

DETAILED ANALYSIS - PREDICTED TEMPERATURE CHANGE RESULTS

For each no-cut and variable retention buffer prescription, we simulated harvest by removing, from pre-harvest stand data, each tree that fell outside of the prescription requirements. We then summarized the remaining tree data according to the needs of the predictive model. Next, we ran the predictive model with the simulated findings and produced predicted temperature outcomes (for more information on the model, see Attachment 3 from the April 2015 Board of Forestry meeting).

All alternative prescriptions fell outside the scope of our ability to model them fully. Some inferences from other prescription outcomes may be relevant, but the predictive model was otherwise not used to estimate their effectiveness.

No-Cut buffers

Estimated temperature responses for the No-cut (a.k.a. “no-harvest”) Buffer prescriptions are presented as continuous values, from 20 to 120 feet slope distance (Figure 1), estimated in 10-foot intervals. The average temperature increase for a 90 foot buffer lies below the Protecting Cold Water (PCW) criterion threshold of 0.3 °C increase (mean = 0.29 °C, 95% CI = 0.07 to 0.52 °C). The values in the Decision Matrix are across-site averages and do not portray predicted individual site responses. The matrix focuses on the mean results from no-cut distances of 50, 70, 80, 90, and 100 feet.

The curve of the mean in Figure 1 and the accompanying credibility intervals portray two features about the relationship between buffer width and temperature increase. The first is that the steepness of the curve declines with distance. This indicates that the thermal protection offered by increasing buffer widths begins to decline beyond 50 - 60 feet. For example, for the increase between 80 and 90 feet we see less of a decline in stream temperature increase than we did between 30 and 40 feet. The Figure indicates that the wider the buffer, the less risk there is of exceeding the Protecting Cold Water criterion.

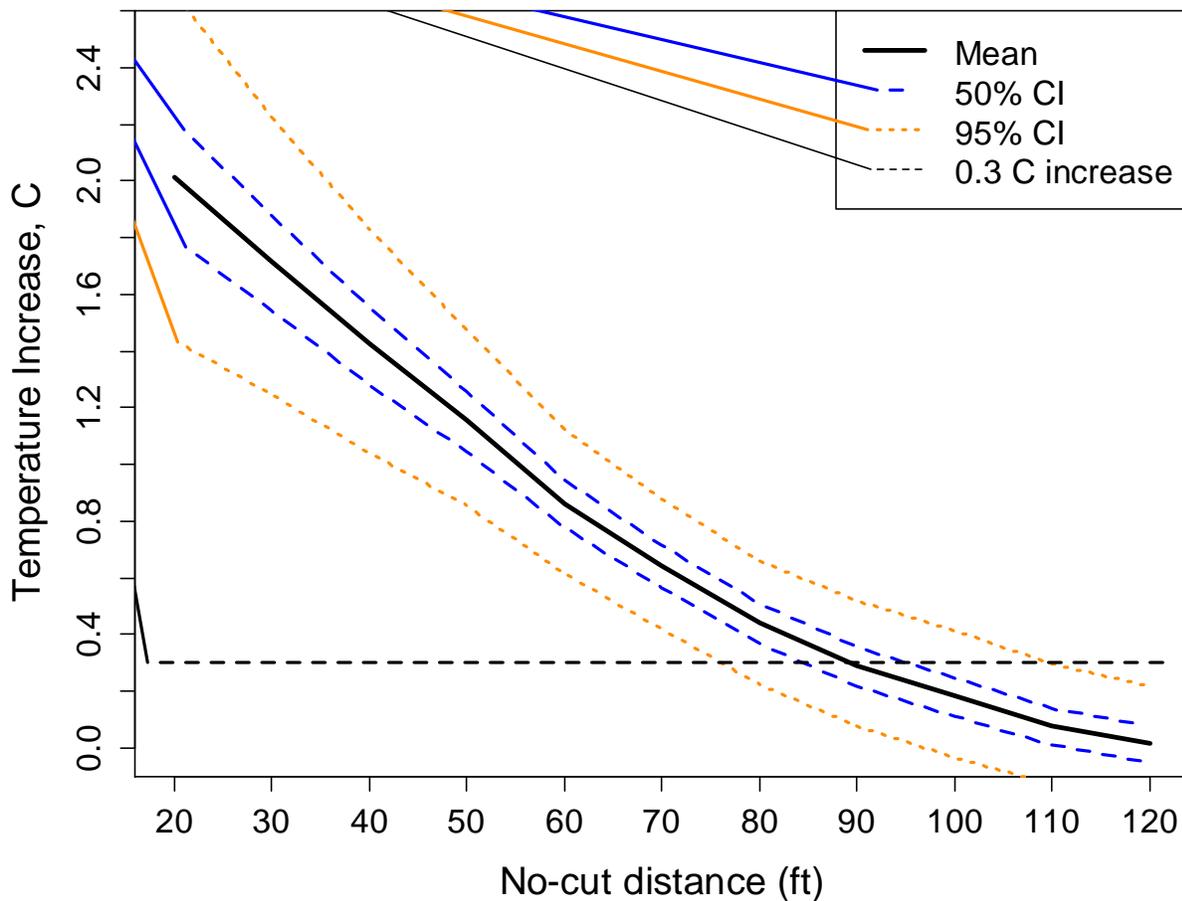


Figure 1. Mean temperature responses among all sites to simulated harvests at set slope distances from the stream. The black line indicates the mean response of the 33 sites, the dashed blue line represents a 50% Credibility Interval (CI) and the dashed orange line a 95% CI. The horizontal dashed black line indicates the PCW threshold of 0.3 °C.

Variable-Retention Buffers

We analyzed several different variable retention buffer prescriptions. Prescriptions' predicted temperature increases varied between the bookends provided by the current Forest Practices Act (FPA) and State Forest Northwest Forest Management Plan (FMP) simulations.

Several variable retention buffer prescriptions were tailored specific to small and medium type-F streams. We present an average predicted response of the 33 RipStream sites, combining results for small and medium streams. Across the landscape, the proportion of small and medium SSBT stream miles are roughly proportional to the number of small and medium RipStream sites. Therefore, we assume that the average response is representative of temperature response at a landscape level.

Prescription: FPA

The FPA prescription demarcates one of the bookends under consideration. On average the predicted mean temperature increase is 1.45 °C (95% CI = 1.1 to 1.8 °C; Figure 2).

A note about many of the subsequent figures: the predictive analysis process produces 1,000 separate findings for each prescription. The summarization of these findings become the analysis results. Results are frequently portrayed as boxplots (e.g., figure 2). Within a boxplot, the line in the middle of the boxes represents the mean of the 1,000 findings. The top and bottom extent of the boxes indicate the 25th and 75th percentiles, or the region in which 50% of the findings fall. The lines (tails) extending from the box demonstrate the range in which 95% of the findings fall. This 95% range is also the 95% credibility interval (there is a 95% chance this prescription will result in an effect within this range). The remaining circles are individual findings that fell beyond those ranges.

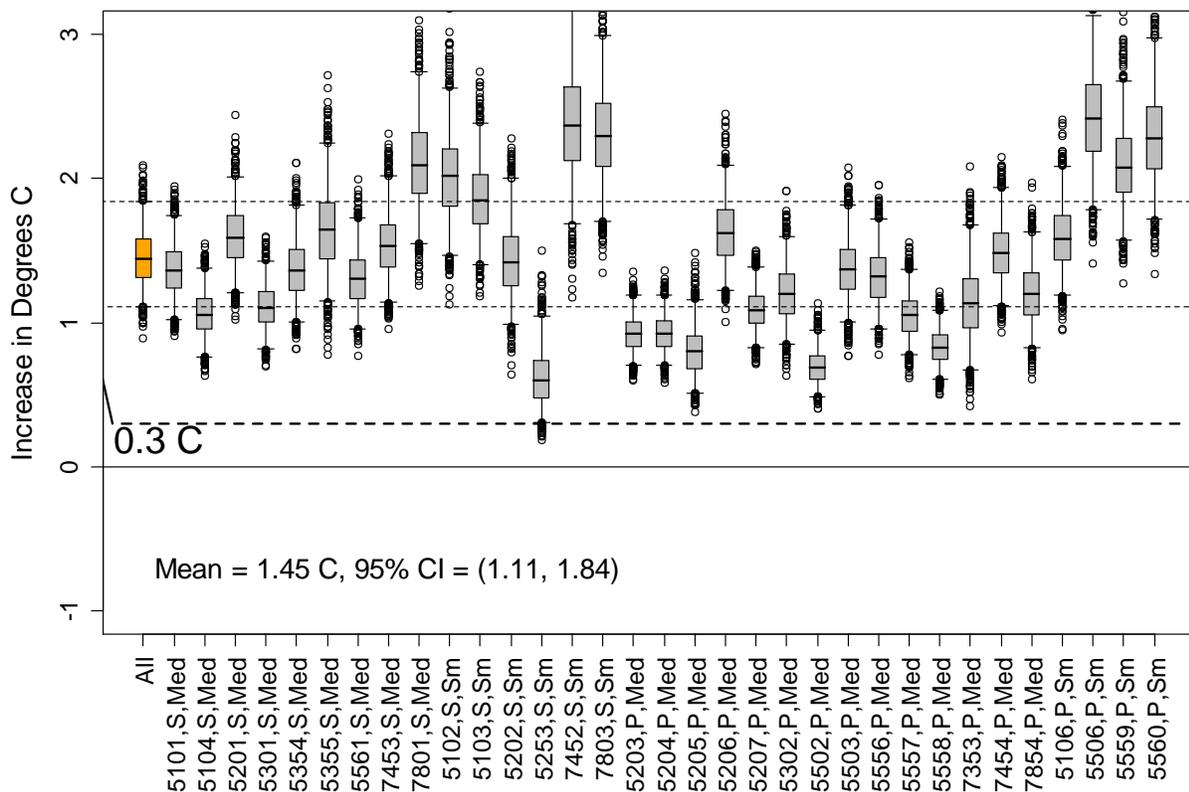


Figure 2. Temperature responses to simulated private forest FPA harvest. The orange boxplot for the All category on the far left represents the estimated average response of all sites. The grey boxplots each represent the predicted response of each site. The thick dashed line indicates the PCW threshold of 0.3 °C while the thin dashed lines represent the 95% credibility interval for the All category.

Prescription: OFIC-E

This prescription results in clarification of expectations for the distribution of RMA trees and an increase in basal area retention for medium streams. Under this scenario we predict a temperature increase of 1.37 °C (95% CI = 1.04 to 1.78 °C; Figure 3).

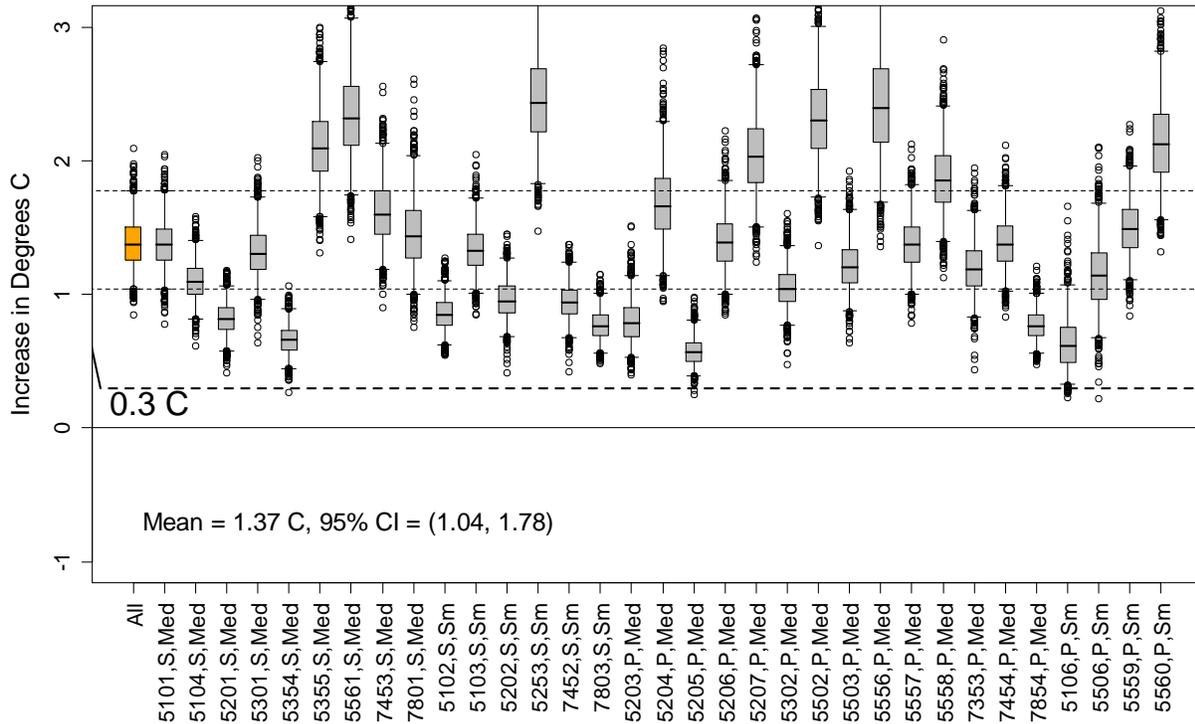


Figure 3. Temperature responses to simulated OFIC-E prescription. The orange boxplot for the All category on the far left represents the estimated average response of all sites. The grey boxplots each represent the predicted response of each site. The thick dashed line indicates the PCW threshold of 0.3 °C while the thin dashed lines represent the 95% credibility interval for the All category.

Prescription: AOL-B

AOL-B increases basal area for small and medium streams by 20 ft², which would preferentially consist of hardwood. Under this scenario, we predict a temperature increase of 1.31 °C (95% CI = 0.99 to 1.67 °C; Figure 4).

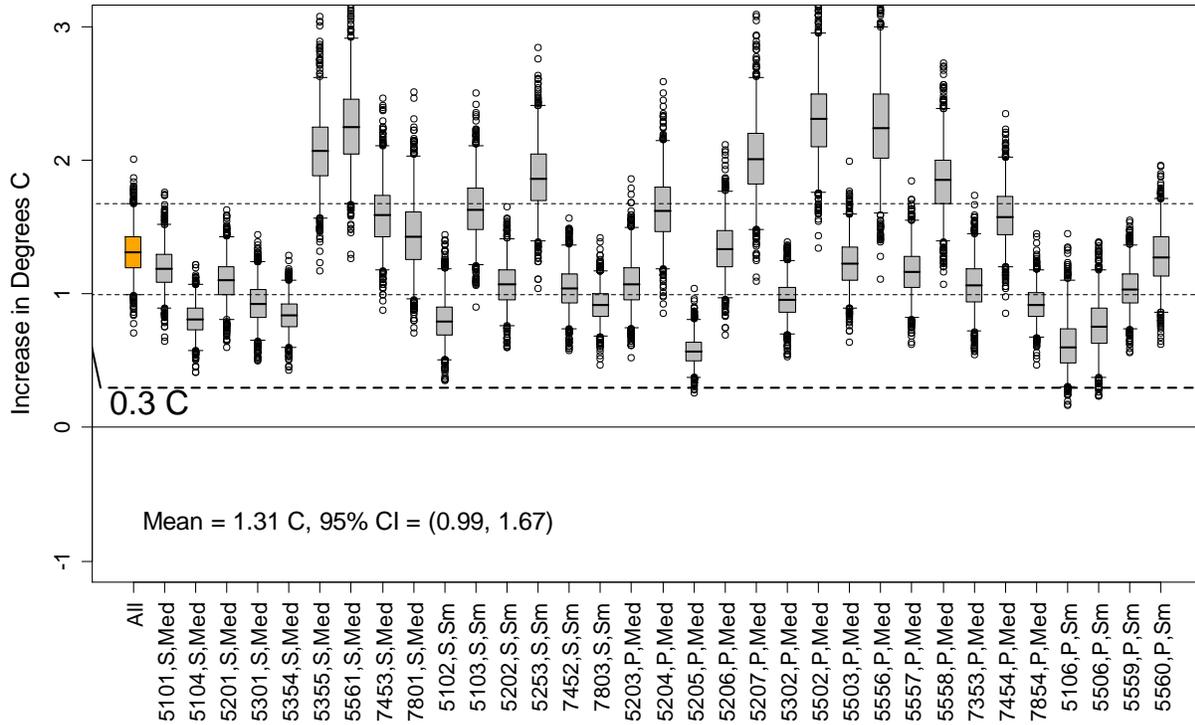


Figure 4. Temperature responses to simulated AOL-B prescription. The orange boxplot for the All category on the far left represents the estimated average response of all sites. The grey boxplots each represent the predicted response of each site. The thick dashed line indicates the PCW threshold of 0.3 °C while the thin dashed lines represent the 95% credibility interval for the All category.

Prescription: RFPC-A

In general, this prescription was slightly more protective than the FPA harvest. Many sites on small streams met their conifer and hardwood basal area targets within the 20-foot no-cut distance, leading to little difference between the two prescriptions. The mean predicted temperature increase was 1.25 C (95% CI = 0.94 to 1.59 °C; Figure 5).

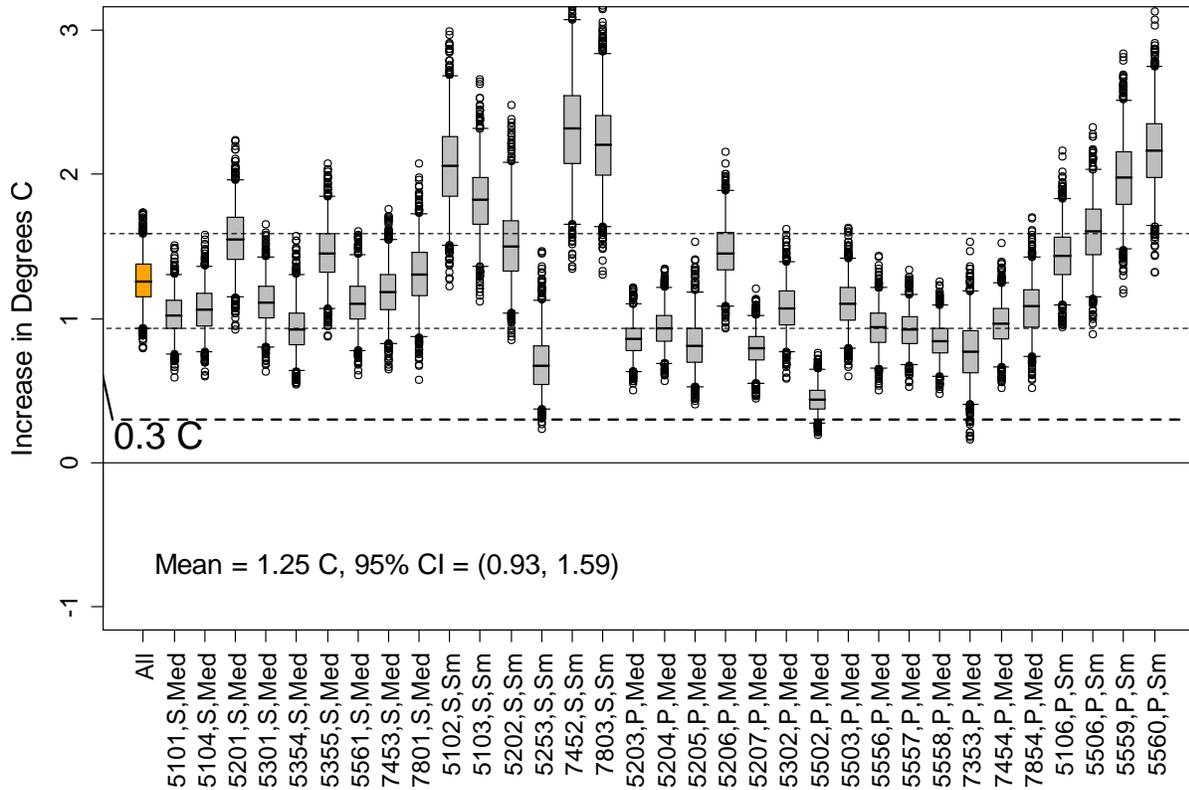


Figure 5. Temperature responses to simulated variable retention prescription RFPC-A. The orange boxplot for the All category on the far left represents the estimated average response of all sites. The grey boxplots each represent the predicted response of each site. The thick dashed line indicates the PCW threshold of 0.3 °C while the thin dashed lines represent the 95% credibility interval for the All category.

Prescription: VR-70/200

Under this scenario the mean predicted temperature increase was 0.87 °C (95% CI = 0.66 to 1.15 °C; Figure 6). Note that a prescription of only a 70-foot no cut buffer (in effect, this prescription with no basal area target) appeared unlikely to meet the PCW (0.3 °C).

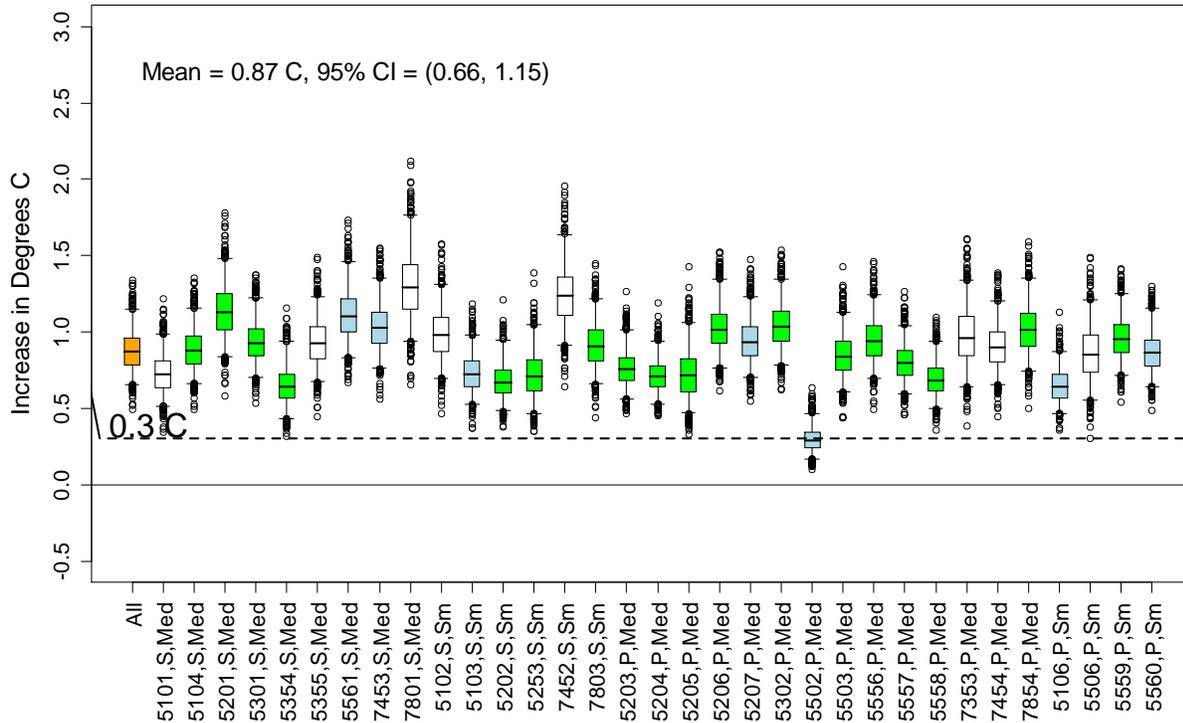


Figure 6. Temperature responses to the VR 70/200 simulation. The orange boxplot for the All category on the far left represents the estimated average response of all sites. The grey boxplots each represent the predicted response of each site. The thick dashed line indicates the PCW threshold of 0.3 °C while the thin dashed lines represent the 95% credibility interval for the All category. Green boxes indicate that both sides of the stream had more than 200 ft²/1000 ft. within the 70 ft. RMA width and were therefore harvested. White boxes indicate neither side met the basal area target; therefore, neither side of the RMA was harvested below the RMA width. Blue boxes indicate one side was harvested to the basal area target while the other was harvested only to the RMA width.

Prescription: VR-80/250

Under this scenario the mean predicted temperature increase was 0.59 °C (95% CI = 0.37 to 0.82 °C; Figure 7), indicating that the prescription was unlikely to meet the PCW.

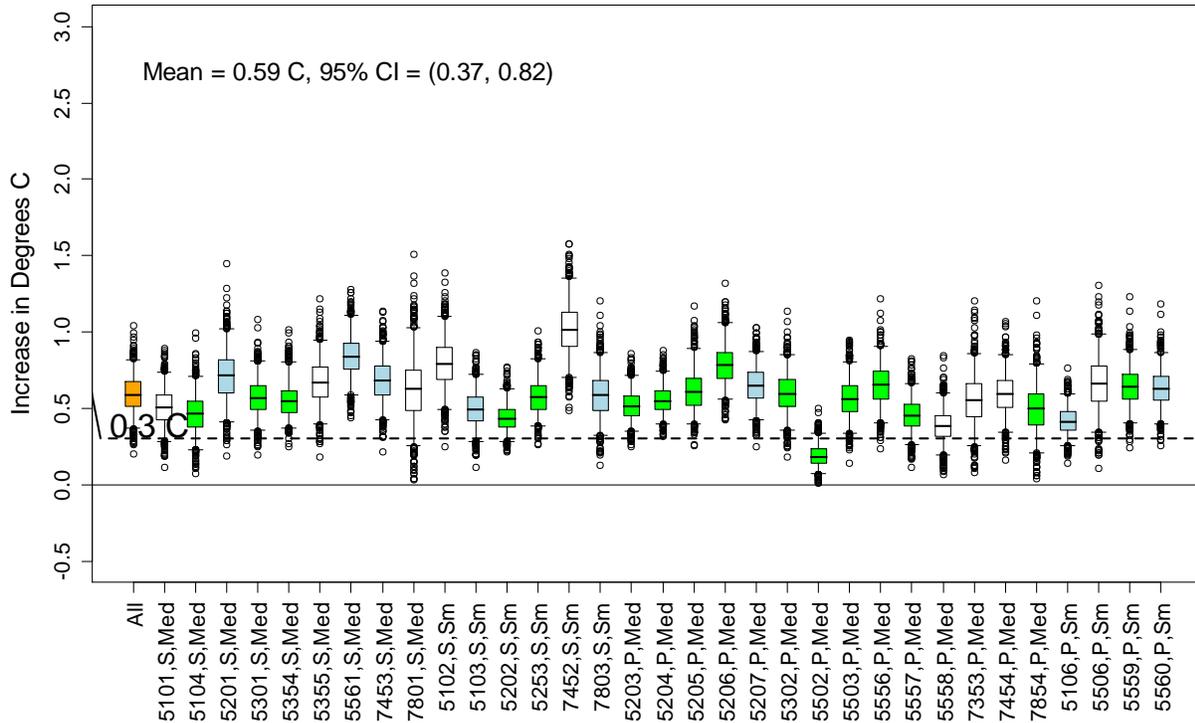


Figure 7. Temperature responses to the VR 80/200 simulation. The orange boxplot for the All category on the far left represents the estimated average response of all sites. The grey boxplots each represent the predicted response of each site. The thick dashed line indicates 0.3 °C while the thin dashed lines represent the 95% credibility interval for the All category. Green boxes indicate that both sides of the stream had more than 250 ft²/1000 ft. within the 80 ft. RMA width and were therefore harvested. White boxes indicate neither side met the basal area target; therefore, neither side of the RMA was harvested below the RMA width. Blue boxes indicate one side was harvested to the basal area target while the other was harvested only to the RMA width.

Prescription: VR-170/275

The 0.3 °C increase level intersects the mean predicted temperature change at approximately 280 square feet, with 95% credibility intervals including 0.3 °C between 240 and 370 square feet (Figure 8). At 275 ft.² the mean buffer width of all plots considered was approximately 85 ft. slope distance. Therefore, this representation of the data shares much in common with the no-cut buffer simulation described above in Figure 1. Figure 9 demonstrates predicted individual site responses to harvest with a basal area target of 275 ft² per 1,000 ft. At 275 ft.² per 1,000 ft., buffer widths for individual sides of the streams varied from 30 to 168 ft. The averages of both banks varied from 40 to 131 ft. On average, this prescription is very close to meeting the PCW.

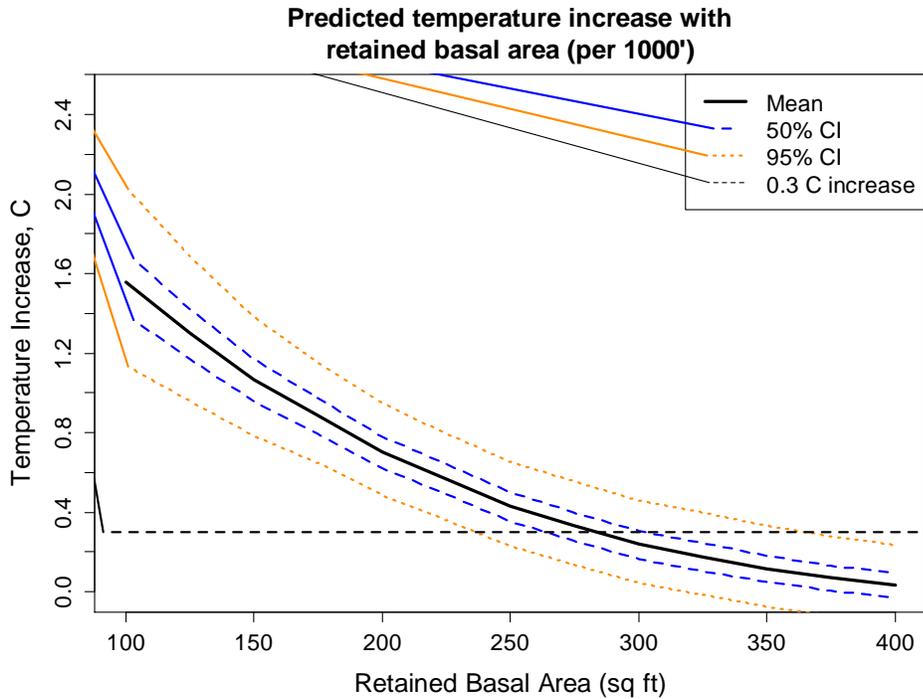


Figure 8. Mean temperature responses among all sites to simulated harvests at set basal area targets. The black line indicates the mean response of the 33 sites, the dashed blue line represents a 50% Credibility Interval (CI) and the dashed orange line a 95% CI. The horizontal dashed black line indicates 0.3 °C.

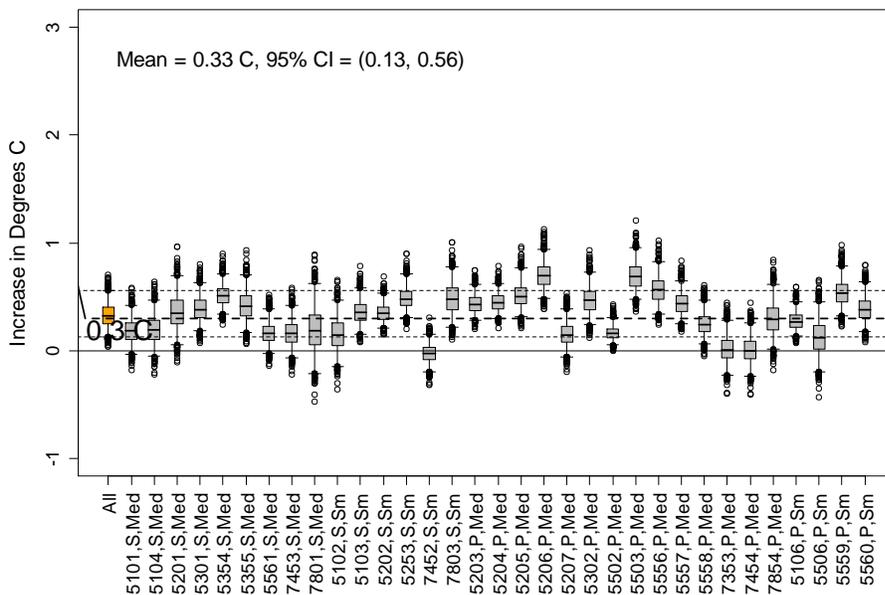


Figure 9. Temperature responses at 275 ft²/1000 ft. of basal area retained at all sites, from the VR-170 simulation prescription. The orange boxplot for the All category on the far left represents the estimated average response of all sites. The grey boxplots each represent the predicted response of each site. The thick dashed line indicates 0.3 °C while the thin dashed lines represent the 95% credibility interval for the All category.

Prescription: FMP

As described at the April 22, 2015 Board meeting, the predicted temperature increase was 0.20 °C (95% CI = 0.04 – 0.37 °C; Figure 10). On average, this prescription is predicted to meet the PCW.

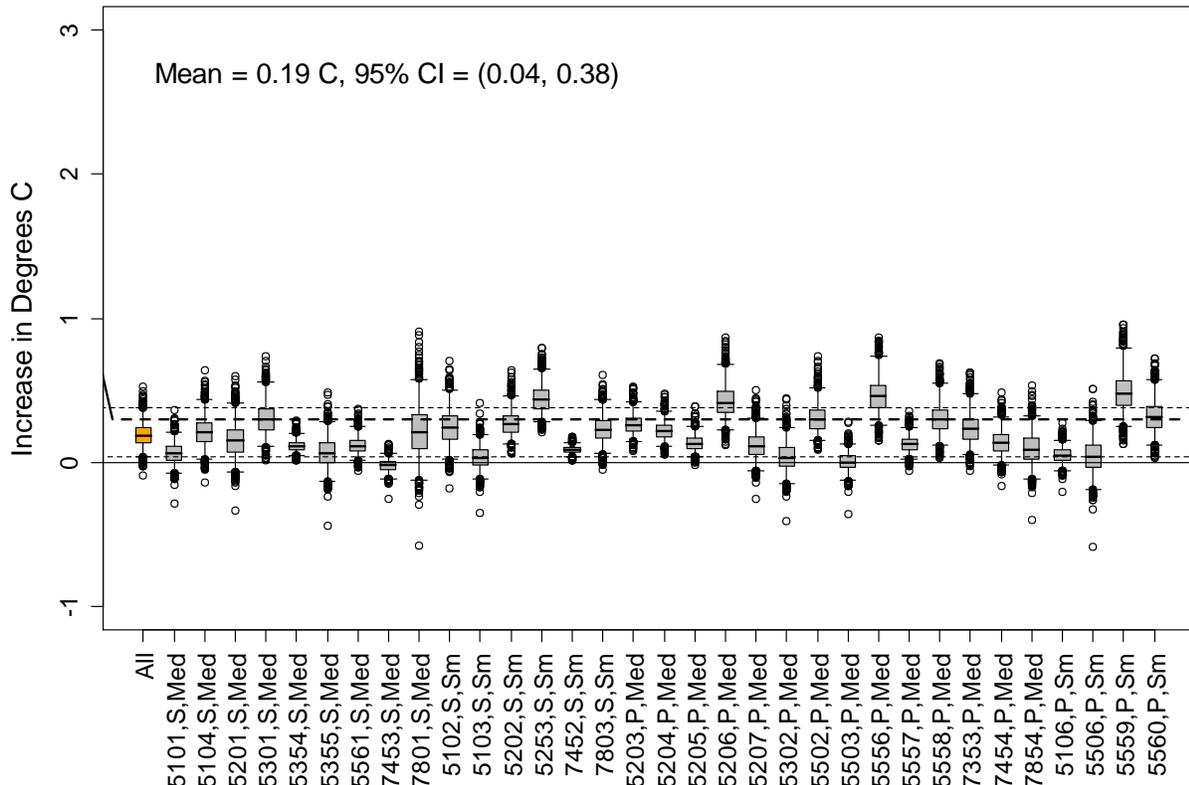


Figure 10. Temperature responses to simulated State Forest NWFMP harvest. The orange boxplot for the All category on the far left represents the estimated average response of all sites. The grey boxplots each represent the predicted response of each site. The thick dashed line indicates the PCW threshold of 0.3 °C while the thin dashed lines represent the 95% credibility interval for the All category.

Alternate Prescriptions

For staggered harvests, we could only model the first entry in these cases, as the RipStream study design relied on simultaneous harvest of both riparian banks or leaving one side unharvested during the study. The prediction model can be used to predict the temperature increase from a single-sided harvest, as occurred with the harvesting of the first bank. We do not present model results for the harvest of the second bank, as the model is not informed by sites that experienced a green-up period of the harvested bank prior to the harvesting of the second bank. We therefore do not know whether the shade response of such sites would be equivalent to a simultaneous harvesting of both banks. The response of the understory to additional light reaching the stream in the first entry could result in a more resilient shading canopy for the second entry; the degree remains unknown.

Prescription: RFPC-B

Temperature increase from the first year's entry (one-sided 50' and 70' buffers) was predicted to be 0.65 °C (95% CI = 0.44 to 0.89 °C; Figure 11). Therefore, the prediction will not likely meet the PCW. We could not use the model to predict a temperature increase for the second entry.

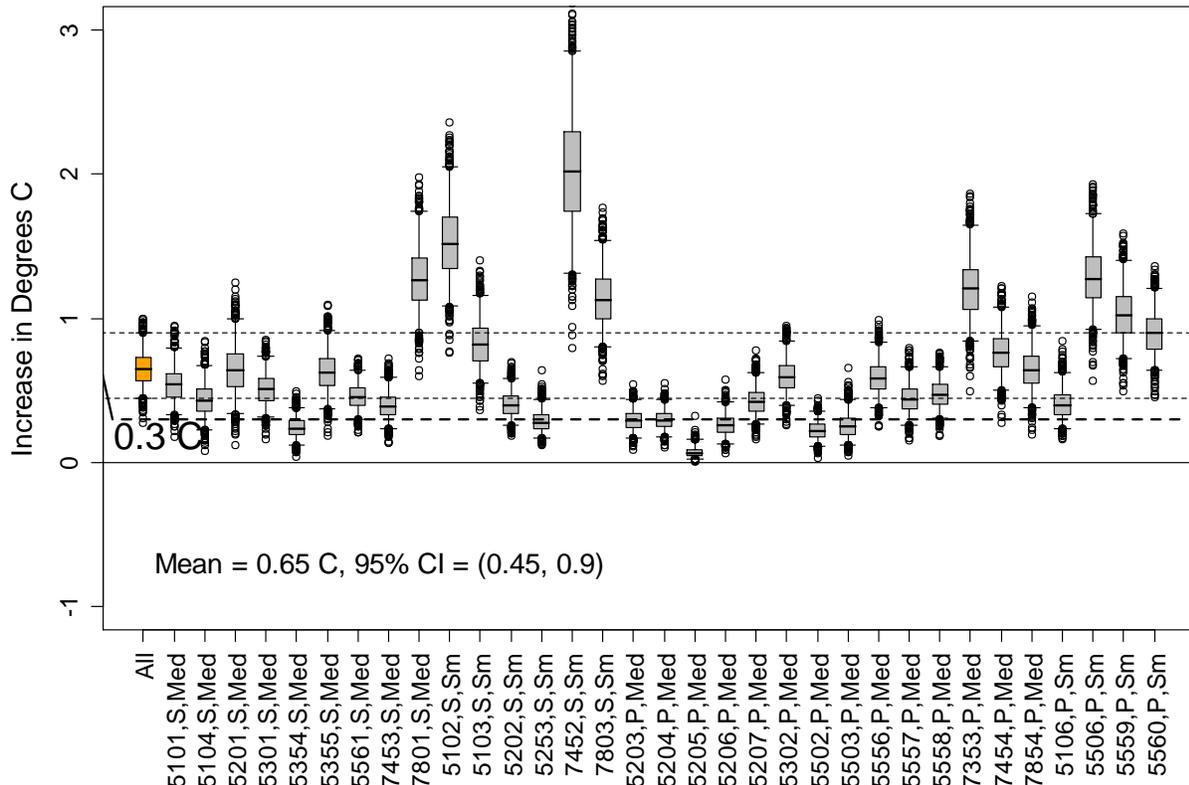


Figure 11. Temperature responses to simulated RFPC-B harvest for the first entry. The temperature response for the second entry cannot be modeled based on RipStream data. The orange boxplot for the All category on the far left represents the estimated average response of all sites. The grey boxplots each represent the predicted response of each site. The thick dashed line indicates the PCW threshold of 0.3 °C while the thin dashed lines represent the 95% credibility interval for the All category.

Prescription: OFIC-C and AOL-A

Since we modeled the first entry only, we treated these as the same prescription. Mean predicted stream temperature response was 0.97 °C (95% CI = 0.50 to 1.45 °C; Figure 12). We do not have a predicted temperature increase for the second entry.

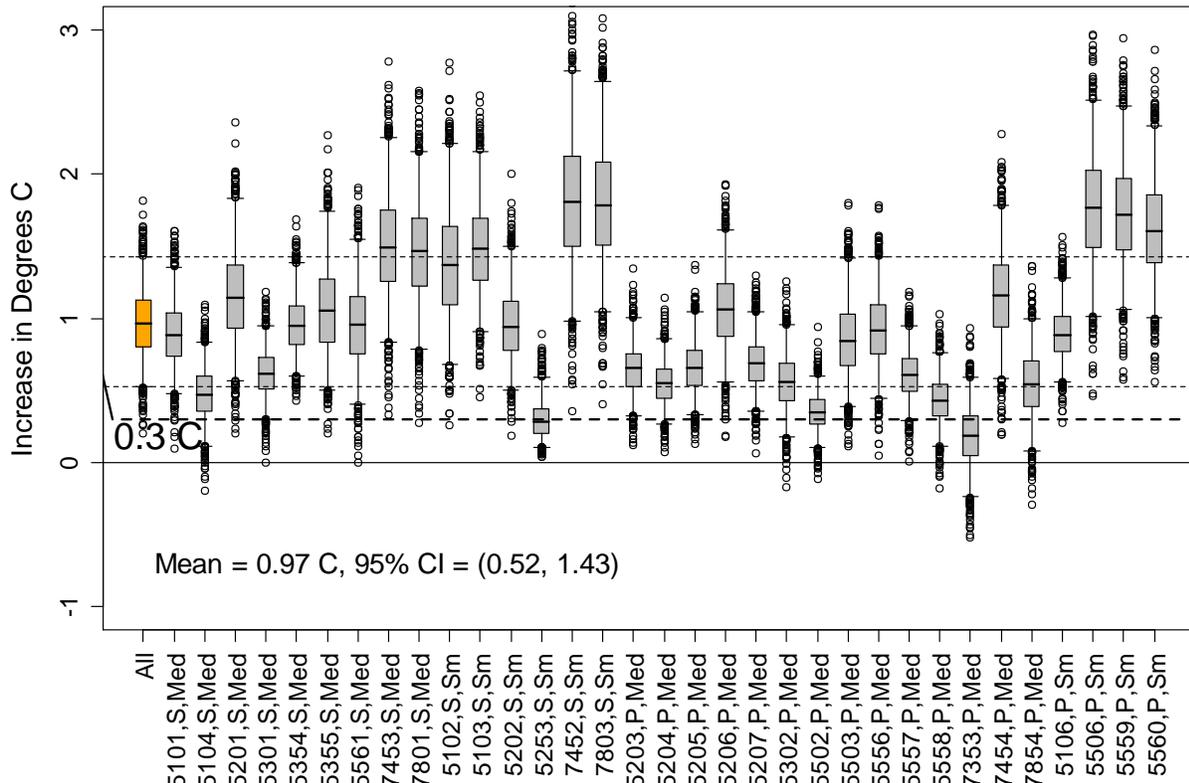


Figure 12. Temperature responses to simulated AOL-A / OFIC-C harvest for the first entry. The temperature response for the second entry cannot be modeled based on RipStream data. The orange boxplot for the All category on the far left represents the estimated average response of all sites. The grey boxplots each represent the predicted response of each site. The thick dashed line indicates 0.3 °C while the thin dashed lines represent the 95% credibility interval for the All category.

South-sided buffers

We did not explicitly model south-sided buffer prescriptions, as the predictive model was not informed by stream orientation.

Prediction Results Summary

Of modeled scenarios, we found that 90' and 100' no-cut buffers, variable retention buffers with a 170' wide RMA and 275 ft² of basal area retained /1,000 ft. of stream, and the state forest FMP were likely to meet the PCW criterion almost or more than 50% of the time. The range of temperature increase responses to the no-cut buffer demonstrate that increasing buffer widths produces a decrease in risk of exceeding the PCW and a decline in buffer effectiveness with distance. The partially modeled scenarios, OFIC-C, AOL-A, and RFPC-B, did not appear likely to meet the PCW after the first harvest entry.