From: SEEDS Joshua
To: Wu, Jennifer; Henning, Alan; Palmer, John; Labiosa, Rochelle; Rueda, Helen; Leinenbach, Peter; jeffrey.lockwood@noaa.gov
Subject: FW: EQC/Board presentation
Date: Wednesday, June 18, 2014 4:18:54 PM
Attachments: DEQ ODFW Joint Presentation PCW & Fish EQC Meeting June 2014_draft3.pptx

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FYI.

From: SEEDS Joshua
Sent: Wednesday, June 18, 2014 4:17 PM
To: 'Jepsen, David'; MCINTOSH Bruce A; FOSTER Eugene P; MICHIE Ryan; STURDEVANT Debra; BOROK Aron; CALDERA Stephanie
Cc: SEEDS Joshua
Subject: RE: EQC/Board presentation

Here is the current version. I will be printing out copies of this for EQC & Dick (b) (6) (b) (6) . I understand Gene may make some last minute changes tonight. I will have a copy of this on a thumb drive as well.

Let me know if anything needs changing immediately.

Thanks,

Josh

From: SEEDS Joshua
Sent: Wednesday, June 18, 2014 12:17 PM
To: 'Jepsen, David'
Cc: FOSTER Eugene P; SEEDS Joshua; MICHIE Ryan
Subject: RE: EQC/Board presentation

Good! I don't want to step on your toes or anything. Just trying to be helpful. Here is the current and probably final version, unless Gene makes some last minute changes.

Thanks,

Josh

From: Jepsen, David [mailto:david.jepsen@oregonstate.edu]
Sent: Wednesday, June 18, 2014 12:14 PM
To: SEEDS Joshua
Subject: RE: EQC/Board presentation

No, they seem fine

From: SEEDS Joshua [mailto:SEEDS.Joshua@deq.state.or.us]
Sent: Wednesday, June 18, 2014 12:13 PM
To: Jepsen, David
Subject: RE: EQC/Board presentation

Any changes to the graphics I picked out?

From: Jepsen, David [mailto:david.jepsen@oregonstate.edu]
Sent: Wednesday, June 18, 2014 10:59 AM
To: SEEDS Joshua
Subject: RE: EQC/Board presentation

Hi Josh, the only edit I would make is on slide 19 where you should insert "allows" after "refuges" and before "greater".

Dave

from: SEEDS Joshua [mailto:SEEDS.Joshua@deq.state.or.us]
Sent: Tuesday, June 17, 2014 2:35 PM

To: Jepsen, David
Cc: FOSTER Eugene P; SEEDS Joshua
Subject: RE: EQC/Board presentation

Dave,

Attached is the current presentation version. Where I simplified or eliminated wording from slides, it is to reduce cluster and complexity. The ideas contained in those words should, in my opinion, definitely be communicated verbally to the EQC and BOF. We will have our messages document and the backing notes if anyone should want more details or references. Please let me know if you have any changes to make.

Thanks,
Josh

From: Jepsen, David [mailto:david.jepsen@oregonstate.edu]
Sent: Tuesday, June 17, 2014 9:28 AM
To: SEEDS Joshua
Subject: RE: EQC/Board presentation

Hi Josh,

Got your phone message. The ppt looks fine. For the science information handout I've added my bullets/edits/citations to the latest version you sent me (yellow-blocked text in attached). You can add the ODFW logo and my name.

Give me a call today if needed. I'll be in a meeting from 1-3.

Dave

From: SEEDS Joshua [mailto:joshua.seeds@state.or.us]
Sent: Monday, June 16, 2014 3:03 PM
To: JEPSEN David B
Subject: EQC/Board presentation

Hi Dave. Here is the presentation's current form and the current form of the compile information about the science.

Josh

Joshua Seeds
Nonpoint Source Pollution Analyst
Drinking Water Protection Program
Oregon Department of Environmental Quality
811 SW 6th Ave.
Portland, OR 97204
Phone: 503-229-5081 Fax: 503-229-6037
Email: seeds.joshua@deq.state.or.us

Stream Temperature Science, WQ Temperature Standard & TMDLs, and Riparian Management in Forestlands

Informational Item: Environmental Quality Commission Meeting
June 19, 2014

Gene Foster & Josh Seeds: DEQ
Bruce McIntosh & Dave Jepsen: ODFW

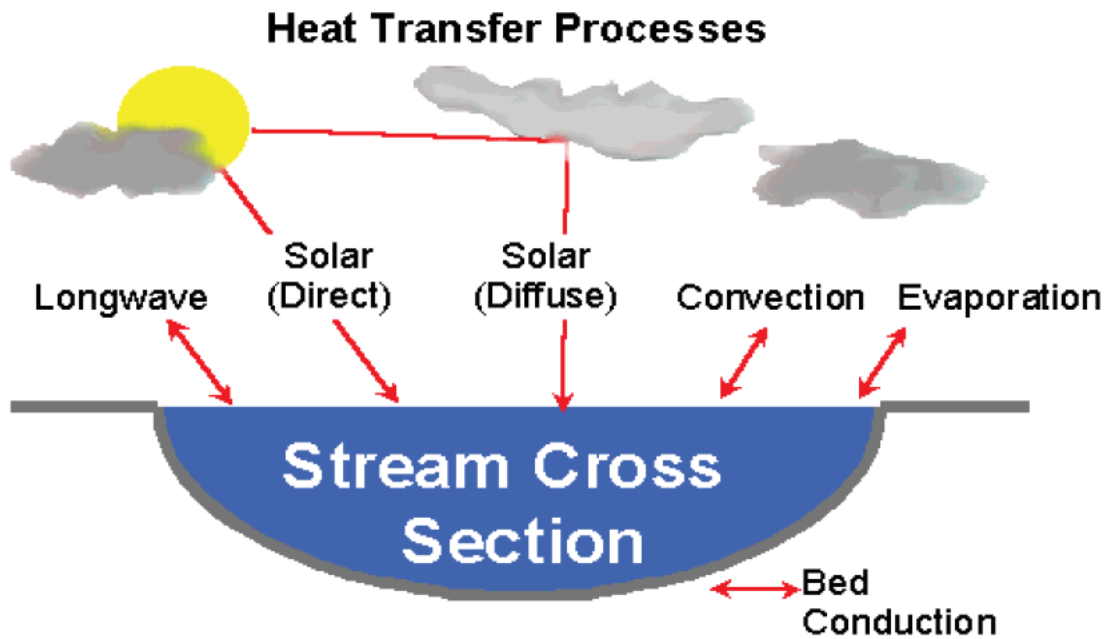
Presentation Purpose

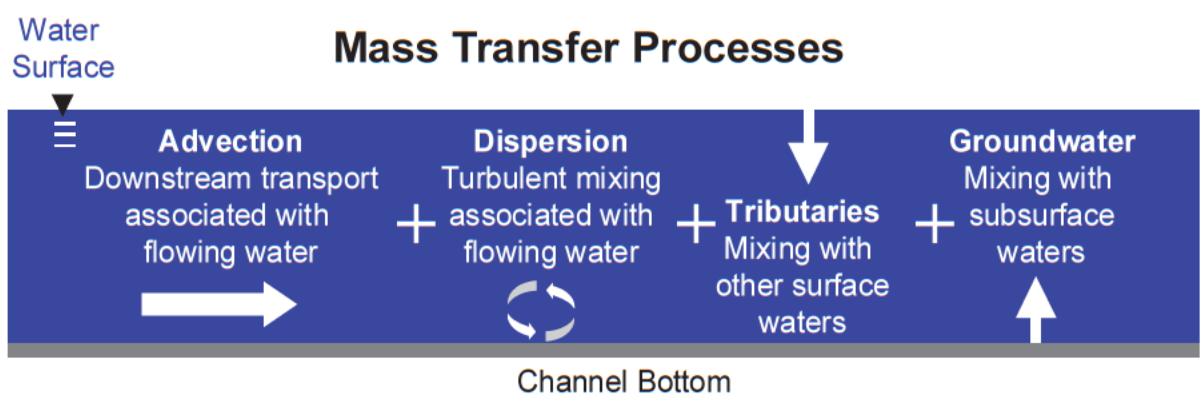
- Summary of the factors affecting stream temperatures in Oregon
- The importance of stream temperature for aquatic biota
- The rationale for minimizing anthropogenic warming and restoring and protecting natural thermal regime approach used in the temperature standard (including the Protecting Cold Water Criteria)
- Explain how TMDLs are used as a tool to protect aquatic species & restore natural thermal regimes
- Provide information on the connection between temperature standards & forest practices in Oregon & neighboring states.

Basics of Stream Temperature

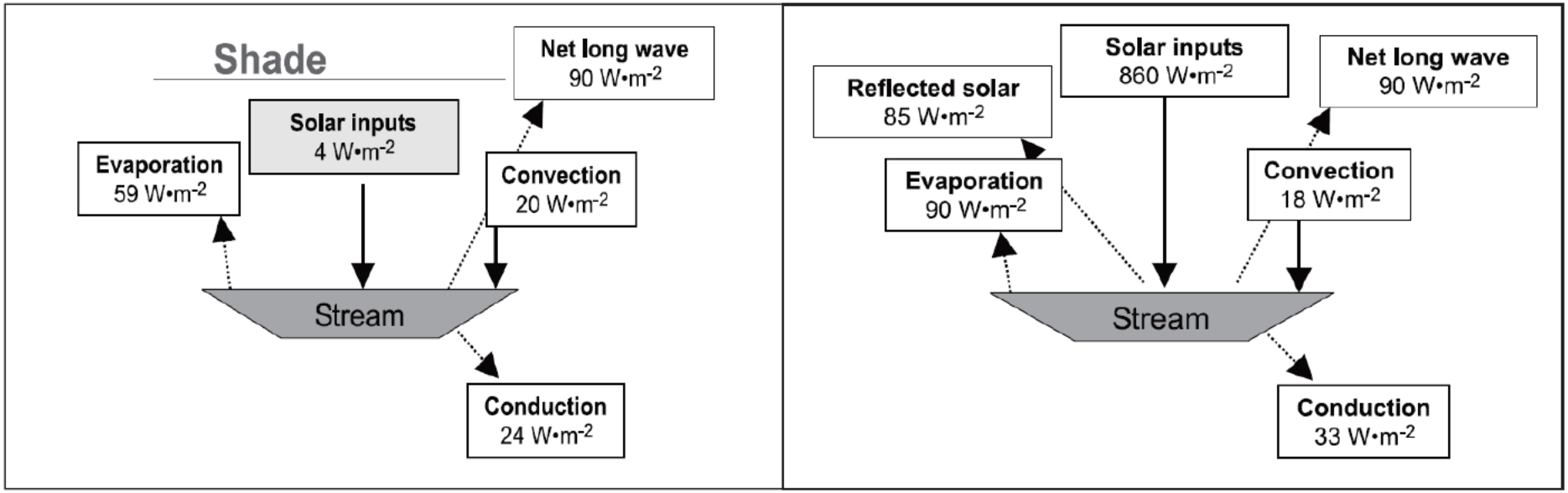
Stream temperatures within watersheds are affected by:

- Heat transfer
- Mass transfer





Basics of Stream Temperature



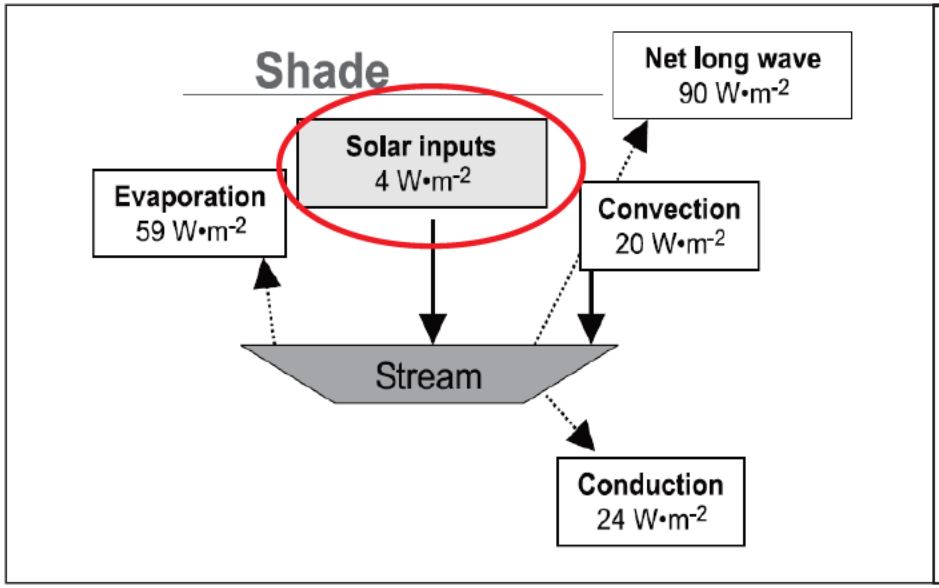
<u>Fully shaded:</u>
Thermal energy lost is -149 W*m^{-2}.

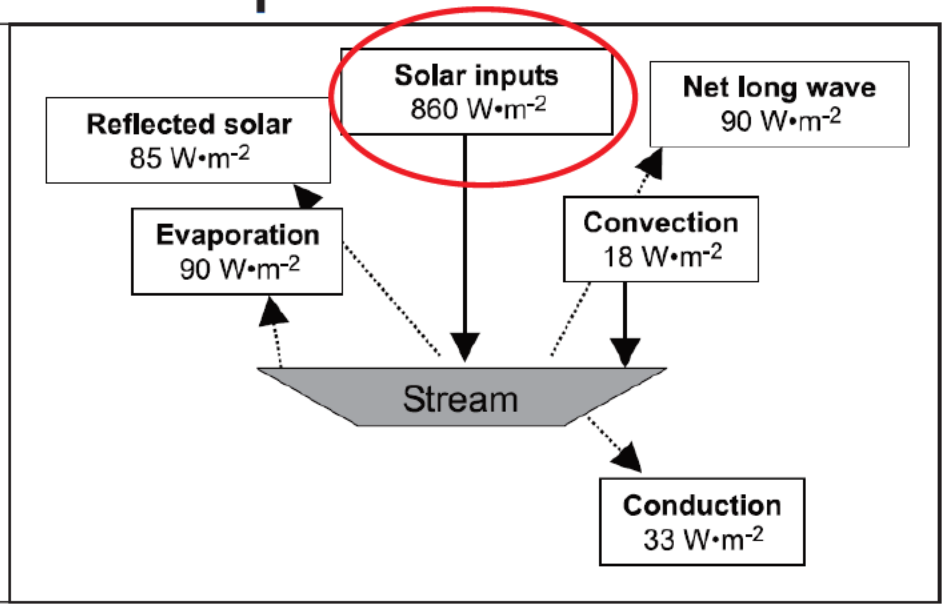
<u>Unshaded:</u>
Thermal energy gained is 580 W*m^{-2}.

- Solar energy drives temperature on smaller streams.
- Streams more easily absorb thermal energy from sunlight than lose it once absorbed.
- Dilution of thermal energy is not the same as dissipation.

Johnson 2004

Basics of Stream Temperature





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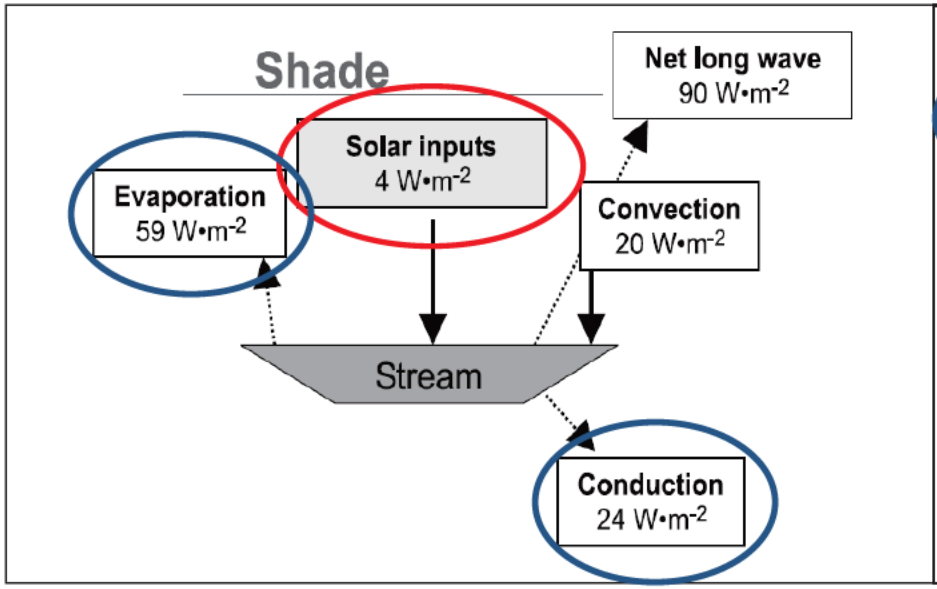
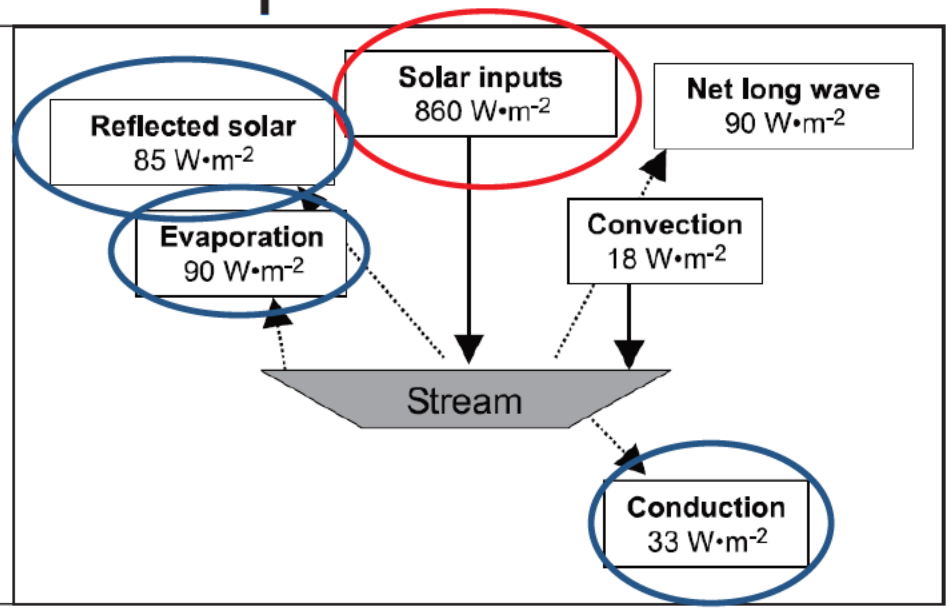
Johnson 2004

Basics of Stream Temperature





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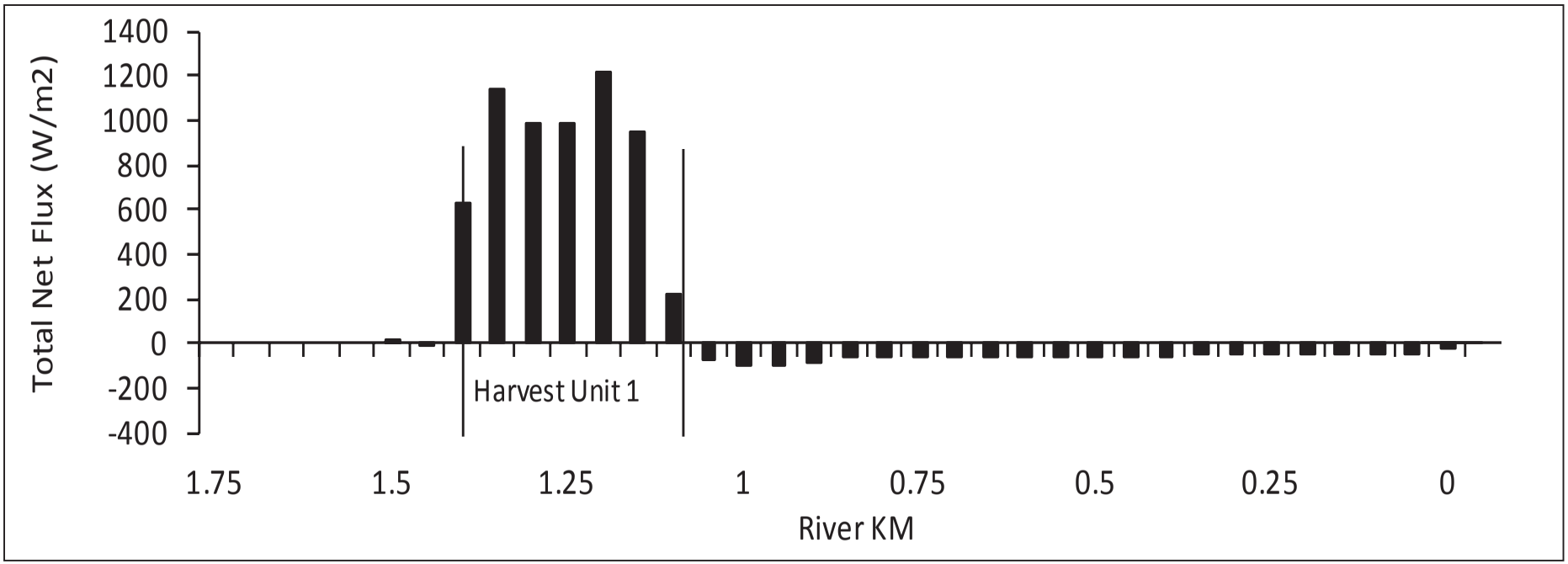
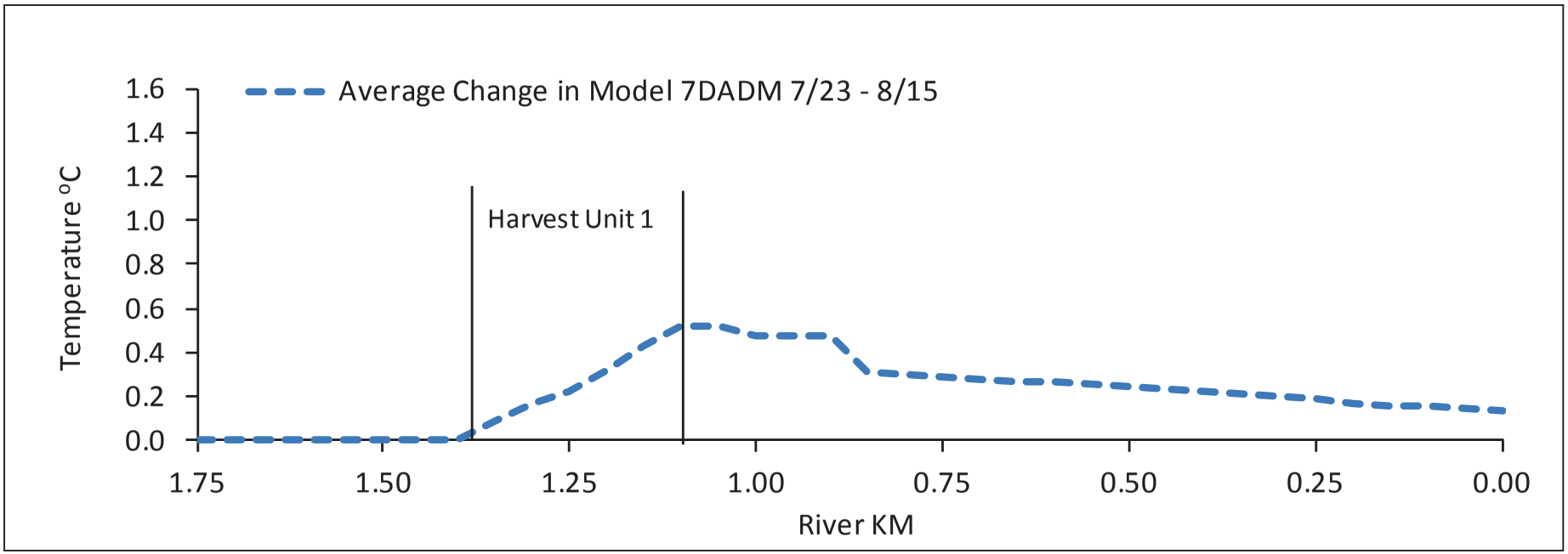
Johnson 2004

Harvest Effect on Net Energy Flux in Drift Creek Tributary



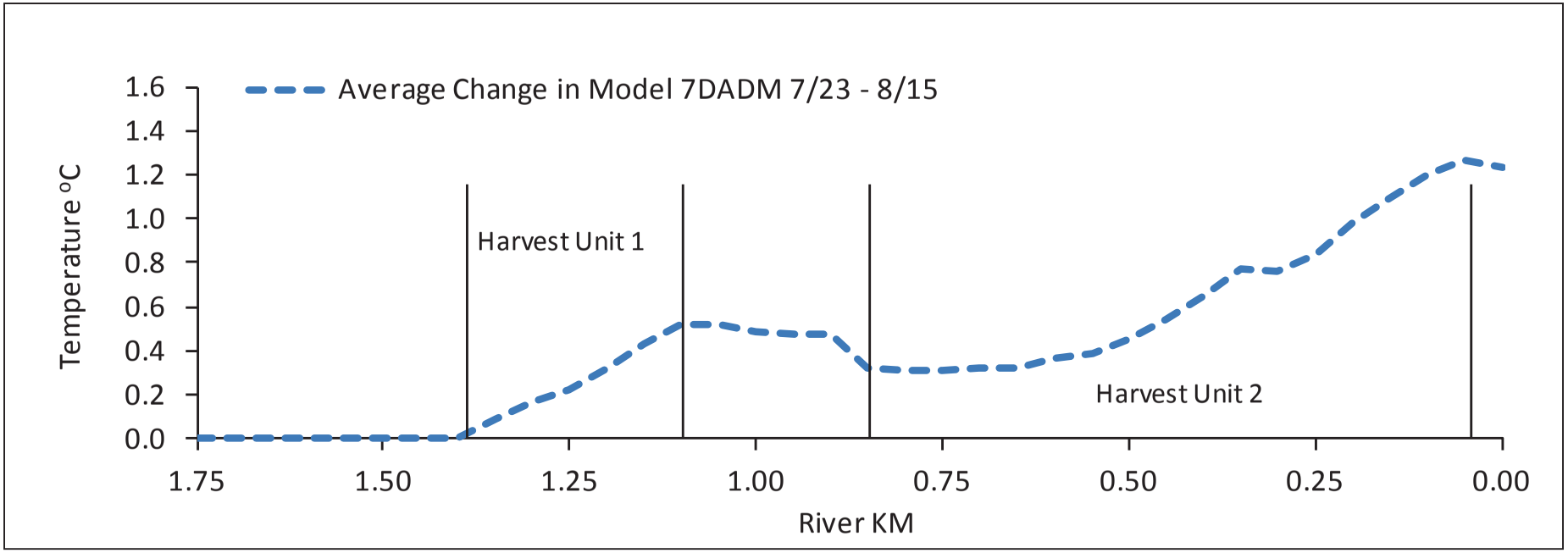
- Gain by solar radiation is greater than loss by other fluxes (evaporation, longwave radiation, etc).

Harvest Effect on Stream Temperature in Drift Creek Tributary



- Since gain is more efficient than loss, thermal energy can be transported downstream.

Multiple Harvest Effect on Cumulative Warming in Drift Creek Tributary

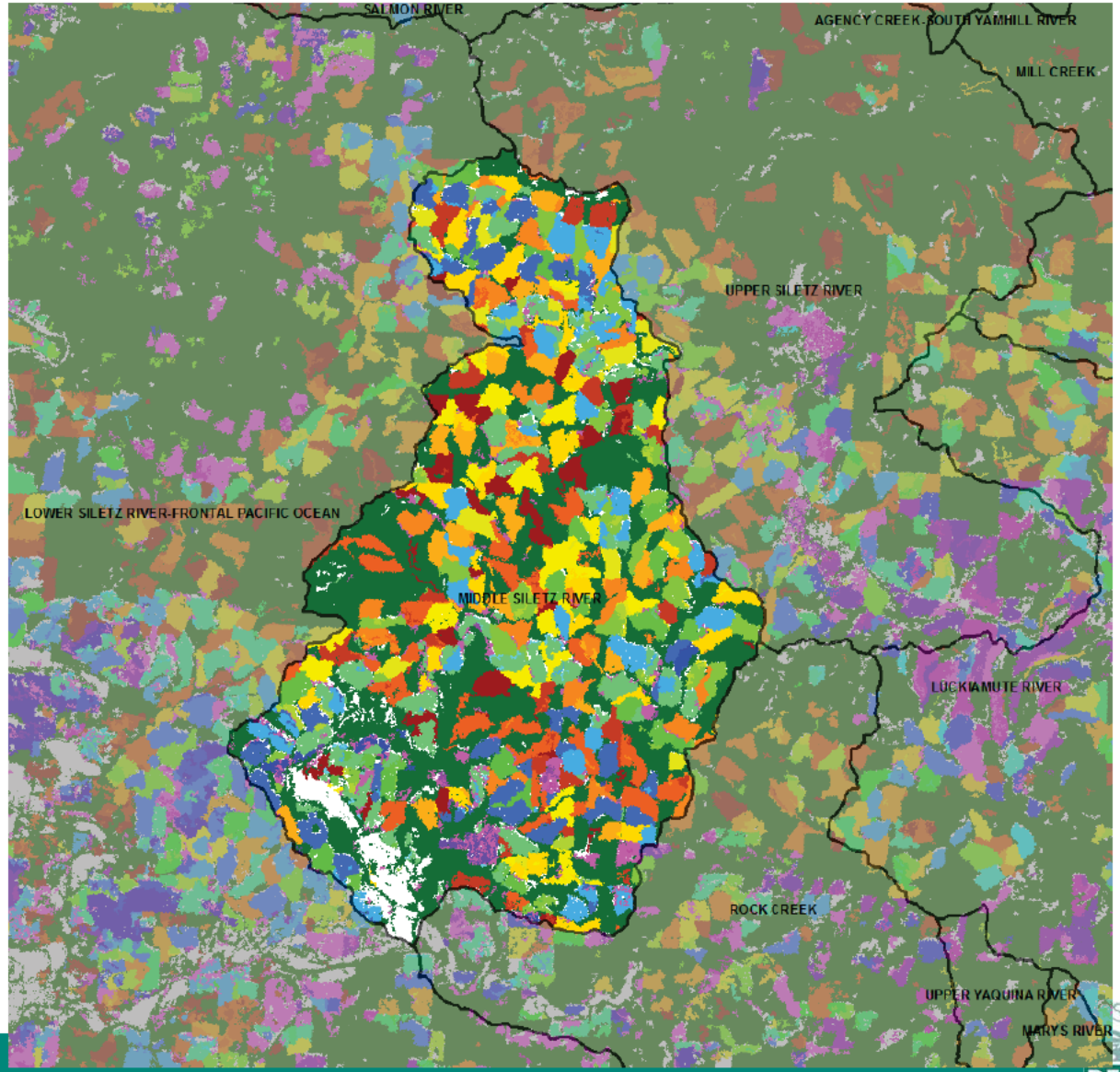


Disturbance on the Landscape

- Riparian disturbances reduce shade & increase stream temperature.
- About 10 years needed for thermal recovery after disturbance.
- Current disturbance regime is different than pre-settlement disturbance regime.
  - Harvest activities occur at a higher rate than natural disturbances.
  - Harvest rotations are substantially shorter than fire return intervals.
  - Important differences between natural disturbances & human disturbances.

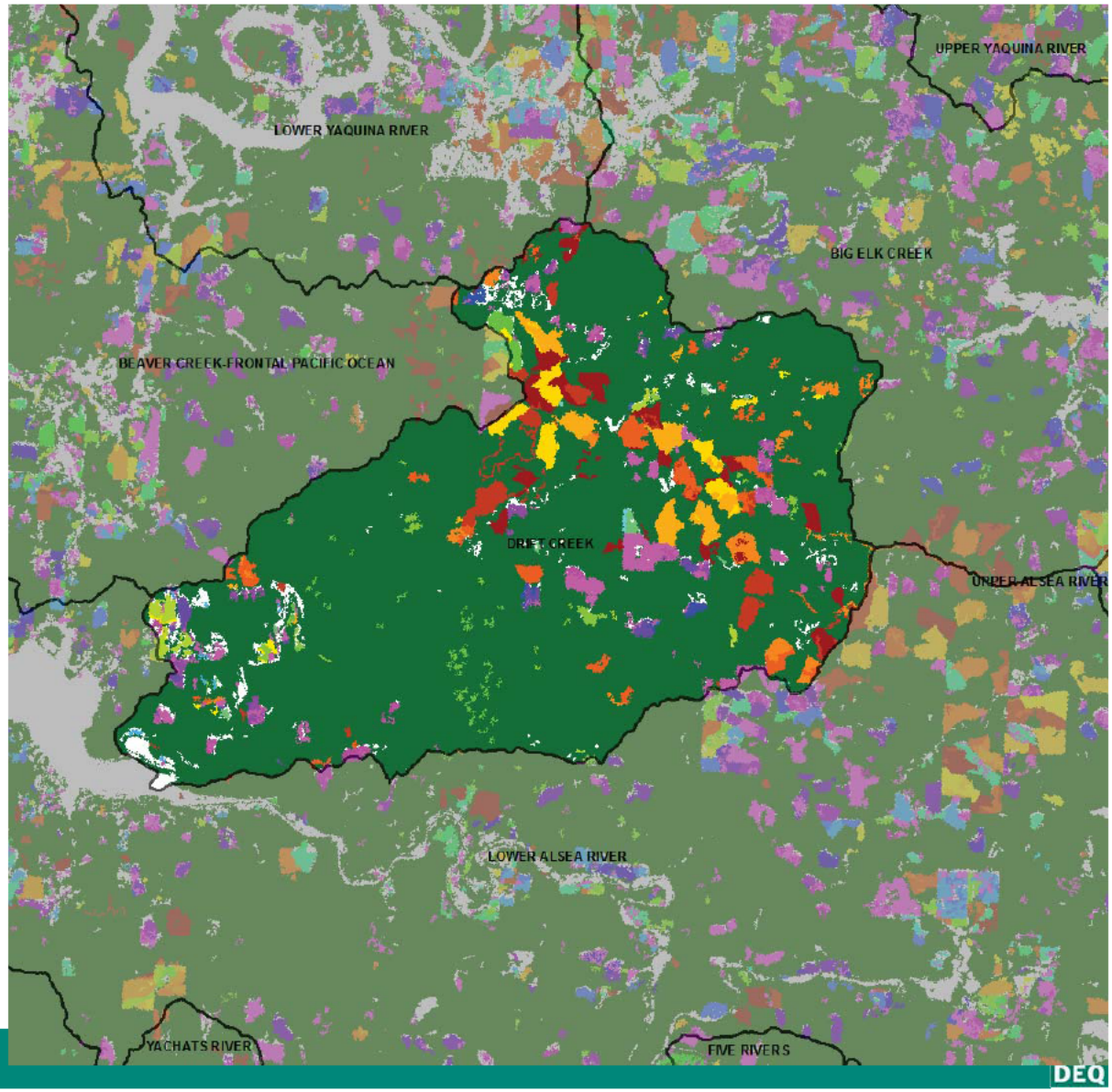
Landscape Disturbance Patterns

Middle Siletz River Watershed



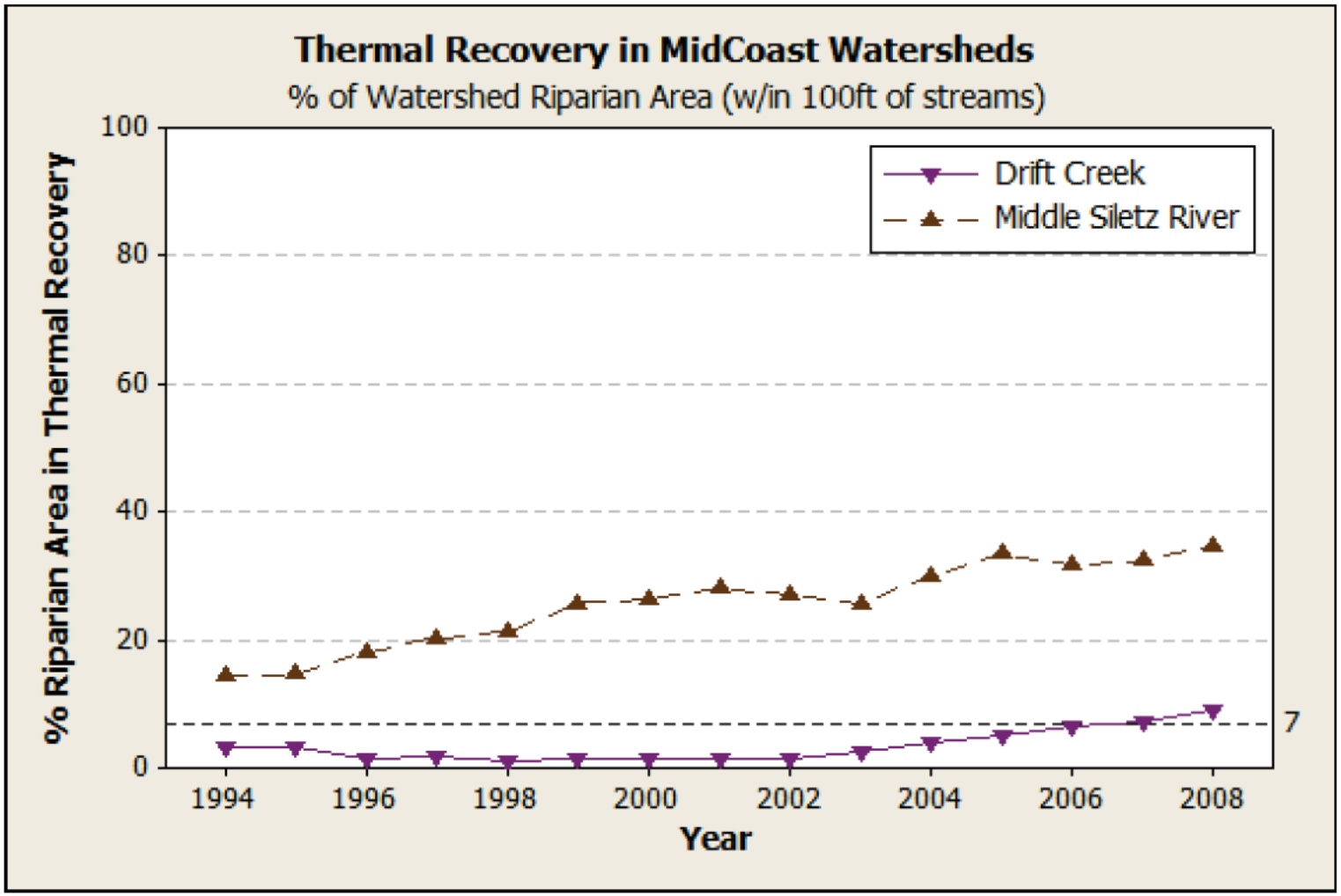
Landscape Disturbance Patterns

Drift Creek Watershed



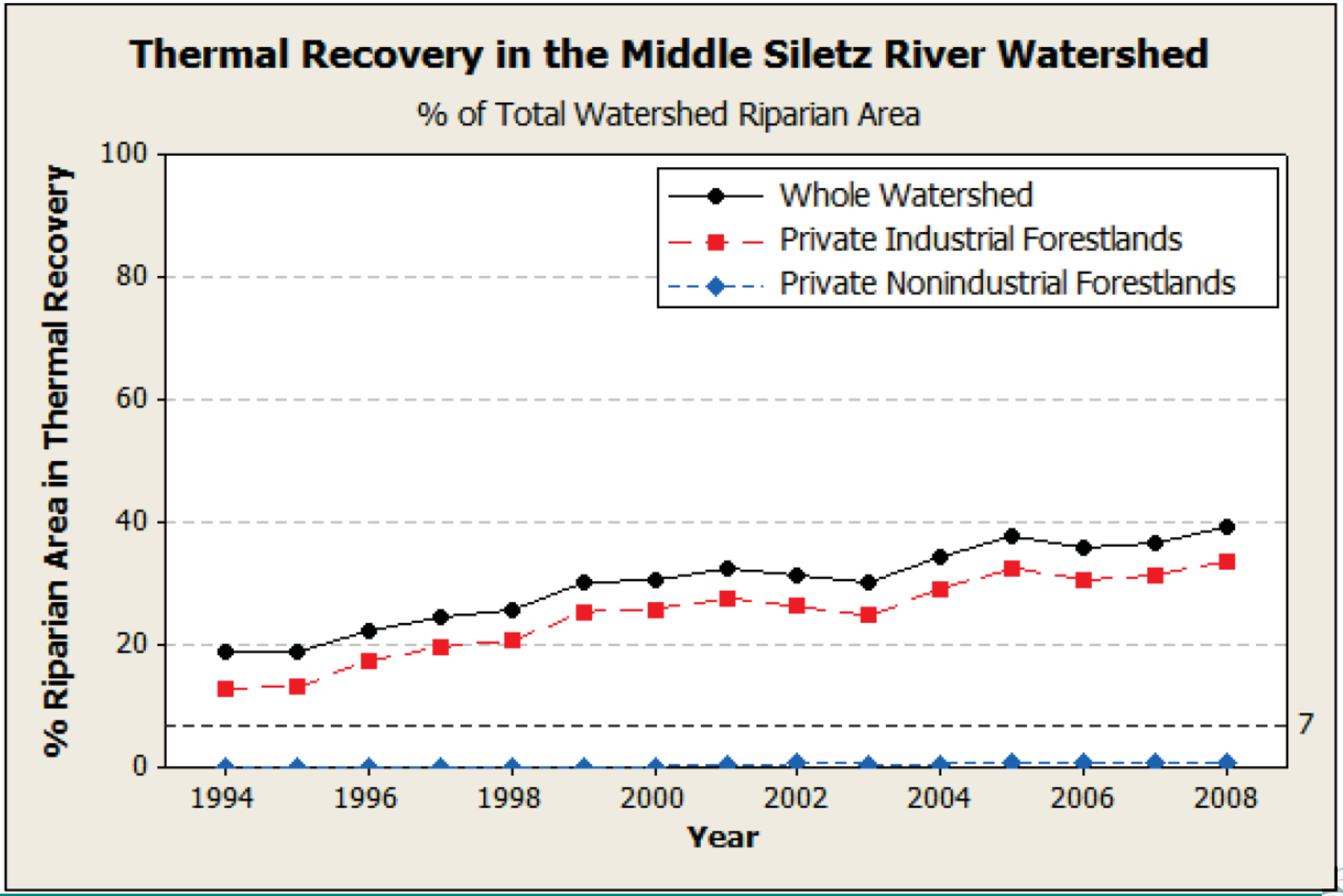
Riparian Area Disturbance

Middle Siletz River & Drift Creek



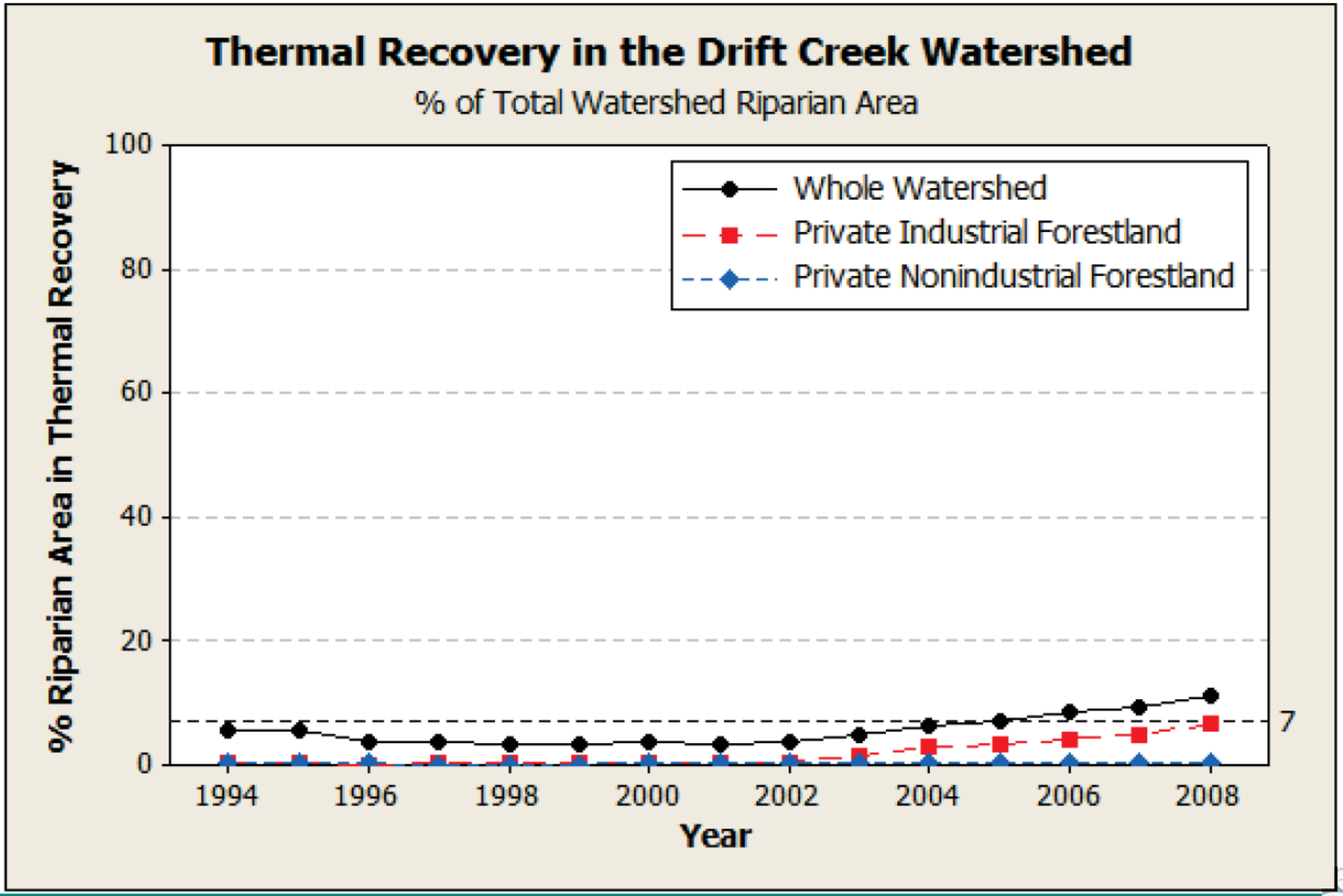
Riparian Area Disturbance by Land Use:

Middle Siletz River Watershed



Riparian Area Disturbance by Land Use:

Drift Creek Watershed



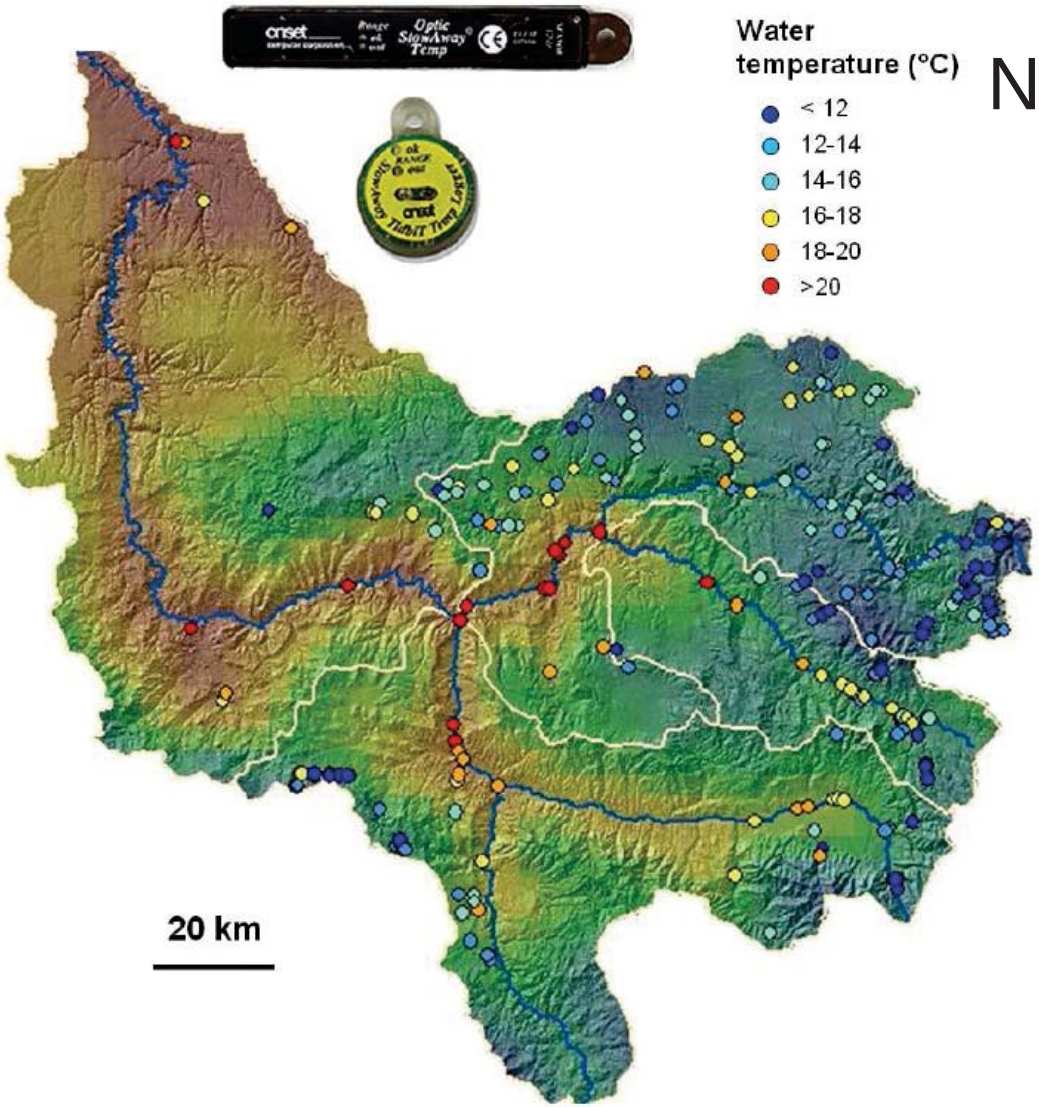
Summary: Downstream Transport of Temperature & Watershed Disturbance Patterns

- Thermal loads can be transported downstream
- Riparian disturbances that reduce shade can increase thermal load to a waterbody
- Multiple riparian disturbances can cause a cumulative increase in temperature downstream
- There are multiple riparian disturbances in watersheds that can cause cumulative increases in temperature

Stream Temperature & Aquatic Life

- Stream temperature influences the rate of ecological & physiological processes.
- Natural thermal regimes provide the best environmental conditions for native aquatic life.
- Temperature effects typically occur on a continuum, but are not linear. Increases above natural thermal potential:
  - Increase physiological risk to fish,
  - Increase extinction risk to salmonid populations, particularly when accrued across the landscape.
- Thermal diversity is necessary at multiple scales.

Natural Thermal Regimes



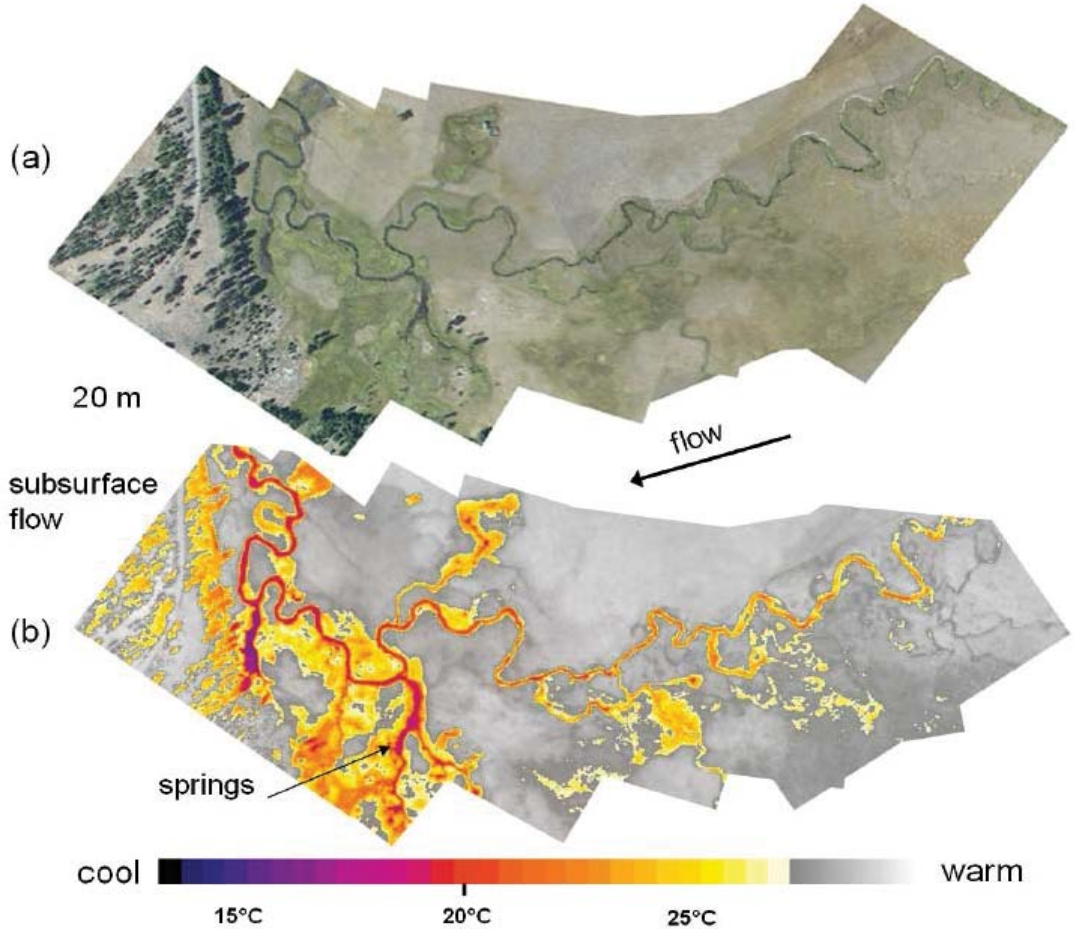
Natural thermal regimes are part of habitat complexity.

- Stream temperature is naturally variable.
- Landscape alteration changes the behavior of stream temperature.
- Fish life histories are linked to seasonal variability, promoting locally adapted populations.

Torgersen et al 2012

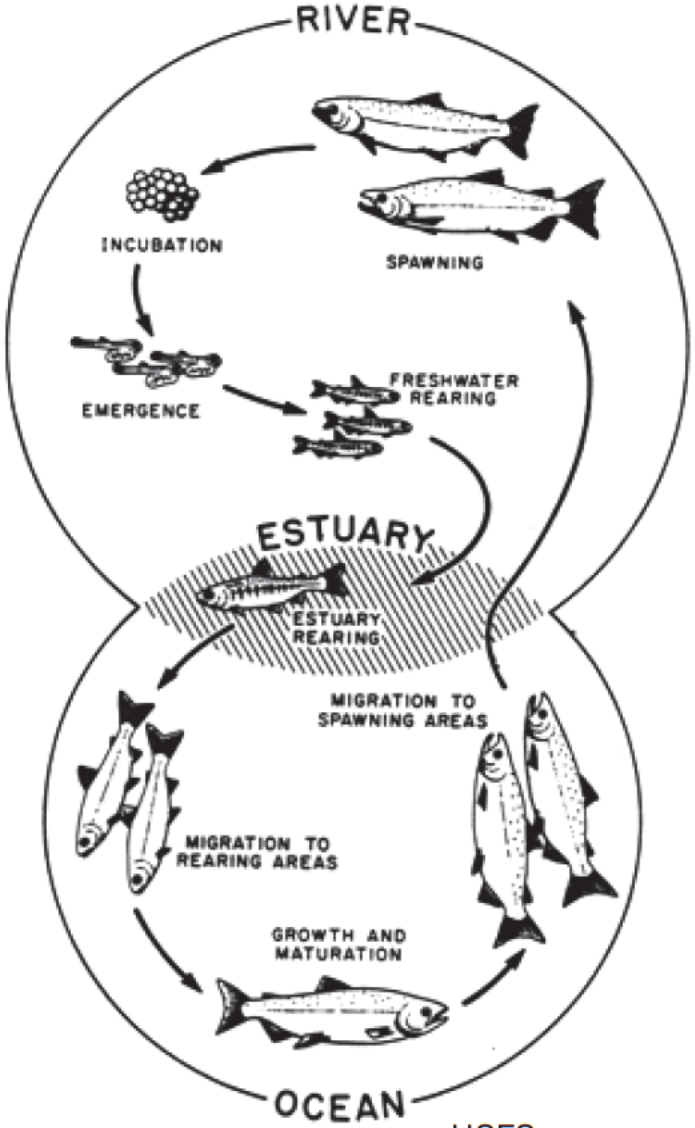
Loss of Stream Temperature Diversity
(including cold water)

- Reduces life history expression, local adaptation, & variation among populations.
- Reduces diversity in fish populations.
- Therefore, reduces population & meta-population resilience.



Torgersen et al 2012

Thermal Diversity & Biological Productivity

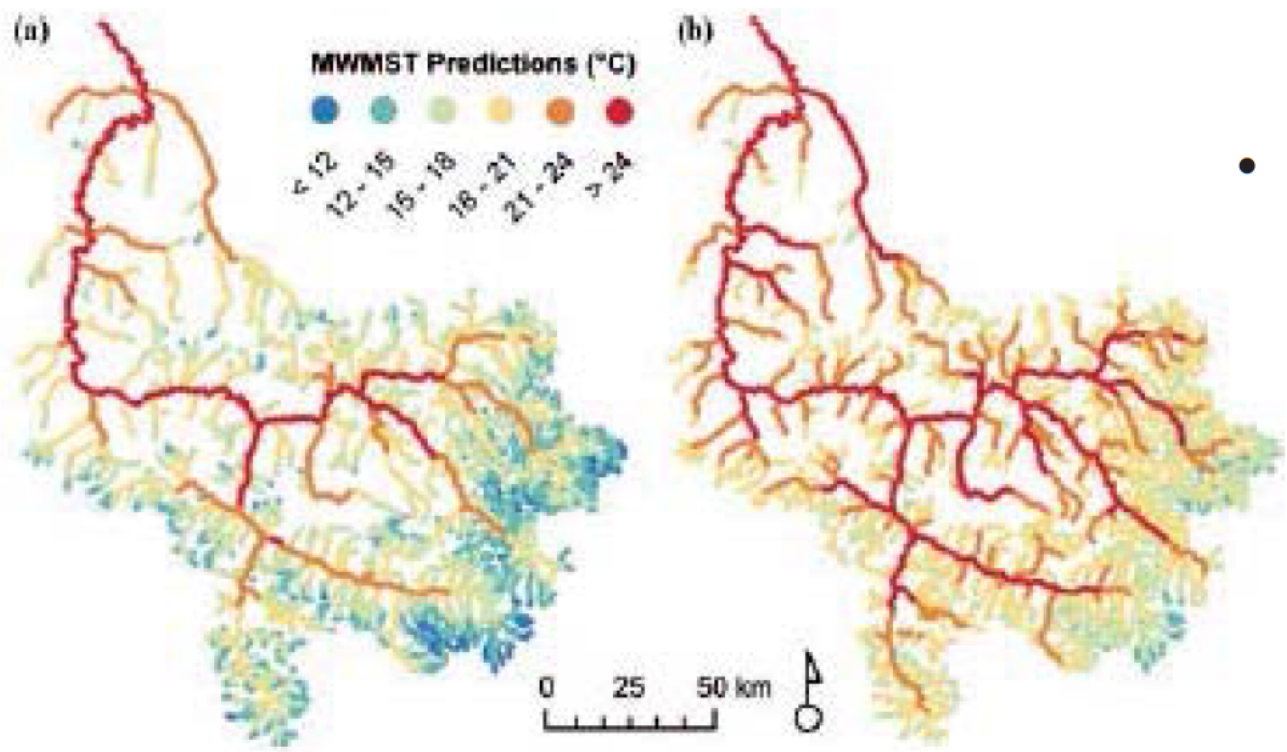


USFS

- Population productivity in freshwater is linked to temperature variability including colder waters.
  - Determines metabolic rates of fish & other aquatic ectotherms.
  - Fish exploit thermal variability to avoid heat stress & to meet metabolic & reproductive needs.
  - Coho exploiting thermal heterogeneity grow faster than individuals with other behaviors.

Temporal & Spatial Refuges

- A network of thermal refuges allows greater use of the overall stream network.
- Species with colder thermal requirements (e.g. bull trout) are confined to cold-water refuges.



- With climate change, current cold waters <u>will be</u> the future thermal refuges.

Ruesch et al 2012

Relevant Oregon Water Quality Standards for Managing Temperature

- Temperature Standard:

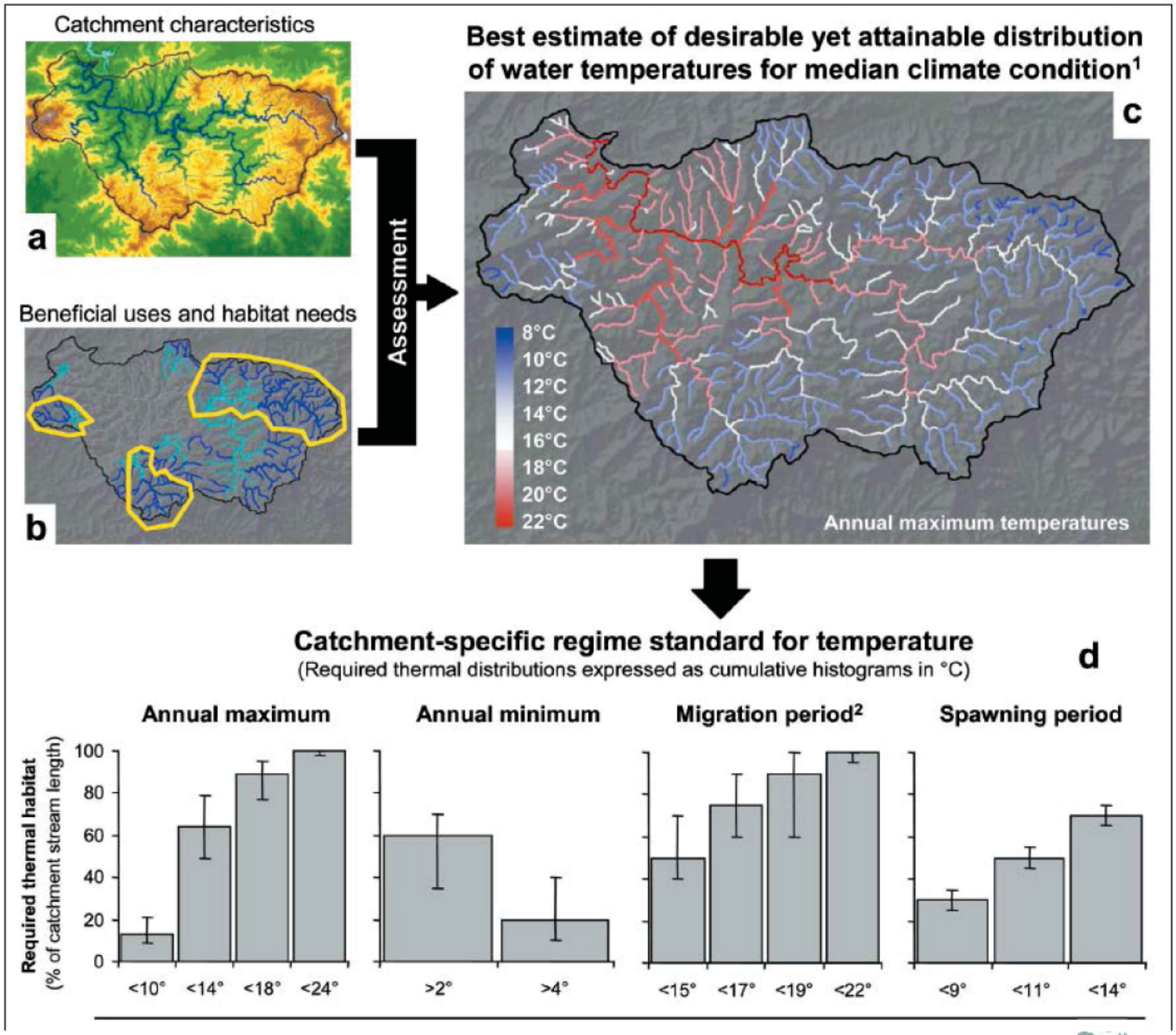
  Minimize anthropogenic warming;

  Maintain & restore natural thermal regimes across landscape for all aquatic species.

  - Biologically-Based Numeric Criteria
  - Protecting Cold Water criterion
  - Human Use Allowance
- Antidegradation Policy
- Designated Uses

Protecting Cold Water Criterion

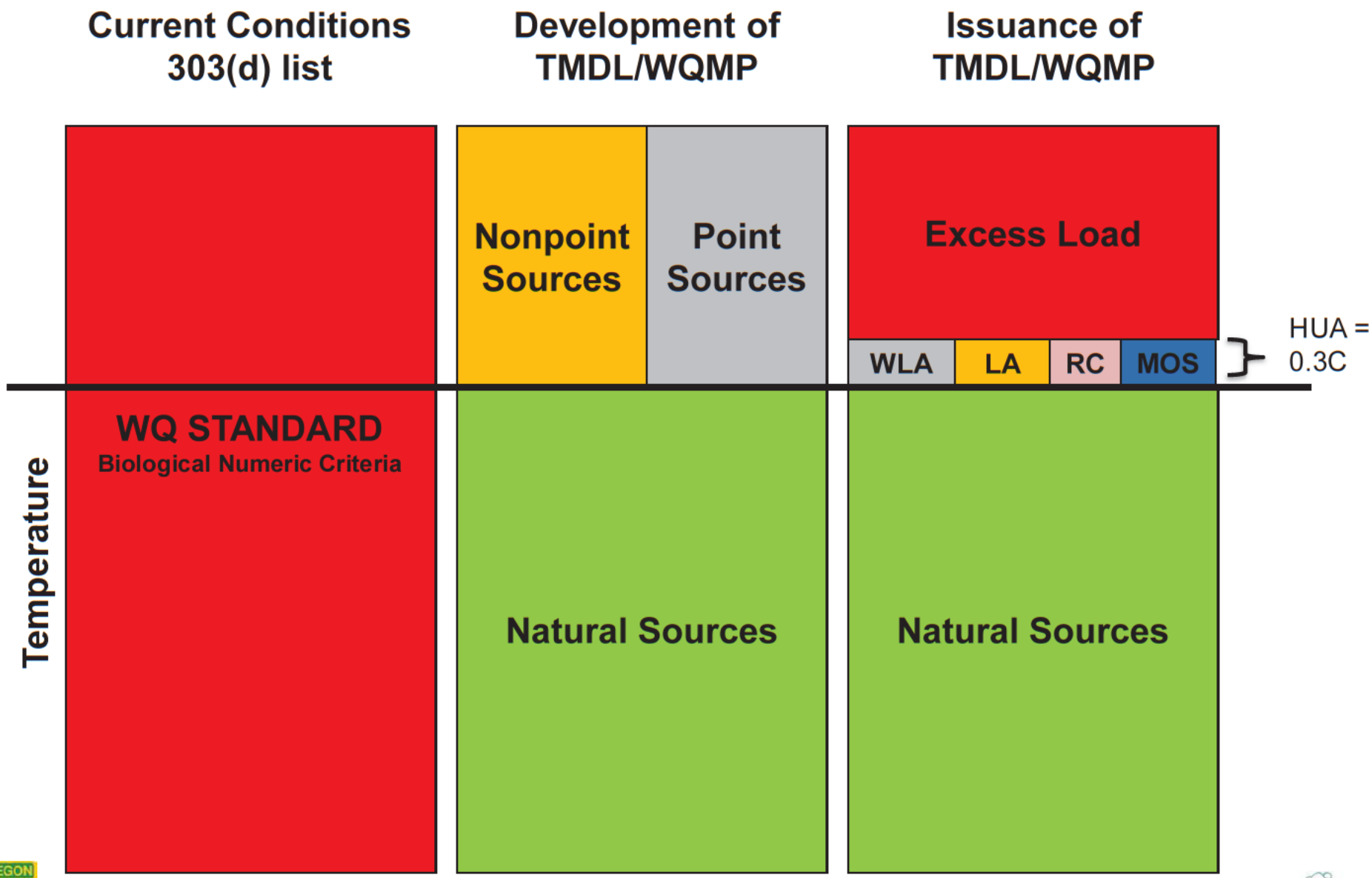
- Protects the natural thermal regime in waters colder than the numeric criteria.



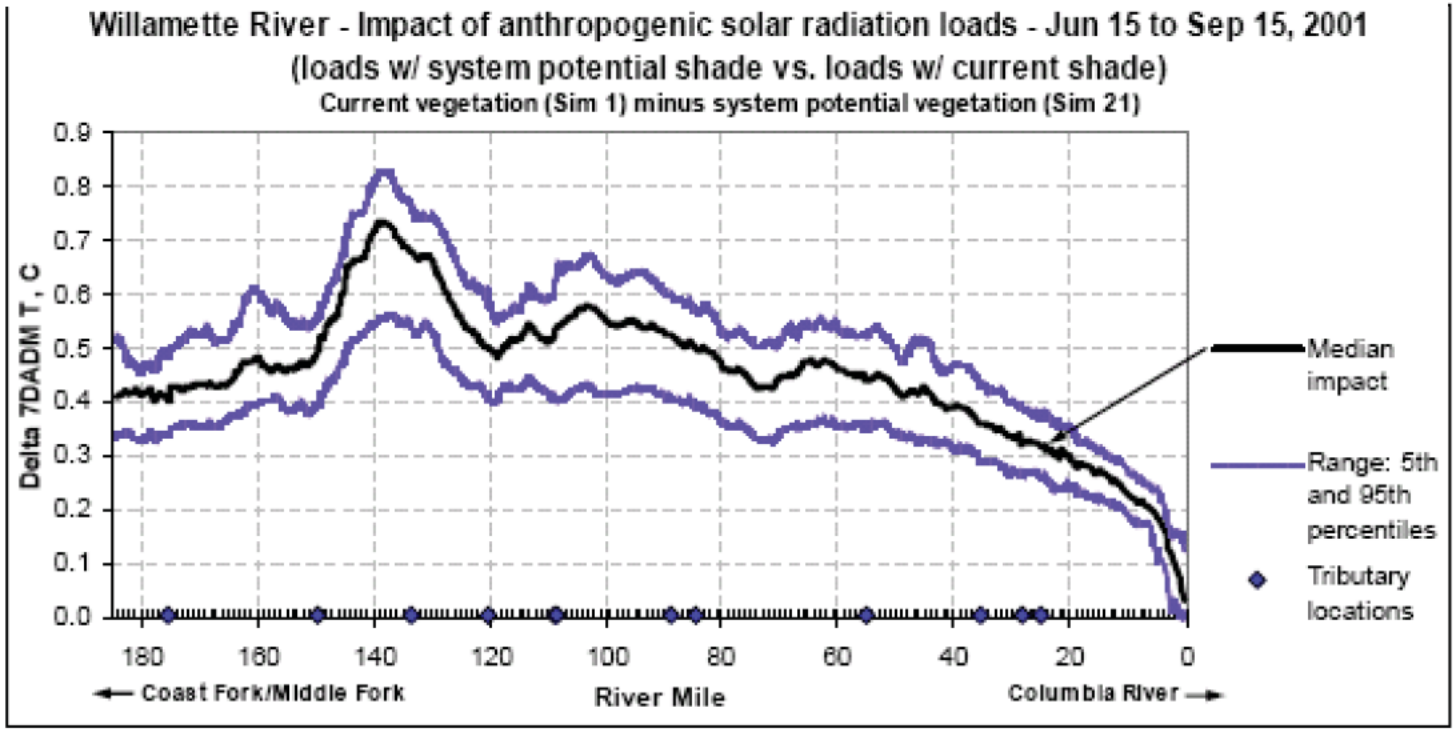
Temperature
Total Maximum Daily Loads

- TMDLs are a regulatory tool under the Clean Water Act to protect aquatic species & restore natural thermal regimes.
  - Human Use Allowance: 0.3°C for all human sources of thermal loading.
  - Human sources are given portions of the HUA as wasteload allocations (point sources) or load allocations (nonpoint sources).

TMDL = WLA + LA + MOS + RC + NS



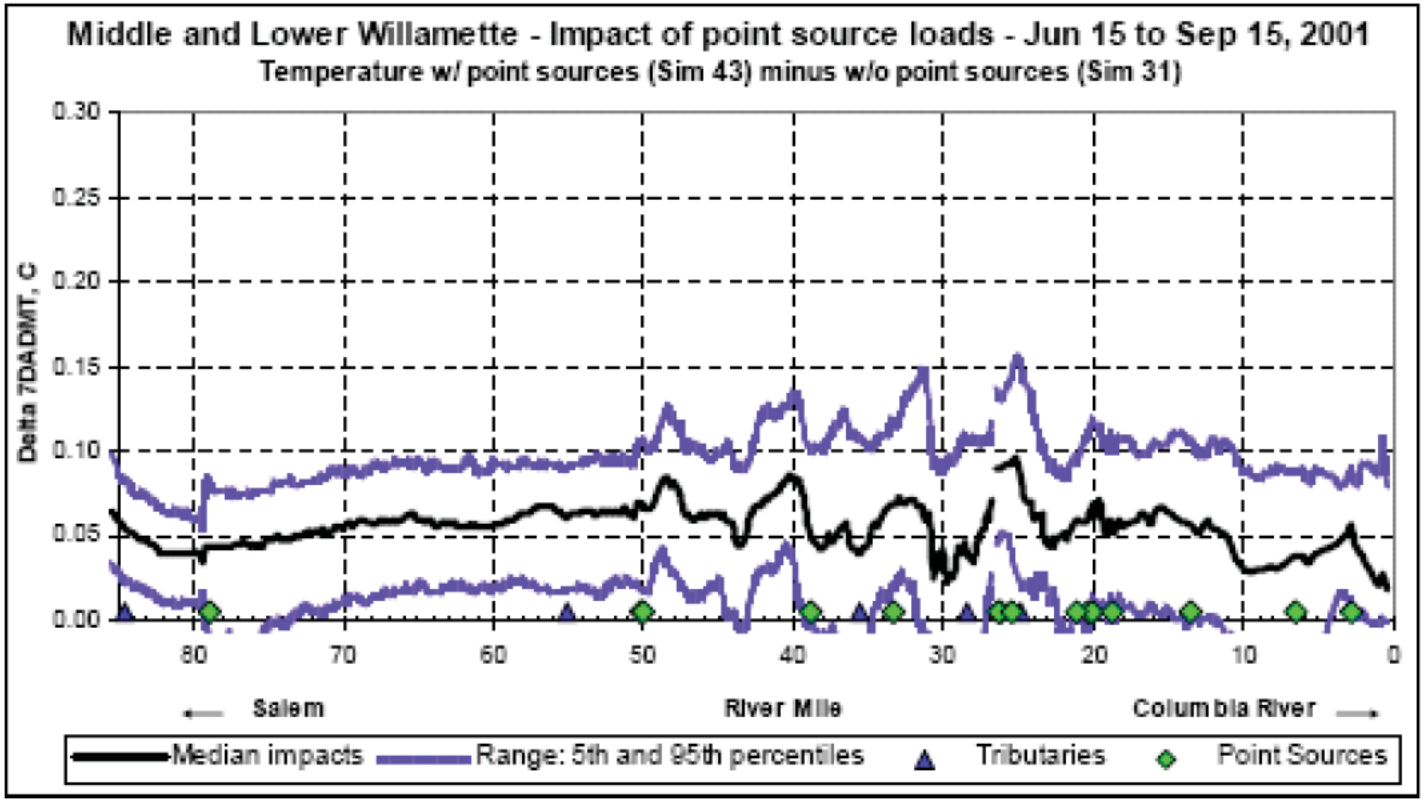
Willamette Temperature TMDL



- Nonpoint Source Impacts = Tenths of degrees

- Lack of shade is a larger source of heat than point sources for the mainstem Willamette

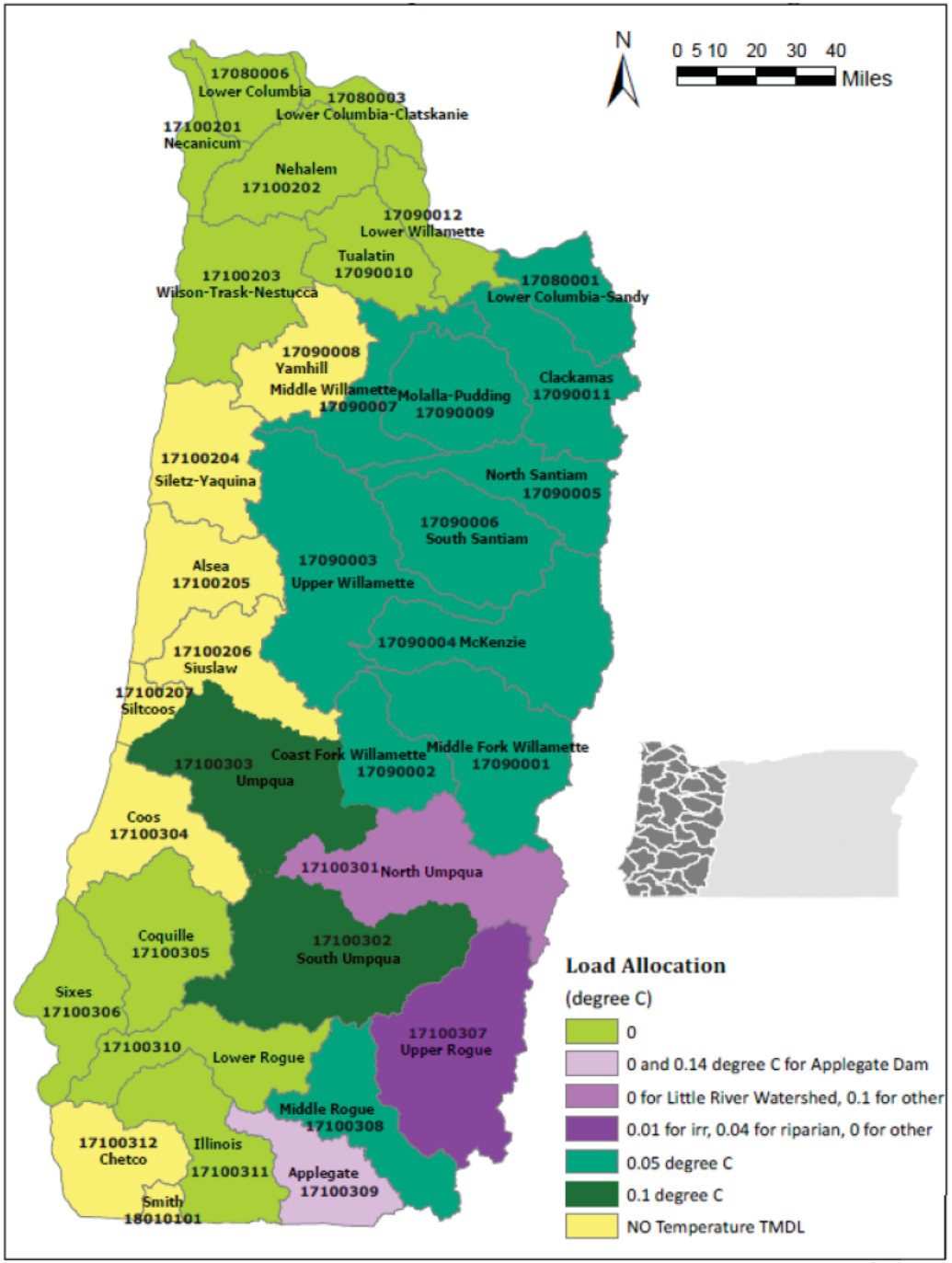
Willamette Temperature TMDL



- Point Source Impacts = Hundredths of degrees
- Thermal effect from point sources are less than from nonpoint sources
- City of Wilsonville recently spent $300K on cooling towers to meet their WLA of 0.0029C

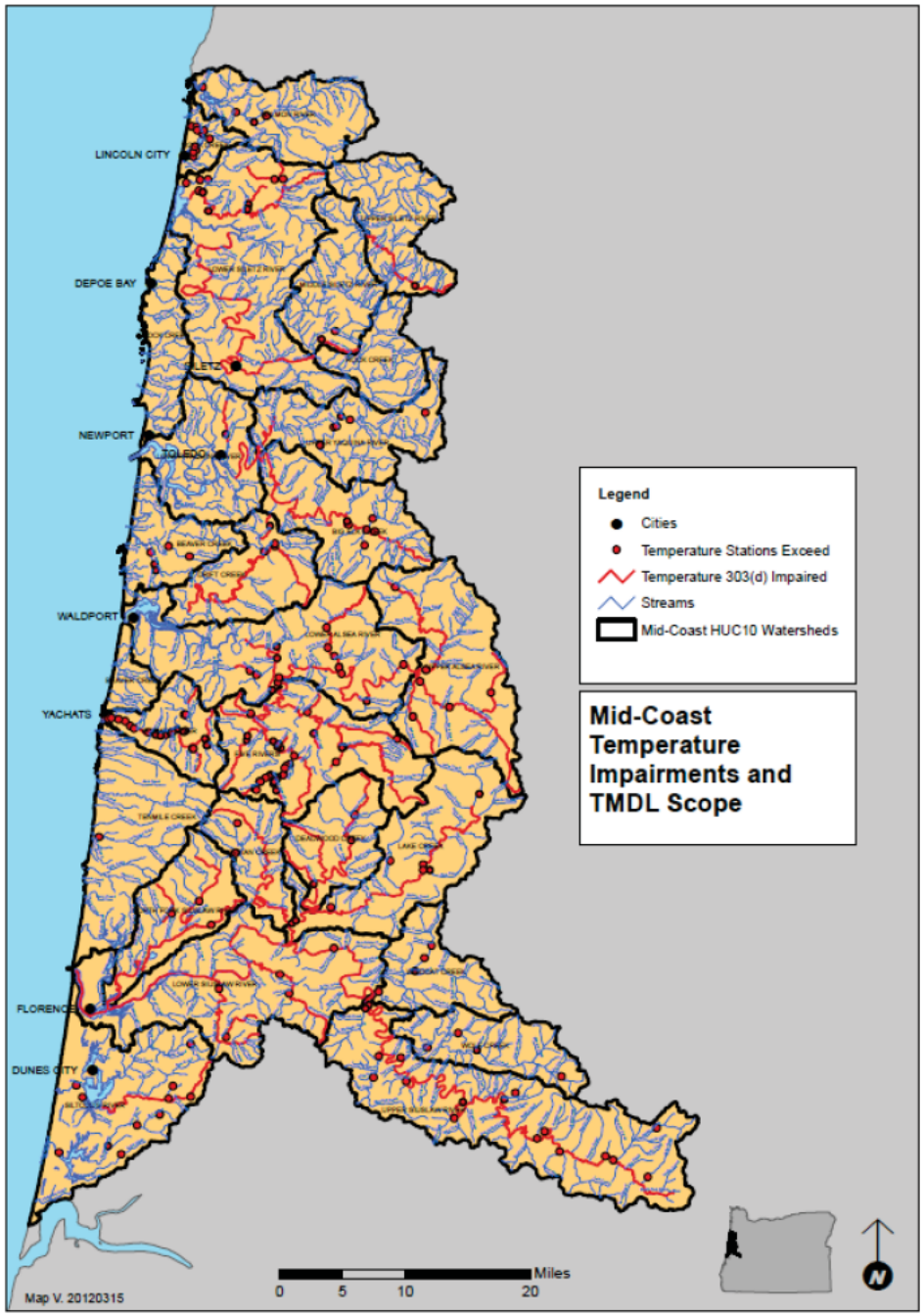
Load Allocations for Temperature in Western Oregon TMDLs

- Temperature load allocations range from 0°C to 0.14°C
- DEQ expects that measures to meet TMDL load allocations would also meet the Protecting Cold Water Criterion



TMDL Development for Temperature Impairments in the MidCoast

- 350+ data stations analyzed (1999 – 2011)
- 200+ stations exceed water quality standards
- 48+ streams identified as impaired - 303(d) list



Mapping Riparian Areas & DMAs

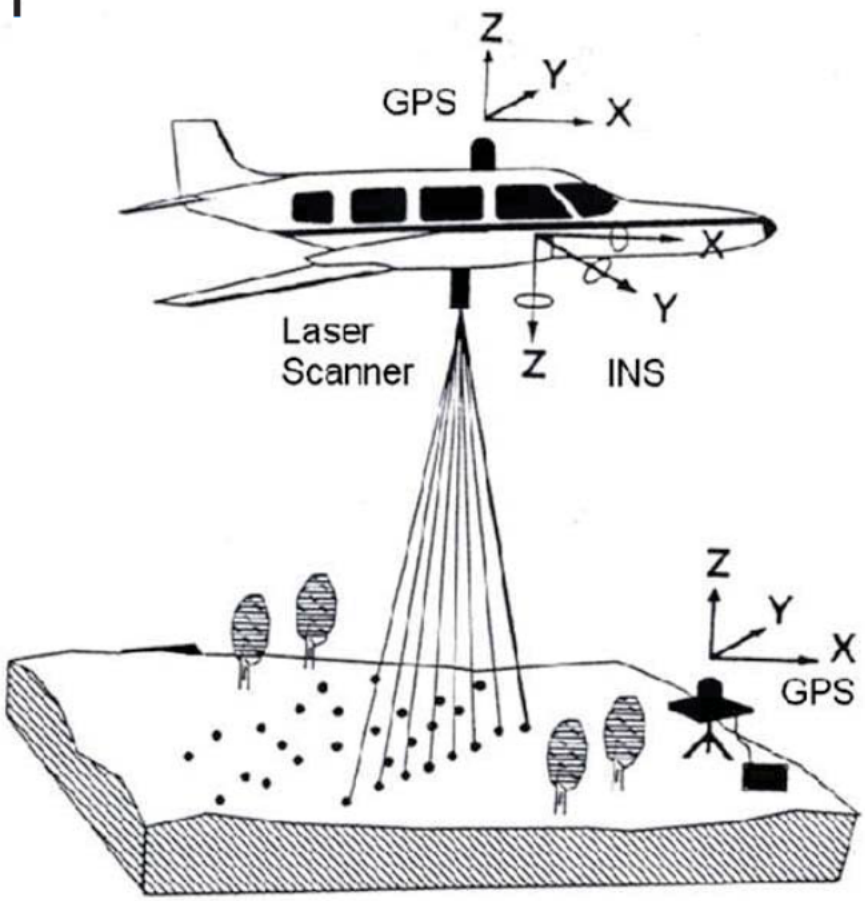
Quantifying Riparian Condition

Vegetation Inventory

- Quantify riparian vegetation condition
- Identify areas that are sources of thermal load

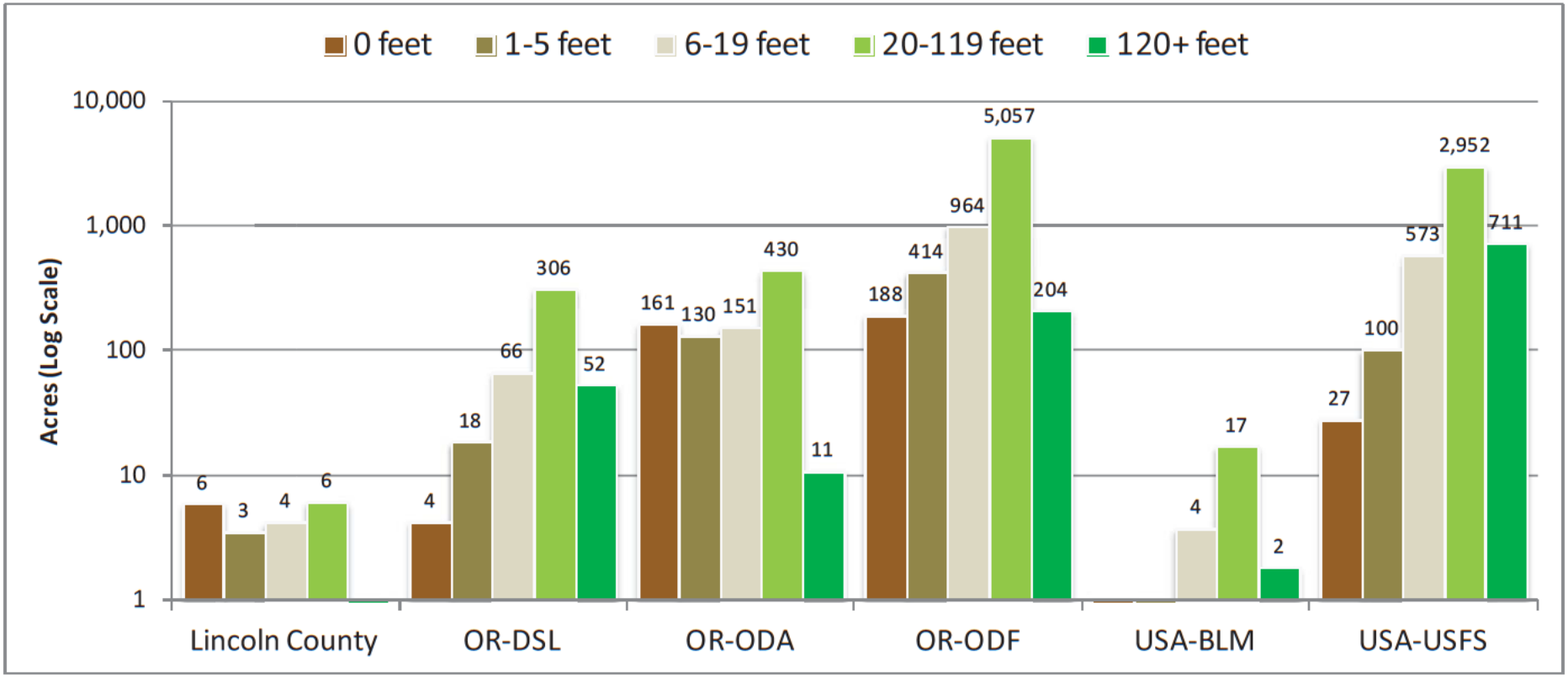
Identify DMA responsibility

- Prioritization of restoration



Quantified Riparian Condition

Big Elk Creek vegetation height by DMA



Riparian condition w/in 30m of Big Elk Creek quantified by using LiDAR

Protecting Cold Water in Adjacent States

Washington:

- No warming >2.8°C allowed for all nonpoint sources combined according to the temperature rule.
- Antidegradation policy & numeric criteria must be met.
  - >0.3°C increase in temperature is considered lowering water quality, requiring an antidegradation review.
- Forest practice sufficiency is measured against the >0.3°C increase threshold for all streams.
- Forest practice rules manage for habitat, require maintenance of shade & sediment filtration.

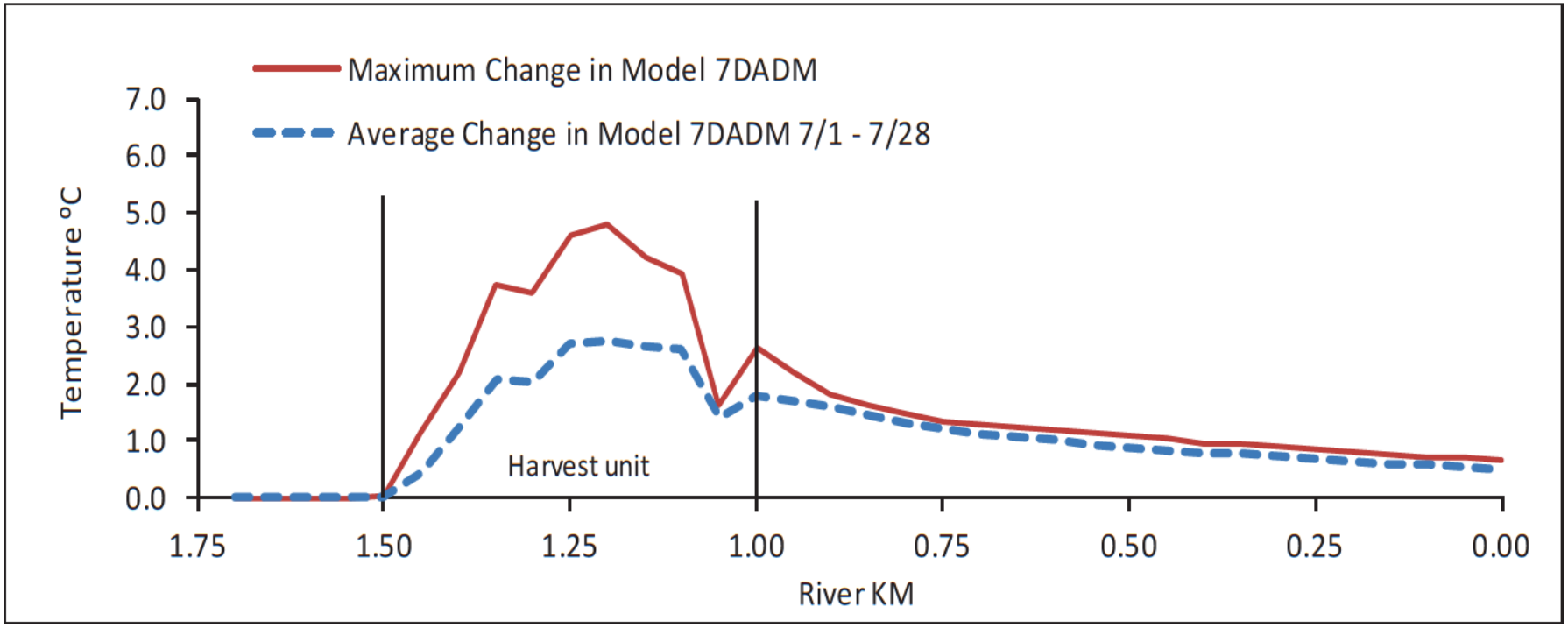
Protecting Cold Water in Adjacent States

California (North Coast):

- Stream temperatures cannot be altered unless alteration does not adversely affect beneficial uses; *and*
- Stream temperature cannot be increased by more than 5°F (2.8°C) above natural temperature; *and*
- The North Coast Region Temperature Policy requires maintaining or achieving "site-specific potential effective shade" in riparian areas on private lands.
- Forest practice rules manage for shade, sediment retention, & habitat.

Questions?

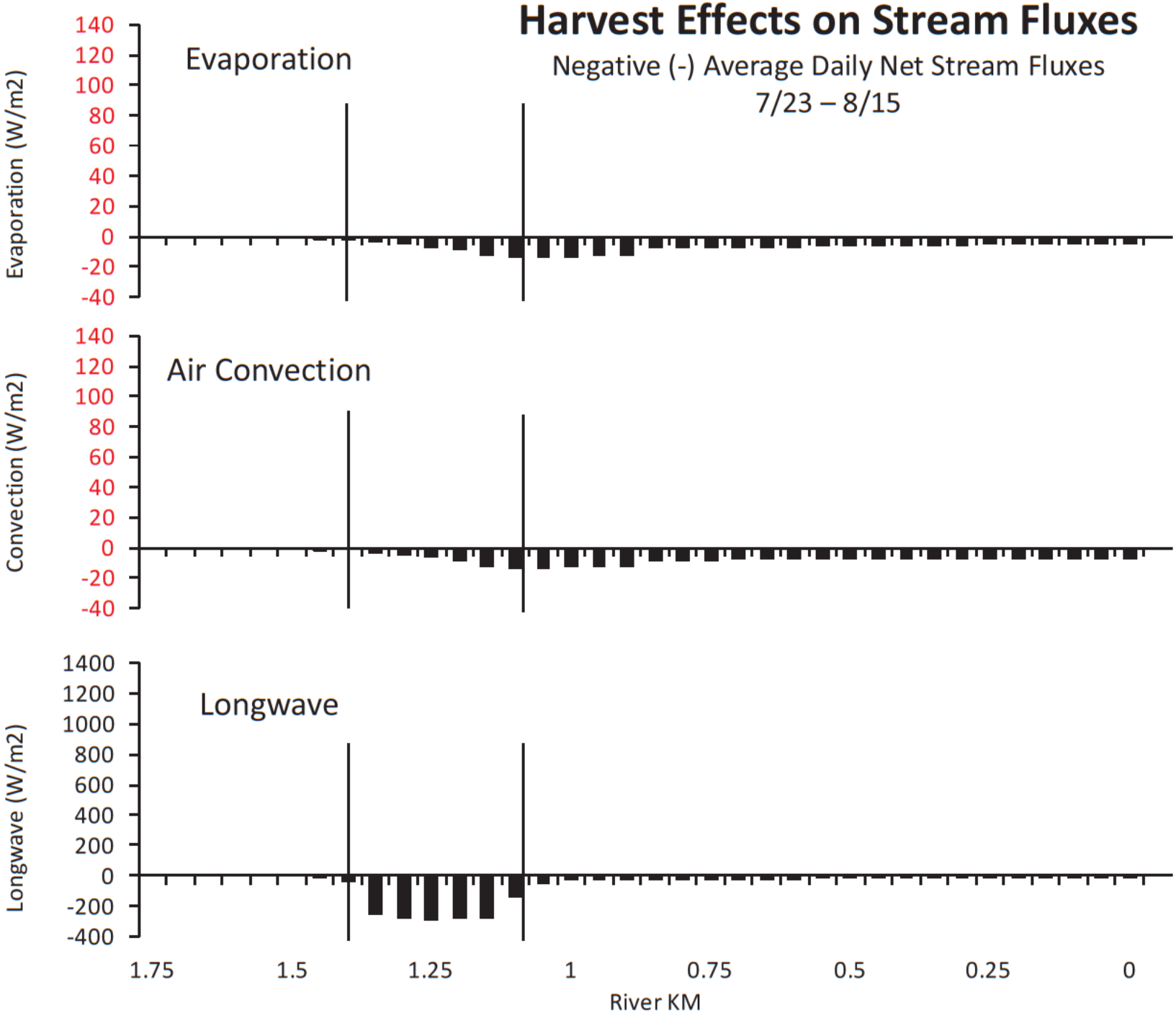
Heat Source Results for Argue Creek



Simulated change in longitudinal 7-day average daily maximum (7DADM) temperatures from harvest at RipStream site 7854, holding all factors constant except vegetation.

Harvest Effects on Stream Fluxes

Negative (-) Average Daily Net Stream Fluxes
7/23 – 8/15



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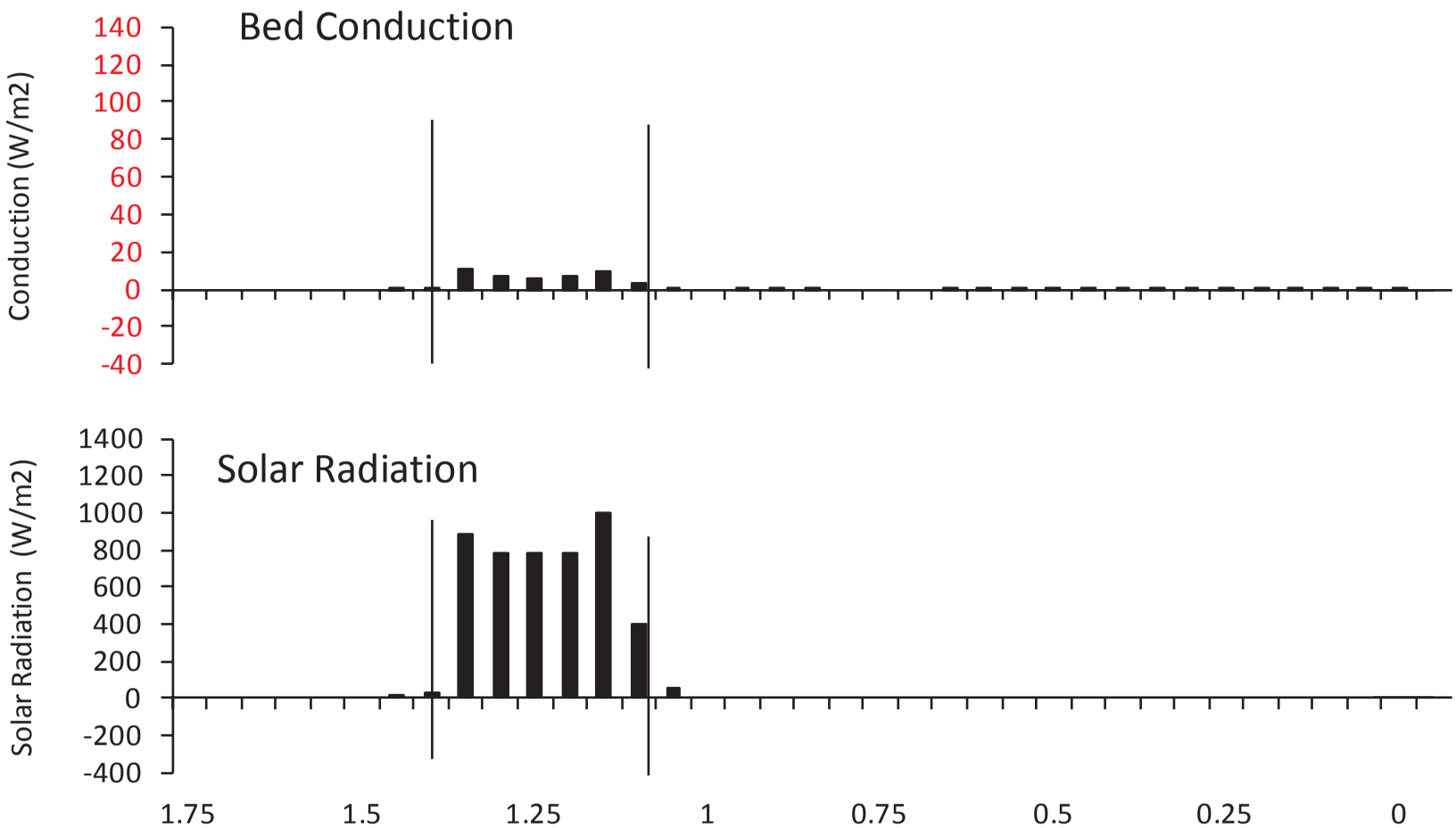


Oregon Temperature WQS

(OAR 340-041-0028)(2)

Commission's Policy is:

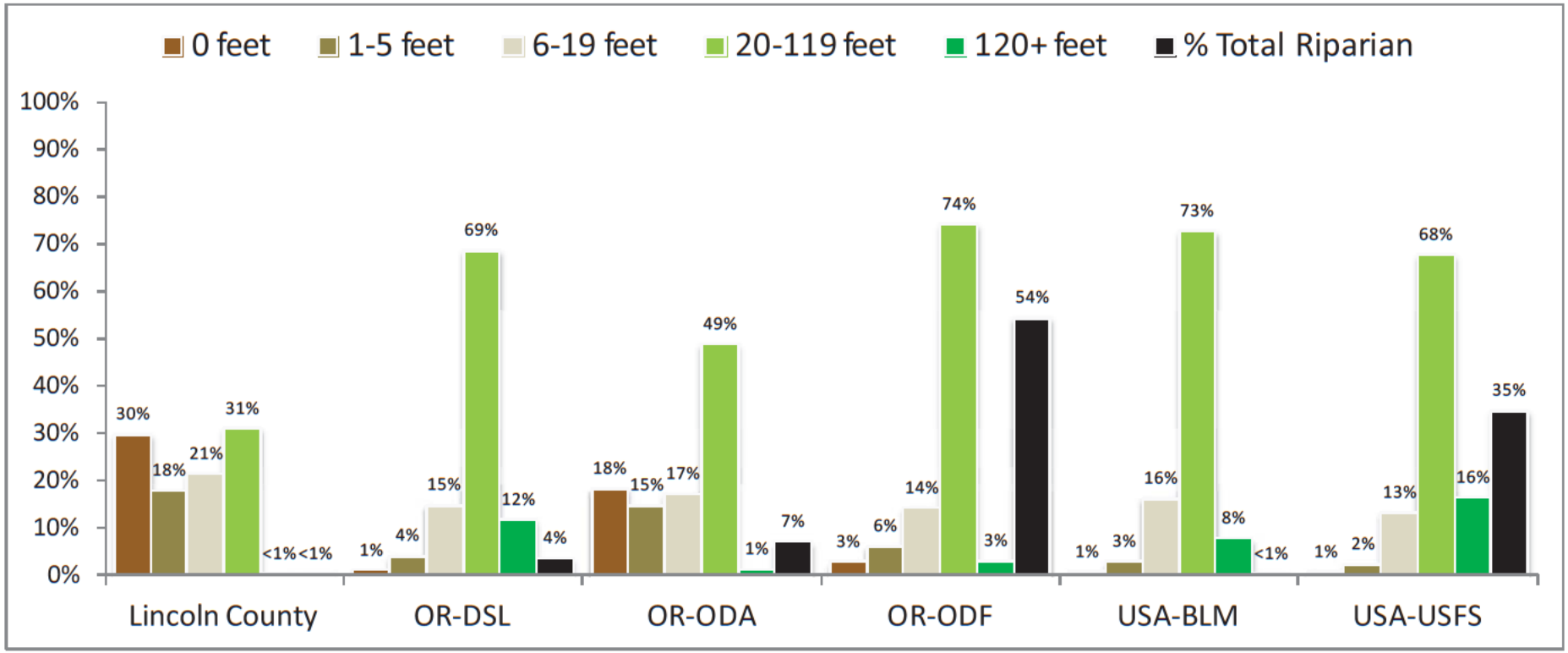
- Protect aquatic ecosystems from adverse warming and cooling caused by anthropogenic activities;
- Minimize the risk to cold-water aquatic ecosystems from anthropogenic warming;
- Encourage the restoration and protection of critical aquatic habitat;
- Control extremes in temperature fluctuations due to anthropogenic activities;
- Minimize additional warming due to anthropogenic sources

Protecting Cold Water Criterion (OAR 340-041-0028(11))

- PCW limits temperature increases to 0.3^{o}C in waterbodies colder than the numeric criteria, measured for all sources combined at the point of maximum impact where salmon, steelhead or bull trout are present [OAR …(11)(a)].
    - Natural thermal regime provides best conditions for fish.*
    - Value in diversity of temperatures, including colder than BBNC.*
    - Prevent accumulation of heat in fish-bearing reaches.*
    - Retain assimilative capacity for climate variation & climate change.

- Point sources must also limit warming in spawning reaches [OAR …(11)(b)].

- Some waterbodies may also be covered by a temperature TMDL. Meeting TMDL allocations should ensure PCW compliance.

*From Summary of 2003 TAC findings.

Percent area in each LiDAR vegetation height classification within 30 meters of the stream for each DMA in the Big Elk watershed