Comparison of Bull Trout Spawning and Juvenile Rearing Areas in Washington with Analysis of Snow Pack Depth as a Possible Cause for Habitat Decline

Introduction

In 1998, Bull Trout (*Salvelinus confluentus)* were listed as threatened under the Endangered Species Act. Since then, populations have been declining, assumed to be largely due to increasing stream temperatures, along with habitat fragmentation and degradation. Bull trout have specific habitat requirements, and temperature plays a large role in egg viability and overall health of the species. They spawn in the Fall, typically associated with a drop in temperature to between 5 and 9°C. These eggs incubate for 4 to 5 months over the winter, and for this reason they are particularly vulnerable to low flows, scouring, and ice accumulation. The optimum temperatures for incubation range from 2°C to 4°C, and spawning areas are usually found associated with springs and subsurface flows due to more stable temperature ranges throughout the year. With increasing global temperatures due to climate change, snow pack accumulation is declining. This paper explores the hypothesis the declining snow pack accumulation can be correlated with declining Bull Trout populations and spawning distribution in Washington due to the existing correlation between snow pack and stream temperature.

Study Area and Datasets

The study area chosen for analysis was Washington State with emphasis on the Cascade Range due to location of SNOTEL stations for data availability. Snow pack data was found on the USGS SNOTEL service. Historical Bull Trout distribution data was acquired from Streamnet.org and consists of 2004 distribution in Washington. Current distribution data was also obtained from Streamnet.org and consisted of a 2012 dataset for the northwest region that included Idaho, Oregon and Montana.

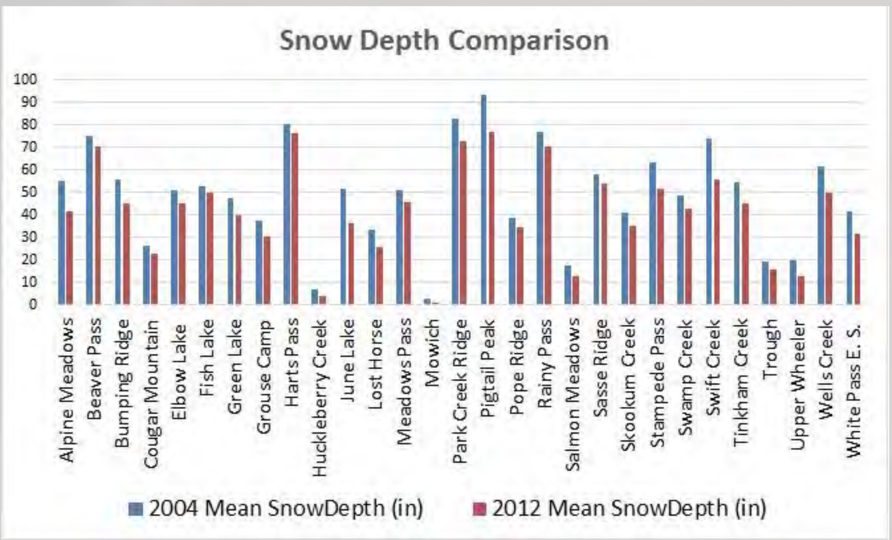
Methods

The first step in the process, gathering data, proved to be difficult. Particularly, it was hard to find historical Bull trout distribution data. The 2004 data was finally acquired, and had to be used to represent historical distribution. The goal was to find data that was at least 10 years apart for the current/historical comparison, but historical data on this species is limited. The 2012 data was then found, and the attribute tables of both were examined. I first clipped the data to the Washington state boundary to eliminate the Idaho, Oregon and Montana data. The distribution data for both datasets then was separated into different life histories (Fluvial, Adfluvial, Migratory, Resident) as well as Use Types (spawning, Juvenile Rearing, Migration Corridors, Foraging). After selecting by attribute for the different use types and creating layers, it became apparent that the main change in distribution was found in the Spawning and Juvenile Rearing areas and the project became focused. The sum of the stream length for the spawning areas was then calculated for both years. The next step was to acquire the snow accumulation data. A shapefile for the SNOTEL station locations for Washington was found, along with snow depth data for those stations. I then created an excel spreadsheet and manually input the now depth data for December 2003, January 2004, February 2004, December 2011, January 2012, and February 2012. These months best represented the Winter season and snow pack accumulation, as well as the incubation period for the Bull trout embryos. I then calculated the mean for each season. Fields were added to the attribute table for the site location layer, and the 2004 and 2012 mean snow depth values were manually entered using the Editor tool for all the stations that had data for the two years of interest. A raster surface was then interpolated using the Spline tool for the 2004 and 2012 mean snow depth data. The classification for each of these new raster was then manually made equal to allow for an accurate representation for comparison. A table was made to display the snow depth data for each station.

Station	2004 Mean SnowDepth (in)	2012 Mean SnowDepth (in)
Alpine Meadows	55	41.7
Beaver Pass	74.9	70.7
Bumping Ridge	55.9	45.3
Cougar Mountain	26.4	22.7
Elbow Lake	51.2	45.3
Fish Lake	52.8	50
Green Lake	47.3	40
Grouse Camp	37.6	30.3
Harts Pass	80.1	76.3
Huckleberry Creek	7.1	4.3
June Lake	51.6	36.3
Lost Horse	33.4	25.7
Meadows Pass	51.2	46
Mowich	3	1
Park Creek Ridge	82.9	72.7
Pigtail Peak	93.3	76.7
Pope Ridge	38.8	34.3
Rainy Pass	76.9	70.3
Salmon Meadows	17.8	13
Sasse Ridge	58	54
Skookum Creek	41.2	35
Stampede Pass	63.1	51.7
Swamp Creek	48.8	43
Swift Creek	74	56
Tinkham Creek	54.3	45.3
Trough	19.6	15.7
Upper Wheeler	19.7	13
Wells Creek	61.4	49.7
White Pass E. S.	41.8	31.7

Figure 1: This table shows the calculated mean snow accumulation depth for the 2004 and 2012 Winter season. At all 29 SNOTEL sites, the mean snow depth for 2012 was less than the depth recorded in 2004.

Figure 2: This histogram created from the table in figure 1 displays the decrease in snow accumulation between 2004 and 2012.

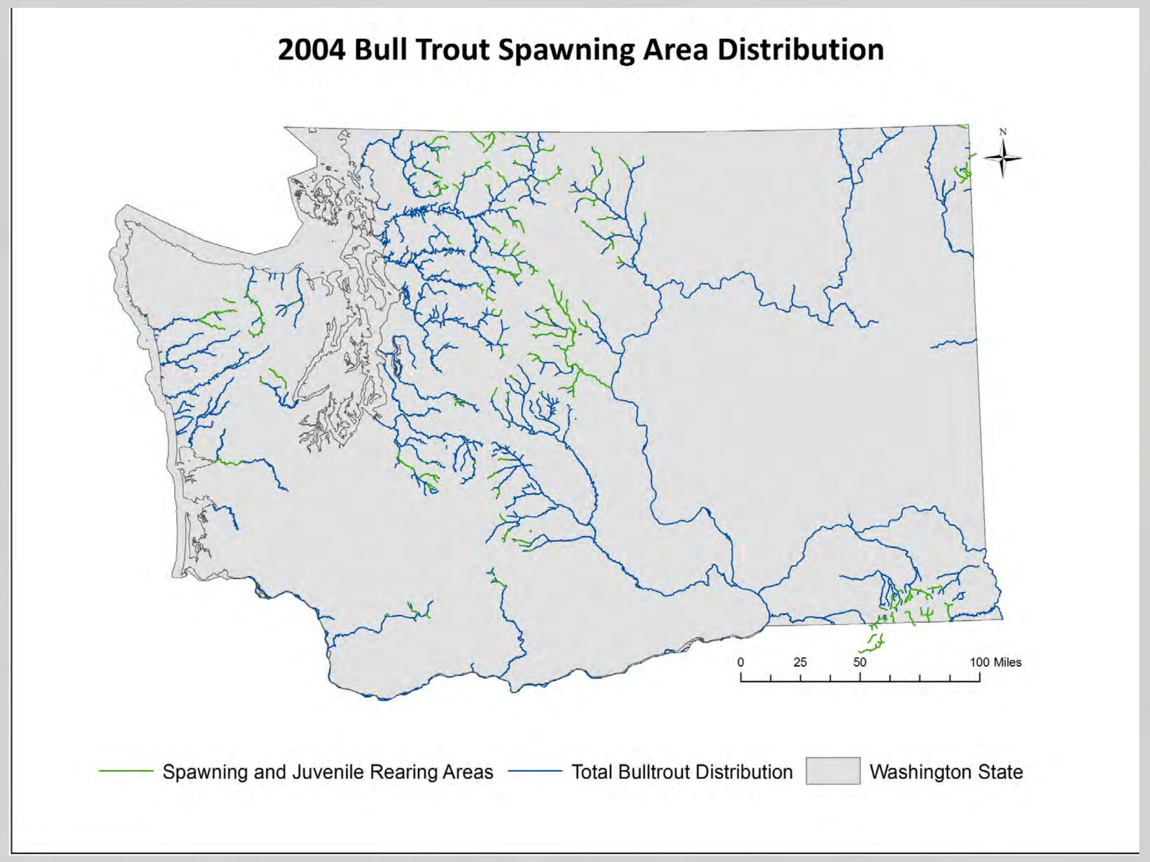


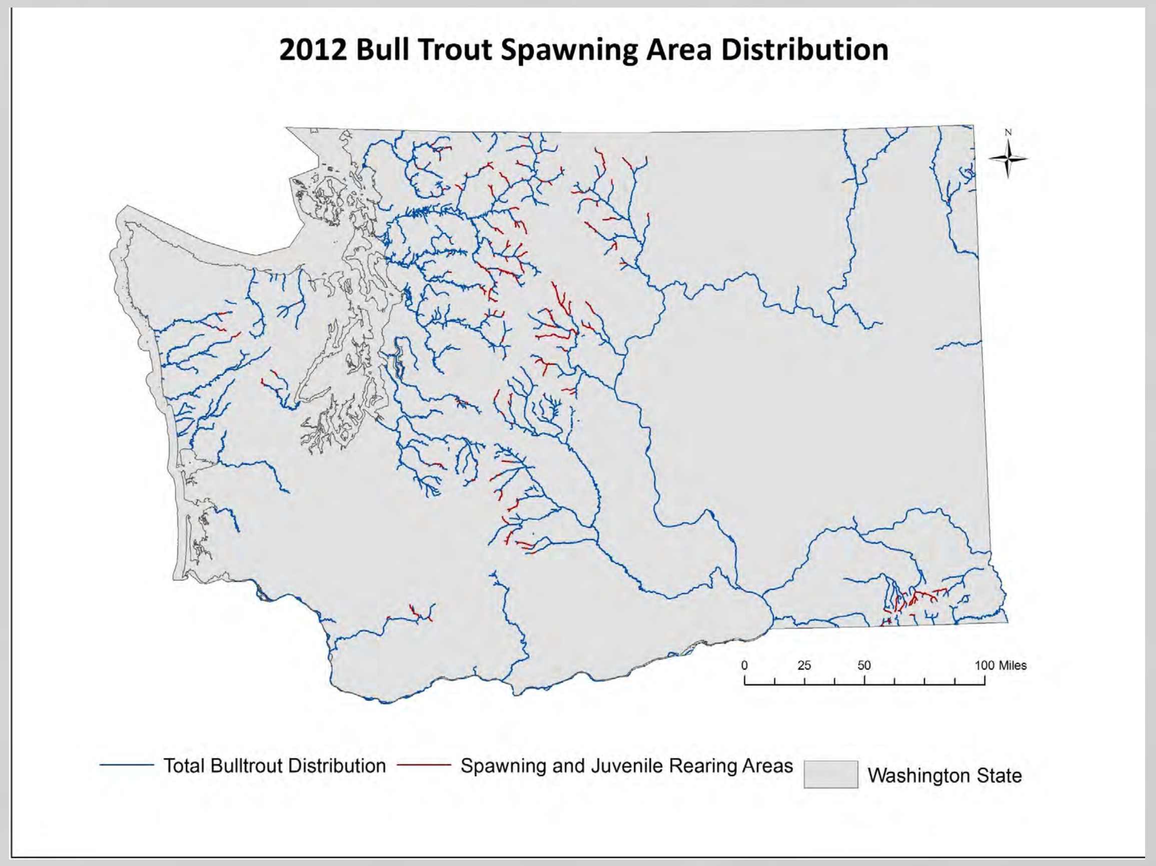
Conclusion

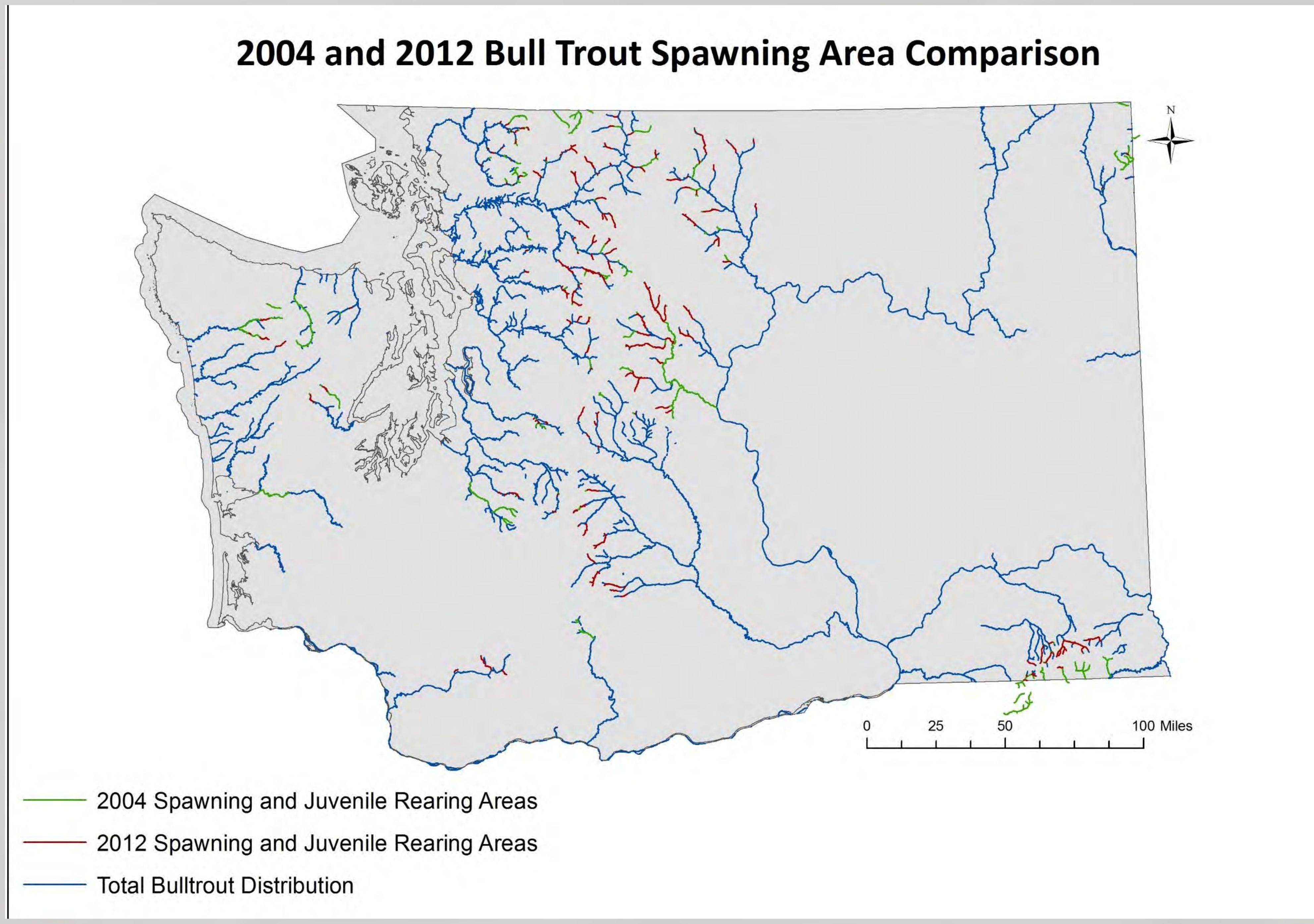
Due to lack of data, the interpolation for snow pack accumulation in this project does not appear to be very accurate. The data shows (in the table) that at most stations the snow depth declined from 2004 to 2012, however this is not the case in many areas of the interpolated raster. There is, however, an obvious decline in the distribution of the Bull trout spawning areas and a decrease in the total area used for spawning and juvenile rearing for this species. The overall distribution for all life histories and stream use types of Bull trout has remained the same. The major shortcomings of this project include a lack of available data that made analysis of the hypothesis difficult. Ideally, there should have at least been 10 years between the historical and current data. Many of the stations had not been in use as far back as 2004 and had to be eliminated from the analysis.

Given the correlation between snow pack, optimal temperature, and groundwater recharging, a reduction in snow pack due to drought or climate change could negatively affect populations. In the future I would like to factor in population data as it becomes available. A great deal more research is needed for this subject. Data for 2014/2015 was not available for Bull trout distribution, and given the extremely low snow pack levels for the 2014/2015 Winter season it will be interesting to see the change in distribution for the next survey. Calculating groundwater recharge was beyond the scope of this project, but is also something I would like to explore in the future due to the association of spawning areas with springs and groundwater. The overall conclusions of this paper are that Bull trout spawning and juvenile rearing distribution has declined over the 8years covered in this study, and that decline is likely correlated with climate change and decreasing snow pack accumulation but that correlation cannot be definitively displayed due to a lack of available data at this time.

Results





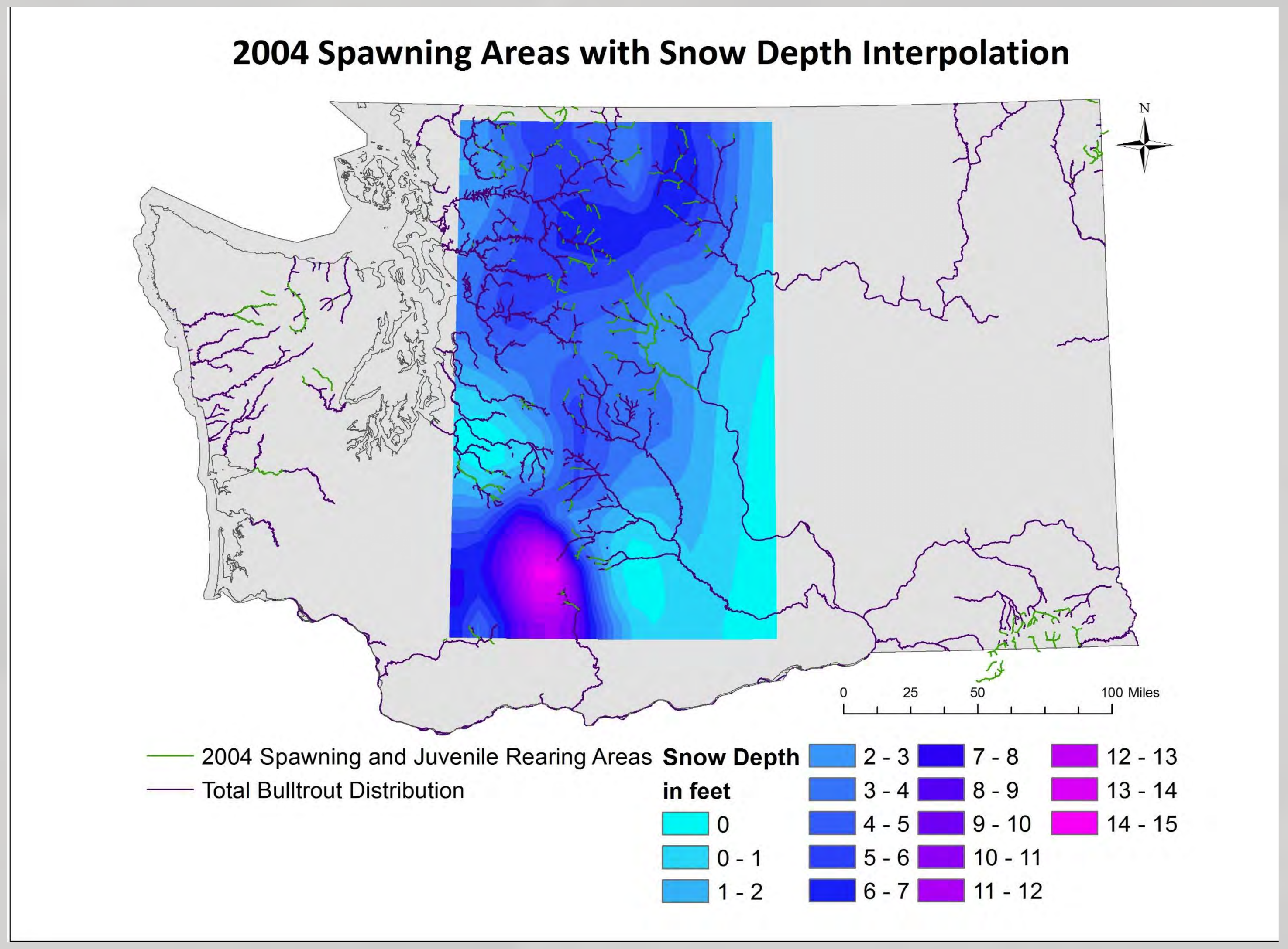


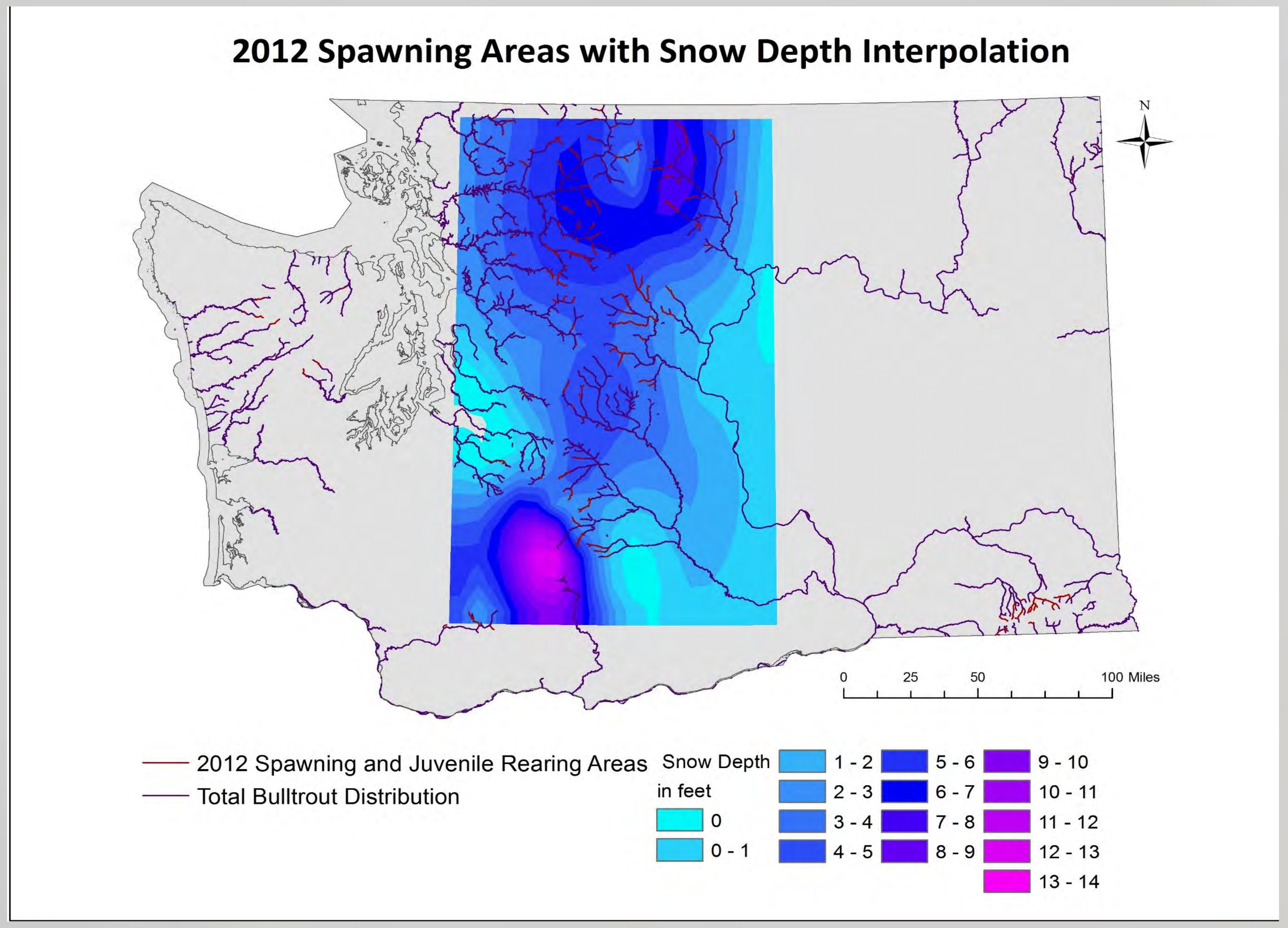
Total Spawning Area

(stream length)

2004: 961.8 Miles

2012: 527.8 Miles





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