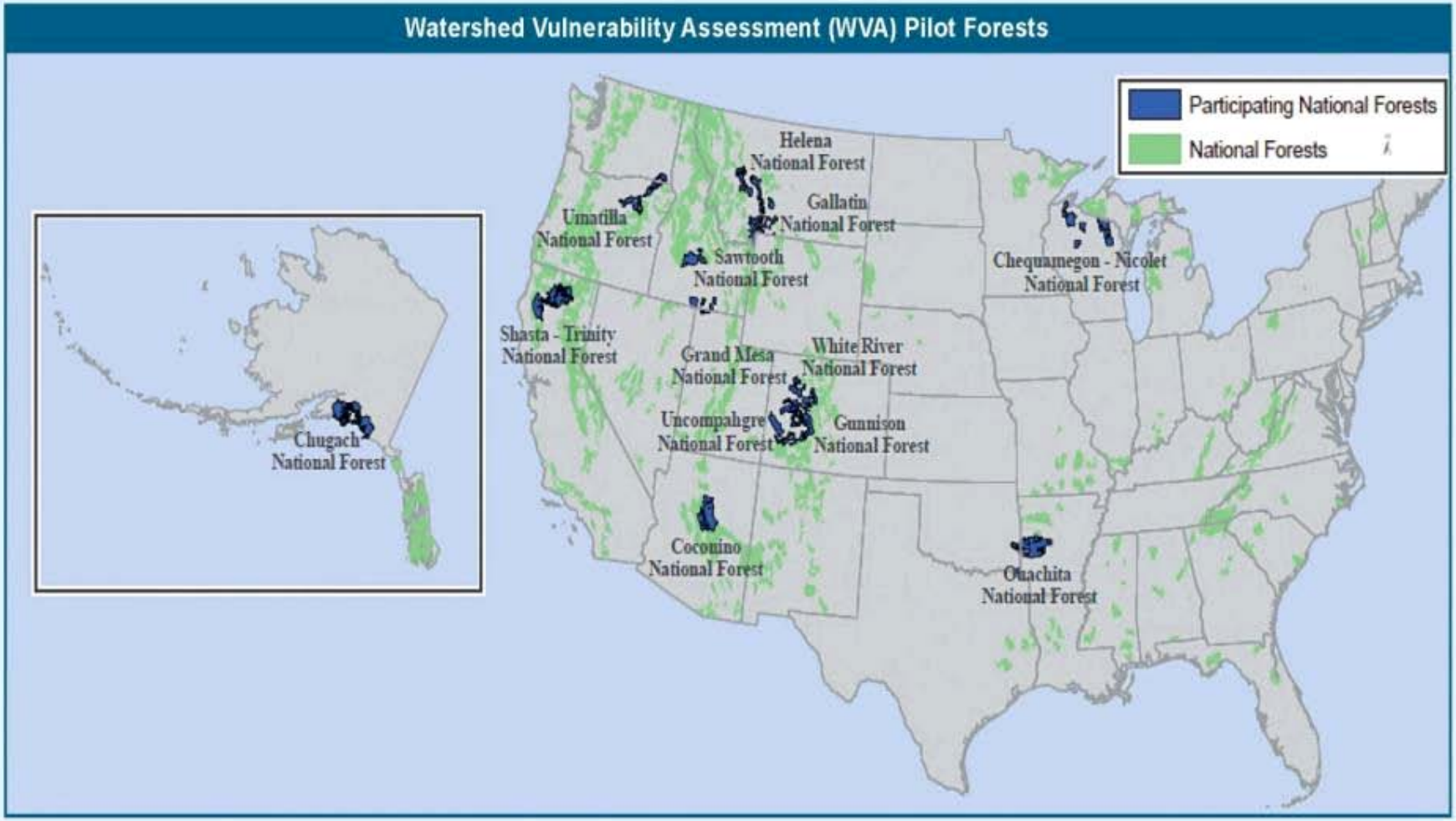
# Upper Salmon Watershed Vulnerability Assessment

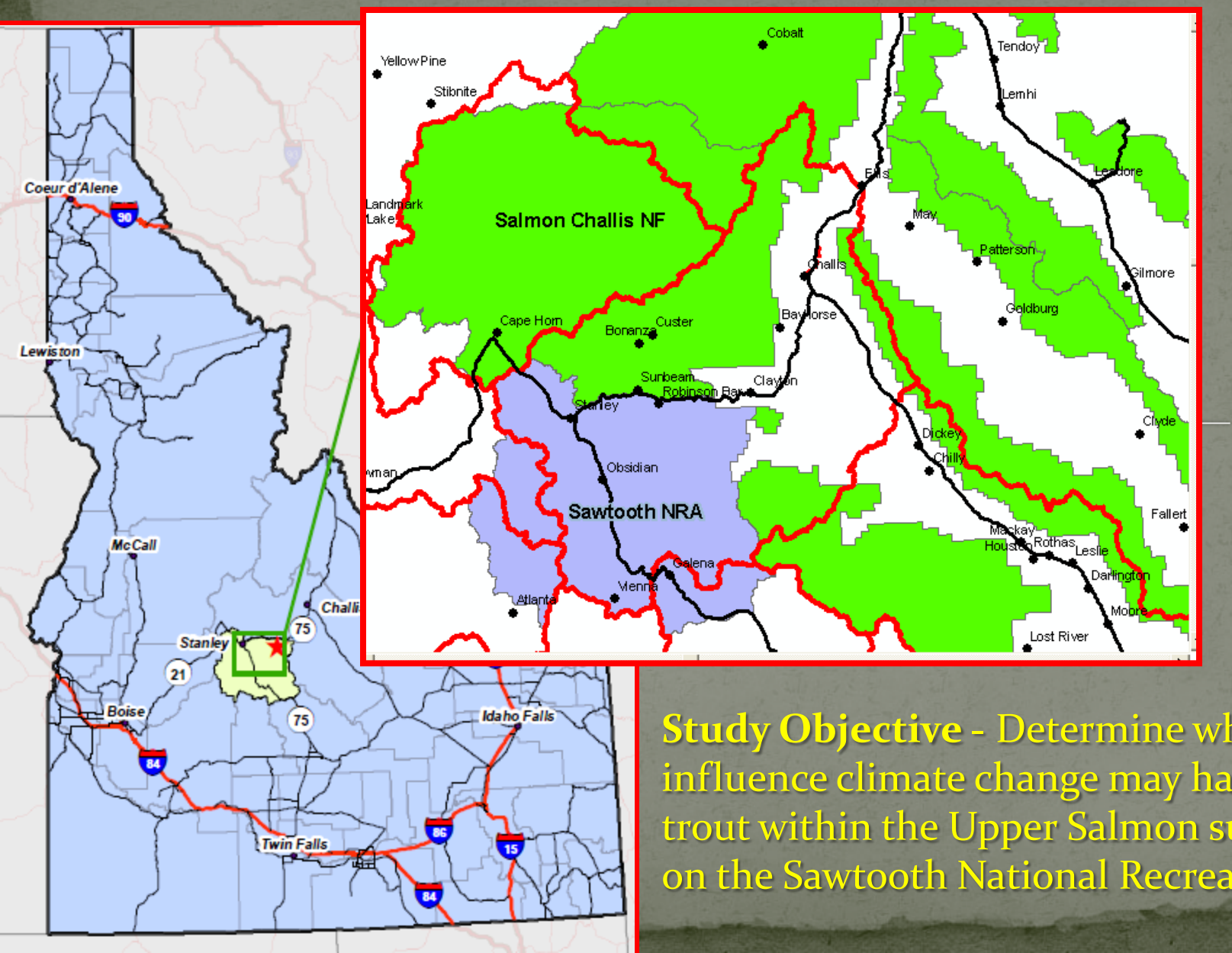

John Chatel Aquatics Program Manager

Sawtooth National Forest




**Goal - Develop a procedure that assesses watershed vulnerability to changes from climate change.**

# Sawtooth National Recreation Area



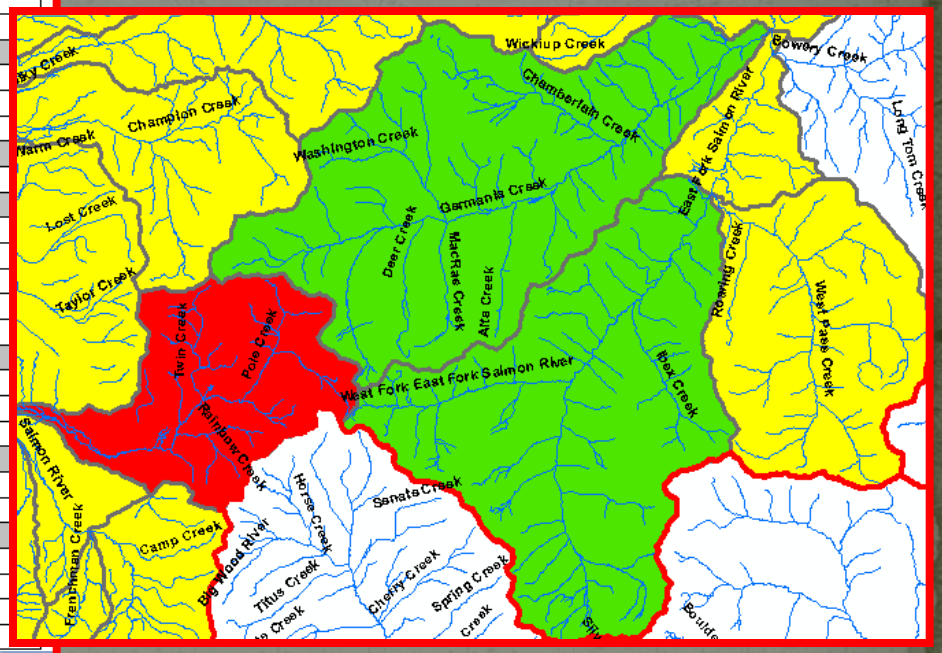

**Study Objective** - Determine what influence climate change may have on bull trout within the Upper Salmon subbasin on the Sawtooth National Recreation Area.

# Baseline

# Establishing Baselines

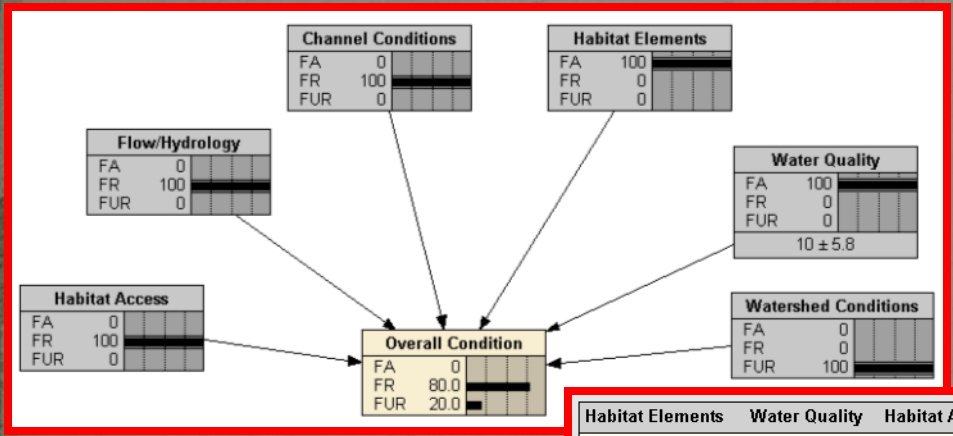
## Matrix of Pathways and Indicators

| PATHWAYS Indicators | Functioning Appropriately | Functioning At Risk | Functioning At Unacceptable Risk |
|---|---|---|---|
| **Bull Trout Population Characacteristics** | | | |
| Subpopulation Size | -- | -- | -- |
| Growth and Survival | -- | -- | -- |
| Life History | -- | -- | -- |
| Genetic Integrity | -- | -- | -- |
| **Water Quality** | | | |
| Temperature | -- | -- | -- |
| Sediment | -- | -- | -- |
| Chemical Concen./Nutrients | -- | -- | -- |
| **Habitat Access** | | | |
| Physical Barriers | -- | -- | -- |
| **Habitat Elements** | | | |
| Substrate | -- | -- | -- |
| Large Woody Debris | -- | -- | -- |
| Pool Character and Quality | -- | -- | -- |
| Off Channel Habitat | -- | -- | -- |
| Refugia | -- | -- | -- |
| **Channel Cond. /Dynamics** | | | |
| Width/Depth Ratios | -- | -- | -- |
| Streambank Condition | -- | -- | -- |
| Floodplain Connectivity | -- | -- | -- |
| **Flow/ Hydrology** | | | |
| Changes in Peak/Base Flows | -- | -- | -- |
| Drainage Network Increase | -- | -- | -- |
| **Watershed Conditions** | | | |
| Road/Density/Location | -- | -- | -- |
| Distrubance history | -- | -- | -- |
| Disturbance Regime/History | -- | -- | -- |
| Riparian Reserves | -- | -- | -- |




- Pathways broken down into watershed condition indicators (WCIs) of aquatic health.
- WCIs are described in terms of functionality (Appropriate {FA}, At Risk {FR}, and At Unacceptable Risk {FUR}).

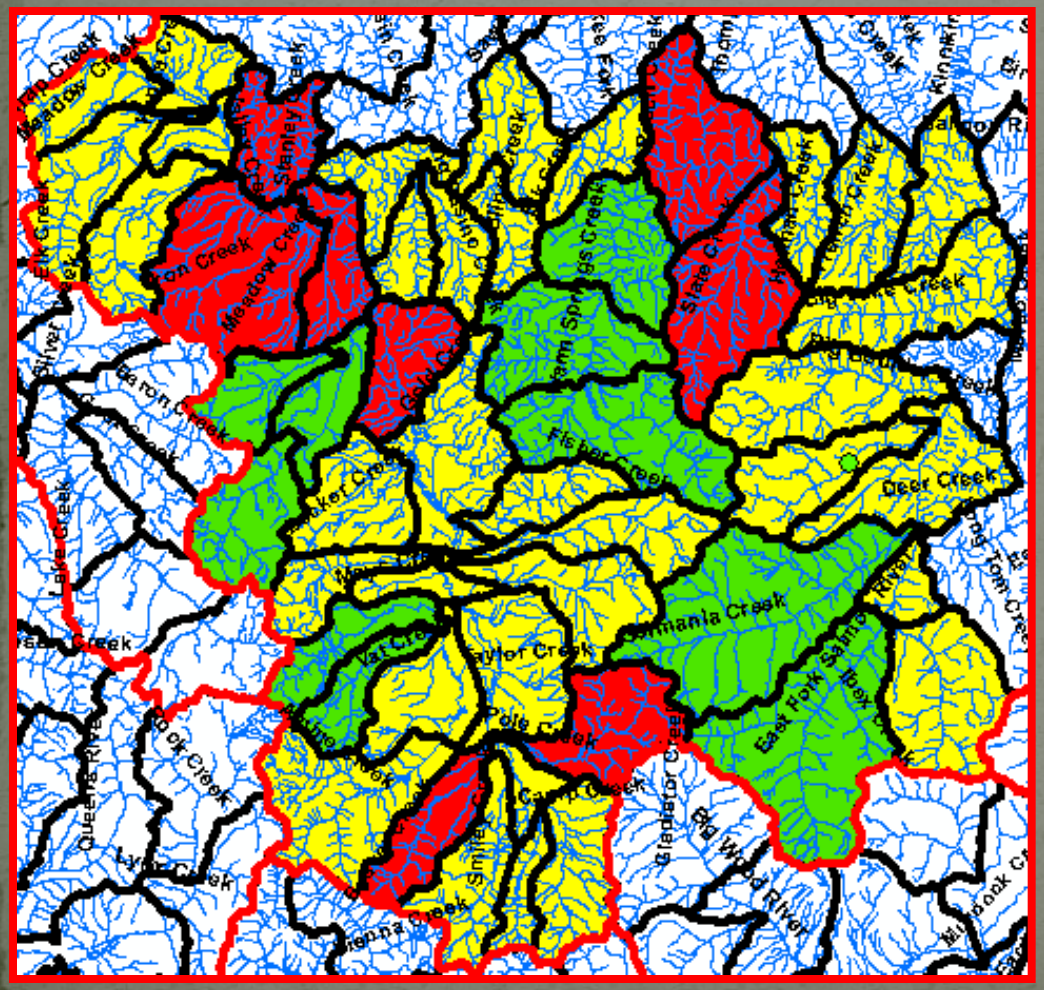
# Establishing Baselines
## (Bayesian Belief Networks)




- Depicts hypothesized causes, effects, and ecological interactions.
- Outcomes are expressed as probabilities.

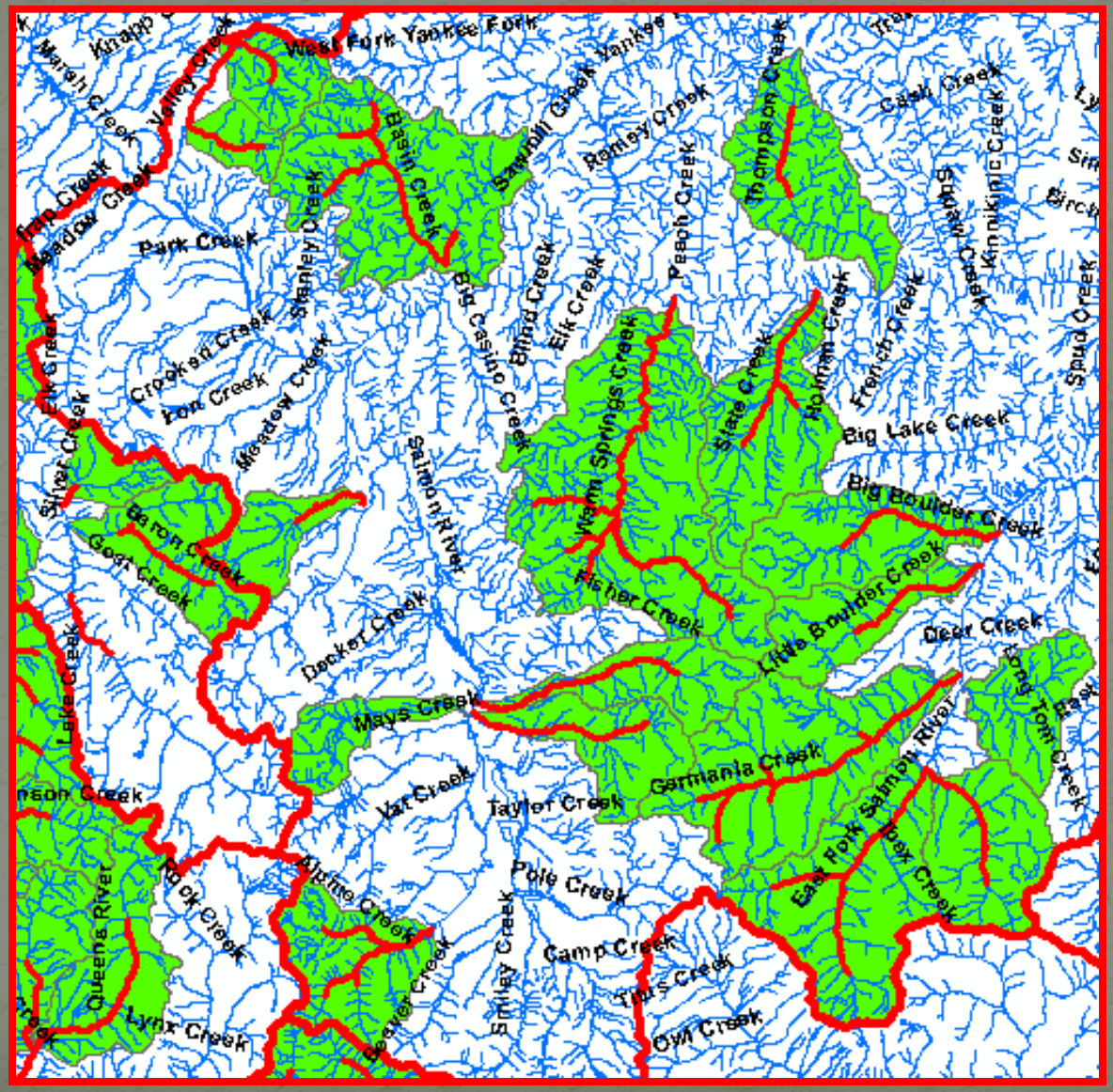
| Habitat Elements | Water Quality | Habitat Access | Channel Conditions | Flow/Hydrology | Watershed Conditions | FA | FR | FUR |
|---|---|---|---|---|---|---|---|---|
| FA | FA | FA | FA | FA | FA | 100 | 0 | 0 |
| FA | FA | FA | FA | FA | FR | 95 | 5 | 0 |
| FA | FA | FA | FA | FA | FUR | 75 | 25 | 0 |
| FA | FA | FA | FA | FR | FA | 90 | 10 | 0 |
| FA | FA | FA | FA | FR | FR | 75 | 25 | 0 |
| FA | FA | FA | FA | FR | FUR | 60 | 40 | 0 |
| FA | FA | FA | FA | FUR | FA | 75 | 25 | 0 |
| FA | FA | FA | FA | FUR | FR | 60 | 40 | 0 |
| FA | FA | FA | FA | FUR | FUR | 45 | 55 | 0 |
| FA | FA | FA | FR | FA | FA | 95 | 5 | 0 |
| FA | FA | FA | FR | FA | FR | 75 | 25 | 0 |
| FA | FA | FA | FR | FA | FUR | 60 | 40 | 0 |
| FA | FA | FA | FR | FR | FA | 55 | 45 | 0 |
| FA | FA | FA | FR | FR | FR | 50 | 50 | 0 |
| FA | FA | FA | FR | FR | FUR | 40 | 60 | 0 |
| FA | FA | FA | FR | FUR | FA | 45 | 55 | 0 |
| FA | FA | FA | FR | FUR | FR | 40 | 60 | 0 |
| FA | FA | FA | FR | FUR | FUR | 25 | 75 | 0 |
| FA | FA | FA | FUR | FA | FA | 95 | 5 | 0 |
| FA | FA | FA | FUR | FA | FR | 90 | 10 | 0 |
| FA | FA | FA | FUR | FA | FUR | 75 | 25 | 0 |
| FA | FA | FA | FUR | FR | FA | 60 | 40 | 0 |
| FA | FA | FA | FUR | FR | FR | 55 | 45 | 0 |
| FA | FA | FA | FUR | FR | FUR | 45 | 55 | 0 |
| FA | FA | FA | FUR | FUR | FA | 40 | 60 | 0 |
| FA | FA | FA | FUR | FUR | FR | 25 | 75 | 0 |
| FA | FA | FA | FUR | FUR | FUR | 10 | 40 | 50 |

# Overall Physical Condition



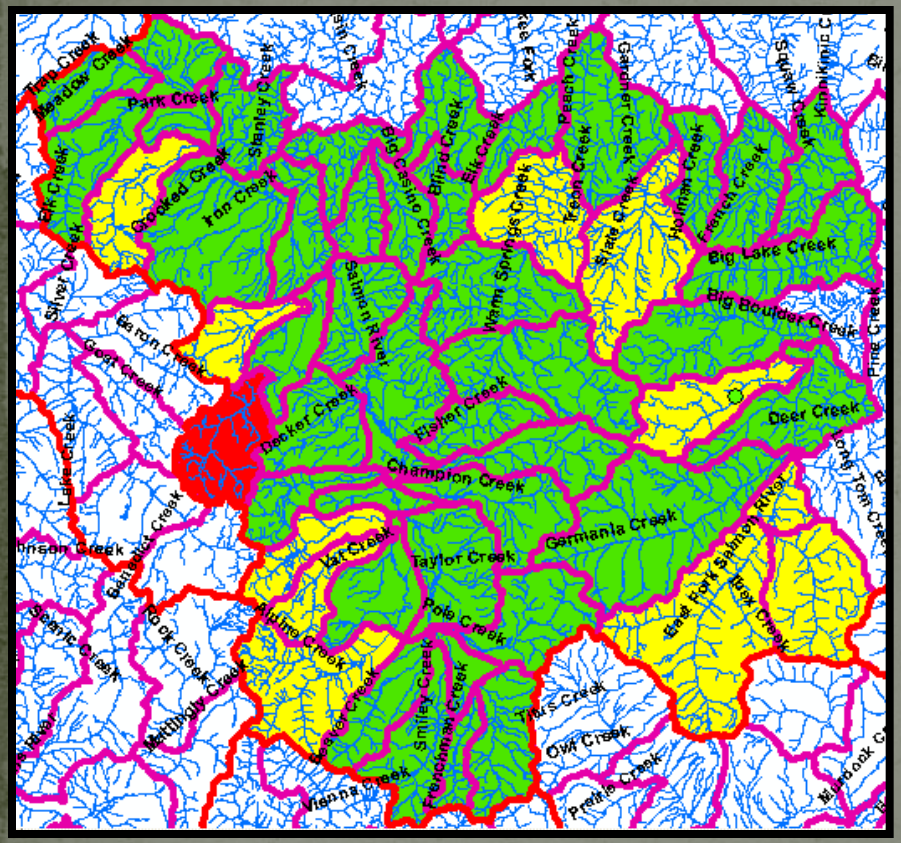

- Fish populations in better habitat conditions are more stable than populations in poorer conditions.
- Better habitat conditions may help buffer populations against some climate change effects.

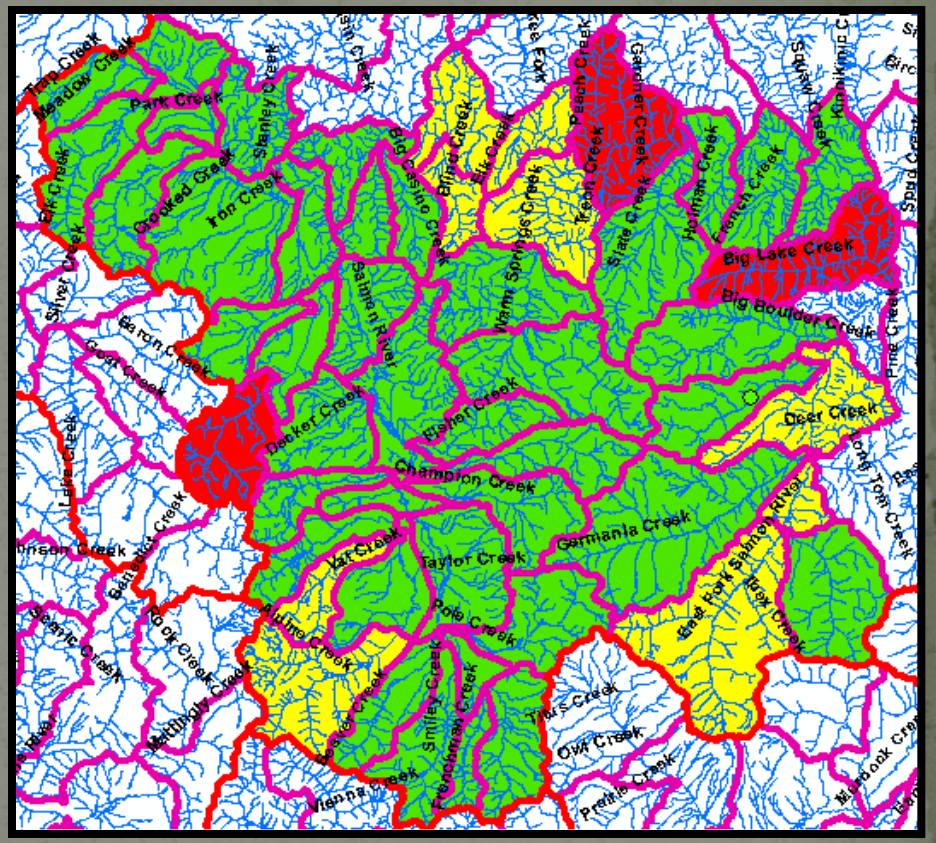
# Bull Trout Distribution



# Risks and Threats

# Risks
# (Natural Watershed Sensitivity)




**Subwatershed Vulnerability**

% of Subwatershed with Sensitive Landtypes (Inherent surface soil erosion, sediment yield and mass instability)

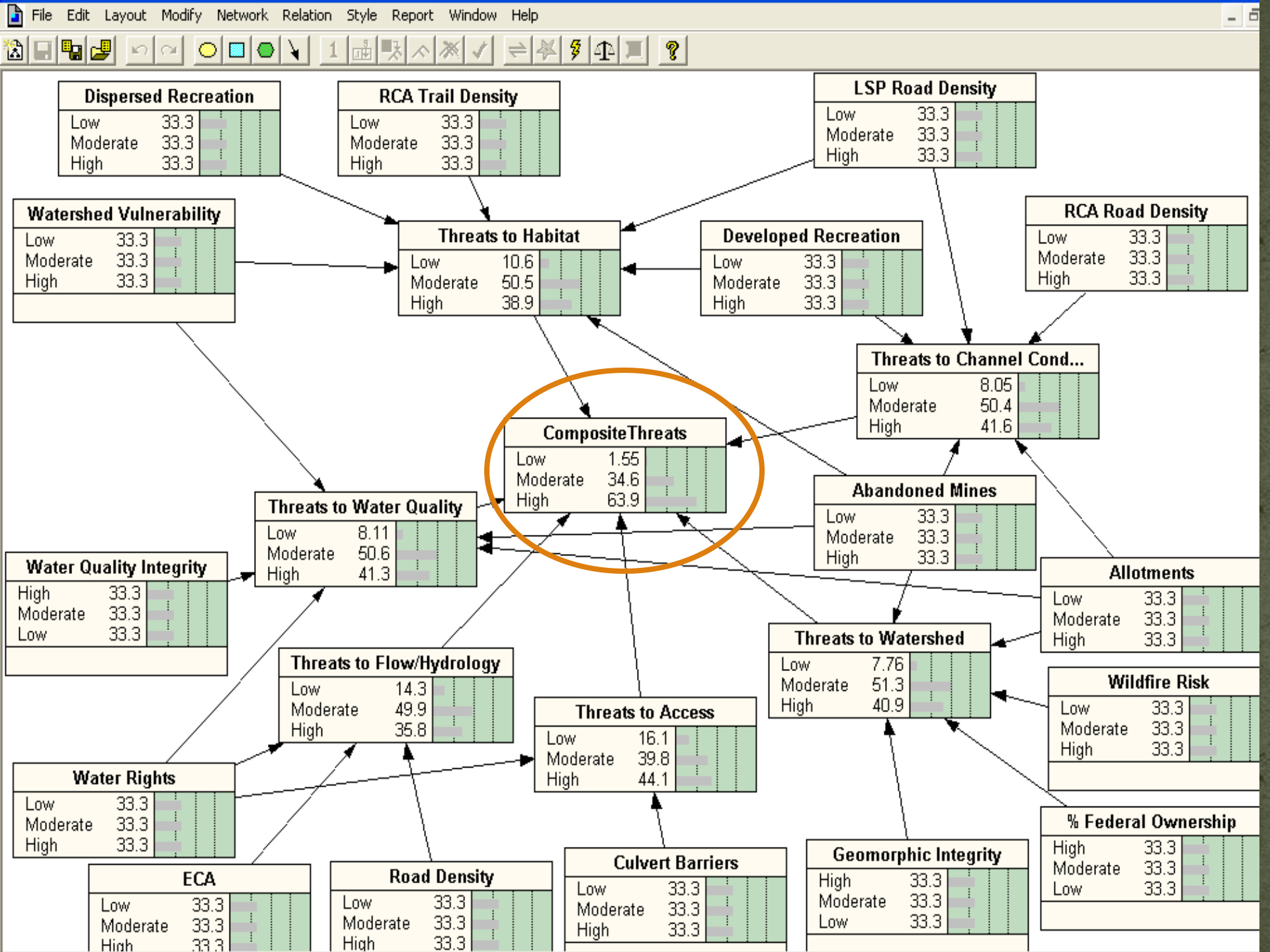
**Landslide Prone Terrain**

Low - 0-9 % of 6th Field
Moderate - 9-23%
High - > 23%

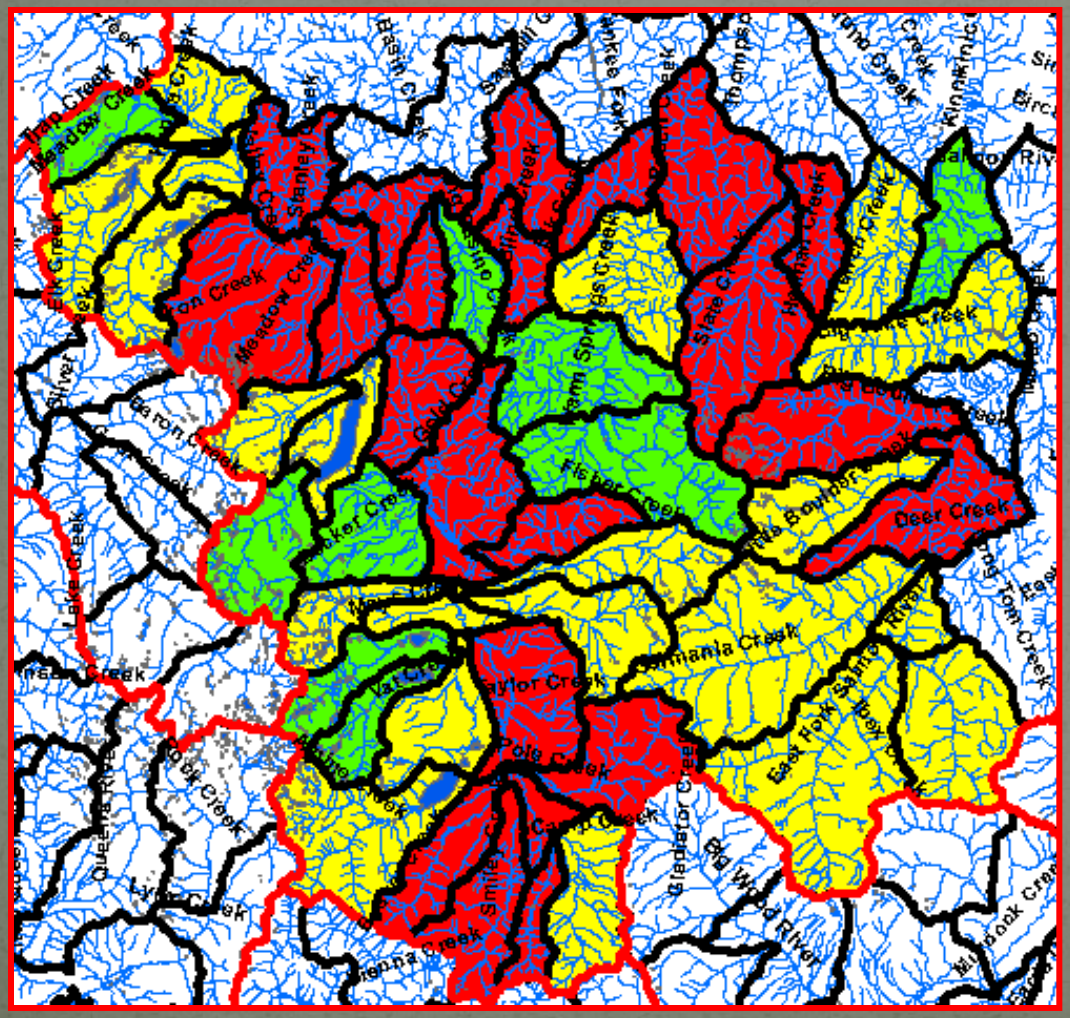
# Threats
## (Stressors)

| Threats | Low | Moderate | High |
|---|---|---|---|
| Percent Federal Ownership | 85-100% | 50-84% | <50% |
| Abandoned Mines | 0-9 sites/6th Field | 10-31 sites/6th Field | >32 sites/6th Field |
| Dispersed Recreation Sites | 0-8 sites/6th Field | 9-31/6th Field | >31/6th Field |
| Developed Recreation Sites | 0-1 sites/6th Field | 2-7 sites/6th Field | >7 sites/6th Field |
| Route Density<br>Miles of road/Sq. Miles of classified and unauthorized roads (w/in admin boundaries). | < 0.7 mi/mi2 | 0.71-1.7 mi/mi2 | >1.7 mi/mi2 |
| RCA Route Density<br>Miles of road/Sq. Miles of classified and unauthorized roads (w/in admin boundaries) within RCAs | < 0.7 mi/mi2 | 0.71-1.7 mi/mi2 | >1.7 mi/mi2 |
| Landslide Prone Road Density | <0.5 mi/mi2 | 0.5-0.7 mi/mi2 | > 0.7 mi/mi2 |
| Water Diversions | No Diversions | 1-2 diversions/6th Field | >2 sites/6th Field |
| ECA | <15% | 15-20% | >20% |

Criteria from the Forest Plan, literature, histogram distributions and professional judgment were used to determine threat levels.


File Edit Layout Modify Network Relation Style Report Window Help
Dispersed Recreation
Low 33.3
Moderate 33.3
High 33.3
RCA Trail Density
Low 33.3
Moderate 33.3
High 33.3
LSP Road Density
Low 33.3
Moderate 33.3
High 33.3
Watershed Vulnerability
Low 33.3
Moderate 33.3
High 33.3
Threats to Habitat
Low 10.6
Moderate 50.5
High 38.9
Developed Recreation
Low 33.3
Moderate 33.3
High 33.3
RCA Road Density
Low 33.3
Moderate 33.3
High 33.3
Threats to Channel Cond...
Low 8.05
Moderate 50.4
High 41.6
CompositeThreats
Low 1.55
Moderate 34.6
High 63.9
Threats to Water Quality
Low 8.11
Moderate 50.6
High 41.3
Abandoned Mines
Low 33.3
Moderate 33.3
High 33.3
Water Quality Integrity
High 33.3
Moderate 33.3
Low 33.3
Allotments
Low 33.3
Moderate 33.3
High 33.3
Threats to Watershed
Low 7.76
Moderate 51.3
High 40.9
Threats to Flow/Hydrology
Low 14.3
Moderate 49.9
High 35.8
Threats to Access
Low 16.1
Moderate 39.8
High 44.1
Wildfire Risk
Low 33.3
Moderate 33.3
High 33.3
Water Rights
Low 33.3
Moderate 33.3
High 33.3
% Federal Ownership
High 33.3
Moderate 33.3
Low 33.3
ECA
Low 33.3
Moderate 33.3
Road Density
Low 33.3
Moderate 33.3
Culvert Barriers
Low 33.3
Moderate 33.3
High 33.3
Geomorphic Integrity
High 33.3
Moderate 33.3
Low 33.3

# Overall Threats & Risks




Subwatersheds with a higher composite threat rating would be more at risk to climate change due to prolonged annual impacts that impair habitat.

# Climate Change (Exposure)

# Observed and Predicted Changes

Observed trends at COOP weather stations (Ketchum and Stanley) on the SNF

| | Current | 2040 Change | 2080 Change |
|---|---|---|---|
| Air Mean | 0.49 °C/decade warming from 1979-2008 | +1.96 °C | +3.92 °C |

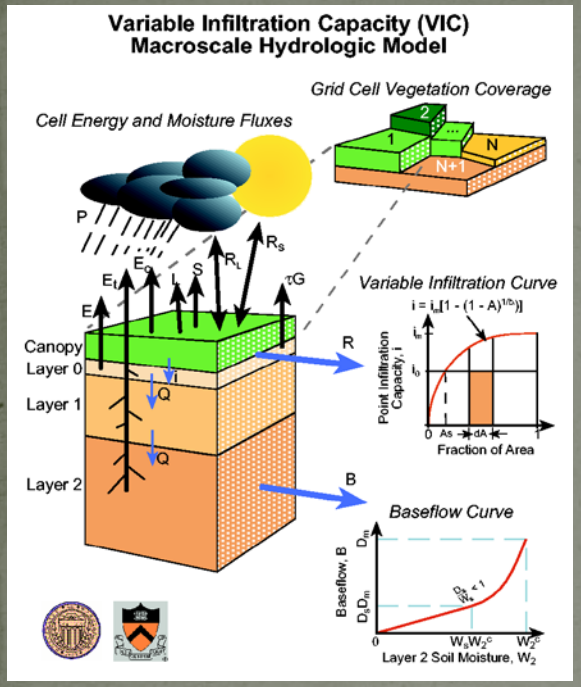
**Annual Streamflow Change**

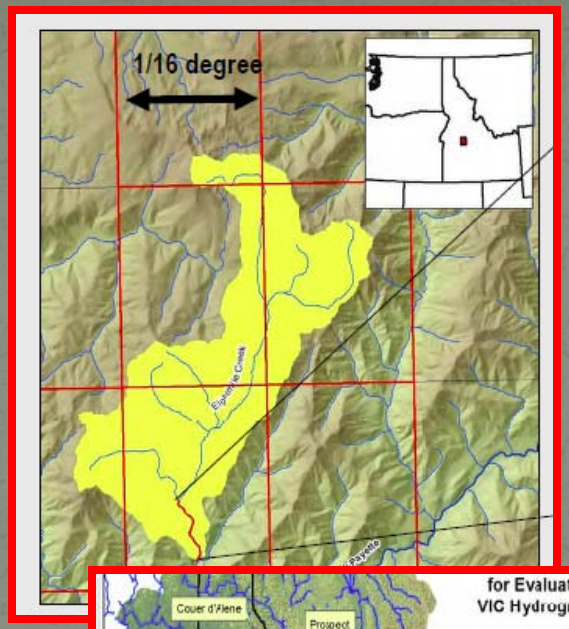
USGS Gauges (SF Boise River, SF Payette River, and Salmon River) show a **-5%/decade** decline (1957-2008).

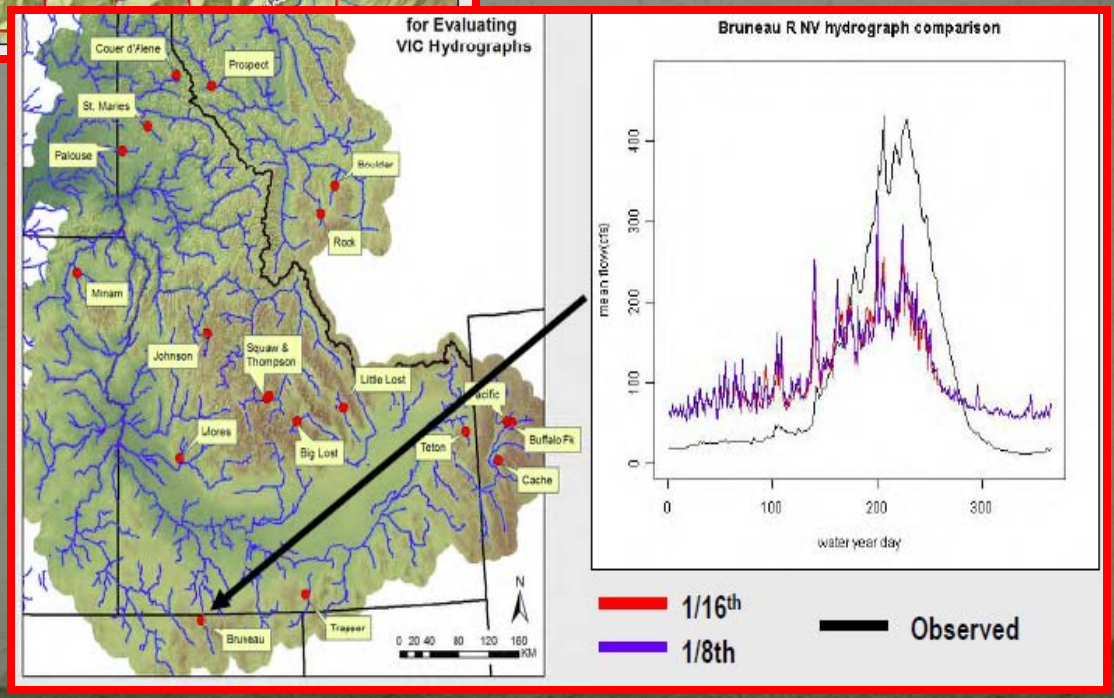
Projected Changes at Salmon Idaho Climate Impacts Group

| Year | A1B Mod-High Scenario | B1 Low Scenario |
|---|---|---|
| 2020 | + 3°C | + 3°C |
| 2040 | + 5°C | + 3°C |
| 2080 | + 9°C | + 5°C |

# Variable Infiltration Capacity (VIC)



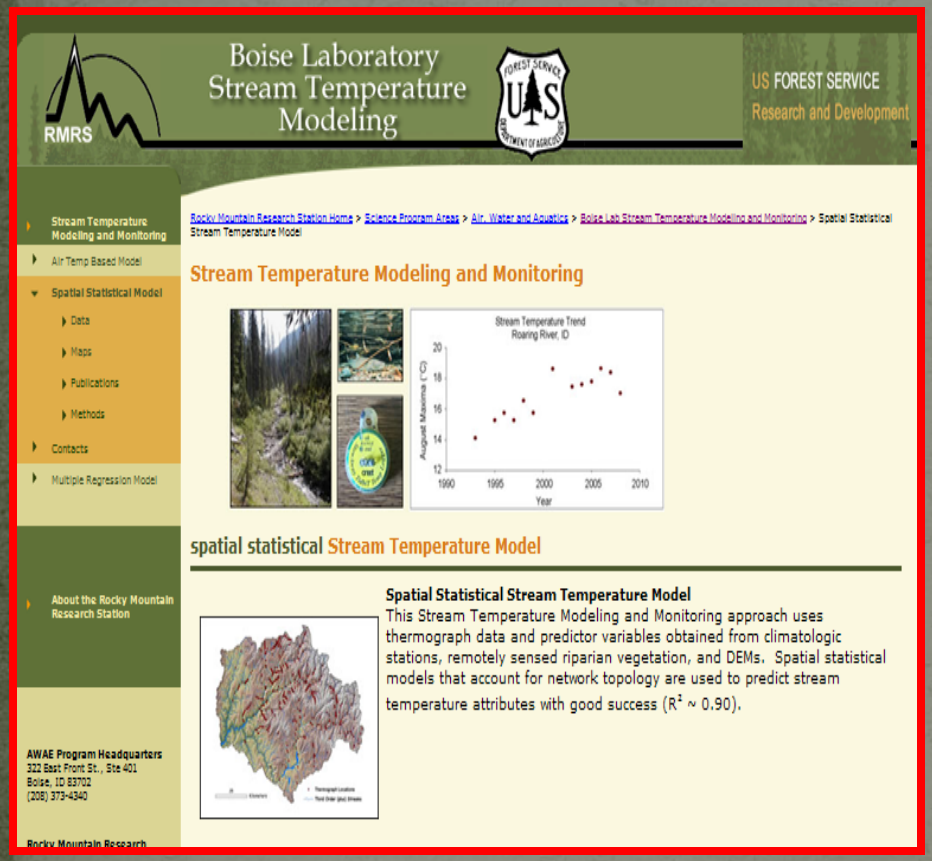




VIC does not model groundwater or systems that lose stream flow.

# VIC Outputs
## (A1B climate scenario)

| Metric | Description | Model Accuracy and Bias | Units |
|---|---|---|---|
| Winter 95 | The number of days in the winter in which flows are among the highest 5% for the year | Predicted with good accuracy and low bias | freq. |
| Mean Summer | The mean flow during the summer (recession of the spring flood to Sept. 30). Calculated the % change from current conditions. | Predicted with moderate accuracy and a slight bias | cfs |

# Water Temperature Model

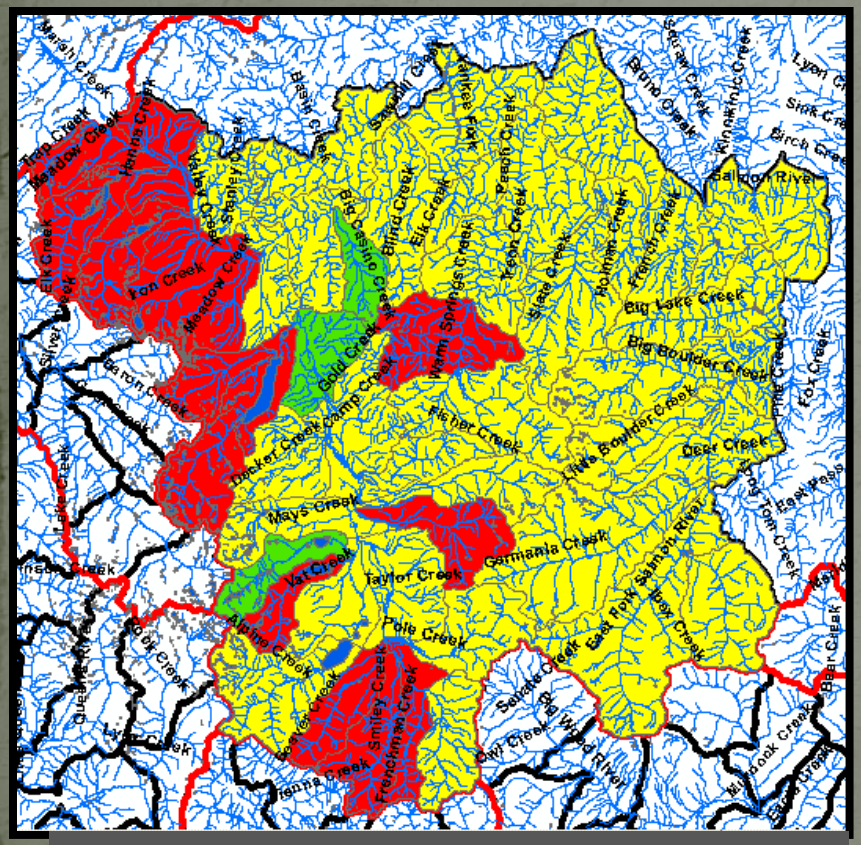



- Used 455 thermographs from 1994-2008 from the Upper Salmon and Upper SF Boise subbasins to develop the model.
- Model considered effects from increased water temperature from lake outflows, water diversions, and wildfires.
- Model predicted summer maximum weekly maximum temperature (mean of daily maximum water temperatures over the warmest consecutive seven-day period)

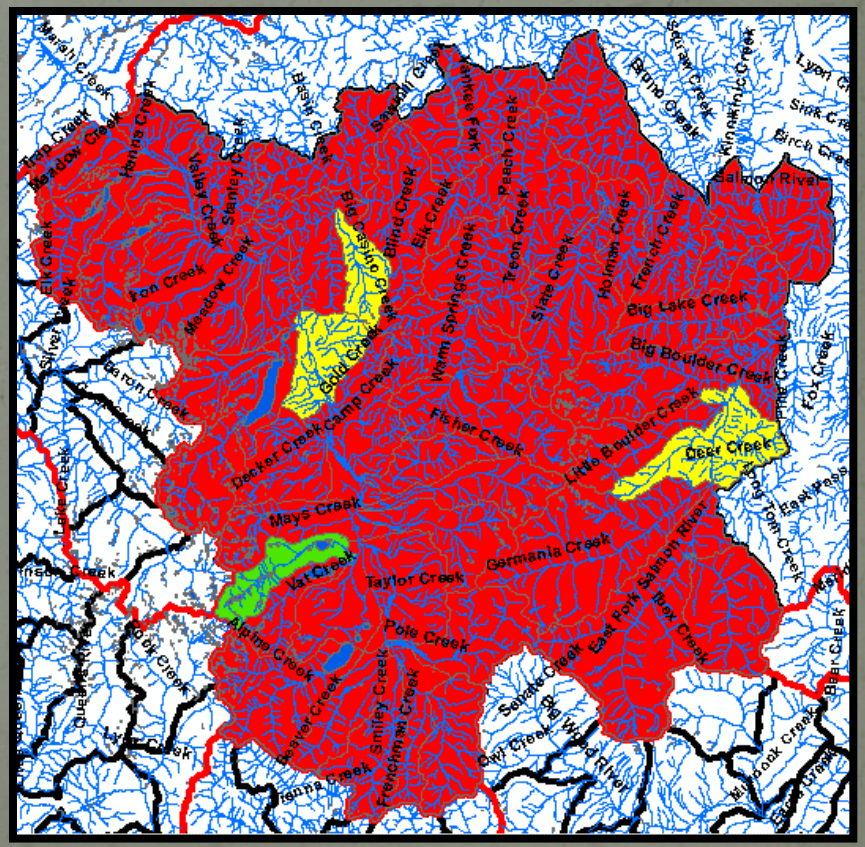
# Results

# Winter 95
## (Peak Flows)

Current – 0.88 days (0.0-4.14)

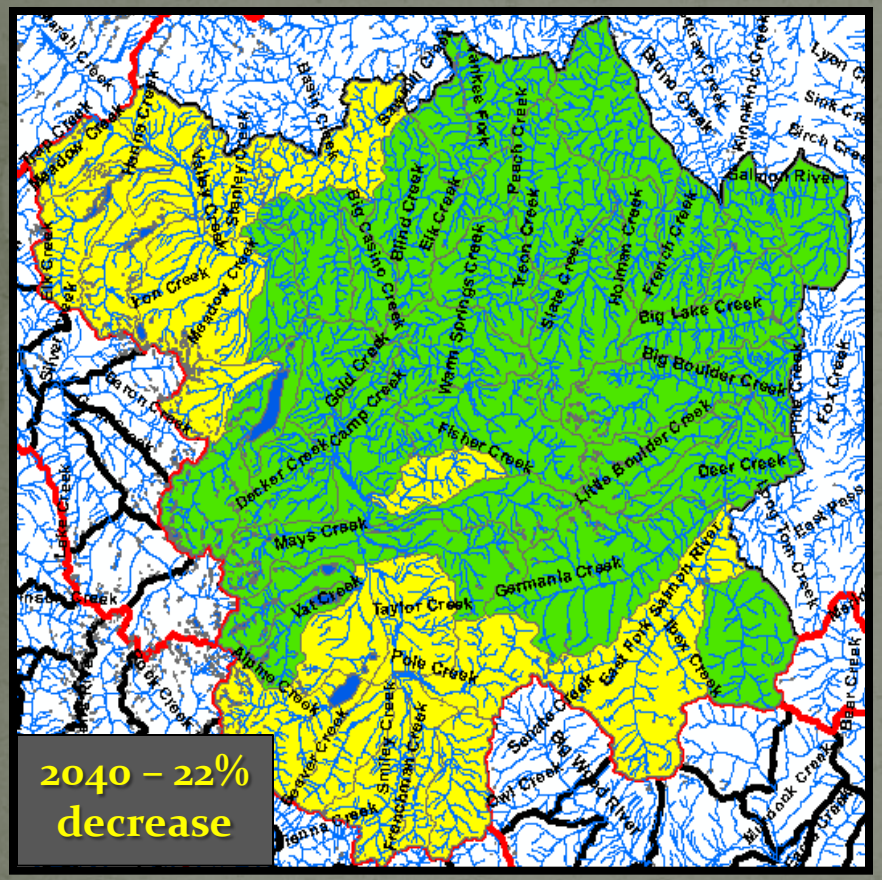


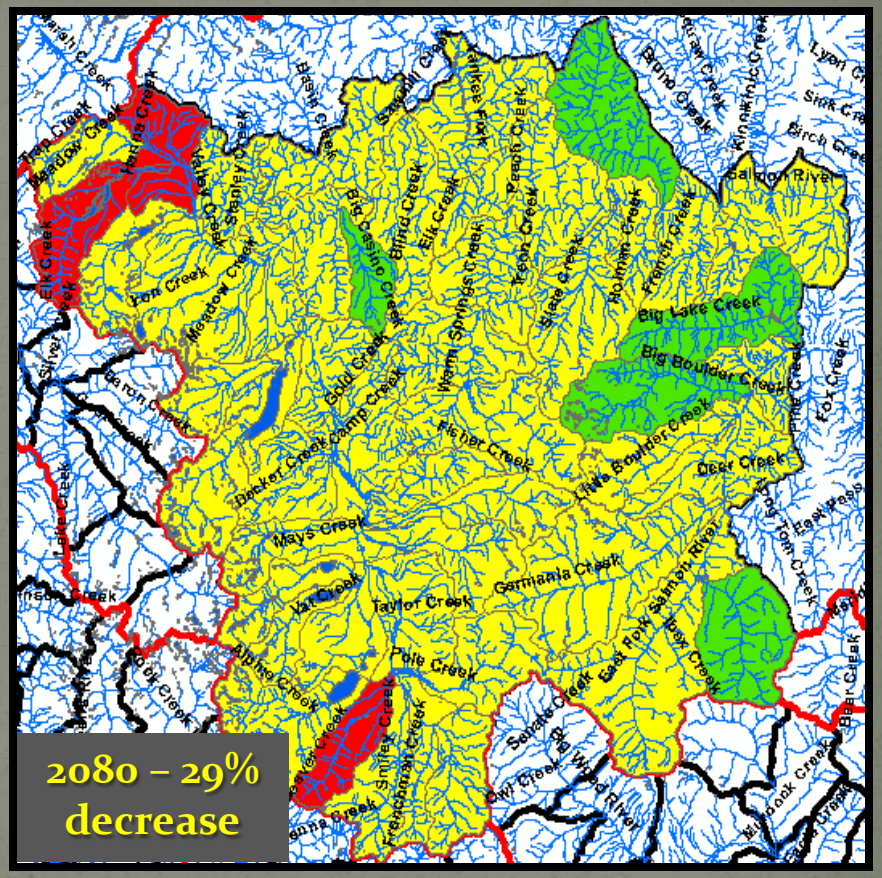

2040 – 2.55 days (0.1-5.95)




2080 – 4.44 days (0.4-8.20)

# MeanSummer
## (Low Flow)



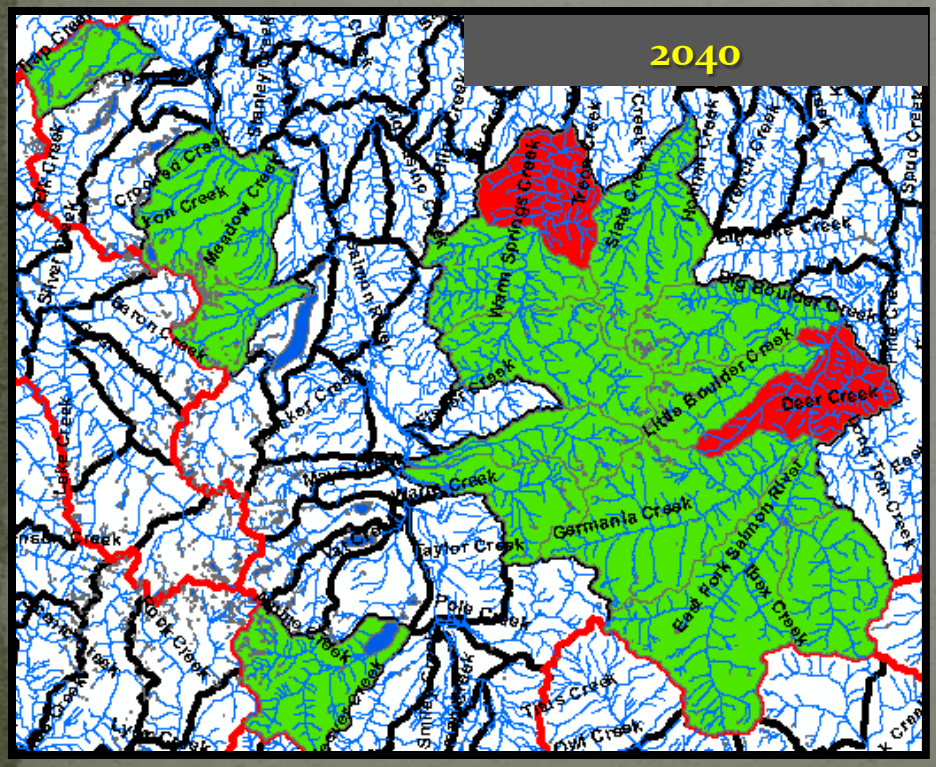



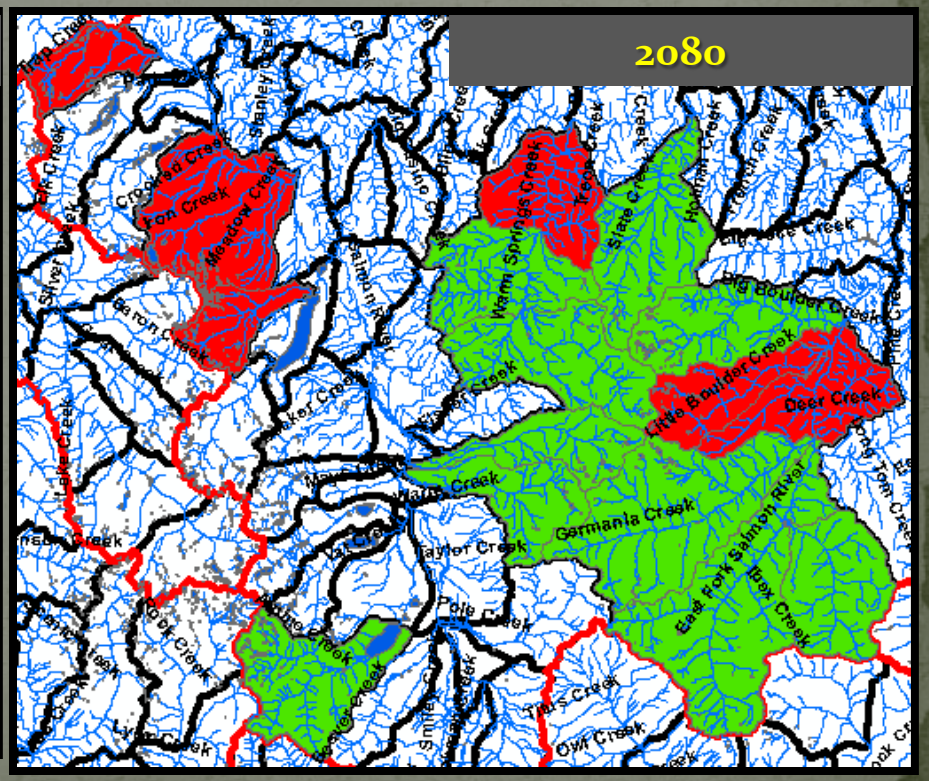

Model predictions should not be viewed as absolute changes, but instead more reflective of a general trend of declining baseflows.

# Summer Maximum Weekly Temperature

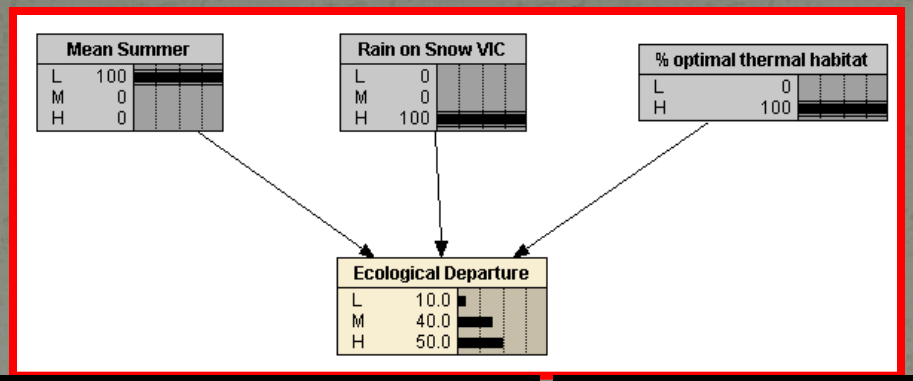
**Predicted MWMT Increases**
2033-0.9 °C, 2040-1.1 °C
2058- 1.7 °C, 2080-2.5 °C

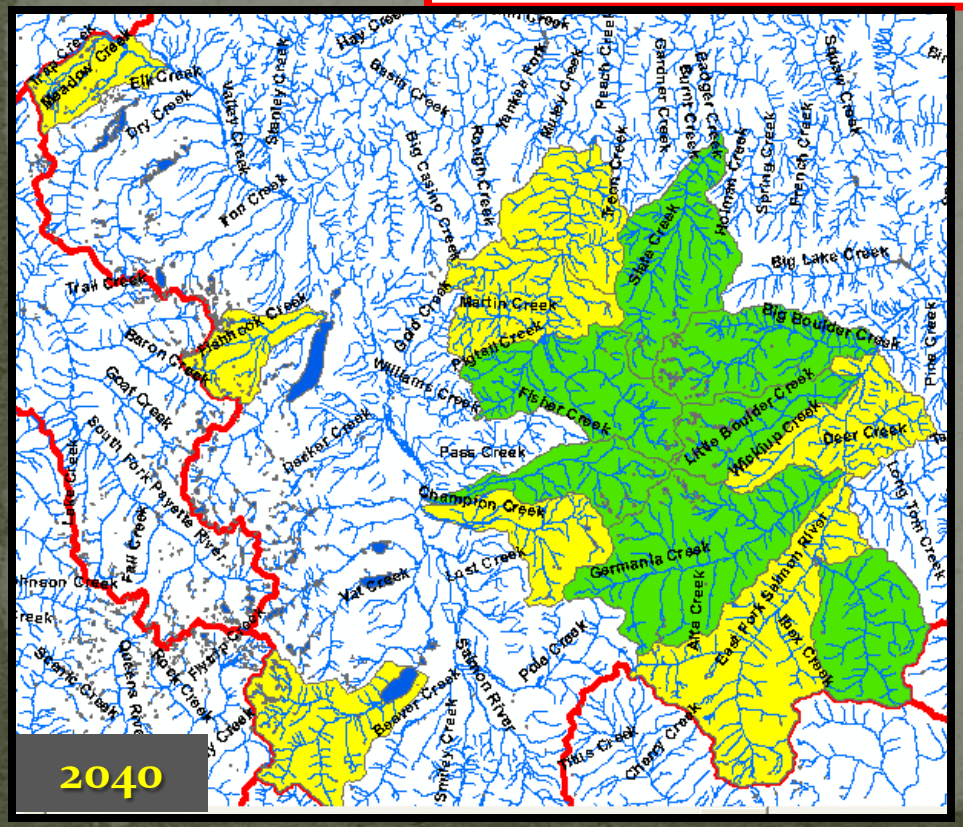
**Current** – 102.4 miles of bull trout habitat with optimal temperatures
2040 – 100.2 miles
2080 – 66.7 miles (35% decrease)

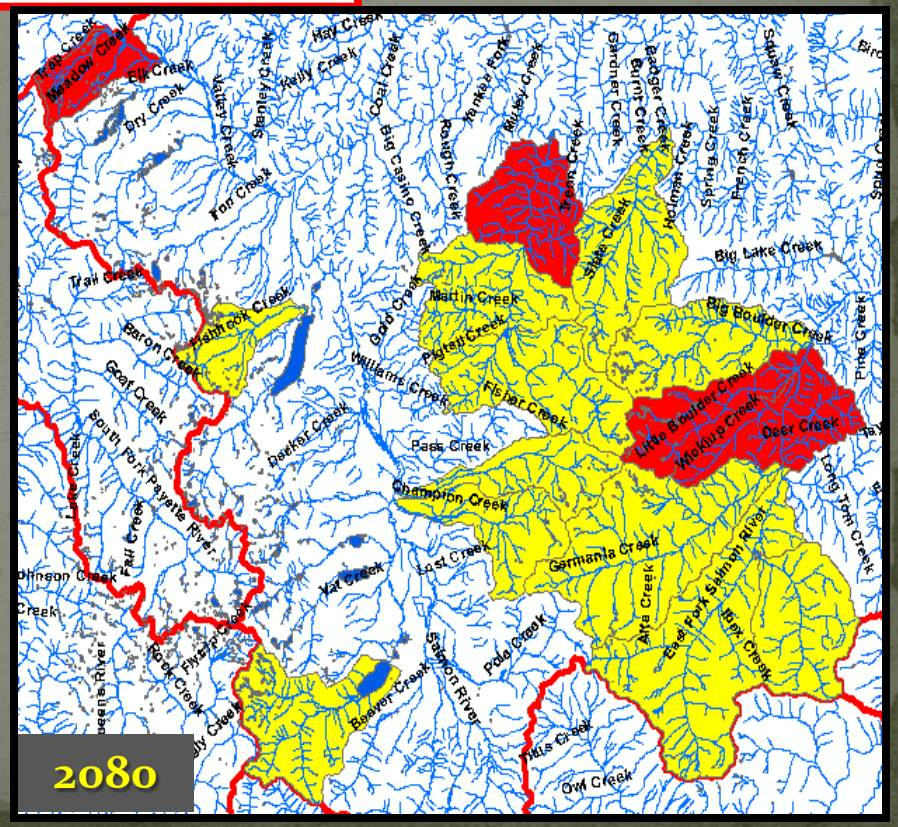


# Ecological Departure for Bull Trout
## (Climate Induced Change)

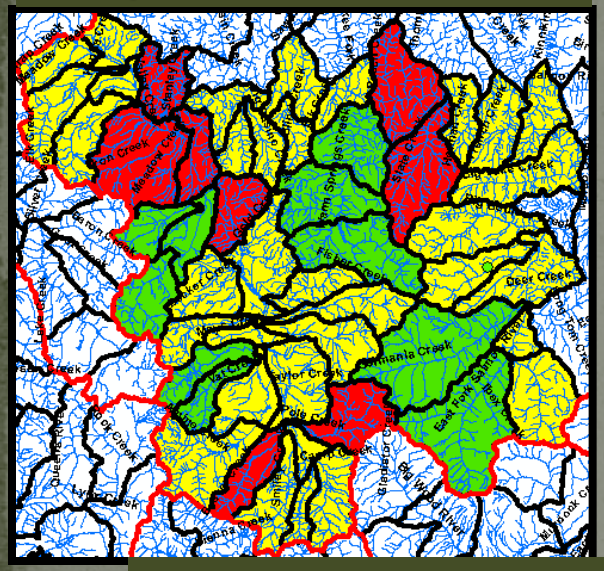


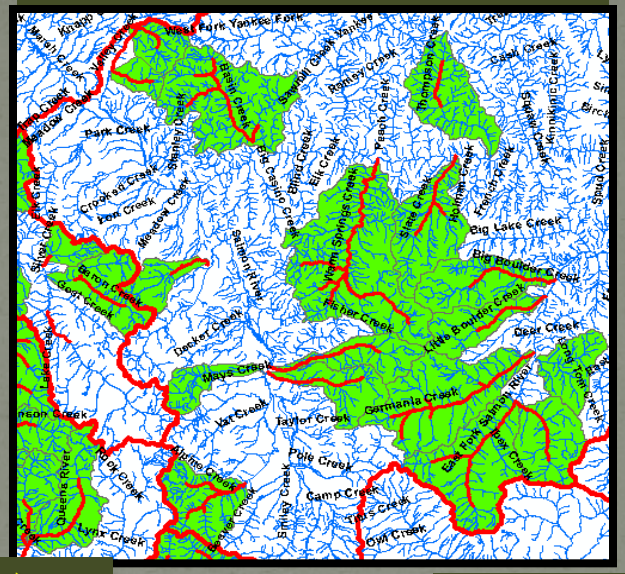



# Population Persistence

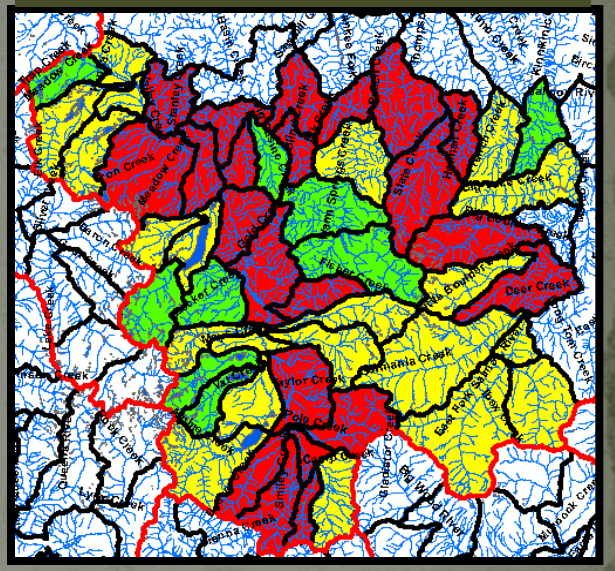
## Physical Condition (Current)



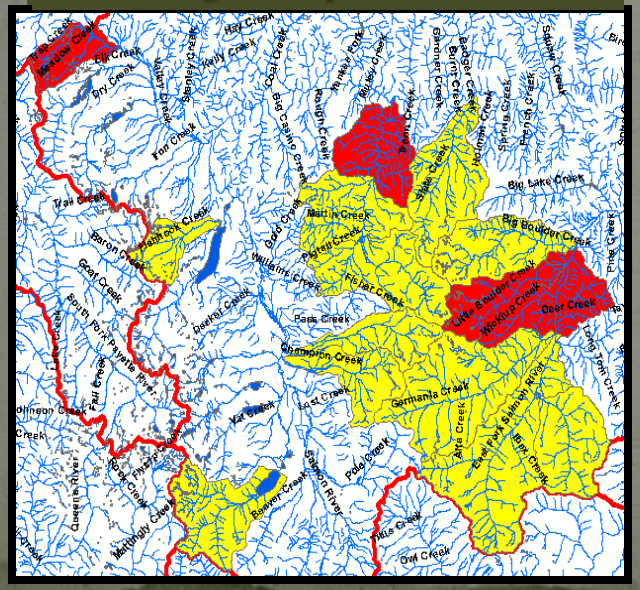

## Bull Trout Condition (Current)




## Risk and Threats (Current)




## Ecological Departure (2080)

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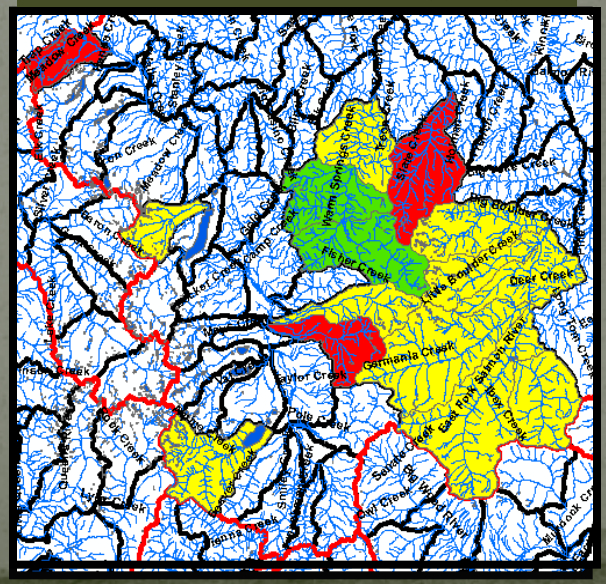
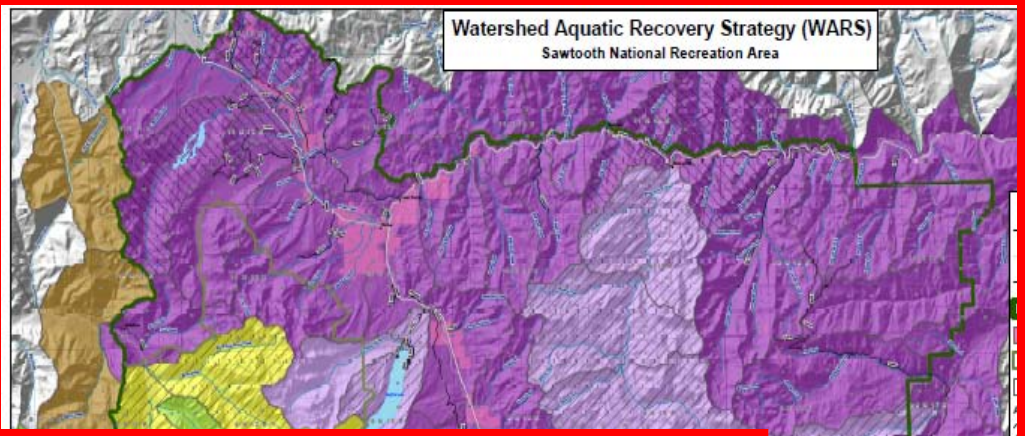
## Bull Trout Persistence (2080)



# So What Can We Do?






# What if Restoration is Not Enough?

# Conclusions

- Local USGS stream gauges and weather stations have already seen a 0.49 °C/decade warming in mean air temperatures from 1979 – 2008 and 5.0%/decade decline in summer flow from 1957-2008.

- VIC projects increases in the frequency of peak flows (2.6 -4.4 days) and a decreases (22-29%) in summer baseflows using A1B projections.

- Summer water temperatures increase slightly by 2040, but accelerate by 2080 using local weather and gauging station projections.

- Bull trout will be at greater risk from climate change, but some local populations will persist.

- Conclusions should be viewed with caution.
  - There is uncertainty about precipitation projections
  - All models have limitations and assumptions that may not come true
  - Baselines and threats are not likely to remain constant

- We are not helpless. There are many restorative actions we can take to make landscapes more resilient to climate change effects.

# Acknowledgements

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GIS

**Bruce Rieman**
Emeritus Fisheries Scientist

**Charlie Luce**
Research Hydrologist

Dona Horan
Fisheries Biologist

Emily Leavitt
Tech Transfer