Climate Shield Cold-Water Refuge Streams for Bull Trout

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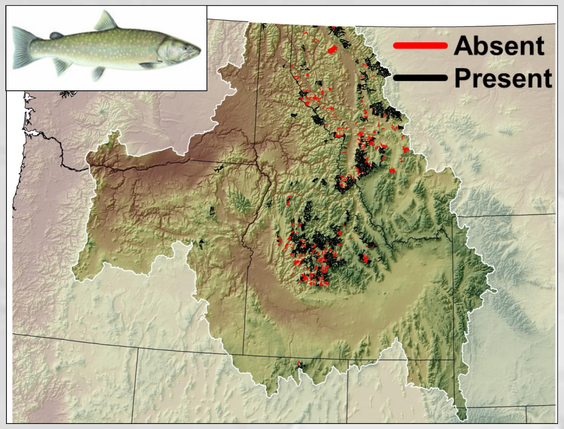
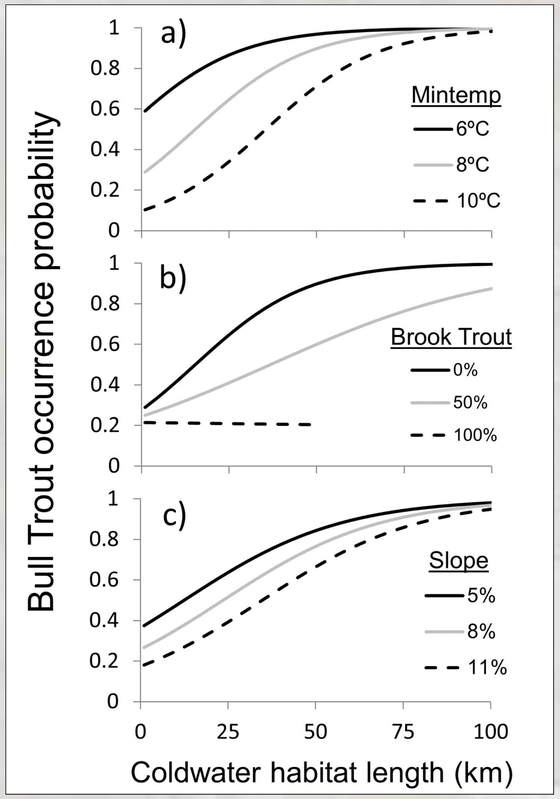


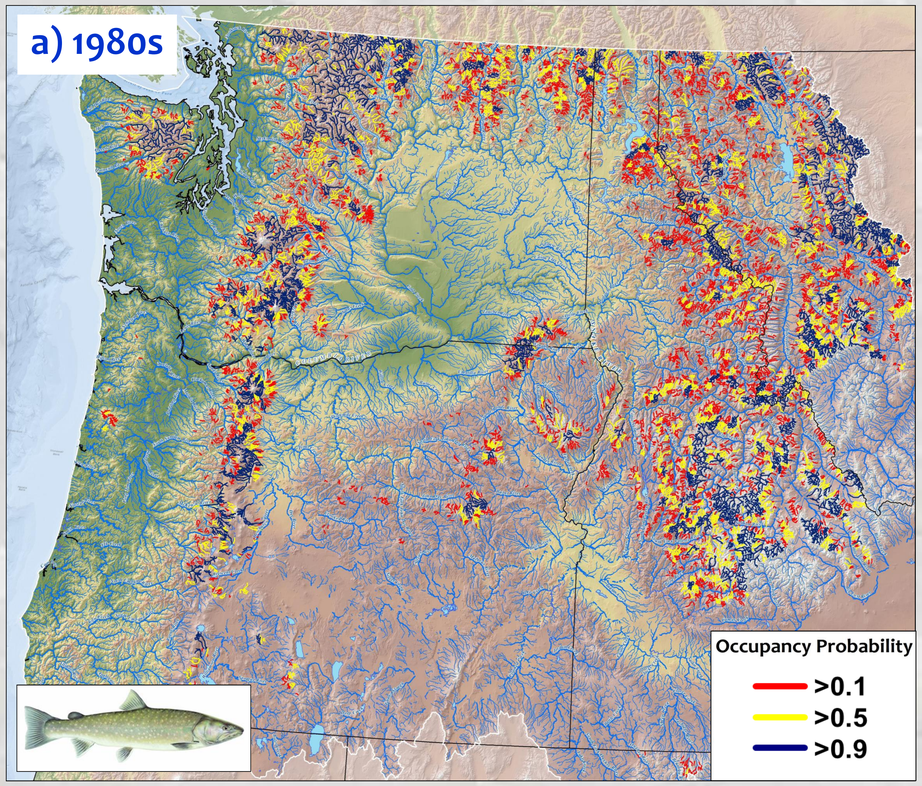
Figure 1. Cold-water streams <11°C (n = 512) where the occurrence of juvenile Bull Trout (<150 mm) was determined from 4,608 site surveys contributed by agency biologists (MTGFP, IDFG, and USFS) and described in numerous peer-reviewed studies. The occurrence of juvenile Bull Trout within a cold-water habitat was taken as evidence of a reproducing population.

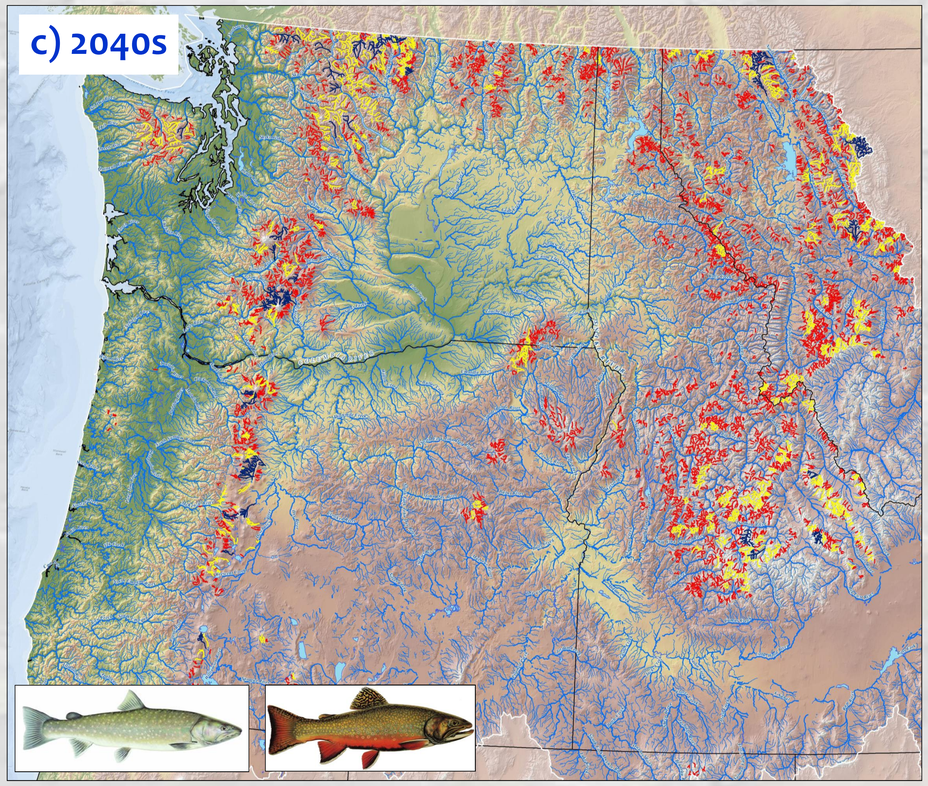
Fish data providers:

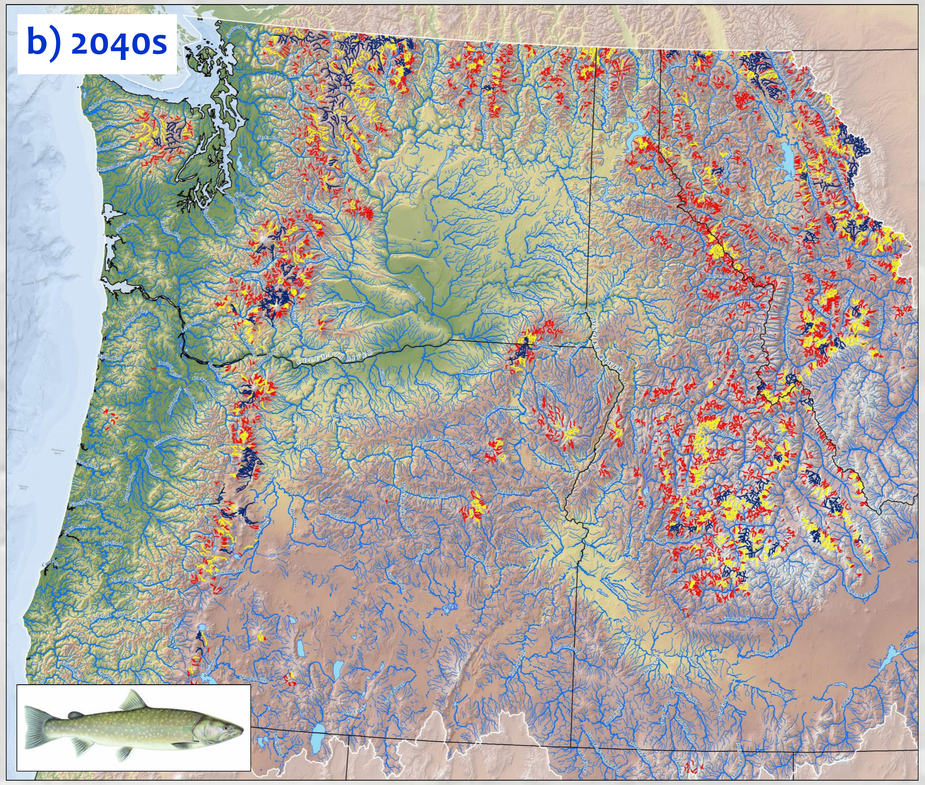
Figure 2. Attributes of the cold-water streams shown above (habitat length, minimum temperature within a stream, channel slope, and Brook Trout prevalence (% of sites within a habitat)) were used as variables in a logistic regression model to predict the probability of juvenile Bull Trout occurrence. The model correctly predicted occurrence in 78% of the 512 streams and was particularly good at identifying climate refugia, which were defined as streams with >0.9 occupancy probabilities (78 of 81 >0.9 streams were actually occupied). Bull Trout required 50-100 kilometers of cold-water stream habitat, on average, to reach the 0.9 probability threshold.



The maps below show cold-water streams (mean summer temperatures <11°C) within the range of Bull Trout that are too cold to be invaded by Brown Trout or Rainbow Trout during different climate periods. The streams are color coded based on their probabilities of occupancy by juvenile Bull Trout, which were predicted using the logistic regression model developed from the dataset described on the left (Figures 1 and 2). The first map shows probabilities in a baseline climate period (1980s) assuming Brook Trout did not occur in any stream (panel a). The subsequent maps show Bull Trout probabilities for a mid-century climate scenario with and without a broad regional Brook Trout invasion (panels b and c).







The large size of cold-water habitats that Bull Trout populations often require to persist mean that few such habitats exist. Climate change is shrinking and warming those habitats and forcing the species to retreat to higher elevations. Ironically, the extreme cold of Bull Trout habitats also acts as a "climate shield" to preclude invasions by all other species except Brook Trout. Although Bull Trout are likely to continue declining this century, some refuge streams with high probabilities of supporting self-sufficient populations will remain. Most refuge streams occur on public lands (>90%) where few are formally protected (<15%) within Wilderness Areas or National Parks. Forecasts of refuge locations could be used to protect key watersheds, provide a basis for climate-smart conservation networks, and rally support among multiple stakeholders concerned with securing the future of Bull Trout in the Northern Rocky Mountains. More details about Climate Shield research are provided in the manuscripts below and at the project website where high-resolution digital maps and ArcGIS shapefiles are available for convenient use in conservation planning.

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Climate Shield website: http://www.fs.fed.us/rm/boise/AWAE/projects/ClimateShield.html

References

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Isaak D., M. Young, D. Nagel, and D. Horan. 2014. Cold-water as a climate shield to preserve native trout through the 21st Century. Pages 110-116 *in* R. F. Carline and C. LoSapio, editors. Wild Trout XI: Looking Back and Moving Forward. Wild Trout Symposium, West Yellowstone, Montana.