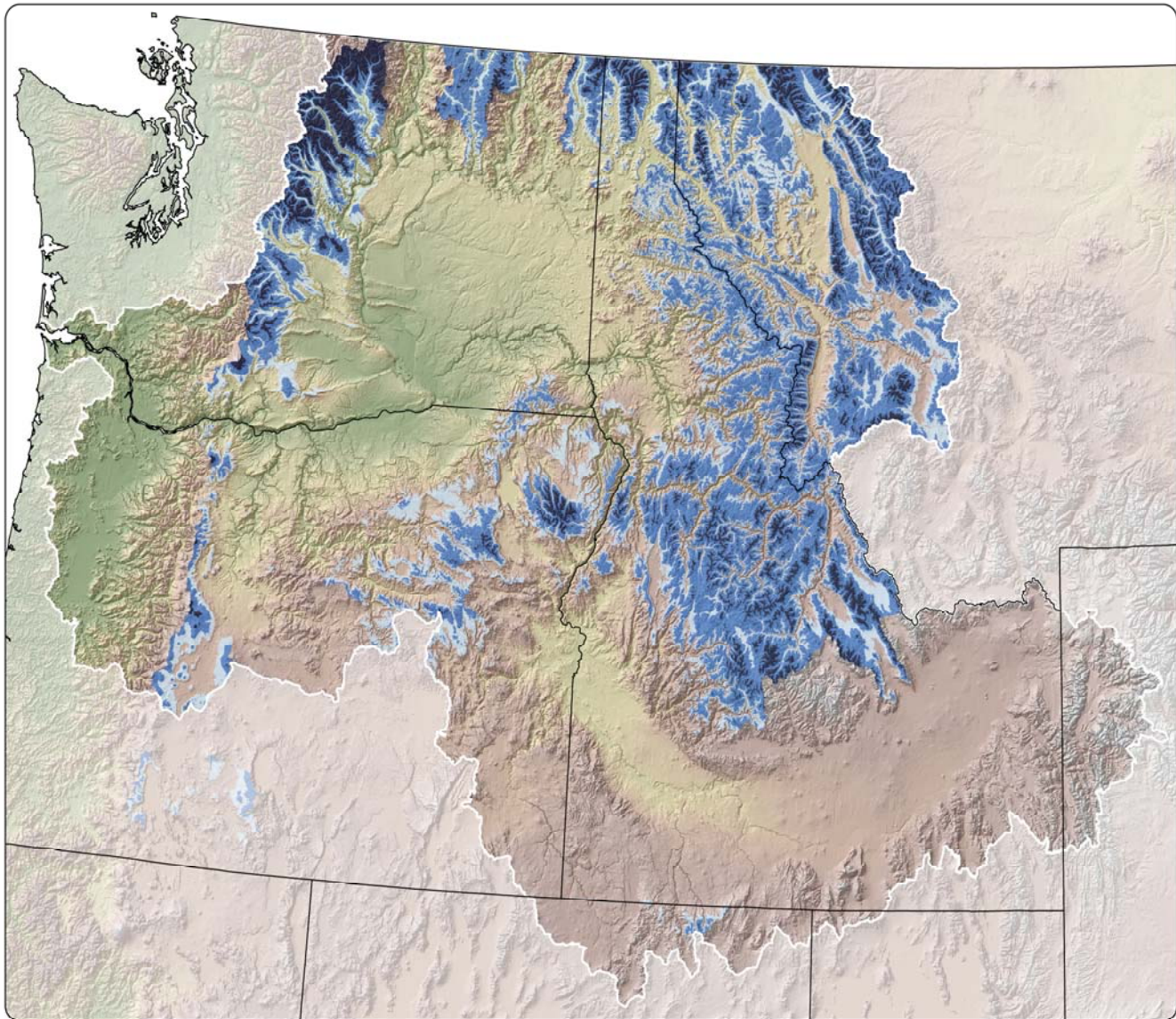








Thermally Suitable Natal Stream Habitat for Bull Trout Current and Projected Climate Conditions

Columbia River Basin



Thermally Suitable Habitat

-    Current bull trout habitat
-   1.6° C air temperature increase
-  5° C air temperature increase

Bull Trout Habitat Mapping

This map depicts a loss of suitable natal stream habitat for bull trout in the Columbia River Basin, based on a predicted warming trend.

Stream temperature habitat distributions are modeled using mean annual air temperature, elevation, latitude and longitude.

Future habitat predictions are governed by estimated increases in mean annual air temperature.

On this map, current habitat is represented by all composite shades of blue, whereas estimated future habitat is depicted by successively darker regions.

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[Article]

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 habitats linked across river networks. Because the size and connectivity of patches that appear to influence the persistence of local populations, climate warming could lead to increasing fragmentation of remaining habitat and accelerated decline of this species. We modeled the relationships between (1) the lower elevation limits of small head water and main-stem air temperature and (2) latitude and longitude across the species' potential range within the interior Columbia River basin of the U.S. We used our results to explore the implications of the climate warming expected in the next 50 or more years. We found a strong correlation between the lower elevation limits of bull trout distributions and longitude and latitude; this correlation was consistent with the pattern in mean annual air temperature. We concluded that climate change strongly influences surface 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 14–67% of thermally suitable natal habitat area and 27–90% of large (>1000 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 would provide a foundation for regional prioritization in conservation management, although more detailed models are needed to prioritize actions at local scales.

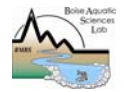
Distribution shifts in many species (Peterson and Yohe 2003; Root et al. 2003) and environmental trends consistent with broad-scale warming (Stocker et al. 2002a; Stewart et al. 2005; Weaferling et al. 2006; Hansen and Lernerstein 2007) show that climate change is no longer an abstraction. Official statistics compiled by the Intergovernmental Panel on Climate Change (IPCC) suggest these trends were associated with a 1.8°C warming during the 20th century (IPCC 2007). Predictions of future global climates suggest larger and faster changes, and current models project a minimum warming of 1°C in mean annual or seasonal air temperatures over the next 50 years and possibly a 5°C increase by 100 years (Rohrer et al. 1992; Egan 1997; IPCC 2007). Similar scenarios hold for predictions downriver to the Columbia River basin, where models project warmings of 1.2–2°C or more by 2050 (Liang et al. 2004; Mao et al. 2006).

A warming climate can have important effects on the regional distribution and local extent of habitats available to salmonids (Moser 1990; Keltner and Rabold 1996; Nakano et al. 1996; Rabold et al. 1996) and other fishes (Stearns and Moser 1992; Egan and Schlobo 1996) because local climate influences surface water (Stephan and Friedl 1993; Stepien and Jones 1996; Melstree and Stefan 1999) and groundwater temperatures (Moser 1990; Stearns and Moser 1992). For coldwater fishes near the southern margin



Joseph Tomelleri

Bull Trout
(*Salvelinus confluentus*)



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