Protecting Forest Water Quality: Progress and Management Implications

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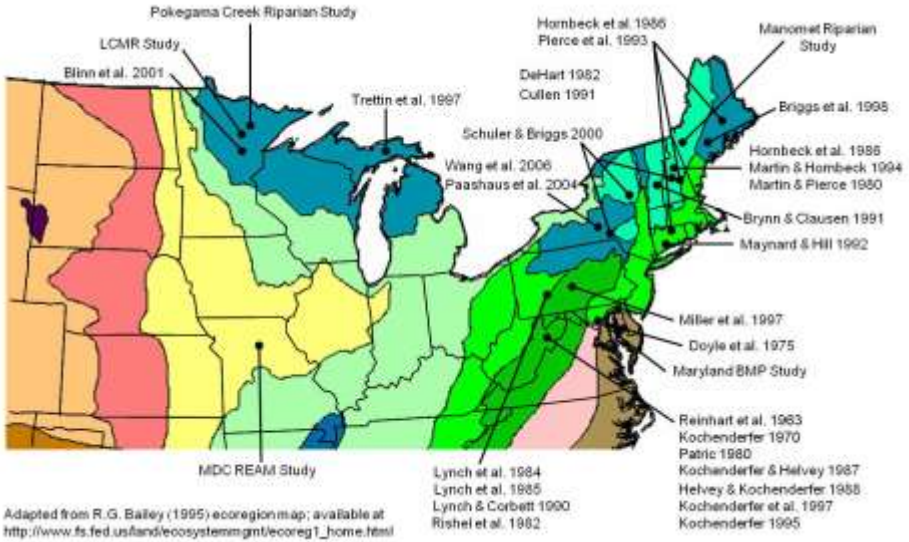
Forest Water Quality

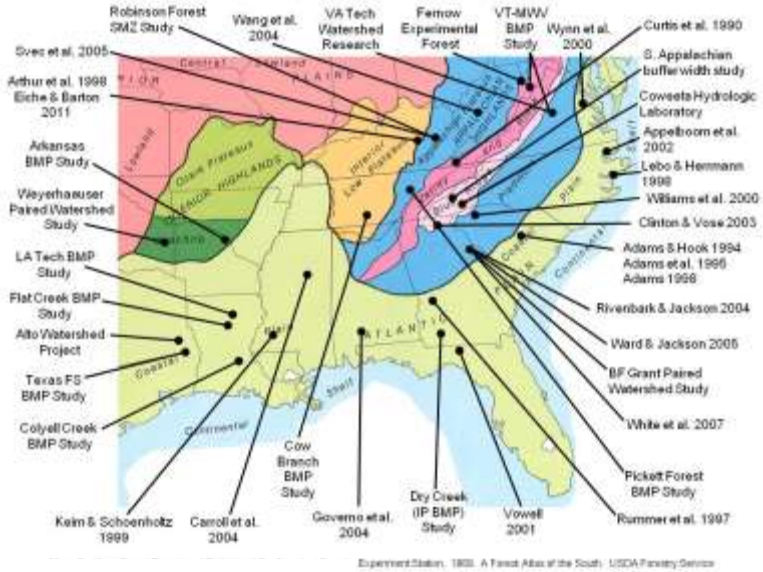
- Oregon's FPA rules and contemporary forest management are effective in reducing water quality impacts
- Water quality recovers over time and downstream following disturbance
- Water quality criteria are sometimes unattainable
- New technology allows us to detect small changes compared to natural variability
- There is a law of diminishing returns

100 Years of BMP Effectiveness Research

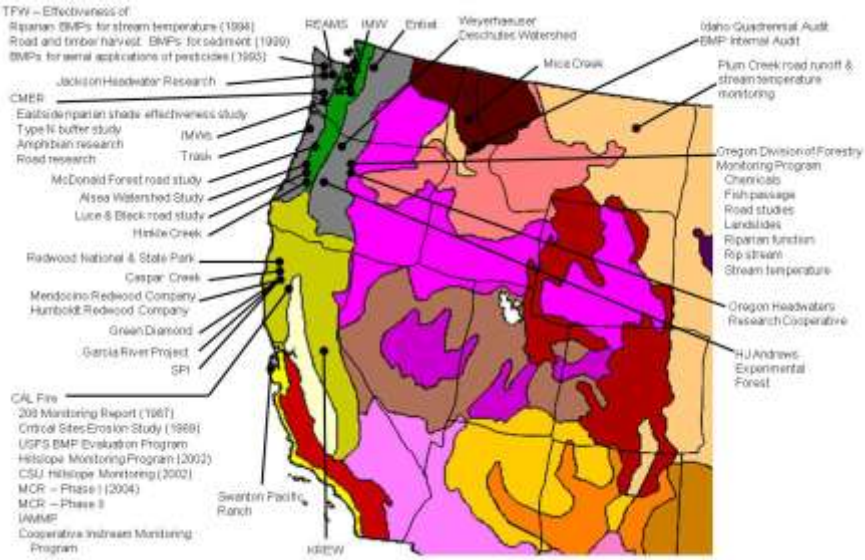
(from Ice and Schilling 2012)



Adapted from R.G. Bailey (1995) ecoregion map; available at http://www.fs.fed.us/land/ecosystemmgmt/ecoreg1_home.html



Experiment Station. 1933. A Forest Atlas of the South. USDA Forestry Service



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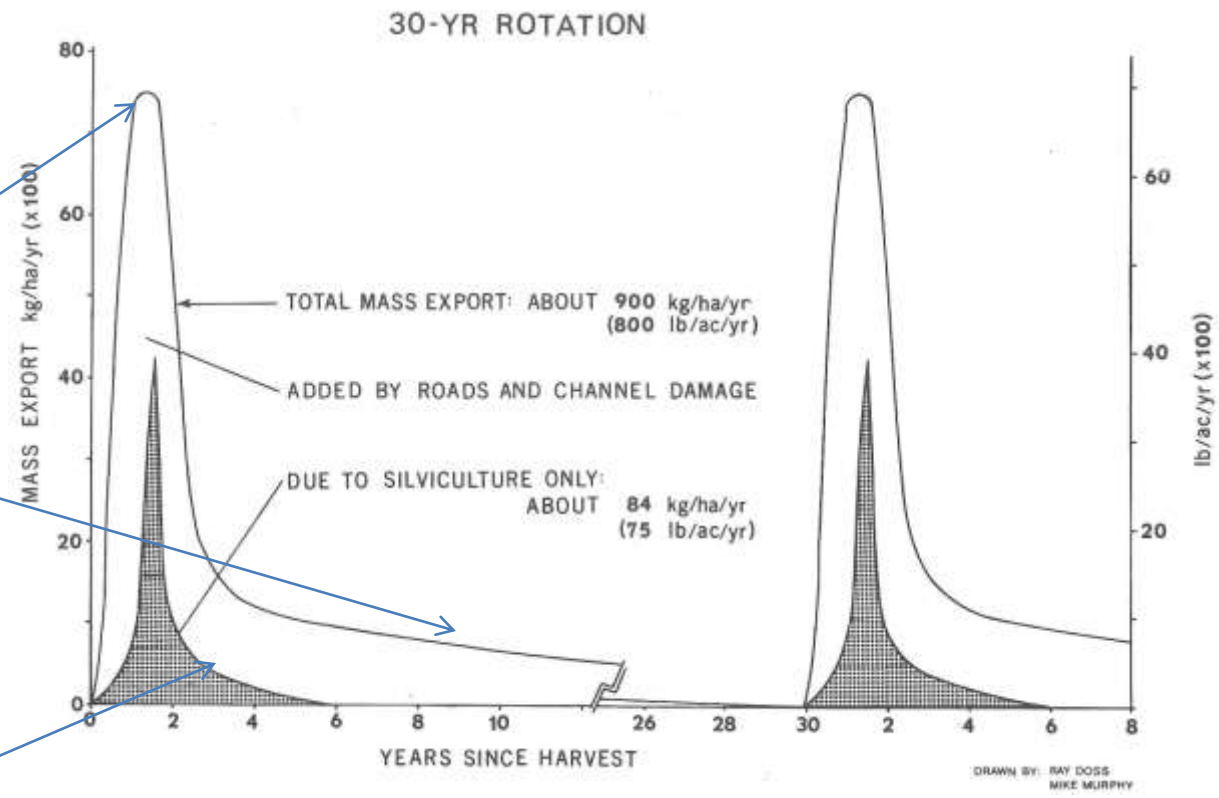
Distorted Perspective of Forest Watershed Results

Past Practices

Contemporary Practices

Distorted View – Focus on Immediate Impacts

- Focus on immediate impacts – increase of 3.3 tons/acre for first year
- 0.4 tons/acre/yr averaged over a 30 yr rotation
- 0.04 tons/acre/yr with BMPs



Sediment: What Have We Learned about Roads?

Long-term patterns of sediment production following road construction and logging in the Oregon Coast Range

Robert L. Beschta
Department of Forest Engineering, Oregon State University, Corvallis, Oregon 97331

1978 *"A 25% patch-cut watershed showed increases during 3 of the 8 post-treatment years. These increases were caused primarily by mass soil erosion from roads."*

Sediment Production From Forest Road Surfaces

LESLIE M. REID AND THOMAS DUNNE

Department of Geological Sciences and Quaternary Research Center
University of Washington, Seattle

1984 "A heavily used road segment in the field area contributes 130 times as much sediment as an abandoned road."

The Generation and Fate of Road-Surface Sediment in Forested Watersheds in Southwestern Washington

ROBERT E. BILBY
KATHLEEN SULLIVAN
STANLEY H. DUNCAN

1989 *"The amount of sediment produced on an hourly basis from a road segment was related to traffic rate…Depth of road ballast and type of surfacing material also influenced sediment generation. "*

Sediment production from forest roads in western Oregon

Charles H. Luce and Thomas A. Black
USDA Forest Service, Rocky Mountain Research Station, Boise, Idaho

1999 *"Road segments where vegetation was cleared from the cutslope and ditch produced about 7 times as much sediment as road segments where vegetation was retained…"*

Effects of Timber Harvest on Suspended Sediment Loads in Mica Creek, Idaho

Diana L. Karwan, John A. Gravelle, and Jason A. Hubbart

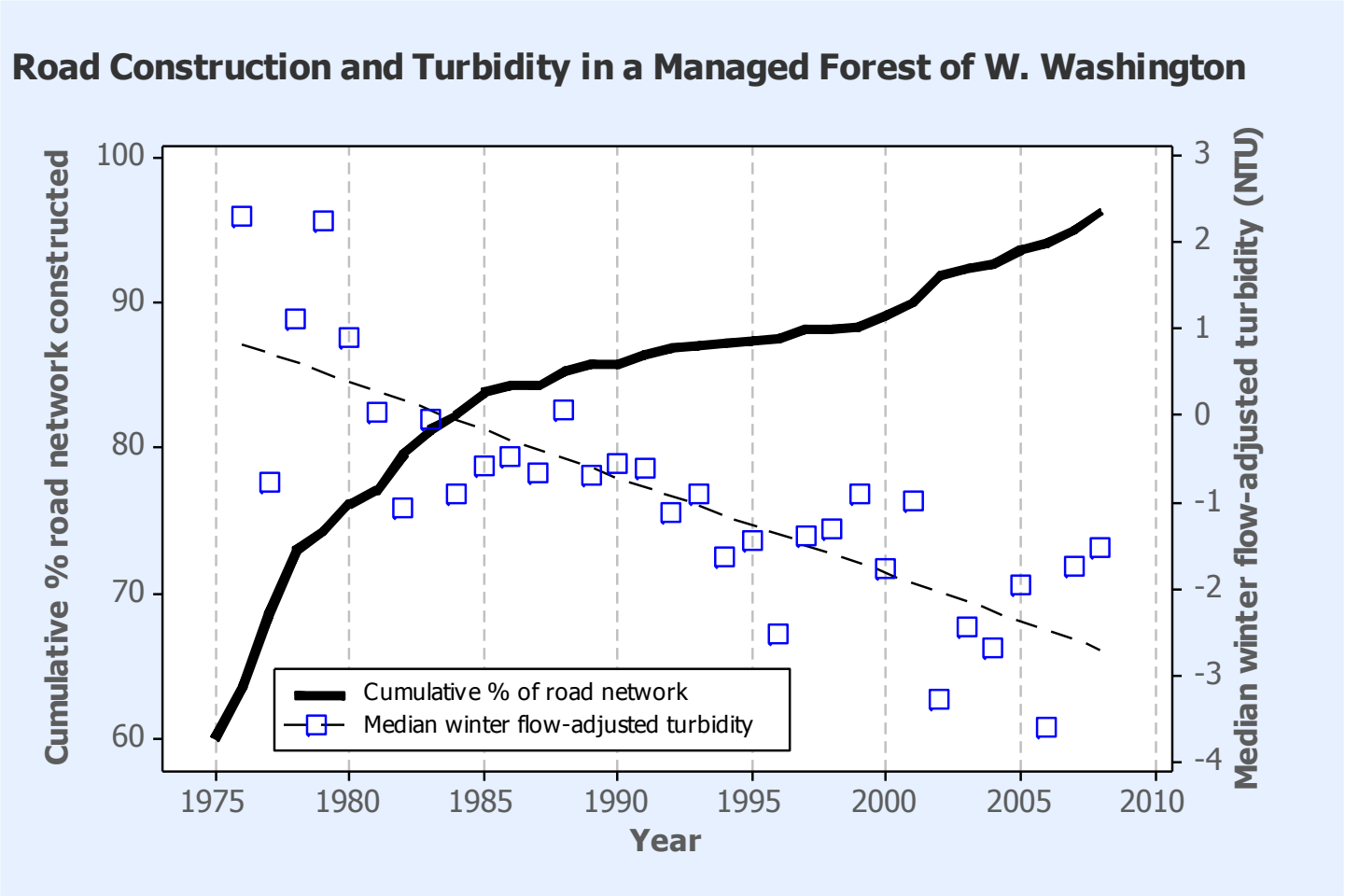
2007 "Road construction, including improvement of existing roads, did not produce a significant difference in monthly suspended sediment load relative to a control watershed."

Reducing Road Segments that Deliver Sediment Directly to Streams

- "In some areas of the Pacific Northwest, up to 75% of logging road drainage systems may directly enter rivers and streams."
- Martin (2009) survey of 1047 miles of private forest roads in WA
  - 73% low delivery potential
  - Half disconnected
  - 12% connected
- Dubé et al. (2010) – 11%

Hydrologically-Connected Roads:
An Indicator of the Influence of Roads
on Chronic Sedimentation, Surface Water Hydrology,
and Exposure to Toxic Chemicals
by Michael J. Furniss, Sam A. Flanagan, and Bryan McFadin

These Practices are Effective in Reducing Road Sediment Production and Delivery

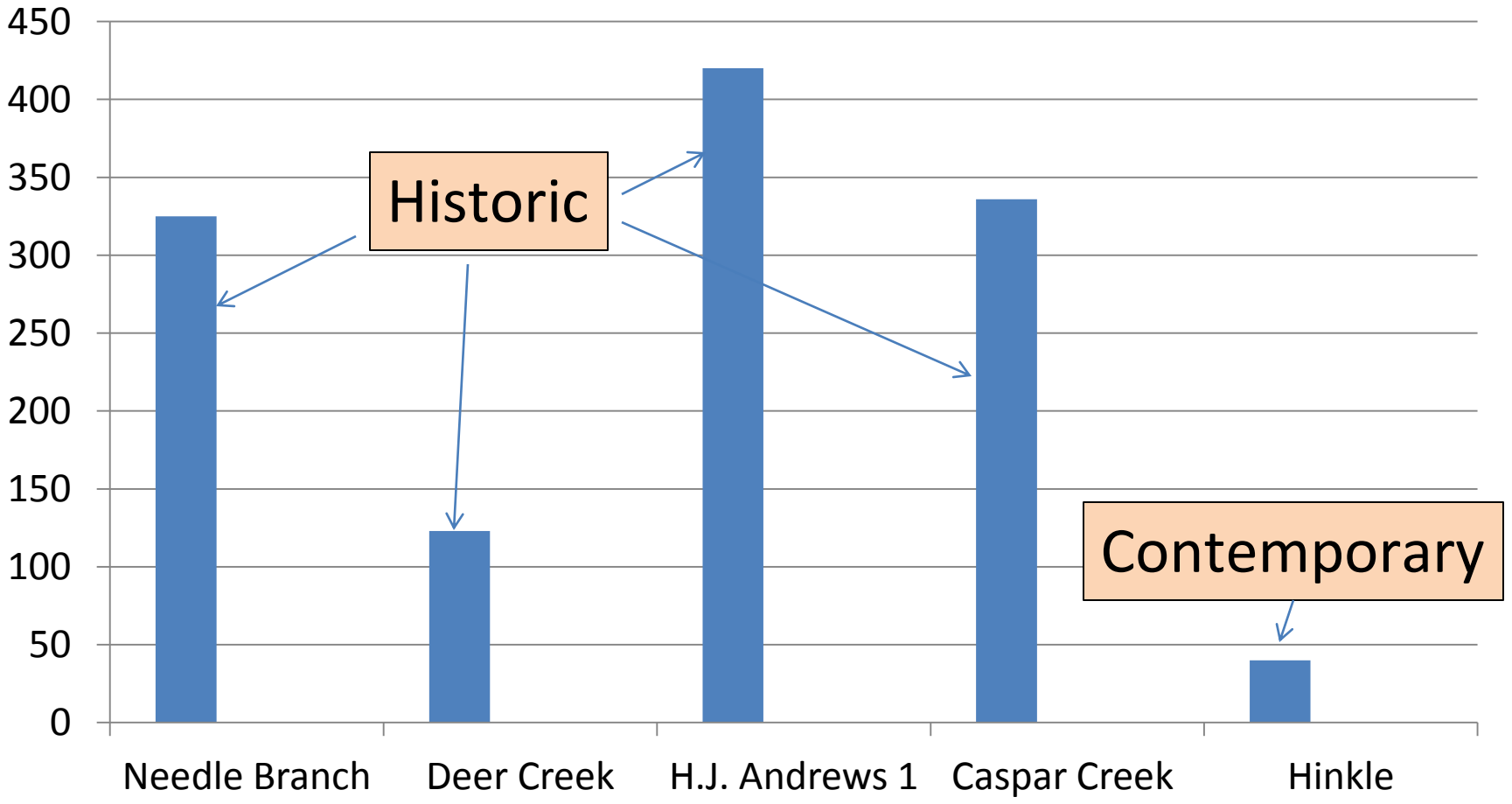


- Late 1980s: removed fill material on steep slopes to stable locations
- Early 1990s: added more ditch-relief culverts (to disconnect roads from streams)
- Mid-1990s: started leaving vegetation in ditch for filtration; minimized ditch grading
- Early 2000s: added sediment traps in ditches, energy dissipaters at culvert outlets

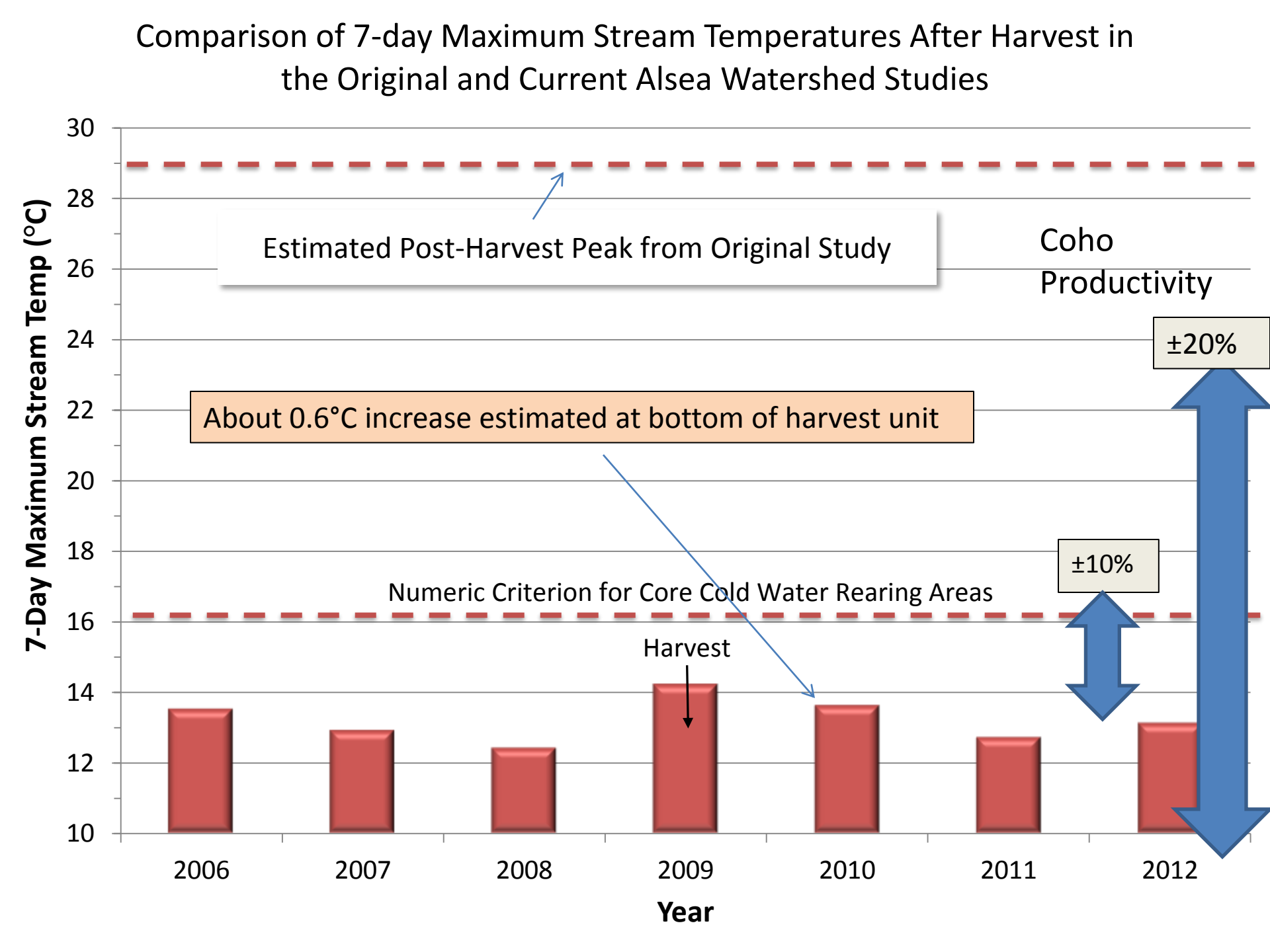
Modified from: Reiter, M., J.T. Heffner, S. Beech, T. Turner, and R.E. Bilby, 2009. Temporal and Spatial Turbidity Patterns Over 30 Years in a Managed Forest of Western Washington. Journal of the American Water Resources Association 45(3):793-808.

Oregon's Forest Practice Rules Effective

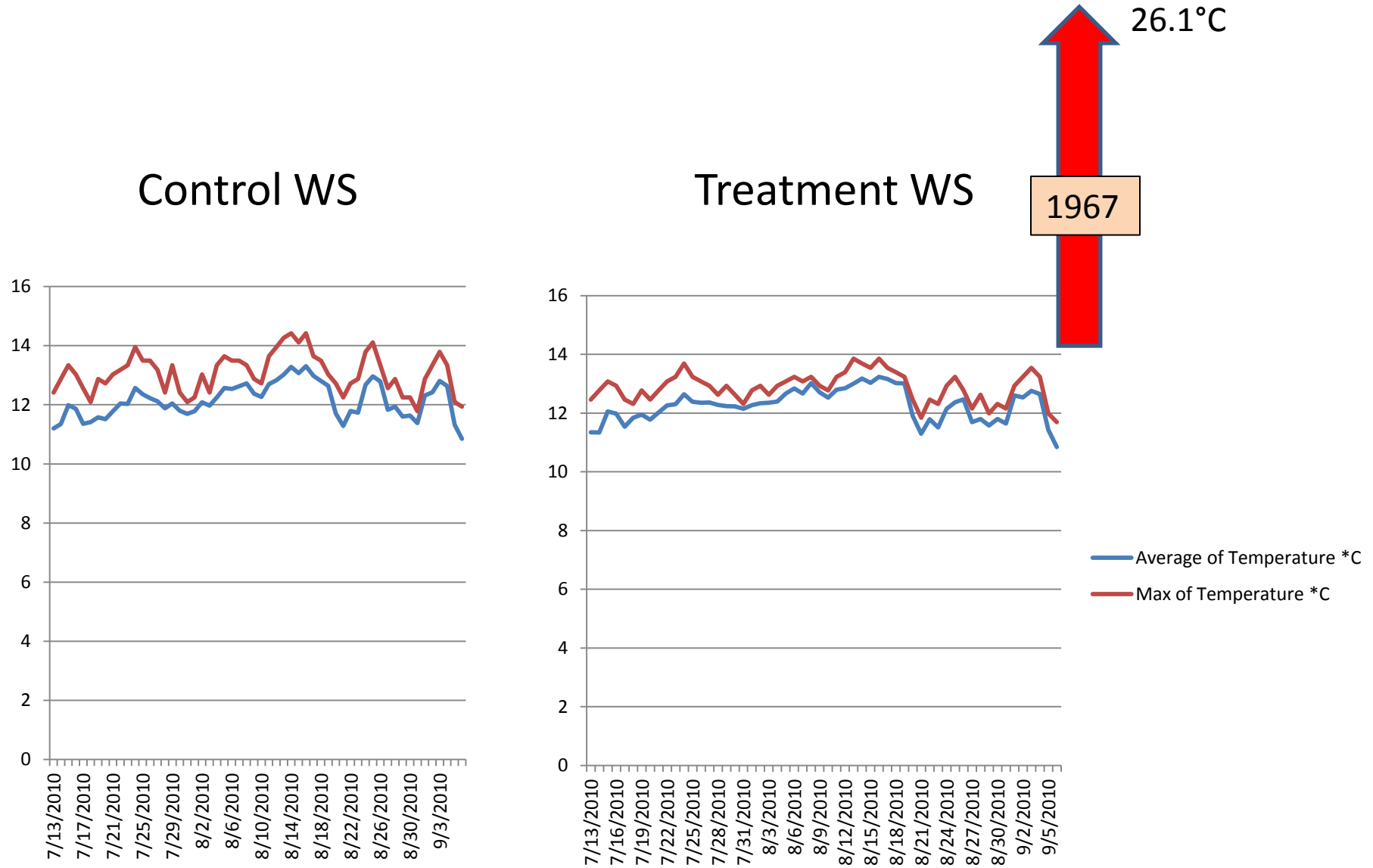
- Water Quality Impacts Reduced -

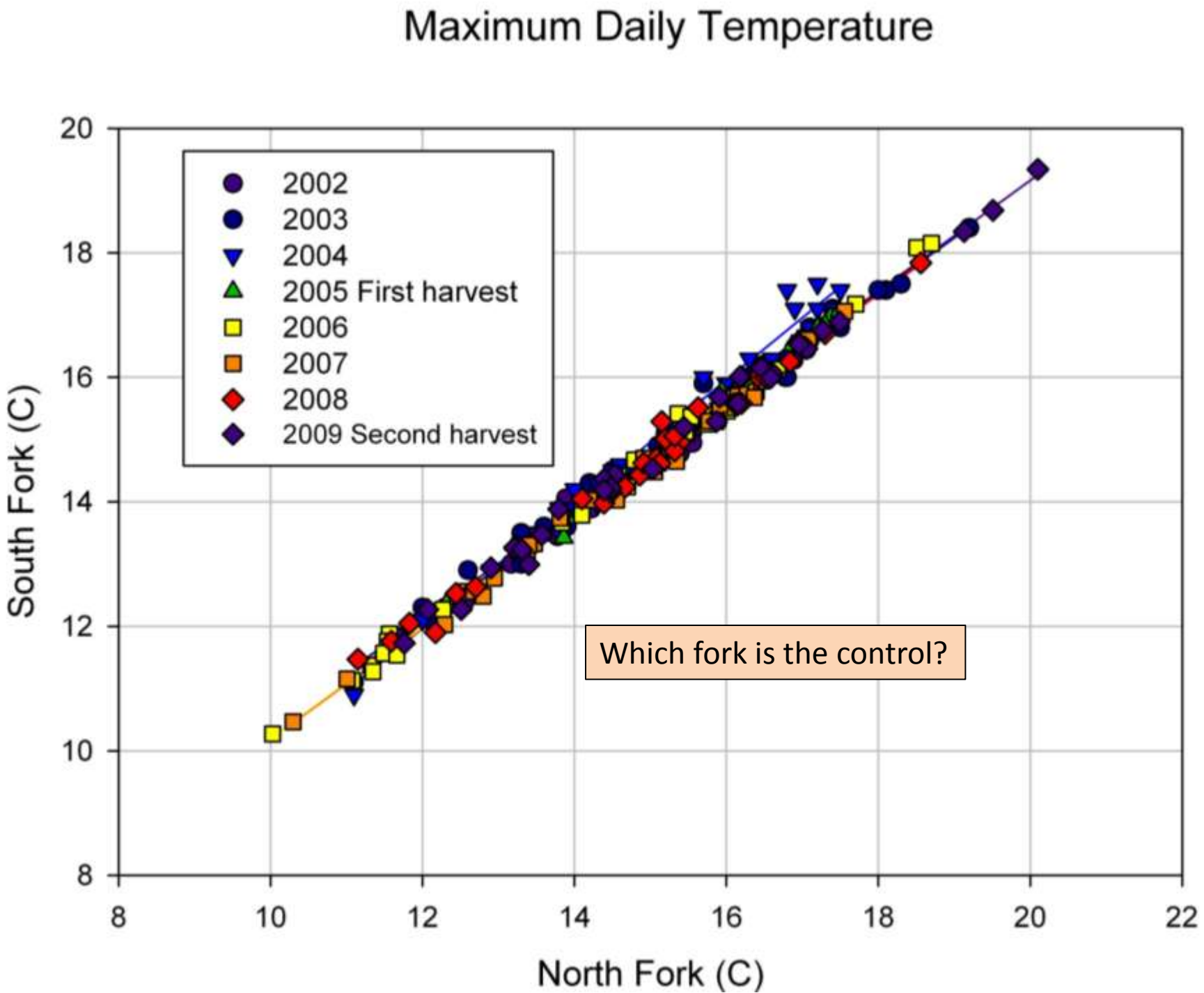


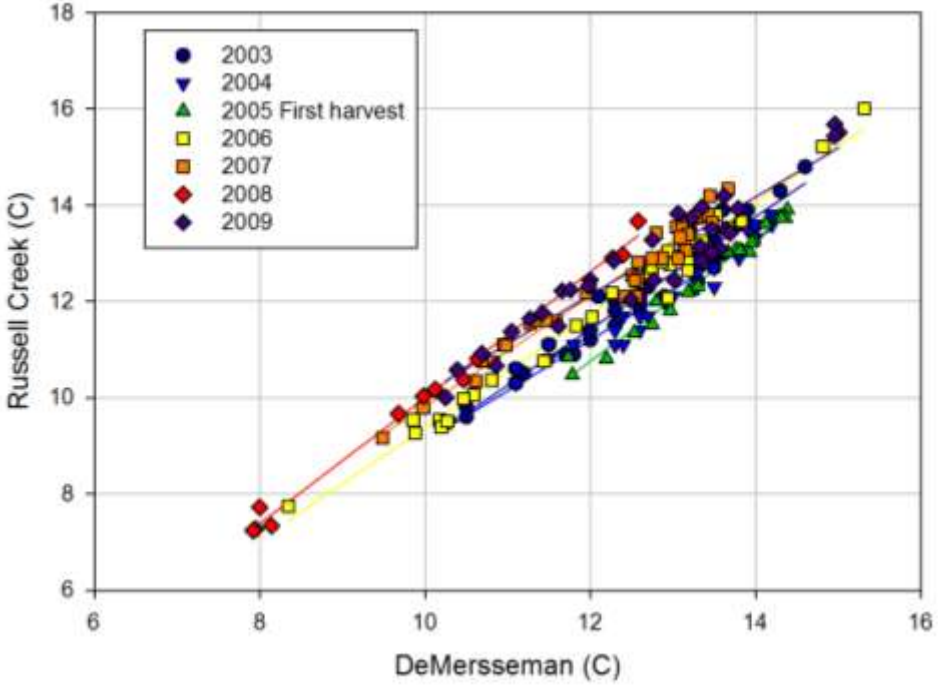
Percent Increase in suspended sediment compared to expected sediment load

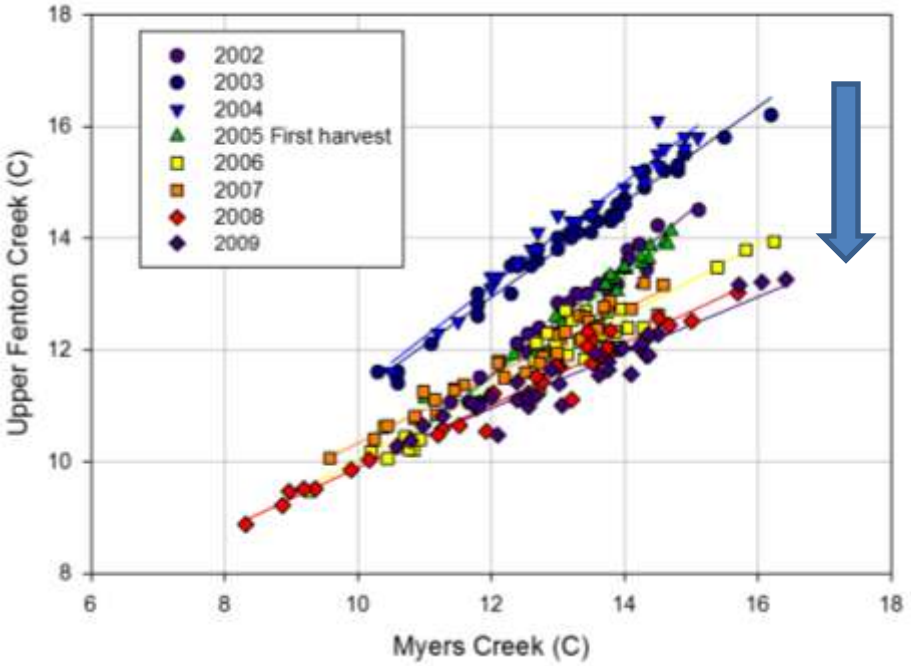

Comparison of 7-day Maximum Stream Temperatures After Harvest in the Original and Current Alsea Watershed Studies
7-Day Maximum Stream Temp (°C)
30
28
26
24
22
20
18
16
14
12
10
Estimated Post-Harvest Peak from Original Study
Coho Productivity
±20%
About 0.6°C increase estimated at bottom of harvest unit
±10%
Numeric Criterion for Core Cold Water Rearing Areas
Harvest
2006
2007
2008
2009
2010
2011
2012
Year

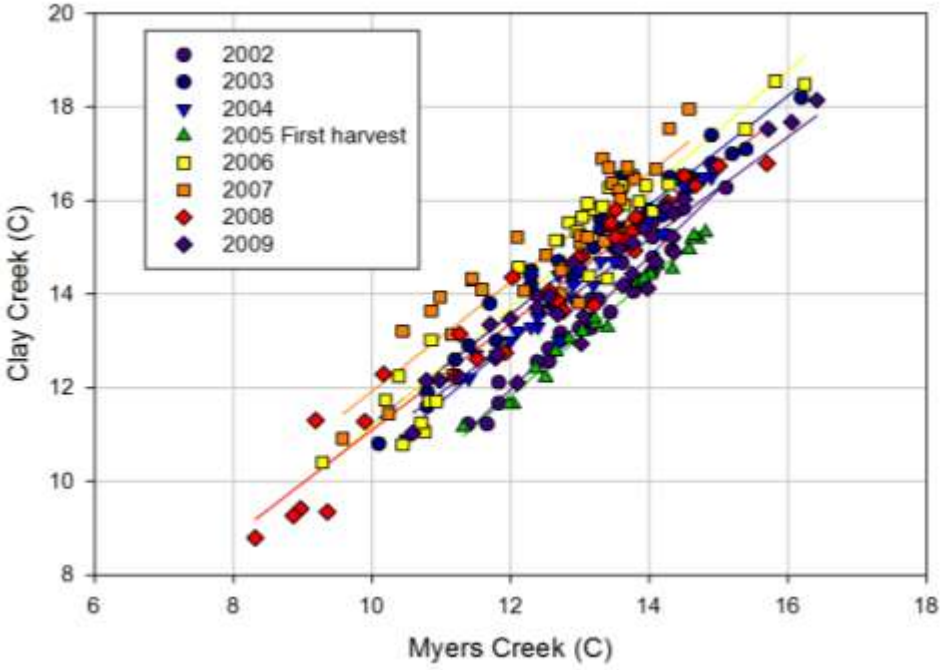
Alsea – First Summer after 2009 Harvest
Water Temperature in °C

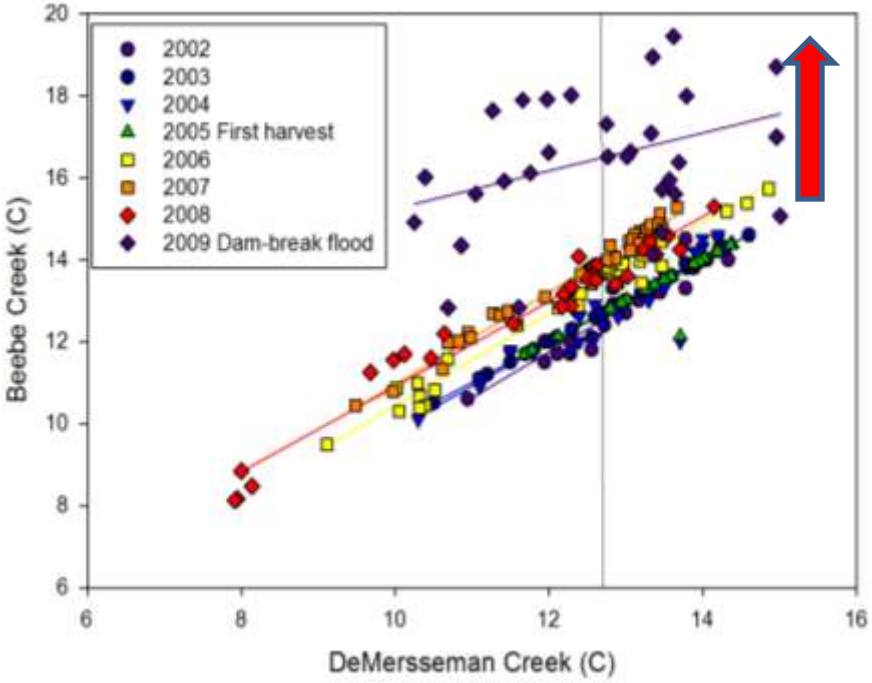



Maximum Daily Temperature
2002
2003
2004
2005 First harvest
2006
2007
2008
2009 Second harvest
Which fork is the control?
South Fork (C)
North Fork (C)
20
18
16
14
12
10
8
8
10
12
14
16
18
20
22

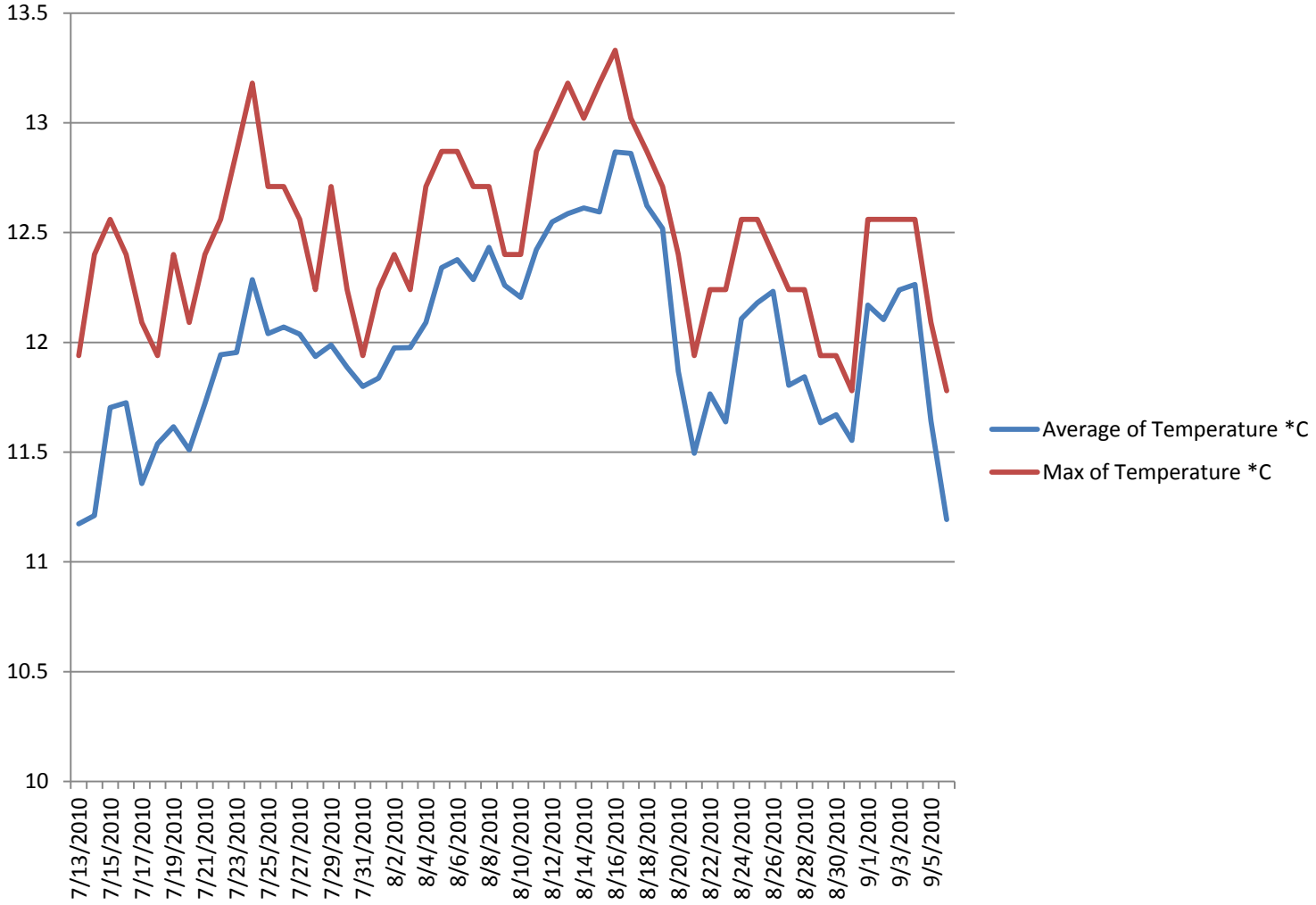

2003
2004
2005 First harvest
2006
2007
2008
2009
Russell Creek (C)
DeMersseman (C)


2002
2003
2004
2005 First harvest
2006
2007
2008
2009
Upper Fenton Creek (C)
Myers Creek (C)


2002
2003
2004
2005 First harvest
2006
2007
2008
2009
Clay Creek (C)
Myers Creek (C)


2002
2003
2004
2005 First harvest
2006
2007
2008
2009 Dam-break flood
Beebe Creek (C)
DeMersseman Creek (C)

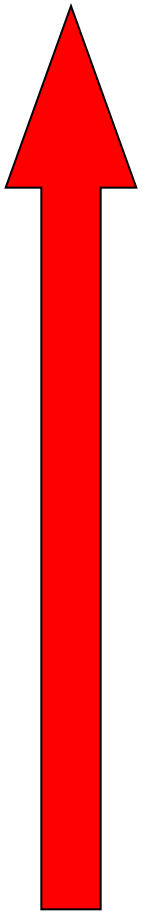
Station at Bottom of No-Fish Reach Year after 2009 Harvest in Alsea WS Study Revisited



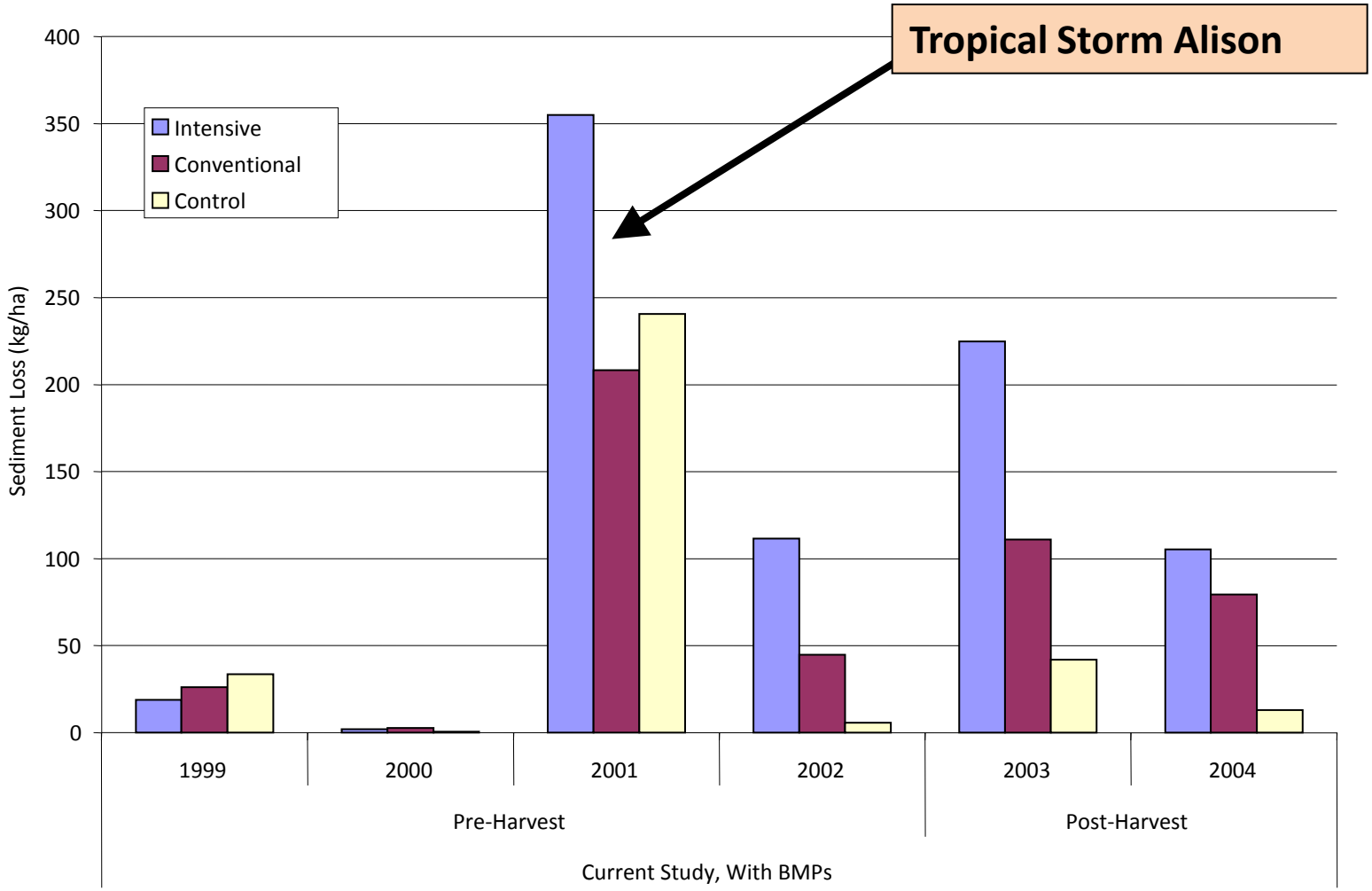
25,000 kg/ha cropland rate x SDR

Sediment Loss 1999-2004
(McBroom et al. 2008)

3000 kg/ha



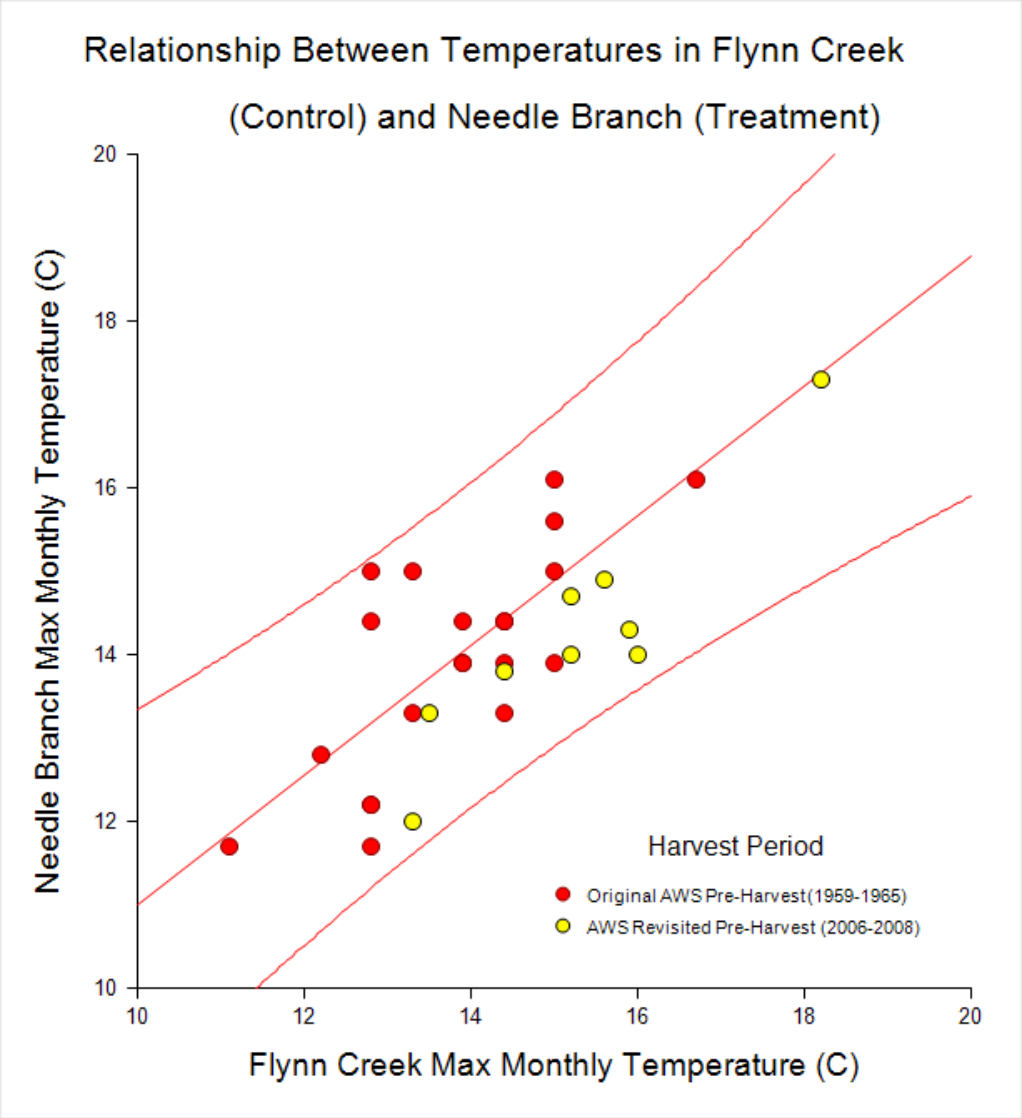
1981 SW



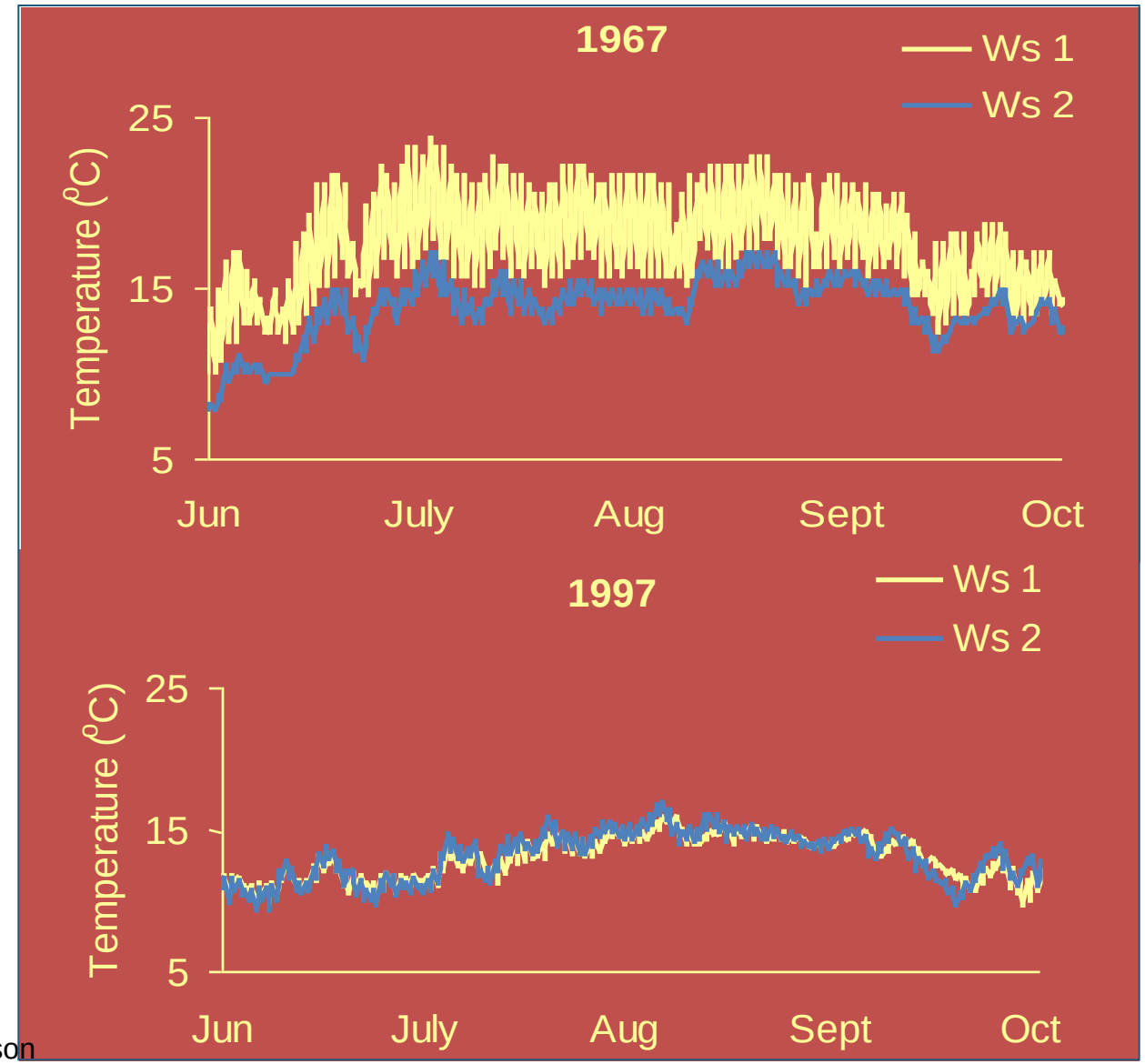
Recovery
Over Time and Downstream

- Forest are managed in a cycle so that any changes that occur tend to recover over time
- All water quality parameters are partially non-conservative, so they recover downstream

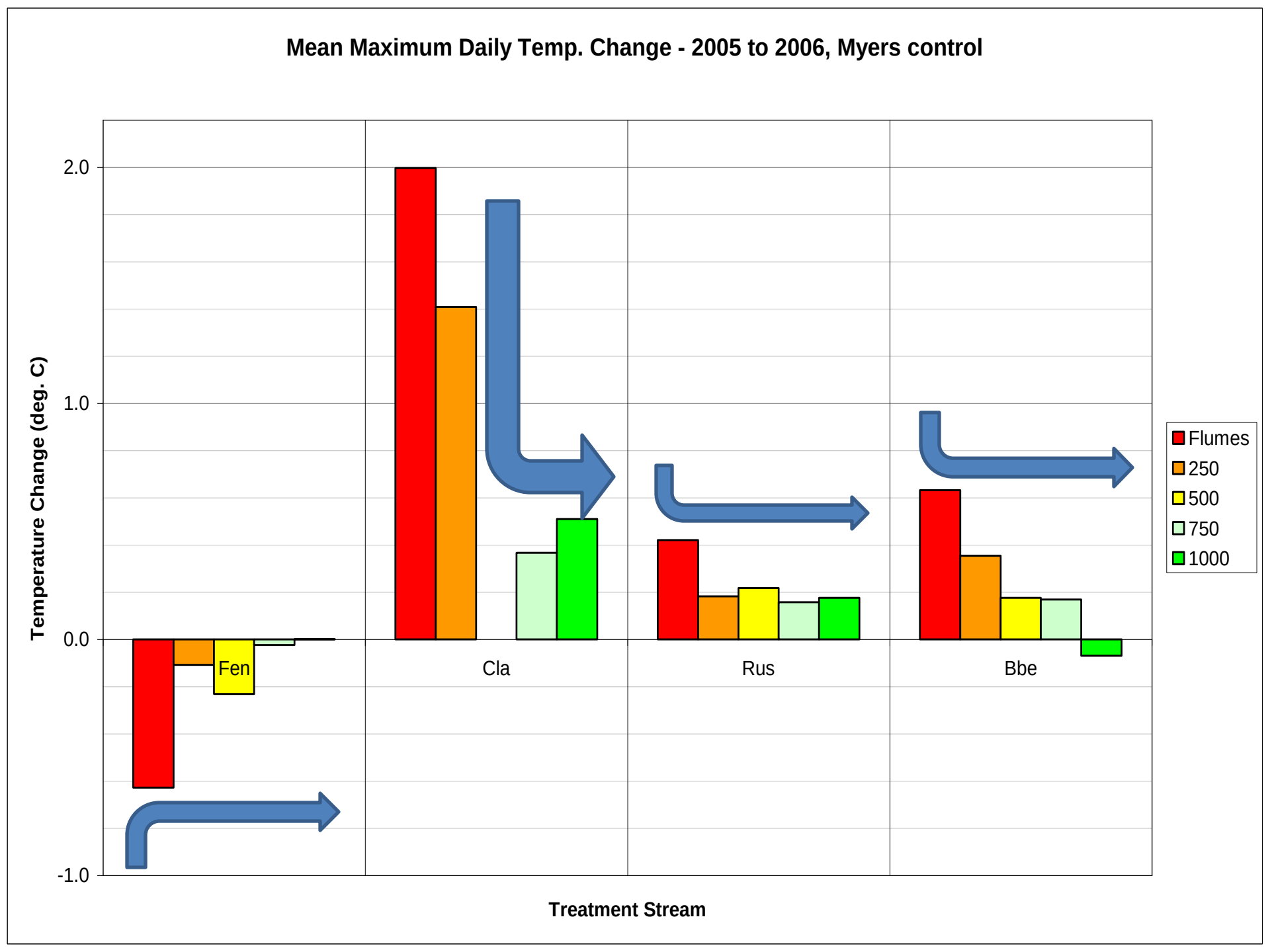
Recovery Over Time



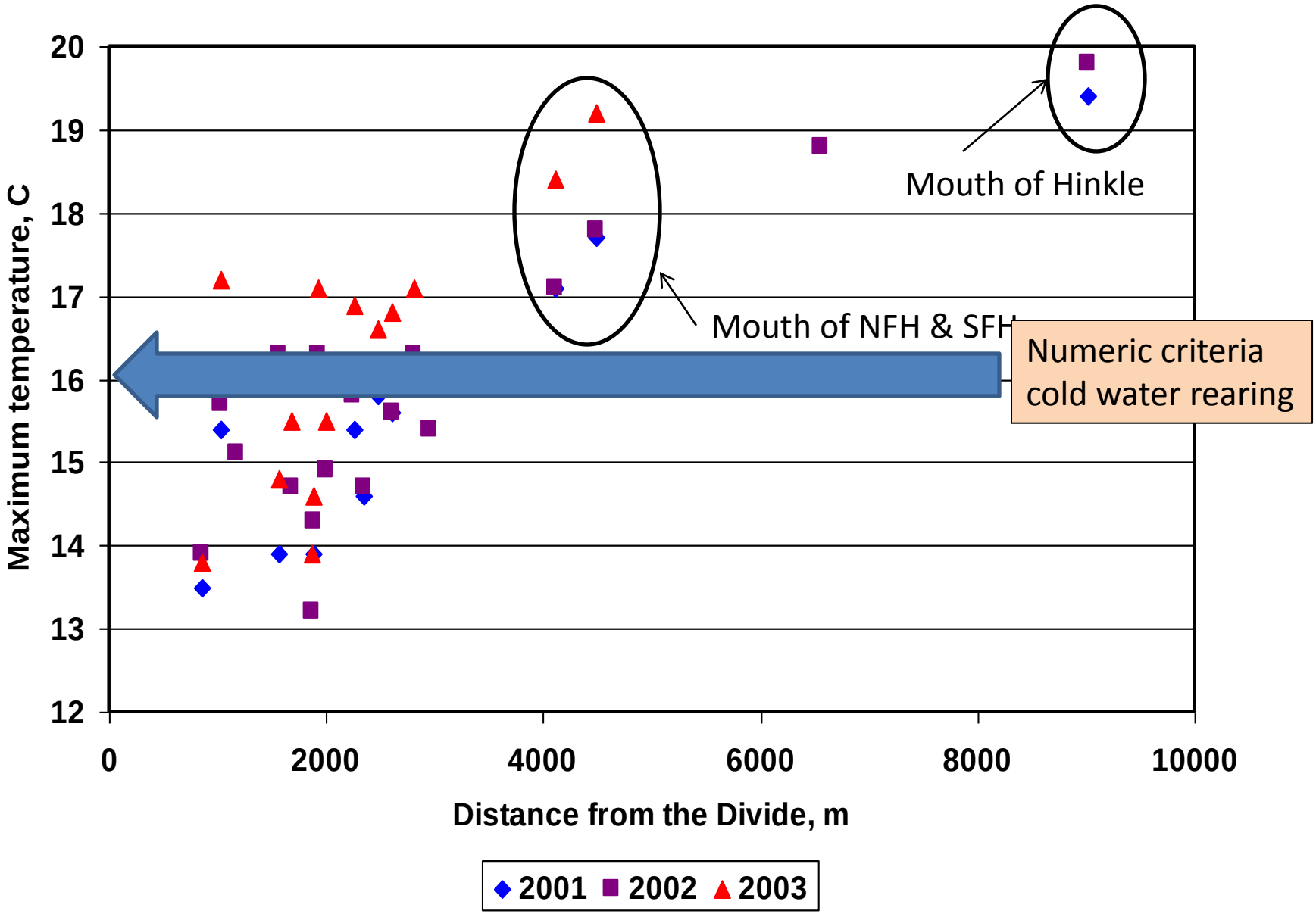
Recovery of HJ Andrews Watershed 1



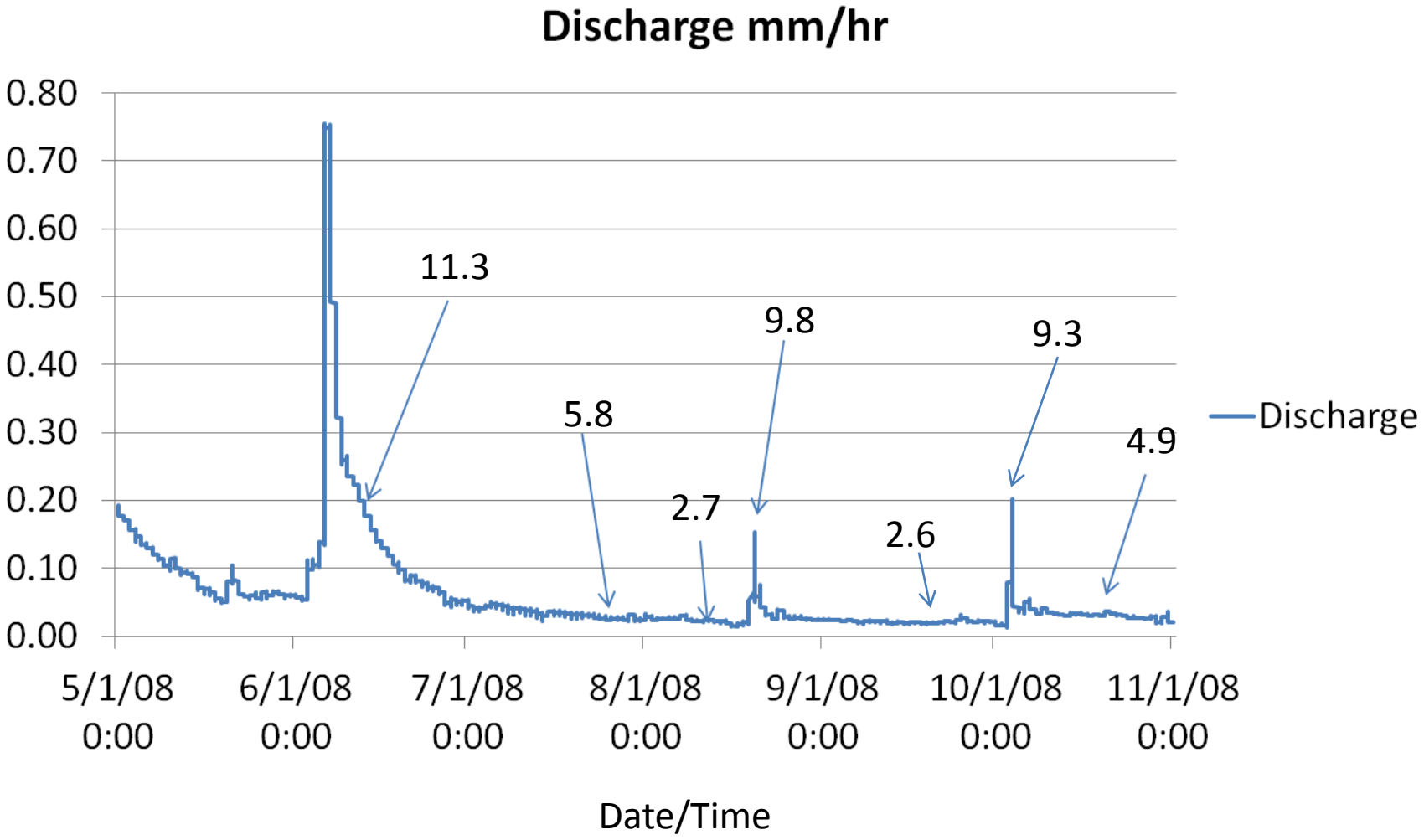
Sherri L. Johnson
Fisheries and Wildlife


Mean Maximum Daily Temp. Change - 2005 to 2006, Myers control
Temperature Change (deg. C)
2.0
1.0
0.0
-1.0
Fen
Cla
Rus
Bbe
Treatment Stream
Flumes
250
500
750
1000

Water Quality Criteria Sometimes Unattainable for Forest Watersheds



2008 NBU Hydrograph (May-October) and DO Response (mg/L)



Water Quality Criteria Sometimes Unattainable

- Nitrate-N high in Alsea control watershed that has not had human disturbance since fires in 1800s – probably a result of presence of significant nitrogen-fixing alder
- Streamwater temperatures also elevated due to decline in alder stands with advanced age
- Proposed biocriteria for sediment cannot be met for control watershed in Alsea despite no management
- Similar findings from across the Northwest and US

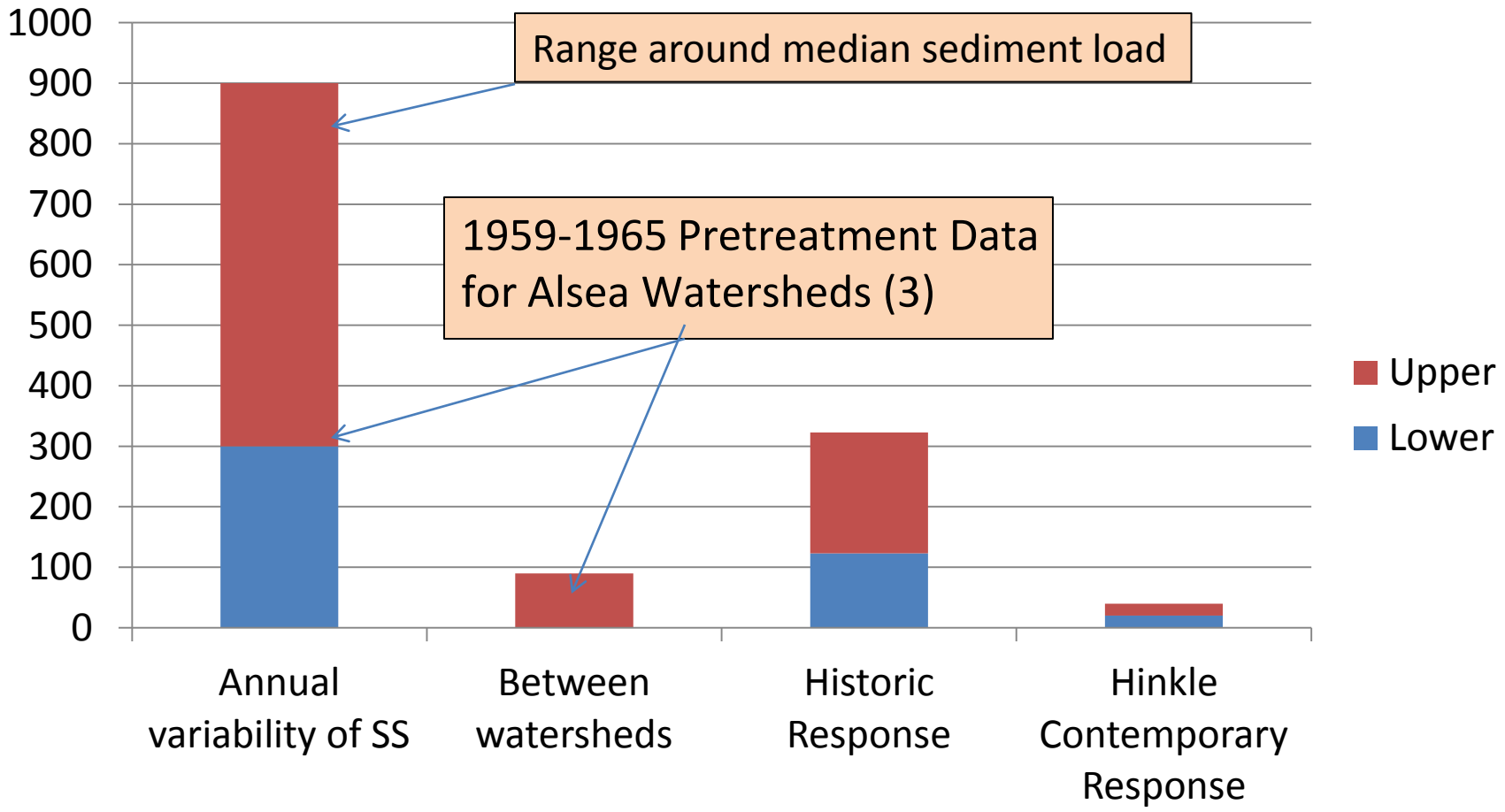
Technology

- Advances in monitoring technology allow detection of very small changes in water quality
- Temperature data loggers can collect data for an entire summer
- DO probes can collect every 30 minutes for days without drift

Are small changes ecologically significant compared to scale of variations seen daily, annually, and in response to disturbance events?

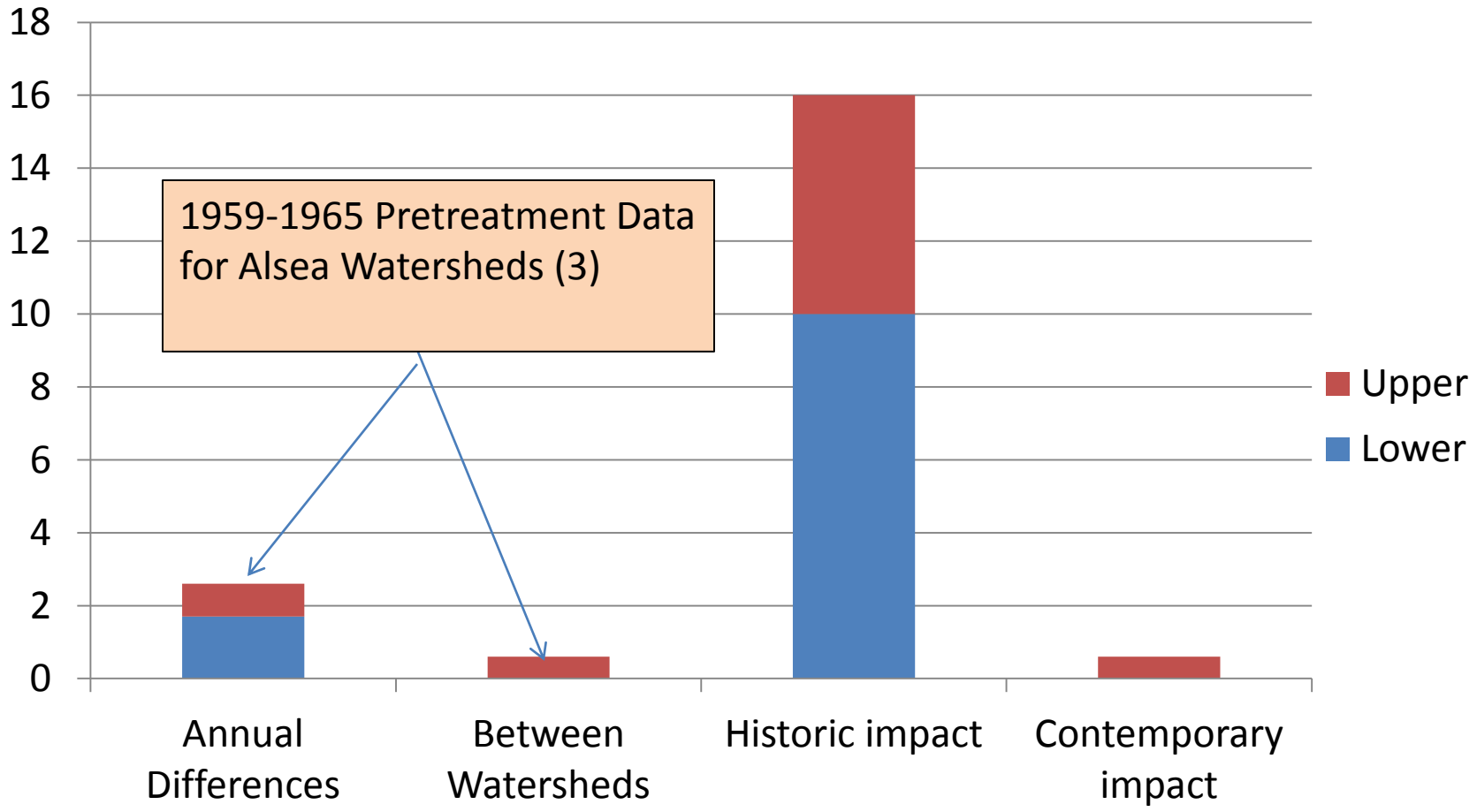
Comparing Natural Variations to Historic and Contemporary Impacts (area adjusted)

Percent Difference for Suspended Sediment



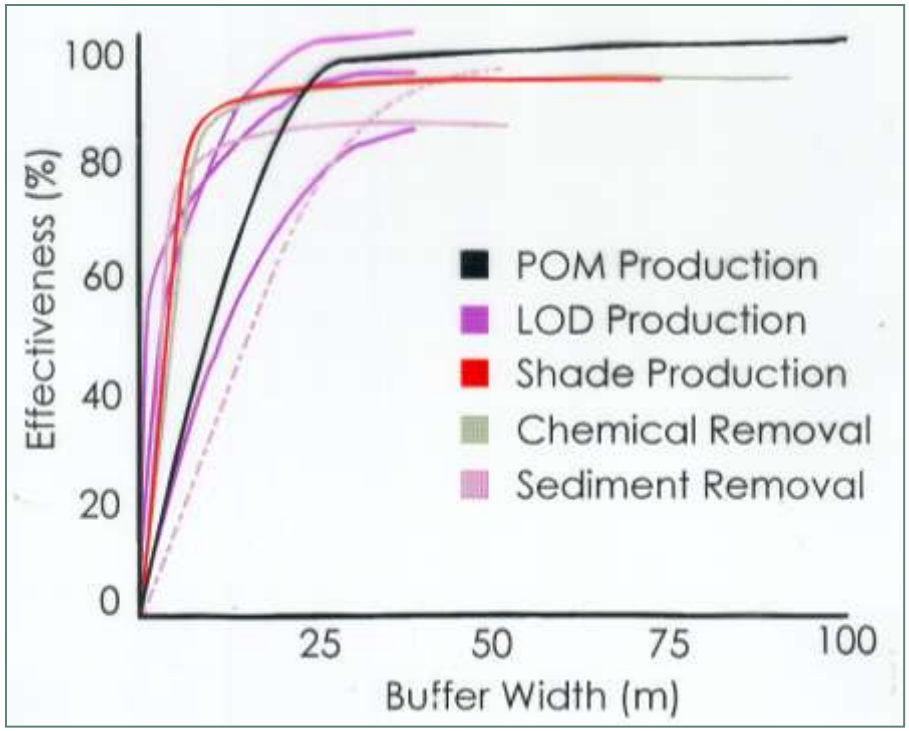
Natural Variations and Historic and Contemporary Management Impacts

(Maximum temperature in °C)



Law of Diminishing Returns

- Riparian function summary – NCASI TB 799
- For equal additional BMP investments there is diminishing return in benefits
- Comprehensive Economic and Environmental Optimization Tool (CEEOT)



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