Siskiyou Streamside Protections Review: Climate Change Contextual Information

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Oregon Board of Forestry, 22 April 2020

Summary from Dr. Jessica Halofsky,

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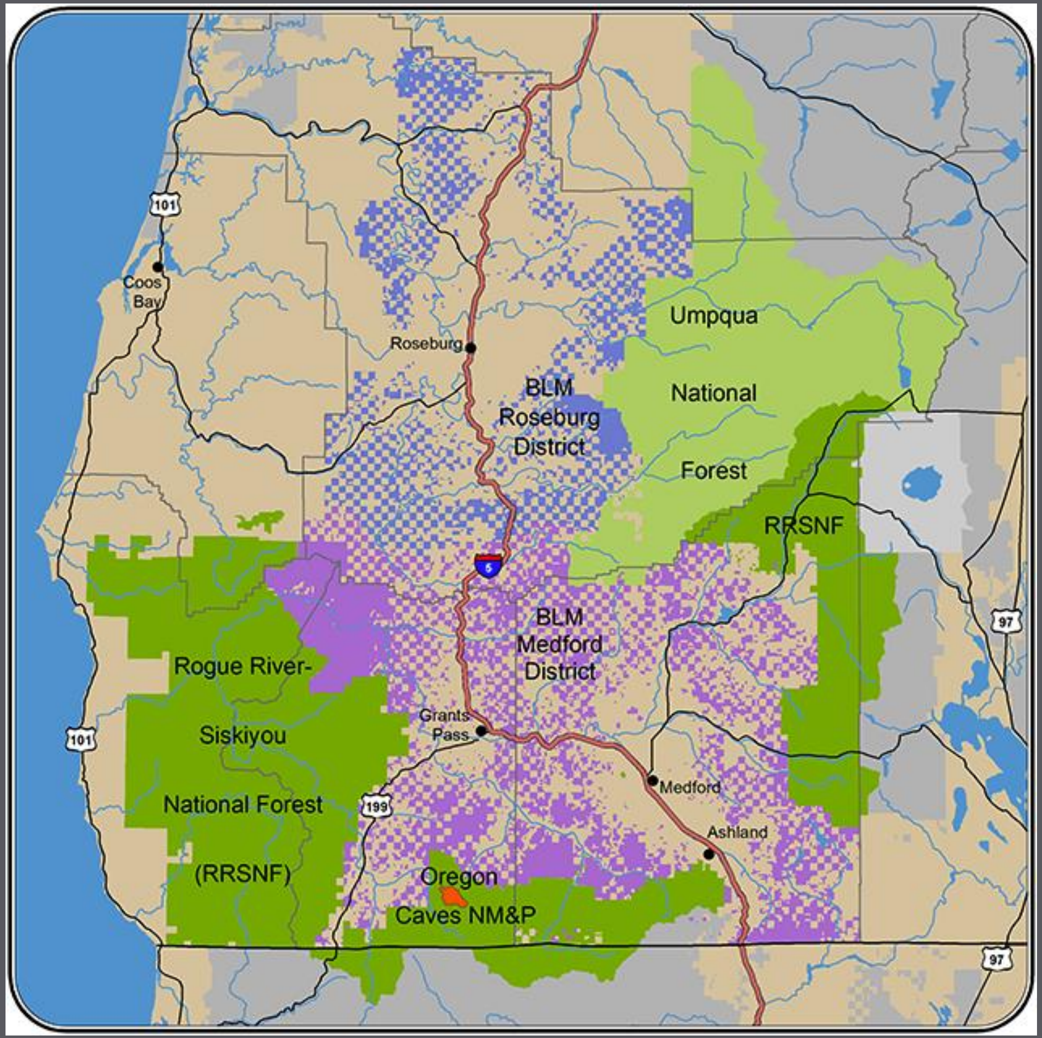
U.S. Forest Service - Pacific Northwest Research Station

Southwest Oregon Adaptation Partnership (SWOAP)



- SWOAP is a Forest Service-led science-management partnership developed to assess climate change vulnerabilities in Southwest Oregon.
- The assessment covered hydrology, fisheries (stream temperature), vegetation, wildlife, and ecosystem services
- The "in press" general technical report is available at: www.adaptationpartners.org/swoap

SWOAP Highlights

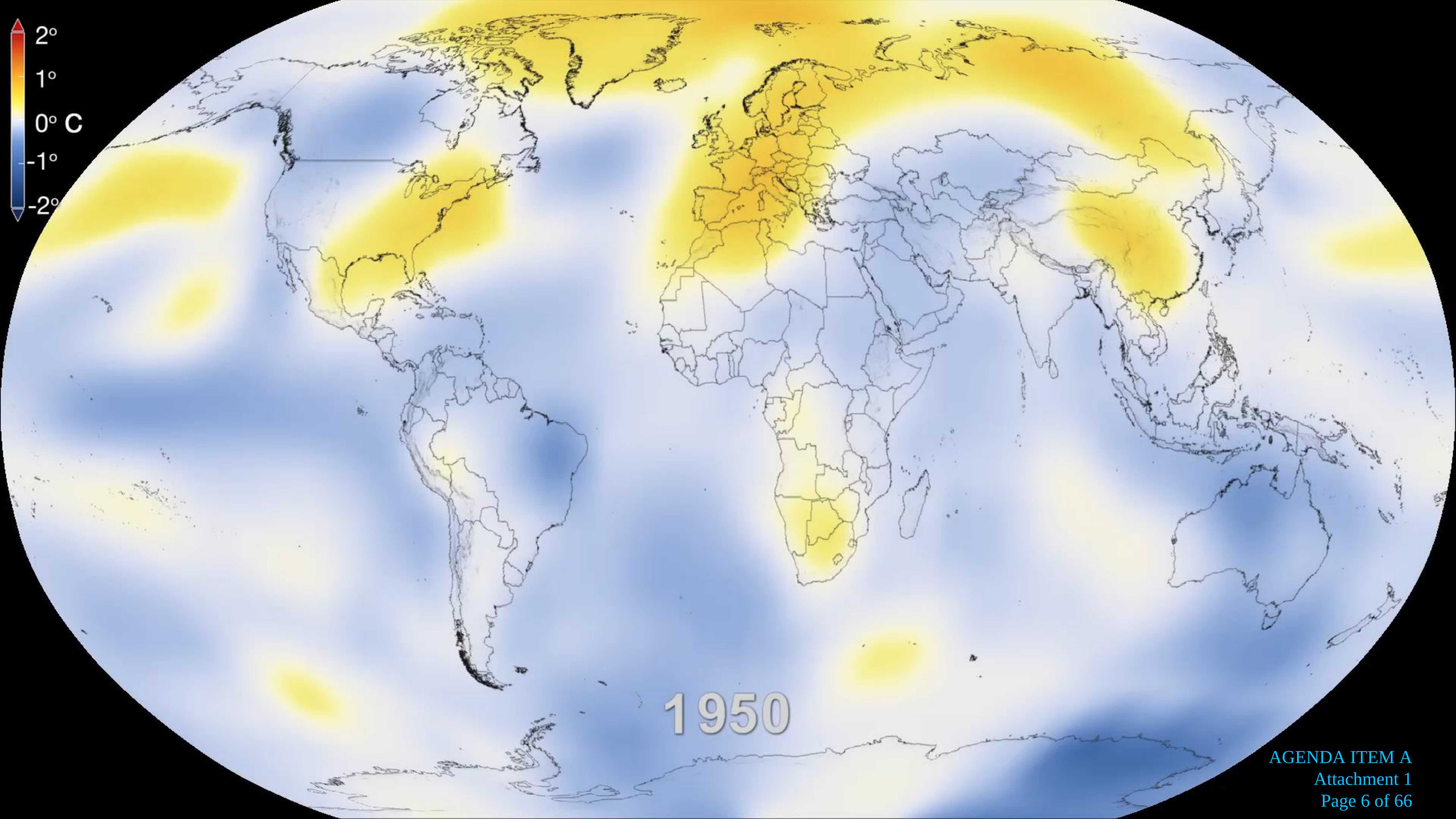
- Compared to observed historical temperature, average warming is projected to increase 4.3 to 10.1°F by the end of the 21st century (2070–2099).
- Increases in stream temperature in southwest Oregon will be driven by increasing air temperature, lower summer streamflows (resulting from loss of snowpack), and changes in vegetation cover over streams, driven primarily by disturbance (fire and insects).
- Decreased summer streamflows and warmer water temperature will reduce habitat quality for cold-water fish species, especially at lower elevations.
- The primary effects of climate change on riparian areas in southwest Oregon will likely be mediated through disturbance; fire exclusion has resulted in denser forests in some riparian areas and adjacent uplands, which may facilitate more wildfires.
- Drying in riparian areas could decrease the extent of the riparian zone in some locations and/or result in shifts in riparian plant community composition.

Stream Temperature and Climate Change in the Siskiyou Region

Kara Anlauf-Dunn

Oregon Department of Fish and Wildlife

Oregon Board of Forestry
April 22, 2020


2°
1°
0° C
-1°
-2°
1950

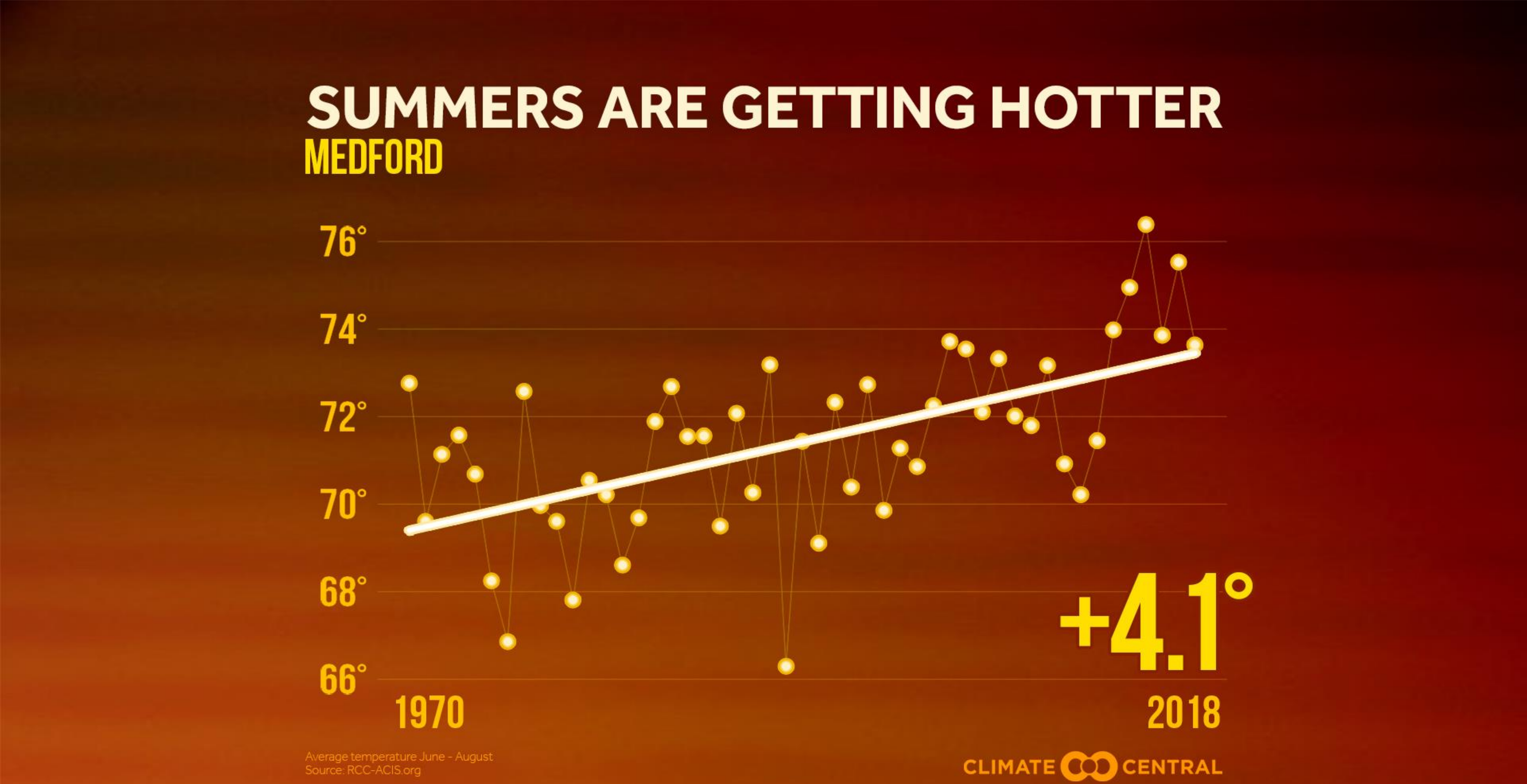
Artwork: Jill Pelto

Influences distribution, phenology, survival

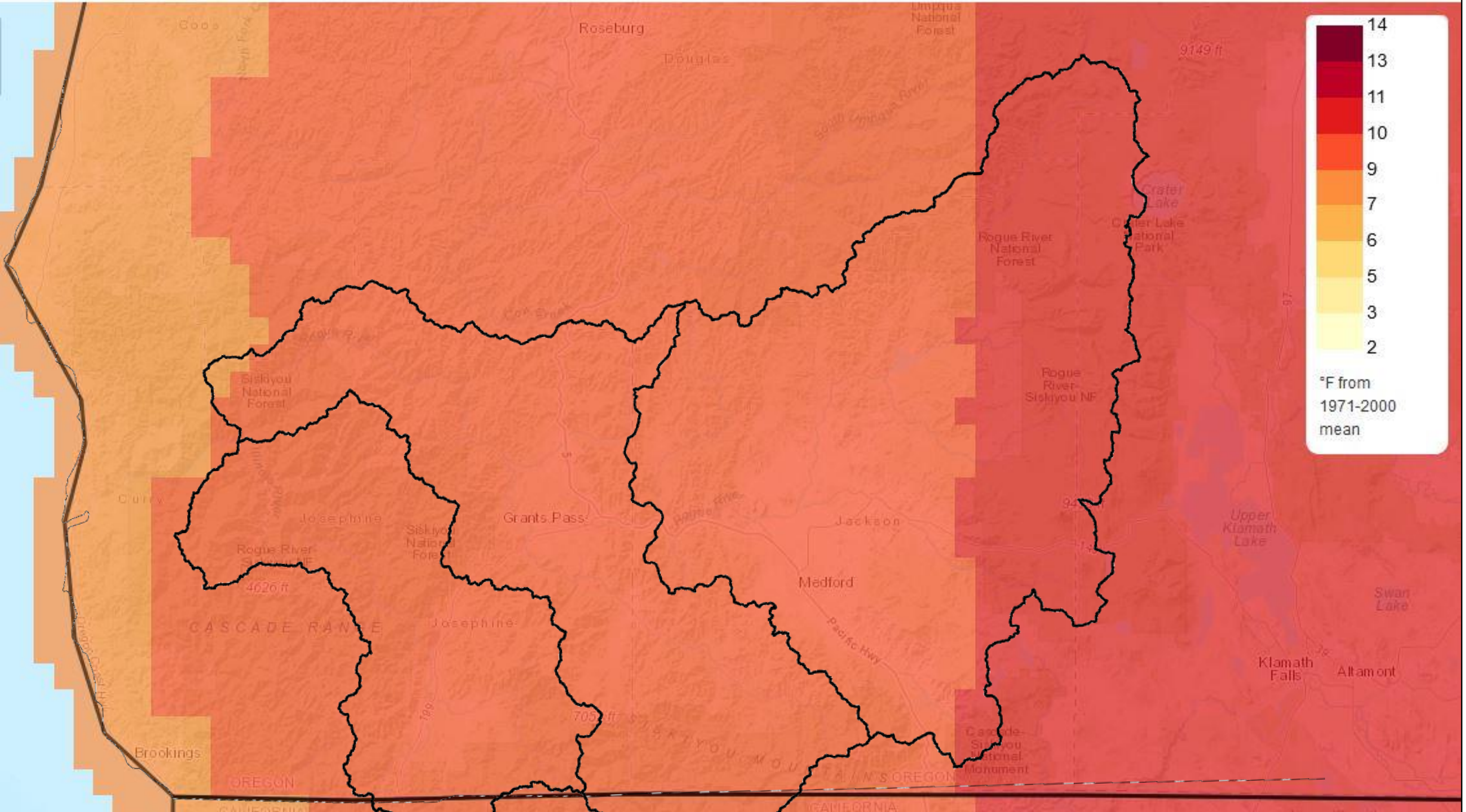
Changes Influencing Stream Temperatures

- Air temperatures
- Surface and groundwater inputs
- Local factors

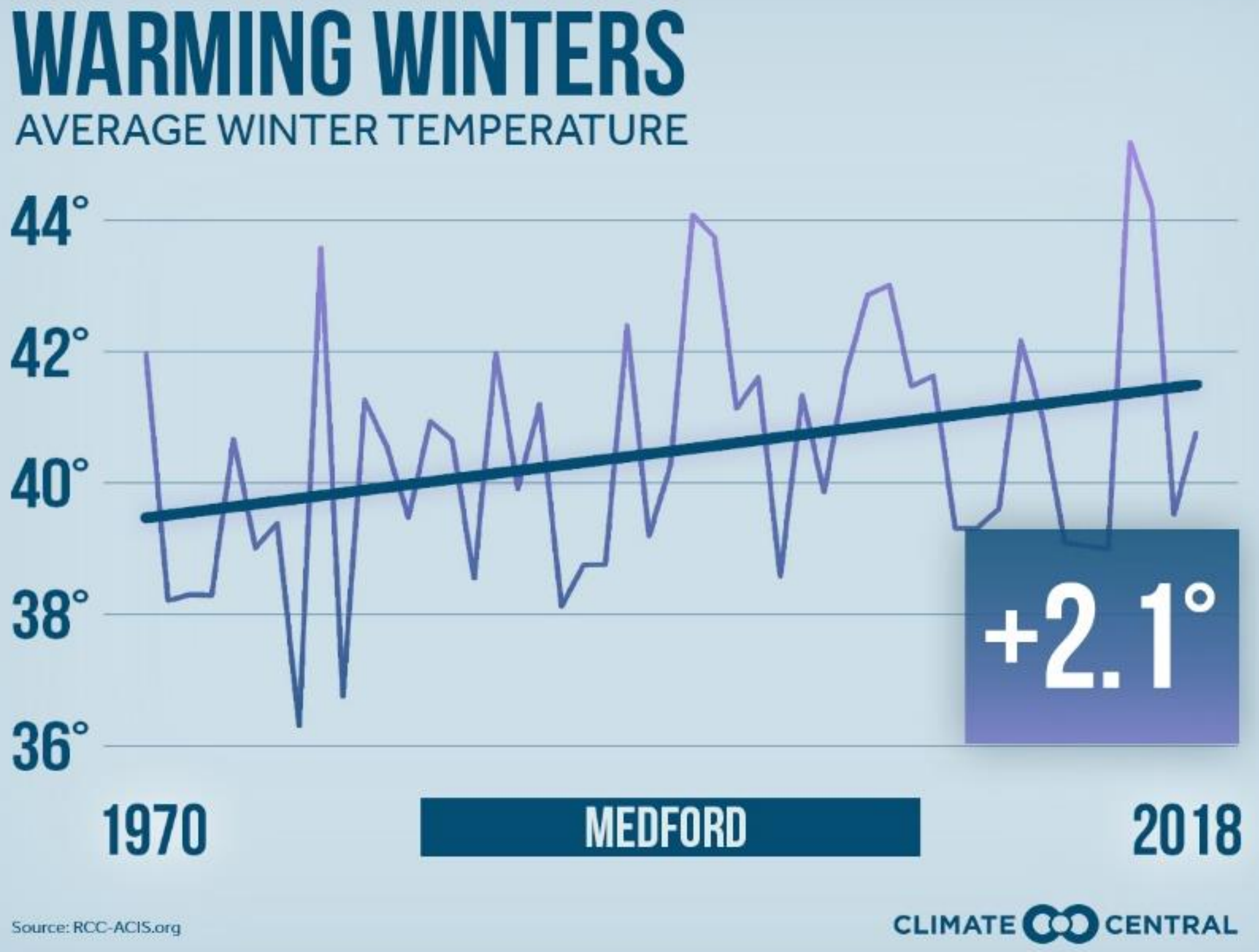
Increasing Air Temperatures


SUMMERS ARE GETTING HOTTER
MEDFORD
76°
74°
72°
70°
68°
66°
1970
2018
+4.1°
Average temperature June - August
Source: RCC-ACIS.org
CLIMATE CENTRAL

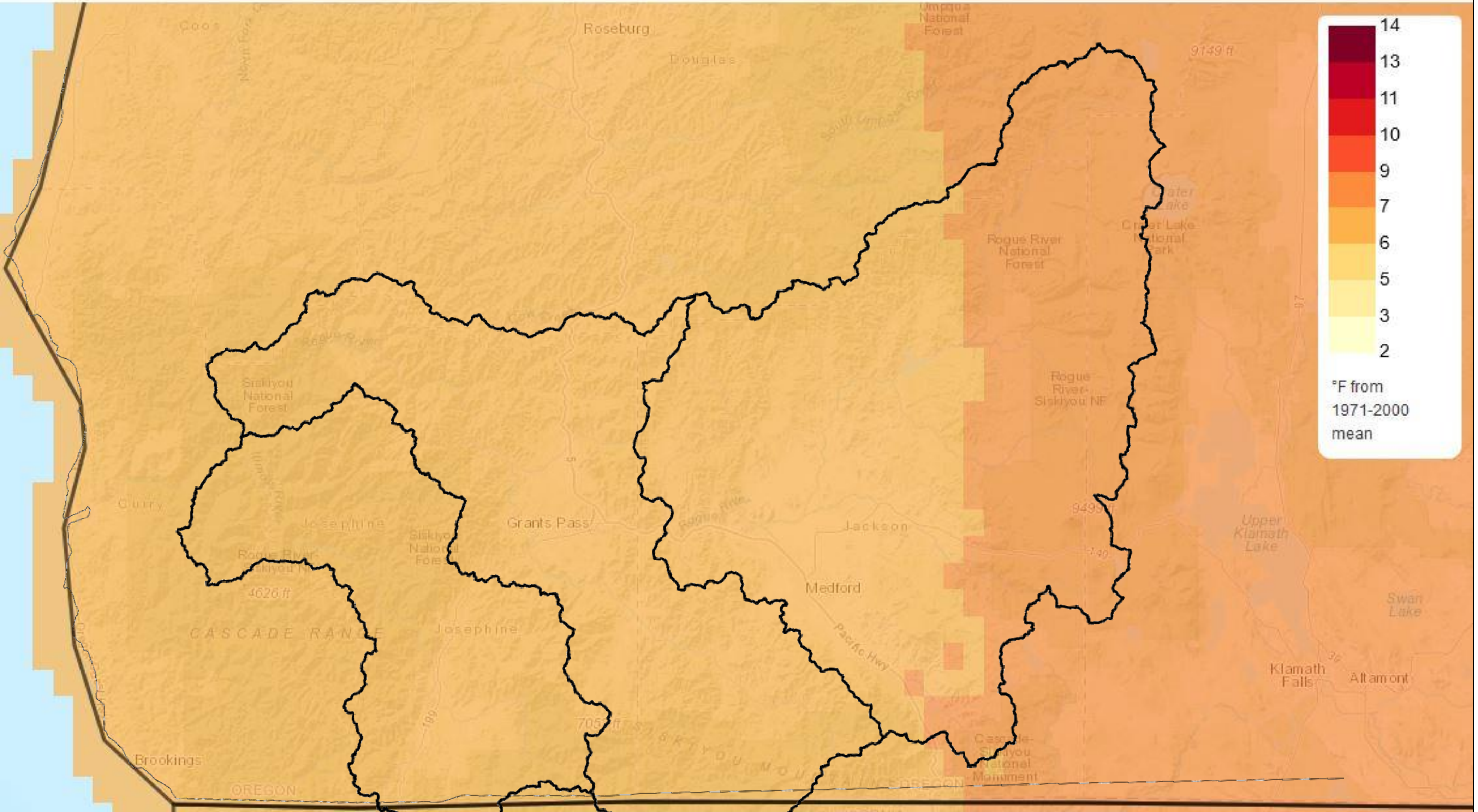
By 2070



Summer temperatures will be 5-11 degrees warmer


WARMING WINTERS
AVERAGE WINTER TEMPERATURE
44°
42°
40°
38°
36°
+2.1°
1970
MEDFORD
2018
Source: RCC-ACIS.org
CLIMATE CENTRAL

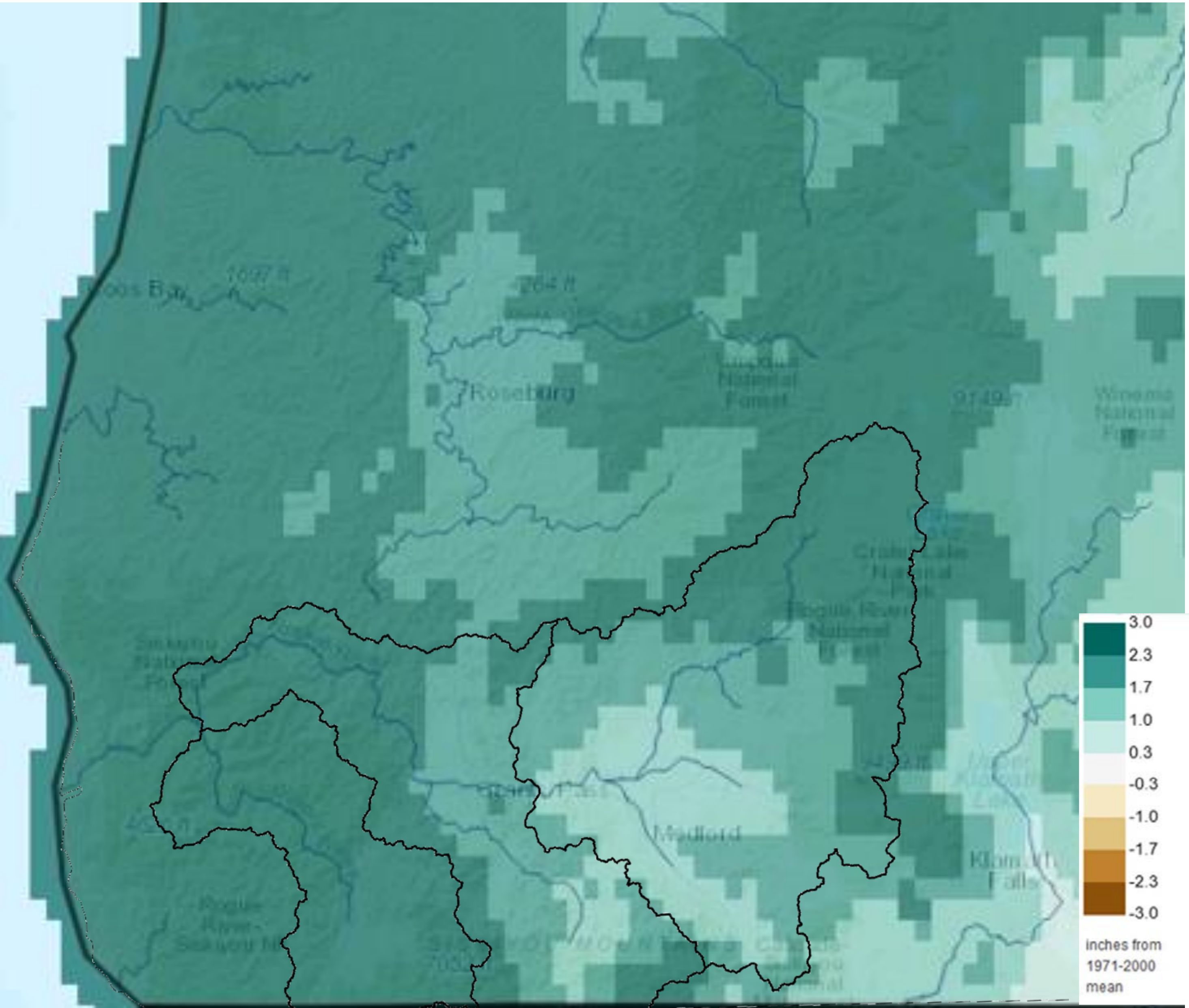
By 2070



Winter temperatures will be 5-7 degrees warmer

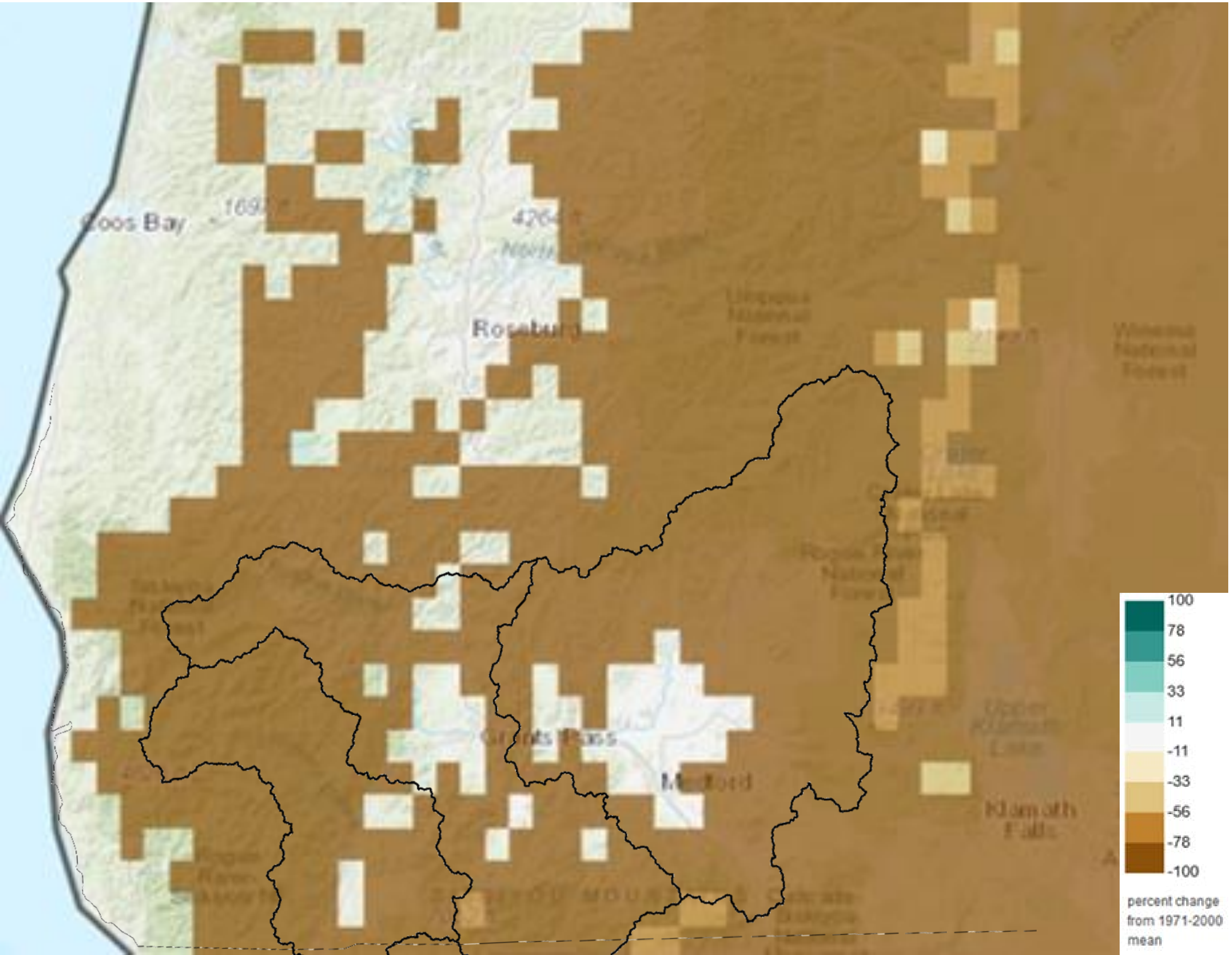

More rain, less snow
KS Wild

By 2070, in the winter



Mean annual rainfall will increase by 0-3 inches

By 2070

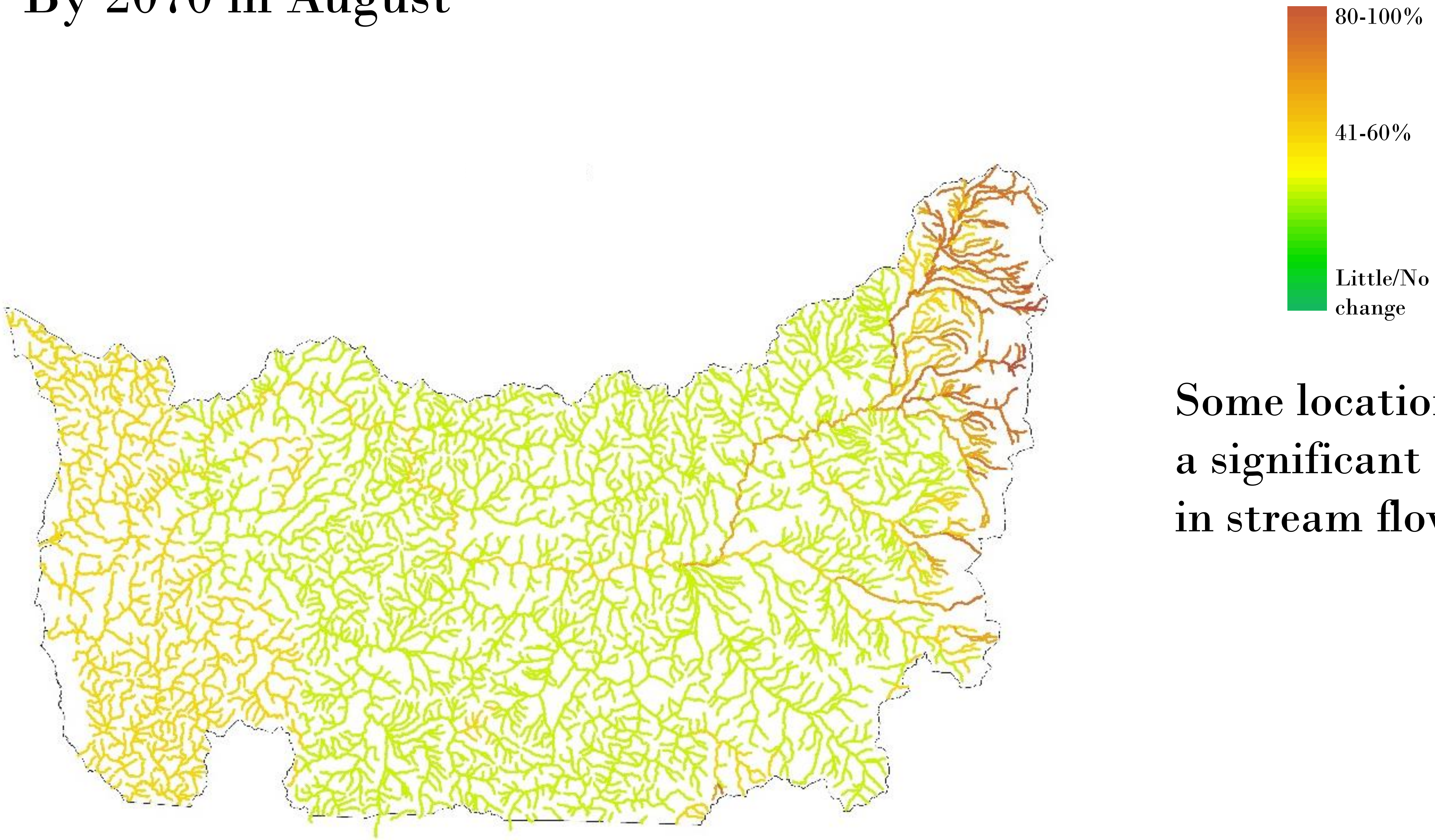


>50% decline in Snow Water Equivalents in the mountains

Reduction in summer and fall stream flows

Photo: John Gussman

By 2070 in August



Some locations will see a significant decrease in stream flow

More Drought

Bear Creek, Rogue Basin

~60-80% likelihood of ***Mega-drought in West*** *by end of century*

NASA

Impact to our Mission

Climate and ocean change are **undermining** the ability of lands and waters to support Oregon's native fish and wildlife

Photo: Mike Putnam

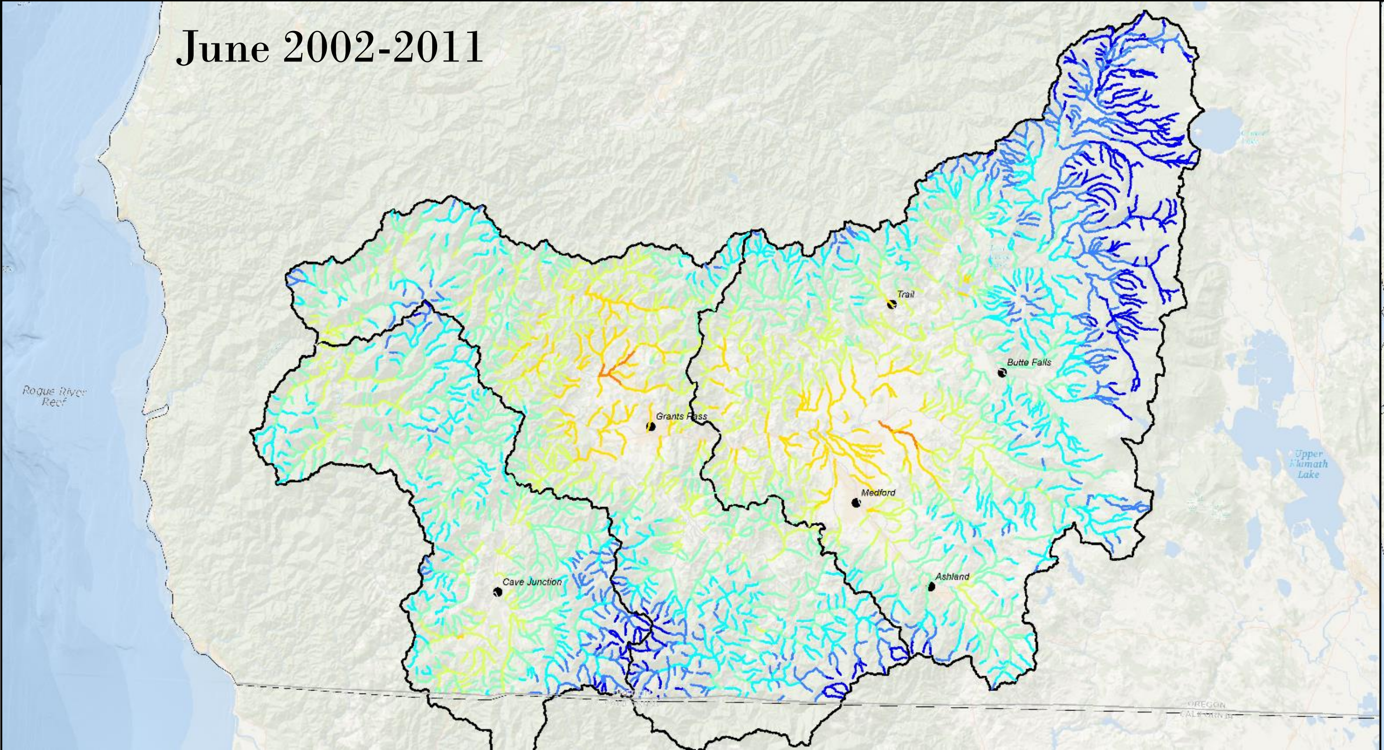
Photo: Mike Putnam

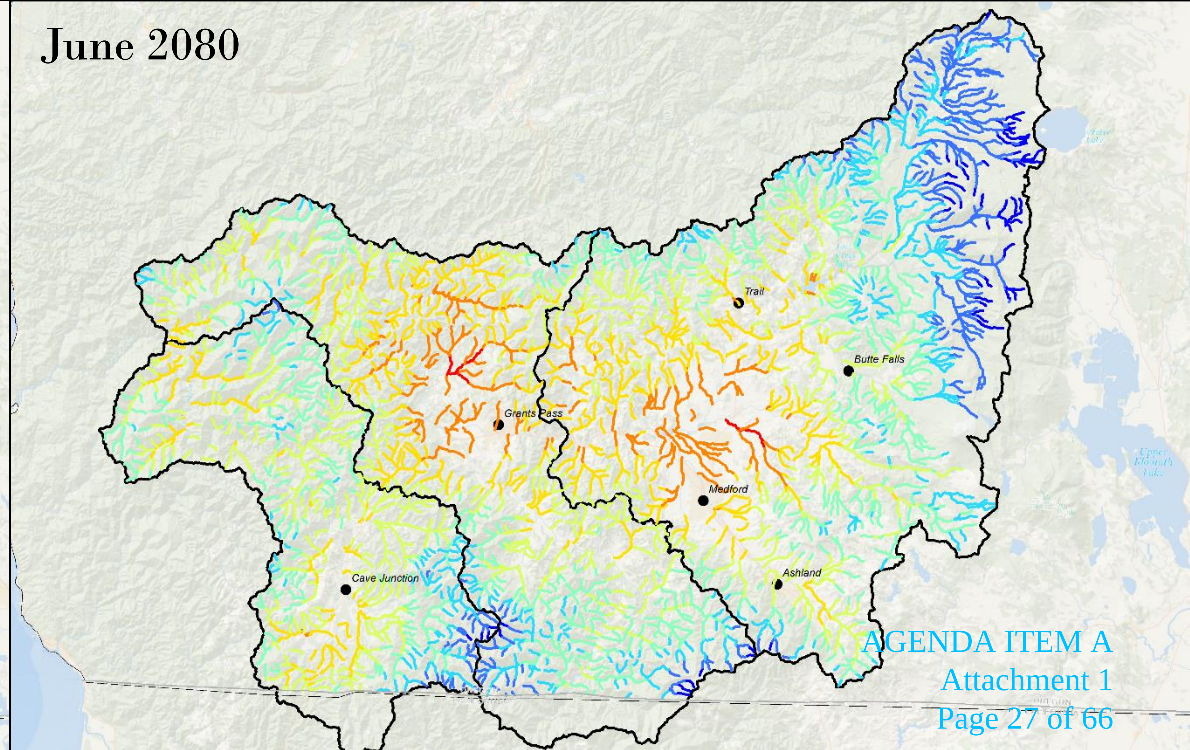
1. Understand and act on risks and opportunities associates with changing climate and ocean conditions

2. Provide leadership toward a coordinated statewide and regional response

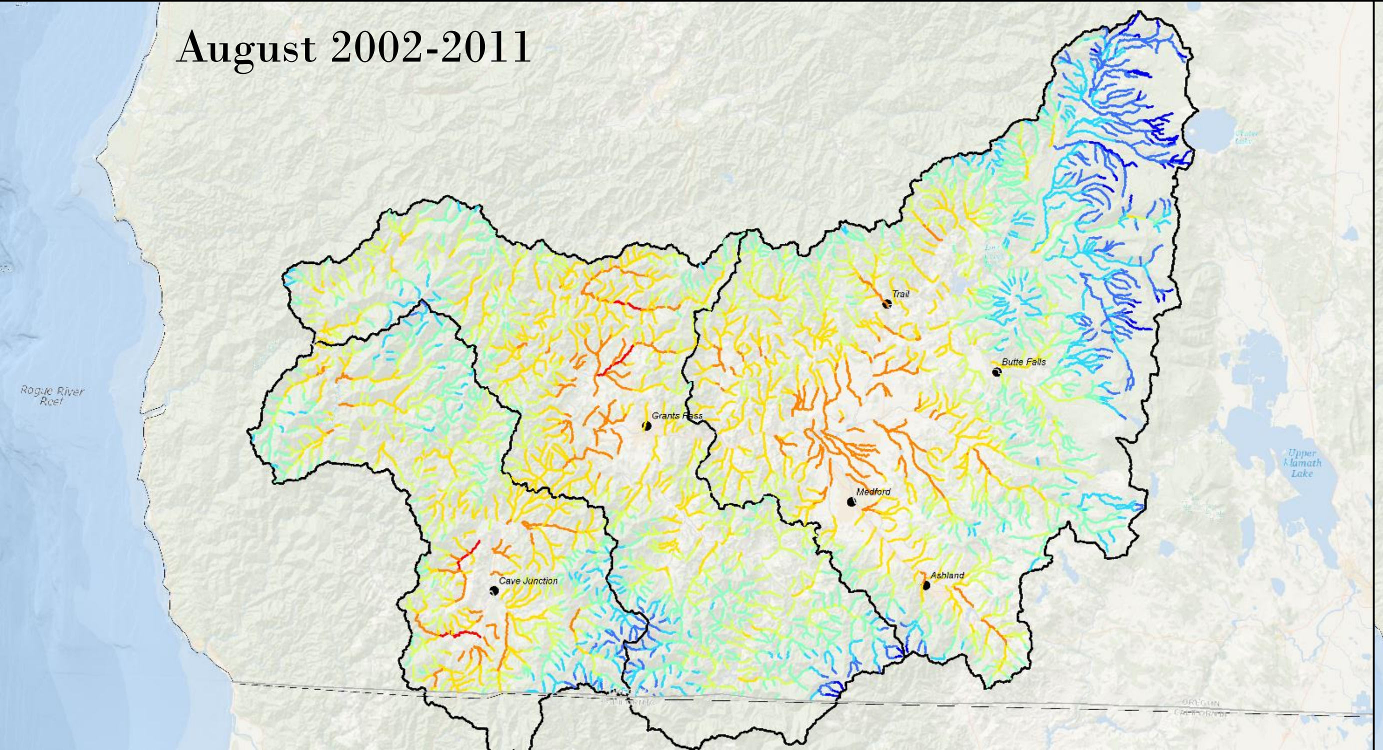
3. Reduce the Department's carbon footprint to the extent practicable with the goal reaching carbon neutrality

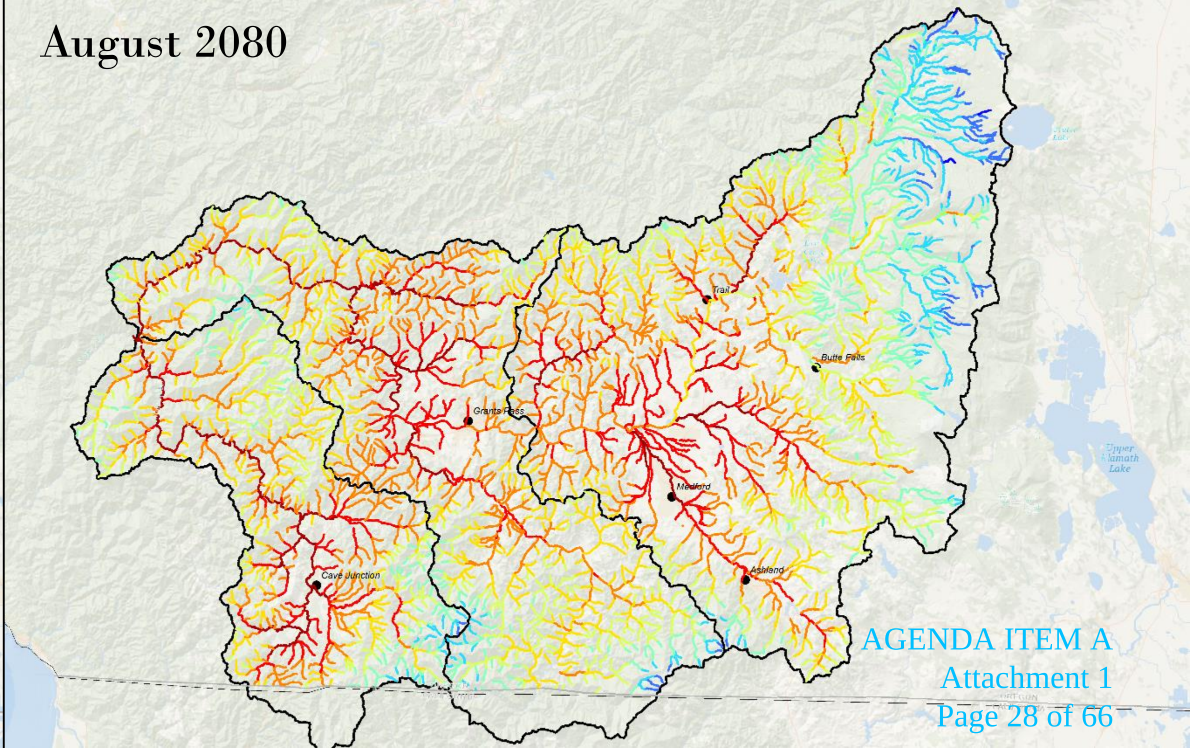
Stream Temperatures





Stream Temperatures



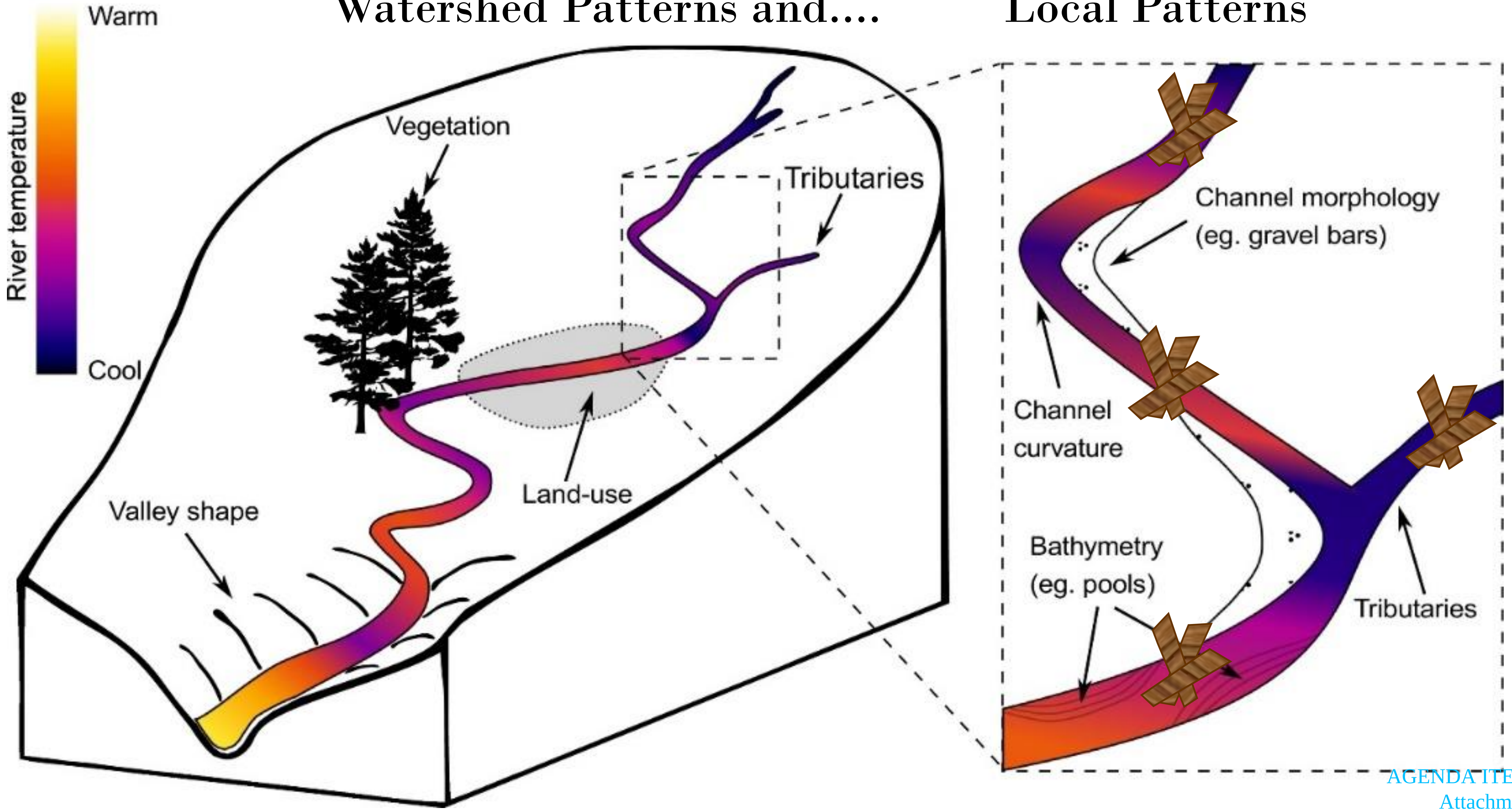


Need To Understand Local Drivers

Geomorphology, Land Cover, Shading

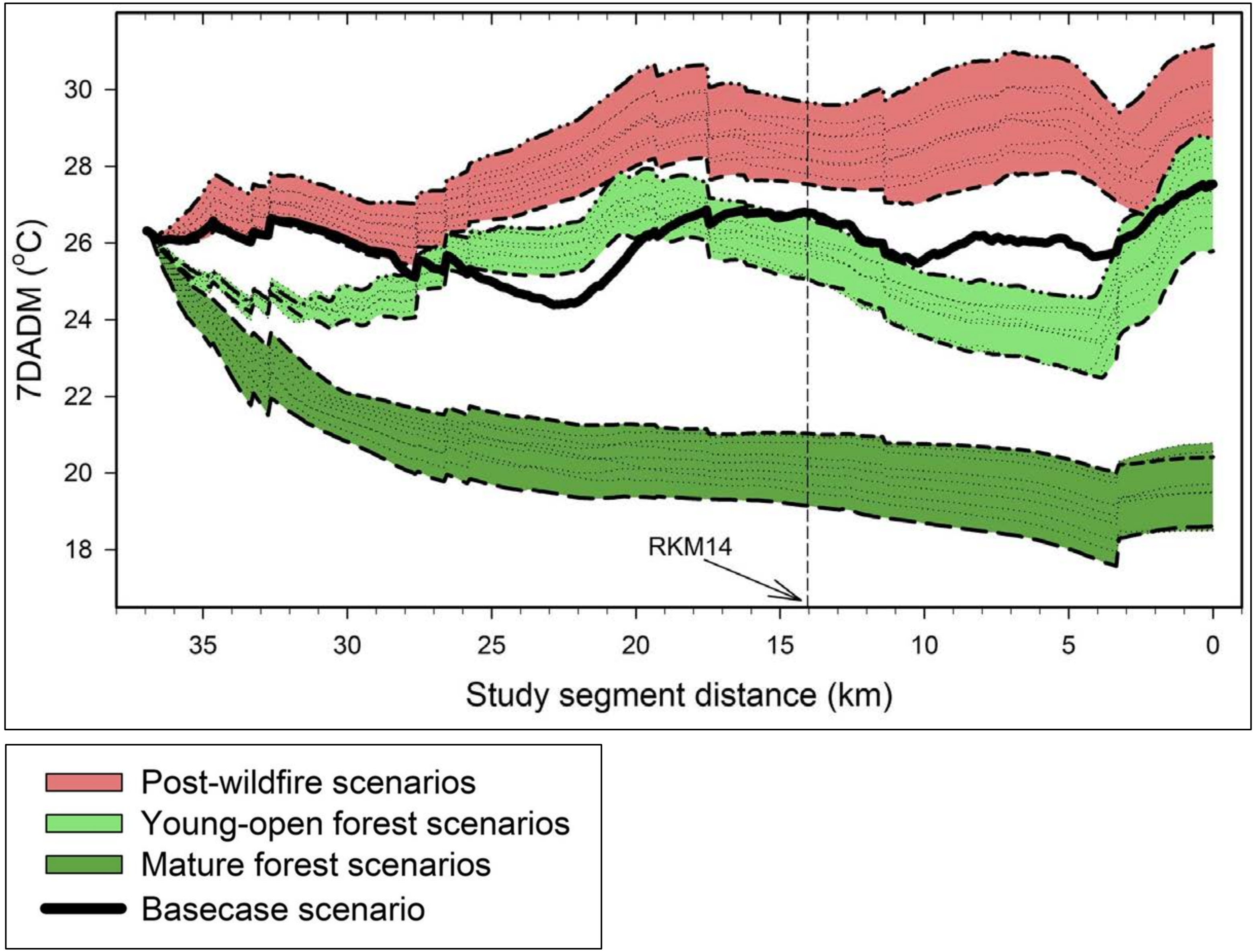
Eiko Jones Photography

Watershed Patterns and.... Local Patterns



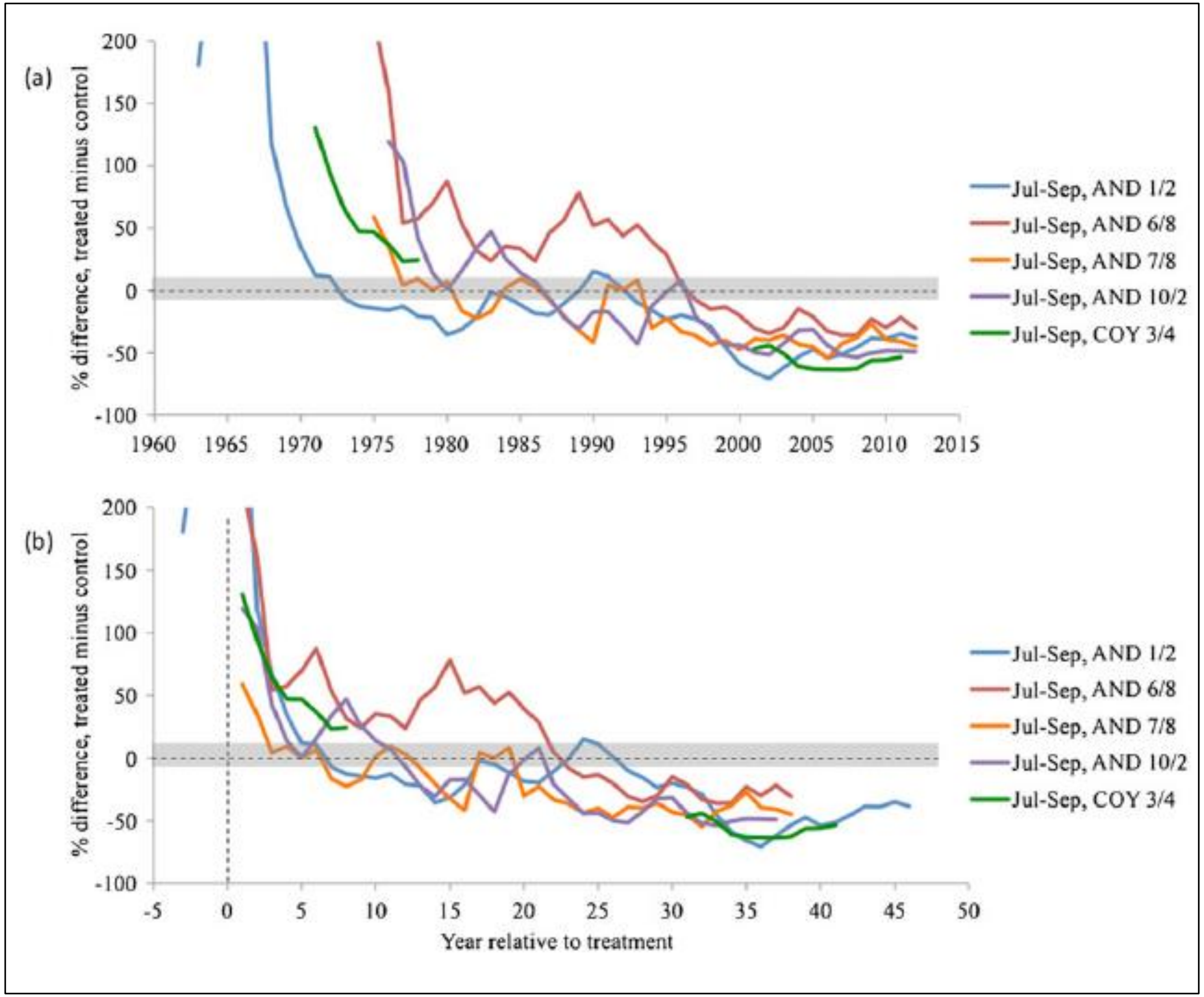
Adapted from Dugdale et al. 2017

Shading Matters



Mature forests decrease stream temperatures

Adapted from Wondzell et al. 2018



Management outside the riparian area influences stream flow and stream temperatures

Perry and Jones 2017

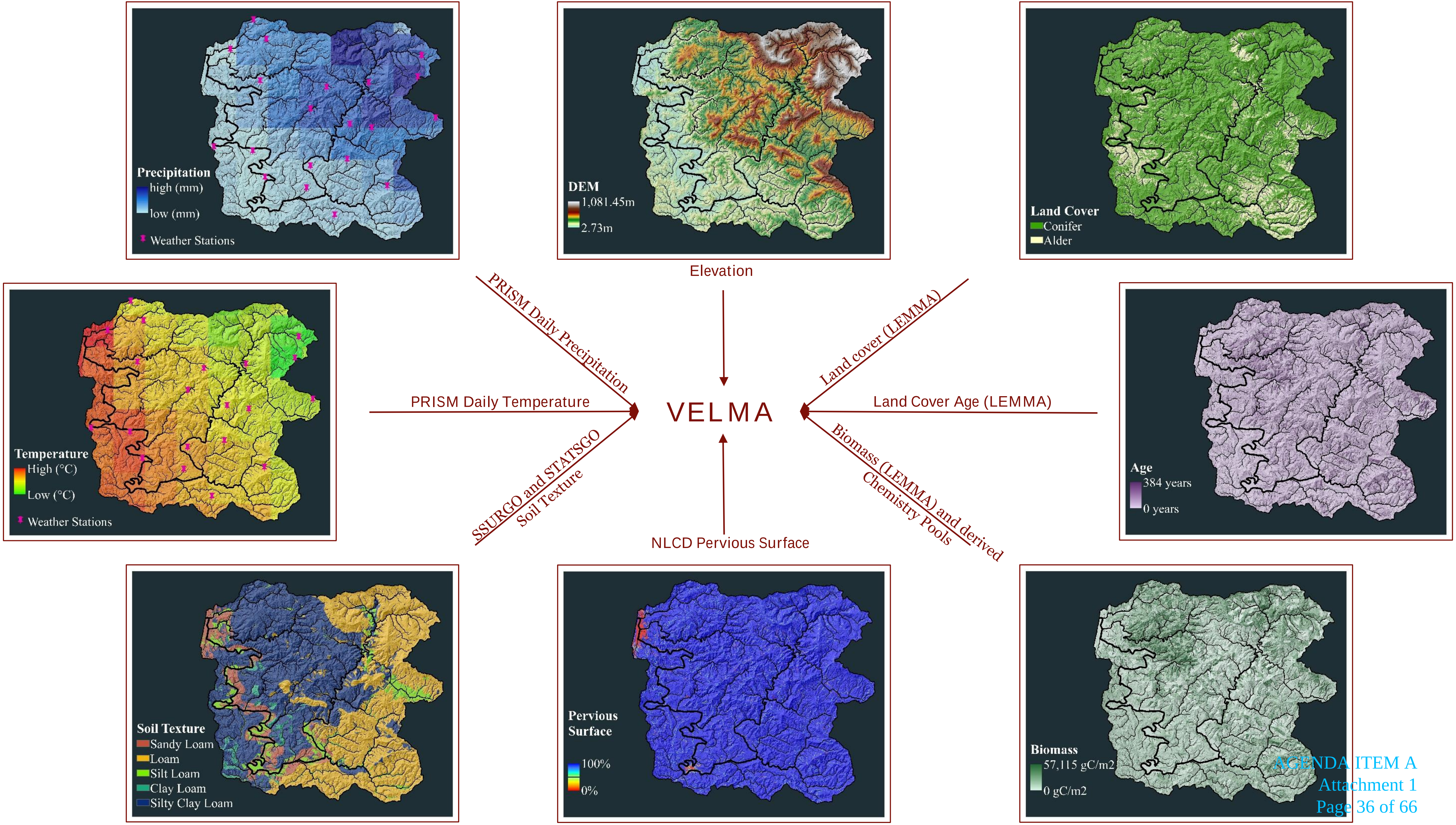
Addressing Key Uncertainties

Photo: Kevin Bladon

Tools and Technology

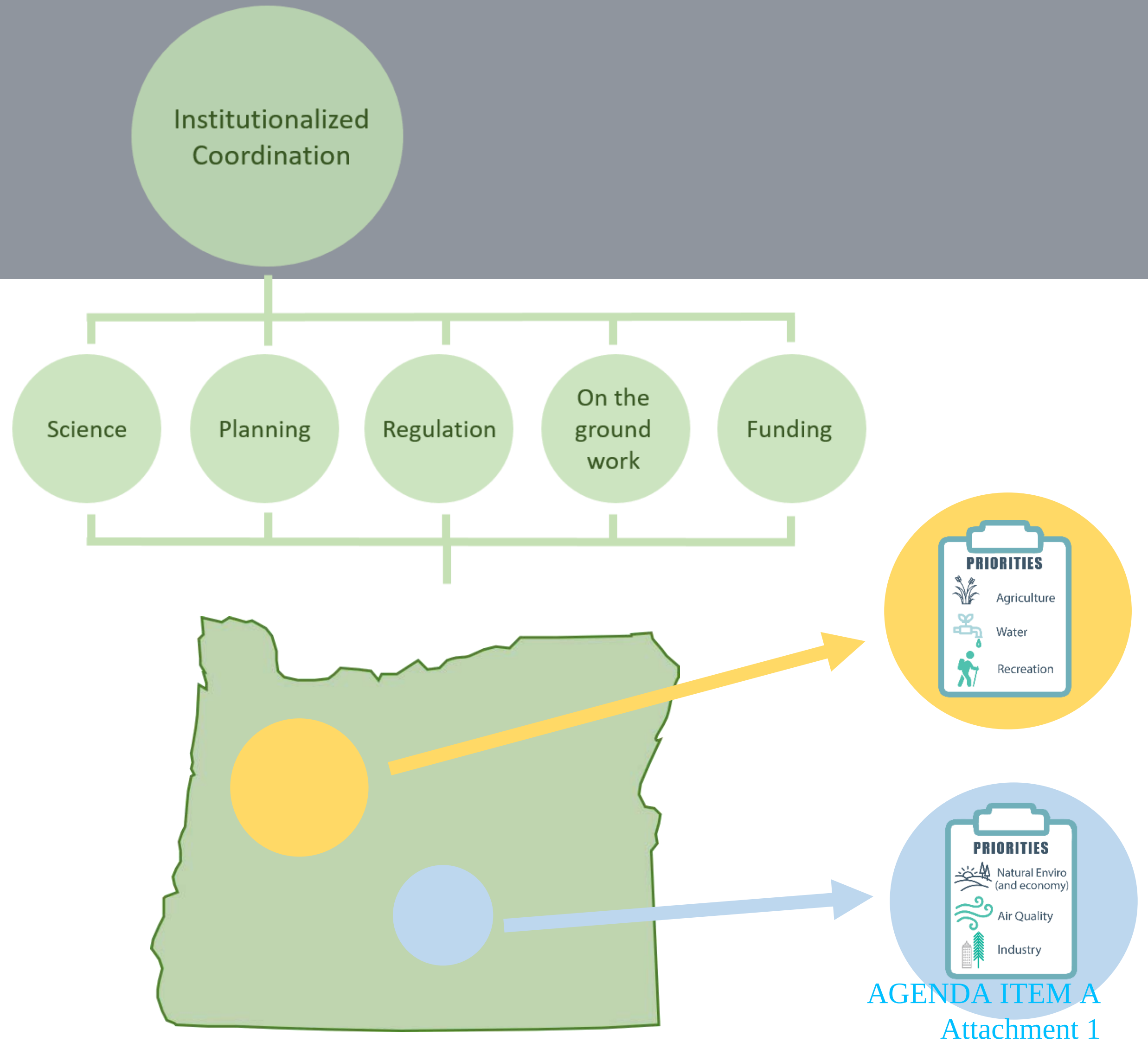
Photo: Mike Putnam

AGENDA ITEM A
Attachment 1

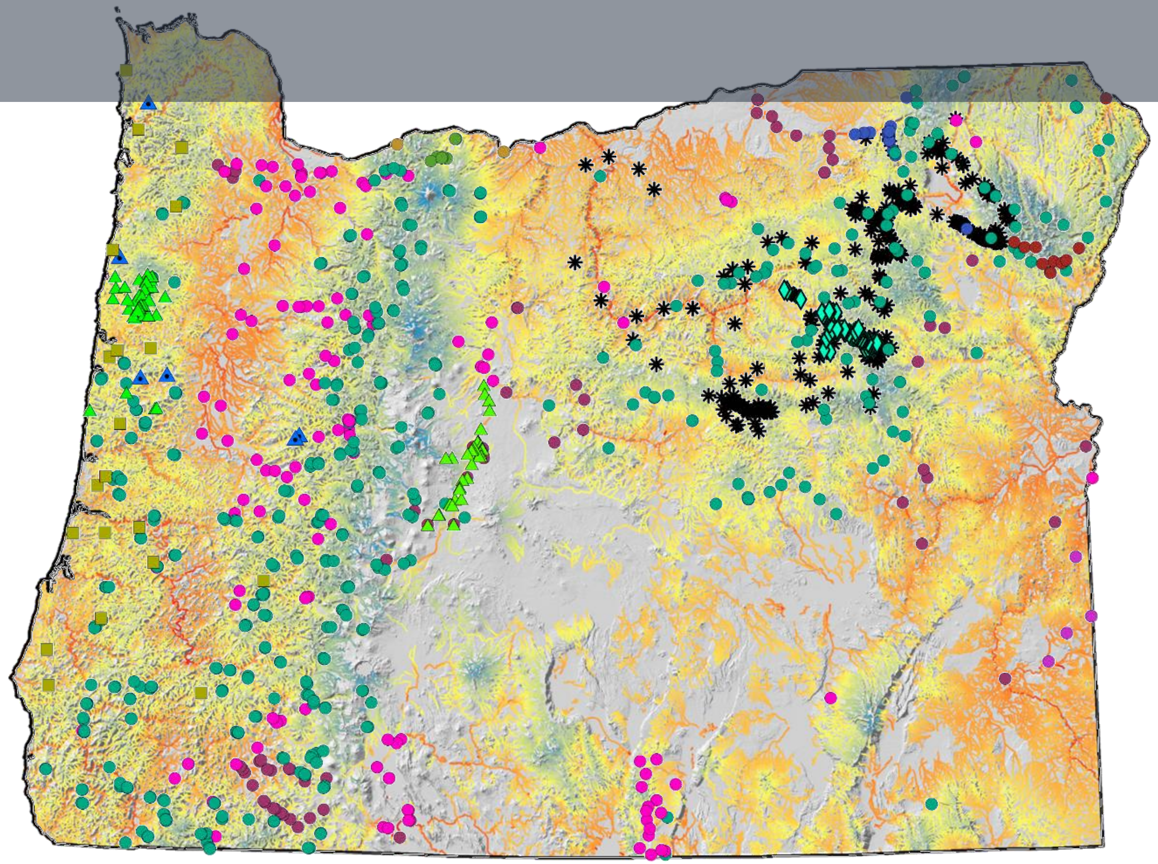

Precipitation
high (mm)
low (mm)
Weather Stations
DEM
1,081.45m
2.73m
Elevation
Land Cover
Conifer
Alder
PRISM Daily Precipitation
Land cover (LEMMA)
Temperature
High (°C)
Low (°C)
Weather Stations
PRISM Daily Temperature
VELMA
Land Cover Age (LEMMA)
Age
384 years
0 years
SSURGO and STATSGO Soil Texture
NLCD Pervious Surface
Biomass (LEMMA) and derived Chemistry Pools
Soil Texture
Sandy Loam
Loam
Silt Loam
Clay Loam
Silty Clay Loam
Pervious Surface
100%
0%
Biomass
57,115 gC/m2
0 gC/m2

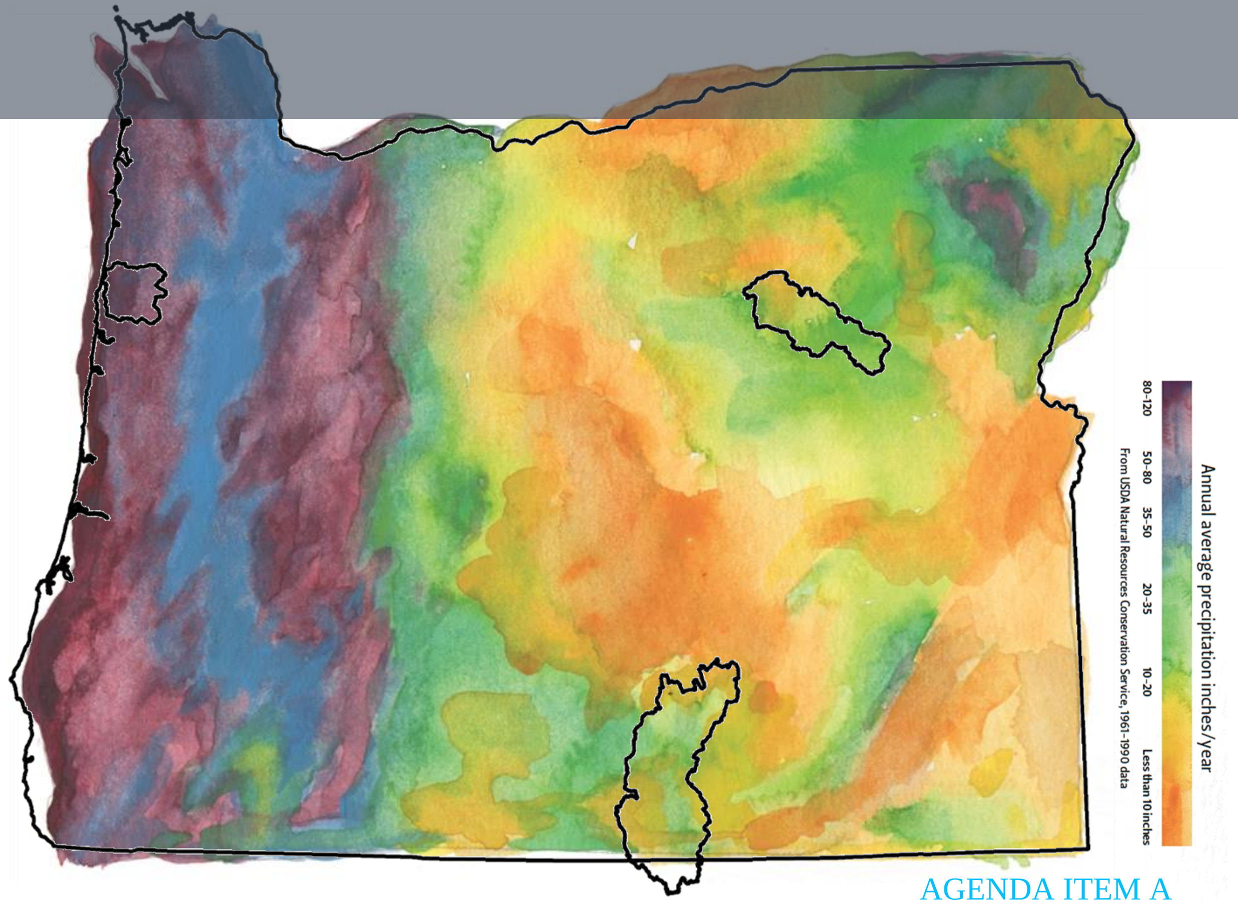
Statewide Coordination

- Coordinated inventories and vulnerability assessments
- Efficient research and monitoring
- Determine clear priorities within and across geographical areas
- Implement priorities



Coordinated Monitoring



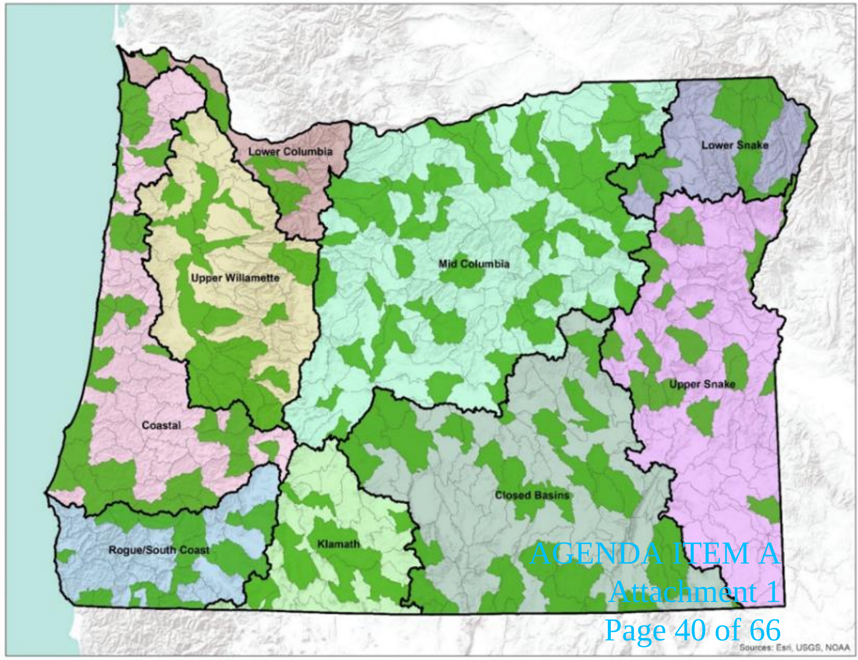


Inventory and Vulnerability Assessment

- Map unique resources
- Calculate the protection or restoration value of reaches
- Spatial optimization to reduce fragmentation
- Ground truth with local review

Outcome

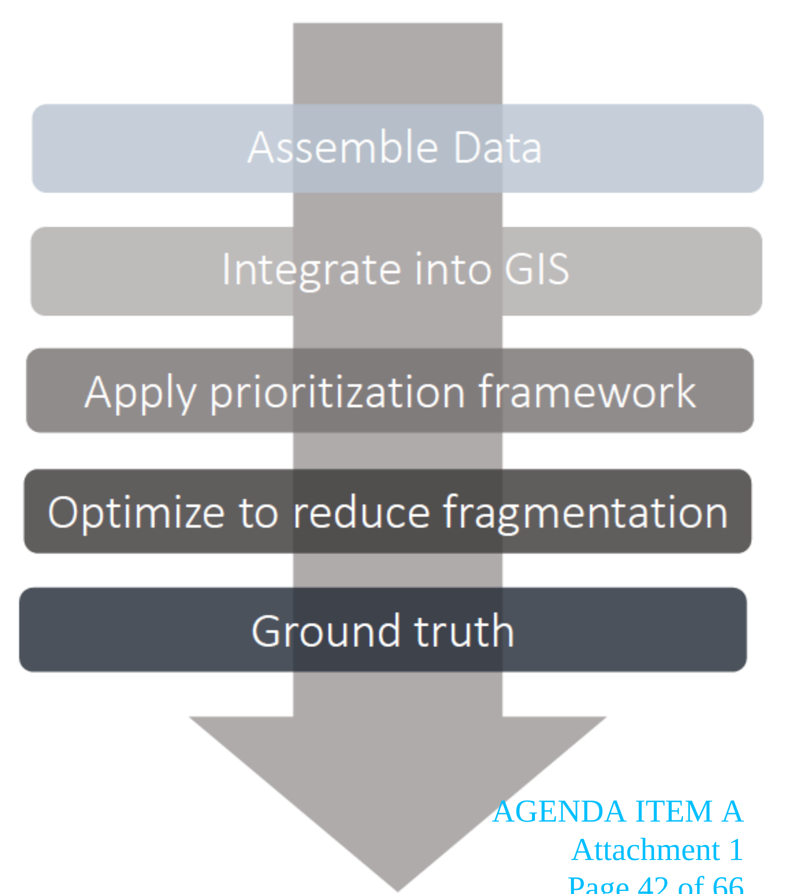
- **Clear geographical priorities** for protecting or restoring flow, temperature, and habitat
- **Flow and temperature** targets for priority areas
- Geographic **scaling of risk** associated with land use



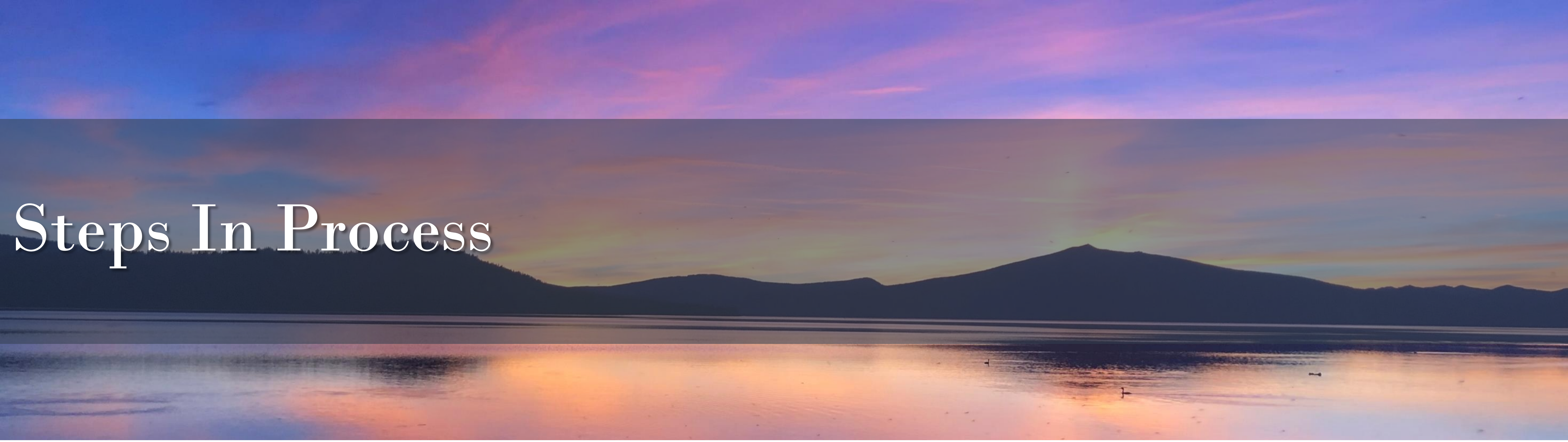
Outcome

Knowledge and monitoring gaps identified

How?



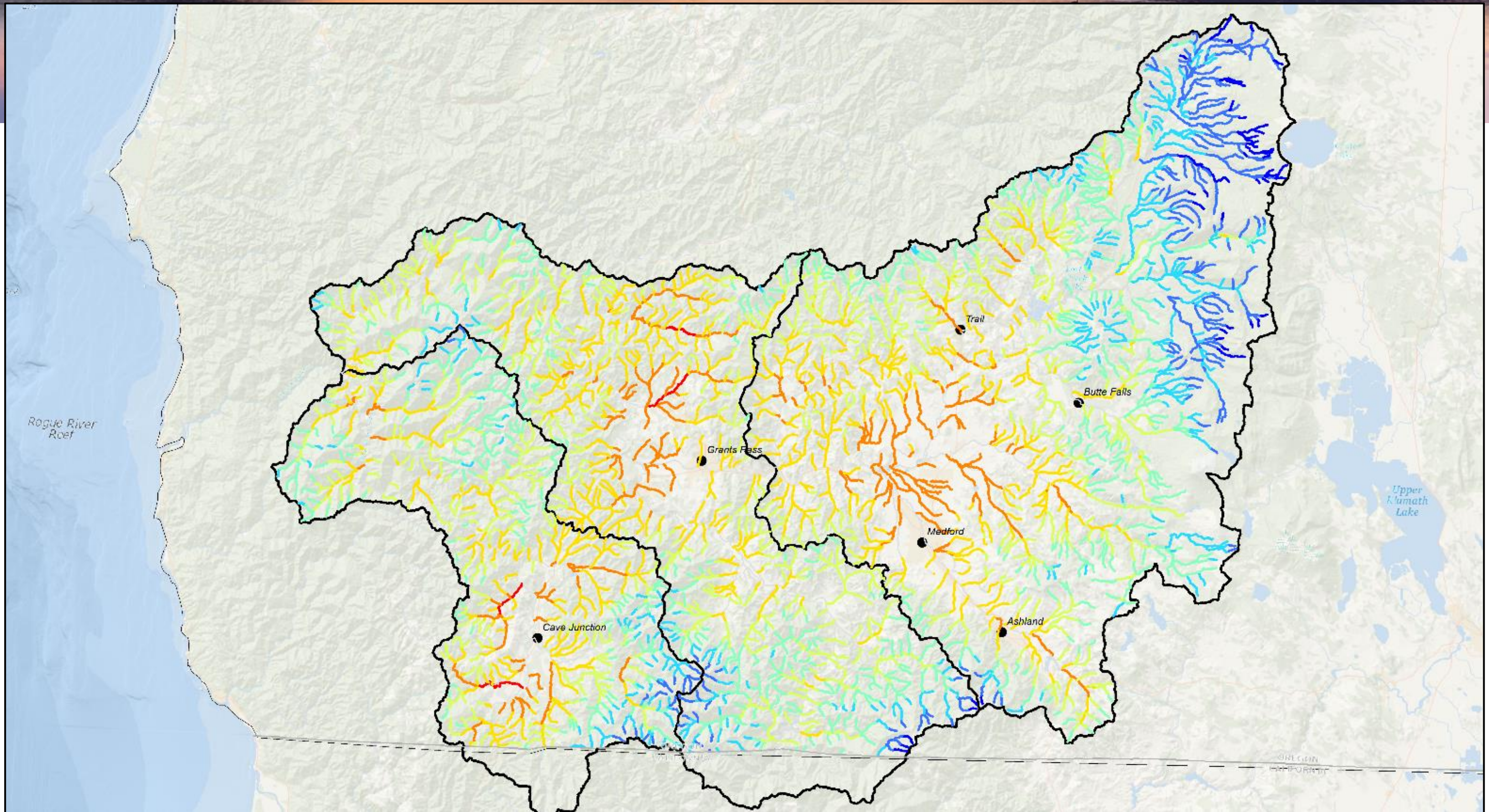
- The **core concept** is to protect the best and focus restoration in areas with highest benefit (now and in future).



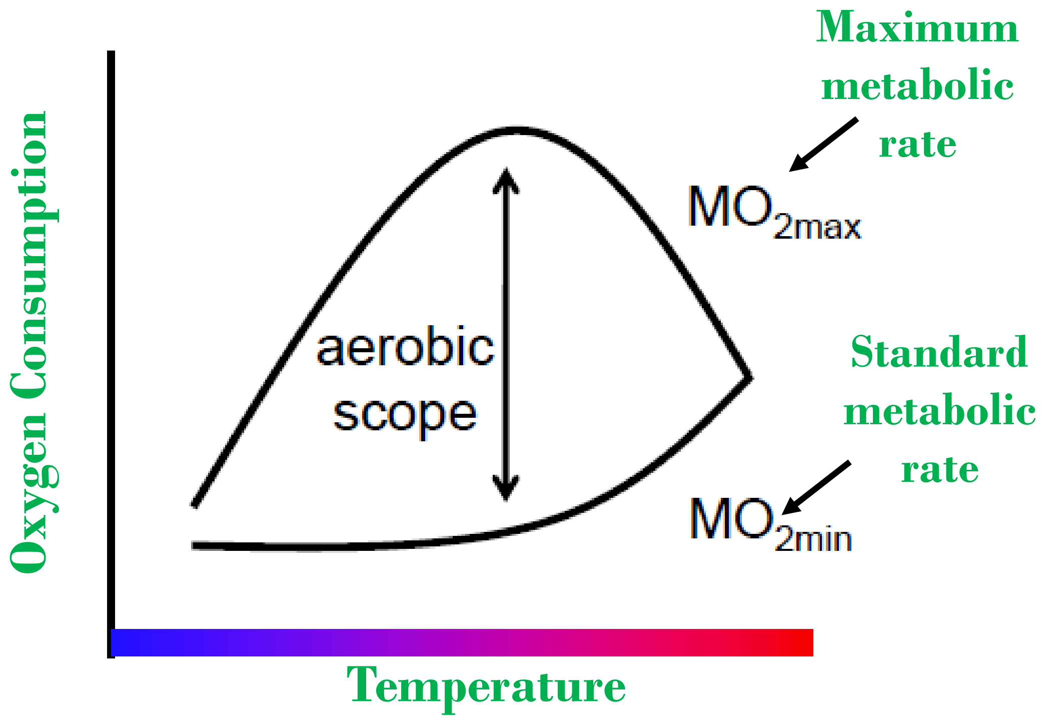
Steps In Process

1. Map stream temperature
2. Develop biological criteria
3. Classify reach suitability
4. Thermal suitability of native salmonids

Step One: Map stream temperature



Step Two: Develop biological criteria

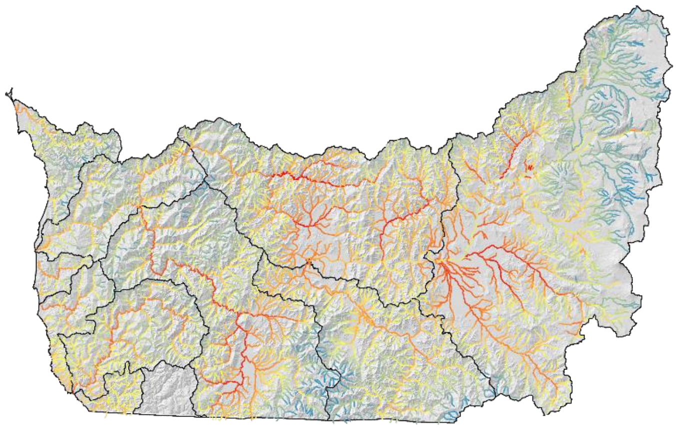


Cold
Coastal Cutthroat

Moderately cold
Redband

Warm
Warner Sucker

Step three: Classify reach suitability



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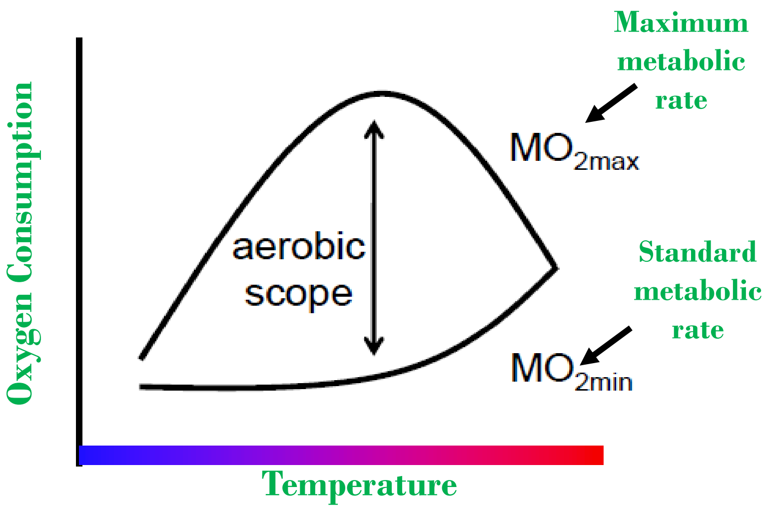

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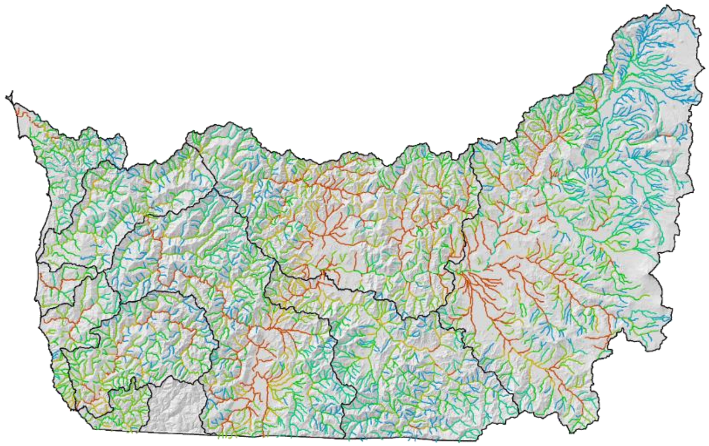
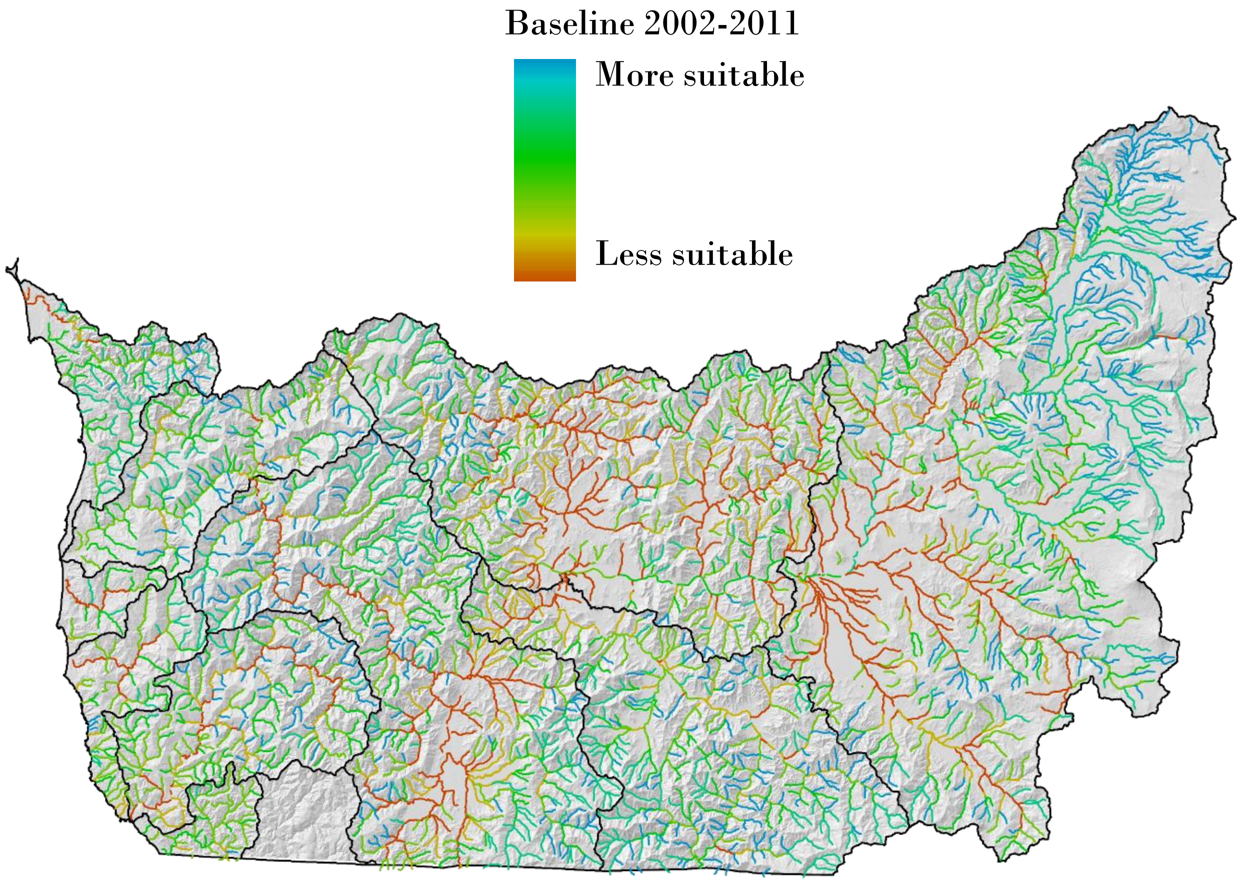
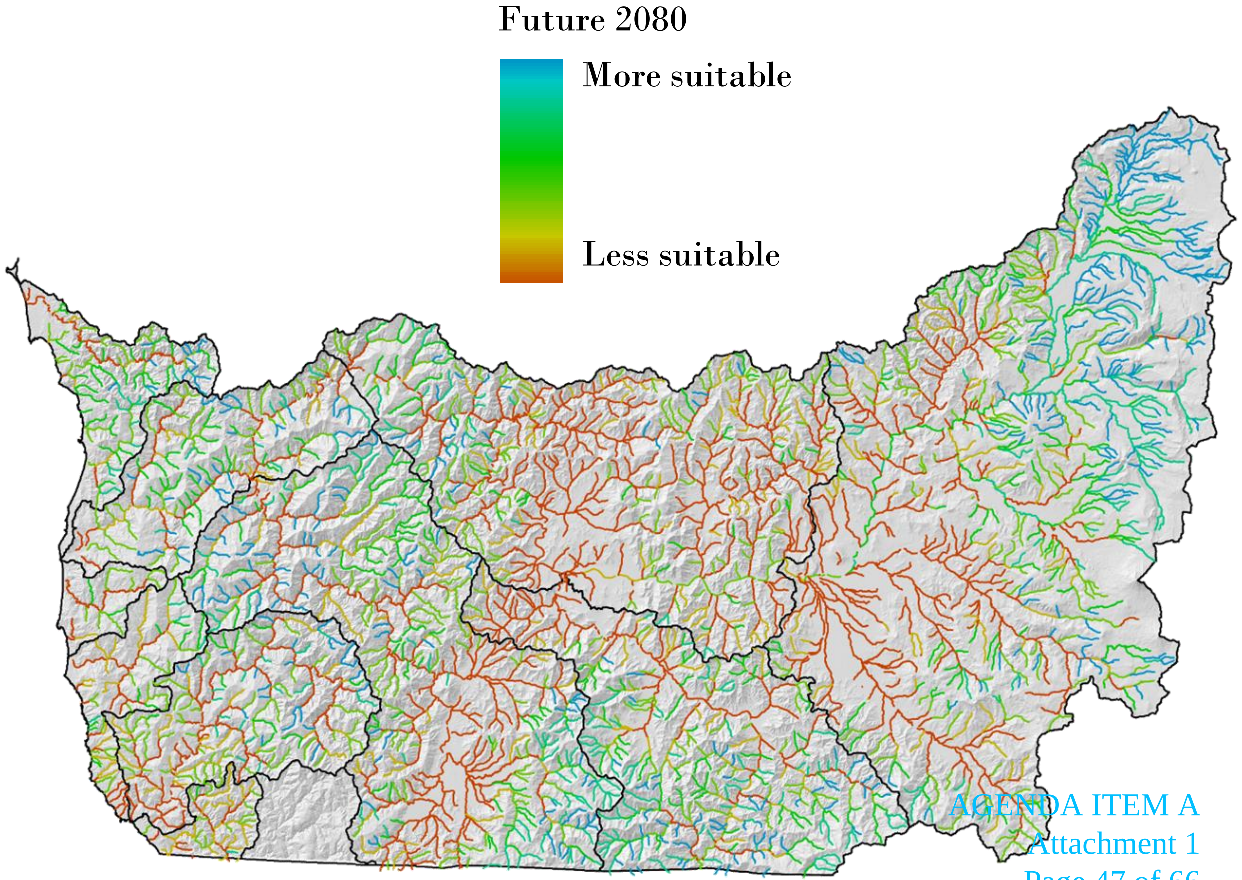


Thermal suitability for native salmonids





Thank you!

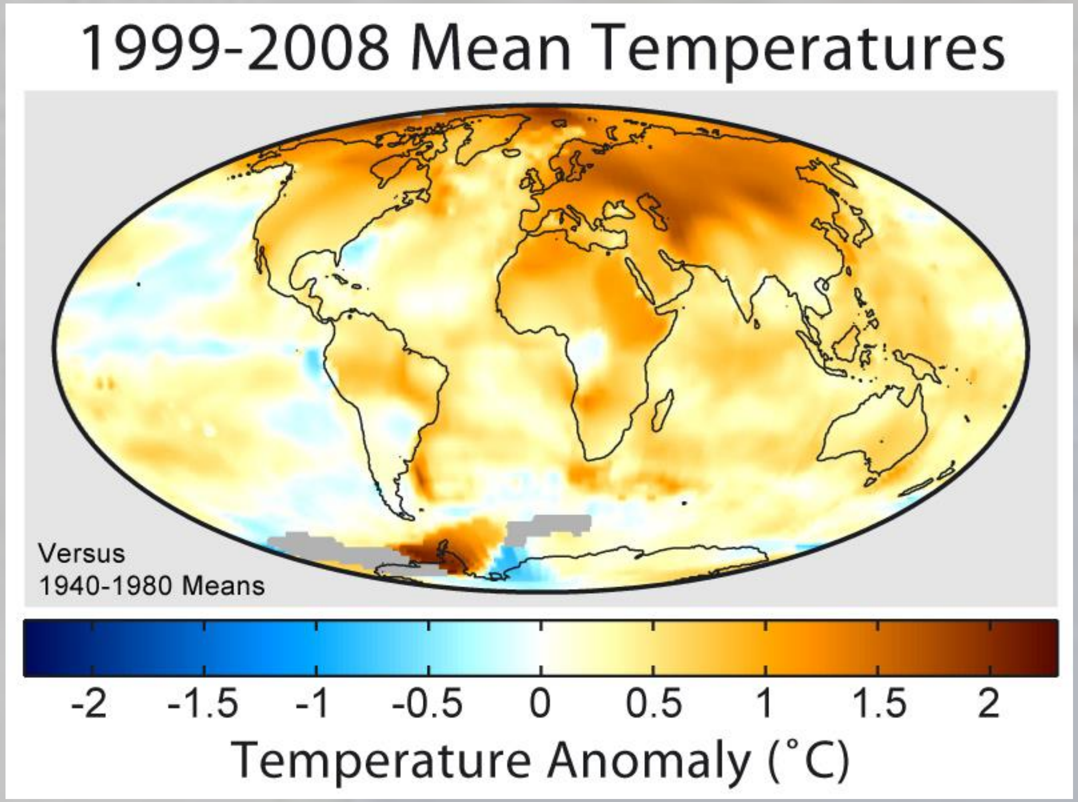
Questions?

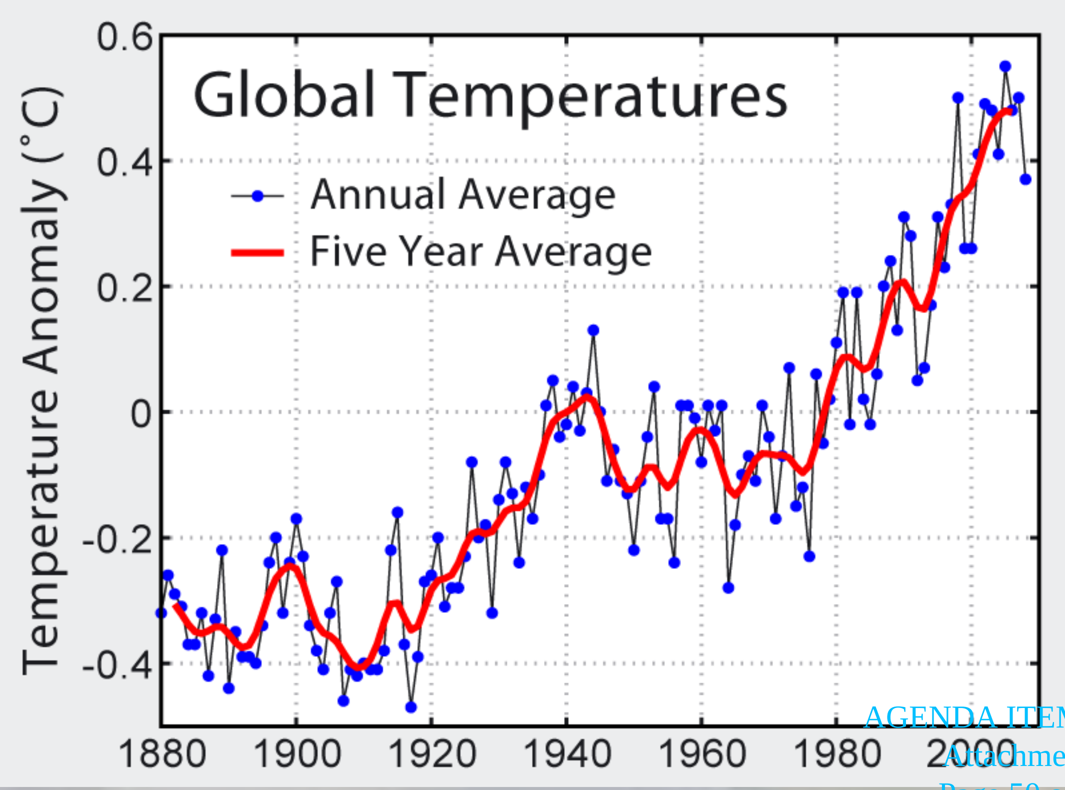
Stream Temperature Monitoring
Kara Anlauf-Dunn
kara.Anlauf-dunn@oregonstate.edu

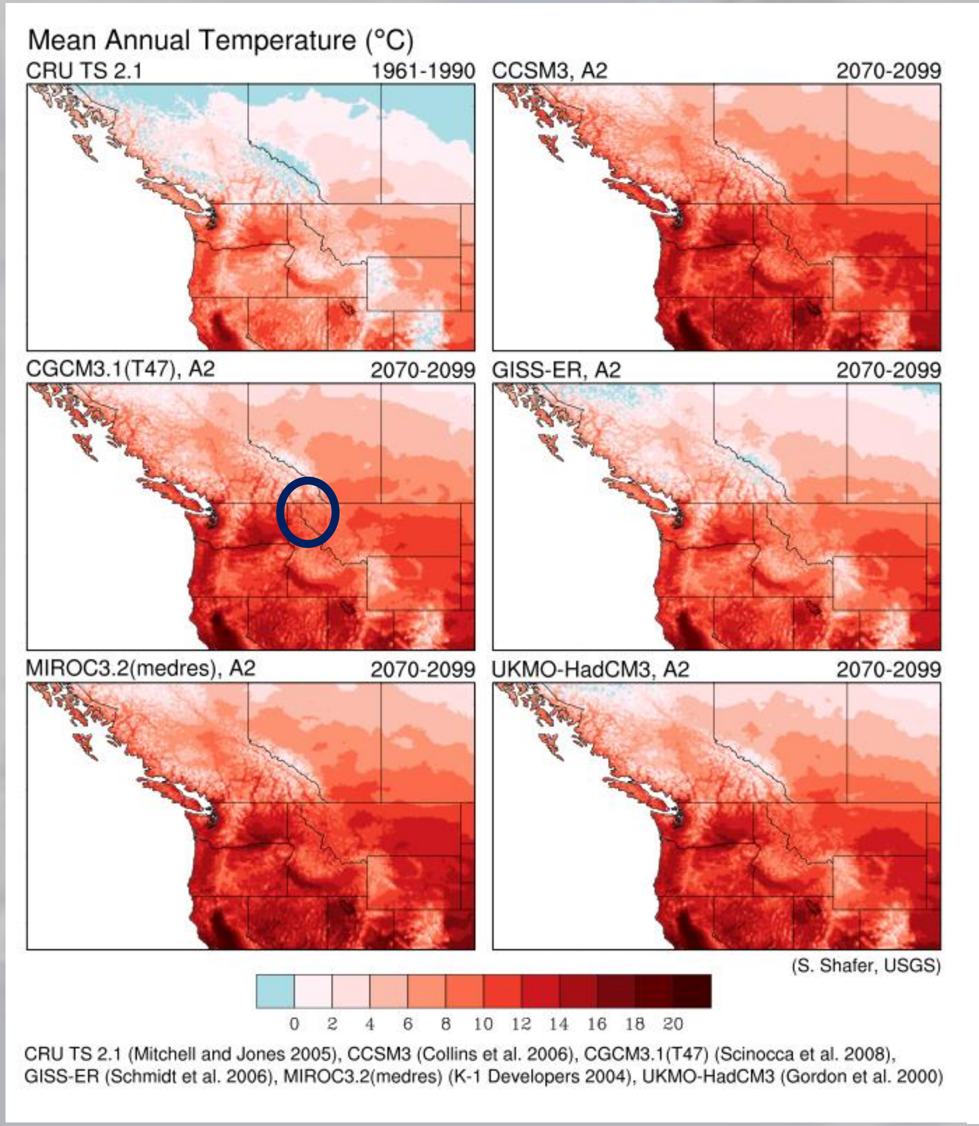
Climate Change Policy
Shaun Clements
shaun.clements@oregonstate.edu

Water Temperatures & Riparian Areas in the Siskiyou Region

Gordon Reeves, Emeritus Scientist
Pacific Northwest Research Station
U.S. Forest Service
Corvallis, OR


1999-2008 Mean Temperatures
Versus
1940-1980 Means
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
Temperature Anomaly (°C)


Global Temperatures
Annual Average
Five Year Average
Temperature Anomaly (°C)
0.6
0.4
0.2
0
-0.2
-0.4
1880
1900
1920
1940
1960
1980
2000


Mean Annual Temperature (°C)
CRU TS 2.1
1961-1990
CCSM3, A2
2070-2099
CGCM3.1(T47), A2
2070-2099
GISS-ER, A2
2070-2099
MIROC3.2(medres), A2
2070-2099
UKMO-HadCM3, A2
2070-2099
(S. Shafer, USGS)
0 2 4 6 8 10 12 14 16 18 20
CRU TS 2.1 (Mitchell and Jones 2005), CCSM3 (Collins et al. 2006), CGCM3.1(T47) (Scinocca et al. 2008), GISS-ER (Schmidt et al. 2006), MIROC3.2(medres) (K-1 Developers 2004), UKMO-HadCM3 (Gordon et al. 2000)

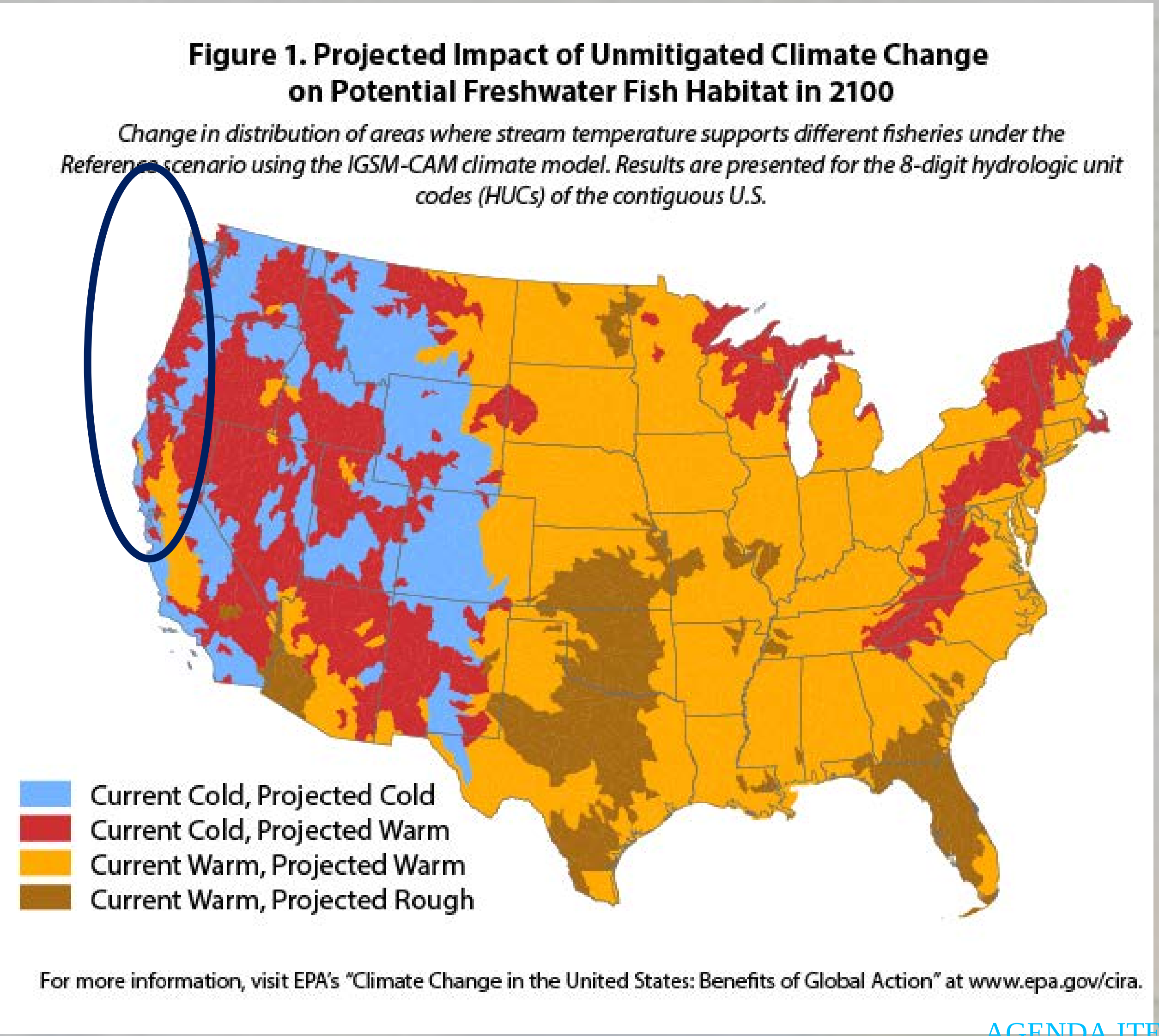
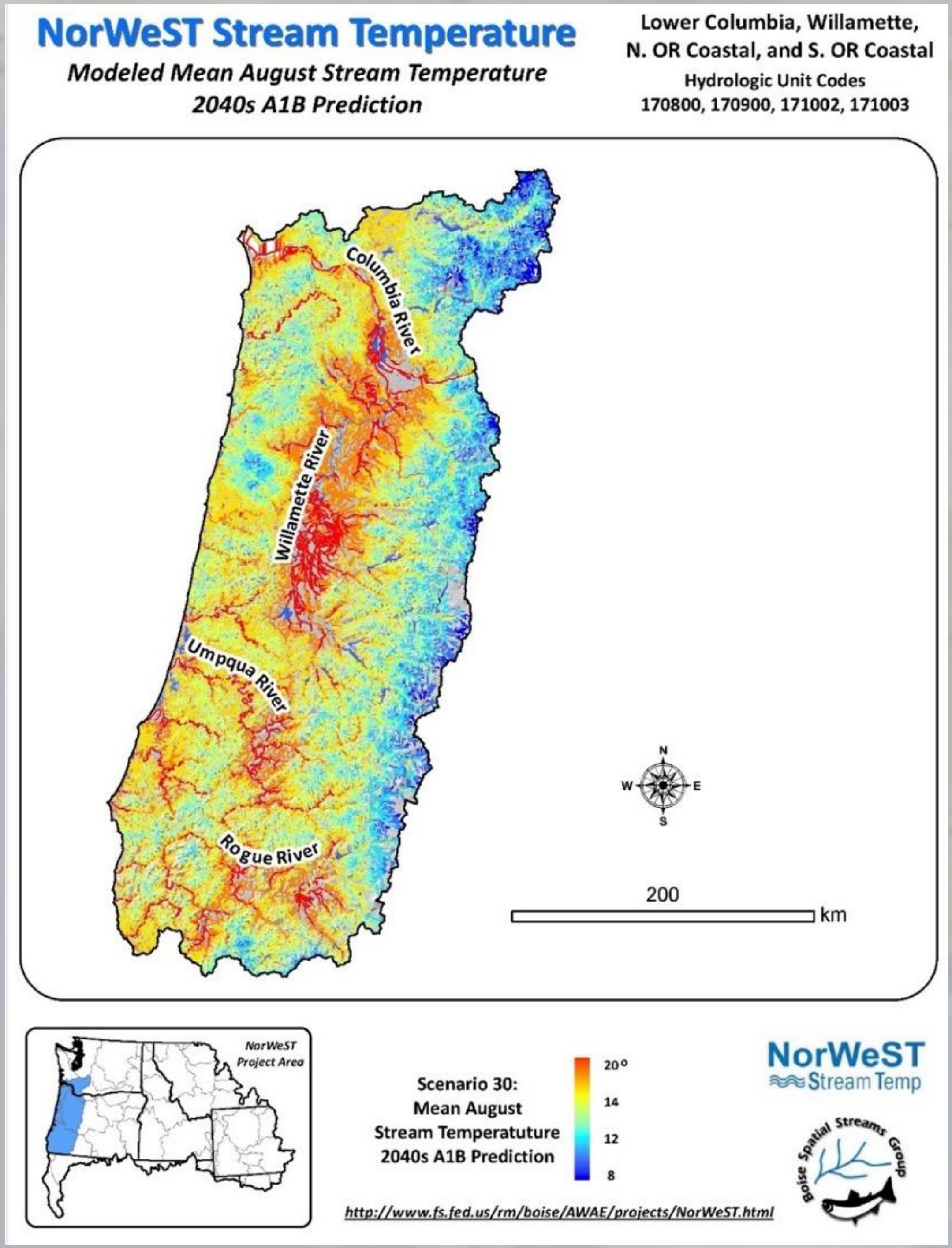
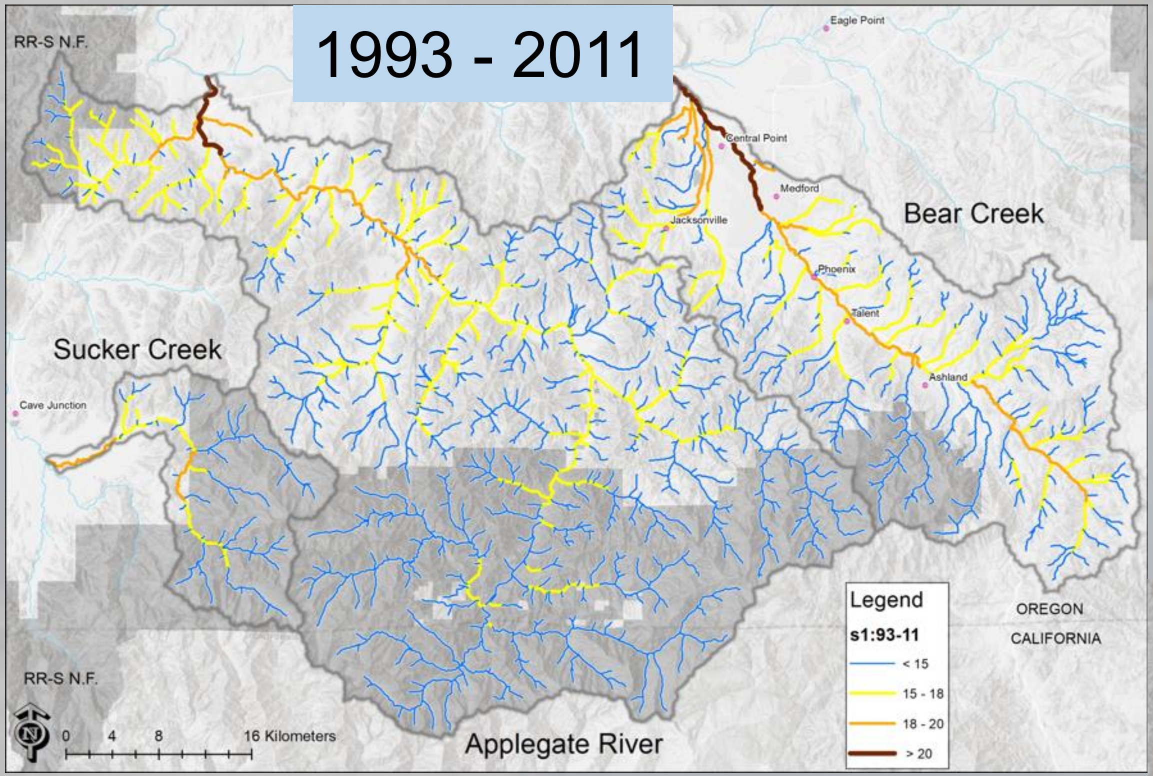


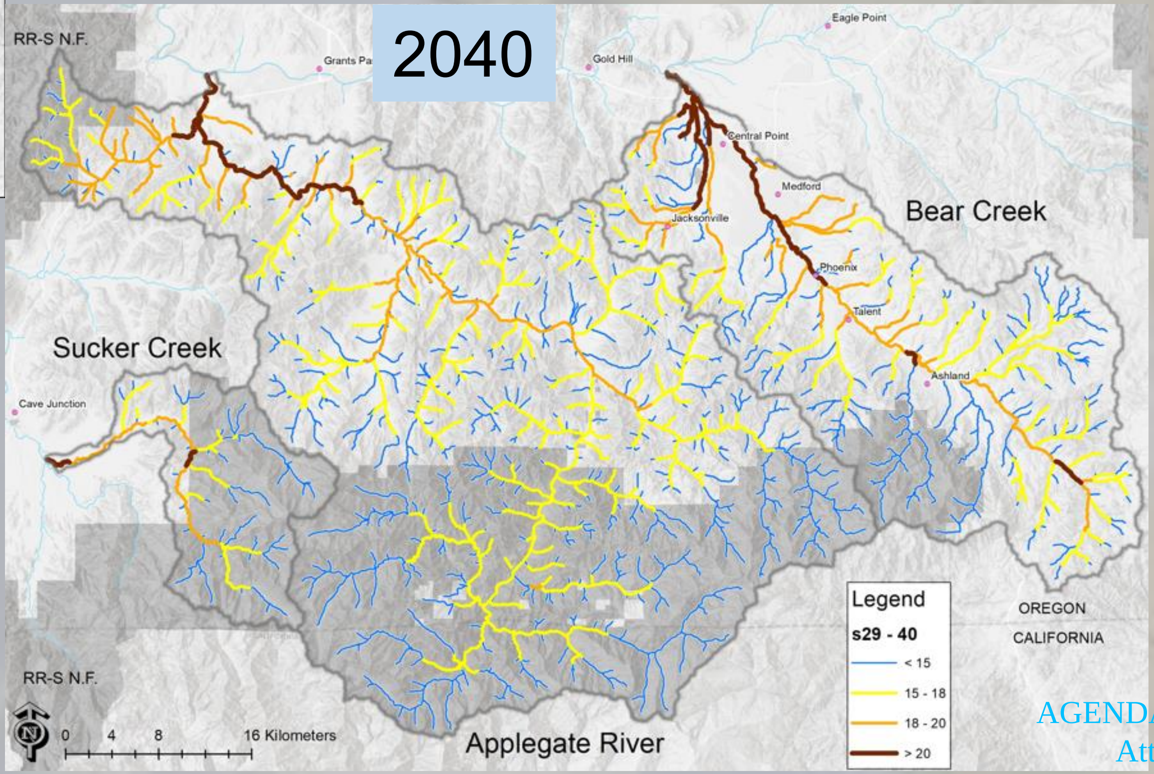
Figure 1. Projected Impact of Unmitigated Climate Change on Potential Freshwater Fish Habitat in 2100
Change in distribution of areas where stream temperature supports different fisheries under the Reference scenario using the IGSM-CAM climate model. Results are presented for the 8-digit hydrologic unit codes (HUCs) of the contiguous U.S.
Current Cold, Projected Cold
Current Cold, Projected Warm
Current Warm, Projected Warm
Current Warm, Projected Rough
For more information, visit EPA's "Climate Change in the United States: Benefits of Global Action" at www.epa.gov/cira.


NorWeST Stream Temperature
Modeled Mean August Stream Temperature
2040s A1B Prediction
Lower Columbia, Willamette,
N. OR Coastal, and S. OR Coastal
Hydrologic Unit Codes
170800, 170900, 171002, 171003
Columbia River
Willamette River
Umpqua River
Rogue River
N
W
E
S
200
km
NorWeST
Project Area
Scenario 30:
Mean August
Stream Temperatuture
2040s A1B Prediction
20°
14
12
8
NorWeST
Stream Temp
Boise Spatial Streams Group
http://www.fs.fed.us/rm/boise/AWAE/projects/NorWeST.html

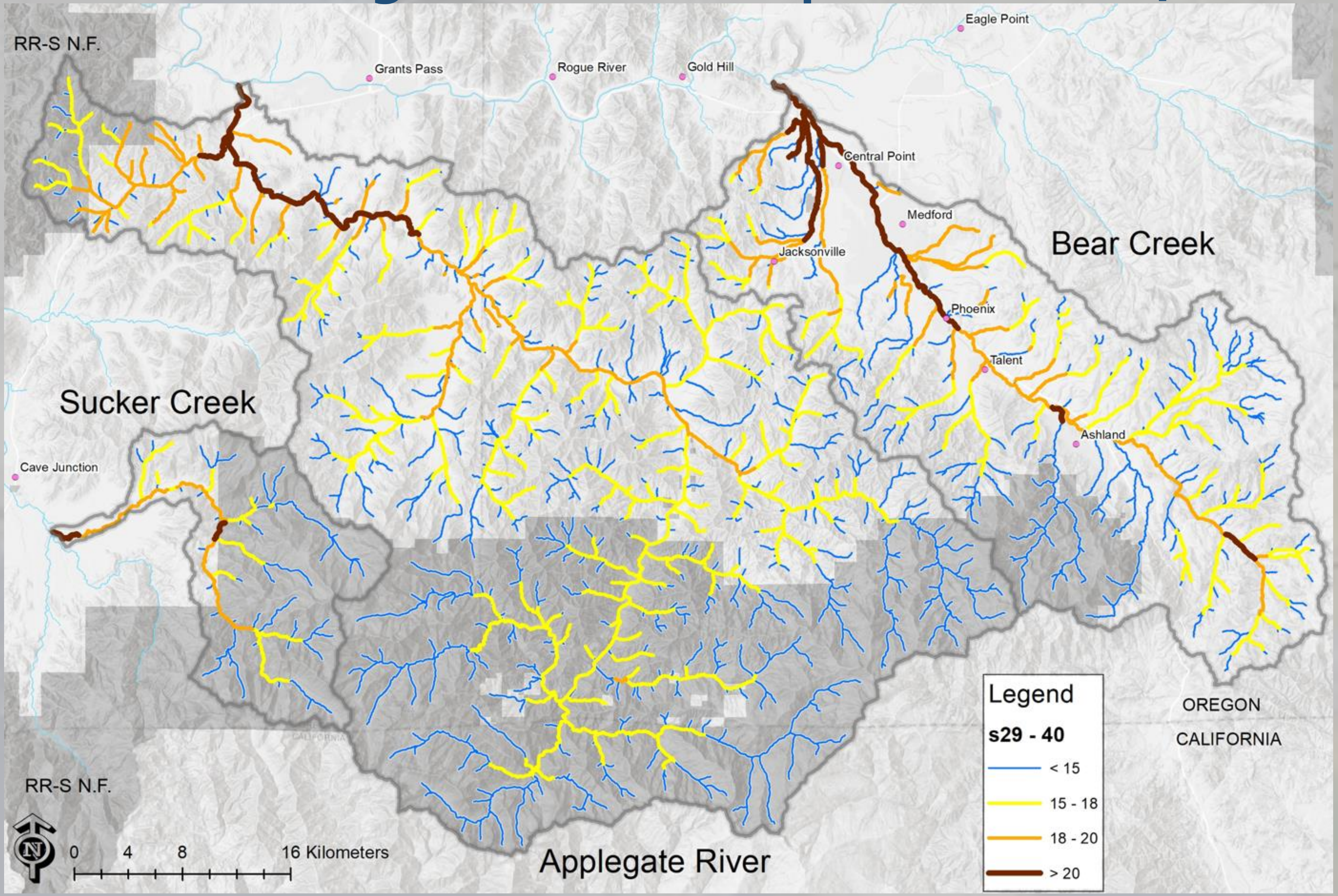

TUNIS 1500 MI.
TUNIS 1500 MI.
TUNIS 1500 MI

NorWeST Modeled Mean August Water Temperatures (°C)

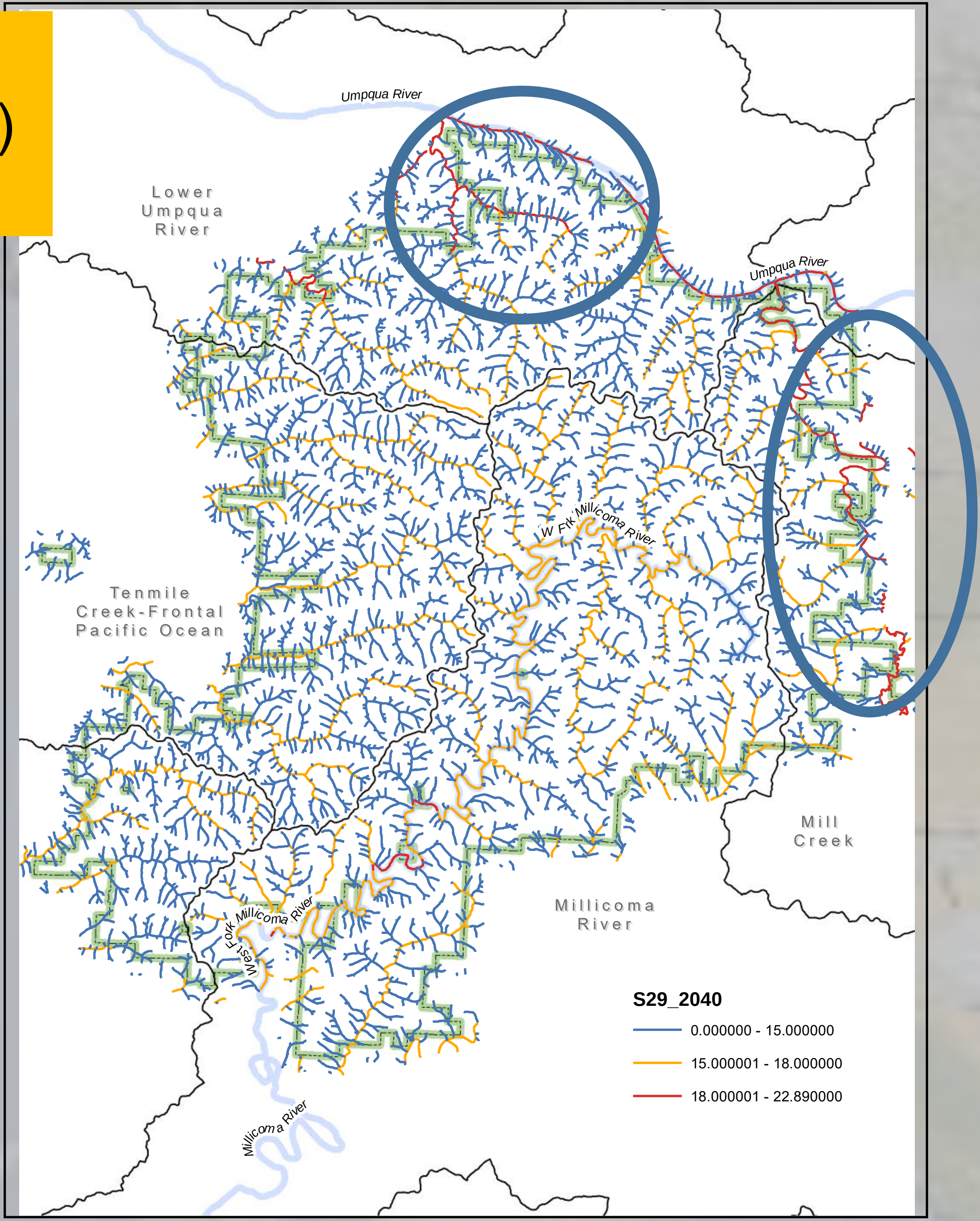




NorWEST Modeled
Mean August Water Temperatures 2040



Modeled Mean August Water Temperatures (°C) in 2040 (NorWest)



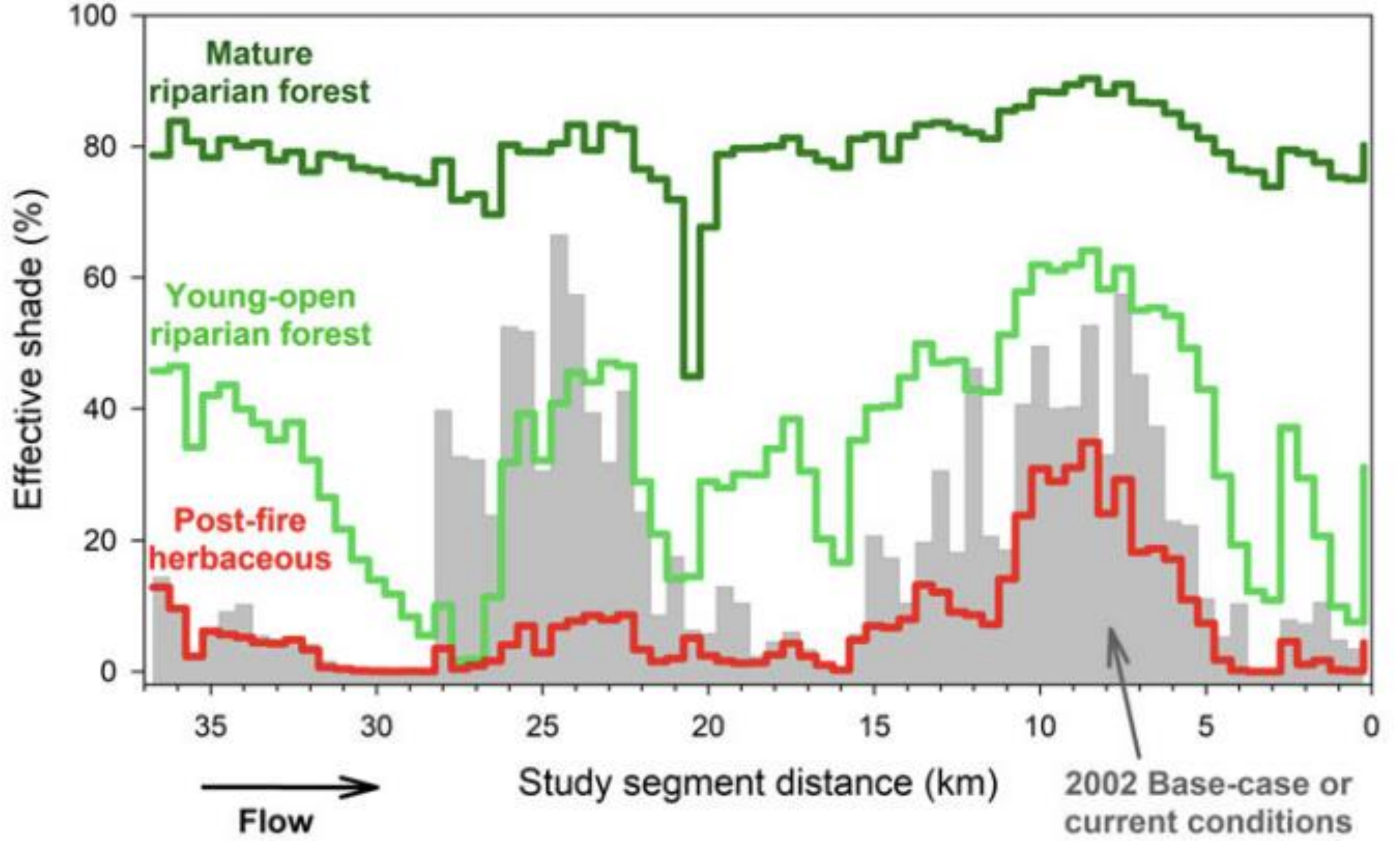


FIGURE 2. Effective shade on July 14 over the length of the study segment for four riparian vegetation scenarios.

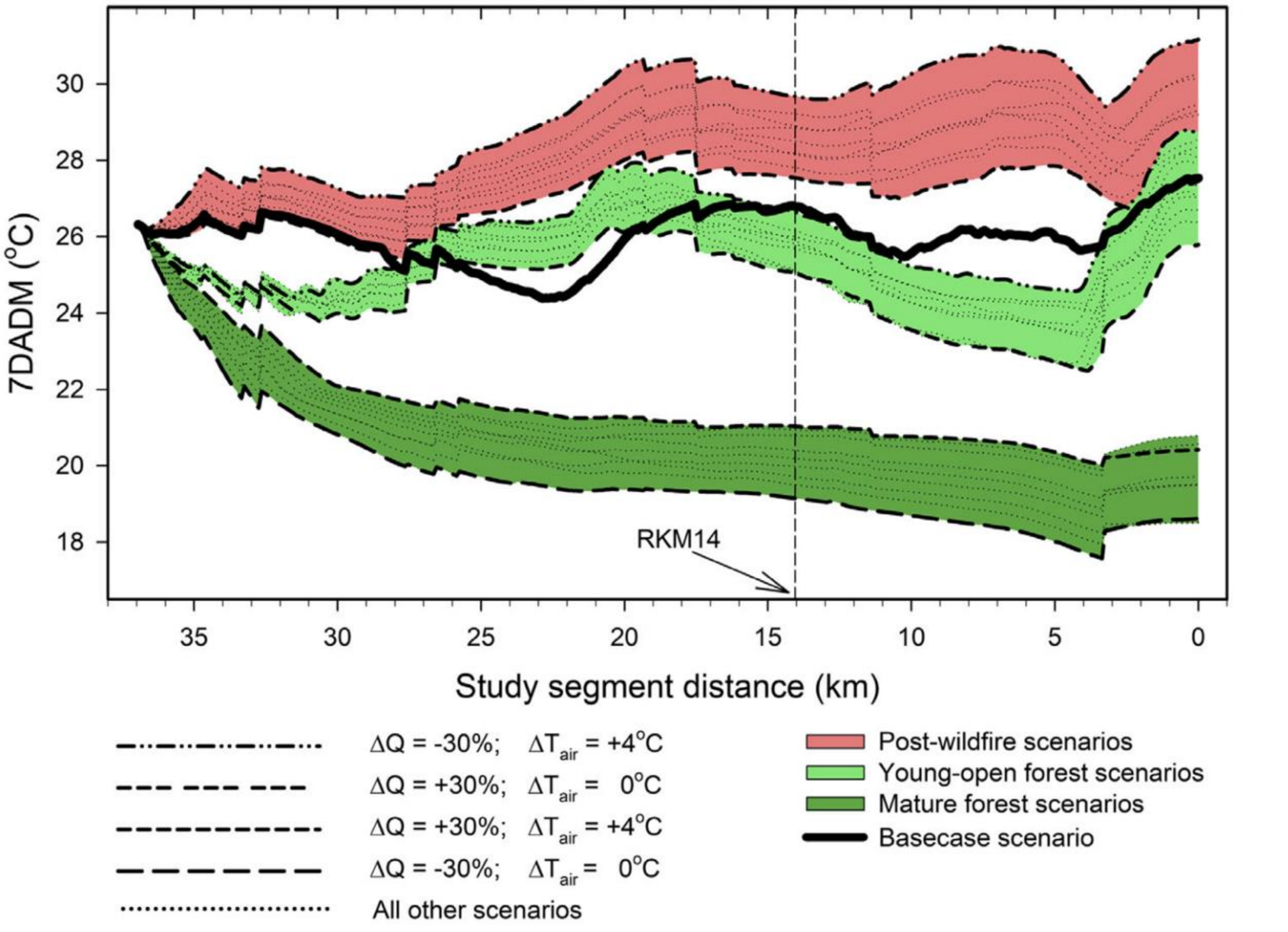
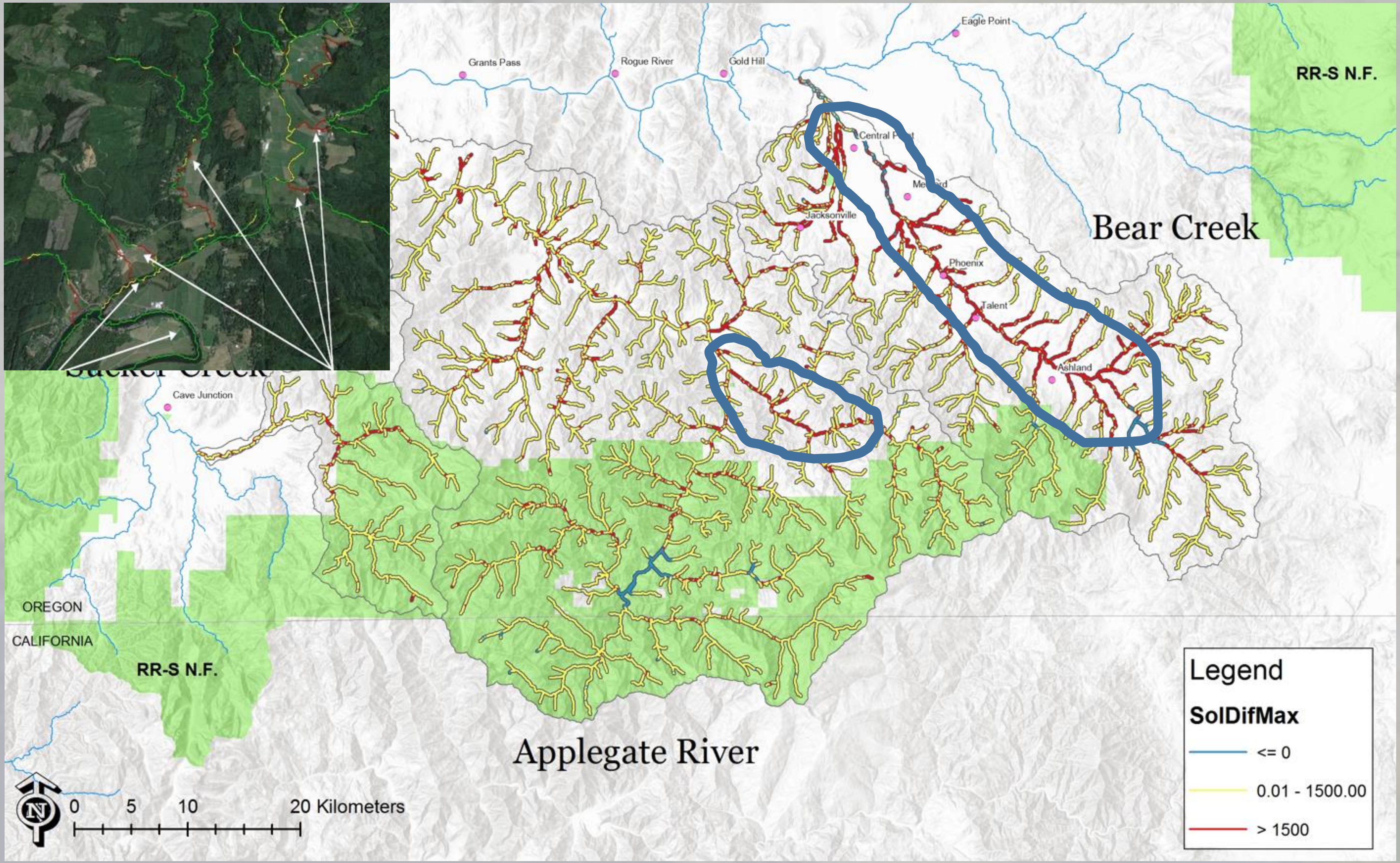


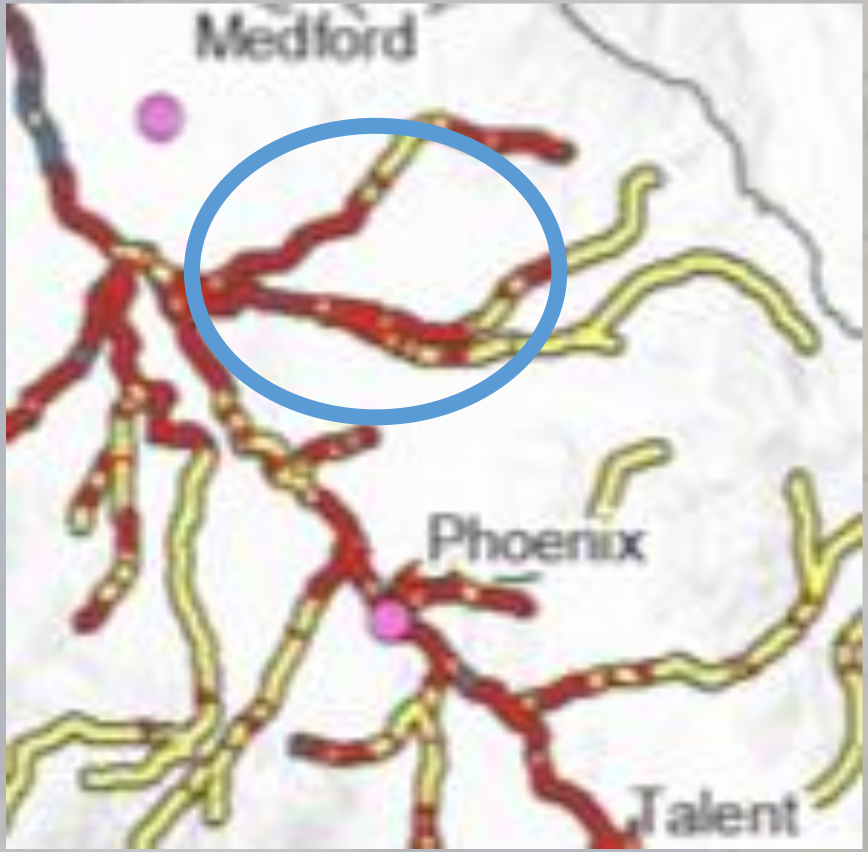
FIGURE 4. Simulated seven-day average daily maximum temperature (7DADM) stream temperatures over the length of the study segment. Simulation results are grouped for three riparian vegetation scenarios (shaded zones) bounded by bold lines representing combinations of T_{air} and Q representing the scenario with the warmest or coldest simulated 7DADM stream temperatures. Note that under both the post-wildfire and young-open forest scenarios, the +30% Q simulations result in the coldest stream temperatures. This pattern is reversed under the mature forest scenario where the +30% Q simulation results in the warmest stream temperatures.

Influence of Riparian Vegetation on Water Temperature

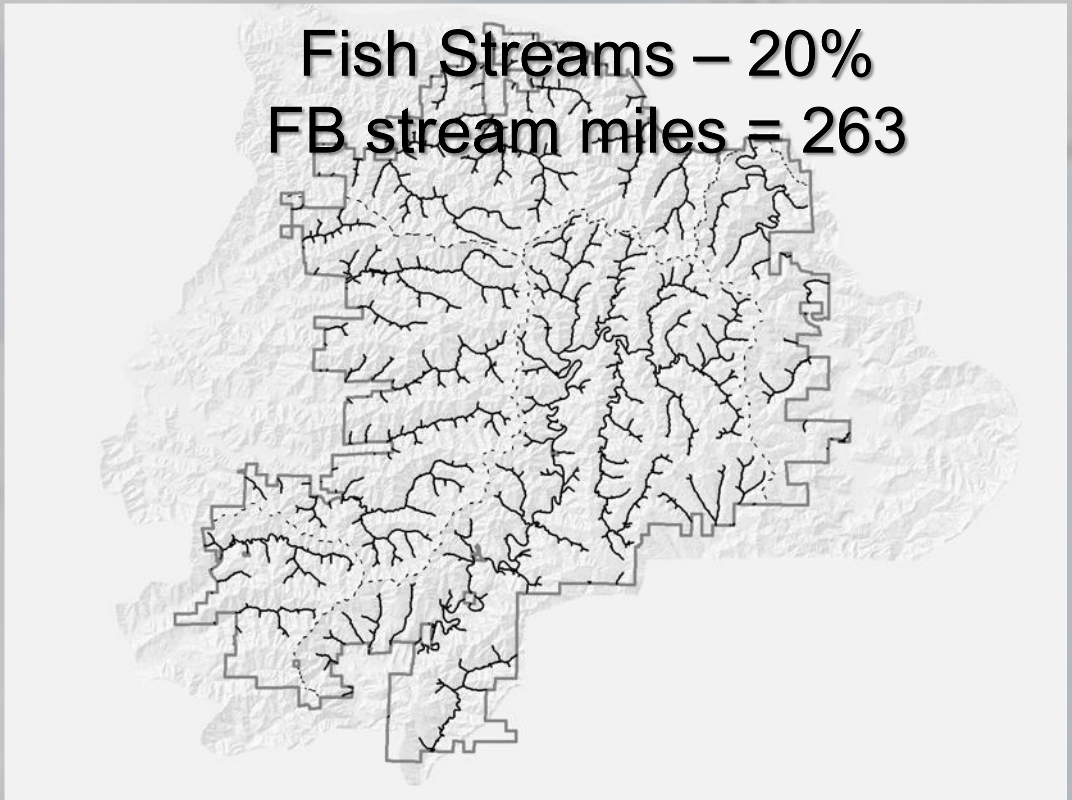


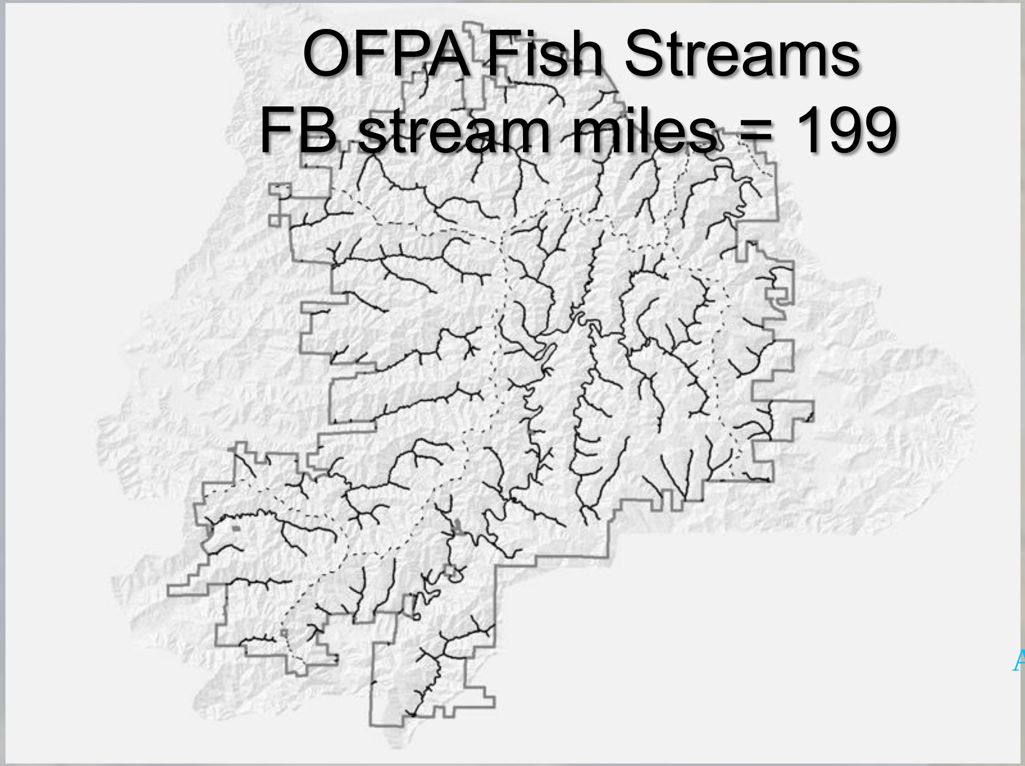
2040 August
Water Temperature

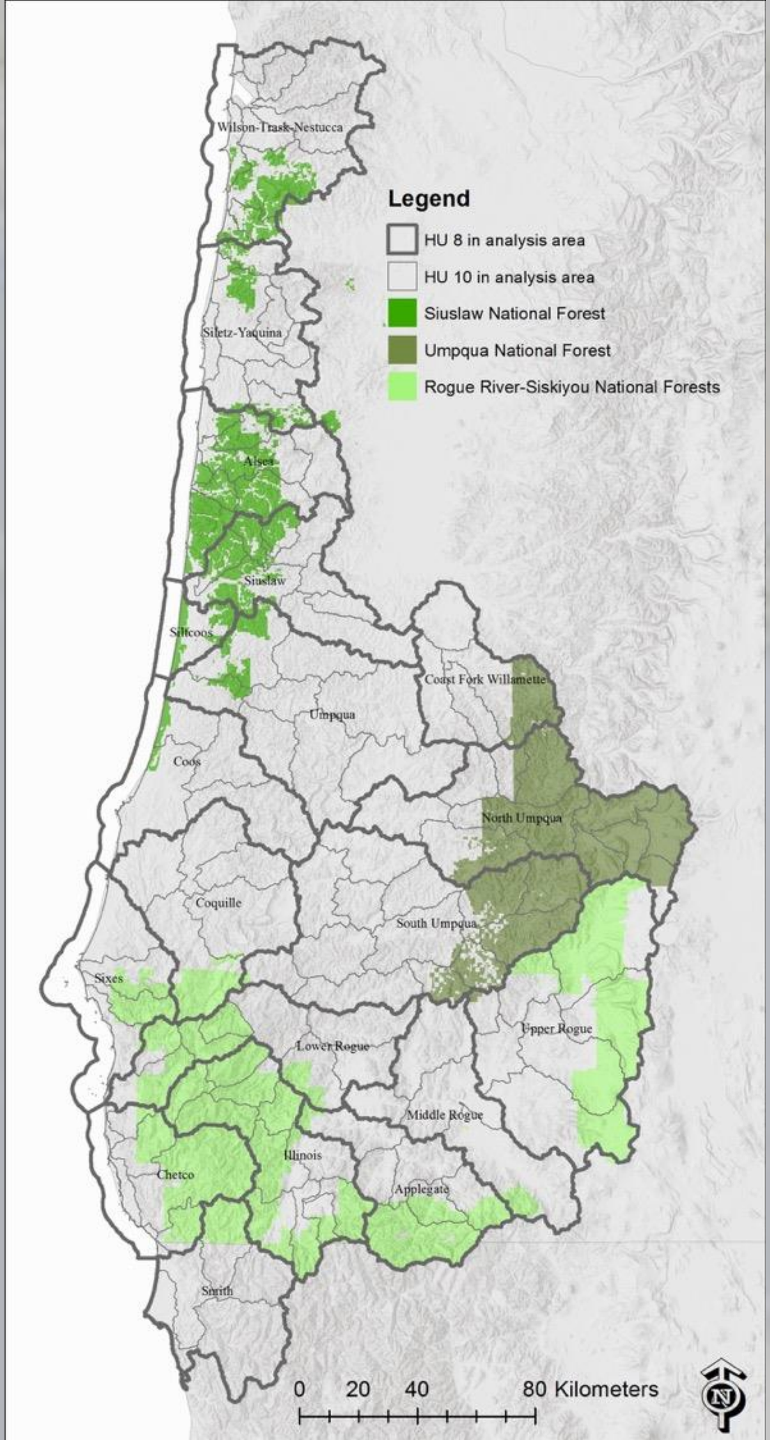
Riparian Influence



What is a fish-bearing stream?







Legend
HU 8 in analysis area
HU 10 in analysis area
Siuslaw National Forest
Umpqua National Forest
Rogue River-Siskiyou National Forests
Wilson-Trask-Nestucca
Siletz-Yaquina
Alsea
Siuslaw
Siltcoos
Coast Fork Willamette
Umpqua
Coos
North Umpqua
Coquille
South Umpqua
Sixes
Upper Rogue
Lower Rogue
Middle Rogue
Illinois
Chetco
Applegate
Smith
0 20 40 80 Kilometers

SUMMARY

- Riparian vegetation can potentially off-set future increases in water temperature
  - Size & Structure to be effective?

SUMMARY

- Riparian vegetation can potentially off-set future increases in water temperature
  - Size & Structure to be effective?
- Need to understand the expression of climate change at the local scale
  - Be strategic in response
    - Requires some type of analysis
    - Could involve variable width buffers

"The significant problems we face today cannot be solved with the same level of thinking that were at when we created them."

Albert Einstein

Board-Panel discussion

M E M O R A N D U M

To: Oregon Board of Forestry
Fr: Mary Scurlock, Oregon Stream Protection Coalition
Re Follow-up to Climate Change Presentations as Context for Siskiyou Rules Review
Date: April 29, 2020

Thank you for the opportunity to provide follow-up testimony related to the implications of the April 22 presentations from experts Jessica Halofsky, Kara Anlauf-Dunn and Gordon Reeves on climate change and aquatic ecosystems in the Siskiyou georegion. The presentations and ensuing discussion were extremely informative, and I appreciated the chance to listen and follow along by phone.

There were a number of key takeaway messages that relate directly to the Board's July 22 decision as to whether small and medium fish streams are being degraded by logging-associated shade reduction allowed by current stream protection rules in the Siskiyou Region.

- *Best available data and analytical tools (NorWest) tell us that climate change is hitting southwest Oregon harder than other regions of western Oregon*, especially with regard to seasonal extremes, snowpack reduction, and an extended summer drought season. The clear implication for policy is that it is even more urgent to control management-induced warming in the Siskiyou and to mitigate climate impacts on coldwater aquatic biota.

- *Although the effects of local drivers on stream temperature vary from place to place, shading matters a great deal everywhere*, and in most cases is the most significant single influence on stream temperature. (Anlauf-Dunn, Reeves citing Wondzell, 2018). Local drivers include things like geology, valley shade, hyporheic exchange, channel curvature/sinuousity and wood loading.

- *Restoring riparian vegetative shade is so effective at protecting and restoring water temperatures that it is widely considered a key strategy for offsetting climate-induced temperature increases*. In many cases, reduced stream warming from restoration of natural riparian shade levels could more than offset summer warming anticipated from climate change.

- *Small and medium fish streams are particularly sensitive to warming caused by reduced shade*, and at the same time are vital in providing the cold water sources that support downstream coldwater refugia.

- *The efficacy of vegetative shading is largely determined by the width and composition of near-stream forests:* i.e. how far the forested buffers extend from the stream and the density, size and types of trees in these areas. No evidence has been presented that this physical relationship between riparian shade and stream temperature (established in the Department's published "Ripstream" research) is different in the Siskiyou than elsewhere in the western Oregon.

- *None of the three experts believes that riparian areas are at risk of providing "too much shade" to streams*. (Whether riparian stands are in an uncharacteristic condition with respect to fire risk and the implications of this for management is a separate question that was acknowledged but not answered).

- *The vegetative condition of upland areas is closely tied to maintenance of instream flows, which also help maintain cool water temperatures*. ODFW suggests the EPA's ecohydrology model -- Visualizing Ecosystems for Land Management Assessment or VELMA -- is a useful predictor of changes in low flows that affect streamflow, hence stream temperature response, under varying land management scenarios. Larger areas of mature forest condition are associated with higher summer streamflows and thus lower stream temperatures. This is consistent with growing evidence that the current practice of pervasive short-rotation clearcutting with some riparian retention leads to persistent low flows and accompanying habitat degradation, and that this overall effect is not limited to specific geographies. (Segura et. al., 2020).

Other takeaways not specific to stream temperature include:

Dr. Reeves raised questions about the Department's identification of fish streams. Stream classification is a critical determinant of the level of protection for water bodies under current rules. One of Dr. Reeves' slides noted a significant discrepancy between the miles of stream designated as fishbearing by ODF (199 miles) and those treated as such in Reeves' analysis (263 miles of habitat using 20% gradient cutoff) in an example watershed. We urge the Board to ensure that ODF and landowners are using best available information to identify the criteria that reasonably describe stream habitat accessible to fish so that the appropriate level of protection is fully and consistently applied. This issue seems particularly likely to come up with the smaller streams implicated in the Siskiyou review because they may include the headward extent of fish habitat.

The OFPA regulatory structure is not currently tailored to local variations. Current rules primarily vary stream protection requirements by the presence of fish habitat and stream size, though they do make a limited nod to the influence of debris-torrent-prone streams. How can/should our rules equitably recognize variation in: a) stream sensitivity to riparian shade, and b) other, localized drivers of stream temperature such as geomorphological characteristics? Are these kinds of factors more relevant in prioritizing restoration investments for management that is not required or incentivized through regulation, or can they be built into regulatory design?

References

Halofsky, J.E.; Peterson, D.L.; Gravenmier, R.A., eds. 201X. Climate change vulnerability and adaptation in southwest Oregon. Gen. Tech. Rep. PNW-GTR-xxx. Portland, OR: USDA Forest Service, Pacific Northwest Research Station. Xxx p. (in press report at www.adaptationpartners.or/swoap especially Isaak, DJ, B.B. Roper, G.H. Reeves, D. Horan. "Chapter 4: Effects of Climate change on Fish Species of Concern in Southwest Oregon.")

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Segura, C, K.D. Bladon, J. A. Hatten, J. A. Jones, V.C. Hale, G. C Ice. 2020. Long-term effects of forest harvesting on summer low flow deficits in the Coast Range of Oregon. Journal of Hydrology 585: 124749 (12 pp) (finding low flow effects similar to those found in the central Cascades by Perry and Jones (2016) in the Alsea basin of the Coast Range).

US Environmental Protection Agency. 2015. VELMA Eco-Hydrological Model, Version 2.0 (https://www.epa.gov/sites/production/files/2016-06/documents/velma_fact_sheet_8_4_15.pdf (2-page fact sheet)

Wondzell, S.M., M. Diabat, and R. Haggerty. 2019. "What Matters Most: Are Future Stream Temperatures More Sensitive to Changing Air Temperatures, Discharge, or Riparian Vegetation?" Journal of the American Water Resources Association 55 (1): 116–132. https://doi.org/10.1111/1752-1688.12707.\ (finding shade from riparian vegetation had the largest influence on stream temperatures in the Middle Fork John Day basin of Eastern Oregon based on HeatSource model simulations of future scenarios).

Date Submitted: 4/27/2020 9:52:38 AM

Message:

There's no excuse to exclude the Siskiyou from the higher standards for river and stream management - the science doesn't support it, the law doesn't support it, and our streams and salmon can't wait another decade of heated torture. If the COVID-19 era has taught us nothing else, it should have taught us that we need -- desperately need -- to respect those creatures we share Earth with. We have got to protect southern Oregon's rivers and streams, just as we protect others.

Mary Shank
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Thomas Imeson, Chair
Oregon Board of Forestry
2600 State Street
Salem, OR 97310

May 6, 2020

Re: Public Comment on Agenda Item 2: Climate Change Presentations - Siskiyou Streamside Protections Review and Draft "Siskiyou Streamside Protections Review: Summary of Literature Review"

Dear Chair Imeson and Members of the Board:

Thank you for the opportunity to provide public comment on Agenda Item 2: Climate Change Presentations - Siskiyou Streamside Protections Review. Rogue Riverkeeper is a non-profit organization that works to protect and restore clean water and native fish populations in the Rogue River Basin through advocacy, accountability, and community engagement.

We have also included public comments on the Draft "Siskiyou Streamside Protections Review: Summary of Literature Review" that was released to the members of the Siskiyou Advisory Committee. Additionally, we included a summary of peer-reviewed literature, peer-reviewed gray literature, and gray literature related to riparian management from forest practices on shade and stream temperature relevant for the Siskiyou region in Appendix A. This information was first provided to the Board in March 2018, but because there are new Board members since that time, we believe that this summary of relevant data (prior to March 2018) may further inform the discussion.

Agenda Item 2: Climate Change Presentations - Siskiyou Streamside Protections Review

The presentations by Dr. Jessica Halofsky (University of Washington and USFS Pacific Northwest Research Station), Kara Anlauf-Dunn (Oregon Department of Fish and Wildlife), and Gordon Reeves (USFS Pacific Northwest Research Station) provided some important context regarding the Board's July 22 decision determining whether there is an adequate basis to find that small and medium fish streams are being degraded by current forest practices under existing stream buffer rules in the Siskiyou region.

- **Shade is an important driver of stream temperature.** There are different local drivers, such as geomorphology, hyporheic exchange, and land cover, in addition to shade that impact stream temperature. However, shade can be the single most influential driver of stream temperature in some places. Specifically, Anlauf-Dunn and Reeves both referenced the Wondzell (2018) study.

- **No evidence was presented that the physical relationship between riparian shade and stream temperature is different in the Siskiyou than in the rest of western Oregon.** Effective shade is largely determined by the width and composition of the riparian area. No evidence was presented that the fundamental relationship between riparian shade and stream temperature as established in the RipStream study is different in the Siskiyou.

- **Riparian areas can mitigate climate change responses.** Under current conditions, there are stream reaches that place temperature constraints on salmonids in southwestern Oregon. Those conditions are likely to worsen, especially where climate variability is expressed in terms of higher temperatures. This could be mitigated by streamside vegetation management. Restoring riparian vegetation and shade is a key strategy to address climate change responses, and particularly so for small and medium streams, as evidenced in the Southwest Oregon Adaptation Partnership (SWOAP) assessment. In Chapter 4, the SWOAP assessment states:

  > "Future stream temperature increases are likely to be particularly stressful to cold-water fishes, so prioritizing enhancement of riparian areas in some places (box 4.1) to maximize shade and decrease solar radiation will be an important action (Webb and Zhang 1997). In smaller streams and rivers where riparian conditions are significantly degraded, fully functional riparian vegetation communities could offset most future stream temperature increases (Johnson and Wilby 2015, Nussle et al. 2015)…"[1]

  Table 4.12 of the SWOAP assessment identifies restoring and protecting riparian vegetation as an adaptation option to address warming stream temperatures and increase habitat resilience.

- **Best available data and analytical tools exist for the Siskiyou.** The NorWest dataset is one of the most comprehensive datasets for predicting temperature change across the region. Estimates in the NorWest dataset for the Siskiyou region are generally good because there are a lot of sensors in this area. A climate gradient exists from north to south in Oregon, and southwest Oregon will likely experience more seasonal extremes, snowpack reduction, and extended summer droughts. In southern Oregon, the riparian areas are likely critical drivers for stream temperature. All three presenters were in agreement that there is a strong foundation of existing information, data, and models to move forward to address these issues.

The presenters also raised some additional questions relevant for the Board. Specifically, Gordon Reeves noted a significant discrepancy between the 199 miles of stream designated as fish-bearing ("Type F") and the 263 miles of stream identified as fish-bearing in Reeves' analysis.

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[1] **Halofsky, J.E.; Peterson, D.L.; Gravenmier, R.A., eds. 201X.** Climate change vulnerability and adaptation in southwest Oregon. Gen. Tech. Rep. PNW-GTR-xxx. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. In press. Available online < http://www.adaptationpartners.org/swoap/ >. P. 12.

These discrepancies raise important questions regarding how ODF and landowners use best available information to identify the criteria that accurately describe fish-bearing streams in order to apply the appropriate level of protections. Additionally, the presenters addressed local variability and raised questions regarding how rules can equitably recognize variations in localized drivers of stream temperature.

Draft "Siskiyou Streamside Protections Review: Summary of Literature Review"

The draft report demonstrates that there continues to be little to no evidence that there is any difference in the fundamental relationship between stream temperature and shade in the Siskiyou region compared to the rest of western Oregon. More specifically, the draft report is clear in its conclusion that buffer widths of 20-70 feet result in violations of the Protecting Cold Water ("PCW") criterion:

> "In summarizing the most relevant studies that involved implementation of FPA rules for vegetation retention along streams during logging operations, we show that 88% of sites with buffers widths 20 to 70 feet and 73% sites of sites with buffers >70 feet appear to exceed the PCW (Table 1)" (p. 9).

Below, we provide some more specific comments. Some of these comments were brought up in person at the Advisory Committee meeting on April 29th. However, for clarity and to ensure that these questions are addressed in the record and available to the Board, we have included them here again.

1. **Thinning rates in the upland in the Siskiyou georegion:**

   On page 7 in a footnote, the draft report states: "Note: the Siskiyou has a much higher rate of thinning of uplands than other geographic regions in western Oregon." The draft report provides no data, analysis, or citations to provide more context or information regarding this statement. As has likely become clear to the Board and ODF, questions regarding how "different" forests are in the Siskiyou has been an ongoing topic of debate on this issue. ODF should provide some additional information and context to this statement.

   The fundamental relationship between stream temperature and shade is not different in the Siskiyou region compared to western Oregon. Multiple Committee members, as well as presentations from the climate scientists before the Board support this as well. We have included the Frissell and Nawa 2016 memo that outlines these points. As stated by Frissell and Nawa (2016):

   > "Available data suggest ecological differences between the Siskiyou and other regions of western Oregon have relatively little effect on stream temperature and riparian shade relations. Any differences that do exist certainly do not modify the basic causal relation between forest shade reduction and warming of stream

> thermal maxima, and they do not undermine the clear relevance of the RipStream findings to southwestern Oregon."[2]

Frissell and Nawa point to a possible exception based on geology in areas of the Siskiyou that drain watersheds rich in ultramafic rock (serepentine terrain). In these areas, soil chemistry may result in limited overall vegetation and tree stem densities. However, due to the fact that this small percentage of area in the Siskiyou is not likely to support enough conifer trees to be considered commercial forest land, it is not likely to have a large impact. ODF could include an analysis of how this geology may play a role in the Siskiyou region.

2. Exceedances of the numeric criterion ("NC")

In the draft report, ODF describes the studies reviewed regarding compliance with the numeric criterion ("NC") water quality standard for temperature. Specifically, ODF refers to the Groom et al. (2017) study that:

> "…showed that on private land, exceedances of the NC that were associated with harvesting occurred at 3 sites out of a total of 18. For these three sites, daily exceedances occurred during 6 to 16% of the time over the course of one post-harvest summer (July and August)" (p. 7).

However, ODF goes on to conclude that there is "little evidence that FPA rules will exceed NC" (p. 10). ODF states that 17% of sites with buffer widths of 20-70 feet and 9% of sites with buffer widths less than 70 feet exceeded the NC. We are concerned that evidence of exceedances of the NC (17% of sites with buffers 20-70 feet) has been characterized as "little evidence." Under the Clean Water Act, any exceedance of the water quality standard would be a violation.

Further, we would emphasize for the Board the comments made by DEQ at the Advisory Committee meeting that expressed concern regarding this characterization of NC exceedances. DEQ staff stated that it is likely that streams with that percent of exceedance (17% of sites with buffers 20-70 feet) would likely have led to a Category 5 303(d) listing. We recommend that ODF coordinate with DEQ in its analysis of NC and amend this section and its conclusions.

3. Conclusions regarding changes in shade as a result of harvesting when buffer widths are greater than or equal to 50 feet

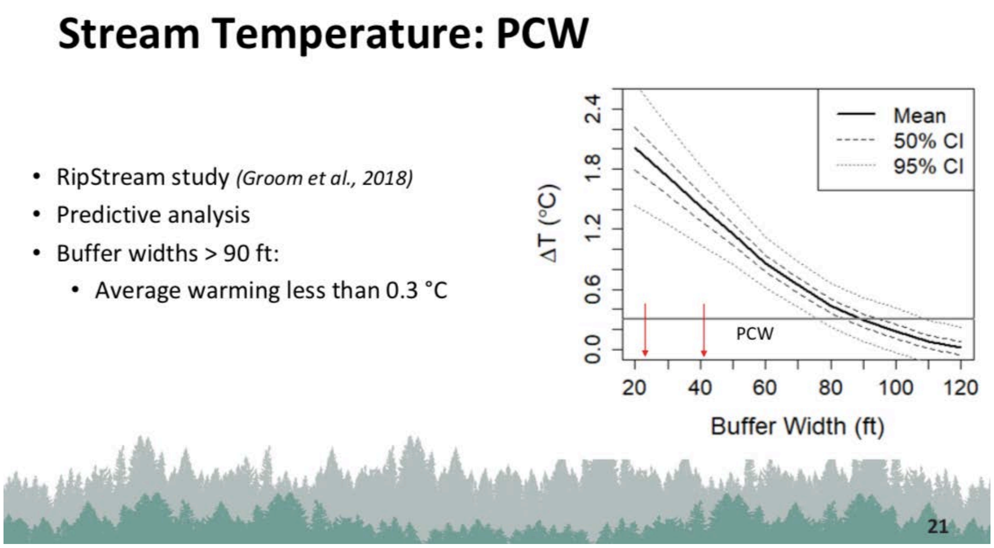
We are concerned that the draft report makes some conclusions regarding "diminishing returns" or "no change in shade" when buffer widths are greater than or equal to 50-feet that may not be aligned with DEQ's analysis (see p. 10). For example, the draft report states that:

[2] Frissell, Christopher A. and Richard K. Nawa. (2016). Protecting Coldwater for Salmon and Steelhead on Private Timberland Streams of Oregon's Siskiyou Region: A Synoptic Scientific Look at Stream Warming, Shade, and Logging. 2016. P. 2.

> “Regarding changes in shade as a result of harvesting, our analysis shows that the DEQ TMDL modeling predicts no changes in shade as a result of harvesting when buffer widths are ~50 feet or greater” (p. 10).

ODF should coordinate closely with DEQ to review these conclusions which, based on comments made by DEQ at the Advisory Committee meeting, are not aligned with DEQ’s analysis of these data and use of the TMDL heat source model. ODF does include some limitations to this interpretation, including the choice to select 90% canopy cover directly over the stream, rather than another percent canopy cover in the actual buffer area (see p. 6). ODF should also provide more analysis and explanation of these conclusions in the context of these limitations and assumptions.

Related to these conclusions regarding buffer width, the draft report would also be strengthened by better emphasizing and analyzing the Groom et al. (2018) results in Figure 2.a on page 5. We believe that this presentation of the Groom et al. (2018) data is useful to understanding the draft report and could be more effectively presented as an additional graph. Some corresponding explanation of how to interpret the graph would be useful in the report as well. An image used in the ODF presentation of this graph is included below for clarity. This graph demonstrates based on the RipStream field data that the PCW is likely not met with buffer widths less than 90 feet.



4. **Cumulative effects**

ODF should provide further clarification about the “Cumulative Effects” section beginning on page 8. It would be helpful for ODF to include both the full text of the studies reviewed as well as a more detailed summary of the methodology of each study. It appears that most of the studies reviewed for the draft report evaluated single harvest impacts rather than cumulative impact across a watershed. If this is the case, ODF should more clearly state that the studies reviewed did not specifically address cumulative effects.

5. **Coordination with ODF and DEQ**

We strongly support continued coordination between ODF and DEQ in the finalization of this report to reflect both regulatory requirements as well as technical analysis.

For example, ODF used DEQ's look up tables developed by DEQ for the Mid-Coast TMDL. DEQ expressed some questions regarding how ODF analyzed these data in TMDL shade modeling, such as the use of 90% canopy cover. We recommend that ODF incorporate edits from DEQ regarding the use of DEQ's shade models and provide additional information regarding model assumptions and limitations. If possible, it would be helpful to include any analysis based on the Rogue TMDL.

A second example would be the statements in the draft report that field data and TMDL heat source model "also highlight the diminishing returns in shade for buffer widths greater than 50 feet (Fig 2b, c)" (p. 6.). However, in a footnote, ODF goes on to state that the TMDL shade values in Figures 2b and 2c do not represent site potential vegetation, which is used by DEQ to estimate shade targets to achieve heat load allocations under TMDLs. It appears that there may be some important differences in how ODF used and interpreted the TMDL heat source model for this draft report compared to how DEQ typically uses and analyzes these data.

Additionally, it would be beneficial to the report to indicate that shade is not only an important control on stream temperature, but that it also has a regulatory importance in the context of water quality standards and the Clean Water Act.

Conclusions

We remain concerned that the Siskiyou region's salmon and steelhead streams are currently left with weaker protections than those in the rest of western Oregon, following the Board of Forestry's November 2015 decision to exclude our region from the 2017 stream buffer rule.

The Rogue River watershed stretches across more than 3 million acres, from its headwaters near Crater Lake to the mouth of the river along Oregon's southern coast at Gold Beach. The Rogue Basin includes approximately 1 million acres of private forest land managed under the Oregon Forest Practices Act. The 2002 statewide sufficiency analysis and the results of the RipStream study in 2011 demonstrated that current stream buffer rules under the Forest Practices Act are not protective of stream temperature and violate the Protecting Cold Water ("PCW") water quality standard.[3] Under ORS 527.765(1), the Board is required to establish regulations and best management practices to "insure that to the maximum extent practicable" water quality standards are achieved and maintained. Critically, the PCW water quality standard applies statewide in streams that support salmon, steelhead, and bull trout ("SSBT") and to upstream stream reaches necessary to meet the criterion downstream.

The science is clear that removing trees near streams reduces shade and can increase stream temperature. A 2004 Independent Multidisciplinary Science Team (IMST) report emphasized the impact of stream buffers, concluding that "the vast majority of published studies document that

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[3] Groom et al. 2011. *Response of Western Oregon (USA) stream temperature to contemporary forest management*, Forest Ecology and Management, 262: 1618-1629.

riparian shade has a significant effect on stream temperature."[4] The draft report demonstrates that there continues to be little to no evidence that there is any difference in the fundamental relationship between stream temperature and shade in the Siskiyou region compared to the rest of western Oregon.

Thank you for the opportunity to provide comment regarding Agenda Item 2: Eastern Oregon/Siskiyou Monitoring Streamside Protections.

Sincerely,

Stacey Detwiler
Conservation Director
Rogue Riverkeeper

[4] Independent Multidisciplinary Science Team. 2004. Oregon's Water Temperature Standard and its Application: Causes, Consequences, and Controversies Associated with Stream Temperature. Technical Report 2004-1 to the Oregon Plan for Salmon and Watersheds, Oregon Watershed Enhancement Board, Salem, Oregon, p. 8.

Appendix A. Riparian Management Impacts on Shade and Stream Temperature in the ODF Siskiyou Georegion

Riparian management impacts on shade and stream temperature in the ODF Siskiyou Georegion

I. Peer-reviewed literature

A. Data from RipStream Study Analysis

Groom, Jeremiah, Liz Dent, and Lisa Madsen. (2011). Stream temperature change detection for state and private forests in the Oregon Coast Range. Water Resources Research. Vol. 47.

Brown, George W. and James T. Krygier. (1970). Effects of Clear-Cutting on Stream Temperature. Water Resources Research. Vol. 6, No. 4.

Brosofske K. D., J. Chen, R. J. Nairman, and J. F. Franklin (1997), Harvesting effects on microclimatic gradients from small streams to uplands in western Washington,Ecol. Appl., 7, 1188–1200.

Johnson S. L. (2004), Factors influencing stream temperatures in small streams: Substrate effects and a shading experiment, Can. J. Fish. Aquat. Sci., 61, 913–923.

Lewis T. E., D. W. Lamphear, D. R. McCanne, A. S. Webb, J. P. Krieter, and W. D. Conroy (1999), Executive summary: Regional assessment of stream temperatures across northern California and their relationship to various landscape-level and site-specific attributes, Forest Science Project report, 14 pp., Humboldt State Univ. Found., Arcata, Calif.

B. Other

Adams, Paul W. (2007). Policy and Management for Headwater Streams in the Pacific Northwest: Synthesis and Reflection. Forest Science 53(2). 2007.

II. Peer-reviewed gray literature

A. ODF and EPA Analysis

Czarnomski, Nicole. (2013). Effectiveness of riparian buffers at protecting stream temperature and shade in Pacific Northwest Forests: A systematic review. Final Report September 2013.
Leinenbach, Peter, George McFadden, and Christian Torgersen. (2013). Effects of Riparian Management Strategies on Stream Temperature. Science Review Team Temperature Subgroup.

B. Threatened and Endangered Species Recovery Plans

Final Recovery Plan for the Southern Oregon/ Northern California Coast Evolutionarily Significant Unit of Coho Salmon (*Oncorhynchus kisutch*). NOAA Fisheries. 2014.

III. Gray literature

A. Bureau of Land Management (BLM) Water Quality Restoration Plans

Water Quality Restoration Plan Southern Oregon Coastal Basin Big Butte Creek Watershed. Bureau of Land Management (BLM) Medford District Butte Falls Resource Area. January 2008.
Althouse Creek Watershed Assessment. Bureau of Land Management. February 2005.
Water Quality Restoration Plan Deer Creek Watershed. Bureau of Land Management. 2011.
Grants Pass Water Quality Restoration Plan Southern Oregon Coastal Basin Middle Rogue Subbasin Grants Pass- Rogue River Watershed Bureau of Land Management (BLM), Medford District Office Grants Pass Resource Area. 2012.
Water Quality Restoration Plan Southern Oregon Coastal Basin Evans Creek Watershed. Bureau of Land Management (BLM) Medford District Butte Falls Resource Area. July 2009.
Water Quality Restoration Plan Jumpoff Joe Creek Watershed. Bureau of Land Management. September 2009.
Water Quality Restoration Plan Klamath Basin Jenny Creek Watershed. Bureau of Land Management. 2011.

B. Total Maximum Daily Loads

Rogue River Basin TMDL Chapter 2: Temperature. Oregon Department of Environmental Quality. 2008.
Lower Sucker Creek Illinois River Subbasin Total Maximum Daily Load and Water Quality Management Plan (Lower Section of Sucker/Grayback Watershed: 1710031103) (USFS boundary at Mile 10.4 to the Mouth). Oregon Department of Environmental Quality. April 2002.
Applegate Subbasin Total Maximum Daily Load (TMDL) HUC # 17100309. Oregon Department of Environmental Quality. December 2003.

C. Other gray literature

Stream habitat and water quality in the Applegate Basin. OWEB Grant 99-485 Final Report. Applegate River Watershed Council. November 2004.
Betts, M., B. Bourgeois, R. Haynes, S. Johnson, K. Puettmann, and V. Sturtevant. 2014. Assessment of Alternative Forest Management Approaches: Final Report of the Independent Science Panel. Prepared with assistance from D.C.E. Robinson, A.W. Hall and G. Stankey, ESSA Technologies Ltd. (Vancouver, BC) for Oregon Department of Forestry (Salem, OR).

I. Peer-reviewed literature

A. Data from RipStream Study Analysis

(1) Groom, Jeremiah, Liz Dent, and Lisa Madsen. (2011). Stream temperature change detection for state and private forests in the Oregon Coast Range. Water Resources Research. Vol. 47.

- "For streams adjacent to harvested areas on privately owned lands, preharvest to postharvest year comparisons exhibited a 40% probability of exceedance. Sites managed according to the more stringent state forest riparian standards did not exhibit exceedance rates that differed from preharvest, control, or downstream rates (5%)." (p. 1)

- "Several previous studies link timber harvest with increases in stream temperature [Beschta and Taylor, 1988; Moore et al., 2005, and references therein], and federal endangered species listings of trout and salmon species (*Oncorhynchus spp*.) in the Pacific Northwest cite stream temperature increases due to logging as a limiting factor for population recovery [Bryant and Lynch, 1996; Myers and Bryant, 1998; Myers et al., 1998]." (p. 1)

- "Since removal of shade is strongly associated with stream temperature increases, timber harvest operations are considered in compliance with Oregon Department of Environmental Quality (DEQ) water quality standards if harvest operations comply with the FPA [DEQ, 2004]. However, ODF must periodically conduct studies to validate the efficacy of the FPA at meeting state water quality standards [ODF, 2007b]." (p. 1)

- "The principal results of this study are applicable to the policy issue at hand; the results may directly inform timber management decisions in Oregon and may apply to other timber-harvesting regions with antidegradation or cold-water standards."

- "Our analysis indicated that timber harvested according to minimum FPA standards along medium or small fish-bearing streams resulted in a 40.1% probability that a preharvest to postharvest comparison of 2 years of data will detect a temperature increase of >0.3C." (p. 9)

- "The results from these analyses and others will inform Oregon Board of Forestry policy discussions on current regulations and potentially inform riparian timber harvest policy regulations elsewhere." (p. 11).

(2) **Brown, George W. and James T. Krygier. (1970). Effects of Clear-Cutting on Stream Temperature. Water Resources Research. Vol. 6, No. 4**.

- "Temperature differences between watersheds and all of the temperature anomalies within the clear-cut watershed can be explained in terms of shade differences. The patch-cuts on Deer Creek did not produce any significant changes in temperature in the main stream. Strips of timber 100 feet long were left beside each perennial stream; the amount of shade on the stream surface was essentially unchanged. On Needle Branch, little shade remained after the clear-cutting and burning were completed. As a result, large changes in annual and daily patterns of temperature were observed." (p. 1138).

(3) Brosofske K. D., J. Chen, R. J. Nairman, and J. F. Franklin (1997), Harvesting effects on microclimatic gradients from small streams to uplands in western Washington,Ecol. Appl., 7, 1188–1200.

- "We conclude that a buffer at least 45 m on each side of the stream is necessary to maintain a natural riparian microclimatic environment along the streams in our study, which were characterized by moderate to steep slopes, 70–80% overstory coverage (predominantly Douglas-fir and western hemlock), and a regional climate typified by hot, dry summers and mild, wet winters. This buffer width estimate is probably low, however, since it assumes that gradients stabilize within 30 m from the stream and that upslope edge effects extend no more than 15 m into the buffer (a low estimate based on other studies). Depending on the variable, required widths may extend up to 300 m, which is significantly greater than standard widths currently in use in the region (i.e., ;10–90 m). Our results indicate that even some of the more conservative standard buffer widths may not be adequate for preserving an unaltered microclimate near some streams." (p. 1188).

(4) Johnson S. L. (2004), Factors influencing stream temperatures in small streams: Substrate effects and a shading experiment, Can. J. Fish. Aquat. Sci., 61, 913–923.

- "Changes in vegetation near streams can have major impacts on stream temperature (Brown and Krygier 1970; Beschta and Taylor 1988; Johnson and Jones 2000). Streams and their riparian areas have been greatly modified across most ecosystems (Bisson et al. 1992; Sugimoto et al. 1997). Small forested streams historically have not been protected under riparian management guidelines or forest harvest best management practices; agricultural or urban streams of all sizes have had even less protection." (p. 914).

- "Riparian vegetation influences microclimatic conditions through biological functions such as evapotranspiration and release of water vapor as well as through physical means such as decreasing wind speeds. Vegetation also provides bank stability, which can impact width to depth ratios and the exposed surface area of the stream. Accumulations of large organic matter inputs have an effect on hydraulic retention times. Although incoming radiation levels in dense natural forests can be as low as those under the experimental shade, riparian forests would have more variability of incoming light levels because of the shape and structure of the vegetation." (p. 919).

(5) Lewis T. E., D. W. Lamphear, D. R. McCanne, A. S. Webb, J. P. Krieter, and W. D. Conroy (1999), Executive summary: Regional assessment of stream temperatures across northern California and their relationship to various landscape-level and site-specific attributes, Forest Science Project report, 14 pp., Humboldt State Univ. Found., Arcata, Calif.

- "Canopy has been widely acknowledged as influencing stream temperature. It has been shown that forest harvesting or road building that removes riparian vegetation (canopy) increases the water temperature of the adjacent stream." (p. 13).

B. Other

(1) Adams, Paul W. (2007). Policy and Management for Headwater Streams in the Pacific Northwest: Synthesis and Reflection. Forest Science 53(2). 2007.

- "Under this backdrop, the National Marine Fisheries Service (NMFS 1998) proposed that Oregon adopt significantly greater Forest Practice Rule restrictions on timber harvest and other practices in western Oregon riparian areas, including headwater streams (Table 3). The NMFS proposal met significant resistance by landowner and other interests, and the Oregon Board of Forestry declined to act on it due to questions about its technical and policy bases. However, the issue did reveal the high level of federal agency concern as well as the nature and scope of the favored riparian forest protection policies." (p. 108)

- "The relatively limited measures required for headwater streams on private lands in Oregon (Table 7) have been the subject of considerable discussion and debate in recent years. For example, although the CWA generally allows state policies to prevail, recent comments from federal agency officials to the Oregon Board of Forestry (OBF) stated that ". . . improvements to management of small non-fish streams, landslide prone areas, and cumulative watershed effects would be necessary to argue convincingly that forest practices meet the [water quality] standards and TMDLs" (Markle 2004), and ". . . we are not confident that [the rule-making and voluntary measures proposed by the Board] can be relied on to meet Oregon's water quality standards . . . we believe additional improvements to the rules are needed" (Gearhard 2004). This input, while simply advisory in nature, came after the OBF had deferred action on draft rule changes to increase protection of small nonfish-bearing streams, although they had also initiated rulemaking for increased protection of headwater woody debris." (p. 111)

II. Peer-reviewed gray literature

C. ODF and EPA Analysis

(1) Czarnomski, Nicole. (2013). Effectiveness of riparian buffers at protecting stream temperature and shade in Pacific Northwest Forests: A systematic review. Final Report September 2013.

- "The Oregon Board of Forestry ("Board") made a finding of degradation that stream protections afforded to small- and medium-sized fish-bearing streams under the Forest Practices Act (FPA) were not likely protective of the Oregon Department of Environmental Quality (ODEQ) Protecting Cold Water (PCW) criterion. This criterion prohibits human activities, such as timber harvest, from increasing stream temperatures by more than 0.3 ºC, for all sources taken together at the point of maximum impact, at locations critical to salmon, steelhead or bull trout. The Board's finding was based on scientific outcomes of the Oregon Department of Forestry (ODF) Riparian and Stream Function (RipStream) monitoring project. ODF has therefore undertaken a systematic science review in support of a riparian rule analysis to address concerns about meeting the PCW criterion." (p. 1).

- "The geographic scope of the findings of degradation are based on Groom et al. (2011b), which studied streams in the Coast Range and Interior Geographic Regions of Oregon (as defined in OAR 629-635-0220). While the exact geographic extent of the rule analysis is yet to be determined, it will be limited to western Oregon. This limitation is due to the vegetation, climate and hydrologic characteristics of eastern Oregon being significantly different enough from those included in the RipStream study to preclude extending a rule to eastern Oregon." (p. 7).

(2) Leinenbach, Peter, George McFadden, and Christian Torgersen. (2013). Effects of Riparian Management Strategies on Stream Temperature. Science Review Team Temperature Subgroup.

- "The Science Roundtable Team (SRT) of technical experts was requested by the Interagency Coordinating Subgroup (ICS) to evaluate models that predict changes in shade and stream temperature as a result of the removal of trees in riparian areas. The management concern is that stream temperature in the summer may increase as a result of riparian management activities and negatively affect coldwater fishes, including salmon, trout, and associated aquatic ecosystems. The area of interest includes conifer forests of the Oregon Coast Range, but the <u>findings of the SRT are intended to be applicable to a broader range of forests in western Oregon and Washington</u>." (p. 1).

- "The effects of riparian vegetation on shade and stream temperature have been studied extensively, and it is generally accepted that removing trees in riparian areas reduces the amount of shade which leads to increases in thermal loading to the stream (Moore and Wondzell 2005). " (p. 2).

- "We focus on shade and the factors that influence its spatial extent, temporal duration, and quality. The primary factors that influence shade are riparian vegetation (Groom et al, 2011b) and the surrounding terrain (Allen et al. 2007)." (p. 3).

- "No-cut buffers adjacent to clearcut harvest units: <u>Substantial effects on shade have been observed with "no-cut" buffers ranging from 20 to 30 m (Brosofske et al. 1997, Kiffney et al. 2003, Groom et al. 2011b),</u> and small effects were observed in studies that examined "no-cut" buffers 46 m wide (Science Team Review 2008, Groom et al. 2011a). For "no-cut" buffer widths of 46-69 m, the effects of tree removal on shade and temperature were either not detected or were minimal (Anderson et al. 2007, Science Team Review 2008, Groom et al. 2011a, Groom et al. 2011b) (Figure 4). The limited response observed in these studies can be attributed to the lack of trees that were capable of casting a shadow >46 m during most of the day in the summer (Leinenbach 2011; Appendix C of this document). Reductions in shade and increases in stream temperature were more apparent at ~30 m "no-cut" buffer widths, as compared to the 46-69 m wide buffers, but the magnitude and direction of response was highly variable for both shade and stream temperature (Kiffney et al. 2003, Gomi et al. 2006, Science Team Review 2008, Groom et al. 2011a, Groom et al. 2011b). <u>At "no-cut" buffer widths of <20 m, there were pronounced reductions in shade and increases in temperature, as compared to wider buffer widths.</u> The most dramatic effects were observed at the narrowest buffer widths (≤10 m) (Jackson et al. 2001, Curry et al. 2002, Kiffney et al. 2003, Gomi et al. 2006, Anderson et al. 2007)." (p. 6).

B. Threatened and Endangered Species Recovery Plans

(1) Final Recovery Plan for the Southern Oregon/ Northern California Coast Evolutionarily Significant Unit of Coho Salmon (*Oncorhynchus kisutch*). NOAA Fisheries. 2014.

Inadequacy of Oregon Forest Practices Act:

- "Because of the preponderance of private timberland and timber harvest activity in the range of this ESU, and potential adverse effects, careful consideration of state forest practices rules and regulations is prudent. At the time of listing, most reviews of the forest practice rules indicated that implementation and enforcement of these rules did not adequately protect coho salmon or their habitats (CDFG 1994, Murphy 1995, Ligon et al. 1999, IMST 1999)." (p. 3-54)

- "Though significant improvements have been made to the current rule package, the Oregon Forest Practice Rules represent the least conservative forest practice regulations administered by the state governments within the SONCC coho salmon ESU. Some riparian areas may be protected by narrow, no-harvest zones; however, the stands located upslope of the no-harvest zones could be subject to intense harvest, leading to diminished riparian function and cumulative effects to anadromous salmonid habitat. In a 2010 status review of Oregon Coast (OC) coho salmon, NMFS concluded that the Oregon Forest Practices Act does not adequately protect OC coho habitat in all circumstances. In particular, disagreements persist regarding: (1) whether the widths of riparian management areas (RMAs) are sufficient to fully protect riparian functions and stream habitats; (2) whether operations allowed within RMAs will degrade stream habitats; (3) operations on high-risk landslide sites; and (4) watershed-scale effects." (p. 3-57)

- "Timber harvest poses an overall very high threat to the coho salmon population. Private industrial timber lands managed under the Oregon Forest Practices Act occupy 30 percent of the landscape, but they coincide with nearly all the low gradient intrinsic potential streams. Therefore, these lands have a disproportionate effect on coho salmon. The high harvest rates and associated roads negatively impact multiple aspects of coho salmon habitat. Deep Creek is an example of where short timber harvest rotations are likely inhibiting channel and coho salmon recovery. Studies of adjacent southwest Oregon basins found that "downstream, cumulative impacts of human activity are pervasive in southwest Oregon, wherever logging has occurred over an extensive portion of a drainage basin or has involved operations on steep, unstable slopes. The downstream effects of channel sedimentation and aggradation can severely damage streams even where buffer zones of riparian vegetation have been retained, and such effects persist more than 20-30 years after logging activities have ceased" (Frissell 1992)." (p. 12-15)

Illinois Population:

- "Degraded riparian forest condition is one of the most significant stresses affecting coho salmon recovery in the Illinois River watershed. Reduction of riparian trees and gallery forests that once covered the alluvial valley floor led to reduced pool frequency and habitat simplification, has increased bank erosion, and contributed to stream warming by widening the waterways (BLM 1997, 2006, USFS 1997a). ODFW surveyed extensive reaches of coho salmon-bearing Illinois River reaches and tributaries (e.g., East Fork

Illinois, West Fork Illinois, Deer, Sucker, Althouse, Elk) and found poor conifer density with fewer than 75 trees (>36" dbh) per 1000 feet." (p. 30-14)

- "The riparian zones have been cleared or substantially modified along the mainstem Illinois River and at the mouth of Free and Easy Creek. Overall, there is a very low amount/volume of large wood in channels throughout the Illinois River sub-basin (USFS 1997a, BLM 2005a)." (p. 30-15)

- "In addition, the Independent Multidisciplinary Science Team (IMST 1999) concluded that the Oregon Forest Practice Rules for riparian protection, large wood management, sedimentation, and fish passage are not adequate to recover depressed stocks of wild salmonids…Most habitat with potential to support coho salmon is privately owned and managed under Oregon's Forest Practices Act, which NMFS' analysis determined has the lowest score for watershed protection measures of all management methods evaluated (Appendix B). Therefore, although much of the habitat in the Illinois River is federally owned, the <u>future threat of timber harvest in the next ten years is high because much of the habitat with the best potential to support coho salmon will be harvested using less protective management actions than those used on Federal lands</u>**.**" (p. 30-22)

- One of the Highest Priority Recovery Actions for the SONCC is to "improve timber harvest practices by revising Oregon Forest Practices Act." (p. 30-1)

National Marine Fisheries Service 2014: 30-25
Table 30-4. Recovery action implementation schedule for the Illinois River population.

Illinois River Population

Table 30-4. Recovery action implementation schedule for the Illinois River population. Recovery actions for monitoring and research are listed in tables at the end of Chapter 5.

Action ID / *Step ID*	Target	KLS/T	Strategy / *Step Description*	Action Description	Area	Priority
SONCC-IllR.7.2.53	Riparian	No	Improve timber harvest practices	Improve regulatory mechanisms	Population wide	1
SONCC-IllR.7.2.53.1			*Determine how to revise Oregon Forest Practice Rules so that they do not limit recovery of SONCC coho salmon and make appropriate revisions*			
SONCC-IllR.7.2.53.2			*Adopt rules for fish-bearing streams sufficient to protect both water quality and fish habitat*			
SONCC-IllR.7.2.53.3			*Adopt rules to increase protection of non-fish-bearing streams that address practices that adversely impact water quality and fish habitat*			
SONCC-IllR.7.2.53.4			*Ensure management measures for landslide prone areas include protection of water quality and fisheries habitat*			
SONCC-IllR.7.2.53.5			*Until more permanent regulatory mechanisms can be put in place, immediately adopt interim rules that increase protection for salmon habitat in forested areas, including increased natural recruitment of large wood on perennial and intermittent streams, increased shade on perennial streams, and protective buffers on intermittent streams*			

<u>Middle Rogue/Applegate Population:</u>

- One of the Highest Priority Recovery Actions for the SONCC Middle Rogue / Applegate Population Coho Population is to " improve timber harvest practices by revising the Oregon Forest Practices Act." (p. 31-1)

- "Reeves et al. (1993) found that the rate of timber harvest in Oregon coastal watersheds should not exceed 25 percent of a watershed to minimize risks and disturbances to aquatic resources. The study covered a period of 30 years (Reeves, G., pers. comm. 2003) and watersheds exceeding that level of harvest did not maintain channel integrity or Pacific salmon species diversity. Middle Rogue-Applegate sub-basin timber harvest rates are typically greater than this threshold on private timber land; therefore, the threat from timber harvest on private land will likely remain high. This private land encompasses most of the high IP coho habitat. The greatest risk from timber harvest is on private industrial timberlands that are managed under the Oregon Forest Practices Act, such as in private in-holdings in upper Slate Creek, Cheney Creek, and the decomposed granitic soils of the upper Beaver Creek watershed." (p. 31-24).

National Marine Fisheries Service 2014:31-28
Table 31-4. Recovery action implementation schedule for the Middle Rogue/Applegate rivers population.

SONCC-MRAR.7.2.50	Riparian	No	Improve timber harvest practices	Improve regulatory mechanisms	Population wide	1
SONCC-MRAR.7.2.50.1	*Determine how to revise Oregon Forest Practice Rules so that they do not limit recovery of SONCC coho salmon and make appropriate revisions*					
SONCC-MRAR.7.2.50.2	*Adopt rules for fish-bearing streams sufficient to protect both water quality and fish habitat*					
SONCC-MRAR.7.2.50.3	*Adopt rules to increase protection of non-fish-bearing streams that address practices that adversely impact water quality and fish habitat*					
SONCC-MRAR.7.2.50.4	*Ensure management measures for landslide prone areas include protection of water quality and fisheries habitat*					
SONCC-MRAR.7.2.50.5	*Until more permanent regulatory mechanisms can be put in place, immediately adopt interim rules that increase protection for salmon habitat in forested areas, including increased natural recruitment of large wood on perennial and intermittent streams, increased shade on perennial streams, and protective buffers on intermittent streams.*					

Upper Rogue Population (entirely within the Siskiyou ODF unit):

- One of the Highest Priority Recovery Actions for the SONCC Upper Rogue River Coho Population is to "improve timber harvest practices by revising the Oregon Forest Practices Act." (p. 32-1)

National Marine Fisheries Service 2014:32-27
Table 32-3. Recovery action implementation schedule for the Upper Rogue River population.

Action ID	Target	KLS/T	Strategy	Action Description	Area	Priority
Step ID	*Step Description*					
SONCC-URR.10.5.14	Water Quality	No	Improve timber harvest practices	Improve regulatory mechanisms	Privately held timberlands	1
SONCC-URR.10.5.14.1	*Determine how to revise Oregon Forest Practice Rules so that they do not limit recovery of SONCC coho salmon and make appropriate revisions*					
SONCC-URR.10.5.14.2	*Adopt rules for fish-bearing streams sufficient to protect both water quality and fish habitat*					
SONCC-URR.10.5.14.3	*Adopt rules to increase protection of non-fish-bearing streams that address practices that adversely impact water quality and fish habitat*					
SONCC-URR.10.5.14.4	*Ensure management measures for landslide prone areas include protection of water quality and fisheries habitat*					
SONCC-URR.10.5.14.5	*Until more permanent regulatory mechanisms can be put in place, immediately adopt interim rules that increase protection for salmon habitat in forested areas, including increased natural recruitment of large wood on perennial and intermittent streams likely to deliver wood downstream, increased shade on all perennials, and protective buffers on small intermittent streams.*					

III. Gray literature

A. Water Quality Restoration Plans – Bureau of Land Management (BLM)

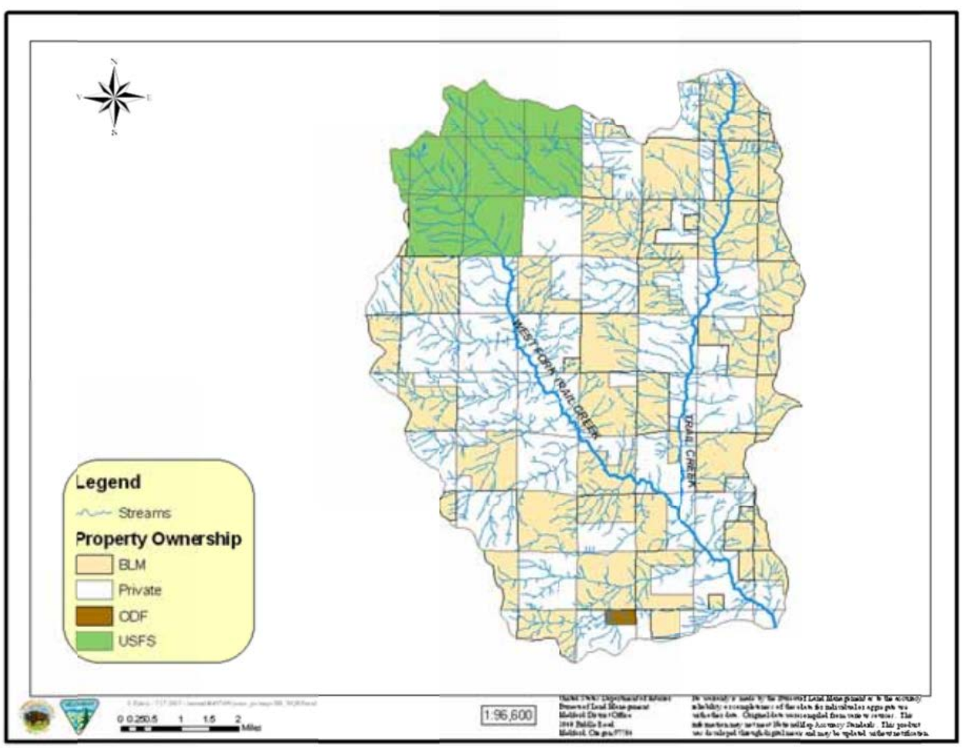
(1) Water Quality Restoration Plan Trail Creek Watershed. Bureau of Land Management. February 2011.

Trail Creek Watershed at a Glance	
Hydrologic Unit Code Number (Trail Creek)	**1710030706**
WQRP Area/Ownership	Total: 35,307 acres BLM: 14,697 acres (42%) U. S. Forest Service: 4,358 acres (12%) Private: 16,176 acres (46%) Oregon Dept. of Forestry: 76 acres (<1%)
303(d) Stream Miles Assessed	Total: 19.2 miles BLM Ownership: 4.8 miles
303(d) Listed Parameters	Dissolved Oxygen, E. Coli
Key Resources and Uses	Salmonids, domestic, aesthetic
Known Human Activities	Agriculture, forestry, roads, recreation, livestock, rural residential development
Natural Factors	Geology: volcanic Soils: various series and complexes, pervasively high clay content (30%-60%) in subsoil horizons (6 to 12 inches)

- "Land ownership patterns, past timber harvest, wildfires, and fire exclusion have contributed to the existing conditions in the watershed. Fire exclusion and harvest methods have contributed to the current high density and multiple-layered stand conditions in many of the proposed harvest units. Past harvest methods also influenced the locations and conditions of the roads within this watershed. Use of the mainstem streams to transport wood during historic timber harvest contributed to removal of large woody debris from streams, and harvest of streams in the watershed providing no riparian buffer has contributed to a reduction of shade provided by riparian canopy to streams, especially on private land, where this form of timber harvest was most common." (p. 7)

- Figure 4. BLM Land Ownership in the Trail Creek Watershed (p. 6)

Figure 4. BLM Land Ownership in the Trail Creek Watershed



- Table 5 Summary of Watershed Conditions on BLM-Administered Lands in the Trail Creek Watershed (p. 14)

Table 5. Summary of Watershed Conditions on BLM-Administered Lands in the Trail Creek Watershed

Shading	
Historical Condition	• Shading was higher, at least in the upper forks of Trail Creek, prior to heavy timber harvesting
Present Condition	• Less than 25% of all fishbearing streams provide greater than 80% stream shading.

- "Stream temperature and habitat recovery is largely dependent on vegetation recovery. Actions implemented now will not begin to show returns in terms of reduced stream temperatures or improved aquatic habitat for a number of years." (p. 19)

(2) Water Quality Restoration Plan Southern Oregon Coastal Basin Big Butte Creek Watershed. Bureau of Land Management (BLM) Medford District Butte Falls Resource Area. January 2008.

Big Butte Creek Watershed at a Glance	
Hydrologic Unit Code Number (Big Butte Creek)	**1710030704**
WQRP Area/Ownership	Total: 158,330 acres BLM: 29,544 acres (19%) U. S. Forest Service: 58,168 acres (37%) City of Medford: 1,427 acres (1%) Private: 69,144 acres (44%) Oregon Dept. of Forestry: 40 acres (<1%)
303(d) Stream Miles Assessed	Total: 54.2 miles BLM Ownership: 17.2 miles
303(d) Listed Parameters	Temperature, Dissolved Oxygen, E. Coli
Key Resources and Uses	Salmonids, domestic, aesthetic
Known Human Activities	Agriculture, forestry, roads, recreation, rural residential development
Natural Factors	Geology: volcanic Soils: various series and complexes

Temperature Impairment:

- "Within the Big Butte Creek Watershed, North Fork Big Butte, Clark, Dog, Doubleday, Hukill, and Jackass Creeks are on the 2004/2006 303(d) list for exceeding the 64.0°F 7-day statistic for rearing salmonids as found in the 1996 standard. There are a total of 64.4 stream miles listed for temperature in the Big Butte Creek Watershed of which 24 miles are on BLM-administered lands (Table 6 and Figure 9)." (p. 16)

- Table 7. Temperature Summary for the Big Butte Creek Watershed

Table 7. Temperature Summary for the Big Butte Creek Watershed

Stream Name	Period of Record[1]	7-day Statistic (ave. for all years) (°F)	Range of 7-day Statistic (for all years)	
			Minimum (°F)	Maximum (°F)
Big Butte Creek (above Rogue River)	1998, 1999	69.2	54.4	65.0
Big Butte Creek (above Dog Creek)	1994-1999, 2001, 2007	62.4	50.4	64.9
Clark Creek (34S-2E-7)	1995-1999,2001, 2003-2005, 2007	64.7	50.9	70.1
Dog Creek (above Big Butte Creek)	1994-1999, 2003, 2005, 2007	71.7	55.1	75.0
Doubleday Creek (35S-2E-13)	1998, 1999, 2002-2007	65.1	53.6	66.7

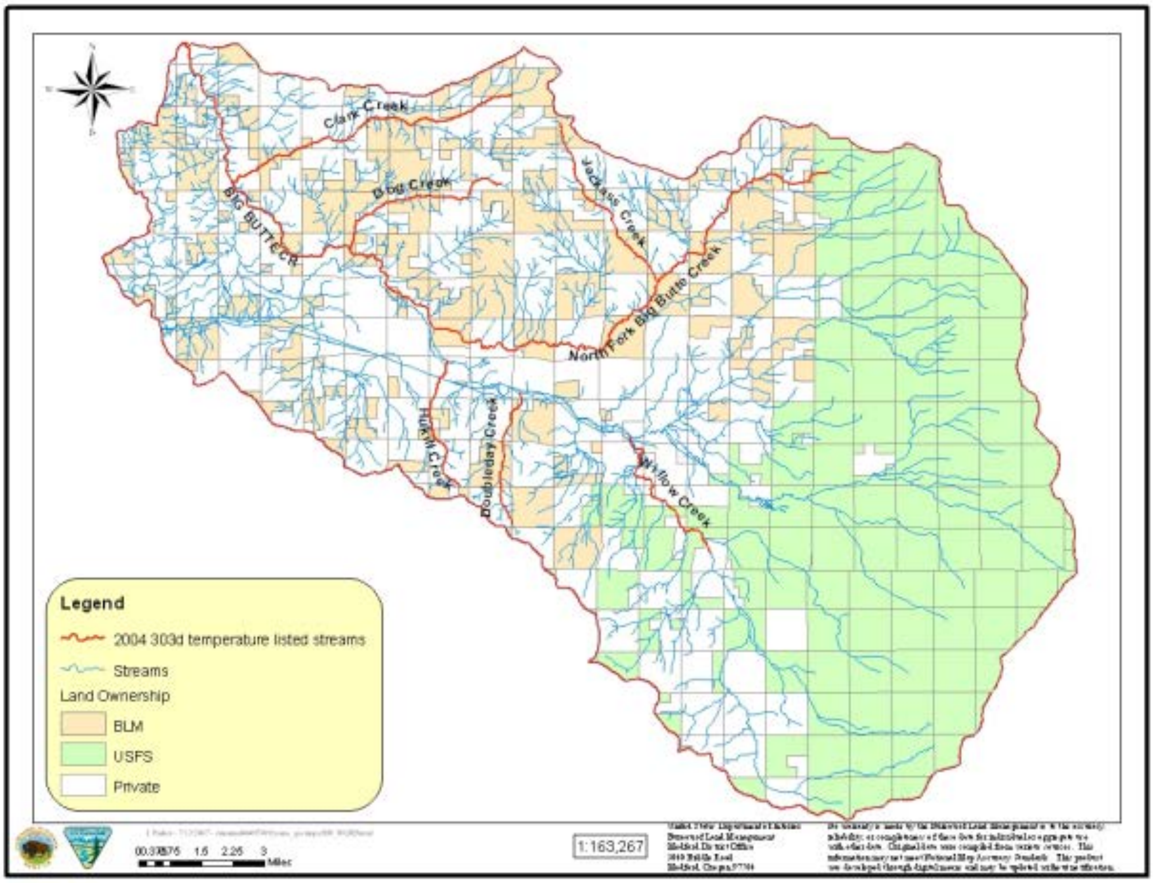
-

Stream Name	Period of Record[1]	7-day Statistic (ave. for all years) (°F)	Range of 7-day Statistic (for all years)	
			Minimum (°F)	Maximum (°F)
Hukill Creek (35S-2E-15)	1995-1999, 2001-2007	63.3	48.6	66.7
Jackass Creek (above North Fork Big Butte Creek	1994-1999, 2001, 2003-2007	68.1	50.8	71.6
North Fork Big Butte Creek (above South Fork confluence)	1994-2002, 2004, 2005, 2007	68.0	58.6	71.7

- [1] Temperature measured from June to September

- Figure 9. 2004/2006 303(d) Temperature Listed Streams for the Big Butte Creek Watershed.

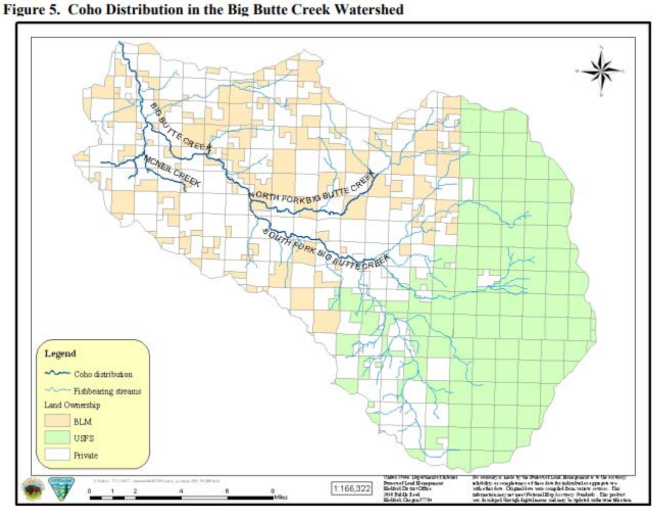
Figure 9. 2004/2006 303(d) Temperature-Listed Streams for the Big Butte Creek Watershed



**Note the mixed ownership on Big Butte/ North Fork Big Butte.*

- Figure 5. Coho Distribution in the Big Butte Creek Watershed (p. 5).

Figure 5. Coho Distribution in the Big Butte Creek Watershed



- "Prior to the completion of the TMDL for the plan area, guidance from the DEQ assumes that streams at system potential will not meet the temperature criterion during the hottest time of year (ODEQ 2004:11).Therefore, 100 percent of the load allocation for the Big Butte Watershed is assigned to natural sources and the allocation for BLM-managed lands is zero percent. Any activity that results in anthropogenic caused heating of the stream is unacceptable. This load allocation may be modified upon completion of the Rogue Basin TMDL." (p. 20-21)

- "It must be noted that only 32 percent of the 303(d) listed stream miles in the plan area are located on lands under BLM jurisdiction. Other organizations or groups that are (or will be) involved in partnerships for implementing, monitoring, and maintaining the Rogue Basin WQMP include the Upper Rogue Watershed Association, Jackson County, Oregon Department of Forestry (ODF), Oregon Department of Agriculture (ODA), Oregon Department of Transportation (ODOT), Oregon Department of Fish and Wildlife (ODFW), Oregon Water Resources Department (WRD), Oregon DEQ, and the U.S. Forest Service. The problems affecting water quality are widespread; coordination and innovative partnerships are key ingredients to successful restoration efforts." (p. 31)

(3) Althouse Creek Watershed Assessment. Bureau of Land Management. February 2005.

- "The first 7.5 miles of Althouse Creek (from its mouth to approximately the mouth of Tartar Gulch) is identified as "water quality-limited" due to warm summer temperature. Observations indicate that other streams in the watershed may warrant examination for water quality limitations due to high summer temperatures, flow modification, and sedimentation." (p. 7).

- "Factors limiting salmonid production include: inadequate stream flows in the summer months; high water temperatures; erosion and sedimentation; lack of large woody material in the stream and riparian area; lack of rearing and holding pools for juveniles and adults, respectively; channelization of streams in the canyons and lowlands; and blockages of migration corridors." (p. 10)

- "Coho salmon within Althouse Creek Watershed are part of the Southern Oregon / Northern California Coho ESU, which was federally listed as threatened on May 6, 1997 (Fed. Reg./Vol. 62, No. 87). The ESU includes all naturally spawned populations of coho salmon in coastal streams between Cape Blanco, Oregon, and Punta Gorda, California. Most of the coho in this ESU are in the Rogue River, with the largest remaining population in the Illinois River (Stouder et al. 1997). Currently summer water temperatures in the valley limit coho production from reaching historical levels (USDA, USDI 1997)." (p. 56)

- "Within the low-gradient reaches of the valley floor where private land ownership dominates, summer stream temperatures are not likely to improve as riparian vegetation is not returned and the demand on water allocation remains." (p. 104)

- "Changes in summer temperatures and the loss of stream complexity in Althouse Creek have affected coho and steelhead freshwater rearing habitat. The lower reaches have been affected most by the development of private land. As a result, the potential is great for private land owners to affect stream health downstream of federal ownership. However, sections of Althouse Creek on BLM and FS land are most likely to continue to provide the best coho and steelhead habitat. Key watersheds within the Illinois Basin will allow remnant stocks of coho to survive while areas disturbed by past practices recover." (p. 104)

(4) Water Quality Restoration Plan Deer Creek Watershed. Bureau of Land Management. 2011.

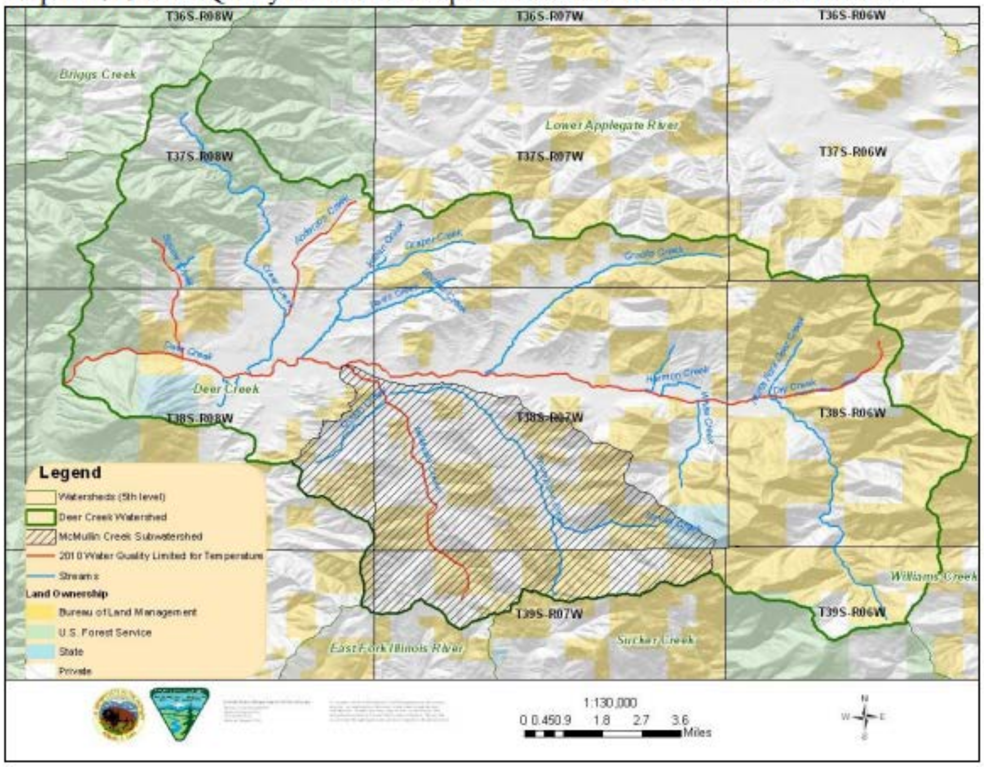
Deer Creek Watershed at a Glance	
Hydrologic Unit Code	1710031105
Watershed area/ownership	Total: 55,922 acres BLM: 23,052 acres USFS: 7,905 acres State: 1,026 acres Private: 23,939 acres
2010 303(d) listed parameters	None
Water Quality Limited for Temperature	*Deer Creek* mouth to river mile 17, *Anderson Creek* mouth to river mile 3.2, *Squaw Creek* mouth to river mile 3
Beneficial Uses	Fish (salmonids) and aquatic life, irrigation, domestic water supply
Known Impacts (human)	Water diversions, bank erosion, agriculture w/o riparian buffer, riparian harvest, woody debris removal, mining
Natural factors	Serpentine soils

- "Due to the mixed ownership in the Deer Creek Watershed, attainment of the water temperature standard requires multi-ownership participation and commitment to improve riparian function." (p. 13)

- Water Quality Limited for Temperature: Deer Creek mouth to river mile 17, Anderson Creek mouth to river mile 3.2, Squaw Creek mouth to river mile 3

- Map 1. 2010 Water Quality Limited for Temperature Streams in the Deer Creek Watershed (p. 2)

Map 1. 2010 Water Quality Limited for Temperature Streams in the Deer Creek Watershed



- "Land ownership is mostly a mix of private and BLM (Map 1), with private being the dominant ownership. The BLM, Medford District administers 41 percent of the lands, private ownership totals 43 percent, U.S. Forest Service manages 14 percent, and the State of Oregon lands total 2 percent…Major land uses in the watershed are agriculture and logging." (p. 2)

- "Based on the ownership distribution and aerial scanning (Google Earth), approximately 70% of the riparian zones in the Deer Creek Watershed lack mature tree structure necessary to provide large instream wood. On private lands, in the lower gradient floodplain reaches of Deer, Anderson/Clear, Draper, and Crooks creeks, reductions in riparian vegetation have decreased stream shade, thereby increasing solar radiation input into surface waters. While harvest activities fragmented riparian habitats, typical stream shade on BLM-managed land in the Deer Creek Watershed is high." (p. 5)

- Table 1. Deer Creek Watershed Water Quality Limited (WQL) Streams (p. 8)

Table 1. Deer Creek Watershed[1] 2010 Water Quality Limited (WQL) Streams

Stream Segment	WQL Stream Miles	Miles on BLM	Pollutant	Season	Standard
Deer Creek	0 - 17	2.8	Temperature	October 15-May 15	7-day-average max. ≤ 13°C.
Deer Creek	0 - 17	2.8	Temperature	Year Around (Non-spawning)	7-day average max.≤ 18°C
Anderson Creek	0 - 3.2	0.1	Temperature	Year Around (Non-spawning)	7-day average max.≤ 18°C
Squaw Creek	0 - 3	0.6	Temperature	Year Around (Non-spawning)	7-day average max.≤ 18°C

1/ Deer Creek Watershed, excluding the McMullin Creek Subwatershed (USDI 2005).

(5) Grants Pass Water Quality Restoration Plan Southern Oregon Coastal Basin Middle Rogue Subbasin Grants Pass- Rogue River Watershed Bureau of Land Management (BLM), Medford District Office Grants Pass Resource Area. 2012.

Grants Pass-Rogue River Watershed at a Glance	
Hydrologic Unit Code	1710030804
Watershed area/ownership	Total: 53,809 acres BLM: 12,482 acres Private: 40,677 acres State: 627 acres Local Government: 23 acres
303(d) Stream miles assessed	20.6 Total miles, 0.6 BLM miles
303(d) listed parameters	Temperature, fecal coliform
Beneficial Uses	Salmonid rearing, migration and spawning; cold water habitat; livestock watering; water supply; recreation
Known Impacts (human)	Timber harvest, roads, diversions, urban development, agriculture
Natural factors	Soils: Serpentine soils – poor growing conditions and low infiltration
Water Quality limited streams	*Savage Creek*—Mouth to mile 4.8 *Rogue River*—Mouth to mile 124.8

- "In 1997, the DEQ found maximum water temperatures above 23°C in Savage Creek exceeding the 17.8°C rearing maximum, leading to the 303(d) listing. A reduction of both baseflow and riparian vegetation in these are primarily responsible for increased water temperatures. Reduced volumes of water are more susceptible to warming and reduced vegetative cover increases solar radiation input. The current average shade on the 0.6 mile of Savage Creek that crosses BLM-managed land is 97 percent and the target shade is 97 percent (ODEQ 2004)." (p. 11)

(6) Water Quality Restoration Plan Southern Oregon Coastal Basin Evans Creek Watershed. Bureau of Land Management (BLM) Medford District Butte Falls Resource Area. July 2009.

Evans Creek Watershed at a Glance	
Hydrologic Unit Code Number (Evans Creek)	**1710030803**
WQRP Area/Ownership	Total: 143,349 acres Bureau of Land Management: 59,285 ac. (41%) Private entities: 82,817ac (58%) U. S. Forest Service: 1,104ac (<1%) Oregon Dept. of Forestry: 142ac (<<1%)
303(d) Stream Miles Assessed	Total: 89.6 miles BLM Ownership: 26.1 miles
303(d) Listed Parameters	Temperature, fecal coliform
Key Resources and Uses	Salmonids, domestic, aesthetic
Known Human Activities	Agriculture, forestry, roads, recreation, rural residential development
Natural Factors	Geology: volcanic Soils: various series and complexes

- Figure 10. Temperature Monitoring Sites for the Evans Creek Watershed (p. 19)

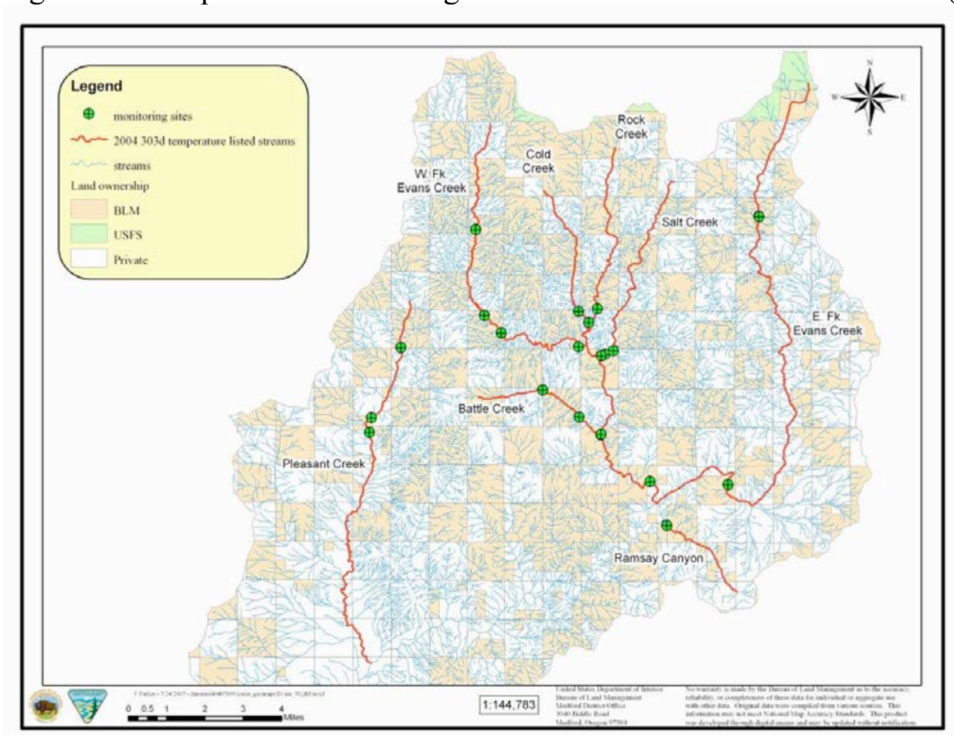


Table 7. Temperature Summary for the Evans Creek Watershed

Stream	Period of Record[1]	7-day statistic (average for all years °F)	7-day statistic range	
			Minimum (°F)	Maximum (°F)
Battle Creek (above W. Fk. Evans Ck.) – BATL	1994-1996, 2000-2002, 2007	65.9	58.1	67.9
Battle Creek (in 34s-03w-09) – BTL1	2000-2002	66.6	56.4	68.4
Battle Creek (in 34s-03w-09) – BTL2	2000-2002	63.9	56.4	66.1
Cold Creek (above Rock Creek) – COLD	1994-1996	69.0	60.8	69.8
Cold Creek (in 33s-03w-33) – CLDC	2000, 2002, 2004, 2005	65.5	53.3	68.7
East Evans Creek (above Sprignett Creek) – EEVN	1994, 1996-2002, 2007	76.8	58.3	82.0
East Evans Creek (above Wolf Creek) – EEAW	2000-2002	63.3	55.4	65.2
East Evans Creek (below Wolf Creek) – EEBW	1998	63.7	59.4	64.9
Pleasant Creek (in 33s-4w-35) – PLZM	2003-2006	66.5	58.7	70.8
Pleasant Creek (below Rt. Fk. Pleasant Ck.) – PLEZ	1994-1997, 1999, 2000	66.4	57.0	70.5
Pleasant Creek (in 34s-04w-15) –PLES	1998, 2003, 2004, 2006	66.5	57.3	68.0
Ramsey Canyon (above Evans Creek) – RAMS	1995-2002, 2004, 2005, 2007	69.3	54.1	73.7
Rock Creek (in 333s-03w-34) – ROCR	2000, 2002, 2004	67.3	57.6	69.6
Salt Creek (above W. Fk. Evans Ck.) – SALT	1996	66.2	59.9	67.1
Salt Creek (above W. Fk. Evans Ck.) – SLTC	2000	68.4	57.1	69.8
West Fork Evans Creek (above Swamp Creek) – WWAS	2004	64.8	57.4	66.0
West Fork Evans Creek (above Elderberry Flat) – WWAE	2004	67.4	58.3	68.4
West Fork Evans Creek (below Elderberry Flat) – WWBE	2004	67.8	60.1	69.0
West Fork Evans Creek (above Evans Creek) – WEVN	1994-1997, 2004-2007	72.7	62.6	77.6
West Fork Evans Creek (above Salt Creek) – WEAS	2000, 2001, 2006	71.8	60.0	75.5
West Fork Evans Creek (above Rock Creek) – WEAR	2000-2002, 2004	72.1	55.1	74.9
West Evans Creek (above Battle Creek) – WEAB	2000-2002, 2006, 2007	75.8	60.5	79.2

1/ Temperature measured from June to September

(7) Water Quality Restoration Plan Jumpoff Joe Creek Watershed. Bureau of Land Management. September 2009.

Jumpoff Joe Creek at a Glance	
Hydrologic Unit Code	17/10/03/10/01
Watershed area/ownership	Total: 69,382 acres BLM Ownership: 21,456 acres State, County, Private: 47,926 acres
303(d) listed parameters	Temperature
Beneficial Uses	Fish (salmonids) and aquatic life, irrigation, domestic water supply
Known Impacts(human)	Water diversions, bank erosion, riparian harvest, woody debris removal, mining
Natural factors	Serpentine and Granitic soils
Water Quality limited streams	*Jumpoff Joe Creek* mouth to river mile 21.3, *Louse Creek* to river mile 12.3, and *Quartz Creek* to river mile 7.3

- "Known Impacts(human) Water diversions, bank erosion, riparian harvest, woody debris removal, mining" (p. 3)

- "DEQ found 7-day average maximum stream temperatures above 18° C in Jumpoff Joe Creek, leading to 303(d) listing. The listed stream segment is River Mile (RM) 0 to RM 21.3, measured at 2 sites on Jumpoff Joe Creek. This is not reflected by water temperatures measured by BLM in the upper part of Jumpoff Joe Creek in section 3, T35S, R5W, estimated RM 15. DEQ found 7-day average maximum stream temperatures above 18° C in Louse Creek, leading to 303(d) listing. The listed stream segment is River Mile (RM) 0 to RM 12.3, measured at 2 sites. DEQ found 7-day average maximum stream temperatures above 18° C in Quartz Creek, leading to 303(d) listing. The listed stream segment is River Mile (RM) 0 to RM 7.3, measured at 2 sites. A reduction of both baseflow and riparian vegetation in the mid- and lower reaches of Jumpoff Joe, Louse, and Quartz Creeks are primarily responsible for increased water temperatures. Reduced volumes of water are more susceptible to warming and reduced vegetative cover increases solar radiation input." (p. 6).

(8) Water Quality Restoration Plan Klamath Basin Jenny Creek Watershed. Bureau of Land Management. 2011.

Jenny Creek Watershed at a Glance	
Hydrologic Unit Code Number	**1801020604**
WQRP Area/Ownership	Total: 134,348 acres BLM: 58,534 acres (44%) BOR: 3,023 acres (2%) USFS: 1,328 acres (1%) State of Oregon: 80 acres (<0.1%) Private: 71,383 acres (53%)
303(d) Stream Miles Assessed	Total: 55.7 miles BLM Ownership: 23.6 miles
303(d) Listed Parameters	Temperature
Key Resources and Uses	Resident salmonids, domestic, recreation, aesthetic
Known Human Activities	Agriculture, forestry, roads, rural residential development, and recreation
Natural Factors	Geology: volcanic landforms Soils: various series and complexes

-

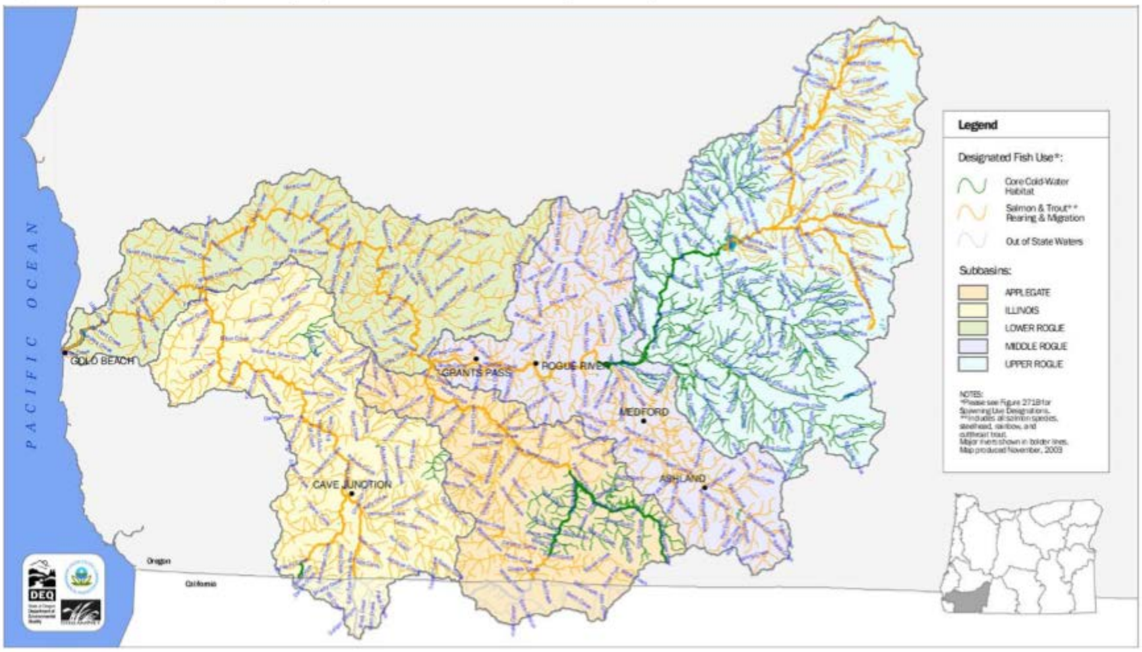
(9) Total Maximum Daily Loads (TMDLs)

(1) Rogue River Basin TMDL Chapter 2: Temperature. Oregon Department of Environmental Quality. 2008.

- "Temperature Issues in the Rogue River Subbasins: Salmonids, often referred to as cold water fish, and some amphibians are highly sensitive to temperature. In particular, Chinook salmon (*Oncorhynchus tshawytscha*) and coho salmon (*Oncorhynchus kisutch*) are among the most temperature sensitive of the cold water fish species in the Rogue River subbasins (DEQ 1995). Excessive summer water temperatures have been recorded in a number of tributaries. These high summer temperatures are reducing the quality of rearing and spawning habitat for chinook and coho salmon, steelhead and resident rainbow trout. The potential causes of high water temperatures in the Rogue River subbasins include urban and rural residential development near streams and rivers, reservoir management, irrigation water return flows, past forest management within riparian areas, NPDES regulated point sources, agricultural land use within the riparian area, water withdrawals, and road construction and maintenance." (p. 2-2).

- Figure 2.1 Fish Use Designations (map from OAR 340-041-0028, Figure 271A) (p. 2-7)

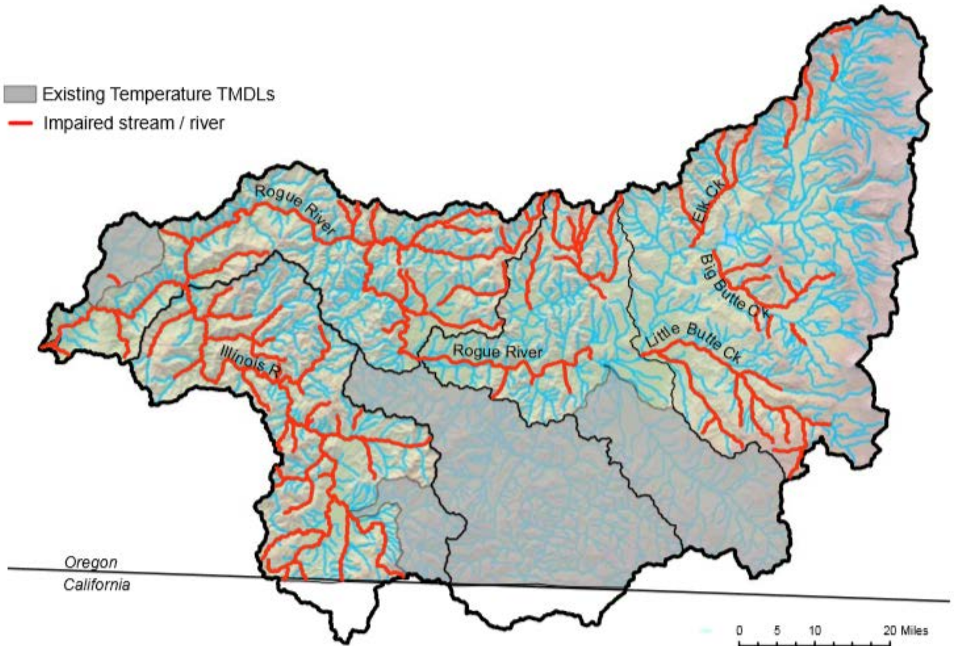
Figure 2.1. Fish Use Designations (map from OAR 340-041-0028, Figure 271A)



- "Monitoring has indicated that water temperatures in the Rogue River subbasins exceed the State of Oregon temperature criteria. The Rogue River basin has 101 individual temperature listings on the 2004/2006 Assessment (one of them is listed in error). Some streams may have more than one temperature listing. For example, Deer Creek in the Illinois River subbasin is listed for exceeding the rearing criteria and the spawning criteria. Figure 2.3 and Table 2.6 highlight the streams on the 2004/2006 303(d) list for temperature." (p. 2-9)

- Figure 2.3 2004/2006 303(d) list for temperature (Red) (p. 2-9)

Figure 2.3. 2004/2006 303(d) list for temperature (Red)



- "The pollutant targeted in this TMDL is heat from the following sources: (1) heat from warm water discharges from various point sources, (2) <u>heat from human caused increases in solar radiation loading to the stream network</u>, and (3) heat from reservoirs and irrigation ditches which, through their operations, increase water temperatures or otherwise modify natural thermal regimes in downstream river reaches." (p. 2-13)

- "Near-stream vegetation disturbance/removal reduces stream surface shading via decreased riparian vegetation height, width and/or density, thus increasing the amount of solar radiation reaching the stream surface (shade is commonly measured as percent-effective shade or open sky percentage3). Furthermore, forests even beyond the distance necessary to shade a stream can influence the microclimate, providing cooler daytime temperatures (Chen et al. 1999). Riparian vegetation also plays an important role in shaping channel morphology, resisting erosive high flows, and maintaining floodplain roughness. Table 2.9 shows the potential for improvement in shade for the Rogue River and selected tributaries as the difference between current and system potential effective shade. The system potential condition as defined in this TMDL is the near-stream vegetative community that can grow on a site at a given elevation and aspect in the absence of human disturbance." (2-19).

- "Effective shade is the surrogate measure that translates easily into solar heat load. It is simple to measure effective shade at the stream surface using a relatively inexpensive instrument called a Solar Pathfinder™. The term 'shade' has been used in several contexts, including its components such as shade angle or shade density. For purposes of this TMDL, effective shade is defined as the percent reduction of potential daily solar radiation load delivered to the water surface. The role of effective shade in this TMDL is to prevent or reduce heating by solar radiation and serve as a linear translator to the loading capacities. Unless otherwise stated within this chapter, the applicable nonpoint source load allocations for Rogue River Basin streams are based upon potential effective shade values presented in this section and the human use allowance (0.04oC cumulative increase at the point of maximum impact).” (p. 2-36)

- “Most streams simulated have no assimilative capacity, which translates into a zero heat load allocation for nonpoint sources. When a stream has assimilative capacity, nonpoint and point sources may receive allocations greater than background.” (p. 2-36)

(2) Lower Sucker Creek Illinois River Subbasin Total Maximum Daily Load and Water Quality Management Plan (Lower Section of Sucker/Grayback Watershed: 1710031103) (USFS boundary at Mile 10.4 to the Mouth). Oregon Department of Environmental Quality. April 2002.

- “Load Allocations (Nonpoint Sources): The numeric temperature criteria in Lower Sucker Creek is not expected to be met and therefore no measurable surface water temperature increases from anthropogenic activities are allowed. Wasteload Allocations (Point Sources): Applies to NPDES permitted point source discharges. The numeric temperature criteria in Lower Sucker Creek is not expected to be met and therefore no measurable surface water temperature increases from anthropogenic activities are allowed. NPDES dischargers, currently and in the future, are allowed no measurable surface water temperature impacts.” (p. 29)

(3) Applegate Subbasin Total Maximum Daily Load (TMDL) HUC # 17100309. Oregon Department of Environmental Quality. December 2003.

- “Temperature Issues in the Applegate Subbasin: Salmonids, often referred to as cold water fish, and some amphibians are highly sensitive to temperature. In particular, Chinook salmon (Oncorhynchus tshawytscha) and coho salmon (Oncorhynchus kisutch) are among the most temperature sensitive of the cold water fish species in the Applegate subbasin. Excessive summer water temperatures have been recorded in a number of tributaries and the mainstem Applegate River. These high summer temperatures are reducing the quality of rearing and spawning habitat for chinook and coho salmon, steelhead and resident rainbow trout. The potential causes of the high water temperatures include past forest management within riparian areas, upslope timber harvest practices, agricultural land use within the riparian area, road construction and maintenance, and rural residential development near streams and rivers.” (p. 13).

- “Nonpoint Sources: Riparian vegetation, stream morphology, hydrology, climate, and geographic location influence stream temperature. While climate and geographic location are outside of human control, riparian condition, channel morphology and hydrology are affected by human land use. Human activities that contribute to degraded thermal water quality conditions in the Applegate Subbasin are associated with agriculture, forestry, roads, urban development, and rural residential-related riparian disturbance. For the Applegate Subbasin temperature TMDL there are 4 nonpoint source categories which may result in increased thermal loads: 1. Near stream vegetation disturbance/removal 2. Channel modifications and widening 3. Hydromodification - Water Withdrawals 4. Natural Sources.” (p. 21)

(10) Other gray literature

(1) Stream habitat and water quality in the Applegate Basin. OWEB Grant 99-485 Final Report. Applegate River Watershed Council. November 2004.

- The assessment of the Stream Habitat and Water Quality in the Applegate basin emphasizes the impacts of sediment, stream flow and temperature on salmonid habitat. Thompson Creek, Little Applegate River, and the upper Applegate were area selected to conduct more specific investigations. (p. 3)

- The ODEQ reports in the Applegate Subbasin Total Maximum Daily Load (ODEQ 2003), "Of the 700 miles of streams and creeks in the Applegate subbasin, approximately 126 miles of streams are known to exceed the 64°F (17.8° C)summer rearing temperature criteria, 2 miles of streams exceed the 55°F (12.8° C)spawning temperature criteria, 9 miles exceed the sedimentation criteria, 9 miles exceed the biological criteria, 14 miles are listed for habitat modification, and 64 miles are listed for flow modification." In the Applegate subbasin, the following streams are on the EPA's Clean Water Act Section 303(d) list of water-quality limited streams for temperature: (p. 7)

  • Applegate River • Star Gulch • Beaver Creek • Sterling Creek • Humbug Creek • Thompson Creek • Little Applegate River • Waters Creek • Palmer Creek • Williams Creek • Powell Creek • Yale Creek • Slate Creek

(2) Betts, M., B. Bourgeois, R. Haynes, S. Johnson, K. Puettmann, and V. Sturtevant. 2014. Assessment of Alternative Forest Management Approaches: Final Report of the Independent Science Panel. Prepared with assistance from D.C.E. Robinson, A.W. Hall and G. Stankey, ESSA Technologies Ltd. (Vancouver, BC) for Oregon Department of Forestry (Salem, OR).

- "Increases in stream temperature summer maxima have been observed at a number of the fish bearing stream sites harvested using FPA in the RipStream study (Groom et al. 2011a, 2011b) and in the Alsea Paired Watershed Study- Revisited (J. Light, pers. comm.) and in a systematic review on stream temperature (Czarnomski et al. 2013). The RipStream and Alsea studies showed increased summer maxima onsite, and also exceeded the "Protecting Cold Water" non-degradation standard set by EPA and the State of Oregon. Downstream of harvest in both studies, maximum stream temperatures decreased. Non-fish streams have shown a range of temperature responses after harvest using FPA; several showed increased summer maxima for stream temperature on site (Kibler 2007, Gomi et al. 2006, Surfleet and Skaugset 2013, M. Reiter, pers. comm.) and showed that the maxima decreased as the stream water travelled downstream through buffers. Streams without any buffers showed the highest temperature increases (Gomi et al. 2006, Bisson et al. 2013)." (p. 37-38).

- "If FPA were applied in State Forests, there would be an increase of forest harvest near streams, due to two main differences: (1) no designation of no-cut or limited entry riparian zones around headwater streams without fish (N), and (2) narrower limited entry zones on all other stream types (see Appendix B: Riparian Guidelines). Under FPA, riparian buffers are not required for N type streams and fewer trees are required to remain standing in the outer riparian management zone of F type streams. Removing all riparian trees near streams has been shown to have multiple impacts to water quality, instream habitat and aquatic biota (see Section 4.2.3)." (p. 85)

Appendix B. Maps of Private Forestland, SSBT Streams, and Temperature Water Quality Limited Streams

Maps of the Oregon Department of Forestry (ODF) Siskiyou Georegion

Figure 1. Private Forestland and SSBT in Rogue Basin

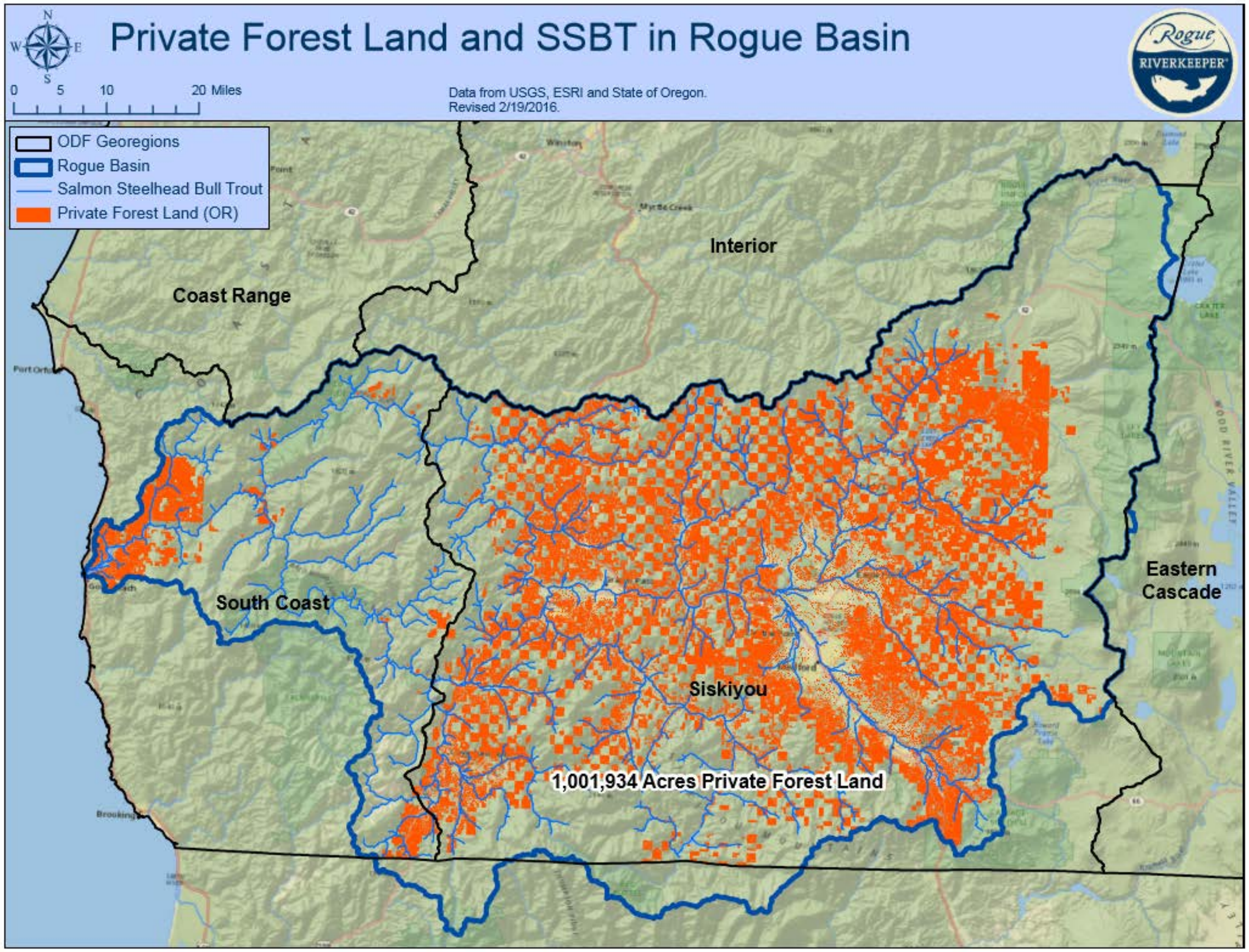


Figure 2. Map of the Siskiyou Georegion with SSBT streams, temperature water quality limited streams, and private forestlands by HUC-10 watershed

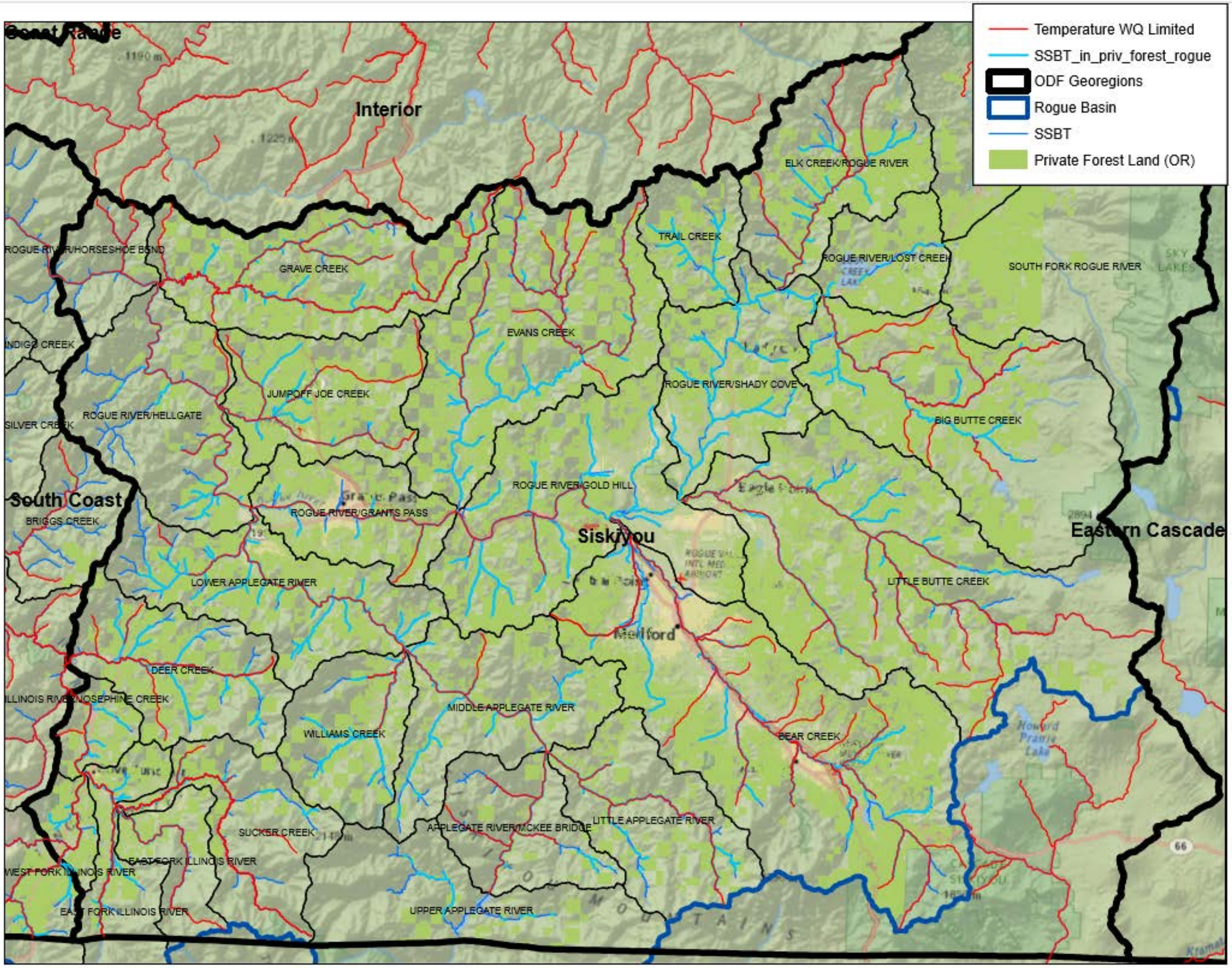


Figure 3. Deer Creek HUC-10 watershed with SSBT streams, temperature water quality limited streams, and private forestlands

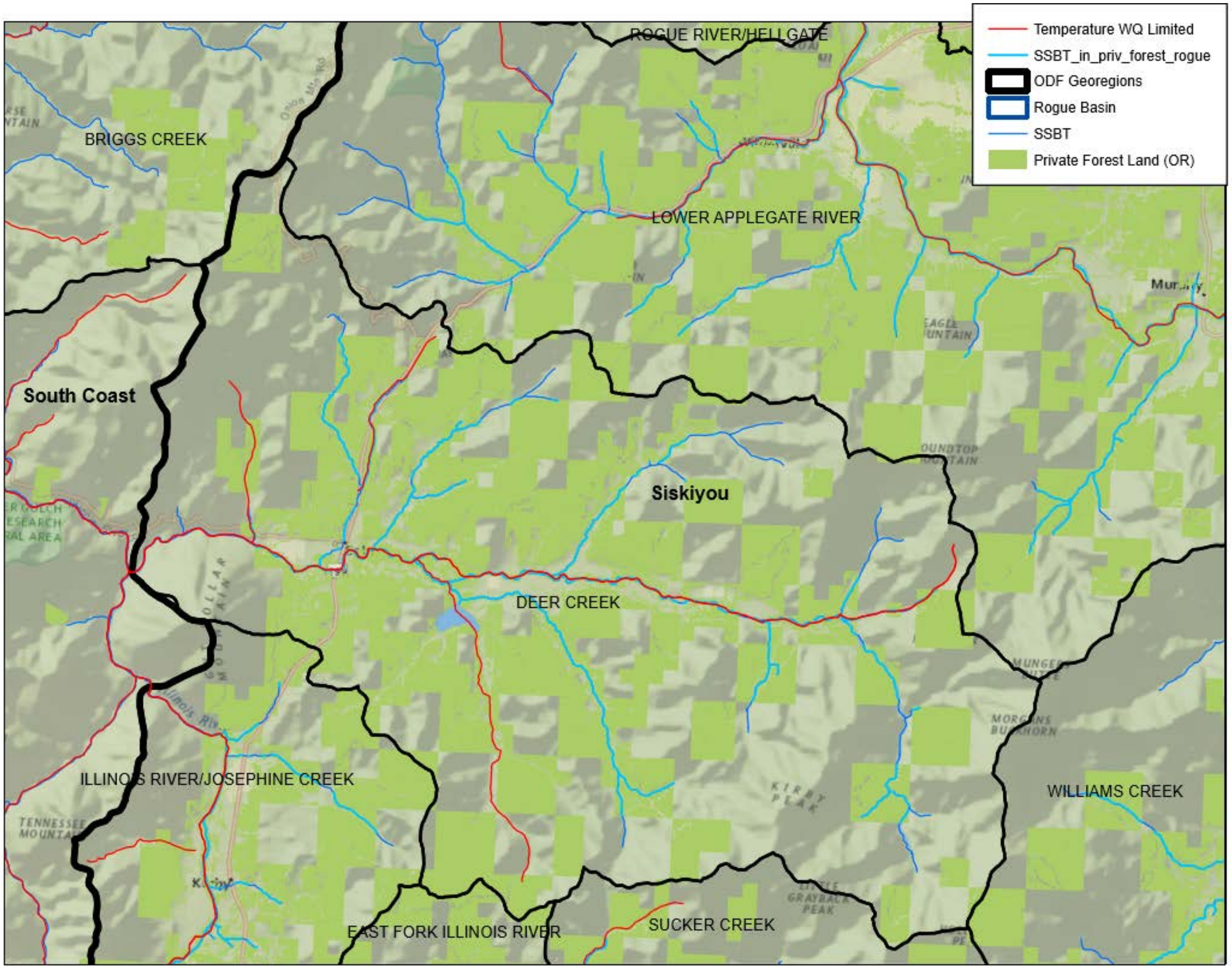


Figure 4. Jumpoff Joe Creek HUC-10 watershed with SSBT streams, temperature water quality limited streams, and private forestlands

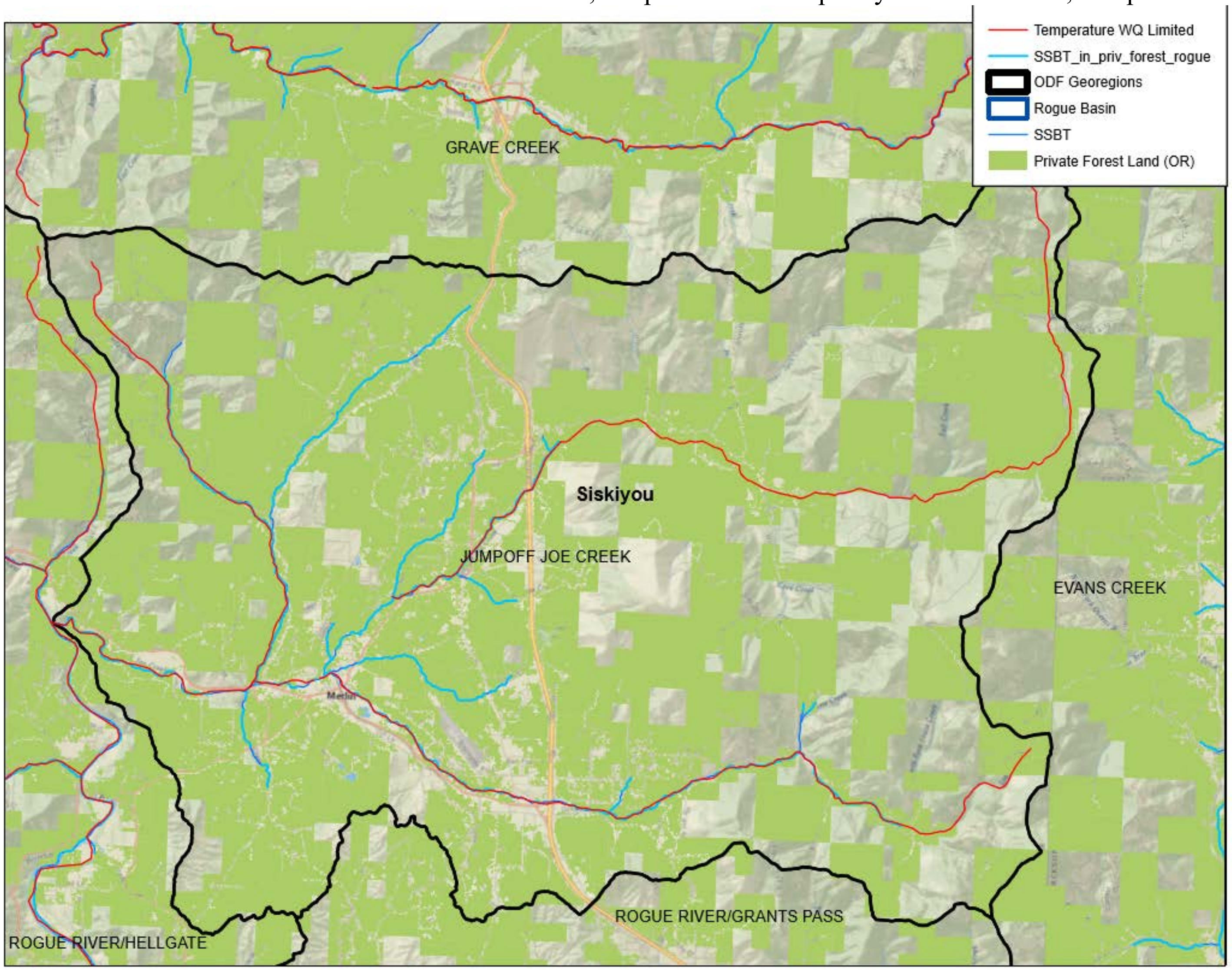


Figure 5. Evans Creek HUC-10 watershed with SSBT streams, temperature water quality limited streams, and private forestlands

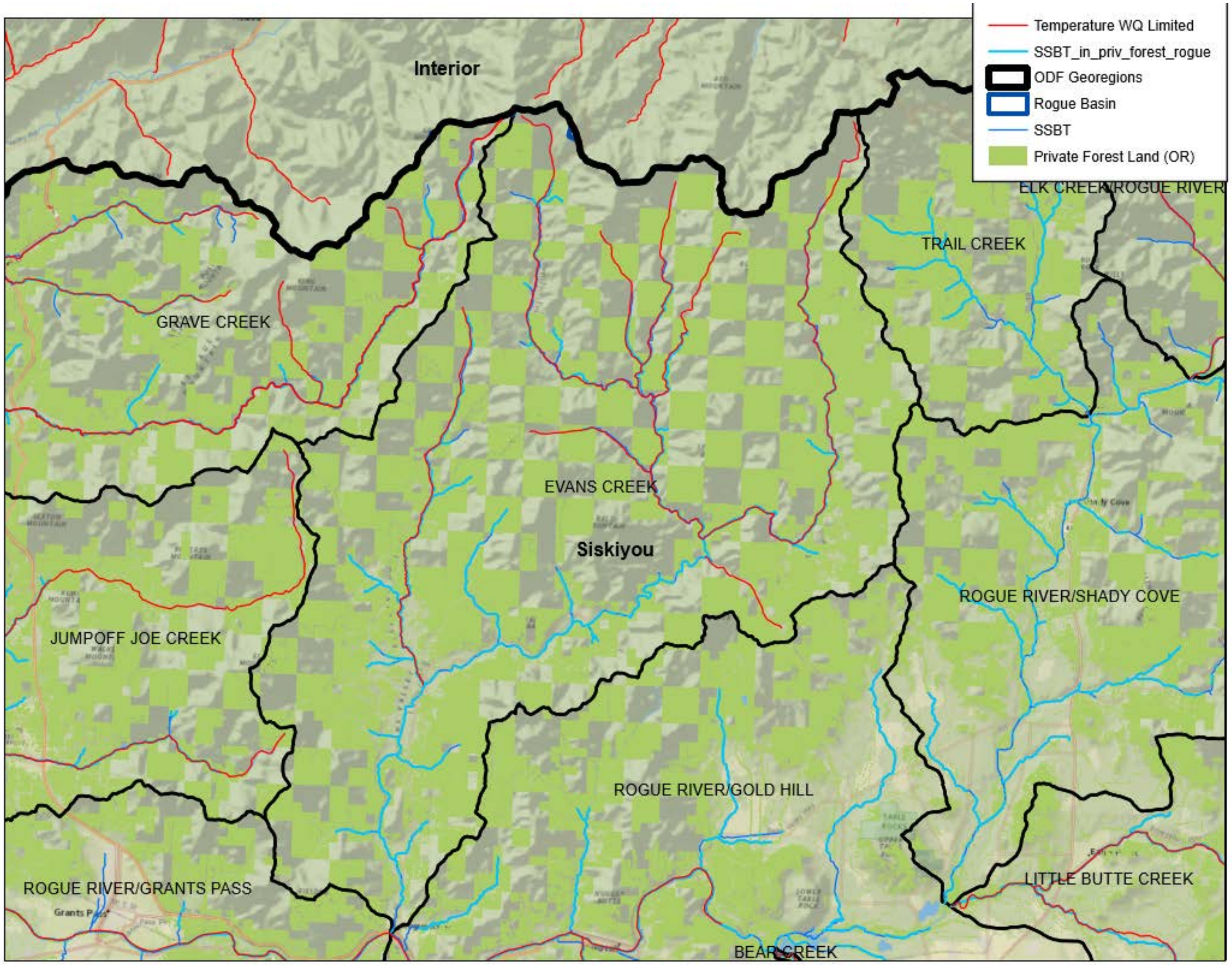


Figure 6. Applegate HUC-10 watersheds, SSBT streams, temperature water quality limited streams, and private forestlands

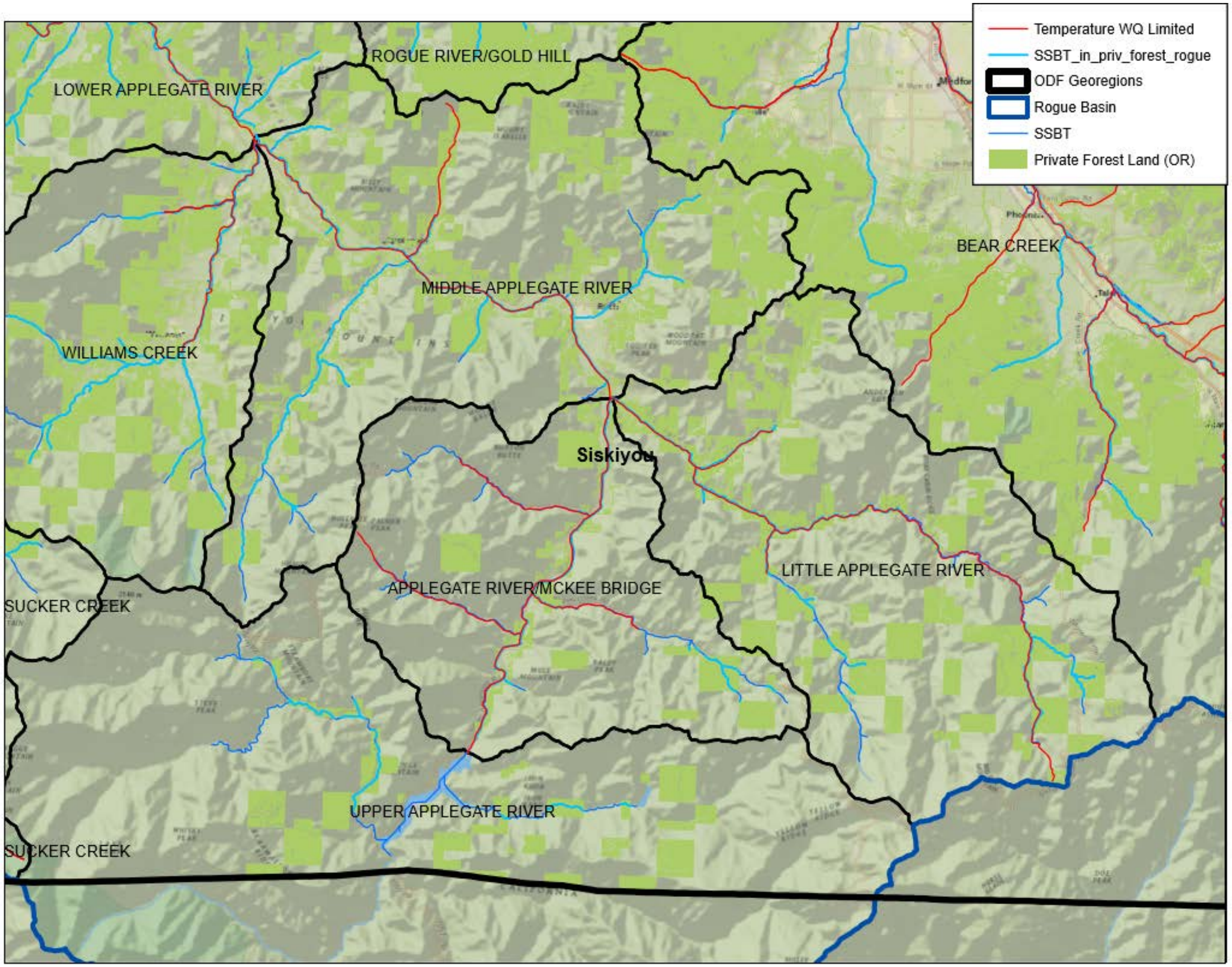
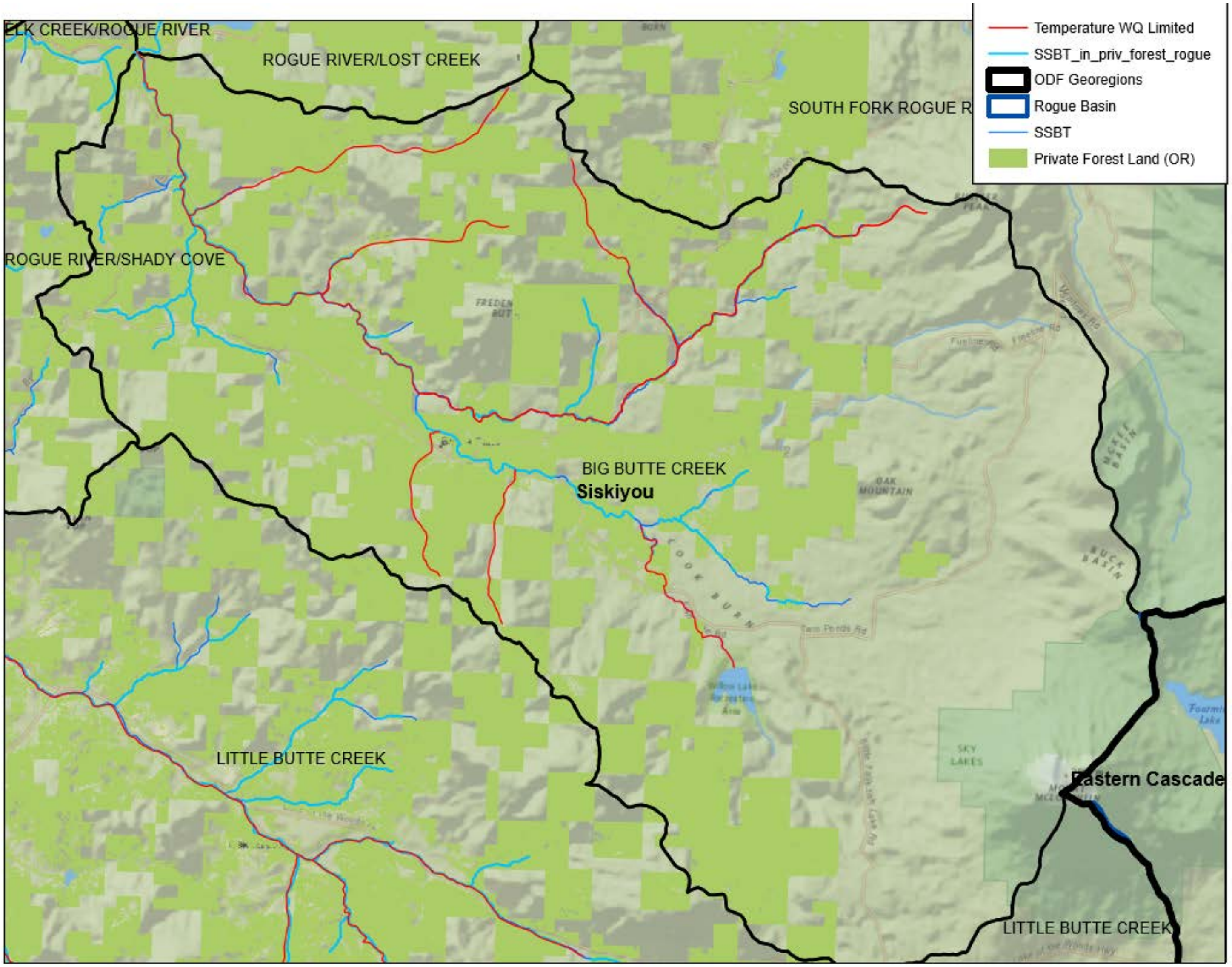


Figure 7. Big Butte Creek HUC-10 watershed, SSBT streams, temperature water quality limited streams, and private forestlands


Temperature WQ Limited
SSBT_in_priv_forest_rogue
ODF Georegions
Rogue Basin
SSBT
Private Forest Land (OR)
ELK CREEK/ROGUE RIVER
ROGUE RIVER/LOST CREEK
SOUTH FORK ROGUE R
ROGUE RIVER/SHADY COVE
BIG BUTTE CREEK
Siskiyou
LITTLE BUTTE CREEK
Eastern Cascade
LITTLE BUTTE CREEK

Jessica Halofsky
Siskiyou Streamside Protections Review
Climate Change Questions

The Southwest Oregon Adaptation Partnership was developed to identify climate change issues relevant for resource management on federal lands in Southwest Oregon (Rogue River National Forest, Umpqua National Forest, Bureau of Land Management [BLM] Medford District, BLM Roseburg District, Oregon Caves National Monument and Preserve). This science-management partnership assessed the vulnerability of natural resources to climate change, and developed adaptation options that minimize negative impacts of climate change and facilitate transition of ecosystems to a warmer climate. The vulnerability assessment focused on water resources, fisheries, vegetation, wildlife, recreation, and ecosystem services. The final report, to be published as a general technical report with the Forest Service Pacific Northwest Research Station, is in press, but the nearly final version is available at: http://adaptationpartners.org/swoap/. Information from the report relevant to the information requests from the board is summarized below. Please see the full report for more detail.

- What are climate model predictions for southwest Oregon in the next 20, 50, or 80 years?

Mean annual temperature in southwest Oregon has increased by 0.05 to 0.13 °C (0.09 to 0.23 °F) per decade since 1895 (depending on the historical dataset used), while annual precipitation has not changed. Global climate models for a high-end greenhouse gas emission scenario (RCP 8.5; comparable to current emissions) project that warming will continue throughout the 21st century. Compared to observed historical temperature, average warming is projected to increase 2.4 to 5.6 ºC (4.3 to 10.1 ºF) by the end of the 21st century (2070–2099). Precipitation may increase slightly in the winter, although the magnitude is uncertain.

  - Where does the greatest certainty/uncertainty lie?

    In general, precipitation projections are much more uncertain than those for temperature. The models generally project either no change in annual precipitation, or a slight increase for southwest Oregon. Because of the large projected temperature increases, the modeled precipitation increases would still lead to a net water loss compared to 1970–1999 given higher evapotranspiration rates. The global climate models generally show an increase in the seasonal amplitude of precipitation, with more winter precipitation (December through February) and less precipitation during the growing season (April through October).

    All global climate models project increases in temperature in the future.

  - How well do the broad climate change scenarios relate to smaller regions like the Siskiyou?

    An important caveat to simulated climate in mountainous regions is that global climate models do not explicitly simulate the effects of elevation and topography, with the large and rugged Cascade Range reduced to a smooth and relatively small topographic feature in the models. Some anticipated effects of climate change in the region—more warming farther inland than near the coast, and amplified winter through spring warming at higher elevations due to changes in snow albedo feedback—may not be captured by common downscaling methods (applying broad-scale climate projections locally).

- What is the broad consensus among the scientific community for how climate change will affect stream temperatures for small and medium streams (not rivers) in the Siskiyou region or similar regions?

There is broad consensus that stream temperatures in small and medium streams are likely to increase in the future with climate change in the Siskiyou region. Decreased summer streamflows and warmer water temperature will reduce habitat quality for cold-water fish species, especially at lower elevations. Based on projections of August stream temperature for 2080 (from the NorWeST summer stream temperature model), proportion of total stream miles with temperature less than 17 ºC will decrease (1) from 56 percent (current) to 17 percent (future) for coho salmon (Oregon Coast evolutionary significant unit [ESU]), (2) from 36 to 13 percent for coho salmon (Southern Oregon–Northern California Coast ESU), (3) from 34 to 16 percent for spring Chinook salmon, (4) from 36 to 12 percent for fall Chinook salmon, (5) from 56 to 22 percent for summer steelhead, (6) from 67 to 25 percent for winter steelhead, (7) from 77 to 52 percent for cutthroat trout, and (8) from 36 to 12 percent for Pacific lamprey. Umpqua chub thermal habitat (much warmer than for other species) will decline slightly by 2080.

  - What might be the most important drivers of change in stream temperature in climate change scenarios in this region?

    Increases in stream temperature in southwest Oregon will be driven by increasing air temperature, lower summer streamflows (resulting from loss of snowpack), and changes in vegetation cover over streams, driven primarily by disturbance (fire and insects).

- What is the broad consensus among the scientific community for how climate change will affect riparian stand structure adjacent to streams in the Siskiyou region or similar regions?

The primary effects of climate change on riparian areas in southwest Oregon will likely be mediated through disturbance. Fires generally burn with lower severity in southwest Oregon riparian areas compared to uplands and affect soil to a lesser extent. However, fire exclusion has resulted in denser forests in some riparian areas and adjacent uplands, which may facilitate more wildfires. Increased fire in riparian areas will likely favor hardwood species and shade-intolerant conifers.

Riparian vegetation depends on the presence of flowing water. With climate change, summer streamflows will likely decrease because of earlier snowmelt and earlier runoff. Increasing temperature and evapotranspiration and decreasing summer streamflows may lead to drying in some riparian areas; some intermittent reaches may become ephemeral, and some perennial reaches may become intermittent. Drying in riparian areas could decrease the extent of the riparian zone in some locations and/or result in shifts in riparian plant community composition. Drier conditions and more frequent fire in riparian areas may favor upland-associated species (e.g., conifers) over those typically associate with riparian areas (e.g., deciduous hardwoods), particularly along smaller streams.

Species that rely specifically on cold, flowing water are particularly vulnerable to warming and drying in riparian areas. Shifts in riparian vegetation will depend on elevation, location within a watershed, and land use. However, shifts to more drought-tolerant species can be expected, and shifts to more disturbance-tolerant species, such as red alder, may occur with increased flooding, wildfire, and insect outbreaks. Nonnative species may also become more competitive in riparian areas with increased opportunities for invasion after disturbance. Changes in riparian plant species composition and reduced riparian extent could result in direct losses to the quantity and quality of ecological contributions of riparian vegetation, such as wildlife habitat, shade over streams, and buffer capacity for maintenance of water quality.

Some riparian areas in southwest Oregon are dominated by Port Orford cedar, a near-endemic species to the Klamath-Siskiyou ecoregion. Port Orford cedar and other species provide dense shade over streams, contributing to cool stream temperatures and high water quality. Port Orford cedar is affected by root rot caused by the nonnative waterborne fungus Phytophthora lateralis. The disease is spread by mud on vehicles and hiking boots, and it can cause high mortality in Port Orford cedar stands. Forest Service and BLM lands in the region have infected Port Orford cedar in several locations. Port Orford cedar is fire tolerant, and seedlings can establish on mineral soil after fire, so increased fire may not negatively affect this species unless fire suppression facilitates the spread of root rot.

- How might currently mature riparian stands be affected?

  Mature riparian stands are at risk of high-severity wildfire.

- How might the regeneration or trajectory of riparian stands be affected?

  Species typically associated with riparian areas may not be able to regenerate in hotter and drier conditions, particularly after wildfire. More drought-tolerant (i.e., upland) species are likely to become more competitive in riparian areas, particularly along smaller streams.

- What might these changes mean for the ability of riparian stands to provide ecosystem services (e.g., shade, large wood, etc.)?

  More frequent fire will result in the loss of riparian shade. Development of large trees in riparian areas, particularly along small streams, may decrease with more frequent fire, thereby decreasing the recruitment of large wood into streams. However, in general, fire in riparian areas could help increase wood inputs to streams.

- What research or work is needed to improve our understanding of climate change impacts on riparian forests and stream temperature in the region?

Monitoring of stream temperature and changes in riparian vegetation is critical to determine how climate change affects southwest Oregon ecosystems over time.

STREAM TEMPERATURE AND CLIMATE CHANGE IN THE SISKYOU REGION

Oregon Department of Fish and Wildlife
May 2020

Background

The Earth's climate and oceans are changing because of activities that emit greenhouse gases into the atmosphere. Oregon is already experiencing changes that are consistent with changes observed and projected globally, such as increased average air and water temperatures, disrupted precipitation patterns, and increased ocean acidification and hypoxia.

These changing climate and ocean conditions are undermining the ability of lands and waters to support Oregon's native fish and wildlife. In particular, many aquatic organisms will be at risk because of increases in stream temperatures.

Water temperature is one the more crucial instream habitat features as it influences a wide range of biological outcomes, including: species phenology (e.g. emergence, migration), growth, survival, and community composition. In addition to direct impacts on aquatic organisms, stream temperature also influences several other water quality parameters, including oxygen solubility, that are important to aquatic organisms.

Stream temperature is extremely dynamic, varying both spatially and temporally at multiple scales (e.g. thermal patches, diel fluctuations, seasonal variations). Given this, thermal regime is likely a better term to describe the spatio-temporal dynamics of stream temperature. Factors influencing thermal regimes can be categorized into three different groups (Steel et al. 2017; Mayer 2012):

Climatic conditions: solar radiation, air temperatures, and precipitation
Landscape controls: elevation, latitude, geology, land cover, basin area, and aspect
Stream and channel characteristics: channel morphology, groundwater exchange, complexity, riparian shading

The relationships among stream temperature and these processes, conditions, controls are complex. Collectively they interact to create a mosaic of thermal heterogeneity. There are many changes in our existing climate system that are already altering thermal regimes and these changes are expected to continue for several decades even if current greenhouse gas emissions are reduced.

Regional Trends and Projections

Air Temperature:

Summer: Average summer air temperature has increased by 4.1°F in Medford since the 1970s[1]. By 2070, it is predicted that summer air temperatures in the Siskiyou region will be 5-11°F warmer than the 1971-2000 average[2]. Additionally, most locations in Oregon will likely

[1] Data obtained from NOAA Regional Climate Center Applied climate Information System (rcc-acis.org)
[2] (NW Climate Toolbox, Data: gridMET, High emissions 8.5 2070-2099 vs. historical simulation 1971-2000, mean change, Multi-model mean derived from 20 downscaled CMIP5 models).

experience a doubling of "hot days" (defined as days with daily high temperatures >86 ºF) (Mote et al. 2019).

Winter: Average winter air temperatures have increased 2.1°F in Medford since the 1970's[1], and regionally it is projected that winter temperatures will be 5-7 °F warmer by 2070.

Precipitation

Rain: Climate projections suggest there will be considerable spatial variability in the extent of precipitation changes in the winter with locations east of the Cascades projected to see increases >20% while west of the Cascades the magnitude of change in precipitation is projected to be <10%. Largely consistent across all climate models, summer precipitation is projected to decrease by as much as 30% by the end of the century in the Pacific Northwest. In the Siskiyou region[2], average spring and fall precipitation will decrease (4% change from historical) in some locations with summer precipitation decreasing by approximately 4-20%.

Snow: Snowpack has declined by 15-30% since mid-century in the Pacific Northwest (Mote et al. 2017) A continued increase in winter temperatures is projected to result in a continued decline of 11-50% in April 1 Snow Water Equivalents[3] in the Siskiyou region by 2070[1].

Extreme Storm Events: The occurrence of severe winter storms is also projected to increase in the future with extreme precipitation increasing in the winter by 10 to 20% (for Western and Eastern Oregon, respectively) (Mote et al. 2019). In locations where winter precipitation increases, there will be an increase in winter stream flows as a result of reduced snow accumulation and rapid runoff, increasing the flooding risks (Mote et al. 2019).

Drought

The increases in global average air temperature are also expect to result in more extremes in weather, particularly in the form of drought. The Rogue Siskiyou region has already been experiencing drought as evidenced by numerous formally perennial streams becoming intermittent or going dry in the last five years (Pete Samarin, ODFW; personal communication). In an analysis of drought potential for the Western states, Ault et al. 2014 concluded that this region has a 40 – 50% chance of experiencing an 11-year drought, with a 20 – 50% chance of experiencing a 35-year mega-drought in the coming century. Conditions similar to those experienced in 2015 will be more prevalent. In 2015, record winter warming and low snow pack resulted in drought, water scarcity, and wildfires

Streamflow

Streams in Oregon are projected to shift toward generally higher winter flows and lower summer and fall flows. For example, summertime stream flow in the Cascade Mountain Range is projected to be reduced by as much as 50% in June (Mote et al. 2019). Stream flows have been generally decreasing in the past half century in the Siskiyou region. Asarian and Walker (2016) documented a decline in summer (July-September) stream flow at many regulated sites and over 70% of unregulated sites in an assessment of long-term trends (1953-2012) in streamflow and precipitation. The changes in rainfall, snow water equivalents (SWE), and snowmelt timing associated with climate change will exacerbate this decline. In the Siskiyou region, many locations are projected to see significant decreases in summer and fall stream flows by 2080 (Gao et al. 2010) (Figure 1; Figure 2; Figure3).

[3] Snow Water Equivalent (SWE) is a measure of the amount of water contained within the snowpack. It can be thought of as the depth of water that would theoretically result if you melted the entire snowpack instantaneously. The Apr 1 SWE metric has traditionally been a useful indicator of the potential water resource during the subsequent summer.

Impact on Stream Temperatures

Stream temperatures will continue to increase in many locations as a result of both the direct (increasing air temperature, decreasing streamflow) and indirect (fire, changes in riparian and upland land cover) impacts of climate change. In the Siskiyou region, June stream temperatures have historically been generally cold and cool at higher elevations with localized warming beginning to occur at lower elevations in the Illinois, Middle Rogue and Applegate basins. In small and medium streams, 2080 projections for June indicate there will be a 9% reduction in stream miles experiencing cooler temperatures (<10º C) (Figure 3), with future June conditions resembling historical August conditions (NorWest[4]). For August, 2080 projections indicate a 6% reduction in cooler temperatures and an 11% increase in the extent of streams with temperatures >20° C (Figure 4).

NOTE: Percentages indicate the approximate change in stream miles between baseline conditions (2002-2011) and 2080 projections. The NorWest[4] predictions of stream temperature change in the future assume no changes to surrounding land management which can either exacerbate or mitigate the changes expected as a result of climate change.

Local Drivers of Stream Temperature

At more local-scales, stream temperatures reflect both climatic conditions and landscape controls. The spatial and temporal variation in stream temperatures a generally related to the source and volume of flows, solar energy loading, and local reach factors.

<u>Flow source</u>

Streams that flow from areas with large groundwater contributions, persistent snowpack, or under dense forest canopies are expected to be cooler and be less sensitive to climate change (Luce et al 2014). Streams in lower elevation, rain-dominated watersheds are more sensitive to summer air temperature variations compared to streams with flows dominated by snowmelt (Lisi et al. 2015).

This sets up a spatially heterogeneous impact of climate warming on stream thermal regimes controlled in large part by geomorphic features. Much of this heterogeneity will be lost with reductions in snowpack (Lisi et al. 2015). Changes in land cover alter the relative importance and magnitudes of these processes but can also be managed to minimize impacts.

<u>Flow volume</u>

The volume of water in a stream has a strong influence on stream temperature. As stream flows decline a stream's volume and thermal mass decline as well, resulting in greater temperature fluctuations and potential for warming. Additionally, decreasing stream flows result in longer travel times, increased exposure to solar loading, and ultimately warmer water temperatures in summer months.

> *Influence of changing precipitation patterns*: During the summer and early fall, most streamflow in this region is derived from shallow groundwater. In high elevation watersheds infiltration and recharge are expected to decline as a result of decreased snowpack. Lower elevation watersheds will also experience reductions in summer stream flows due to decreases in summer precipitation and reduced wet-season recharge caused by the increased intensity of future precipitation events.

[4] NorWest is a regional temperature model estimating August mean temperature at stream reach scales. See Isaak et al. 2017 for more details.

Furthermore, as snow melt timing occurs earlier in the year and the region experiences a decrease in summer precipitation, streams will be dependent on the stored shallow groundwater for longer periods, resulting in reduced stream flows in mid to late summer as groundwater resources are exhausted.

Riparian and upland influence: In addition to the influence of precipitation patterns, the hydrological and biogeochemical processes occurring in the riparian and upland areas can have a significant influence on the volume of water reaching streams. For example, Perry and Jones (2017) found that the conversion of old-growth forests to Douglas-fir plantations resulted in reductions in summer streamflow associated with increased evapotranspiration from young, actively growing trees. In addition to the impacts of land/forest management, climate change may also influence these pathways via wildfire and/or changing suitability zones for shrub/forest species. We have not accounted for these latter impacts in analysis of potential changes in stream flow/temperature.

Solar energy loading

Solar energy loading levels affect stream temperature both directly and indirectly. Both physical (e.g., slope, aspect), land cover (e.g., riparian and upland vegetation composition and condition), and disturbance (e.g., fire, forest harvest) significantly impact the amount of solar radiation that reaches the earth's surface.

Riparian zone: Riparian trees directly reduce the amount of solar energy reaching the stream surface. The extent of shading is dependent on the type and age of the riparian stand, as well as the width of the stream. Several studies have evaluated the impact of stream shading on stream temperatures. Wondzell et al. (2018), working in the John Day Basin in Oregon, found decreases in stream temperature given different riparian management scenarios (post-wildfire with 7% shade, current vegetation with 19% shade, a young-open forest with 34% shade, and a mature riparian forest with 79% effective shade), with mature forest scenarios resulting in the largest decrease.

Upland Zone: The type and age of land cover in the upland zone influences the amount of solar radiation hitting the ground surface, and thereby soil temperature. Soil temperature, in turn, influences the temperature of surface flows that eventually reach the streams.

Wildfire Warmer air temperatures and increased drought conditions will create more favorable conditions for wildfire. Analysis shows that past warm, dry summers were associated with an increase in the area burned; the warmest years on record (2012, 2014, 2017) were also the years that saw the most acres burned (Mote et al. 2019). While water temperatures can increase as a result of the direct heating from fire, the prolonged impacts are generally a result of reduced riparian shading and changes to stream morphology (Dunham et al., 2007; Isaak et al., 2010). There is evidence that smoke from wildfire can attenuate solar radiation and air temperatures, resulting in a temporary cooling effect to water temperatures (David et al. 2018).

Reach-scale Factors

When looking at local patterns, a number of factors influence the spatial and temporal dynamics of stream temperature at reach-scales (Dugdale et al. 2017; Steel et al .2017; Mayer 2012).

Channel morphology: stream width, depth, and channel gradient influence thermal capacity.
Groundwater exchange/hyporheic exchange: can create pockets of cool water, refuge locations, and contribute to thermal heterogeneity in a reach.

Complexity: sinuosity (channel curvature), instream roughness (wood, substrate), variation in habitat types all contribute to localized patterns of temperature creating thermal micro-habitats. *Riparian shading:* composition, age, condition of riparian vegetation can moderate stream temperatures strongly influence by solar radiation and air temperatures.

Summary and link to Forest Management

Stream temperature is influenced by a number of factors, several of which are being impacted negatively by climate change. However, management of land and water can play a role in reducing these impacts. In particular, forests play a key role in influencing both riparian shading and the temperature and volume of surface water inputs to streams. The impacts of climate change on stream temperature will not be uniform. In some locations we expect the changes in stream temperature to exceed species thermal tolerance and there may be little opportunity to prevent these changes through land and water management. In other locations, there will be opportunities to use management actions to mitigate the severity of the impacts. This variation in both the impact and ability to manage the impact calls for a strategic approach to management.

Opportunities for Coordination

To guide a strategic approach to addressing the impacts of climate change on fish and wildlife, the Oregon Department of Fish and Wildlife is developing a climate change policy. The goals of the policy are:

1. Understand and act on risks and opportunities associates with changing climate and ocean conditions

2. Provide leadership toward a coordinated statewide and regional response

3. Reduce the Department's carbon footprint to the extent practicable with the goal reaching carbon neutrality

The first goal centers around using science to understand and act on the risks and opportunities associated with climate change. The second goal recognizes that the impacts of climate change are broad and will be felt across Oregon and in all sectors-to be successful we need to be coordinating our response among Agencies. Such a coordinated response involves inventorying and assessing the vulnerability and resiliency of the States natural resource assets. This information is critical to aid planning, help to determine clear priorities within and across geographical areas and streamline implementation of actions to achieve these priorities. There are a number of opportunities for coordination between ODFW and ODF that would benefit both agencies and result in more informed decision making.

Coordinated Temperature Monitoring and Aquatic Prioritization

In many places in Oregon, increases in stream temperature associated with a changing climate, and compounded by human alterations, threaten to displace aquatic species and disrupt their ecology. The ability to manage this risk spatially and work strategically across sectors will depend on our ability to accurately monitor and predict stream temperatures year round at a fine spatial/temporal resolution. For the Oregon Department of Forestry (ODF), contributing to and collaborating on stream temperature monitoring could mean better data that affords flexibility in rule setting, particularly as it relates of buffer widths.

We are proposing a two level approach that consists of 1) statewide monitoring which will have less precision but still provide accurate year-round representations of stream temperature patterns and 2) a selection of intensively monitored watersheds to help us understand the nuances related to spatial and temporal variability in stream temperatures. Having high resolution temperature data and temperature projections allows us to further refine assessments of the relative value of a stream reach to aquatic species and thereby identify areas that are likely resilient to climate change, areas that could become resilient with management, and areas that are unlikely to support species regardless of management.

Development of simulation and modeling tools to inform management

ODFW is developing a range of tools to help the Department better understand how climate change will impact fish and wildlife and their habitats. As one example, we are currently working with EPA to deploy an eco-hydrological model VELMA (Visualizing Ecosystem Land Management Assessments) that produces simulations of hydrologic and ecological processes over time. VELMA produces model estimates of streamflow, discharge and other hydrologic characteristic using data inputs that influence local hydrology. ODFW is currently using the tool to evaluate the future impact of climate change on stream flows in coastal Oregon. However, the model can also be used to quantify long-term effects of alternative forest management on certain habitat variables, including peak and low flows and riparian condition (additionally, the ability to model stream temperature is under development).

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Figure 1. Percent difference between historical monthly flows to 2080 August flows. Data from the Variable Infiltration Capacity (VIC) model.

Figure 2. Comparison of historical and future mean monthly flows in the Illinois and Applegate basins using data from the Variable Infiltration Capacity (VIC) model.

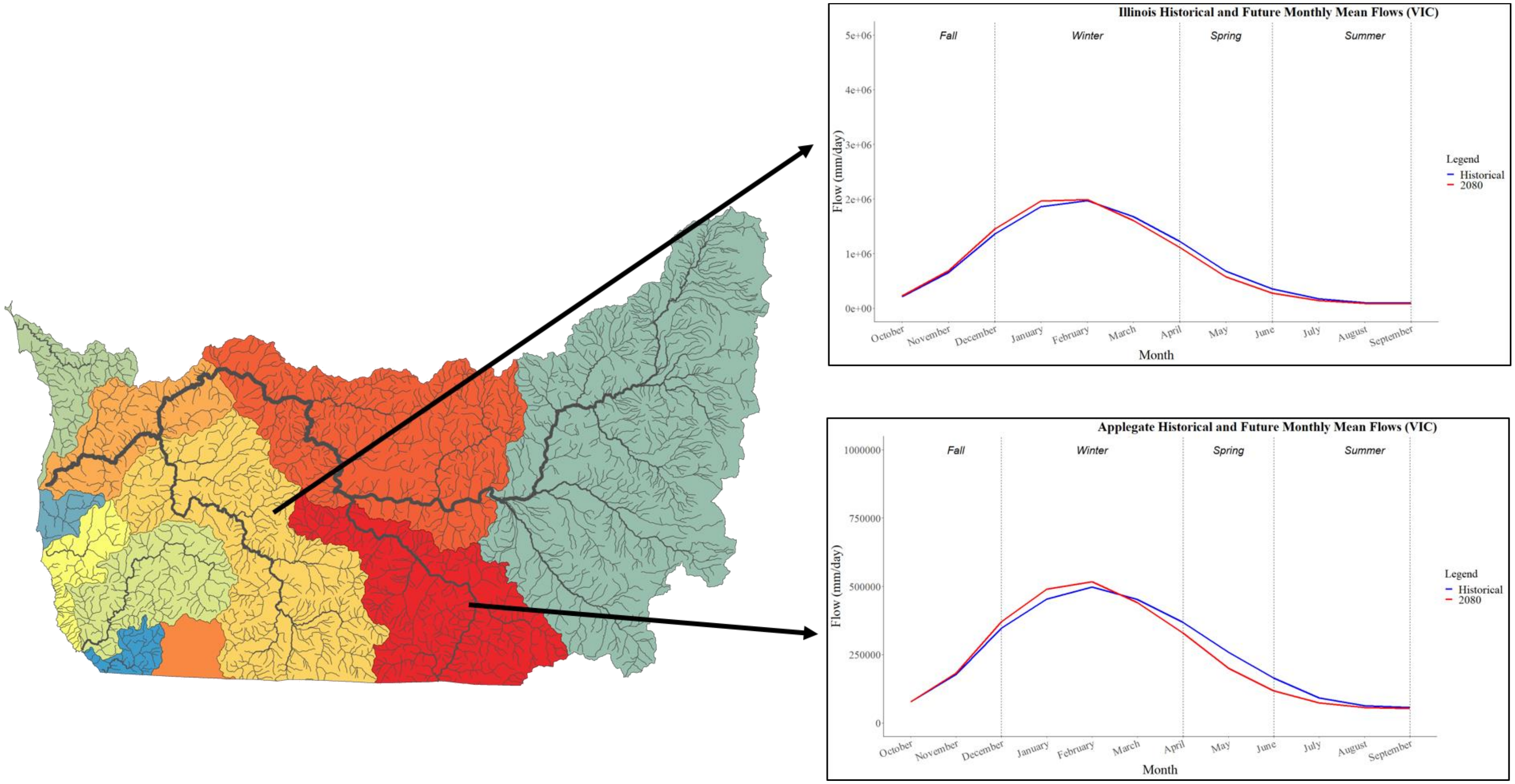


Figure 3. Comparison of historical and future mean monthly flows in the Middle and Upper Rogue basins using data from the Variable Infiltration Capacity (VIC) model.

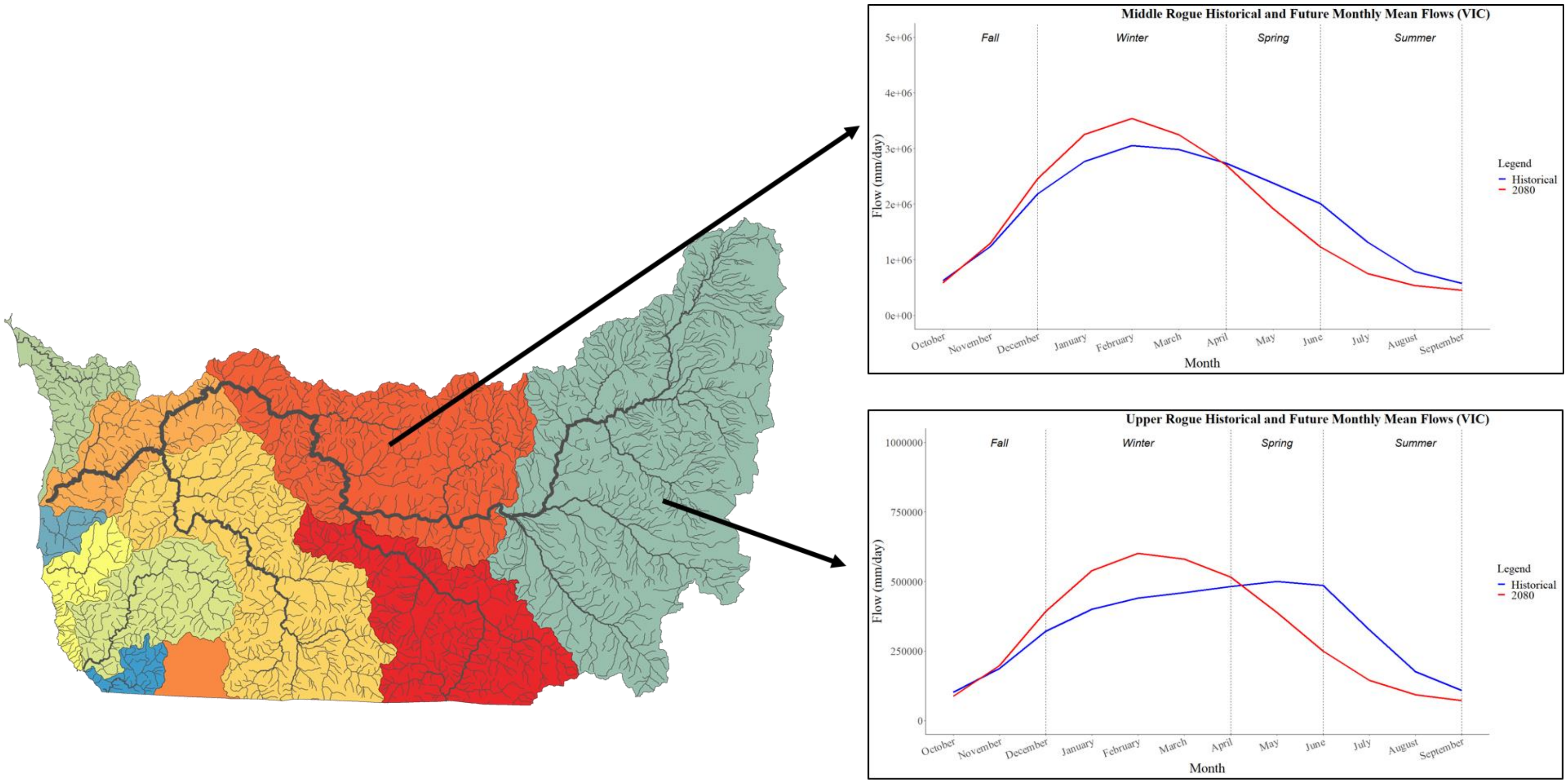


Figure 4. NorWest stream temperature estimates for the Siskiyou region for a) June mean 2002-2011 and b) June mean 2080.

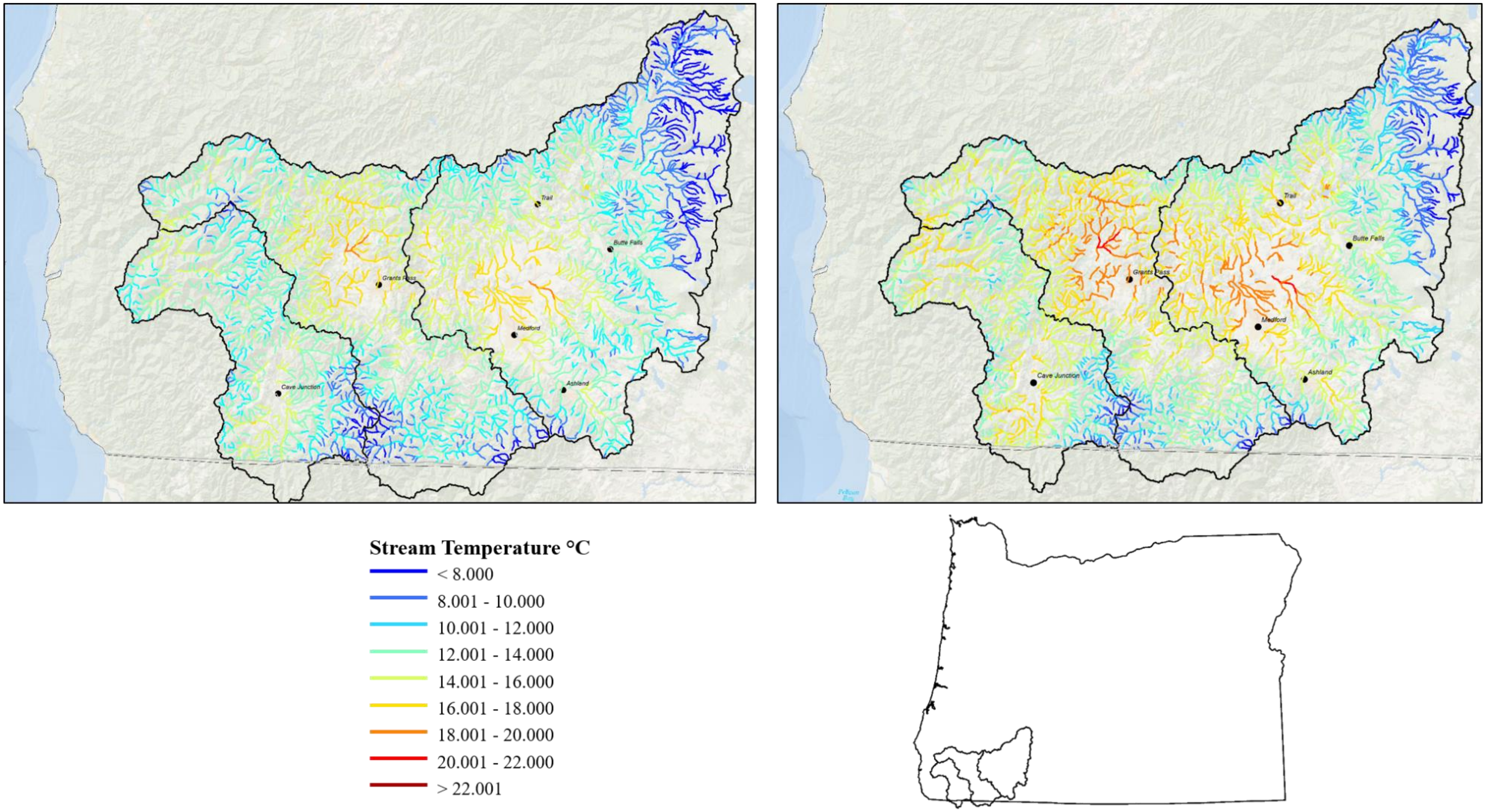
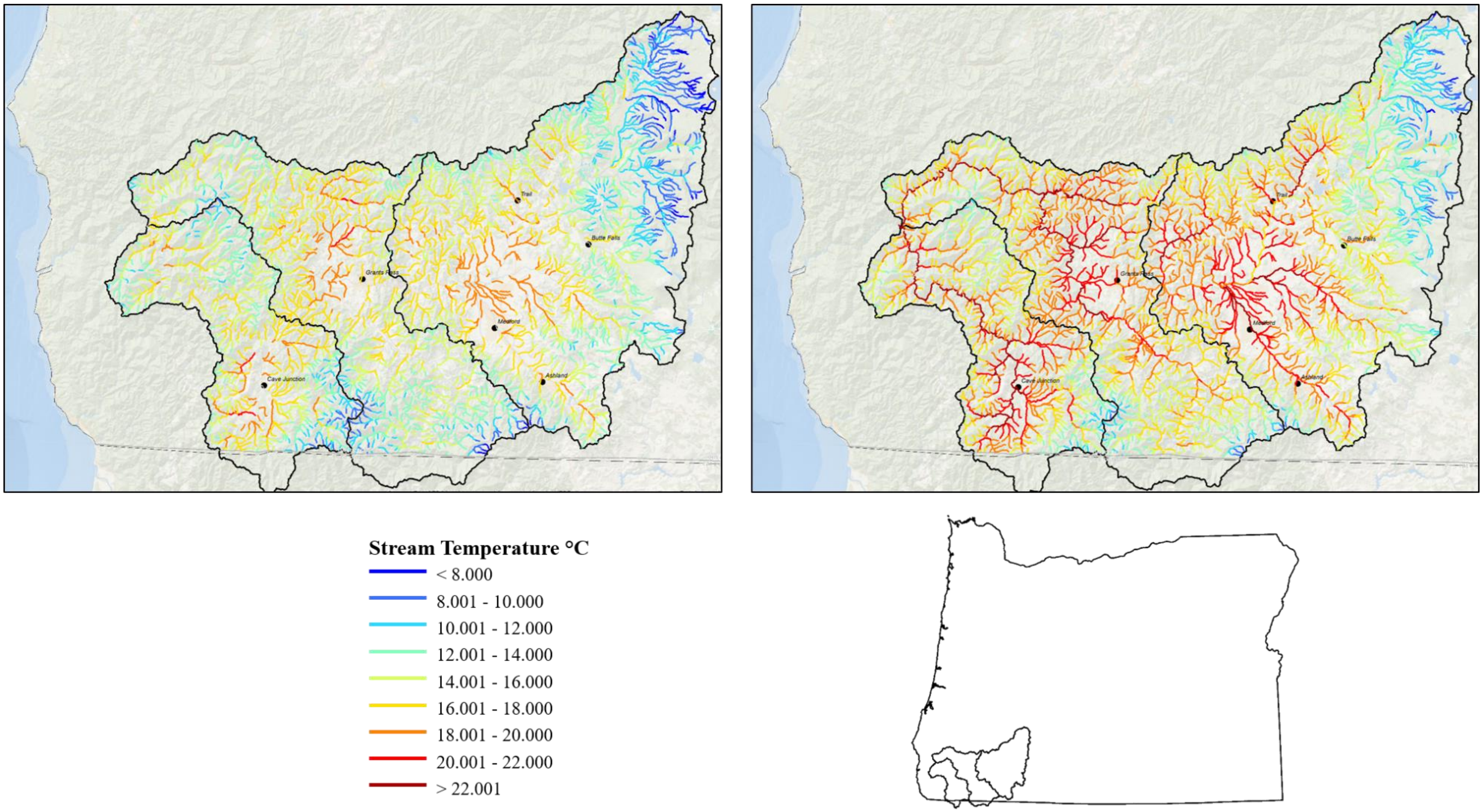


Figure 5. NorWest stream temperature estimates for the Siskiyou region for a) August mean 2002-2011 and b) August mean 2080.



2021-23 Biennial Budget Development

Board of Forestry - Policy Option Package Overview

April 22, 2020

Overview

- Agency Request Budget (ARB)
- Governor's Budget (GB)
- Legislatively Adopted Budget (LAB)
- Policy option packages (POPs) – Proposed changes to our programs not included in our Current Service Level (CSL) budget
- Developed using the guiding principals
- Framed within the current 21-23 Department of Administrative Services (DAS) budget instructions

Timeline

- April 17 – Legislative Concepts are due to DAS
- April 22 – BOF overview of agency POPs
- June 3 – BOF provides final approval of agency POPs
- July 22 – BOF reviews and approves the ARB
- Sep 1 – Agency submits ARB to Chief Financial Office of DAS

Fire Protection

- **Fire Season Severity Resources**
  - General Fund request for supplemental firefighting resources
  - Moved into the Emergency Board budget through the budget process
- **Fire Season Organizational Sustainability and Modernization**
  - Enhancing Oregon's complete and coordinated protection system
  - Adding capacity to advance ODF's initial and extended attack strategy
- **Severity Modernization – Additional Special Purpose Appropriation**
  - Investments to slow the size and frequency of large fires across Oregon
  - Additional hand, equipment and aviation resources for statewide use

Private Forests

- **Supporting Sustainable Family and Community Forestry**
  - New capacity to meet forestry challenges in WUI areas and communities
  - Field foresters providing landowners assistance and FPA administration
- **Forest Practices Act Effectiveness and Implementation**
  - Advances the mission of maintaining working forests and their viability
  - Enhances capacity in the implementation and effectiveness of the FPA
- **Expanded Capacity for Sudden Oak Death Program**
  - Aims to slow and or contain the spread of SOD
  - Adds capacity to respond to current and future forest health issues

State Forests

- **Funding Recreation, Education and Interpretation**
  - Addresses growing demands in recreation management on state forests
  - Provides funding for costs of providing recreational opportunities

Partnership and Planning

- **Forests Climate Change Mitigation and Adaptation**
  - Addresses Governor Brown's Executive Order 20-04
  - Adds capacity to assist in reducing and regulating greenhouse gas
- **Implementing Shared Stewardship**
  - Increases capacity to implement work through Good Neighbor Authority
  - Opportunities to implement projects across public and private lands

Administration

- **Agency Deferred Maintenance and Capital Improvement**
  - Required 2% reporting of deferred maintenance per SB1067
- **Firefighter Life Safety**
  - Provides investments in the O&M of wireless communication systems
  - Provides location tracking capabilities of firefighter resources
- **Diversity, Equity, & Inclusion / Environmental Justice / Sustainability and Government to Government Leadership**
  - Multi-faceted capacity to address strategies in DEI, EJ & G2G
- **Administrative Modernization**
  - Provides capacity in key areas to address risk, liability and business improvements
- **Facilities Capital Management Program Capacity**
  - Adds capacity to further strategic management of facilities infrastructure

Questions?