APPENDIX A. Availability of Stream Temperature and Discharge Data for Climate Assessments

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The quality of a climate change assessment depends heavily on the quality of information about the climatic conditions that constrain populations within the area of interest. For stream organisms, "climate" manifests most directly through the local thermal and hydrologic regimes. Early climate assessments often represented these factors using variables like air temperature, elevation, and latitude but the growing availability of inexpensive and reliable sensors, stream databases, and analytical techniques is rapidly improving the amount and accuracy of climate data available for streams. In our Bull Trout BN, for example, we used temperatures predicted from a new type of spatial statistical stream network model (Peterson et al. 2007; Ver Hoef and Peterson 2010; Ver Hoef et al. 2012) that was fit to a temperature database compiled from several resource agencies (Isaak et al. 2010; Figure A1). Spatial network models may be especially promising for such applications because they account for autocorrelation among non-random, clustered samples that often characterize such databases but provide unbiased parameter estimates and more accurate predictions than many non-spatial techniques. However, a wide variety of statistical and mechanistic models are available for modeling stream temperatures (Caissie 2006; Webb et al. 2008; Wehrly et al. 2009) and are now being used in many areas (e.g., Flint and Flint 2008; Lyons et al. 2009; McKenna et al. 2010; van Vliet et al. 2011; Ficklin et al. 2012).

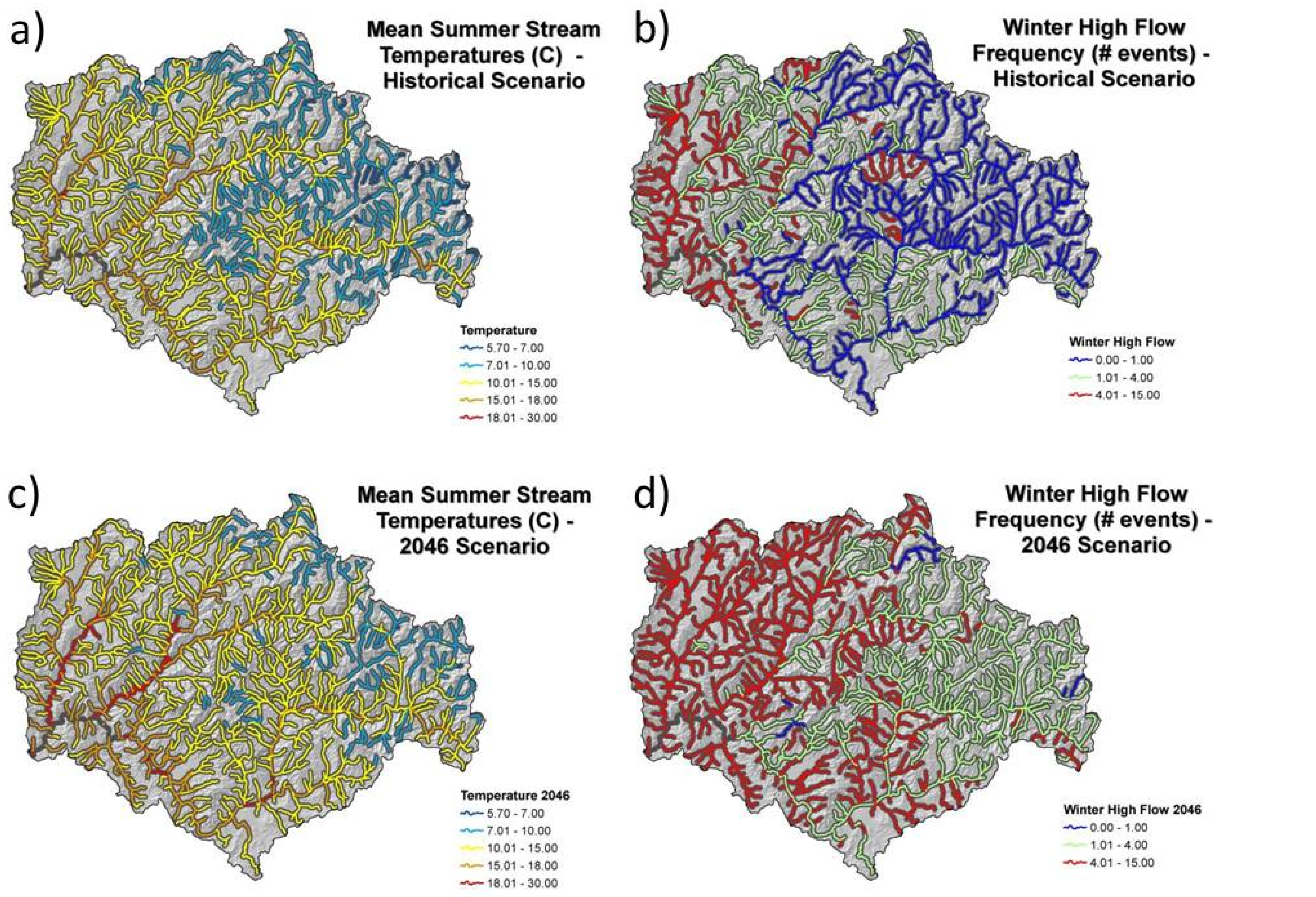

Figure A1. Maps of mean summer stream temperature and winter high flow (w95) in the Boise River Basin during historical and 2040s climate scenarios. These were among the individual variables integrated into the Bull Trout BN which was used to map the probability of occupancy across the basin.

For information about stream discharge in our BNs, we used flow metrics derived from the mechanistic Variable Infiltration Capacity (VIC) hydrologic model (Liang et al. 1994; Hamlet and Lettenmaier 2007) after it had been validated for making predictions in small, headwater streams (Wenger et al. 2010; Wenger et al. 2011; Figure A1). Similar flow metric predictions have been made for both historical and future climate conditions for most stream segments within the NHD+ national hydrography layer (Cooter et al. 2010) across the western U.S. and are archived online for easy access (http://www.fs.fed.us/rm/boise/AWAE/projects/modeled_stream_flow_metrics.shtml). As with stream temperature models, a variety of hydrologic models are available in different areas and outputs from these models could be linked to biological parameters in climate vulnerability assessments (Storck et al. 1998; Ajami et al. 2004; Gassman et al. 2007).

Regardless of which models are selected to provide information about stream temperature and discharge, all require empirical measurements for calibration. For discharge data, the best source is the U.S. Geological Survey National Water Information System (NWIS; http://waterdata.usgs.gov/nwis/) that provides real-time and historical information from a national network of flow gages (Falcone et al. 2010). Comparable stream temperature databases that consist of long-term monitoring records are rare (Kaushal et al. 2010; Isaak et al. 2011) but large amounts of short-term temperature data (i.e., 1 – 3 years' duration) often exist and efforts are underway in many places to develop regional databases and establish better monitoring networks. For both stream temperature and discharge, modern digital sensors make data collection routine and inexpensive (Stone and Hotchkiss 2007; Isaak and Horan 2011) and expansion of these data types is occurring rapidly (Porter et al. 2012).

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