RIPSTREAM MODEL LIMITATIONS

Greg Peterson PE

New Study on How Buffers Affect Stream Temperatures

Figure 1

Figure 1; recent real data for 4 sites, not model dependent

6x more thermistors, so far better resolution & fewer data gaps than Ripstream

Specifically designed to address buffer design.

-gradual pre-harvest T change ="natural source" baseline gradient of +0.35°C/km to +1°C/km

-BMP (i.e. FPA), uncut, & partial buffers all had 0 increase above natural baseline, except Upper Mill Cr, where extensive buffer ice damage led to +1°C rise in upper BMP harvest. Also low flow Brome Cr BMP had a -0.6°C drop

-partial buffers are 12m no-touch S-side, or 9-12m both sides if N-S orientation

-had 3 "no tree" clear cuts for intentional warming (+1.5°C to +2.5°C), to study downstream cooling

-Far more variation in a natural systems than ±0.3°C. A typical watershed has many sources of variation that go un-noticed and averages don't really tell the story.

See Newton's 1996 report for non-shade factors that also influence stream temperature

Ripstream Model

-ave. pre-H baseline T gradient of +1°C/km, although +0.1 to +2.4°C/km at 20 other sites

-lots of peculiar things can influence temperature data , other than tree harvests.

-created 2 pseudo 'paired watershed" site groups, but without detailed site definition and calibration

State sites are control group. Private sites are treatment group. Focus on the difference between groups to isolate T change due to harvest, & not other factors

-Site data from **Figure A** (and Figure 3, Ref d) was used to create **Table 1**.

Must adjust post-H data for; 1) ave pre-H baseline T, 2) for ave control site change;

	Private=harvest sites	State= control sites
ave. post Harvest T change;	0.70°C	0.66°C
ave. pre-H baseline T	-0.05°C	-0.30°C
ave. Delta T above baseline	0.66°C	0.36°C
State ave. post-H T changed 0.36C, but not harvest related, so control changes by 0.36C		
Adjustment re; average control site change	-0.36°C	-0.36°C
Adjusted average Delta T due to harvest	0.30°C	0

Ripstream Private Site Data Issues

Figure A

-6 sites w/ beaver dam/landslides/debris, 10 sites missing years, 2 sites lacked pre-H data

-5 sites had 70% of warming for all sites, and the remaining 13 site averaged <0.3°C rise.

-5 private sites with the highest Delta T had unusual post-H data abnormalities;

-Argue Creek; shown as +2°C, but only 1st yr. missing 3 yrs Would be 0°C if include 4th yr

-Buck Cr; very abnormal -1.95°C pre-H cooling, -, only +0.05°C post-H change

-W Frk Ecola; very abnormal -1.2°C pre-H cooling, 0 post-H change

-Elk Creek No; show 1st & 2nd yr at +1.5°C. but would be 1.1°C when include other 3 yrs

-Shangrila; shown as +2°C, but only 1st & 2nd yr. Will be +1.5°C when include other 2 yrs

Argue Cr data issue accounts for 0.12°C of ave Delta T for all 18 private sites

Buck Cr & W Frk Ecola data issues account for 0.15°C of ave Delta T " "

Pre-H cooling is abnormal & not a sustainable trend

Elk Crk & Shangrila data issues account for 0.11°C of ave Delta T " "

Data aberrations can get lost in averages, but can seriously distort & skew results.

RIPSTREAM MODEL LIMITATIONS

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Introduction

I am a Registered Professional Engineer in Oregon and Washington, and my 40 years environmental engineering career emphasized environmental assessments, water processes, and cooling processes. I am a member of DEQ's Technical Working Group (TWG) for the mid-Coast temperature TMDL process, which spent over 2 years trying to formulate a riparian temperature model for mid-Coast TMDL streams. I've managed environmental models on over fifty sites for private clients, EPA, and state agencies, and through this work, I've learned that;

* A model's underlying methodology and assumptions are the key to representing the real-world
* A computer can't provide all answers and infer a level of precision beyond what's reasonable.
* It takes in-depth expertise of a subject to keep on top of peculiarities, data problems, & aberrations.
* All models have limitations and there's more than one way to interpret results

I'm not a researcher, forester, nor statistician, but rather a professional engineer who's also a small woodland owner. Individual site parameters were the primary source of information, and a simple spreadsheet was developed, based on real numbers. I purposefully did not attempt to replicate model runs nor statistical analysis, which I found to be unduly complex and lacking transparency, but rather focused on interpreting published data and its application to the issues at hand.

Background

Ripstream was intended to demonstrate whether the current FPA enabled harvests to meet a "human use allowance" of 0.3°C above the "natural factors" temperature baseline. It was not designed to define RMA buffer parameters or options for temperature management, and its data is not representative of other regions. The greatest challenge in analyzing harvesting effects on stream temperature is separating natural effects from the change due to harvests and I will describe the limitations of the Ripstream model's approach.

New Study on How Buffers Affect Stream Temperatures

Cole recently studied 4 Oregon streams to determine the effectiveness of different riparian buffers to mitigate harvest impacts on stream temperature. Each site was designed with at least two sets of control + harvest + recovery sections and considerable variability and year-to-year differences were found within each. Three buffer types were used;

- -BMP (i.e.FPA-compliant) two-sided buffers with minimum BA left
- -partial buffers with South-bank one-side 12m no-cut buffers (for azimuth of 170 to 220 degrees) and two-side 12m no-cut buffers when N-S orientation
- -'no tree' buffers, had all trees removed, with only brush left within 3m. These were intended to provide warming, to enable study of downstream cooling

Twenty eight thermistors were used for each stream, which is more than 6 times the 4 used for Ripstream. More sensors improved resolution and minimized data gaps, enabling better definition of heating/cooling mechanisms, and better data for buffer design. **Figure 1** (Ref h) shows 2 years of pre-harvest and 4-5 years of post-harvest data for 4 streams; Big Rock, Brome Creek, Mary's River, and Mill Creek. While buffer layout protocols were the same, hydrology, substrates, and overstory canopies differed, thus the buffers did not provide the same shade. Each stream is a separate case study with some common features.

Pre-harvest data was collected over two years, indicating a gradual "natural source" baseline temperature gradient average of; +0.35°C/km on Brome Creek, +0.4°C at Mary's River, +0.7°C on Mill Creek, and +1°C/km at Big Rock. Post-Harvest monitoring indicated that all BMP (i.e. FPA), uncut, and 3

partial buffer sections had no average temperature increase. The +1°C rise at Mill Creek's upper BMP harvest was due to extensive ice damage to the 50 ft wide stream-side alder canopy. This section of Mill Creek was also noted to have a particularly low stream velocity/flow. Both partial and BMP buffers on the Mary's River also lost some tree canopy to wind and ice prior to harvest, but only the BMP section showed minor warming, and this was likely because of low stream velocity/flow. Brome Creek's BMP and partial buffer sections both cooled more than 0.6°C in the treatment section. The three "no tree" clear cuts warmed between +1.5°C to +2.5°C, and and downstream cooling rate differed for each stream.

Newton & Zwieniecki (Ref b), found that in natural waters, and even in well shaded headwater reaches, there were up to ±2°C aberrations in many temperature data sets and that a high degree of statistical accuracy was rarely possible, requiring the frequent use of averages to define variables and general relationships. **Figure 1** shows that a ±0.3°C standard is dwarfed by natural variations in natural systems. The typical watershed has so many sources of variation that go un-noticed and the use of average values doesn't really tell the story. See Newton's 1996 report (Ref b, figures 9-27) for a description of non-shade natural factors that have been shown to influence stream temperatures.

Natural Source Temperature Baseline

Common sense (and the TMDL process) recognizes that in all watersheds, there is a natural temperature gradient along a stream, forming a cumulative "natural source" temperature baseline, usually involving gradual warming, as water moves downstream during the summer. Dent, et al. (Ref a) reported Ripstream '02 to '04 pre-H data, saying that while all sites were well shaded, with high cover, there were 'variable longitudinal temperature patterns', which varied widely, as some pre-H stretches cooled 1°C/300m, while others warmed up to 3.3°C/300. The average pre-H control reach warmed +1°C/km, however individual sites that contributed to this average and their characteristics were not identified. Newton reported pre-H baseline gradients of 0.1 to 2.4°C/km at 20 other sites. He also identified stream size, gradient, flow, distance from headwaters, and other non-shade variables that influence pre-H temperature. Post-harvest data needs to subtract the underlying pre-harvest baseline.

Ripstream made the simplifying assumption that state sites, with their negligible RMA harvests, ultra-wide 170' deep buffers, and one-sided "harvests", would have post-harvest conditions essentially the same as pre-harvest, and classified the state site group as the control group, and private sites as the treatment group. This decision created pseudo 'paired watershed' groups.

At other 'paired watersheds', the first step is to thoroughly define each watershed and establish a statistically significant hydrologic relationship between control and treatment watersheds, followed by a lengthy calibration period, as was done at Hinkle Creek. However, such efforts did not happen in Ripstream, perhaps due to the distance separating sites, the number of sites, their widely diverse characteristics, and the cost to do so. While changes in weather, stream flow, rainfall, and inflow occur on every site, consistent and predictable relationships between sites were probably not practical to establish with the funds available, so the focus switched to comparing group averages, perhaps presuming that the effects of the many site differences might cancel each other out. With this approach, there is no way of knowing if a regional event, such as a heavy summer rain or a sustained drought, would preferentially affect sites in one group over the other group, or vice versa. If such a bias developed, it could be unfairly be labelled as a harvest-related effect, when it is not. There's a certain element of luck involved in which site group will benefit and which will suffer from such events. Such a fatal flaw could seriously undermine the scientific basis of any comparisons made.

Control temperatures will inevitably vary during post-H monitoring, when changes in weather, stream flow, rainfall, inflow, etc occur. After determining changes to the average control group average, private

post-H temperatures must be adjusted to maintain the same comparison of changes attributable to private harvest methods, rather than other variables.

Site Temperature Change

Published individual site data from **Table A** (and Figure 3, Ref d) was used to identify specific site and temperature parameters, as summarized in **Table 1**. Thirty-one (18 private and 13 State) of 33 Ripstream sites had both pre- and post-harvest data sets, and the 13 state sites averaged +0.3°C pre-H warming and the 18 private sites averaged +0.05°C pre-H pre-H warming. The term "Delta T" was created to identify the difference between pre-H and post-H data. **(See Table 1)**

Baseline temperatures remain constant under constant conditions. but with changes in weather, streamflow, rainfall, inflow, etc, the control group's post-H average will change and, private post-H temperatures must be adjusted to maintain a uniform comparison of changes attributable to private harvest methods, rather than other variables. Two adjustment must be made to post-harvest data; 1)for the ave pre-H baseline temperatures, and 2) for ave control site change.

	Private=harvest sites	State= control sites
ave. post-H T change;	0.7°C	0.66°C
ave. pre-H baseline T	-0.05°C	-0.30°C
ave. Delta T above baseline	0.66°C	0.36°C
State ave. post-H T changed 0.36C, but not harvest related, so control changes 0.36C		
Adjustment re; average control site change	-0.36°C	-0.36°C
Adjusted average T effect of harvest	0.30°C	0

Private Site Temperature Change; The 18 private sites, averaged 0.05°C Pre-H warming and 0.7°C post-H warming, resulting in a 0.66°C "Delta T" rise (**see Table 1**). One private site had no change, 2 sites cooled, and 15 warmed following harvest. Five private sites constituted 70% of all private site temperature rise and warrant comment;

Name	#	Description of private high Delta T site data issues	Discrepancy
Argue Creek	7854	major debris flow in '07 at Post 3, stream driven subterranean. Data from 2nd, 3rd, & 5th post-H yr. absent. 4th yr data not shown in Ref d), which would change Delta T from +2°C to 0°C	2°C too high
Elk Creek No	5559	Post H rise of +2.1°C rise 1st yr, +1.0°C 2nd yr, +0.9°C 3rd year, +0.8°C 4th yr, +0.7°C 5th yr. Only 1st & 2nd yrs shown, instead of +1.1°C ave	0.4°C too high
Shangri-La	5205	1st yr post-H data missing. 2nd & 3rd yr showed +2°C & +2.1°C rise, dropping to +1.1°C & +1°C in 4th & 5th yr. Only 2nd year +2°C shown, instead of +1.5°C ave	0.5°C too high
Buck Creek	5557	-1.9°C pre-H cooling, (likely a data aberration) & post-H rise +0.05°C, so still a relative "warming" vs. pre-H value. 3rd & 4th yr missing	-
W Fork Ecola Cr	5204	-1.2°C pre-H cooling (likely a data aberration). post-H cool 0.2°C, so still a relative "warming" vs. pre-H value	-

Argue Cr accounts for 0.12°C of the ave Delta T and Buck Cr & W Frk Ecola together account for 0.15°C. The effect of all 5 discrepancies is 0.33°C of the average Delta T. These abnormalities have an enormous bearing on the overall averages and should have been investigated further. Other data issues include;

Siletz Tribe (#5503) beaver dams which had an unknown influence over an unknown time. Other sites lacking post-H data include; Drift Creek (#5556, 3rd & 5th year), Big So Fork (#5203 ,1st year), Smith Creek (#5106, 2nd year).

Figure A also shows that post H temperatures could change significantly between subsequent post-H years, yet little attempt was made to explain these aberrations. For example, Drift Creek #5556 had a 1°C drop, W Fork Ecola Cr #5204 had a 1°C rise, & Elk Cr No (#5559) had a 1.3°C drop. Such sudden changes at individual site infer that either; a) there might be other signifiant variables, other than harvests, that affect temperature, or b) that there may be unexplainable data aberrations that could distort conclusions if too many fall into one group or the other. The multiple sensors and other techniques used by Cole (Ref h) would have greatly reduces the number of data gaps and aberrations now found through out the Ripstream data.

The above site disturbances and data gaps were not mentioned in published reports (Ref; d & e), and if they had, might have clouded the conclusions offered. Had all post-H year data sets been available, data summaries would have changed and/or different conclusions reached.

Each of these high delta T sites had two-sided harvests and nonuniform BA distribution post-H. Addressing the discrepancies mentioned above is appropriate and overdue. Changing to one-side harvests and a more uniform BA distribution likely could further bring the 5 high Delta T private sites within the 0.3°C standard . A good example of the potential benefit of one-sided harvest and uniform BA distribution is Bridge Forty (# 5502), whose 6020' length, made it the longest site, yet it had 0.0°C delta T.

State Site Temperature Change; Even with no appreciable RMA harvest and ultra-wide buffers, the state sites averaged 0.36°C Delta T rise above their average 0.3°C pre-H warming. Two state sites (#7452 & 5253) had +2.0°C and +2.1°C Delta T and together were responsible for 88% of the Delta T for all 13 state sites. A third state site (#5253) had +1.1°C Delta T, and was responsible for 24% of the total state Delta T. Four state sites warrant comment;

Name	#	Description of state high Delta T site data issues (see Fig A & Fig 3, Ref d)
n/a	7452	Post-H rise of 2°C in 1st yr, no 2nd & 3rd yr,drops to +1.5°C 4th yr, no 5th yr. Results in ave of +1.75°C vs reported +2.0°C
n/a	5253	Post H rise +2.1°C 1st yr, drops to +0.1°C 2nd yr, no 3rd year, <+0.1°C 4th & 5th yr. Results in ave +0.5°C vs reported +2.1°C
n/a	5301	Post-H rise of +1.1°C for 1st thru 5th yrs. This increase is abnormal for a control site & warrants investigation
n/a	5103	2nd yr +0.9C not shown. Fig 3 shows a post-H ave of -0.8°C, which should have been -0.2°C

These discrepancies should have been investigated further, since their cumulative effect is to distort the state site average values. Five other state sites also had significant disturbances(See ref c);

Name	#	Description
Cook East	5101	No Pre-Harvest data. A big landslide dammed stream in '07 near post 3, Missing temperature data for last 2 yrs; '07 & '08

Name	#	Description
Knapp Knob	7801	Beaver dam formed in 1/5 of treatment reach from '05 to '07 from Post 1 to 3. Temperature declined by 0.7°C, then increase to pre-H level after stream bypassed pond in '07
Bale Bond	5104	Major slide around '07 at Post 3, affecting 400' of 1200' treatment reach
Lotta Thin	5355	Beaver dam in '09 affecting 100' of treatment reach from Post 4 & 5.
n/a	7453	No Pre-Harvest, or 2nd, 3rd, & 5th post-H year.

Other state sites lacking post-H data include; #5253 (3rd year), #7452 (2nd, 3rd, 5th year), #7803 (3rd & 4th year), #5354 (5th year).

Each disturbance disrupts the state data set and compromises data quality. Two sites without pre-H data (#5101 & 7453) were mentioned in published reports (Ref; d & e), but were not included in post-H averages shown on Table 1, since lacking a pre-H reference, Delta T is irrelevant.

Figure A shows that post H temperatures could change up to 2°C between subsequent post-H years, yet no attempt was made to explain data aberrations, such as site #5103 was shown with a 1st year -1°C drop, yet there was also a +2°C rise in the 2nd year, resulting in an overall +1°C Delta T, but the second year was not shown in Figure 3. State site #5253 had a +2°C Delta T in the1st year and then dropped -2°C to 0°C in the 2nd year. While both years were shown in the data summary, no attempt was made to explain them, nor why there were such sudden changes for sites without RMA harvest.

As previously discussed, with negligible RMA harvests and wide buffers, state sites collectively form an control group, whose stream temperatures would remain constant under constant weather and hydrologic conditions, but change with the weather. Since private and state sites are similarly influenced, control group changes will also affect the private group. Following harvest, there was an average change of +0.36°C Delta T across state sites and in order to retain the same comparative tracking of the effects of private site harvests, the private average delta T of 0.66°C should be adjusted downward by the 0.36°C change experienced in the control group (i.e. the state site group).

Discussion of ODF report (Ref g)

ODF's report, page 13, last para, claims that "the mean temperature increase was 0.0°C for State Forests", however, the state group actually averaged 0.36°C Delta T rise above the average 0.3°C pre-H warming (see Table 1). This 0.36°F "post-harvest" change, was not due to the effects of harvests, since harvests in state RMAs were negligible. The private site group must also be adjusted by 0.36°F, which will enable appropriate comparisons to be made, to demonstrate change attributable to FPA harvest standards, and not other variables.

The ODF report, (pg 20-21, & Fig 9), discusses "temperature change persistence" , saying that for 15 sites, an average of 50% of the temperature rise across harvest sites (i.e. treatment reach), remained 1000 ft downstream, with a range of 12 to 80%. Newton (Ref b) and Cole (ref h) measured much better temperature recoveries. The average pre-harvest warming was shown to average +1°C/km across all sites and it is inappropriate to presume consistent cooling below this baseline gradient.

Conclusions

Water naturally warms going downhill; Pre-harvest data established that there is an average "natural source" temperature gradient, of about +0.3°C/300m (or 1°C/km) across the Ripstream sites, although other studies have reported values of 0.1 to 2.4°C/km at 20 other sites, with stream size,

gradient, flow, distance from headwaters, and other non-shade variables shown to have an influence on this natural gradient. There are probably other site-specific differences which could affect this value.

A changing tide affects all boats: State pre-harvest stream data was assumed to represent the "natural source" baseline. With changes in weather, streamflow, rainfall, inflow, etc, the average 'post-harvest *control group* temperature will change and, private *post-H temperatures must be adjusted* to maintain the same comparison of changes attributable to FPA harvest standards, rather than other variables.

Mother nature isn't that predictable; Data aberrations of up to 2C have been noted in past studies, and Ripstream is no exception. These cause unexpected heating/cooling, data gaps, and unexplained events. The use of average & statistics tends to mask aberrations and extremes, but variability reigns in natural systems, and in many case, abnormal data is difficult to explain. Computers give the sense that nature can be more accurately described and predicted than is appropriate.

Ripstream data inconsistencies, particularly between Fig A & Fig 3,Ref d, gave rise to numerous uncertainties, data gaps, and unused data. While some are unavoidable w/ natural systems, this makes cause-and-effect algorithms and the identification of key variables an elusive task.

Bibliography

a) Dent, Vick, Abraham, Schoenholtz, & Johnson, 2008, Summer Temperature Patterns in Headwater Streams of the Oregon Coast Range, Journal of the American Water Resources Association
b) Newton & Zwieniecki, 1996,Temperature & Streamflow by Sidestream Cover, ODF Forest Practices Division, OSU Dept of Forest Sciences
c) RipStream Review Committee meeting notes, July 26 2011
d) Groom, Dent, et al, Aug 3, 2011, Response of western Oregon stream temperature to contemporary forest management, Forest Ecology and Management
e) Groom, Dent, et al, 2011, Stream temperature change detection for state and private forests in the Oregon Coast Range, Water Resources Research
f) Oregon Dept of Forestry, July 13, 2015, Riparian Rule Analysis: Additional analyses of riparian prescriptions and considerations for Board decisions
g) Oregon Forest Industries Council (OFIC) Proposal for Protecting Cold Water, April 2015
h) Cole & Newton, Dept of Forest Engineering, Oregon State, Influence of streamside buffers on stream temperature response following clear-cut harvesting in western Oregon

Figure 1
Influence of buffers on Stream Temperature

Fig. 7. Seven day moving mean maxima for the four streams for 2 years preharvest (solid lines) and 4 or 5 years postharvest (broken lines). Arrows pointing up indicate confluences. Symbols represent thermistor locations.

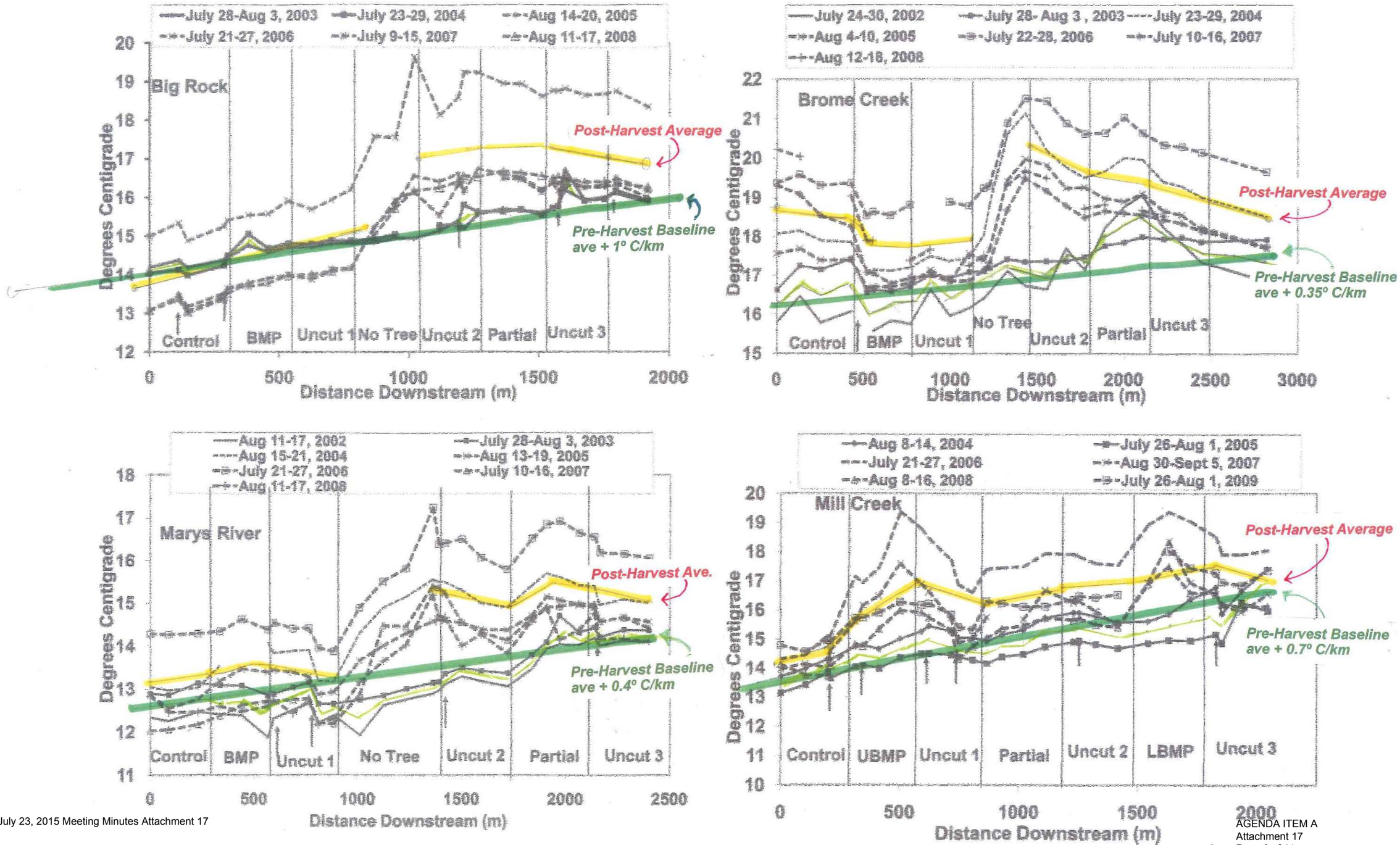

Figure A

Temperature Change (all years)

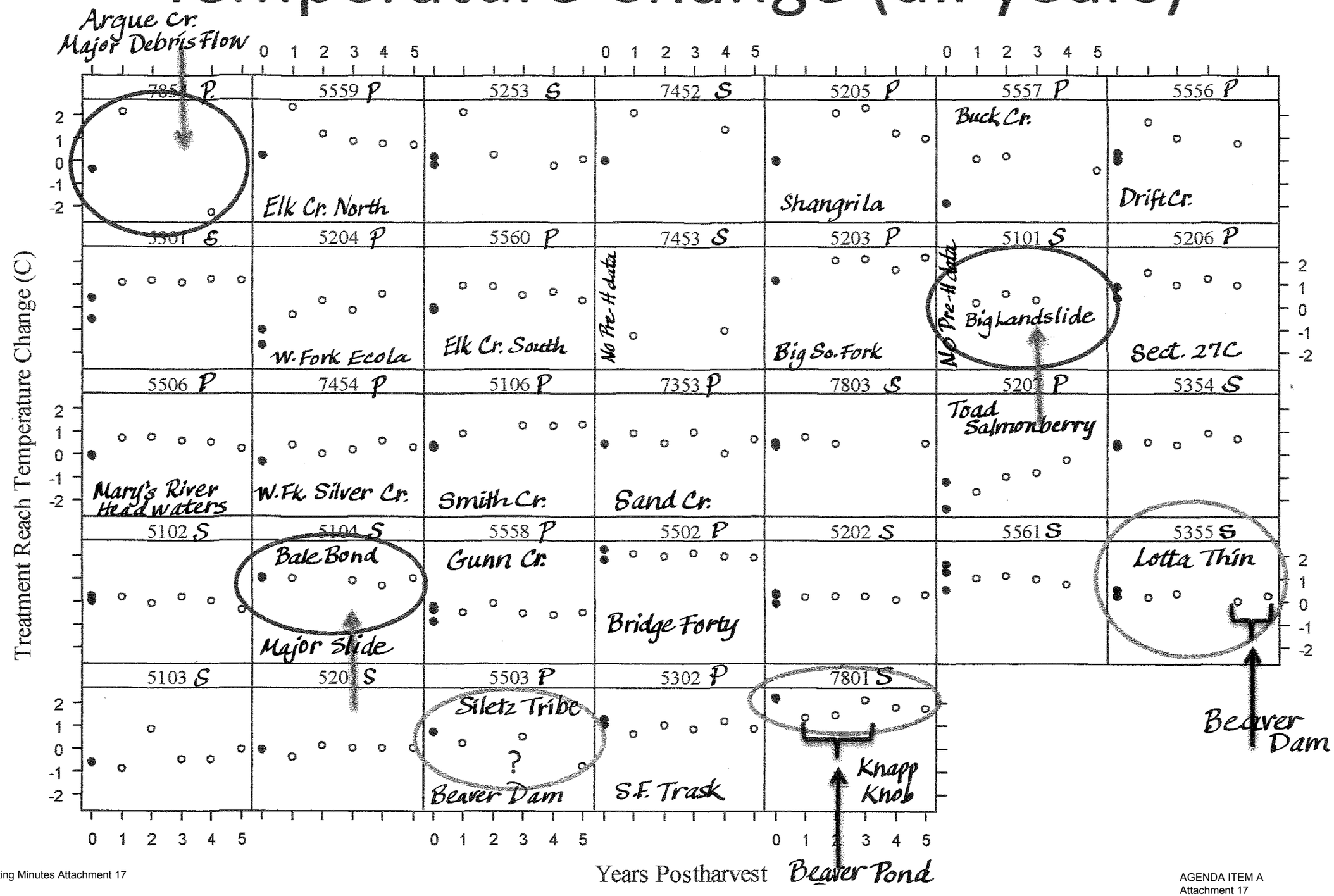

Table 1. Site data from Figure 3 (Ref d) - for 18 Private and 13 state sites

	Private Site #	Pre-Harvest T change C	Post Harvest T change C	Delta T= Human Use Allowance	Delta T category	name, # sides harvested	Length unit ft	Stream Orient	pre H con BA sf/ac	pre H HW BA sf/ac	Post H conifer BA sf/ac	Post H hardwd BA sf/ac	Post H total BA sf/1000'	Ave Height ft	Post H Shade %	grad %	El
Private Med	**5205**	**0**	**2**	**2**	**>0.3 C**	**Shangrila; two**	**1800**	**1/3 NS**	**275**	**31**	**54**	**79**	**152**	**88**	**0.56**	**4.6**	**172**
Private Sml	5560	0	1	1	>0.3 C	Elk Cr So, two	940	NNE	145	21	93	55	170	94	0.51	10.3	941
Private Med	7454	-0.1	0.05	0.15	<0.3C	W F Silver Cr, one side	1565	N to S	116	46	30	100	150	72	0.74	5	898
Private Sml	**5559**	**0.25**	**1.5**	**1.25**	**>0.3 C**	**Elk Cr No, two**	**1000**	**NNE**	**153**	**38**	**63**	**77**	**160**	**98**	**0.53**	**10.5**	**941**
Private Med	5556	0.1	1.1	1	>0.3 C	Drift Creek, two side	1050	E to W	127	40	75	72	169	96	0.69	8.1	926
Private Med	**7854**	**-0.1**	**2**	**2.1**	**>0.3 C**	**Argue Cr; two**	**1370**	**W to E**	**86**	**68**	**50**	**91**	**162**	**103**	**0.76**	**2.4**	**600**
Private Med	**5557**	**-1.9**	**0.05**	**1.95**	**>0.3 C**	**Buck Crk, two**	**1600**	**NW to SE**	**73**	**110**	**34**	**78**	**128**	**77**	**0.69**	**17.5**	**1157**
Private Sml	5506	-0.05	0.6	0.65	>0.3 C	Mary's River HW, two	1070	N to S	26	107	13	78	104	94	0.73	6.7	1582
Private Med	5206	0.6	1.1	0.5	>0.3 C	Sect 27 C. two	1600	E to W	216	31	164	74	273	100	0.79	10	429
Private Med	5558	-0.5	-0.4	0.1	<0.3C	Gunn Crk, two side	1000	N to S	132	22	124	41	189	82	0.84	4.7	586
Private Med	5207	-1.7	-1.2	0.5	>0.3 C	Toad Salmonberry, one	3161	SW to NE	137	46	80	60	161	76	0.87	6.6	1798
Private Sm	5106	0.25	0.35	0.1	<0.3C	Smith Cr; two side	3201	E to WSW	58	95	37	97	154	64	0.87	8	267
Private Med	**5204**	**-1.2**	**-0.2**	**1**	**>0.3 C**	**W Fork Ecola Cr, two**	**2601**	**SE to NW**	**209**	**24**	**95**	**98**	**221**	**73**	**0.83**	**5.6**	**1071**
Private Med	5302	1.1	0.5	-0.6	<0.3C	SF Trask, two	2901	E to W	114	43	107	64	196	94	0.86	3.6	2000
Private Med	5203	1.1	1.2	0.1	<0.3C	Big So Fork, two side	2201	E to W	197	45	122	72	222	78	0.84	5	713
Private Med	7353	0.4	0.7	0.3	<0.3C	Sand Cr, one	2271	N to S	129	23	89	18	123	85	0.88	1.4	400
Private Med	5503	0.6	0.3	-0.3	<0.3C	Siletz Trib, two	2501	SW to NE	57	145	19	131	172	79	0.85	1	13
Private Med	5502	2	2	0	same	Bridge Forty,one	6020	various	153	13	114	0	131	59	0.85	5.1	2952
# sites	**18**	**18**	**18**	**18**	**7 / 1 / 10**												
Ave T Change=		**0.05**	**0.70**	**0.65556**		**ave=**	**2103**		**134**	**53**	**76**	**71**	**169**	**84**	**0.76**	**6.5**	**969**

Ave Delta T Above "natural source" warming= 0.66 C

Adjust for ave. post-H control site change= -0.36 C

Adjusted Ave Delta T above "natural source"= 0.30 C

Name	State Site #	Pre- H T change C	Post-H T change C	Delta T= Human Use Allowance	Delta T category	Site notes;
Bale Bond	5104	0.9	1	0.1	<0.3C	major slide '07 in 100' of treatment reach
Cook East	5101	no Pre Harvest data			-	big landslide dam in '07, no data last 2 yr:
Lotta Thin	5355	0.15	0.15	0	same	beaver dam in 100' of treatment reach, '0:
State	5354	0.25	0.3	0.05	<0.3C	
State	**7452**	**0**	**2**	**2**	**>0.3 C**	
State	5103	-0.8	-0.8	0	same	
State	**5301**	**0**	**1.1**	**1.1**	**>0.3 C**	
State	7803	0.25	0.3	0.05	<0.3C	
State	5202	0.1	0.1	0	same	
State	5561	1.1	1	-0.1	<0.3C	
State	5102	0.1	0	-0.1	<0.3C	
State	**5253**	**0**	**2.1**	**2.1**	**>0.3 C**	
Knapp Knob	7801	1.9	1.4	-0.5	<0.3C	beaver dam in treatment reach, '05-'07
State	5201	-0.05	-0.1	-0.05	<0.3C	
State	**7453**	**n/a no Pre Harvest data**				
# sites	**15**	**13**	**13**	**13**	**7 / 3 / 3**	
Ave Temp=		**0.30**	**0.66**	**0.36**		See Reference d)

Ave Delta T Above "natural source" warming

average post-H control site change= 0.36 C

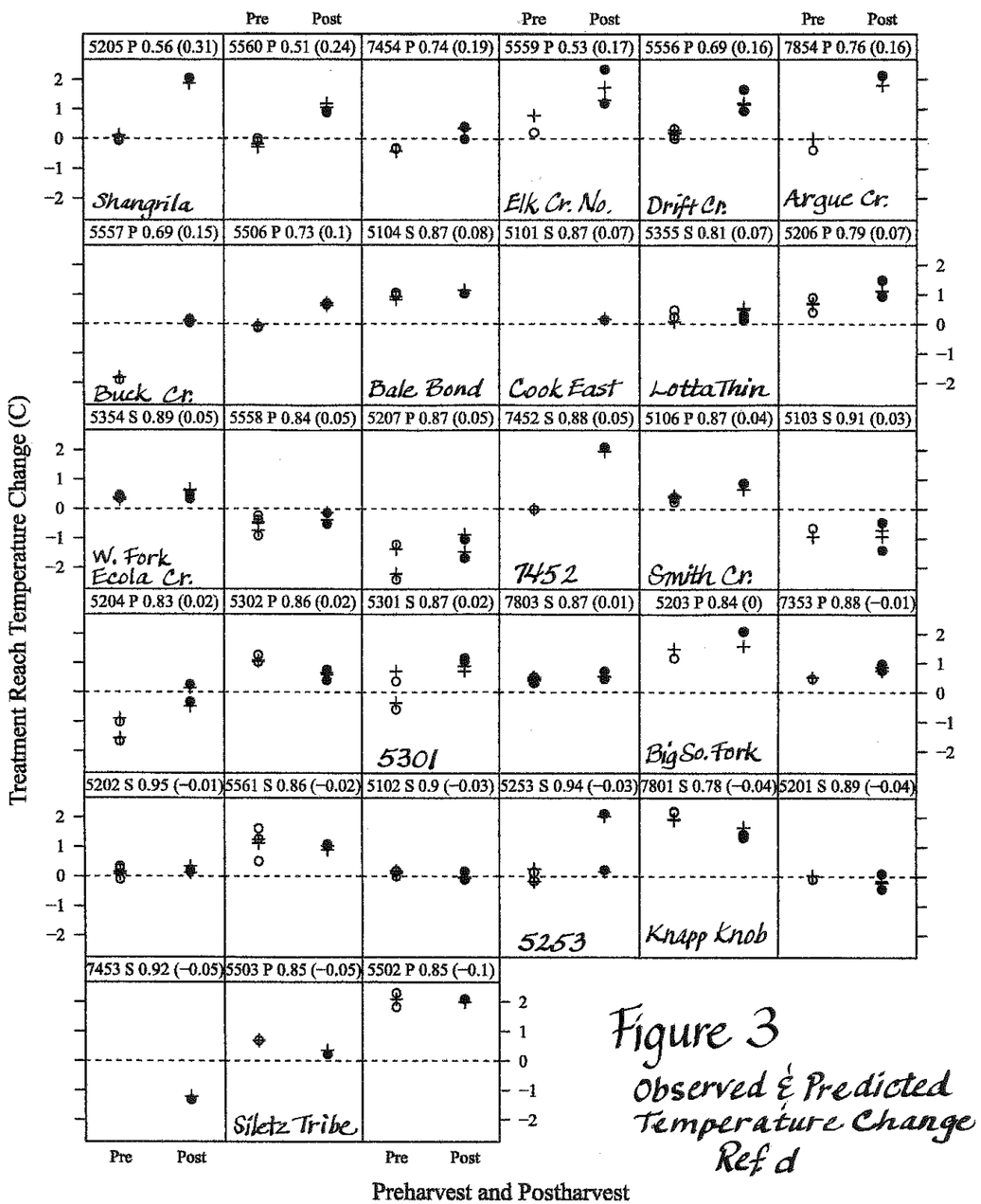

Figure 3
Observed & Predicted Temperature Change
Ref d