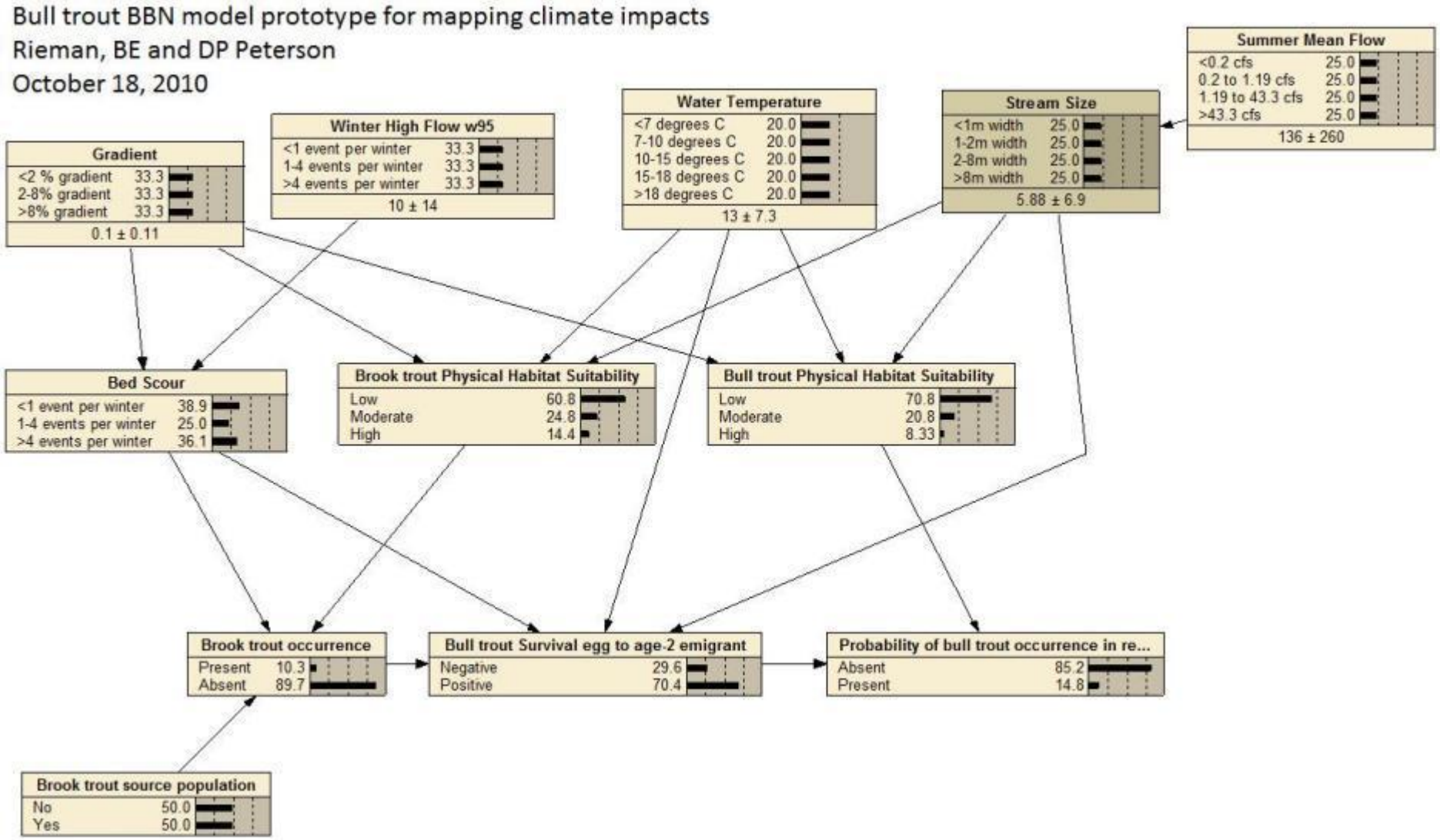
Stream flows based on VIC model outputs & methods described in Wenger et al. 2010. *Water Resources Research* doi:10.1029/2009WR008839

Map 20

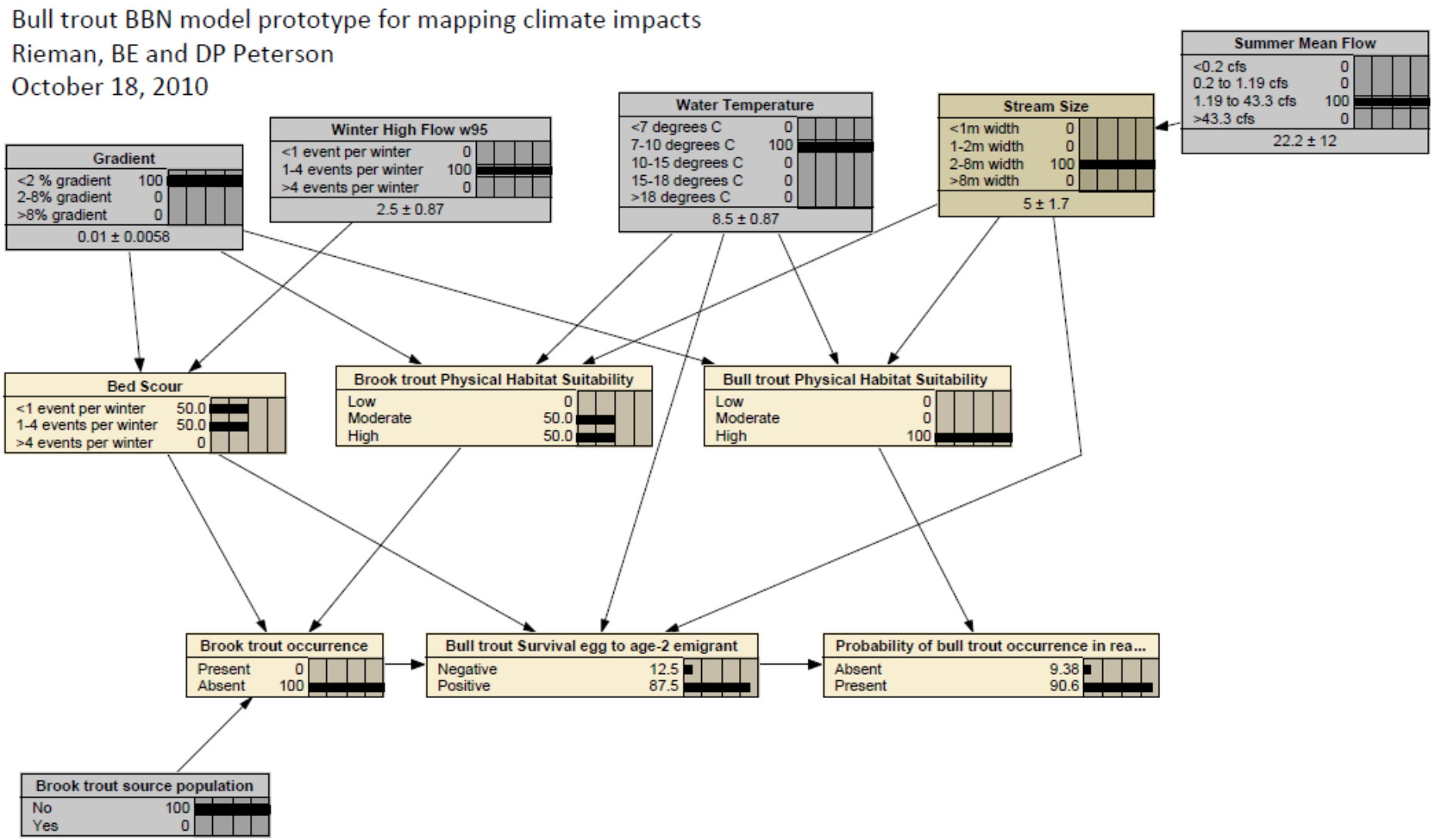


Stream flows based on VIC model outputs & methods described in Wenger et al. 2010. *Water Resources Research* doi:10.1029/2009WR008839

Bayesian Belief Network (BBN) model to integrate climate change impacts to bull trout - Component inputs come from downscaled VIC hydrologies (Wenger et al. 2010) and thresholds relevant to bull trout are described in (Wenger et al., CJFAS – in revision). Spatial stream temperature model and outputs relevant to bull trout are described in Isaak et al. (2010). See Doug Peterson's talk for a full description of BBN's.

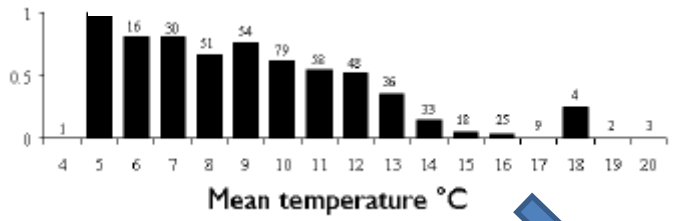


Entering a finding: the model generates a prediction for bull trout occurrence by NHD+ stream segment based on input conditions for gradient, flow, temperature, and brook trout; and given the probabilistic and causal relationships defined in the BBN.



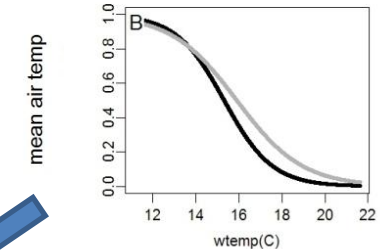
Empirical habitat relationships and important threshold for bull trout are integrated into the BBN decision support tool, e.g., **MEAN SUMMER WATER TEMPERATURE**:

Juvenile bull trout occurrence



Rieman and Chandler (1999)

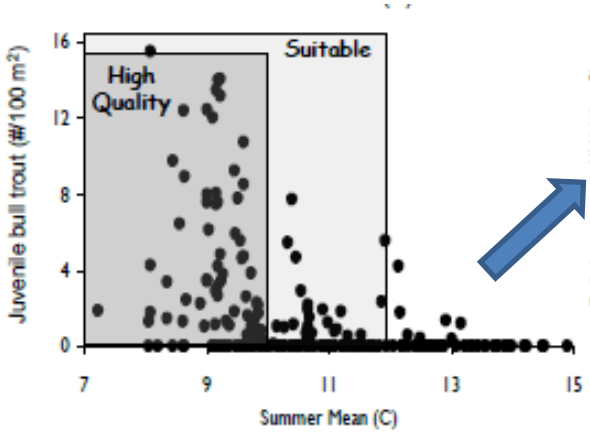
Bull trout



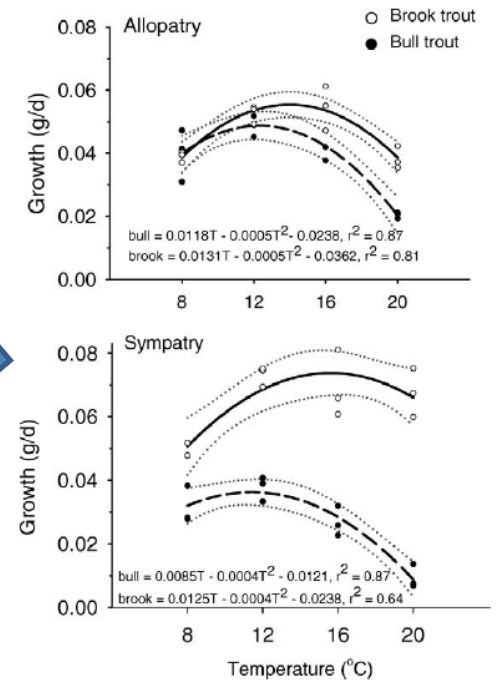
Wenger et al (in review)

BBN states for bull trout

Water Temperature		
<7 degrees C	20.0	Ideal
7-10 degrees C	20.0	Ideal
10-15 degrees C	20.0	Suitable
15-18 degrees C	20.0	Marginal
>18 degrees C	20.0	Poor
13 ± 7.3		



Isaak et al. (2010)

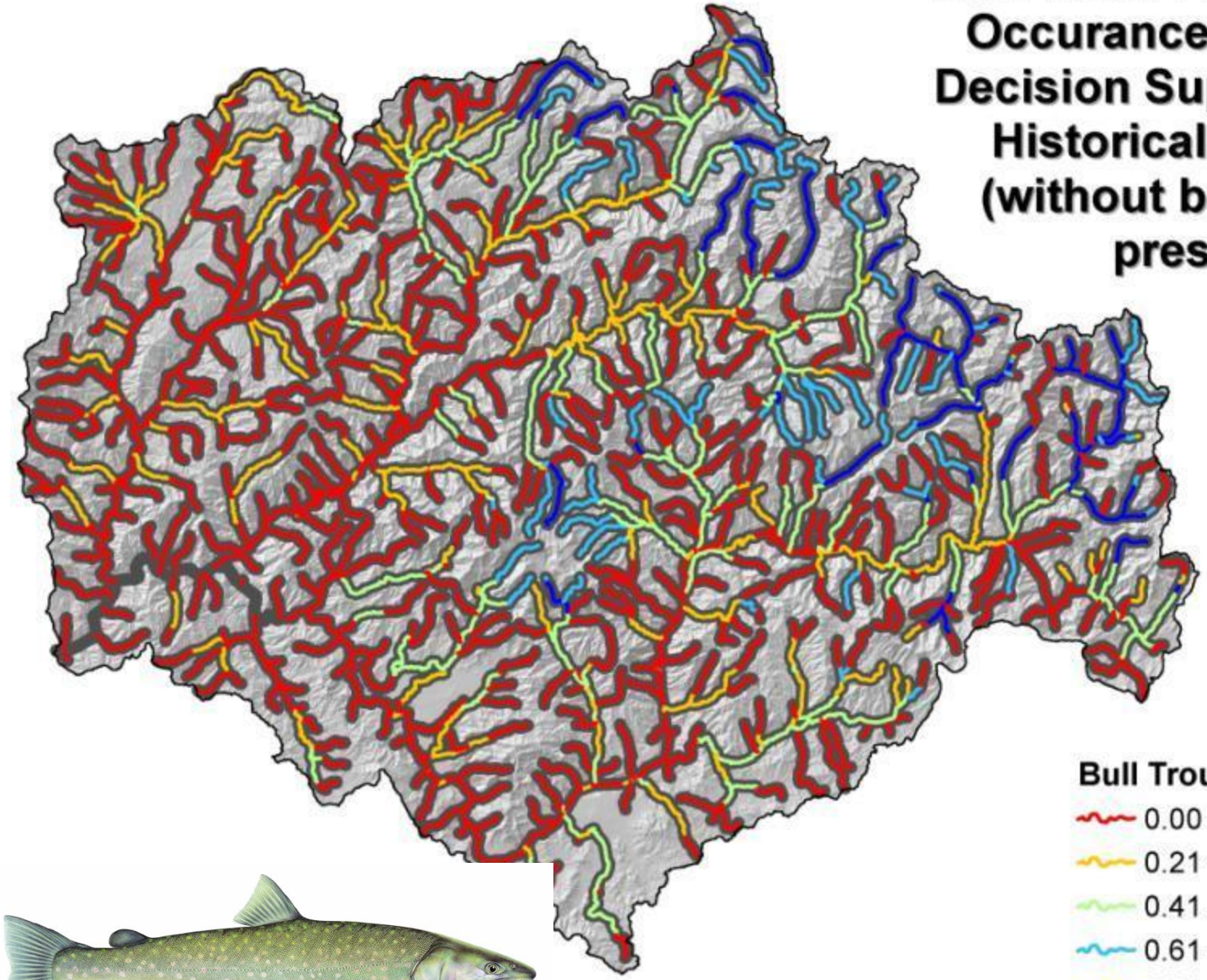


McMahon et al (2007)

Stream temperature thresholds based on empirical observations, statistical models, and controlled experiments. Other BBN variables developed using the same approach.

Map 21

Bull Trout Probability of Occurance from BBN Decision Support Tool - Historical Scenario (without brook trout present)

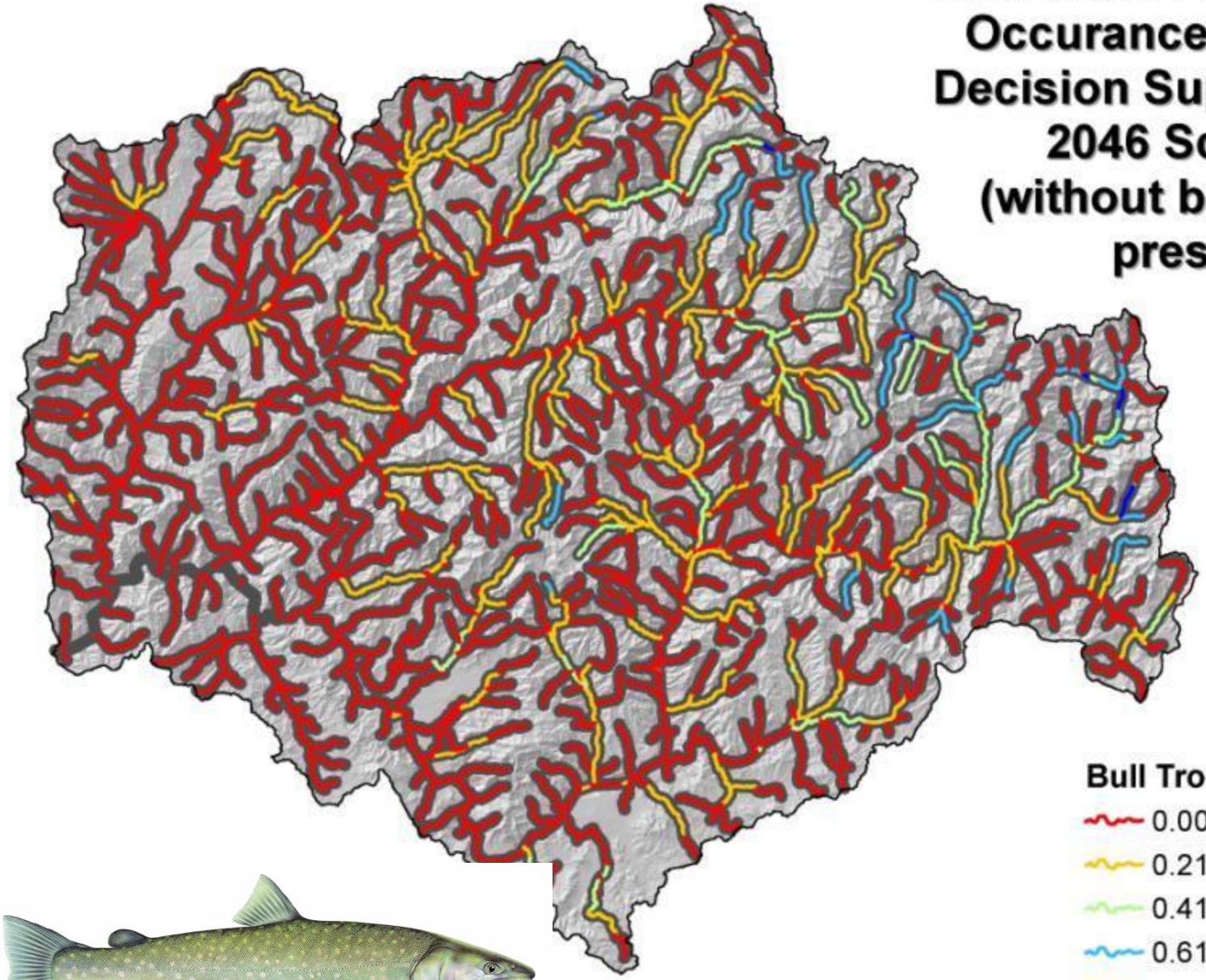


Bull Trout Probability

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Map 22

Bull Trout Probability of Occurance from BBN Decision Support Tool - 2046 Scenario (without brook trout present)

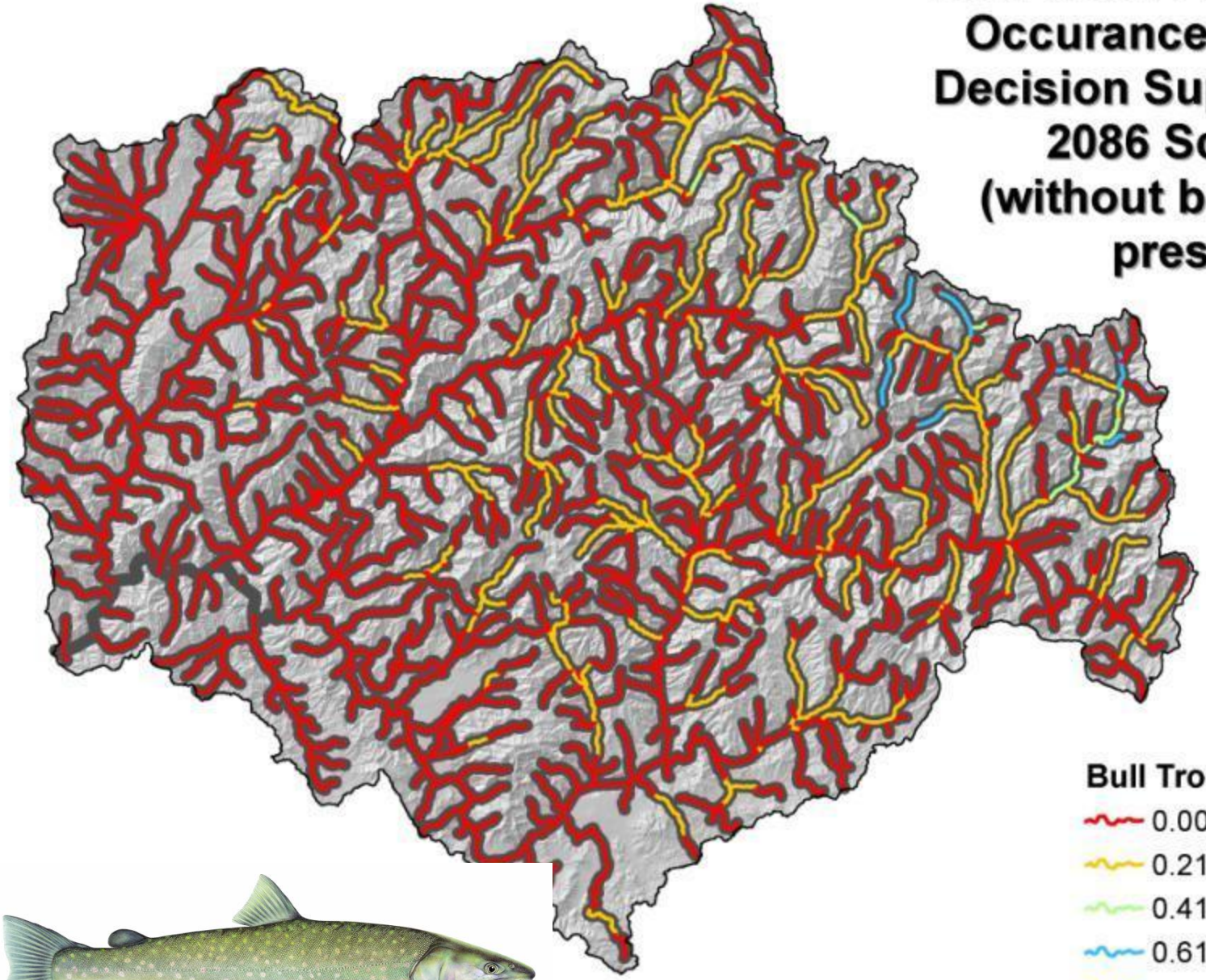


Bull Trout Probability

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Map 23

Bull Trout Probability of Occurance from BBN Decision Support Tool - 2086 Scenario (without brook trout present)

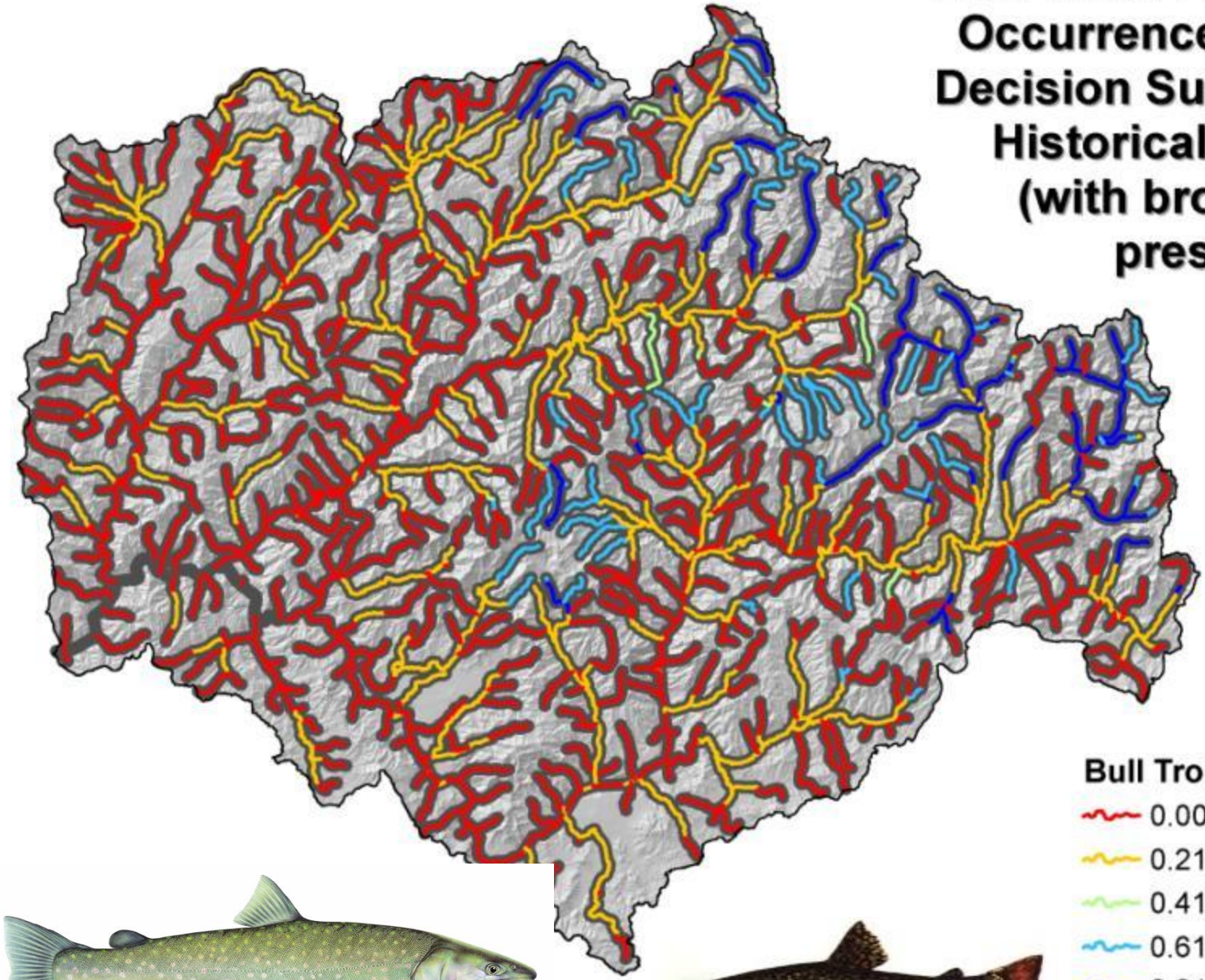


Bull Trout Probability

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Map 24

Bull Trout Probability of Occurrence from BBN Decision Support Tool - Historical Scenario (with brook trout present)

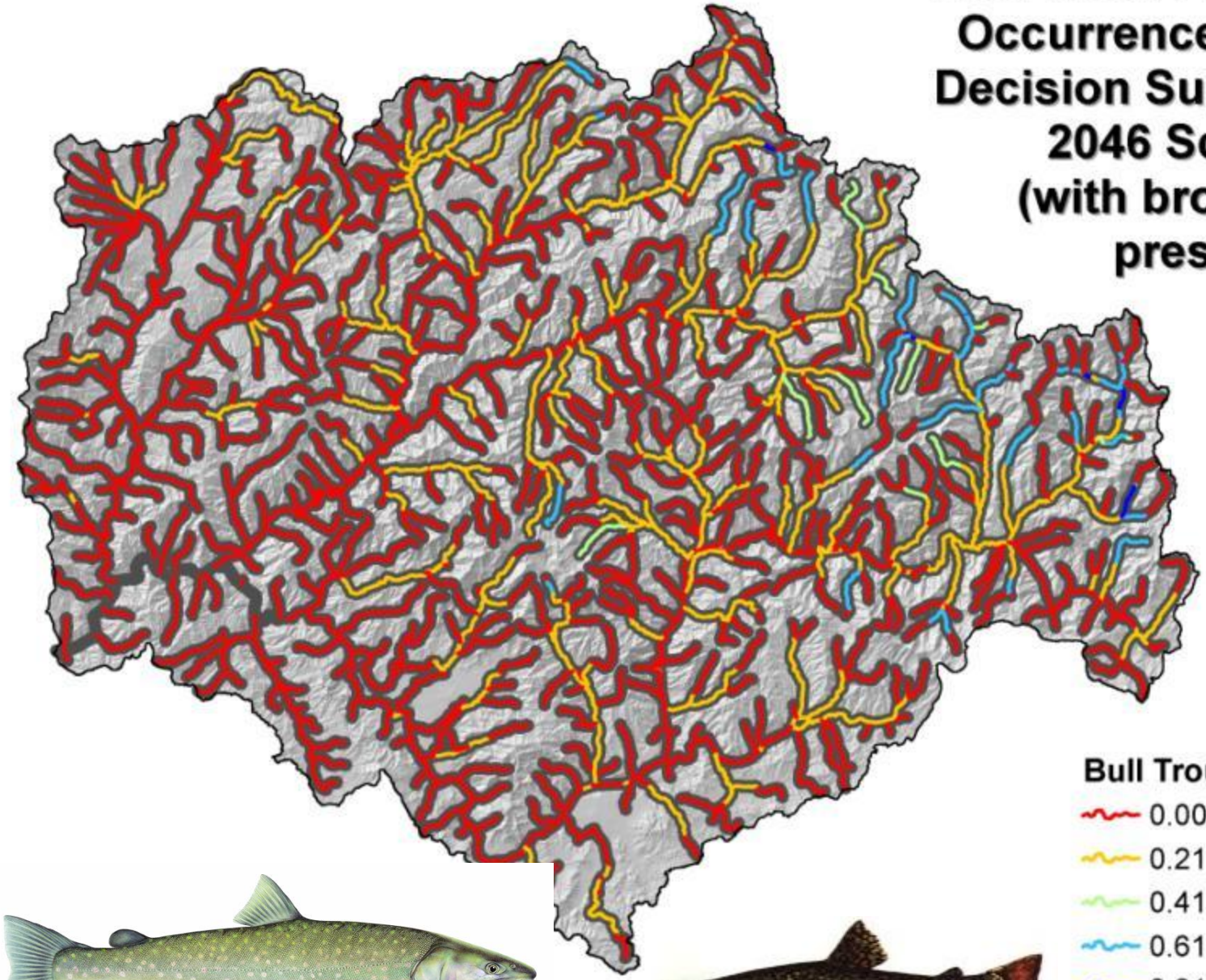


Bull Trout Probability

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Map 25

Bull Trout Probability of Occurrence from BBN Decision Support Tool - 2046 Scenario (with brook trout present)

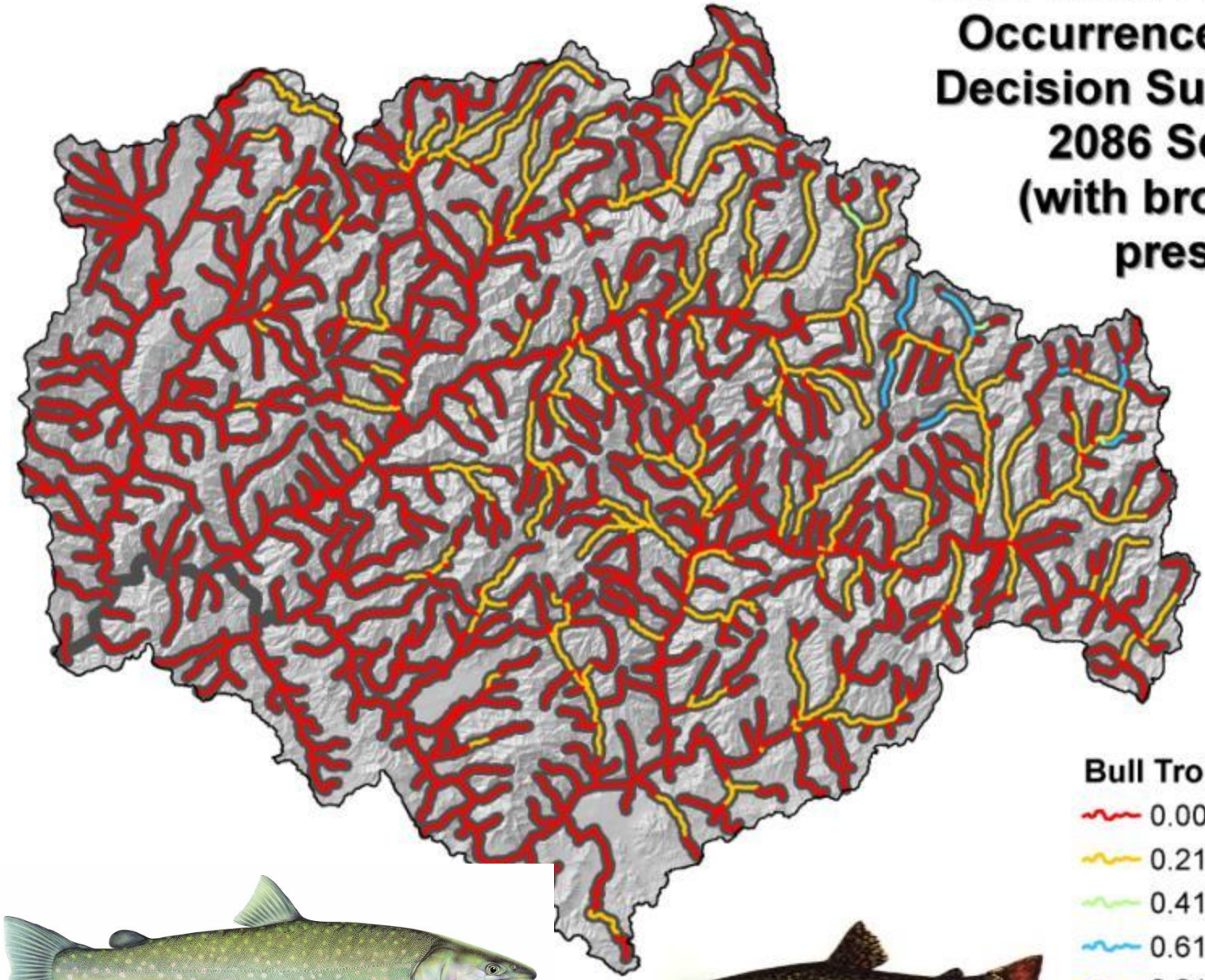


Bull Trout Probability

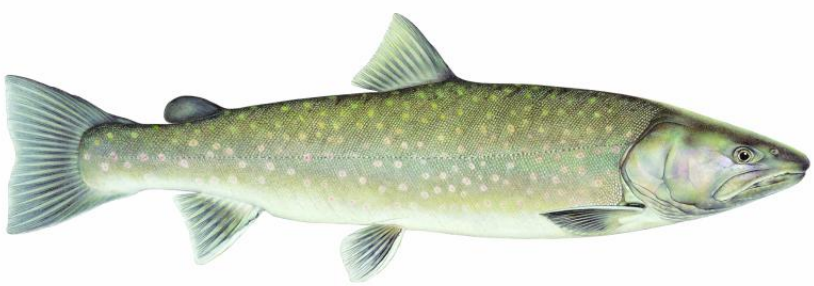
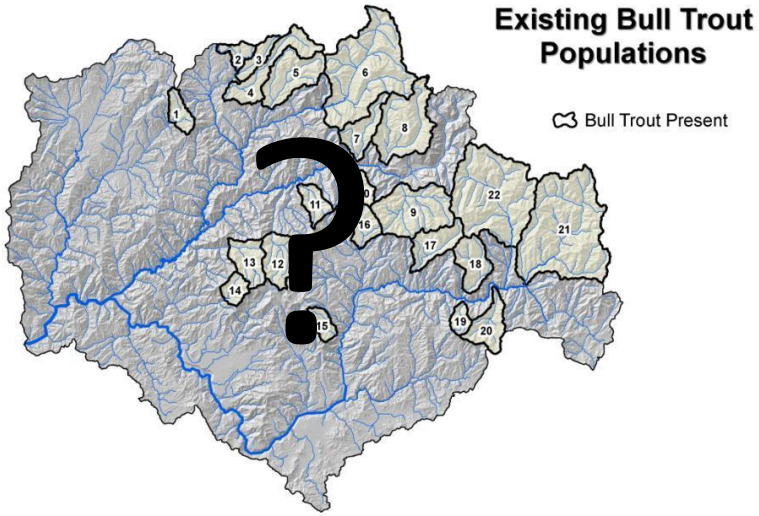
- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Map 26

Bull Trout Probability of Occurrence from BBN Decision Support Tool - 2086 Scenario (with brook trout present)



Bull Trout Probability

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Day 2 task: Using the future climate scenarios and Bayesian Belief Network decision support tool, re-visit your initial bull trout population rankings and again rank them from 1 to 5. Do they stay the same or do the priorities change?