A Map of Thermally Suitable Bull Trout Habitat: Current and Projected Climate Conditions Across the Interior Columbia Basin

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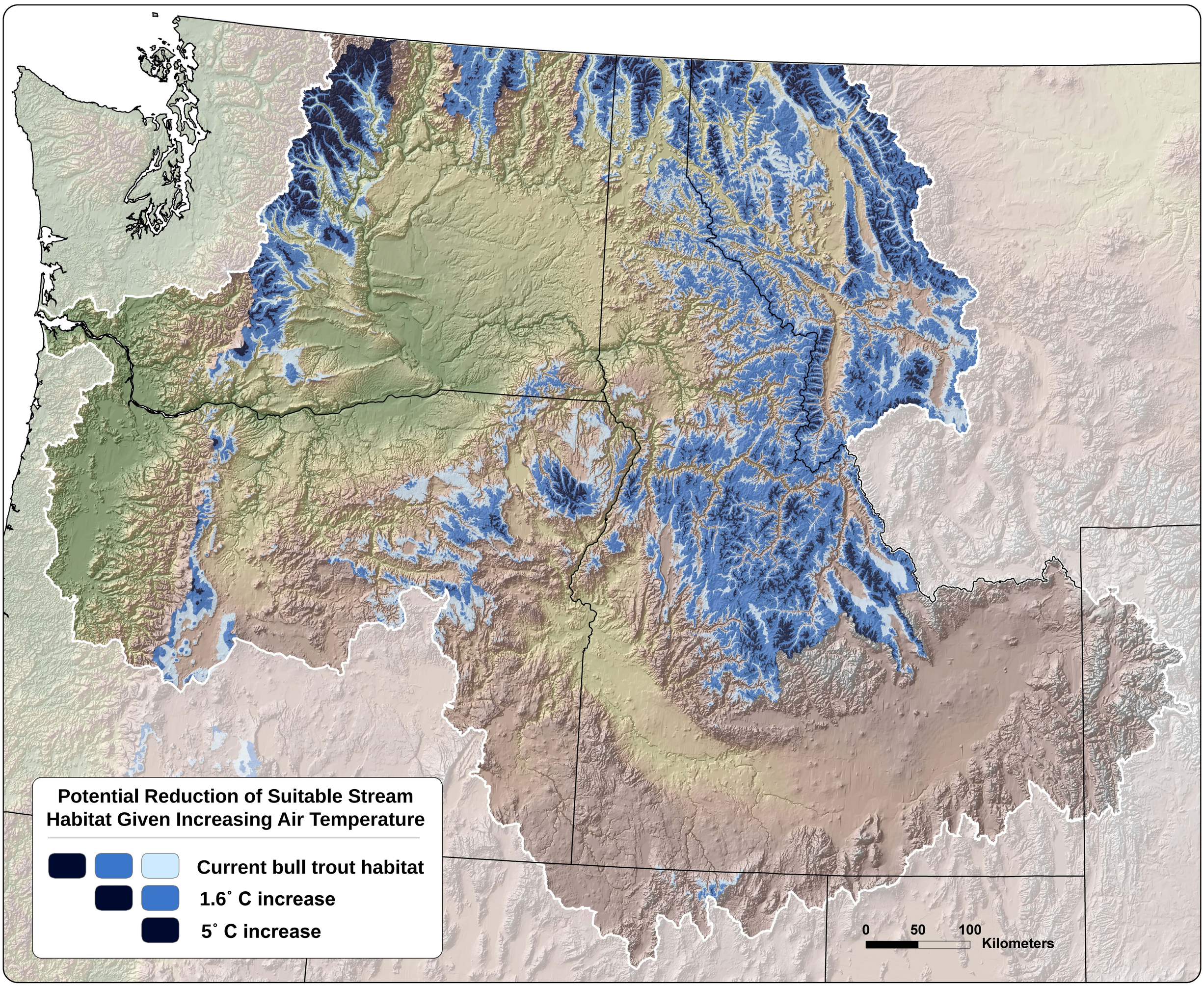

Bull Trout Habitat Mapping

This map depicts potential losses of stream habitat suitable for bull trout spawning and rearing under air temperature increases projected for global warming. Current habitat is represented by all composite shades of blue, whereas estimated future habitat is depicted by successively darker regions.

To develop the model that predicted current bull trout distribution, we gathered information from published accounts and management surveys that defined the lower elevation limit of juvenile bull trout (< 150 mm) along a longitudinal profile of selected streams throughout the interior Columbia Basin. This elevation was determined for 76 streams (Figure 1) and regressed against latitude and longitude to describe spatial trends across the Basin from north-to-south or east-to-west.

Juvenile Bull Trout Lower Elevation Limit
Y (meters) = 18693 - 191(latitude) + 73.6(longitude) ($R^2 = 0.74$)

Thus, for every increase of 1° latitude (longitude), bull trout distributions shift -191 m (73.6 m).

A similar regression was developed to predict the "30-year normal" mean annual air temperature from 1961 to 1990 based on latitude, longitude, and elevation. Air temperatures were measured at 191 weather stations across the interior Columbia Basin.

Mean Annual Air Temperature
Y (C) = 67 - 0.86(latitude) + 0.12(longitude) - 0.0062(elevation) ($R^2 = 0.89$)

To check for similarity with trends in bull trout distributions, the air temperature equation was used to calculate the elevation change for a constant temperature across a degree of latitude (and longitude). Thus, for every 1° latitude (longitude), a given mean annual air temperature shifts - 138 m (88 m).

Concordance between the latitude-longitude parameters in both models suggested bull trout distributions tracked mean annual air temperatures. Future distributions of bull trout were mapped by adjusting the current distribution limits upwards by 250 m and 800 m to represent 1.6 C and 5°C air temperature increases, respectively. The air temperature lapse rate was determined from the mean annual air temperature equation.

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Anticipated Climate Warming Effects on Bull Trout Habitats and Populations Across the Interior Columbia River Basin

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Abstract.—A warming climate could profoundly affect the distribution and abundance of many fishes. Bull trout *Salvelinus confluentus* may be especially vulnerable to climate change given that spawning and early rearing are constrained by cold water temperatures creating a patchwork of natal headwater habitats across river networks. Because the size and connectivity of patches also appear to influence the persistence of local populations, climate warming could lead to increasing fragmentation of remaining habitats and accelerated decline of this species. We modeled the relationships between (1) the lower elevation limits of small bull trout and mean annual air temperature and (2) latitude and longitude across the species' potential range within the interior Columbia River basin of the USA. We used our results to explore the implications of the climate warming expected in the next 50 or more years. We found a strong association between the lower elevation limits of bull trout distributions and longitude and latitude; this association was consistent with the patterns in mean annual air temperature. We concluded that climate does strongly influence regional and local bull trout distributions, and we estimated bull trout habitat response to a range of predicted climate warming effects. Warming over the range predicted could result in losses of 18–92% of thermally suitable natal habitat area and 27–99% of large (>10,000-ha) habitat patches, which suggests that population impacts may be disproportionate to the simple loss of habitat area. The predicted changes were not uniform across the species' range, and some populations appear to face higher risks than others. These results could provide a foundation for regional prioritization in conservation management, although more detailed models are needed to prioritize actions at local scales.

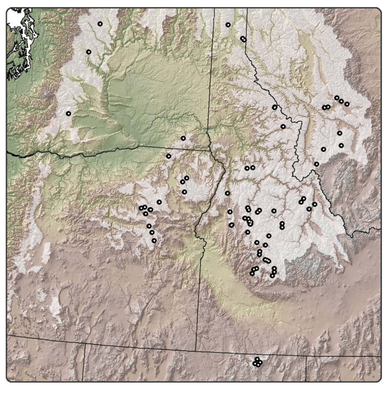
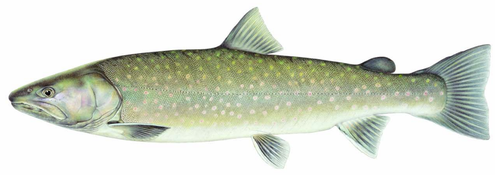


Figure 1. Sample points identified as the lower limit for bull trout in 76 study streams. Points are overlain on the current modeled lower limit extent.



Joseph Tomelleri

Bull Trout
(*Salvelinus confluentus*)

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Additional maps, data, and information for this poster are available at:

http://www.fs.fed.us/rm/boise/AWAE/projects/stream_temperature.shtml