

Temperature Total Maximum Daily Loads for the John Day River Basin

Technical Support Document Appendix B: Heat Source Model Scenario Report

October 2026 – Public Comment Review Draft



Document information

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Front cover: John Day River at Muleshoe Campground. Picture by Victoria Avalos.

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1 Introduction

Once stream temperature models were calibrated (see **TSD Appendix A**), scenarios that represent different sets of conditions were developed by changing one or more the input values. The scenarios were intended to represent “natural” conditions such as potential vegetation, flow and channel morphology. The goal was to combine the various scenario inputs into one background scenario, which estimated the instream temperatures free from anthropogenic influences. The methodologies for developing these scenarios are described in Section 3 below.

The Heat Source model was used to predict hourly stream temperatures, solar radiation fluxes, daily effective shade, and stream temperature responses. The map in **Figure 1-1** provides an overview of where the Heat Source model was used to simulate conditions.

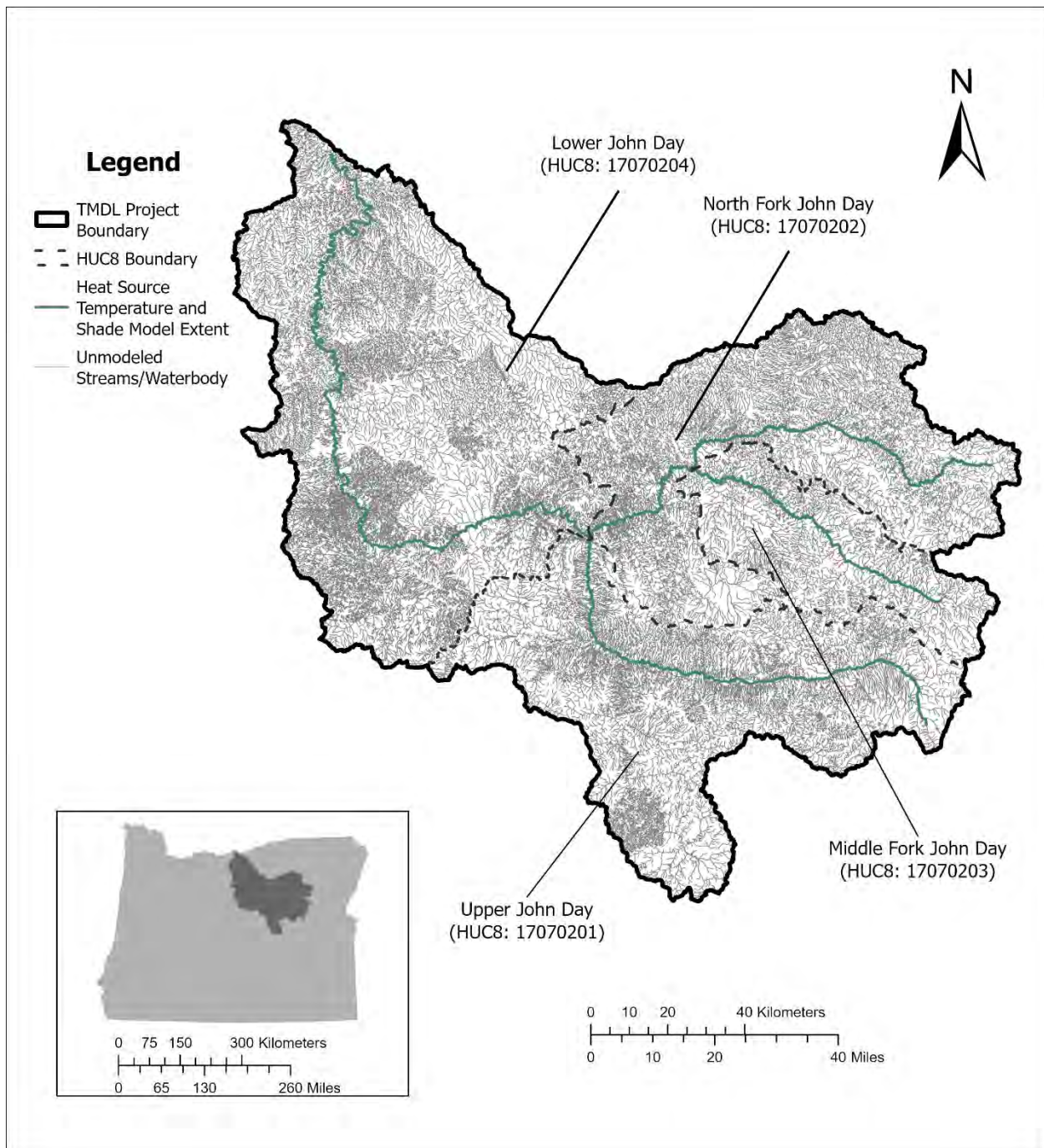


Figure 1-1: Overview of TMDL project area with model extents.

2 Model analysis and interpretation

This section discusses the calculation metrics that were used when evaluating the scenarios.

2.1.1 Significant digits and rounding

The TMDL analysis and interpretation of all model and scenario results accounted for significant digits and rounding. To evaluate human use allowance (HUA) attainment, DEQ calculates and records values to the hundredths (0.01°C). Because DEQ assigns some source sector HUAs to the hundredths, attainment is tracked with equal precision. The TMDL analysis follows the rounding procedures outlined in a DEQ permit-related internal management directive (IMD) on rounding and significant digits (DEQ, 2013b). This IMD says that for “calculated values” (which includes model results), if the digit being dropped is a “5,” it is rounded up. For example, if an HUA allocation is set at 0.05°C and the model shows warming equal to 0.054°C, the value is rounded down to 0.05°C and the result is attainment. If the model shows warming equal to 0.055°C, the value is rounded up to 0.06°C and the result is non-attainment.

2.1.2 Calculating the 7-Day Average Daily Maximum temperature

For each scenario the 7DADM temperature was calculated using the hourly model output. The 7DADM was calculated using the procedure outlined in DEQ’s Temperature IMD (DEQ, 2008). As outlined in this IMD, the 7DADM temperature is calculated by (i) calculating the daily maximum for each day and each location, then (ii) calculating a 7-day rolling average of the daily maximums, the result for which lands on the 7th day and is considered the 7DADM for that day. Following transition to a new fish use designation (such as spawning), the first day that the 7DADM is reported occurs on the 7th day after the new fish use designation begins. For example, if spawning begins October 15, the first 7-day period would be October 15 to 21, with the first 7DADM temperature reported on October 21.

2.1.3 Biologically based numeric criteria

The applicable Oregon temperature criteria for the John Day River Basin are defined in DEQ water Quality Standards, Chapter 340 (OAR 340-041-0170, Table 170B) and are summarized below:

- 20°C (68.0°F) - Migration corridors
- 18°C (64.4°F) - Salmon & Trout Rearing and Migration
- 16°C (60.8°F) - Core cold water habitat
- 13°C (55.4°F) - Salmon and Steelhead Spawning
- 12°C (53.6°F) - Bull trout spawning and juvenile rearing use

These criteria are referenced in rule as the biologically based numeric criteria (or BBNC). The BBNC vary spatially and temporally and are evaluated based on 7DADM temperature.

3 Model scenarios

This section describes the model conditions associated with each of the scenarios. The results of these scenarios are found in **Section 4**, where results are organized by model.

3.1 Restored vegetation

Restored vegetation, sometimes referred to as system potential vegetation, is an estimate of the mature species composition, height, and density of vegetation that would occur in the absence of human disturbances. Restored vegetation conditions were used in stream temperature modeling scenarios to quantify the impacts of nonpoint source solar radiation loads, and ultimately to develop nonpoint source load allocations for the TMDL.

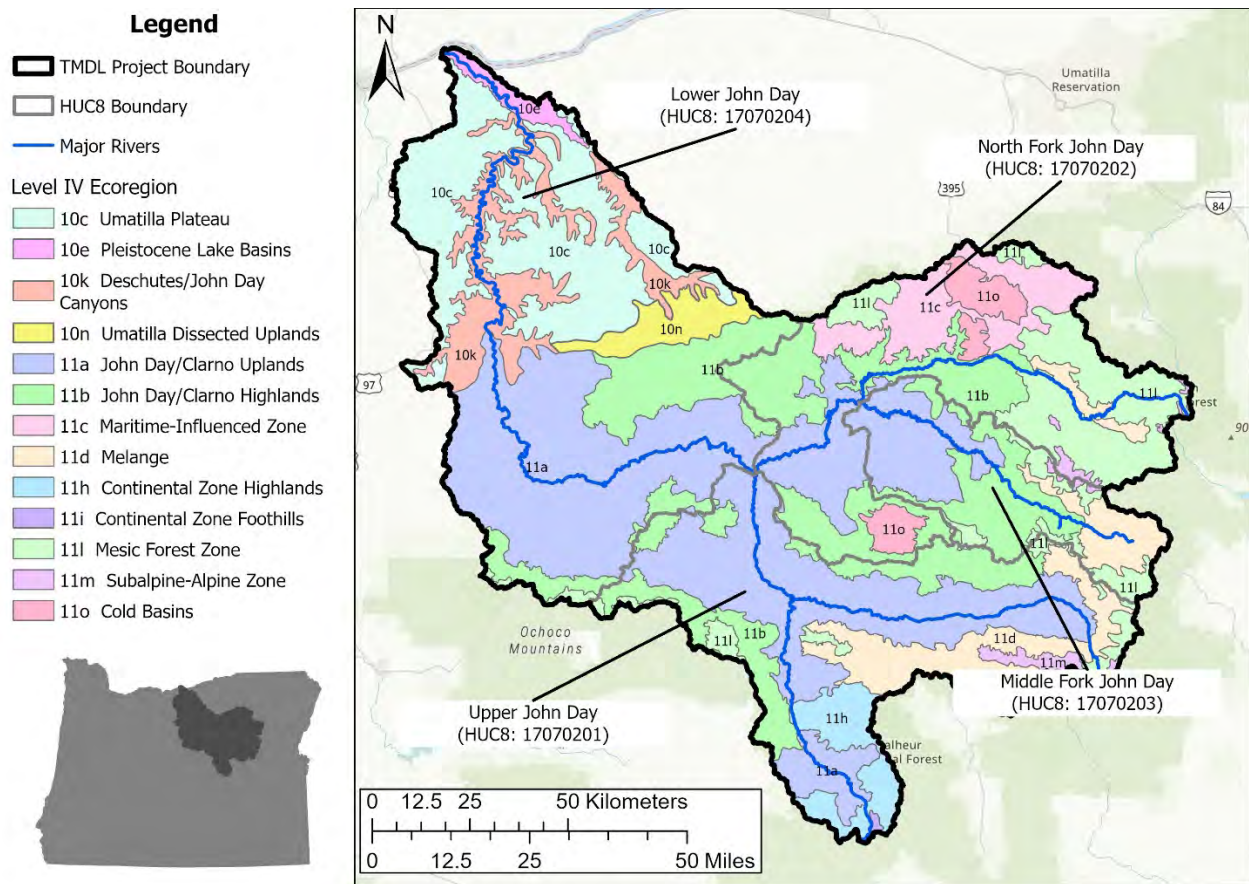


Figure 3-1: EPA level III and IV Ecoregions in the John Day River Basin.

3.1.1 Restored Vegetation A (RV A)

Appendix C describes the methodology used to determine restored vegetation in the John Day River Basin. In brief, the potential vegetation estimates are spatially delineated first on level IV Ecoregion polygons (**Figure 3-1**) and second, on valley form sensu McAllister (2008). In some instances, other differentiating features are applied to increase spatial resolution. The output of

this delineation is a list of Ecoregion-physiographic types (EP Types) that covers all possible EP Types within the landscape. Each EP Type is assigned a vegetation height and shade density attribute, based on basin-specific historic assessments, plant association studies and observations during TMDL monitoring, technical committee review and, for additional vegetation height information, general botanical literature. Every reach within the landscape can be assigned an explicit EP Type after identifying valley form and ecoregion. For each EP Type, a single height and shade density was assigned to each vegetation community. Where stands of shade-producing vegetation are intermittent, each vegetation community within that EP Type was assigned a frequency based on the proportion of the stream length it occupies. For example, reaches within EP Type 8 are potentially 80% conifer forest and 20% willow-shrub-grasses. While preserving the proportion of stream length, the placement of each vegetation community was randomly assigned.

In the restored vegetation A (RV A) scenario transportation corridors (such as roads and highways) and urban, residential, commercial or industrial development (buildings) are removed and replaced with restored vegetation conditions based on EP Types (**Figure 3-1**, TSD Appendix C).

3.1.1.1 John Day River

The EP Type reaches for the John Day River are described in Appendix C, Section 3.10. The John Day River had an additional consideration below river km 282 (North Fork confluence), which contains upslope areas that are naturally incapable of supporting trees or other shade producing vegetation, due to soil type, water table depth, instability, etc.. Outside of a 50 m buffer around the main channel, these areas are not predicted to support near-stream vegetation. Model inputs outside of the 50 m buffer retained their existing vegetation coverage (i.e., barren steep rocky slopes, bedrock outcrops, etc.) in the restored vegetation scenario (TSD Appendix A), unless they were clearly anthropogenically influenced (i.e., roads, buildings, rail, dams, etc.), in which case, they were assigned the nearest neighbor's land cover. Inside the 50 m riparian buffer, the restored vegetation communities were assigned restored land cover as described above.

3.1.1.2 North Fork John Day River

The EP Type reaches for the North Fork John Day River are described in Appendix C, Section 3.10. North Fork John Day Reaches 3-7 lie within the North Fork John Day Wilderness Area, which is assumed to represent the best estimate of an un-impacted landscape. In the Wilderness reaches, the current vegetation conditions were assumed to be at potential and were not changed in the potential vegetation scenario.

3.1.1.3 Middle Fork John Day River

The EP Type reaches for the Middle Fork John Day River are described in Appendix C, Section 3.10. The Middle Fork John Day River is expected to have reaches of wetland meadow complexes which were identified based on gradient, valley form and current and historical conditions (see Appendix C). The meadow complexes were incorporated into the restored

vegetation model scenario. A large, restored meadow is expected to have an increase in hyporheic flow. To simulate this, the percent of flow moving through the hyporheic zone increased from 0% to 1% (of stream flow at each model input node) per 200 meters in the meadow reaches.

3.1.2 Restored Vegetation B (RV B)

The Restored Vegetation B (RV B) scenario is the same as the Restored Vegetation A scenario except it does not remove near-stream transportation corridors (such as roads and highways) and urban, residential, commercial or industrial development (buildings) that were identified in the Current Condition Calibration model. All other near-stream vegetation is restored to system potential vegetation and uses the same approach in the Restored Vegetation A scenario.

This scenario quantifies the impacts of nonpoint source solar radiation loads and is used to develop the HUA for solar loading from existing transportation corridors, buildings, and utility infrastructure.

3.1.3 2023 Vegetation Condition

The temporal coverage of the calibrated model simulates the mainstem John Day in 2004, and 2002 for the North Fork and the Middle Fork John Day Rivers. In order to have a more up to date understanding of how vegetation and shade influence temperature, DEQ used 2023 canopy height data from Planet Labs to update the TTools data used in the model inputs (TSD Appendix A). Planet labs developed a proprietary model that estimates vegetation structure metrics, canopy height and canopy cover, based on satellite imagery. Information on Planet Labs is discussed in TSD Appendix A

3.2 Flow

Restored flow, or natural flow, is the volume of water estimated to be in the modeled reach if there were no human-related influences. In parts of the Basin, flow of water in the John Day River Basin has been altered significantly from historic and natural conditions. Restored flow conditions were used in stream temperature modeling scenarios to quantify the impacts of water withdrawals on temperature, and ultimately to develop nonpoint source load allocations for the TMDL. **Table 3-1** shows the mean August flow during the model year at four gages in the Basin. The percent exceedance shown in the Table is the percent of other years' mean August flows that exceeded the model years. In other words, the John Day River August flows at John Day were relatively high during 2004 (only 34% of years on record had higher August flows), while the North Fork John Day River August flows at Monument were relatively low (only 27% of years on record had lower August flows). It is important to note that there is relatively little consumptive use in the upper North Fork drainage – progressively less above Monument and much less above the Middle Fork. The difference between 2002 and background temperature and flow profile, above the Middle Fork, should not be interpreted as human-caused flow deficit. Rather, the estimate reflects annual variability and generalized estimation methods.

Table 3-1: Mean August flow during model year and percent exceedance at gages in the John Day River Basin.

USGS Gage	Mean August flow during model year	Percent exceedance flow in August in model year
John Day River at Blue Mountain Hot Springs (14036860)	28.2 cfs (2004)	58% (11 year record)
John Day River at John Day (14038530)	42.1 cfs (2004)	34% (40 year record)
North Fork John Day River at Monument (14046000)	81.5 cfs (2002)	73% (81 year record)
Middle Fork John Day River at Ritter (14044000)	30.4 cfs (2002)	48% (80 year record)

3.2.1 Restored Flow

Oregon Water Resources Department (OWRD) provided estimates of natural flow using the methodology outlined in Determining Surface Water Availability in Oregon (OWRD 2002). OWRD estimates were available monthly along the modeled rivers and for some tributary inflows to the model streams. At these points, OWRD provides estimates of the 50% and 80% exceedances level natural flows, there is a 50% and 80% chance, respectively, that the actual flow will exceed the estimated values. The estimated 50th percentile natural flows were used herein to target a median natural flow conditions.

To simulate restored flow to the modeled reaches, DEQ modified tributaries (to model corridors) where OWRD estimated natural inflows. These tributary inputs were modified to reflect the natural flow estimates by OWRD. After comparing the resulting modeled river (John Day River, North Fork John Day River, and Middle Fork John Day River) flow with the natural flow estimate of OWRD, further flow modifications in the tributaries were necessary. Inflows from the tributaries were modified to create the closest match between the model flows and OWRD estimates during the lowest flow period of the year, generally August. The resulting natural potential flow estimates in the model, and the associated thermal influence, are shown subsequently in this appendix.

3.2.1.1 John Day River

In order to provide a better estimate of restored flows conditions, estimates of natural flow inputs to the John Day River from its tributaries were derived as discussed above. For the restored flow scenario, all irrigation return flows derived for calibration (described in TSD Appendix A) and points of diversion were eliminated. To supply the flow of water from the tributaries, commensurate with the OWRD estimates of natural flow in the mainstem, appropriate tributaries' current flows were increased according to **Table 3-2**.

Table 3-2: John Day River inflows from tributaries to simulate restored flows.

Inflow	Adjustment factor
Boundary	Current flow times 1.7
Call Creek	OWRD estimates
Deardorff Creek	Current flow times 1.25
Return of side channel (Isham Creek?), Strawberry, Slyfe/Strawberry, Dixie, Indian, Pine, Seep (near Dean and Dissel), Canyon Creek Laycock, Enterprise drain return flow, Beech, Spring (near Birch Cr), Spring, Belshaw & Fields Creeks & Spring	Current flow doubled
South Fork John Day River	Current flow times 1.5

3.2.1.2 North Fork John Day River

In order to provide a better estimate of restored flow conditions, estimates of natural flow inputs to the North Fork John Day River from its tributaries were derived as discussed above. All irrigation return flows derived for calibration (described in Appendix A) and points of diversion were eliminated. In the North Fork John Day, OWRD provided estimates of the 50th percentile natural flow at several points along the mainstem as well as the tributaries. In order to match the OWRD instream flow estimates, the tributary flows were increased by calculating the ratio between the OWRD estimates of natural flow to the current flow rate on August 1, then applying that ratio to each daily flow during the model period. OWRD did not estimate natural flow for several tributaries. For these tributaries, the current flow was doubled as an estimate of natural flow. Additional flow was needed during June and early July, so three tributary flow profiles were multiplied by a factor of 2 to 6. Granite and Big Creeks received 2.5 cms of additional flow at all times in June. The changes to the tributaries' flow are summarized in **Table 3-3**.

Table 3-3: North Fork John Day River inflows from tributaries to simulate restored flows.

Inflow	Adjustment factor
Trail, Middle Fork John Day, Desolation, Camas, Cottonwood, Granite, Big, Potamus, Crane, Ditch, Stony, Mallory, Texas Bar Creeks	Ratio between OWRD estimate and current flow on August 1
Big Wall Creek	Current flow multiplied by 0.8
Meadow Brook	Current flow doubled
Trail, Granite, Big	Current or estimate of flow was multiplied by 2 to 6 or flow was added directly during June and parts of July.

3.2.1.3 Middle Fork John Day River

In order to provide a better estimate of restored flow conditions, estimates of natural flow inputs to the Middle Fork John Day River from its tributaries were derived as discussed in Section 3. All points of diversion (described in Appendix A) were eliminated. To supply the volume of water

from the tributaries, commensurate with the OWRD monthly estimates of natural flow instream, the tributary flows were increased by calculating the ratio between the OWRD estimate of natural flow to the current flow rate on August 1, then applying that ratio to each daily flow during the model period (**Table 3-4**). OWRD did not estimate natural flow for several tributaries. For these tributaries, the current flow was doubled as an estimate of natural flow. The calibration flows, representing natural river processes of gaining and losing reaches, were also doubled. In general, these adjustments to flow made the instream monthly flow estimates from OWRD match the predicted results from the model scenario. In addition, all points of diversion were eliminated.

Table 3-4: Middle Fork John Day River inflows from tributaries to simulate restored flows.

Inflow	Adjustment factor
Granite, Slide, Indian, Big, Camp, Big Boulder, Granit Boulder, Vinegar, Clear Creeks	Ratio between OWRD estimate and current flow on August 1
Bridge, Davis, Vincent, Dead Cow, TIR pool, Deerhorn, Little Boulder, Little Butte, Hunt, Butte, Ruby, Beaver, Ragged, Dry, Dunston, Gibbs, Quartz, Deep, Armstrong, Big, Huckleberry, Cross Hollow, Hansen Canyon, Lick, Flower, Spring (LB), Upper Ritter H.S., Ritter Hot Springs, Long, Spring Complex (LB) Creeks	Current flow doubled
Calibration flows	Current flow doubled

3.2.2 Consumptive use

The Consumptive Use scenario evaluates the temperature effects of withdrawals in the modeled rivers. In this scenario, tributaries and diversions were adjusted to reflect 1% of the consumptive use rate, which was calculated from the restored flow scenario and the current condition calibration scenario (**Equation 3-1**).

$$\text{Consumptive Use Rate} = \frac{(\text{Restored Flow} - \text{CCC})}{\text{Restored Flow}} \times 100 \quad \text{Equation 3-1}$$

The average percent consumptive use rate in the Current Condition Calibration for each river model's reference point are shown in **Table 3-5**. Diversion inflows were reduced in proportion to the mean consumptive-use rate (**Equation 3-2**), while tributary inflows were adjusted using natural-flow values to reflect both withdrawal impacts and partial return flows (**Equation 3-3**).

$$Diversi\textit{on}_{CU} = Diversi\textit{on}_{CCC} \times \frac{CU_{CU}}{CU_{CCC}} \quad \text{Equation 3-2}$$

Where,

- $Diversi\textit{on}_{CU}$ = Diversion inflow value for the consumptive use scenario
- $Diversi\textit{on}_{CCC}$ = Diversion inflow value for the current condition calibration scenario
- CU_{CU} = Consumptive use rate for the consumptive use scenario, for all models this value is 1
- CU_{CCC} = Consumptive use rate for the current condition calibration scenario, values of which are found in **Table 3-5**

$$Tributary_{CU} = Tributary_{Restore} - (Tributary_{Restore} - Tributary_{CCC}) \times \frac{CU_{Cu}}{CU_{CCC}} \quad \text{Equation 3-3}$$

Where,

- $Tributary_{CU}$ = Tributary inflow value for the consumptive use scenario
- $Tributary_{Restore}$ = Tributary inflow value for the restored flow scenario
- $Tributary_{CCC}$ = Tributary inflow value for the current condition calibration scenario
- CU_{CU} = Consumptive use rate for the consumptive use scenario, for all models this value is 1
- CU_{CCC} = Consumptive use rate for the current condition calibration scenario, values of which are found in **Table 3-5**

Table 3-5: Average consumptive use rates at the model outlet for the current condition calibration scenario.

Modeled River	Average Consumptive Use Rate
John Day River	56.30%
North Fork John Day	44.44%
Middle Fork John Day	40.14%

3.3 Tributary temperatures

3.3.1 Tributary temperature A

The Tributary Temperature A scenario is used to evaluate the temperature impacts on the modeled rivers resulting from elevated tributary temperatures that exceed applicable criteria. For this scenario, the tributaries were set to attain the applicable temperature criteria at their mouths. For tributaries that exceed the water quality standard, the maximum temperatures for the tributary were dampened as to not exceed the standard while maintaining the minimum

temperature values and proportionally dampening the diel pattern. The temperatures were dampened using . **Figure 3-2** through **Figure 3-10** are visualize this temperature dampening.

$$T_{dampened} = T_{min,obs} + \frac{(T_{obs} - T_{min,obs}) \times (T_{WQS} - T_{min,obs})}{T_{max,obs} - T_{min,obs}} \quad \text{Equation 3-4}$$

Where, -

$T_{dampened}$ = New, dampened temperature.

$T_{min,obs}$ = Minimum observed tributary temperature for model period.

$T_{max,obs}$ = Maximum observed tributary temperature for model period.

T_{WQS} = Water quality standard for tributary.

T_{obs} = Temperature observation.

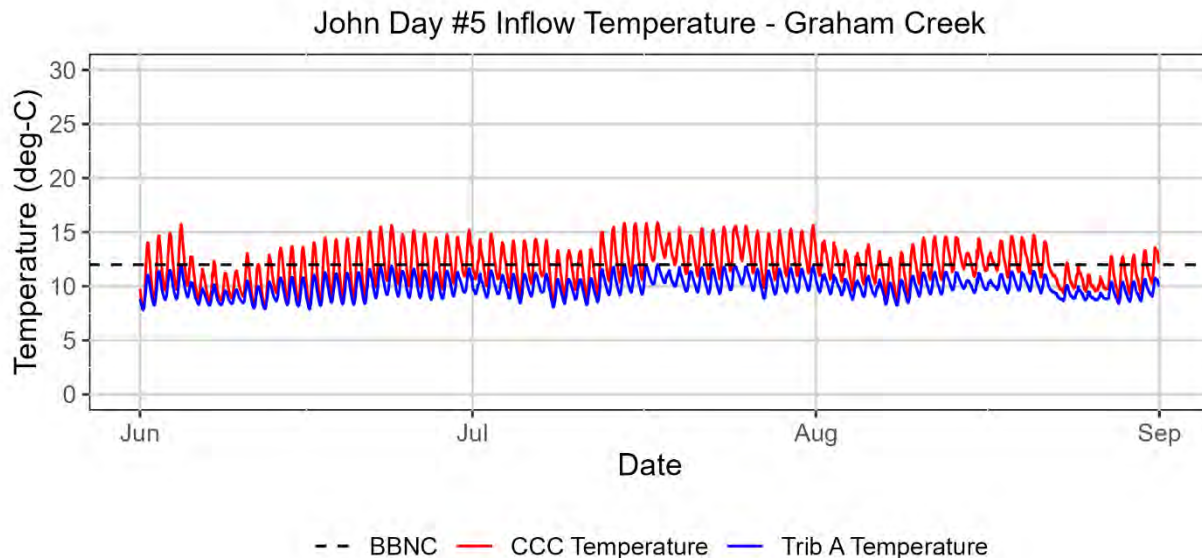


Figure 3-2: Time series of inflow temperature at Inflow #5 (Graham Creek) of the John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 12°C.

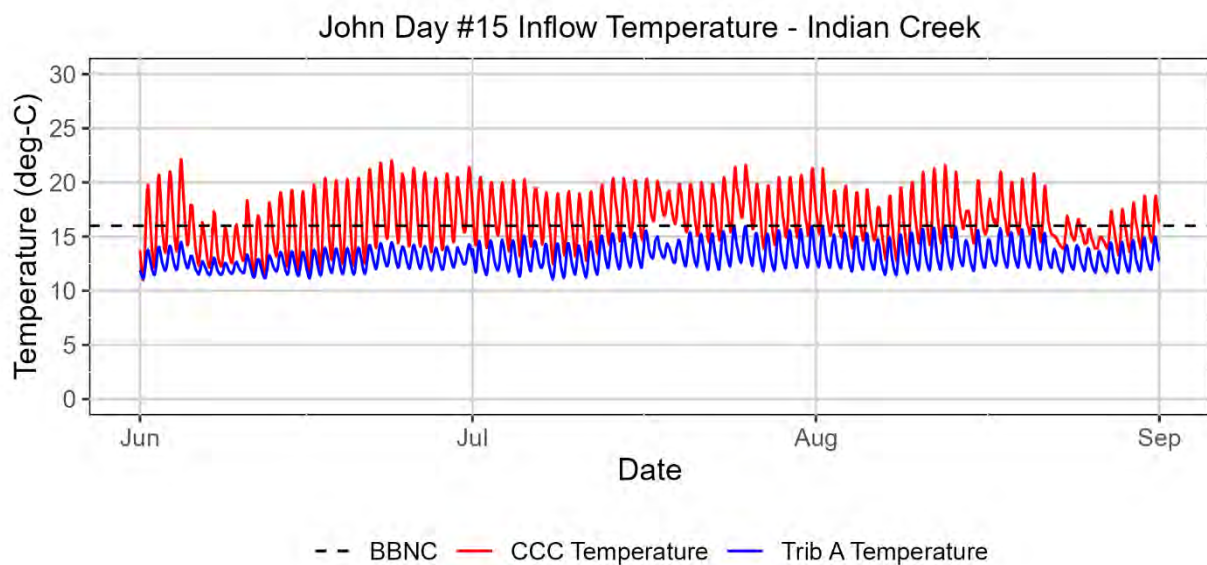


Figure 3-3: Time series of inflow temperature at Inflow #15 (Indian Creek) of the John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 16°C.

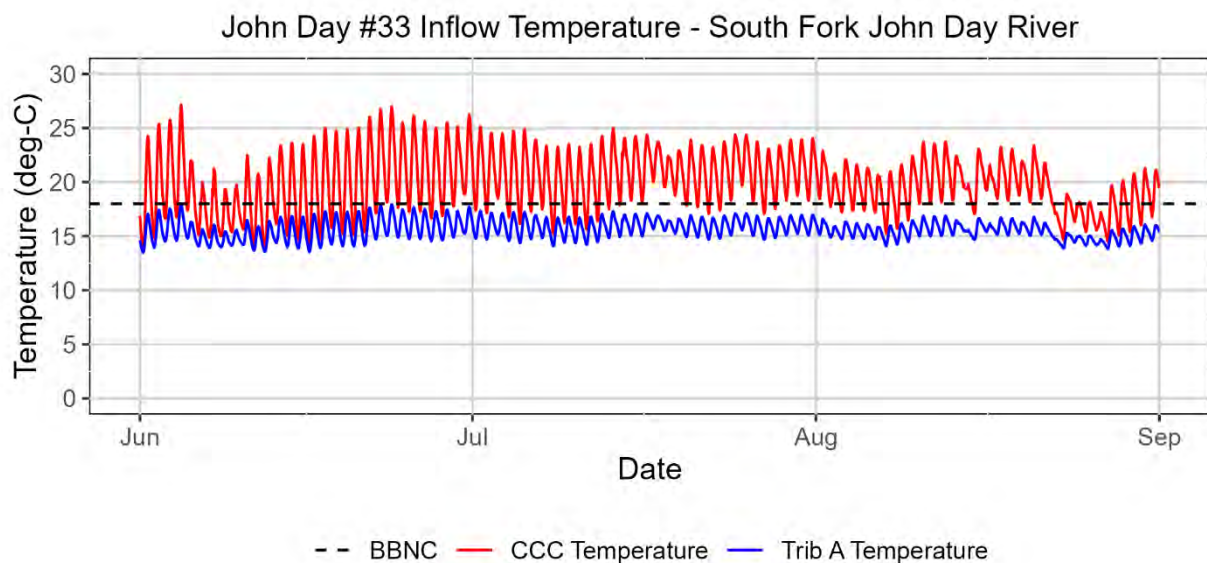


Figure 3-4: Time series of inflow temperature at Inflow #33 (South Fork John Day River) of the John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 18°C

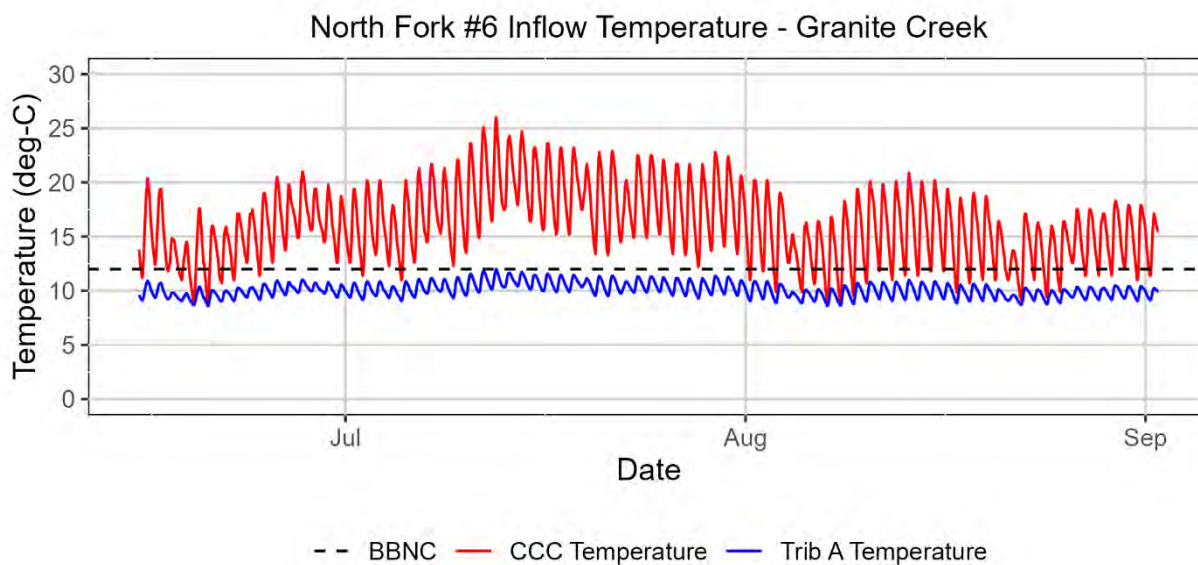


Figure 3-5: Time series of inflow temperature at Inflow #6 (Granite Creek) of the North Fork John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 12°C.

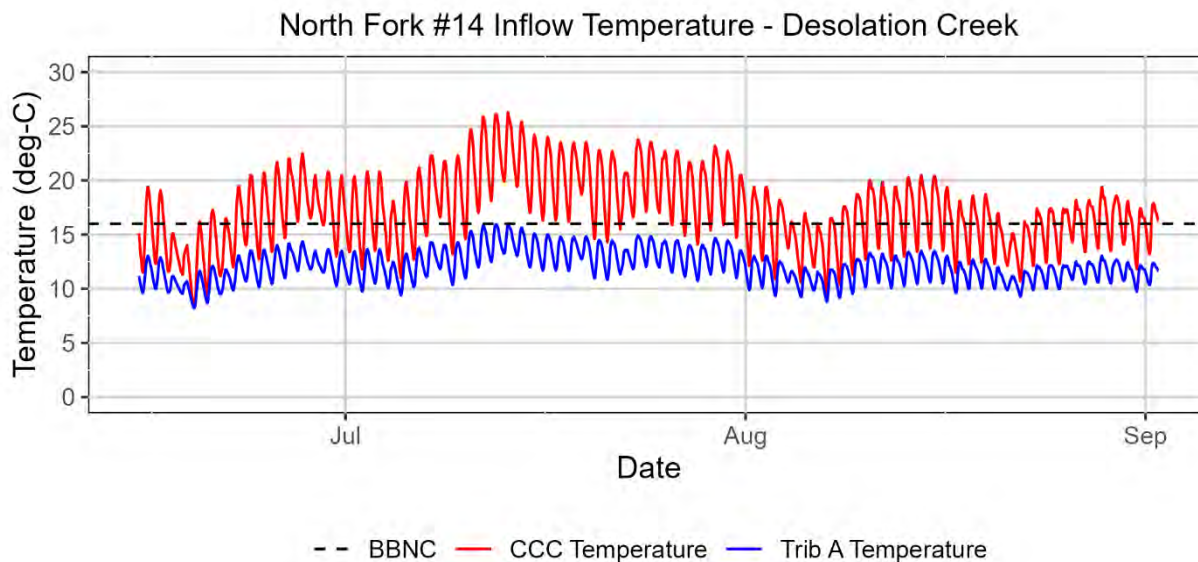


Figure 3-6: Time series of inflow temperature at Inflow #14 (Desolation Creek) of the North Fork John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 16°C.

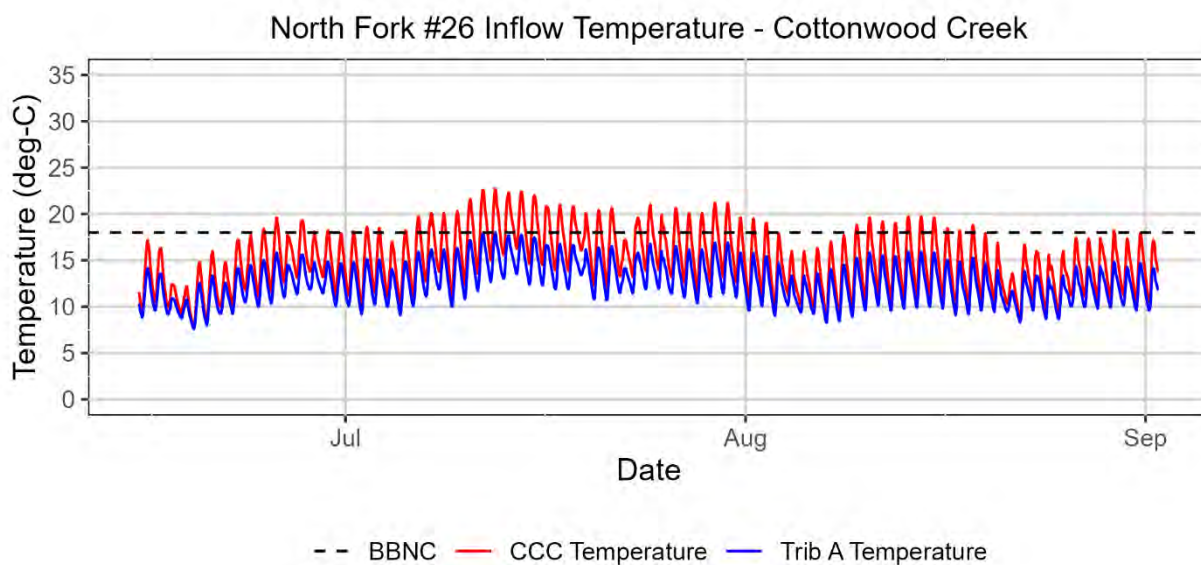


Figure 3-7: Time series of inflow temperature at Inflow #26 (Cottonwood Creek) of the North Fork John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 18°C.

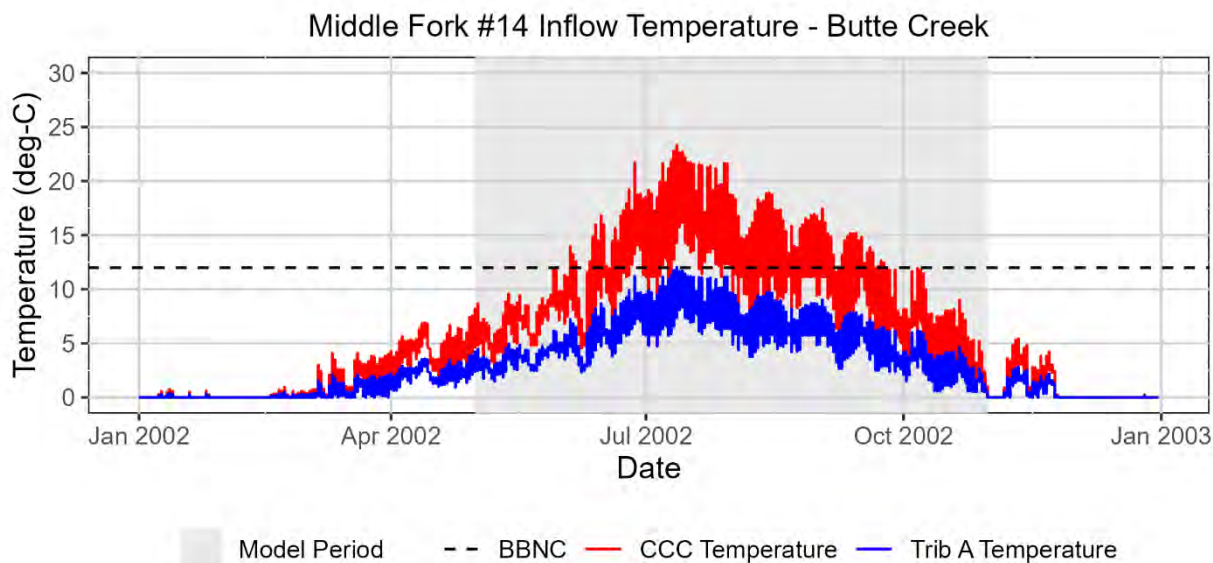


Figure 3-8: Time series of inflow temperature at Inflow #14 (Butte Creek) of the Middle Fork John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 12°C. The shaded gray area indicates the model period (May 1, 2002 - October 31, 2002).

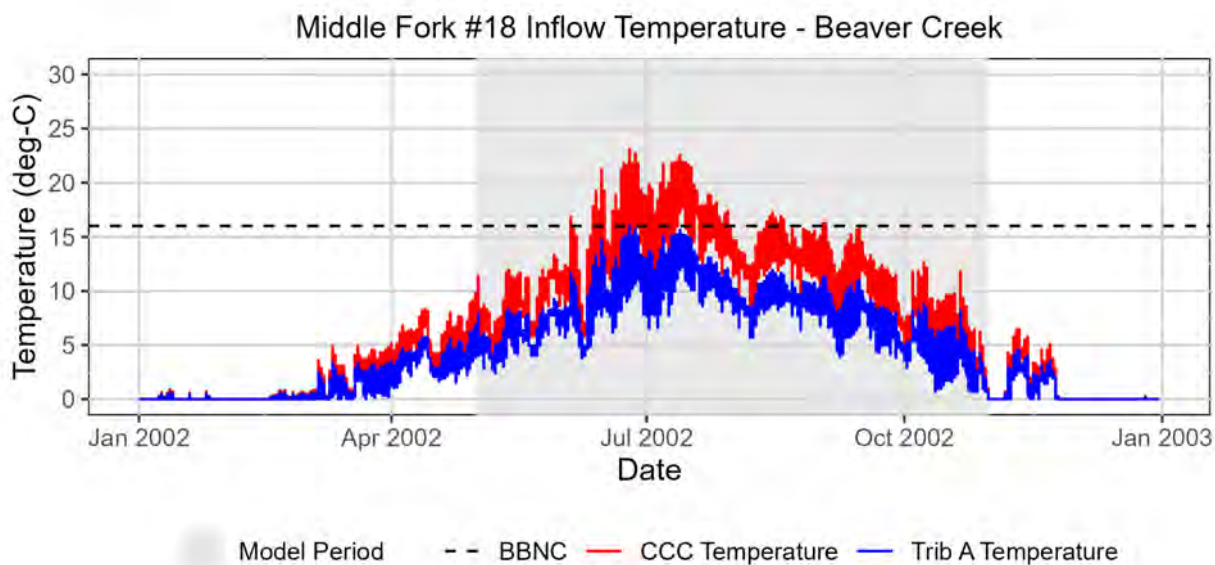


Figure 3-9: Time series of inflow temperature at Inflow #18 (Beaver Creek) of the Middle Fork John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 16°C. The shaded gray area indicates the model period (May 1, 2002 - October 31, 2002).

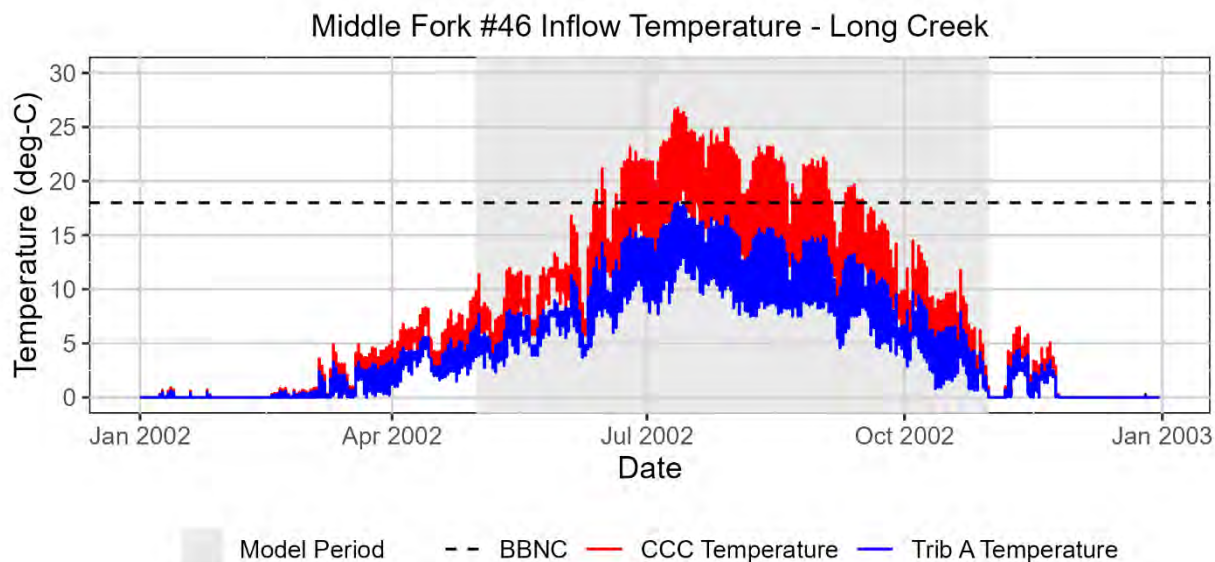


Figure 3-10: Time series of inflow temperature at Inflow #46 (Long Creek) of the Middle Fork John Day River model comparing Current Condition Calibration (red) and to the dampened Tributary Temperature A (blue) inputs to meet the BBNC of 18°C. The shaded gray area indicates the model period (May 1, 2002 - October 31, 2002).

3.3.2 Tributary temperature B

The Tributary B scenario is used to evaluate the temperature response to tributary temperatures set at their respective TMDL HUA allocations. For this scenario, each tributary's temperatures are increased by 0.30°C or the total HUA assigned to point and nonpoint sources on that tributary, including reserve capacity. All other model inputs are the same as the calibration. This scenario is compared to the Current Condition Calibration to evaluate mainstem temperature when HUA is fully utilized by the tributaries. This scenario is designed to evaluate the change in mainstem temperatures resulting from applying the full HUA to tributaries, it does not assume or imply that attaining the HUA in tributaries will cause warmer temperatures in the mainstem rivers.

3.4 Channel morphology

The morphology of the streams and rivers in the John Day River Basin has been altered significantly from historic and natural conditions. As channels and uplands are modified through land use changes, instream and bedload sediment loads generally increase, which generally results in widening the downstream channel. Through restoration, though channel widths will not always decrease, we generally expect potential decreases in channel widths of 25-50% (Anderson et al. 2004, Beechie et al. 2007, Castro & Jackson 2001, Grande Ronde Model Watershed 2002, Hey, R. 2006, Li et al. 1994, McDowell, P. 2000, ODSL 2005, River Design Group 2007, Rosgen 1996, Smith & Smith 1984, USBLM 1998, USFS 1995, USFS 2007). Alternatively, one example of channel widening via restoration is found in the USFS restoration of nine miles of upper-middle part of the North Fork John Day, where channel and vegetation restoration through and area of dredge mine tailings resulted in a slight widening of the channel. There are other areas in the John Day River Basin, including the Granite Creek watershed, where in-channel dredging occurred and similar results might be expected, where tailing piles have artificially narrowed channels.

Several attempts were made to estimate the potential morphological conditions. First, several morphological parameters were measured in undisturbed reference reaches. Of the possible parameter pairings, the strongest correlations were identified, such as drainage area and channel width. When the regression equations were extrapolated to model corridors, the results were unrealistic in lower regions, which are associated with fewer representative reference reaches. Then, the potential morphology parameters were estimated from the literature. The literature values were estimated for small watersheds up to 900 sq. km, which may or may not well represent the lower John Day mainstem (10,000 – 22,000 sq. km). There is still no clear source of information from which to estimate potential morphology in the Basin, particularly as drainage area increases.

Due to the uncertainty in estimating historic or natural channel morphological traits, a series of channel width reduction scenarios were simulated for each model. The bankfull widths were reduced by 10-50% every 50 m, while cross sectional areas were preserved (**Figure 3-11**). Assuming a trapezoidal shape, the resulting bottom widths and angle of the bank ("z" as defined in Appendix A) were calculated and input to the scenario. As the bankfull widths were reduced,

some wetted areas were converted to land. Those areas were assigned a vegetation type from the nearest downstream neighbor. The range of natural morphological scenarios produced a range of potential instream temperatures, which showed the impact morphology can have on rivers in the Basin.

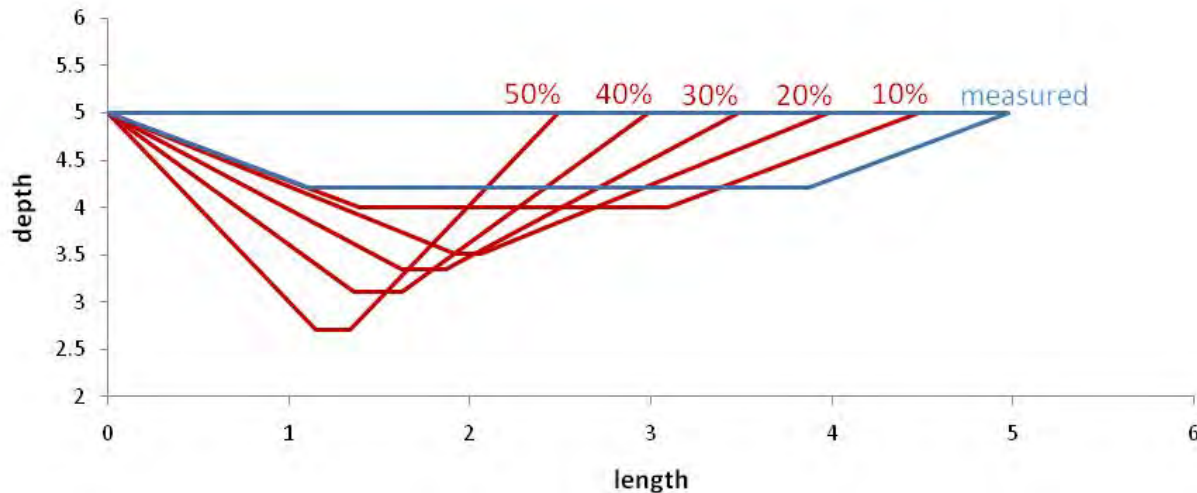


Figure 3-11: Example of how bankfull width is reduced in the Channel Morphology scenarios, and the resulting channel shapes from these reductions.

These scenarios represent a range of potential morphological conditions that bound the probable natural condition. The model results were therefore one representation of the natural morphological condition, but it should be realized that further understanding of Basin morphologic potential is needed for robust quantitative estimations.

3.4.1.1 John Day River

To test the sensitivity of river temperature to morphological changes, five scenarios were run with bankfull widths incrementally decreased from 10% to 50%, as described and illustrated in **Figure 3-11**.

3.4.1.2 North Fork John Day River

To test the sensitivity of river temperature to morphological changes, five scenarios were run with the bankfull widths incrementally decreased from 10% to 50% downstream of Reichman Canyon (rkm 39.00). On other model corridors in the Basin, DEQ simulated the 10-50% reduction range along the entire model reach. The North Fork is treated differently. This is because the upper river, from somewhere between Desolation Creek and Reichman Canyon upstream to the headwaters, may not have potential to narrow. Part of the area is Wilderness Area, and below the Wilderness, wide-scale restoration (USFS) and associated monitoring indicates that recovery did not lead to a net reduction in channel width. Downstream of Hwy 395 (rkm 93.85) and upstream of Reichman Canyon (rkm 39.00), the bankfull widths were decreased by the percent shown in **Table 3-6**.

Table 3-6: North Fork John Day River morphology scenario bankfull width reductions by river km (rkm).

Name of scenario	Percent of bankfull width reduction for Headwaters to rkm 93.85	Percent of bankfull width reduction for rkm 93.85 to rkm 39.00	Percent of bankfull width reduction for rkm 39.00 to mouth
Morph10	0	10	10
Morph20	0	10	20
Morph30	0	20	30
Morph40	0	20	40
Morph50	0	30	50

3.4.1.3 Middle Fork John Day River

To test the sensitivity of river temperature to morphological changes, five scenarios were run with bankfull widths incrementally decreased from 10% to 50%, as described and illustrated in **Figure 3-11**.

3.5 Wasteload allocations

The Wasteload Allocation scenario modified point source discharges to reflect proposed or existing TMDL wasteload allocations. In the model, effluent temperatures were calculated using equations described in the John Day River Basin TSD (Section 9.2.5), and effluent flows were based on the NPDES-permitted average design flow.

This scenario is mostly identical to the Current Condition Calibration, except that point source discharges are included in the model and reflect the proposed TMDL wasteload allocations. The WLA scenario evaluates the thermal impact of all point source dischargers set at the WLA discharge.

The allocation approach for point sources in Oregon was to use the current maximum thermal loads at critical 7Q10 low flow conditions as the starting point to calculate HUA assignments and waste load allocations. The model was then used to determine if this amount of warming provided capacity for other source categories and reserve capacity. The HUA assigned to each facility at the point of discharge is therefore based on the temperature increase above the applicable criteria using the maximum effluent discharge at 7Q10 river flows, assuming 100% mix.

3.6 No point sources

The No Point Source scenario for the John Day River model is equivalent to the Calibrated Current Conditions (CCC) scenario, which includes zero discharges from the three individually permitted point sources along the river.

3.7 Background

This scenario evaluates the stream temperature response from background sources only. Background sources include all sources of pollution or pollutants not originating from human activities. Background sources may also include anthropogenic sources of a pollutant that DEQ or other Oregon state agency does not have authority to regulate, such as pollutants emanating from another state, tribal lands, or sources otherwise beyond the jurisdiction of the state (OAR 340-042-0030(1)). The background scenario combines the Restored Vegetation A, Restored Flow, and 30% Channel Morphology inputs into one scenario. In a more natural state, other parameters are expected to change in a river, such as increased hyporheic exchange and reduced incoming temperatures from tributaries. The large number of tributaries, the variability in the derivation of their current temperature profiles, the lack of information about their potential temperature profiles, and the sensitivity of the model to inflows culminated in a large uncertainty around estimating natural tributary temperatures. Therefore, no estimates of potential tributary temperatures were made and temperatures are consistent with the Current Condition Calibration scenario.

3.8 HUA attainment

The HUA attainment scenario setup is adapted from the HUA Baseline scenario for each modeled river. Vegetation, tributary temperatures, and point source dischargers were updated to reflect their TMDL allocations. Typically, elements of this scenario include point source discharges (when present) set to reflect their individual proposed WLA flows and temperatures, restored vegetation (representing no temperature increase HUA from excessive solar radiation), and tributary temperatures increased by the HUA portion assigned to point and nonpoint sources on each tributary.

For sources explicitly assessed in each stream's HUA Attainment model, the model setup included those sources' inputs set to reflect their assigned HUA portion; comparison of the Attainment scenario to the HUA Baseline scenario results thus explicitly assessed the cumulative thermal impacts of those specific sources attaining their assigned TMDL allocations. In the John Day River HUA Attainment model, for example, the discharge flows and temperatures of each NPDES permittee in the model extent were the same as in the John Day River WLA scenario. Likewise, model tributary inputs were the same as in the John Day River Tributary Temperatures scenario. All other John Day River Attainment scenario inputs were identical to those of the HUA Baseline scenario.

4 Model scenario results and comparisons

When comparing the hourly results from two model scenarios to determine the temperature change, the following steps were taken:

1. Calculate the 7DADM or daily maximum temperatures for scenario 1 at every model output location for every day of the model period.
2. Calculate the 7DADM or daily maximum temperatures for scenario 2 at every model output location for every day of the model period.
3. For allocation scenarios, the HUA is defined as the maximum allowable increase above the applicable biologically-based numeric criteria (BBNC). Thus, to determine the maximum temperature change in relation to HUAs, only days when the BBNC was exceeded were considered and thus days when 7DADM or daily maximum river temperatures did not exceed the BBNC were excluded. Note that the BBNC varied spatially and temporally and this was accounted for in the assessment.
4. Compute the difference between the 7DADM or daily maximum temperatures of scenario 1 and scenario 2 only for days that exceed the BBNC.
5. Round the differences to two decimals Celsius, based on the adopted rounding procedure discussed in Section 2.1.1.

The 7DADM is the preferred temperature metric for comparing two scenarios. If the model period or available data were less than 7 days, the daily maximum temperature metric was used instead. It was assumed that the daily maximum temperatures approximate 7DADM results.

The point of maximum impact (POMI) is used to describe the location in the model stream where the temperature difference between two model scenarios is greatest. The POMI is used to describe both the location of maximum required reduction as well as the location of maximum cooling or warming due to management scenario actions.

A summary of the model descriptions can be found in **Table 4-1**.

Table 4-1: Model scenario descriptions for the John Day River Basin TMDL.

Scenario name	Description
Restored Vegetation A	Evaluates stream temperature and shade responses with fully restored near-stream vegetation.
Restored Vegetation B	Evaluates stream temperature and shade responses with partially restored near-stream vegetation. Scenario does not remove transportation corridors (such as roads and highways) and urban, residential, commercial or industrial development (buildings).
Topographic Shade	Evaluates stream temperature and shade responses with no near-stream land cover.

Scenario name	Description
2023 Vegetation	Evaluates stream temperature and shade responses based on 2023 estimates of near-stream vegetation.
Restored Flow	Evaluates stream temperature responses with all consumptive use diversions/withdrawals removed.
1% Consumptive Use	Evaluates stream temperature response with tributaries and diversions/withdrawals adjusted to reflect 1% of the consumptive use rate.
Tributary Temperatures A	Evaluates stream temperature response when tributaries meet their respective temperature criteria at the tributary's confluence with the modeled river.
Tributary Temperatures B	Evaluates stream temperature responses with tributary temperatures increased by the total HUA allocations on those tributaries, including reserve capacity (HUA=0.30°C).
Channel Morphology	Evaluates stream temperature responses to channel narrowing.
Wasteload Allocations	Evaluates the thermal impact of all point source dischargers set at the WLA discharge. This scenario is only for the John Day River.
No Point Sources	This scenario is identical to the Current Condition Calibration. This scenario is only for the John Day River.
HUA Attainment	Evaluates attainment of HUA by setting NPS and PS to their respective LA and WLAs. In this scenario vegetation, tributary temperatures (+0.25°C), and point source dischargers (where applicable) were updated to reflect their TMDL allocations. This scenario does not include the reserve capacity.
HUA Baseline	This scenario is identical to the Restored Vegetation A scenario.
Background	Evaluates stream temperature responses with consumptive uses removed, fully restored near-stream vegetation, and model headwater temperatures decreased to account for upstream riparian disturbance. The boundary condition headwater temperature was set to S. Fork Little Butte Creek measurements (upstream of Beaver Dam Cr.), which is in an adjacent watershed at a point of minimum upstream disturbance. The boundary condition headwater flow was increased by 2.5 cfs to simulate removal of consumptive uses. No other adjustments were made.

4.1 John Day River

Table 4-2 summarizes the 7DADM stream temperatures predicted at the mouth and at the POMI of the John Day River for all model scenarios.

Table 4-3 daily maximum stream temperatures predicted at the mouth of John Day River for all model scenarios.

Table 4-2: Summary of maximum 7DADM stream temperature at the mouth and at the outlet of the John Day River for all model scenarios over the entire model period.

Temperature Metric	Scenario	Stream Temperature at Outlet (°C)
7DADM	Calibration	28.23
7DADM	Current Condition	27.87

Temperature Metric	Scenario	Stream Temperature at Outlet (°C)
7DADM	Restored Vegetation A	28.21
7DADM	Restored Vegetation B	28.21
7DADM	Topography	28.23
7DADM	Restored Flow	28.16
7DADM	1% Consumptive Use	28.17
7DADM	Tributary Temperature A	28.20
7DADM	Tributary Temperature B	28.23
7DADM	Channel Morphology	28.19
7DADM	Wasteload Allocation	28.23
7DADM	HUA Attainment	28.21
7DADM	Background	27.53

Table 4-3: Summary of daily maximum stream temperature at the mouth and at the outlet of the John Day River for all model scenarios over the entire model period

Temperature Metric	Scenario	Stream Temperature (°C)	Location
Daily maximum	Calibration	29.42	Outlet
Daily maximum	Current Condition	29.02	Outlet
Daily maximum	Restored Vegetation A	29.40	Outlet
Daily maximum	Restored Vegetation B	29.40	Outlet
Daily maximum	Topography	29.43	Outlet
Daily maximum	Restored Flow	29.19	Outlet
Daily maximum	1% Consumptive Use	29.19	Outlet
Daily maximum	Tributary Temperature A	29.39	Outlet
Daily maximum	Tributary Temperature B	29.42	Outlet
Daily maximum	Channel Morphology	29.09	Outlet
Daily maximum	Wasteload allocation	29.42	Outlet
Daily maximum	HUA Attainment	29.39	Outlet
Daily maximum	Background	27.53	Outlet

4.1.1 Restored vegetation

This section summarizes the temperature impacts of vegetation under current conditions, restored vegetation conditions, and topographic shading. The Restored Vegetation A scenario examines the temperature impacts of restoring all vegetation to the system potential. The maximum 7DADM stream temperature change is calculated as Current Condition Calibration minus Restored Vegetation A. Positive values indicate cooling under the Restored Vegetation A scenario relative to the Current Condition Calibration, whereas negative values indicate warming under this scenario.

Table 4-4 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Restored Vegetation A scenarios for the John Day River. Results show the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.06°C, indicating 0.06°C of cooling under the Restored Vegetation A scenario. In

addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 8.40°C, indicating 8.40°C of cooling under the Restored Vegetation A scenario at stream model km 410.

Figure 4-1 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Restored Vegetation A model scenarios for the John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-4: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Restored Vegetation A model scenarios for the John Day River over the entire model period.

Model KM	Maximum change in Stream Temperature (°C)	Location
0	0.06	outlet
410	8.40	POMI

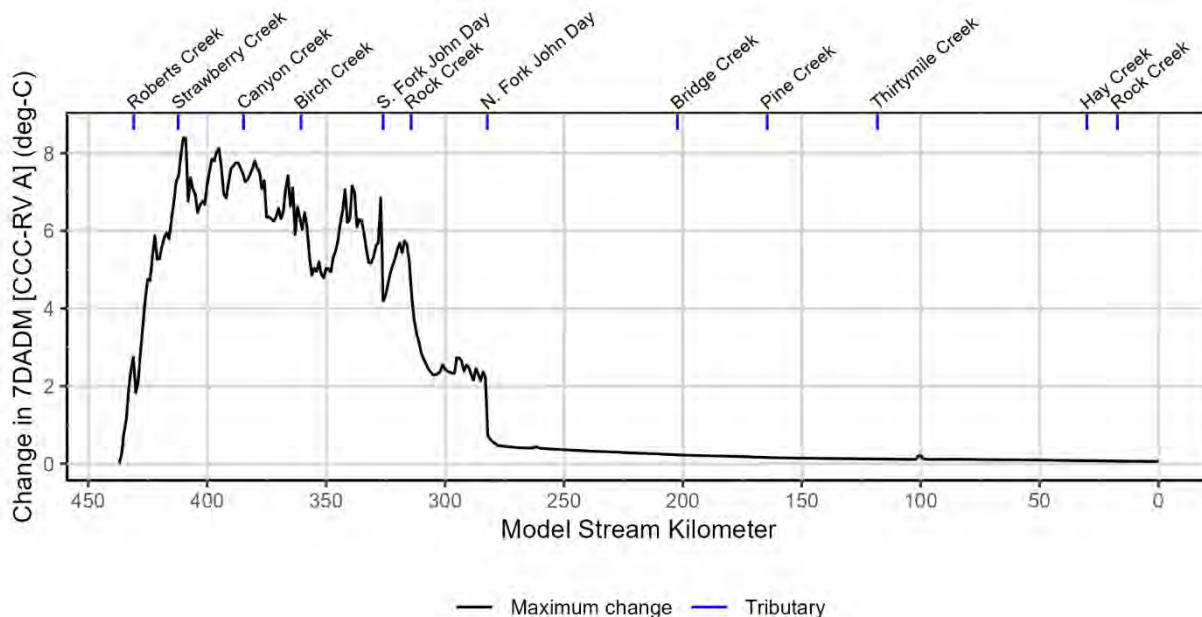


Figure 4-1: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Restored Vegetation A (RV A) model scenarios for the John Day River over the entire model period and extent when temperatures exceed the BBNC. Positive values indicate cooling under the Restored Vegetation A scenario relative to Current Condition Calibration, whereas negative values would indicate the scenario causes warming.

The Restored Vegetation B scenario examines the temperature impacts of restoring all vegetation to the system potential, except for existing infrastructure (i.e. buildings and roads). The maximum 7DADM stream temperature change is calculated as Current Condition Calibration minus Restored Vegetation B. Positive values indicate cooling under the Restored Vegetation B scenario relative to the Current Condition Calibration, whereas negative values indicate warming under this scenario.

Table 4-5 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Restored Vegetation B scenarios for the John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.06°C, indicating 0.06°C of cooling under the Restored Vegetation B scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 8.24°C, indicating 8.24°C of cooling under the Restored Vegetation B scenario at stream model km 410.

Figure 4-2 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Restored Vegetation B model scenarios for the John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-5: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Restored Vegetation B scenarios for the John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.06	outlet
410	8.24	POMI

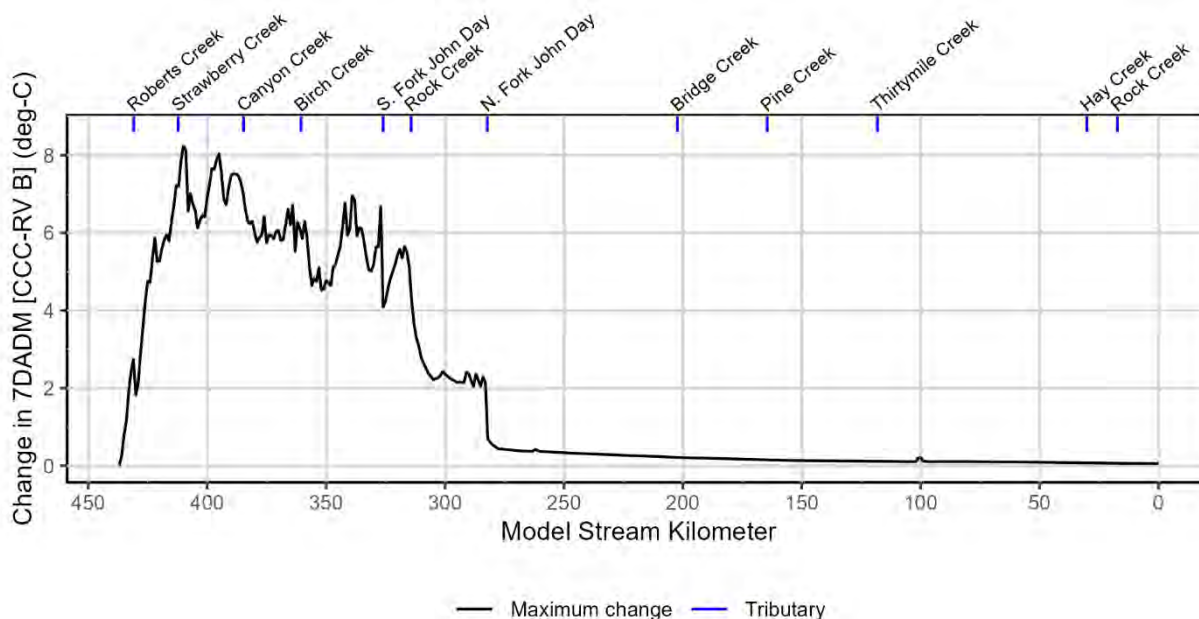


Figure 4-2: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Restored Vegetation B (RV B) model scenarios for the John Day River over the entire model period. Positive values indicate cooling under the Restored Vegetation B scenario relative to current conditions, whereas negative values would indicate the scenario causes warming.

By comparing the Restored Vegetation B scenario to the Restored Vegetation A scenario examines the temperature impacts of transportation corridors (such as roads and highways) and urban, residential, commercial or industrial development (buildings). The comparison is

calculated as the Restored Vegetation B scenario minus the Restored Vegetation A scenario. Positive values indicate warming under the Restored Vegetation B relative to the Restored Vegetation A scenario, whereas negative values indicate cooling in this scenario.

Table 4-6 summarizes the maximum 7DADM stream temperature change between the Restored Vegetation B and Restored Vegetation A scenarios for the John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.00°C, indicating no difference between the Restored Vegetation B and Restored Vegetation A scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 2.09°C, indicating 2.09°C of warming in the Restored Vegetation B scenario at stream model km 379.

Figure 4-3 shows the change in the maximum 7DADM stream temperatures between the Restored Vegetation B and Restored Vegetation A model scenarios for the John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-6: Summary of maximum 7DADM stream temperature change between Restored Vegetation A and Restored Vegetation B scenarios for the John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.00	outlet
379	2.09	POMI

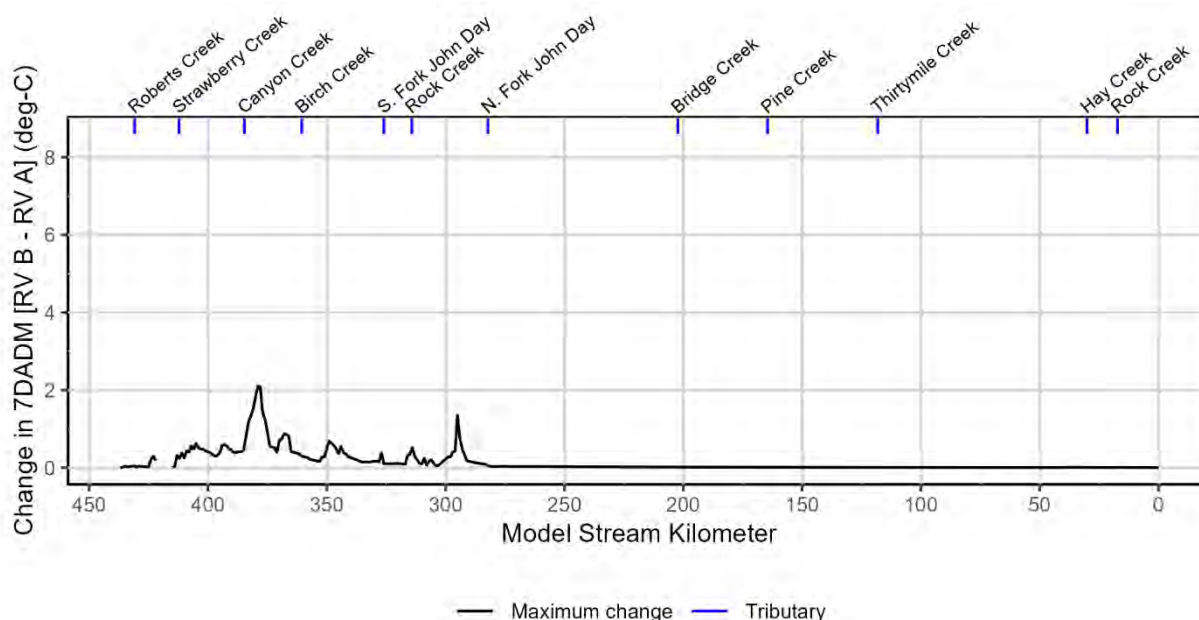


Figure 4-3: Change in maximum 7DADM stream temperatures between the Restored Vegetation B (RV B) and Restored Vegetation A (RV A) model scenarios for the John Day River over the entire model period. Positive values indicate warming under the Restored Vegetation B scenario relative to Restored Vegetation A, whereas negative values would indicate the Restored Vegetation A causes warming.

The HUA assigned to solar loading from existing transportation corridors (such as roads and highways) and urban, residential, commercial or industrial development (buildings) along the John Day River ranges from 0.025°C to 0.10°C. The model results show that if all infrastructure is retained along the John Day River, then the HUA will be exceeded. The results can be used to inform management decisions, as the comparison describes both the location of maximum required reduction as well as the location of maximum warming due to solar loading from infrastructure.

Table 4-7 summarizes the mean effective shade for the Calibration, Current 2023 Condition, Restored Vegetation A, and Topographic Shade scenarios for the John Day River. The difference in mean effective shade between the Restored Vegetation A and Current 2023 Condition scenarios is equal to 11.21 percentage points.

Figure 4-4 and **Figure 4-5** compare effective shade predictions from the Restored Vegetation A and Current 2023 Condition scenarios for the John Day River. **Figure 4-6** compares effective shade predictions from the Current 2023 Condition and Topographic Shade scenarios for the John Day River.

Table 4-7: Summary of mean effective shade for the Calibration, Current Condition, Restored Vegetation and Topographic Shade scenarios for the John Day River.

Scenario	Mean effective shade (%)
Calibration (2004)	7.38
Current 2023 Conditions	8.43
Restored Vegetation	19.64
Shade Gap (Restored – Current 2023)	11.21
Topographic Shade	4.60

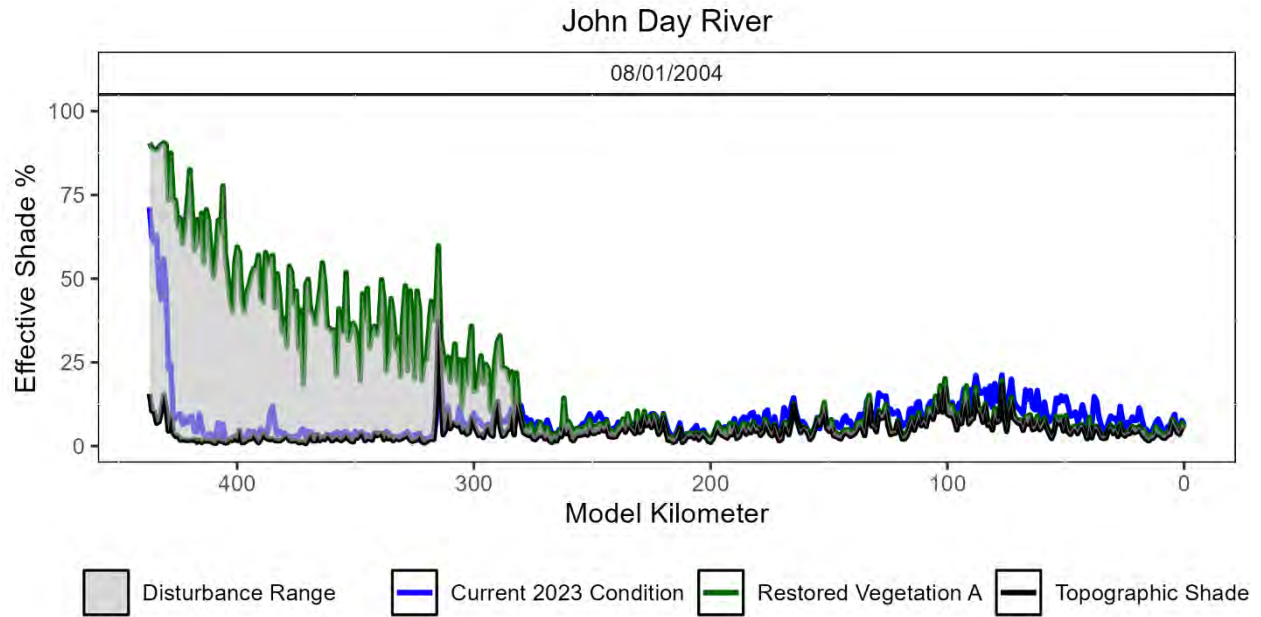


Figure 4-4: Comparison of effective shade from the Current 2023 Condition, Restored Vegetation A, and Topographic Shade scenarios for the John Day River.

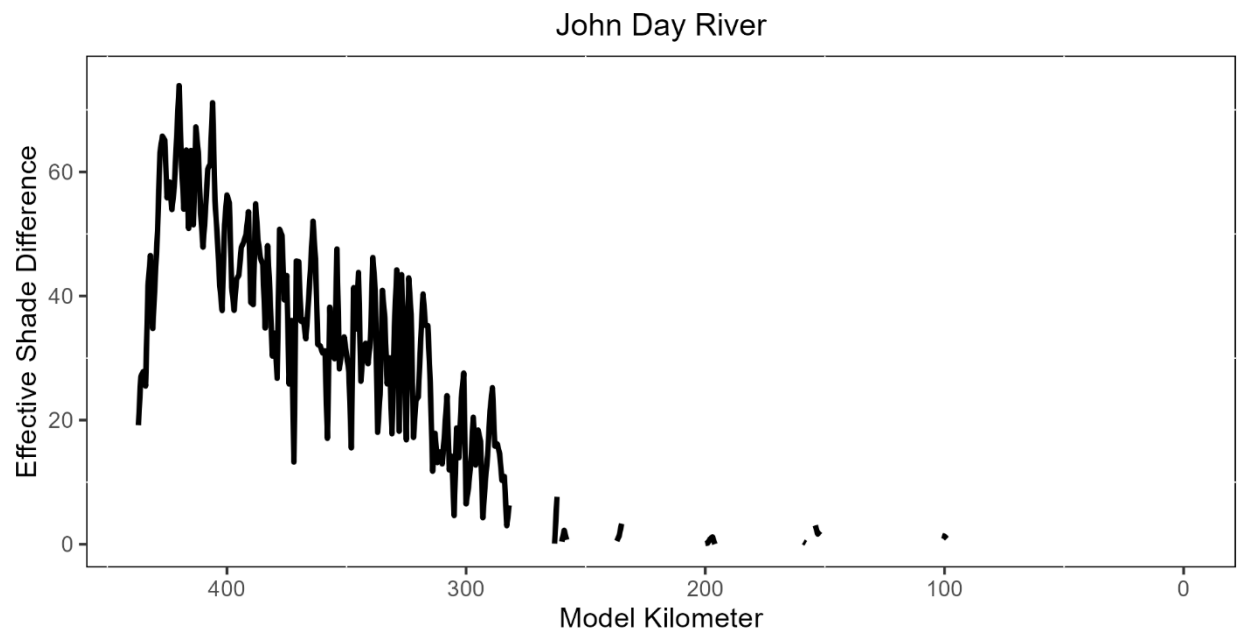


Figure 4-5: Percentage point difference between effective shade from the Restored Vegetation A and Current 2023 Condition scenarios for the John Day River. Missing values indicate that the shade difference is negative due to instances of higher effective shade in the Current 2023 Condition scenario versus the Restored Vegetation scenario.

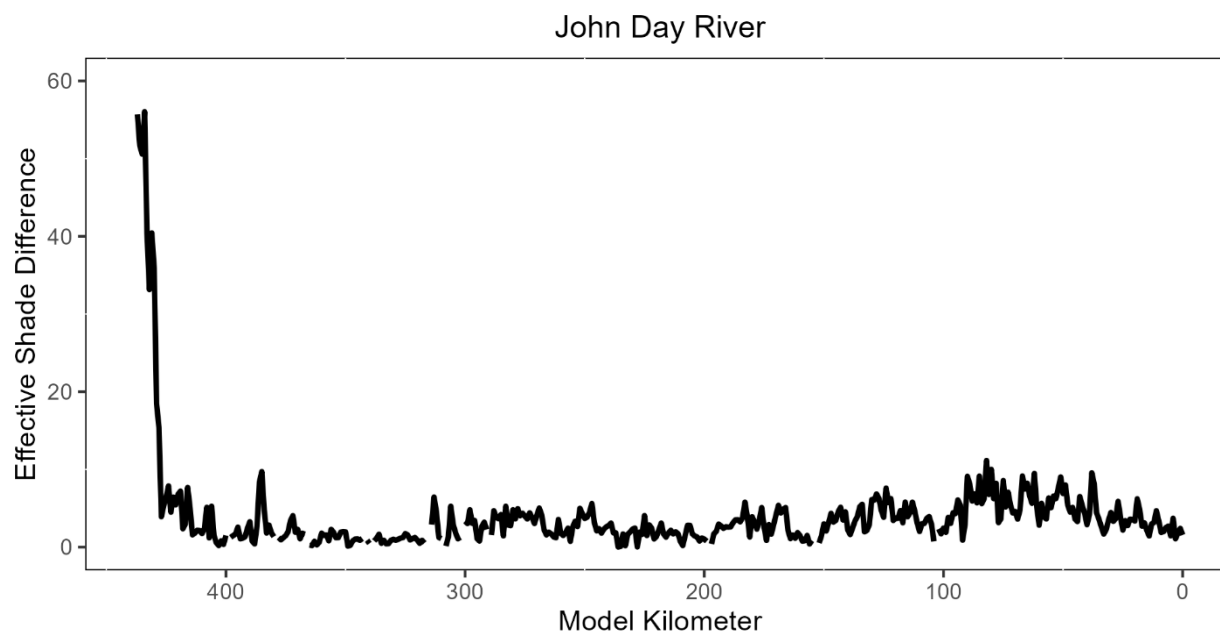


Figure 4-6: Percentage point difference between effective shade from the Current 2023 Condition and Topographic Shade scenarios for the John Day River. Missing values indicate that the shade difference is negative due to instances of higher effective shade in the Topographic Shade scenario versus the Current 2023 Condition scenario.

4.1.2 Flow

This section summarizes the temperature impacts of changes to flow regimes, including restored flows and changes to consumptive use.

The Restored Flow scenario evaluates the temperature impacts from flow deviations from natural conditions. The temperature impact of restored flows is calculated as maximum 7DADM change in Current Condition Calibration minus Restored Flow scenario. Positive values indicate cooling under the Restored Flow scenario relative to the Current Condition Calibration, whereas negative values indicate warming.

Table 4-8 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Restored Flow scenarios for the John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.28°C, indicating 0.28°C of cooling under the Restored Flow scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 6.26°C, indicating 6.26°C of cooling under the Restored Flow scenario at stream model km 290.

Figure 4-7 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Restored Flow model scenarios for the John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-8: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Natural Flow model scenarios for the John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.28	outlet
290	6.26	POMI

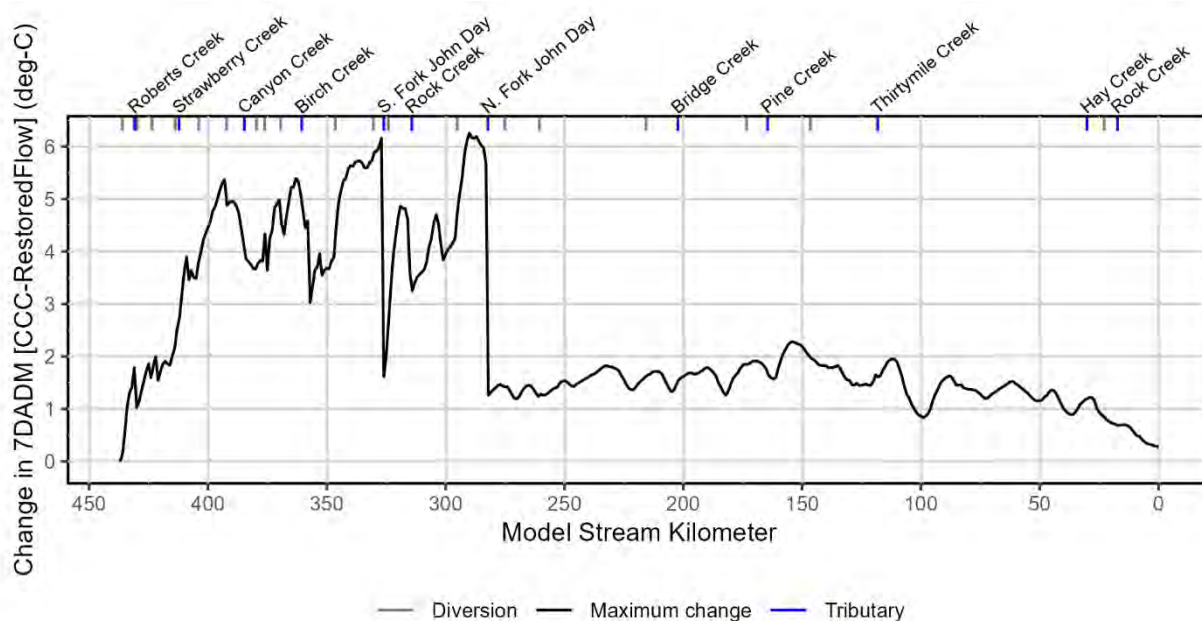


Figure 4-7: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Restored Flow (RestoredFlow) scenarios for the John Day River over the entire model period. Positive values indicate cooling under the Restored Flow scenario relative to Current Condition Calibration, whereas negative values would indicate the Restored Flow scenario causes warming.

The Consumptive Use scenario evaluates the effect of water withdrawals (1% of consumptive use) on temperature, calculated as the 1% Consumptive Use scenario minus the Restored Flow scenario. Positive values indicate warming under the 1% Consumptive Use scenario relative to the Restored Flow scenario, whereas negative values would indicate cooling.

Table 4-9 summarizes the maximum 7DADM stream temperature change between the 1% Consumptive Use and Restored Flow scenarios for the John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.00°C, indicating no difference between the 1% Consumptive Use and Restored Flow scenarios. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 0.10°C, indicating a 0.10°C of warming under the 1% Consumptive Use scenario, and occurs at stream model km 327.

Figure 4-8 shows the change in the maximum 7DADM stream temperatures between the 1% Consumptive Use and Restored Flow model scenarios for the John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-9: Summary of maximum 7DADM stream temperature change between 1% Consumptive Use and Natural Flow model scenarios for the John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.00	outlet
327	0.10	POMI

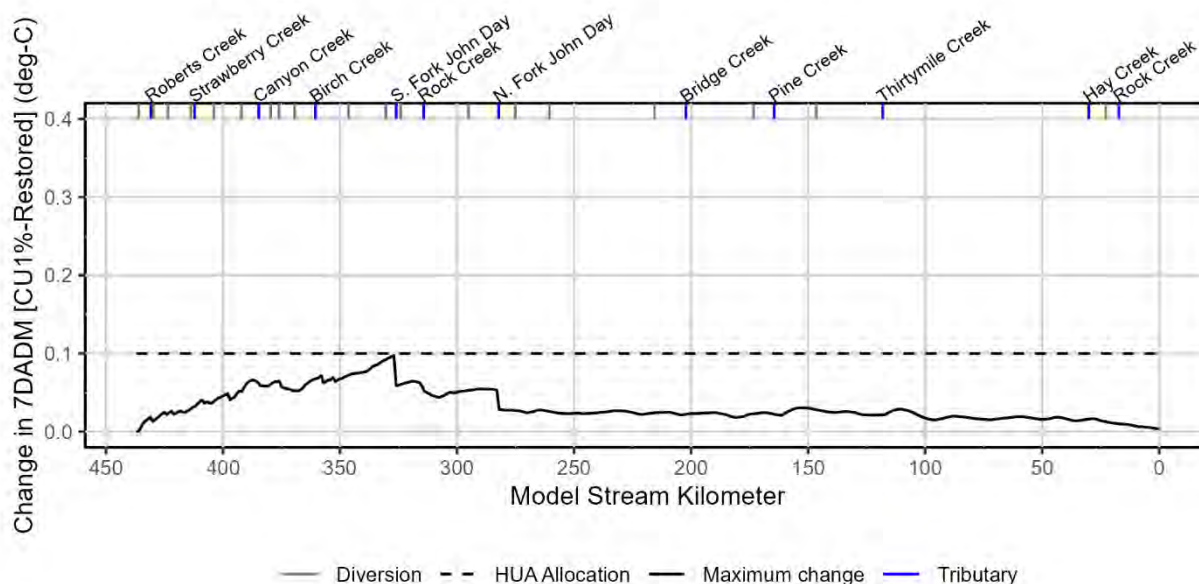


Figure 4-8: Change in maximum 7DADM stream temperatures between the 1% Consumptive Use (CU1%) and Restored Flow (Restored) scenarios for the John Day River over the entire model period. Positive values indicate warming under the 1% Consumptive Use scenario relative to the Restored Flow scenario, whereas negative values would indicate the scenario causes cooling.

4.1.3 Tributary temperatures

This section summarizes the temperature impacts of tributary temperatures. Tributary Temperature A scenario examines exceedances of the water quality standards at the tributaries by setting the tributary temperature to the applicable criteria. The maximum 7DADM stream temperature change is calculated as Current Condition Calibration minus Tributary Temperature A scenario. Positive values indicate cooling under the Tributary Temperature A scenario relative to the Current Condition Calibration, whereas negative values indicate the scenario causes warming.

Table 4-10 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Tributary Temperature A scenarios for the John Day River. Results show the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.43°C, indicating 0.43°C of cooling under the Tributary Temperature A scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 7.80°C, indicating 0.43°C of cooling under the Tributary Temperature A scenario that occurs at stream model km 282.

Figure 4-9 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Tributary Temperature A model scenarios for the John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-10: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Tributary Temperature A model scenarios for the John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.43	outlet
282	7.80	POMI

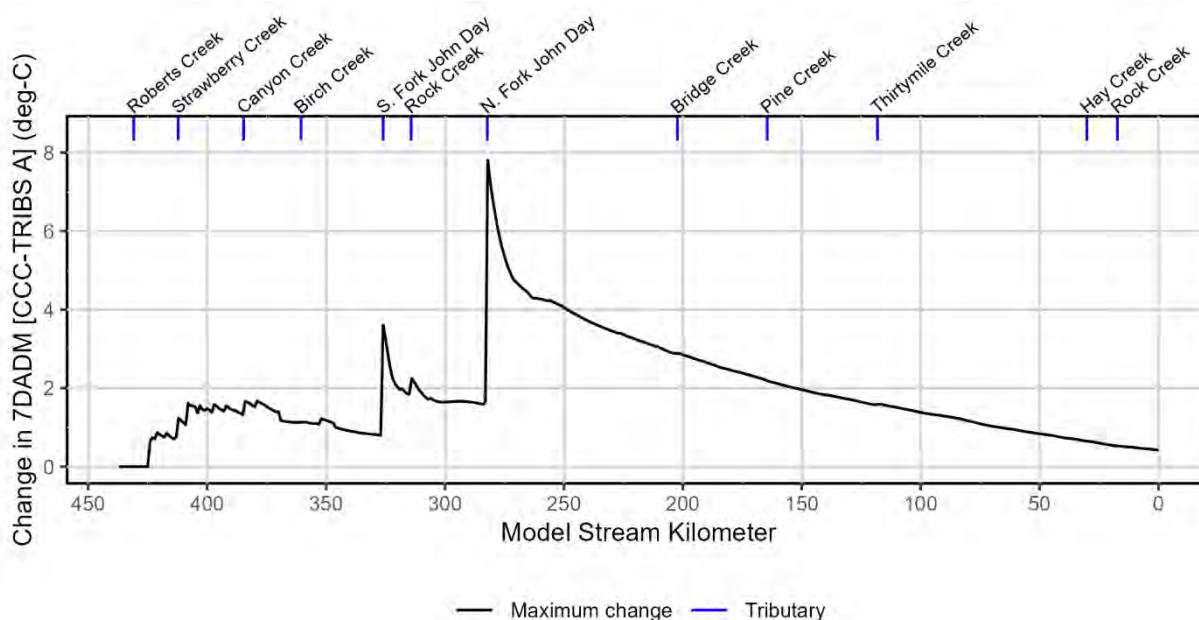


Figure 4-9: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Tributary Temperature A (TRIBS A) model scenarios for the John Day River over the entire model period. Positive values indicate cooling under the Tributary Temperature A scenario relative to Current Condition Calibration, while negative values indicate the scenario causes warming.

Tributary Temperature B scenario examines the temperature impacts of increasing the modeled tributary temperatures by the proposed HUA on those tributaries. In this scenario, modeled tributary temperatures are increased by 0.30°C to represent full utilization of the HUA, including reserve capacity. This scenario is designed to evaluate the change in mainstem temperatures resulting from applying the full HUA to tributaries, it does not assume or imply that attaining the HUA in tributaries will cause warmer temperatures in the John Day River. The maximum 7DADM change is calculated as Tributary Temperature B minus Current Condition Calibration. Because the HUA restricts cumulative warming from point sources and nonpoint sources to no more than 0.30°C, increasing tributary temperatures by 0.30°C allows evaluation of whether mainstem temperature attainment is maintained if the HUA is fully utilized by the tributaries.

Positive values indicate the degree of warming from HUA attainment relative to the base (Current Condition Calibration), whereas negative values indicate cooling.

Table 4-11 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Tributary Temperature B scenarios for the John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.02°C, indicating 0.02°C of warming under the Tributary Temperature B scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 0.26°C, indicating 0.26°C of warming under the Tributary Temperature B scenario and occurs at stream model km 282.

Figure 4-10 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Tributary Temperature B model scenarios for the John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-11: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Tributary Temperature B (HUA = 0.30) model scenarios for the John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.02	outlet
282	0.26	POMI

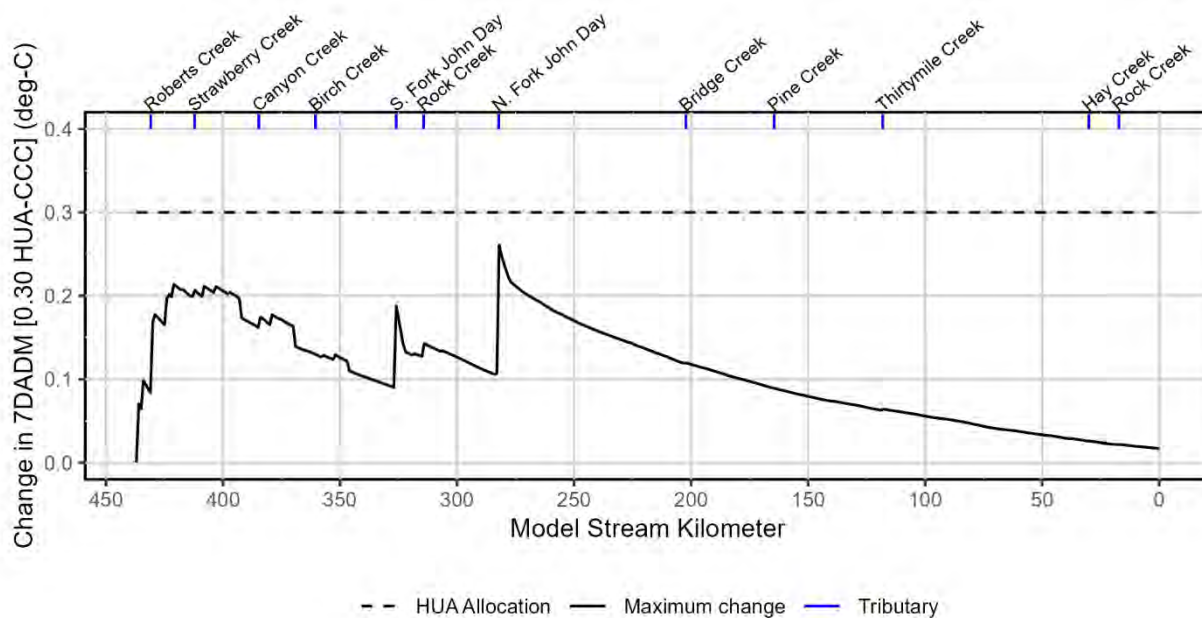


Figure 4-10: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Tributary Temperature B (HUA = 0.30°C; 0.30 HUA) model scenarios for the John Day River over the entire model period and extent when the temperatures exceed the BBNC. Positive values indicate warming under the Tributary Temperature B scenario relative to the Current Condition Calibration, whereas negative values indicate cooling.

The TMDL allocations to warming from John Day River tributaries are presented in the main TMDL report (See Section 9.1.1). The Tributary Temperature B model analysis results support that the categorical HUA portions assigned to thermal sources on modeled John Day River tributaries will be achieved when those sources attain their applicable Load Allocations and Wasteload Applications.

4.1.4 Channel morphology

This section summarizes the temperature impacts of restoring bankfull width towards a more natural, narrower channel. The Channel Morphology scenario reduced the bankfull width by a defined percentage, i.e. the 30% Channel Morphology scenario is a 30% reduction in measured bankfull width. The Channel Morphology scenarios are compared to the Current Condition Calibration, calculated as Current Condition Calibration minus the Channel Morphology scenario. Positive values indicate cooling under the Channel Morphology scenarios, whereas negative values indicate warming.

Table 4-12 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and 30% Channel Morphology scenarios for the John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.63°C, indicating 0.63°C of cooling under the 30% Channel Morphology scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 6.84°C, indicating 6.84°C of cooling under the 30% Channel Morphology scenario, and occurs at stream model km 393.

Figure 4-11 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and 30% Channel Morphology model scenarios for the John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-12: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and the 30% Channel Morphology model scenarios for the John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.63	outlet
393	6.84	POMI

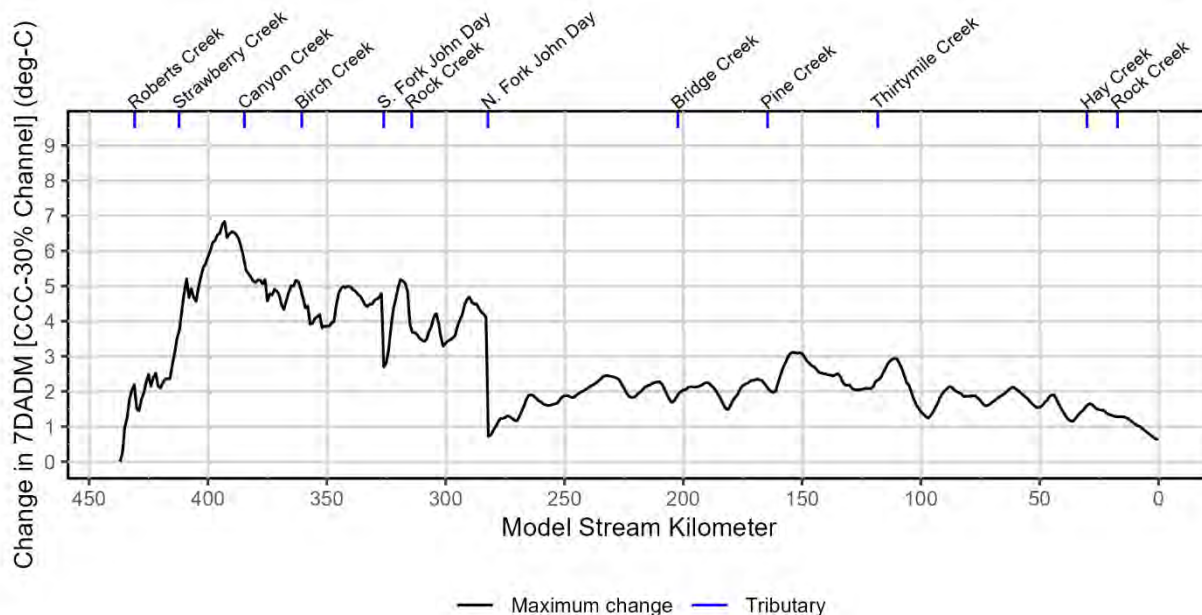


Figure 4-11: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and 30% Channel Morphology (30%Channel) scenarios for the John Day River over the entire model period. Positive values indicate cooling under the 30% Channel Morphology scenario, whereas negative values indicate warming.

Table 4-13 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and each Channel Morphology scenario for the John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) ranges from 0.28°C under the 10% Channel Morphology scenario to 1.13°C under the 50% Channel Morphology scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) ranges from 4.68°C under the 10% Channel Morphology scenario to 8.34°C under the 50% Channel Morphology scenario. The POMI for all the iterations of Channel Morphology scenarios occurs at stream model km 393.

Figure 4-12 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and all the iterations of the Channel Morphology model scenarios for the John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-13: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and the Channel Morphology model scenarios (10% to 50%) for the John Day River over the entire model period.

Channel Morphology Reduction	Maximum Change in Stream Temperature (°C) at Outlet	Maximum Change in Stream Temperature (°C) at POMI (km 393)
10%	0.28	4.68
20%	0.46	5.84
30%	0.63	6.84
40%	0.85	7.81
50%	1.13	8.34

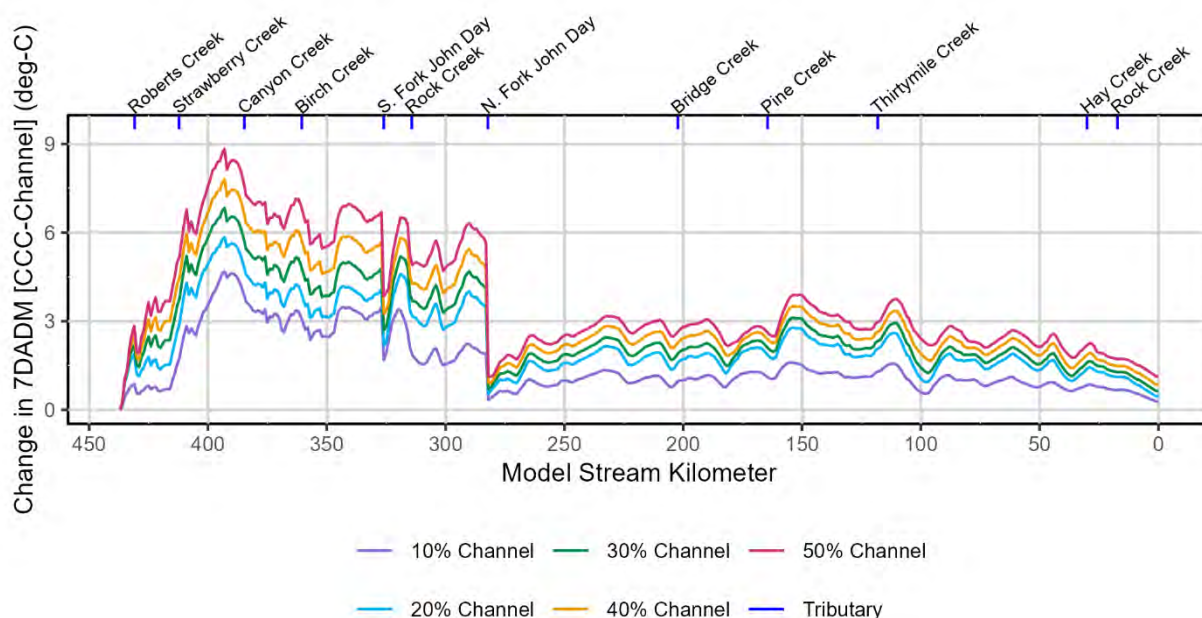


Figure 4-12: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and all iterations of the Channel Morphology scenarios for the John Day River over the entire model period. Positive values indicate cooling under the different Channel Morphology scenarios, whereas negative values indicate warming.

4.1.5 Wasteload allocations

This section summarizes the temperature impacts of point sources discharging at their wasteload allocations. The impact of the wasteload allocations was determined by comparing the Wasteload Allocation scenario to the No Point Source scenario, calculated as the WLA scenario minus the No Point Source Scenario. Positive values indicate warming from the Wasteload Allocation scenario relative to the No Point Source scenario, whereas negative values would indicate cooling.

Table 4-14 summarizes the 7DADM stream temperature changes between the Wasteload Allocations and No Point Sources scenarios for the John Day River. The results show that at the most downstream node (the outlet) the wasteload allocations have no impact on 7DADM temperatures (0°C warming). At the POMI, the 7DADM temperature difference is 0.10°C, indicating 0.10°C of warming under the Wasteload Allocation scenario.

Figure 4-13 displays the change in maximum 7DADM stream temperatures between the Wasteload Allocations and No Point Sources scenarios over the entire John Day River model period and extent when the temperatures exceeded the BBNC. The greatest temperature change occurred at the Mt. Vernon STP (model km 370), where the 7DADM stream temperature was approximately 0.10°C warmer in the Wasteload Allocations scenario than in the No Point Sources scenario. The 0.10°C of warming is equal to the WLA assigned to this point source.

Table 4-14: Summary of maximum 7DADM stream temperature change between Wasteload Allocations and No Point Sources model scenarios for the John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.00	outlet
370	0.10	POMI

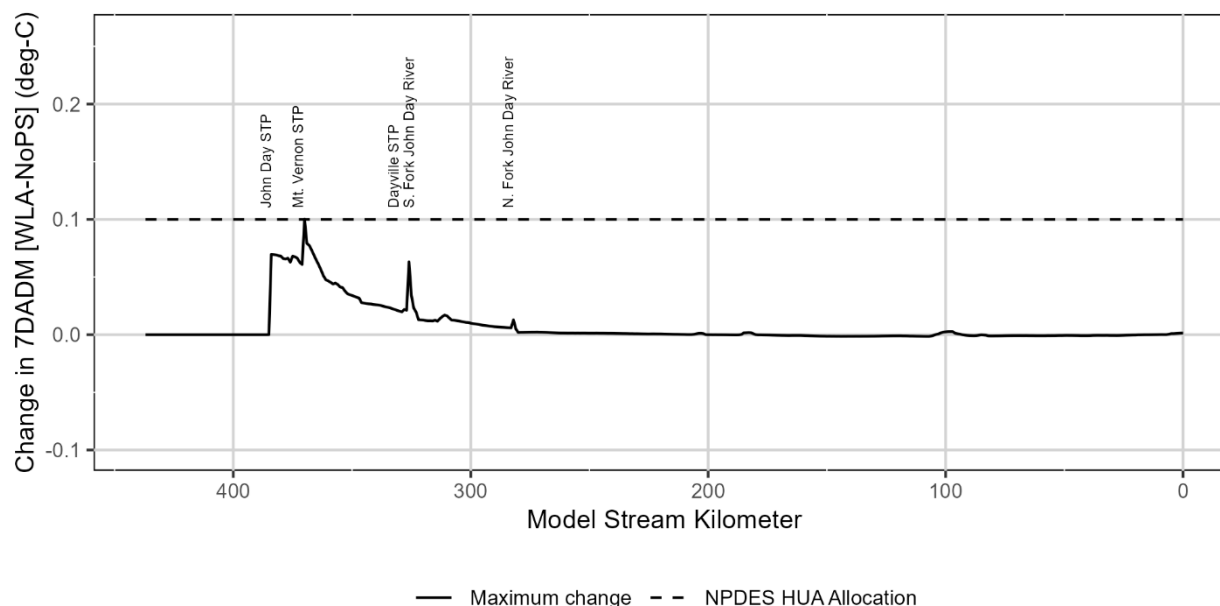


Figure 4-13: Change in maximum 7DADM stream temperatures between the Wasteload Allocations (WLA) and No Point Sources (NoPS) scenarios for the John Day River over the entire model period. Positive values indicate warming from the Wasteload Allocation scenario relative to the No Point Source scenario, whereas negative values would indicate the scenario causes cooling.

4.1.6 Background

This scenario summarizes the temperature impacts of background conditions, calculated as Current Condition Calibration minus Background. Positive values indicate cooling under the Background scenario relative to the Current Condition Calibration, whereas negative values would indicate the Background scenario causes warming.

Table 4-15 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Background scenarios for the John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 1.00°C, indicating 1.00°C of cooling under the Background scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 13.52°C, indicating 13.52°C of cooling under the Background scenario, and occurs at stream model km 327.

Figure 4-14 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Background model scenarios for the John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-15: Summary of maximum 7DADM stream temperature change between Current Conditions Calibration and Background model scenarios for the John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	1.00	outlet
327	13.52	POMI

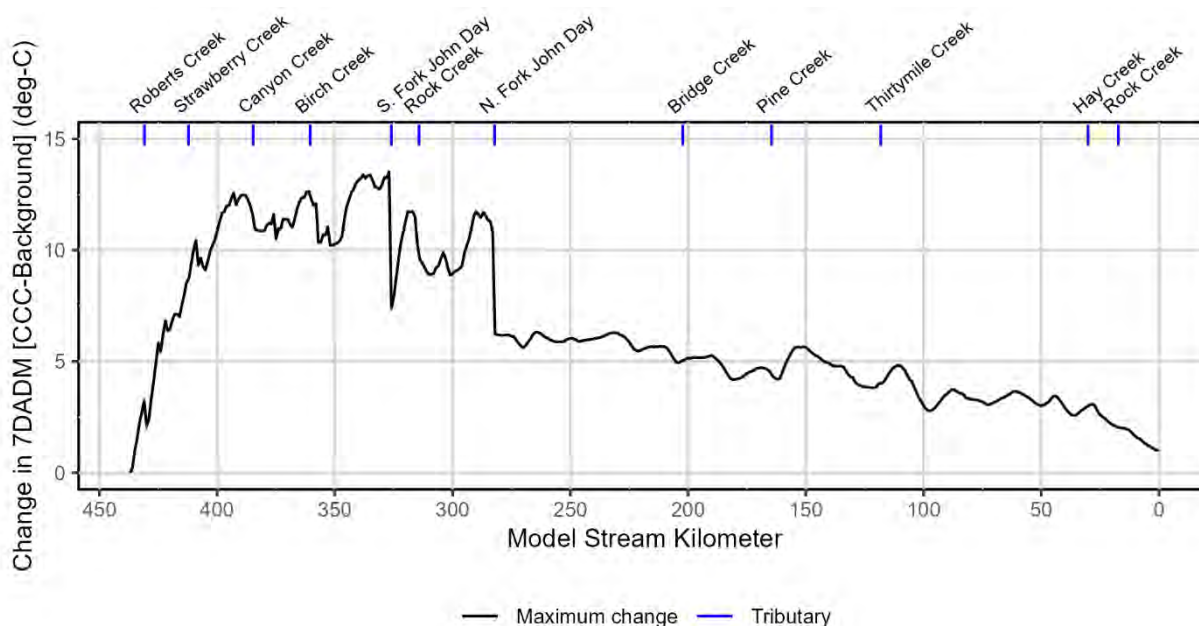


Figure 4-14: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration and Background model scenarios for the John Day River over the entire model period. Positive values indicate cooling under the Background scenario, relative to the Current Condition Calibration. Negative values indicate warming under the Background scenario.

The Background scenario to the BBNC which describes the Background amount of excess thermal load attributed to background sources. This scenario is calculated as the Background scenario minus the BBNC. Positive values indicate warming under the Background scenario relative to the BBNC, whereas negative values would indicate cooling.

Table 4-16 summarizes the maximum 7DADM stream temperature change between the Background scenario and the BBNC for the John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 7.53°C, indicating 7.53°C of warming under the Background scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 7.65°C, indicating 7.65°C of warming under the Background scenario, and occurs at stream model km 27.

Figure 4-15 shows the change in the maximum 7DADM stream temperatures between the Background model scenario and the BBNC for the John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-16: Summary of maximum 7DADM stream temperature change between the Background model scenario and BBNC for the John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	7.53	outlet
27	7.65	POMI

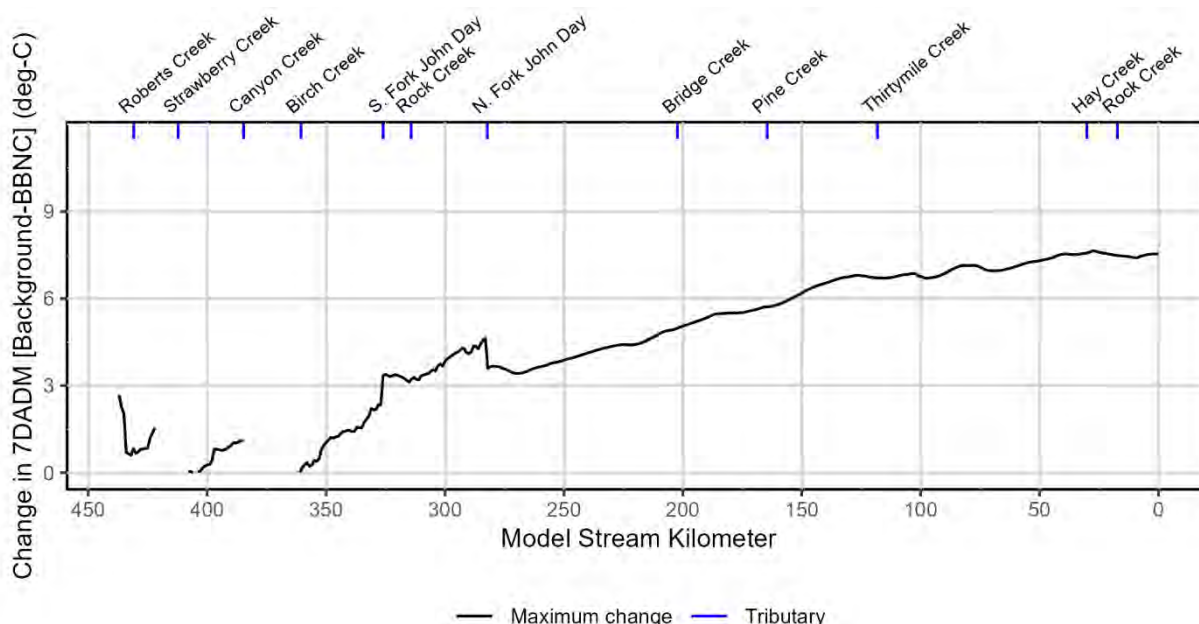


Figure 4-15: Change in maximum 7DADM stream temperatures between the Background model scenario and the BBNC for the John Day River over the entire model period and extent when the temperatures exceeded the BBNC. Positive values indicate warming under the Background scenario relative to the BBNC, whereas negative values would indicate cooling.

4.1.7 HUA Attainment

This section summarizes the temperature impacts on the John Day River of the proposed load allocations and wasteload allocations, as applicable. The HUA Attainment scenario determines if the modeled thermal sources achieve their allocated portion of the HUA. To determine this, results from the HUA Attainment scenario and the HUA Baseline were compared. **Table 4-17** summarizes the HUA Attainment scenario model set up.

Table 4-17: HUA Attainment model scenario set up for John Day River.

Model input variable	Attainment scenario setup description
Riparian landcover	Equal to Restored Vegetation A scenario.
Tributary temperatures	Hourly tributary temperatures were increased by the assigned allocations on each tributary; hourly

Model input variable	Attainment scenario setup description
	temperatures were increased by 0.25°C which is the total proposed HUA minus the reserve capacity.
Tributary flow	Equivalent to Current Condition Calibration flows.
Boundary condition temperature	Equivalent to boundary condition temperatures used in Current Condition Calibration.
Boundary condition flow	Equivalent to boundary condition flows used in Current Condition Calibration.
Withdrawals	Equivalent to withdrawals used in current conditions model calibration.
NPDES point sources	There are three NPDES point source discharges within the model extent. Each point source is set to their proposed wasteload allocations, which are represented in the Wasteload Allocation scenario.
Nonpoint source dam and reservoir operations	There are no dam or reservoir operations within the model extent, though there is an allocation assigned to this source of 0.00°C.
Solar loading from existing infrastructure	Solar loading from existing infrastructure was modeled but not included in attainment scenario. An allocation was assigned separately.

The HUA Attainment scenario was then compared to the HUA Baseline. The HUA Baseline scenario is the same as the Restored Vegetation A scenario. The scenario is calculated as the HUA Attainment scenario minus the HUA Baseline scenario. Positive values indicate warming under the HUA Attainment scenario relative to the HUA Baseline, whereas negative values would indicate cooling.

Table 4-18 summarizes the maximum 7DADM stream temperature change between the HUA Attainment and HUA Baseline scenarios for the John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.001°C, indicating 0.001°C warming under the HUA Attainment scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 0.16°C, indicating 0.16°C of warming under the HUA Attainment scenario, and occurs at stream model km 326.

Figure 4-16 shows the change in the maximum 7DADM stream temperatures between the HUA Attainment and HUA Baseline model scenarios for the John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-18: Summary of maximum 7DADM stream temperature change between the HUA Attainment and HUA Baseline model scenarios for the John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.001	outlet
326	0.16	POMI

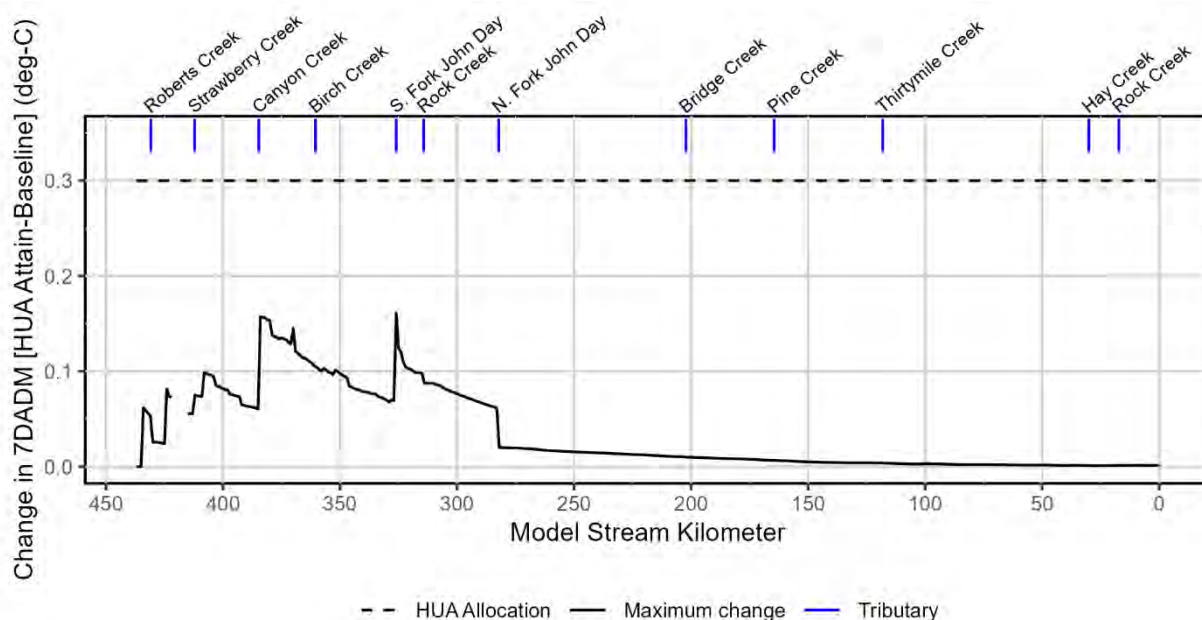


Figure 4-16: Change in maximum 7DADM stream temperatures between the HUA Attainment and HUA Baseline model scenarios for the John Day River over the entire model period and extent when the temperatures exceeded the BBNC. Positive values indicate warming under the HUA Attainment scenario relative to the HUA Baseline, whereas negative values indicate the scenario causes cooling.

4.2 North Fork John Day River

Table 4-19 summarizes the 7DADM stream temperatures predicted at the mouth and at the POMI of the North Fork John Day River for all model scenarios.

Table 4-20 daily maximum stream temperatures predicted at the mouth of the North Fork John Day River for all model scenarios.

Table 4-19: Summary of maximum 7DADM stream temperature at the mouth of the North Fork John Day River for all model scenarios over the entire model period.

Temperature Metric	Scenario	Stream Temperature (°C)	Location
7DADM	Current Conditions	27.42	Outlet
7DADM	Restored Vegetation A	27.07	Outlet
7DADM	Restored Vegetation B	27.09	Outlet
7DADM	Restored Flow	26.65	Outlet
7DADM	1% Consumptive Use	26.75	Outlet
7DADM	Tributary Temperature A	26.92	Outlet
7DADM	Tributary Temperature B	27.44	Outlet
7DADM	Channel Morphology	26.31	Outlet
7DADM	HUA Attainment	26.72	Outlet

Temperature Metric	Scenario	Stream Temperature (°C)	Location
7DADM	Background	26.41	Outlet

Table 4-20: Summary of daily maximum stream temperature at the mouth of the North Fork John Day River for all model scenarios over the entire model period.

Temperature Metric	Scenario	Stream Temperature (°C)	Location
Daily Maximum	Current Conditions	28.46	Outlet
Daily Maximum	Restored Vegetation A	28.12	Outlet
Daily Maximum	Restored Vegetation B	28.13	Outlet
Daily Maximum	Restored Flow	27.57	Outlet
Daily Maximum	1% Consumptive Use	27.69	Outlet
Daily Maximum	Tributary Temperature A	27.98	Outlet
Daily Maximum	Tributary Temperature B	28.48	Outlet
Daily Maximum	Channel Morphology	27.21	Outlet
Daily Maximum	HUA Attainment	27.74	Outlet
Daily Maximum	Background	27.40	Outlet

4.2.1 Vegetation scenarios

This section summarizes the temperature impacts of vegetation under current conditions, restored vegetation conditions, and topographic shading. The Restored Vegetation A scenario examines the temperature impacts of restoring all vegetation to the system potential. The maximum 7DADM stream temperature change is calculated as Current Condition Calibration minus Restored Vegetation A. Positive values indicate cooling under the Restored Vegetation A scenario relative to the Current Condition Calibration, whereas negative values indicate warming under this scenario.

Table 4-21 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Restored Vegetation A scenarios for the North Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) equal to 0.43°C, indicating 0.43°C of cooling under the Restored Vegetation A scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 7.68°C, indicating 7.68°C of cooling under the Restored Vegetation A scenario, and occurs at stream model km 152.2.

Figure 4-17 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Restored Vegetation A model scenarios for the North Fork John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-21: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Restored Vegetation A model scenarios for the North Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.43	outlet
152.2	7.68	POMI

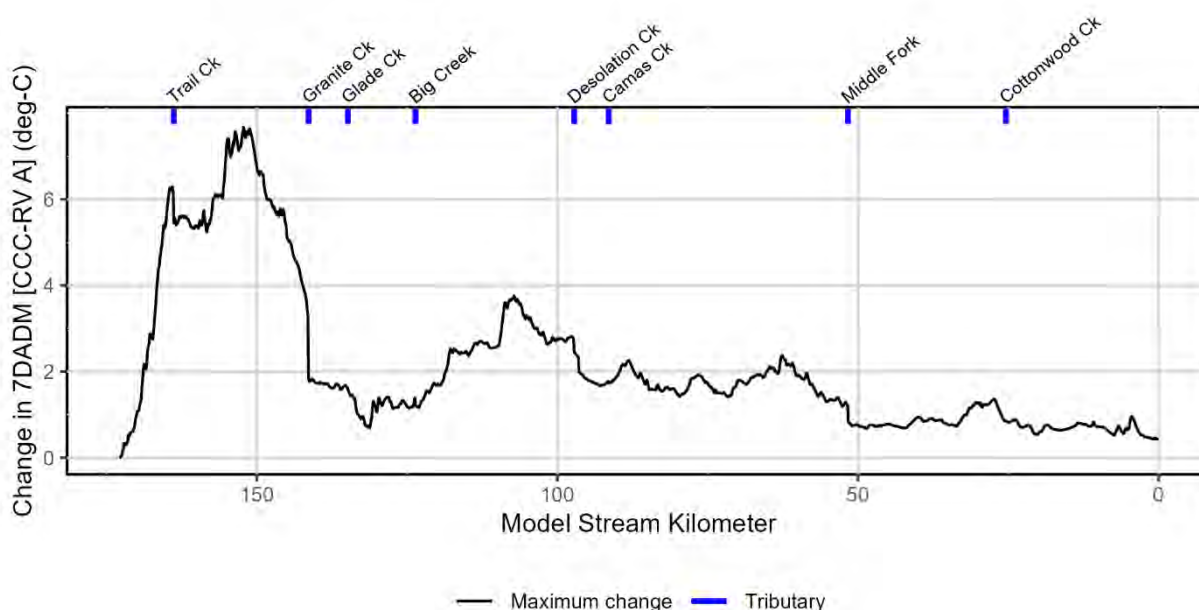


Figure 4-17: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Restored Vegetation A (RV A) model scenarios for the North Fork John Day River over the entire model period and extent when temperatures exceed the BBNC. Positive values indicate cooling under the Restored Vegetation A scenario relative to Current Condition Calibration, whereas negative values would indicate the scenario causes warming.

The Restored Vegetation B scenario examines the temperature impacts of restoring all vegetation to the system potential, except for existing infrastructure (i.e. buildings and roads). The maximum 7DADM stream temperature change is calculated as Current Condition Calibration minus Restored Vegetation B. Positive values indicate cooling under the Restored Vegetation B scenario relative to the Current Condition Calibration, whereas negative values indicate warming under this scenario.

Table 4-22 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Restored Vegetation B scenarios for the North Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.42°C, indicating 0.42°C of cooling under Restored Vegetation B. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 7.68°C, indicating 7.68°C of cooling under the Restored Vegetation B scenario, and occurs at stream model km 410.

Figure 4-18 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Restored Vegetation B model scenarios for the North Fork John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-22: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Restored Vegetation B model scenarios for the North Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.42	outlet
152.2	7.68	POMI

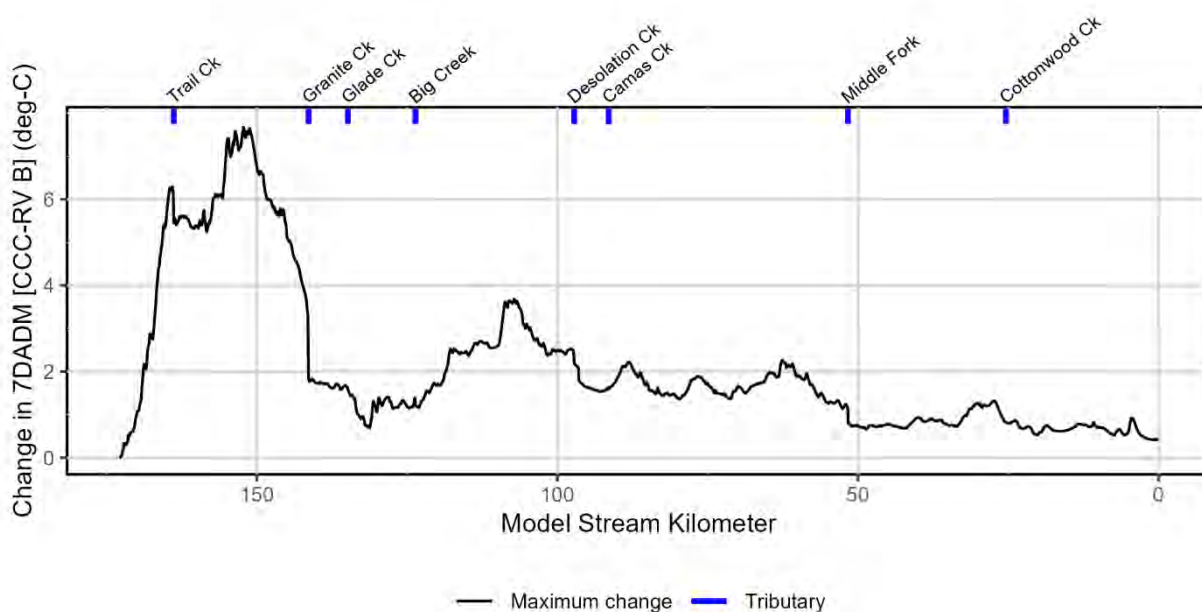


Figure 4-18: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration and Restored Vegetation B (RV B) model scenarios for the North Fork John Day River over the entire model period. Positive values indicate cooling under the Restored Vegetation B scenario relative to the Current Condition Calibration, whereas negative values indicate the scenario causes warming.

By comparing the Restored Vegetation B scenario to the Restored Vegetation A scenario examines the temperature impacts of transportation corridors (such as roads and highways) and urban, residential, commercial or industrial development (buildings). The comparison is calculated as the Restored Vegetation B scenario minus the Restored Vegetation A scenario. Positive values indicate warming under the Restored Vegetation B relative to the Restored Vegetation A scenario, whereas negative values indicate cooling in this scenario.

Table 4-23 summarizes the maximum 7DADM stream temperature change between the Restored Vegetation B and Restored Vegetation A scenarios for the North Fork John Day River. The results show the maximum 7DADM temperature difference at the most downstream node

(the outlet) is equal to 0.03°C, indicating 0.03°C of warming under the Restored Vegetation B scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 0.29°C, indicating 0.29°C of warming under the Restored Vegetation B scenario, and occurs at stream model km 97.5.

Figure 4-19 shows the change in the maximum 7DADM stream temperatures between the Restored Vegetation B and Restored Vegetation A model scenarios for the North Fork John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-23: Summary of maximum 7DADM stream temperature change Restored Vegetation B and Restored Vegetation A model scenarios for the North Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.03	outlet
97.5	0.29	POMI

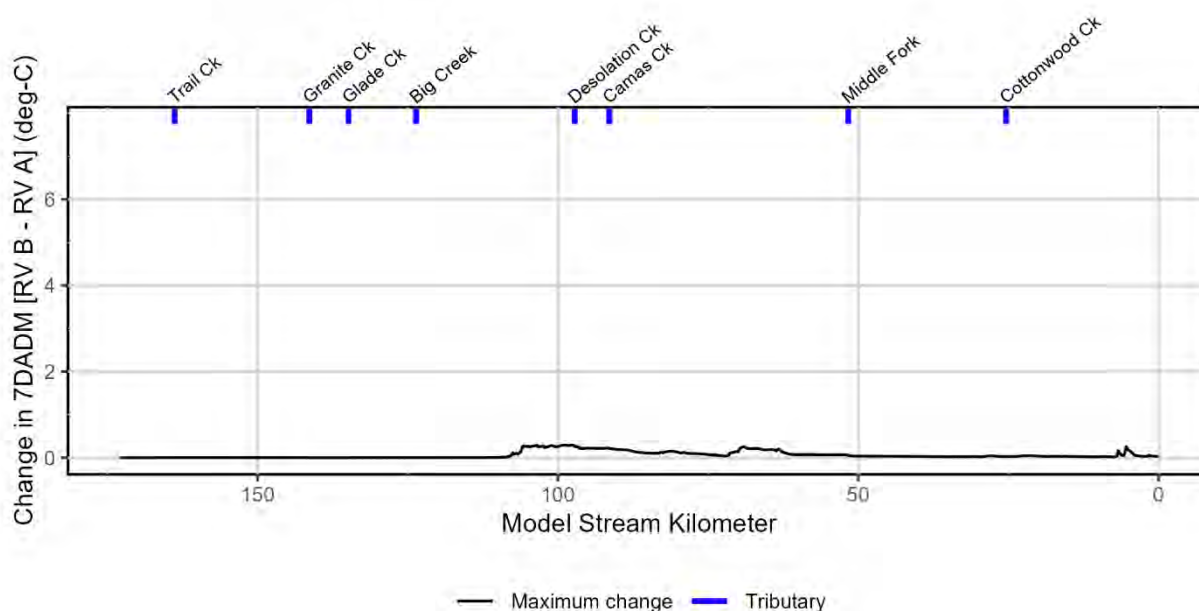


Figure 4-19: Change in maximum 7DADM stream temperatures between the Restored Vegetation B (RV B) and Restored Vegetation A (RV A) model scenarios for the North Fork John Day River over the entire model period. Positive values indicate warming under the Restored Vegetation B scenario relative to Restored Vegetation A, whereas negative values would indicate the Restored Vegetation A causes warming.

The HUA assigned to solar loading from existing transportation corridors (such as roads and highways) and urban, residential, commercial or industrial development (buildings) along the North Fork John Day River is 0.10°C. The model results show that if all infrastructure is retained along the modeled river, then the HUA will be exceeded. The results can be used to inform management decisions, as the comparison describes both the location of maximum required reduction as well as the location of maximum warming due to solar loading from infrastructure.

Table 4-24 summarizes the mean effective shade for the Calibration, Current 2023 Condition, Restored Vegetation A, and Topographic Shade scenarios for the North Fork John Day River. The difference in mean effective shade between the Restored Vegetation A and Current 2023 Condition scenarios is equal to 19.69 percentage points.

Figure 4-20 and **Figure 4-21** compare effective shade predictions from the Restored Vegetation A and Current 2023 Condition scenarios for the North Fork John Day River. **Figure 4-22** compares effective shade predictions from the Current 2023 Condition and Topographic Shade scenarios for the North Fork John Day River.

Table 4-24: Summary of mean effective shade for the Current Condition, Restored Vegetation A and Topographic Shade scenarios for the North Fork John Day River.

Scenario	Mean effective shade (%)
Calibration	24.17
Current 2023 Condition	19.57
Restored Vegetation	39.27
Shade Gap (Restored – Current 2023)	19.69
Topographic Shade	11.35

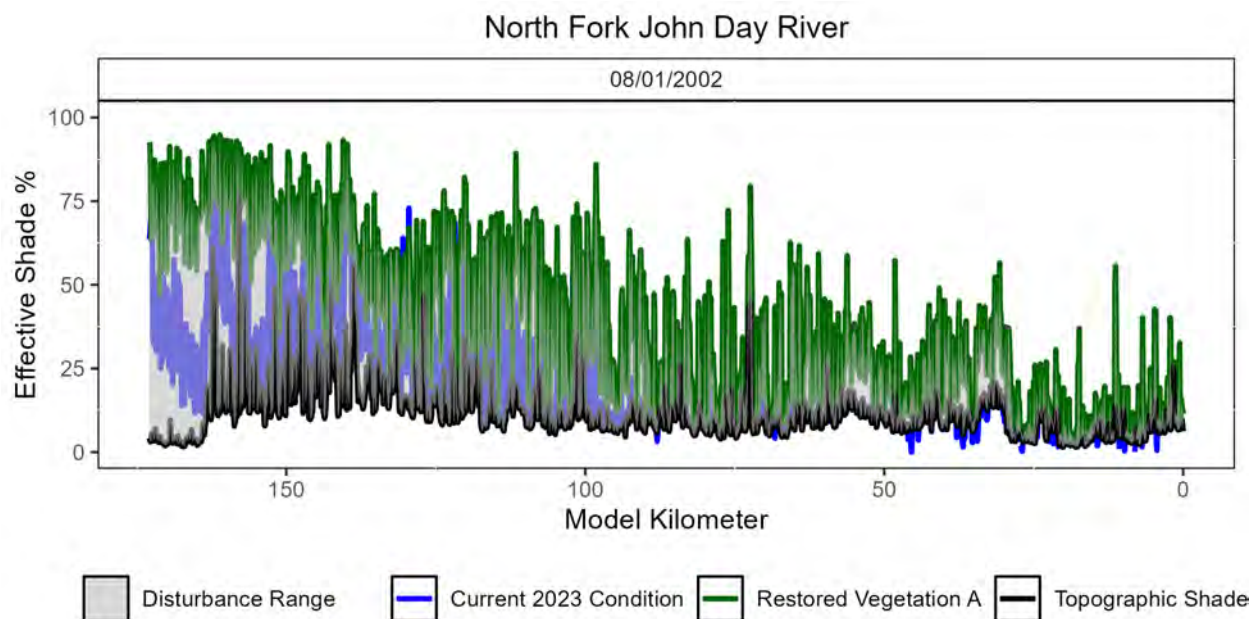


Figure 4-20: Comparison of effective shade from the Current Condition, Restored Vegetation, and Topographic Shade scenarios for the North Fork John Day River.

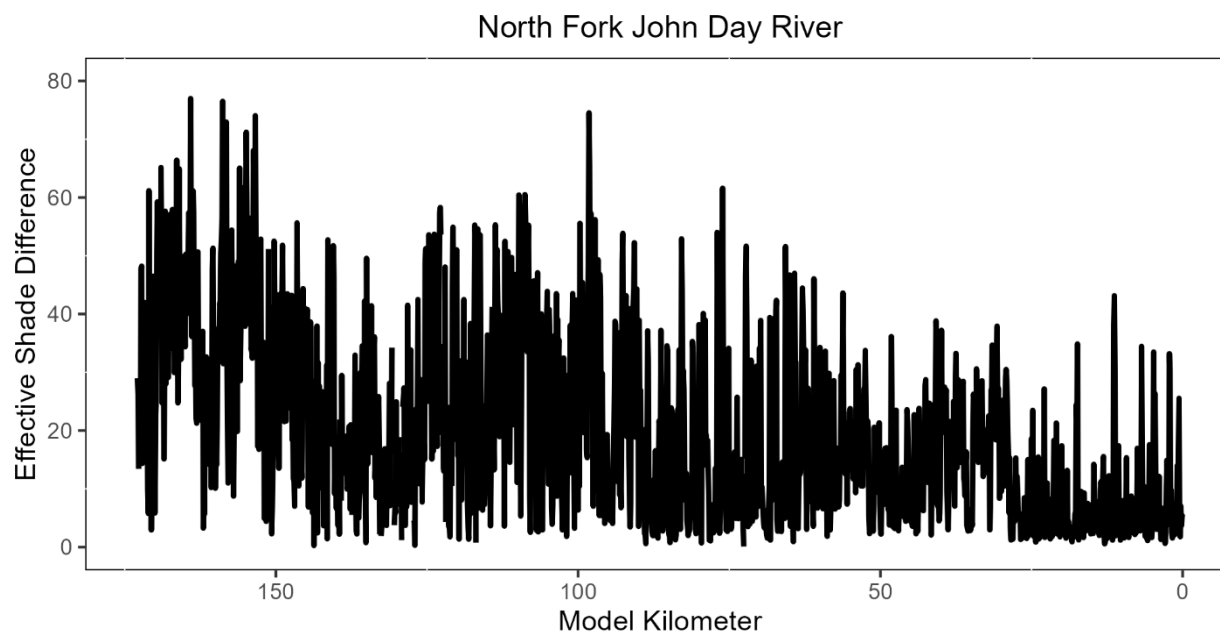


Figure 4-21: Percentage point difference between effective shade from the Restored Vegetation A and Current 2023 Condition scenarios for the North Fork John Day River.

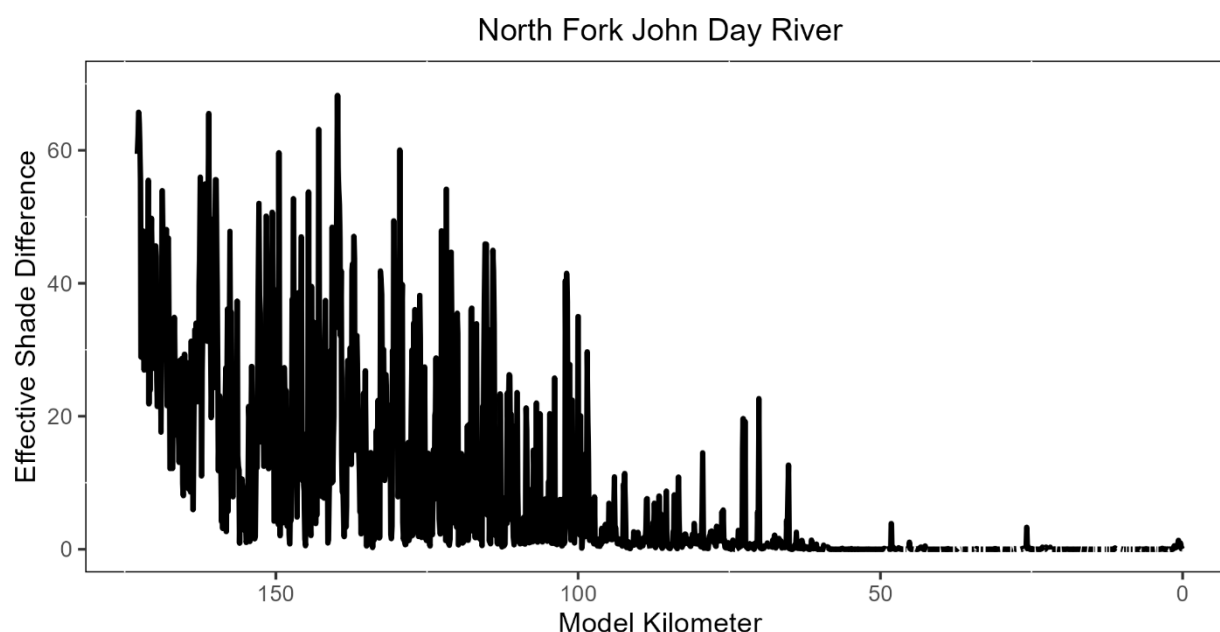


Figure 4-22: Percentage point difference between effective shade from the Current Condition and Topographic Shade scenarios for the North Fork John Day River.

4.2.2 Flow scenarios

This section summarizes the temperature impacts of changes to flow regimes, including restored flows and changes to consumptive use.

The Restored Flow scenario evaluates the temperature impacts from flow deviations from natural conditions. The temperature impact of restored flows is calculated as maximum 7DADM change in Current Condition Calibration minus Restored Flow scenario. Positive values indicate cooling under the Restored Flow scenario relative to the Current Condition Calibration, whereas negative values indicate warming.

Table 4-25 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Restored Flow scenarios for the North Fork John Day River. The results show the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 1.61°C, indicating a 1.61°C of cooling under the Restored Flow scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 2.34°C, indicating a 2.34°C of cooling under the Restored Flow scenario that occurs at stream model km 132.7.

Figure 4-23 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Restored Flow model scenarios for the North Fork John Day River over the entire model period and extent when the temperatures exceeded the BBNC.

Table 4-25: Summary of maximum 7DADM stream temperature change between Current Conditions and Restored Flow model scenarios for the North Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	1.61	outlet
132.7	2.34	POMI

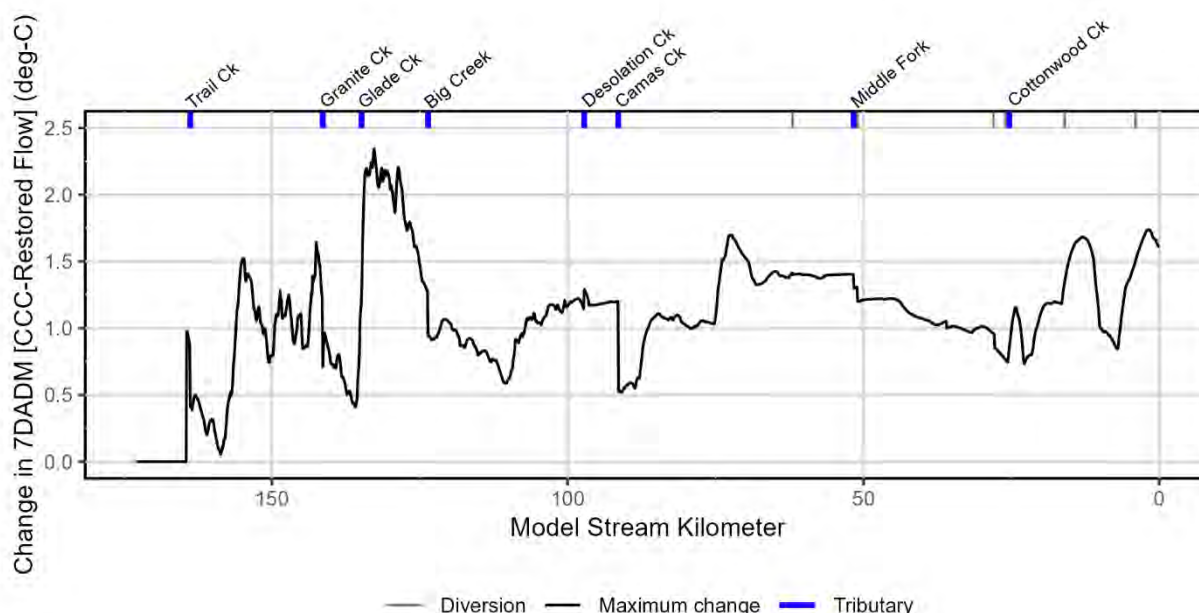


Figure 4-23: Change in maximum 7DADM stream temperatures between the Current Conditions and Restored Flow model scenarios for the North Fork John Day River over the entire model period and extent when temperatures exceed the BBNC. Positive values indicate cooling under

the Restored Flow scenario relative to the Current Condition Calibration, whereas negative values indicate the Restored Flow scenario causes warming.

The Consumptive Use scenario evaluates the effect of water withdrawals (1% of consumptive use) on temperature, calculated as the 1% Consumptive Use scenario minus the Restored Flow scenario. Positive values indicate warming under the 1% Consumptive Use scenario relative to the Restored Flow scenario, whereas negative values would indicate cooling.

Table 4-26 summarizes the maximum 7DADM stream temperature change between the 1% Consumptive Use and Restored Flow scenarios for the North Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.02°C, indicating a 0.02°C of warming under the 1% Consumptive Use scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 0.04°C, indicating a 0.04°C of warming under the 1% Consumptive Use scenario, and occurs at stream model km 128.6.

Figure 4-24 shows the change in the maximum 7DADM stream temperatures between the 1% Consumptive Use and Restored Flow model scenarios for the North Fork John Day River over the entire model period and extent when the temperatures exceed the BBNC.

Table 4-26: Summary of maximum 7DADM stream temperature change between the 1% Consumptive Use and Restored Flow model scenarios for the North Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.02	outlet
128.6	0.04	POMI

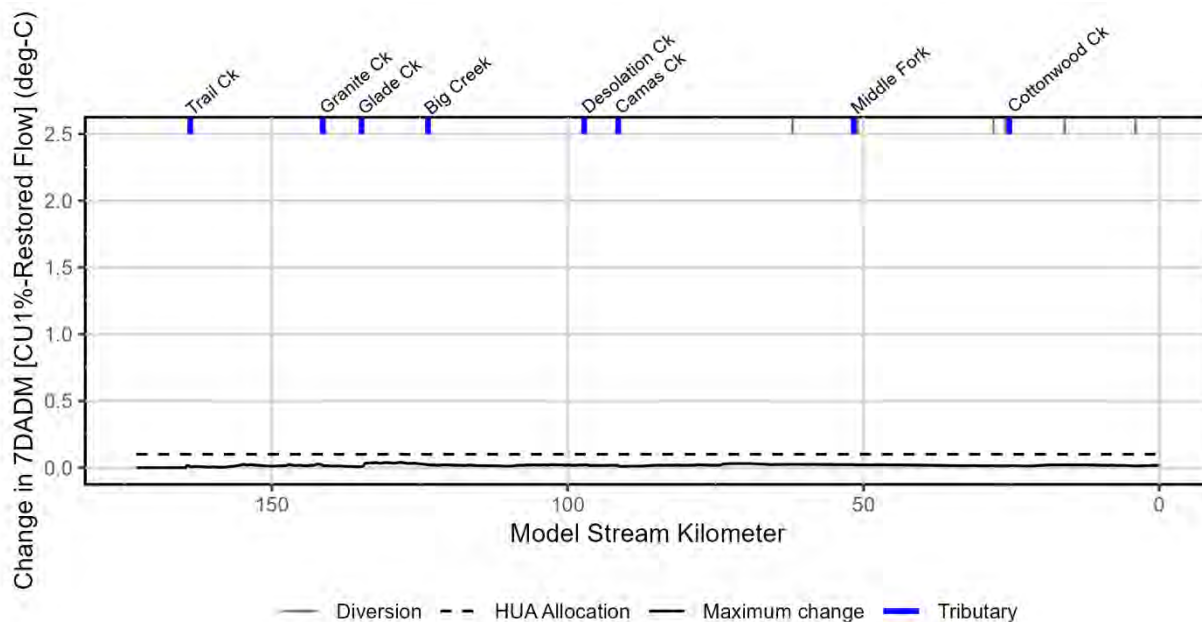


Figure 4-24: Change in maximum 7DADM stream temperatures between the 1% Consumptive Use (CU1%) and Restored Flow scenarios for the North Fork John Day River over the entire model

period. Positive values indicate warming under the 1% Consumptive Use relative to the Restored Flow scenario, whereas negative values would indicate the scenario causes cooling.

4.2.3 Tributary temperatures

This section summarizes the temperature impacts of tributary temperatures. Tributary Temperature A scenario examines exceedances of the water quality standards at the tributaries by setting the tributary temperature to the applicable criteria. The maximum 7DADM stream temperature change is calculated as Current Condition Calibration minus Tributary Temperature A scenario. Positive values indicate cooling under the Tributary Temperature A scenario relative to the Current Condition Calibration, whereas negative values indicate the scenario causes warming.

Table 4-27 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Tributary Temperature A scenarios for the North Fork John Day River. Results show the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 1.73°C, indicating 1.73°C of cooling under the Tributary Temperature A scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 5.65°C, indicating 5.65°C of cooling under the Tributary Temperature A scenario, and occurs at stream model km 51.

Figure 4-25 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Tributary Temperature A model scenarios for the North Fork John Day River over the entire model period and extent when the temperatures exceed the BBNC.

Table 4-27: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Tributary Temperature A model scenarios for the John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	1.73	outlet
51	5.65	POMI

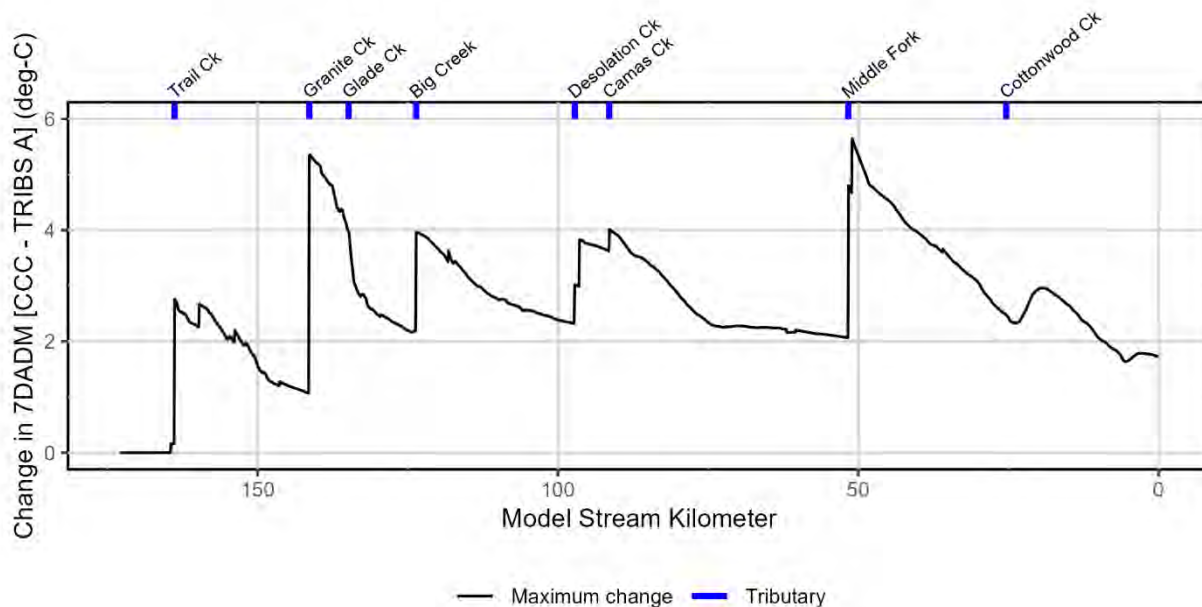


Figure 4-25: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Tributary Temperature A (TRIBS A) model scenarios for the North Fork John Day River over the entire model period. Positive values indicate cooling under the Tributary Temperature A scenario relative to Current Condition Calibration, while negative values indicate the scenario causes warming.

Tributary Temperature B scenario examines the temperature impacts of increasing the modeled tributary temperatures by the proposed HUA on those tributaries. In this scenario, modeled tributary temperatures are increased by 0.30°C to represent full utilization of the HUA, including reserve capacity. This scenario is designed to evaluate the change in mainstem temperatures resulting from applying the full HUA to tributaries, it does not assume or imply that attaining the HUA in tributaries will cause warmer temperatures in the North Fork John Day River. The maximum 7DADM change is calculated as Tributary Temperature B minus Current Condition Calibration. Because the HUA restricts cumulative warming from point sources and nonpoint sources to no more than 0.30°C, increasing tributary temperatures by 0.30°C allows evaluation of whether mainstem temperature attainment is maintained if the HUA is fully utilized by the tributaries. Positive values indicate the degree of warming from HUA attainment relative to the base (Current Condition Calibration), whereas negative values indicate cooling.

Table 4-28 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Tributary Temperature B scenarios for the North Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.13°C, indicating 0.13°C of warming under the Tributary Temperature B scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 0.21°C, indicating 0.21°C of warming under the Tributary Temperature B scenario, and occurs at stream model km 51.

Figure 4-26 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Tributary Temperature B model scenarios for the North Fork Temperature TMDLs for the John Day River Basin, TSD Appendix B

John Day River over the entire model period and extent when the temperatures exceed the BBNC.

Table 4-28: Summary of maximum 7DADM stream temperature change between the Tributary Temperature B (HUA=0.30) and Current Condition Calibration model scenarios for the North Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.13	outlet
51	0.21	POMI

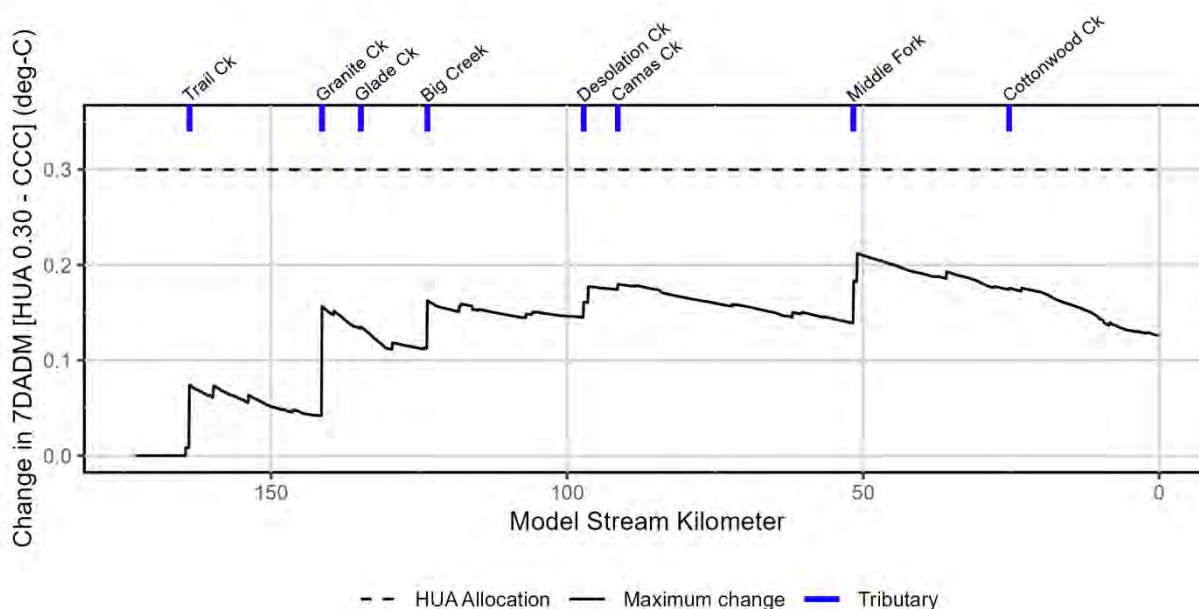


Figure 4-26: Change in maximum 7DADM stream temperatures between the Tributary Temperature B (HUA 0.30) model scenario and Current Conditions Calibration (CCC) for the North Fork John Day River over the entire model period. Positive values indicate warming under the Tributary Temperature B scenario relative to Current Condition Calibration, while negative values indicate the scenario causes cooling.

The TMDL allocations to warming from North Fork John Day River tributaries are presented in the main TMDL report (See Section 9.1.1). The Tributary Temperature B model analysis results support that the categorical HUA portions assigned to thermal sources on modeled North Fork John Day River tributaries will be achieved when those sources attain their applicable Load Allocations.

4.2.4 Channel Morphology

This section summarizes the temperature impacts of restoring bankfull width towards a more natural, narrower channel. The Channel Morphology scenario reduced the bankfull width by a defined percentage, i.e. the 30% Channel Morphology scenario is a 30% reduction in measured

bankfull width. The Channel Morphology scenarios are compared to the Current Condition Calibration, calculated as Current Condition Calibration minus the Channel Morphology scenario. Positive values indicate cooling under the Channel Morphology scenarios, whereas negative values indicate warming.

Table 4-29 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and 30% of Channel Morphology scenarios for the North Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 1.71°C, indicating 1.71°C of cooling under the 30% Channel Morphology scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 2.81°C, indicating 2.81°C of cooling under the 30% Channel Morphology scenario, and occurs at stream model km 72.3.

Figure 4-27 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and 30% Channel Morphology model scenarios for the North Fork John Day River over the entire model period and extent when the temperatures exceed the BBNC.

Table 4-29: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and the 30% Channel Morphology model scenarios for the North Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	1.71	outlet
72.3	2.81	POMI

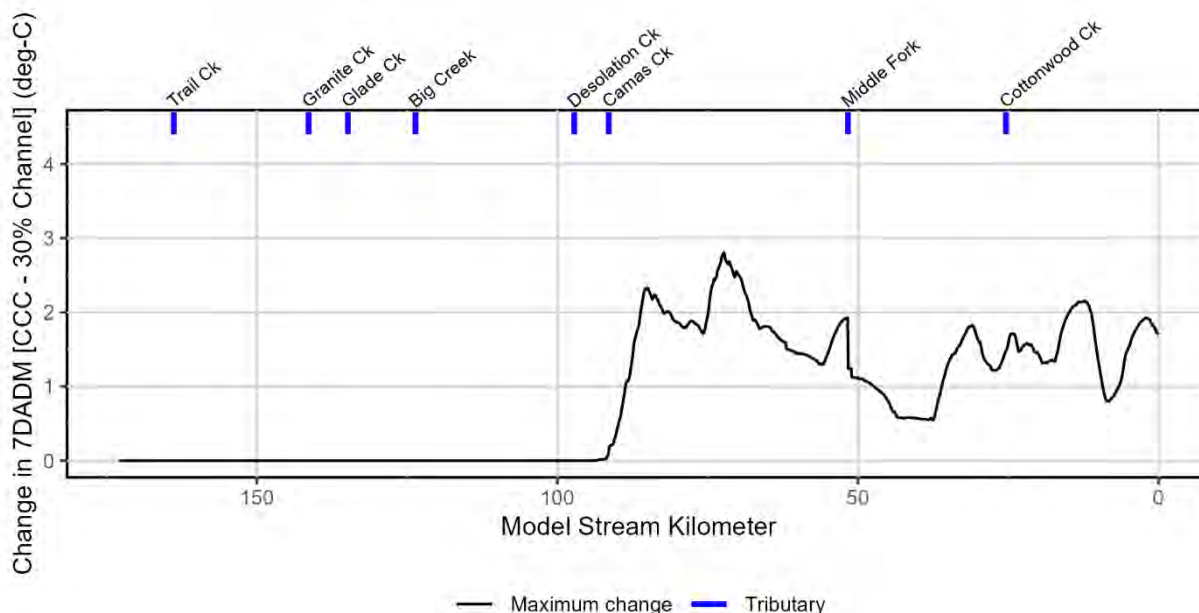


Figure 4-27: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and 30% Channel Morphology (30%Channel) scenarios for the North Fork John

Day River over the entire model period. Positive values indicate cooling under the 30% Channel Morphology scenario, whereas negative values indicate warming.

Table 4-30 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and each Channel Morphology scenario for the North Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) ranges from 0.61°C under the 10% Channel Morphology scenario to 3.37°C under the 50% Channel Morphology scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) ranges from 2.26°C under the 10% Channel Morphology scenario to 3.76°C under the 50% Channel Morphology scenario. The POMI for all the iterations of Channel Morphology scenarios occurs at stream model km 72.3.

Figure 4-28 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and all iterations of the Channel Morphology model scenarios for the North Fork John Day River over the entire model period and extent when temperatures exceed the BBNC.

Table 4-30: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and the Channel Morphology model scenarios (10% to 50%) for the North Fork John Day River over the entire model period.

Channel Morphology Reduction	Maximum Change in Stream Temperature (°C) at Outlet	Maximum Change in Stream Temperature (°C) at POMI (km 72.3)
10%	0.61	2.26
20%	1.17	2.26
30%	1.71	2.81
40%	2.48	2.81
50%	3.37	3.76

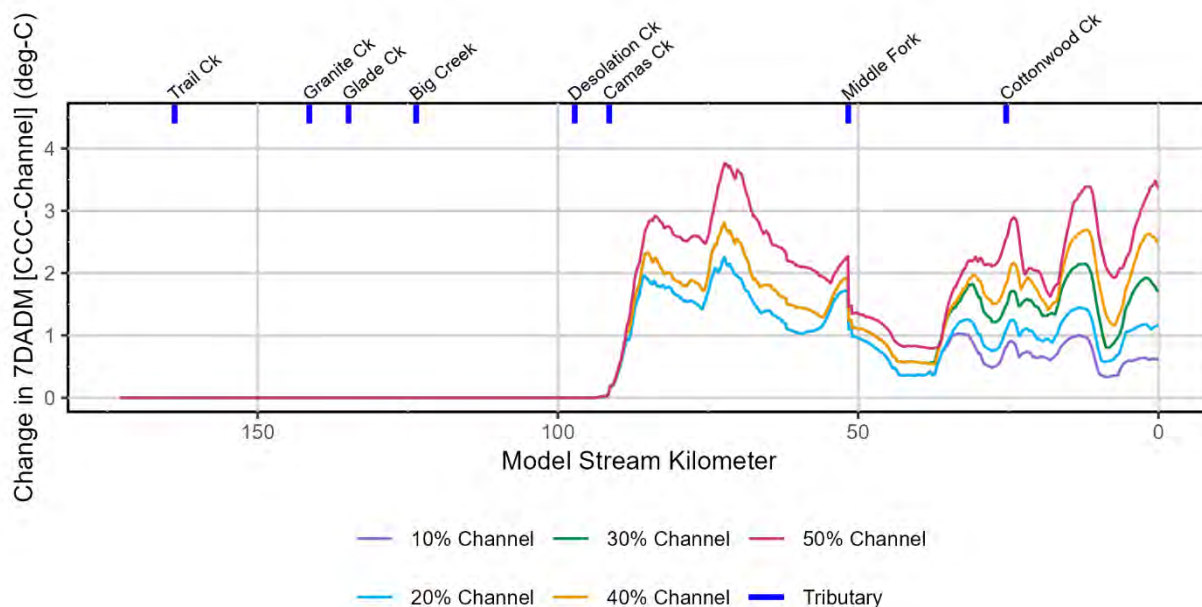


Figure 4-28: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and all iterations of the Channel Morphology scenarios for the North Fork John Day River over the entire model period. Positive values indicate cooling under the different Channel Morphology scenarios, whereas negative values indicate warming.

4.2.5 Background

This scenario summarizes the temperature impacts of background conditions, calculated as Current Condition Calibration minus Background. Positive values indicate cooling under the Background scenario relative to the Current Condition Calibration, whereas negative values would indicate the Background scenario causes warming.

Table 4-31 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Background scenarios for the North Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 4.20°C, indicating 4.20°C of cooling under the Background scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 6.11°C, indicating 6.11°C of cooling under the Background scenario, and occurs at stream model km 164.5.

Figure 4-29 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Background model scenarios for the North Fork John Day River over the entire model period and extent when the temperatures exceed the BBNC.

Table 4-31: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Background model scenarios for the North Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	4.20	outlet

Model KM	Maximum Change in Stream Temperature (°C)	Location
164.5	6.11	POMI

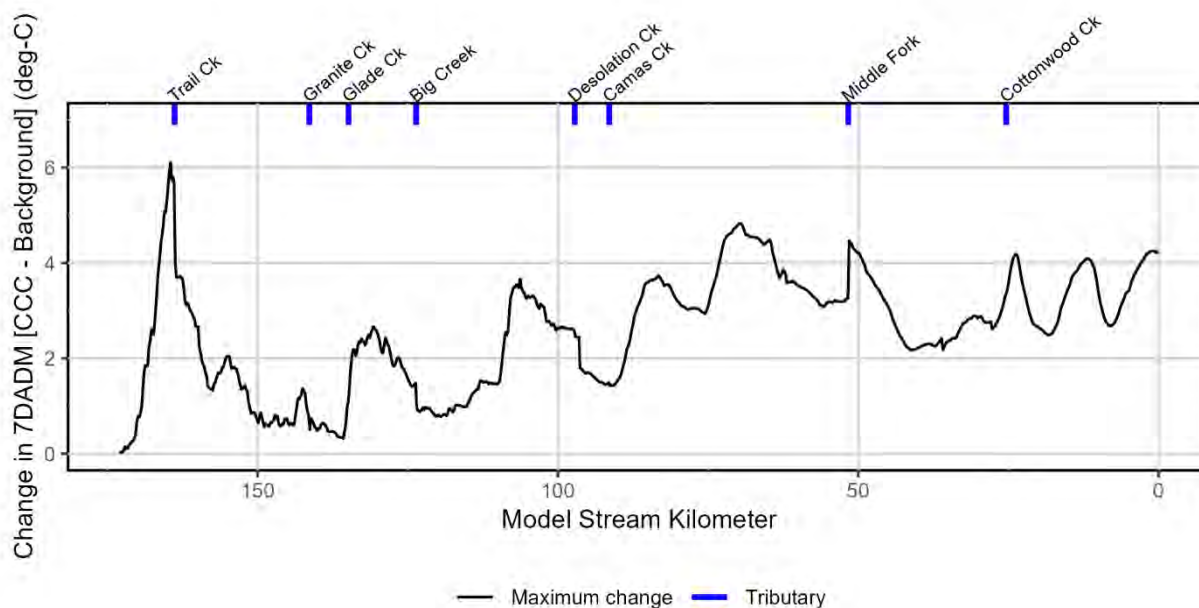


Figure 4-29: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration and Background model scenarios for the North Fork John Day River over the entire model period. Positive values indicate cooling under the Background scenario, relative to the Current Condition Calibration. Negative values indicate warming under the Background scenario.

The Background scenario to the BBNC which describes the Background amount of excess thermal load attributed to background sources. This scenario is calculated as the Background scenario minus the BBNC. Positive values indicate warming under the Background scenario relative to the BBNC, whereas negative values would indicate cooling.

Table 4-32 summarizes the maximum 7DADM stream temperature change between the Background scenario and the BBNC for the North Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 7.04°C, indicating 7.04°C of warming under the Background scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 12.89°C, indicating 12.89°C of warming under the Background scenario, and occurs at stream model km 152.3.

Figure 4-30 shows the change in the maximum 7DADM stream temperatures between the Background model scenario and the BBNC for the North Fork John Day River over the entire model period and extent when the temperatures exceed the BBNC.

Table 4-32: Summary of maximum 7DADM stream temperature change between the Background (30%) model scenario and the BBNC for the North Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	7.04	outlet
152.3	12.89	POMI

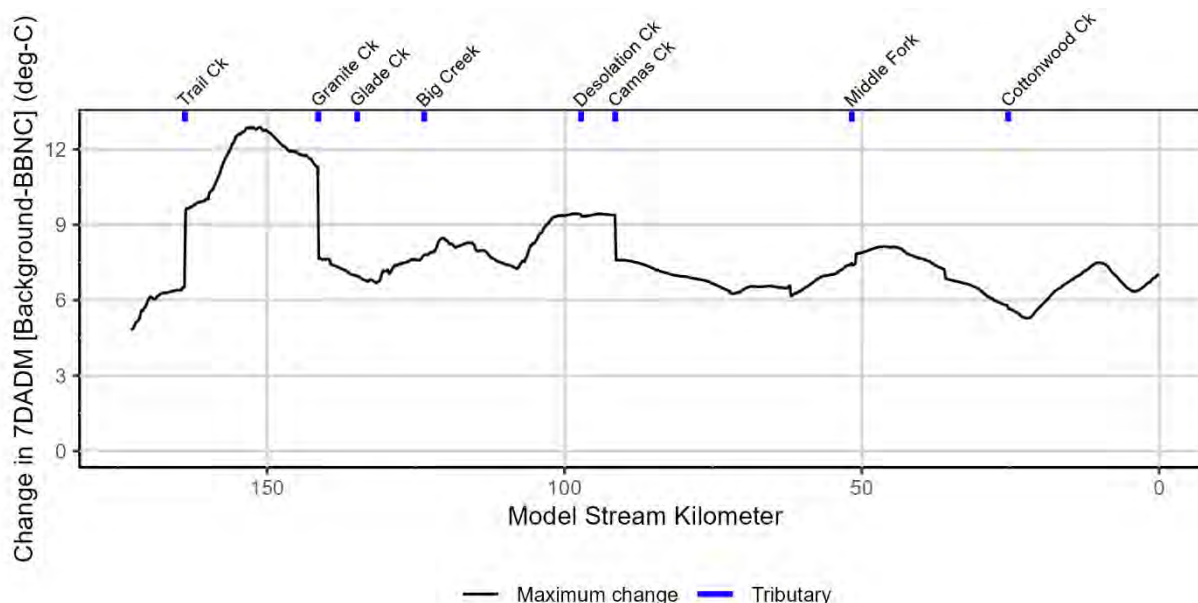


Figure 4-30: Change in maximum 7DADM stream temperatures between the Background model scenario and the BBNC for the North Fork John Day River over the entire model period and extent when the temperatures exceeded the BBNC. Positive values indicate warming under the Background scenario relative to the BBNC, whereas negative values would indicate cooling.

4.2.6 HUA Attainment

This section summarizes the temperature impacts on the North Fork John Day River of the proposed load allocations and wasteload allocations, as applicable. The HUA Attainment scenario determines if the modeled thermal sources achieve their allocated portion of the HUA. To determine this, results from the HUA Attainment scenario and the HUA Baseline were compared. **Table 4-33** summarizes the HUA attainment scenario model set up.

Table 4-33: HUA Attainment model scenario set up for the North Fork John Day River.

Model input variable	Attainment scenario setup description
Riparian landcover	Equal to Restored Vegetation A scenario,
Tributary temperatures	Hourly tributary temperatures were increased by the assigned allocations on each tributary; hourly temperatures were increased by 0.25°C which is the total proposed HUA minus the reserve capacity.

Model input variable	Attainment scenario setup description
Tributary flow	Equivalent to Current Condition Calibration flows.
Boundary condition temperature	Equivalent to boundary condition temperatures used in Current Condition Calibration scenario.
Boundary condition flow	Equivalent to boundary condition flows used in Current Condition Calibration scenario.
Withdrawals	Equivalent to withdrawals used in Current Condition Calibration scenario.
NPDES point sources	There are no NPDES point source discharges within the model extent, the allocation assigned to point sources is 0.00°C.
Nonpoint source impoundments	There are no impoundments within the model extent, the allocation assigned to this source of 0.00°C.
Solar loading from existing infrastructure	Solar loading from existing infrastructure was modeled but not included in attainment scenario. An allocation was assigned separately.

The HUA Attainment scenario was then compared to the HUA Baseline. The HUA Baseline scenario is the same as the Restored Vegetation A scenario. The scenario is calculated as the HUA Attainment scenario minus the HUA Baseline scenario. Positive values indicate warming under the HUA Attainment scenario relative to the HUA Baseline, whereas negative values would indicate cooling.

Table 4-34 summarizes the maximum 7DADM stream temperature change between the HUA Attainment and Baseline scenarios for the North Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.06°C, indicating 0.06°C of warming under the HUA Attainment scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 0.18°C, indicating 0.18°C of warming under the HUA Attainment scenario, and occurs at stream model km 51.

Figure 4-31 shows the change in the maximum 7DADM stream temperatures between the HUA Attainment and Baseline model scenarios for the North Fork John Day River over the entire model period and extent when the temperatures exceed the BBNC.

Table 4-34: Summary of maximum 7DADM stream temperature change between the HUA Attainment and Baseline scenarios for the North Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.06	outlet
51.0	0.18	POMI

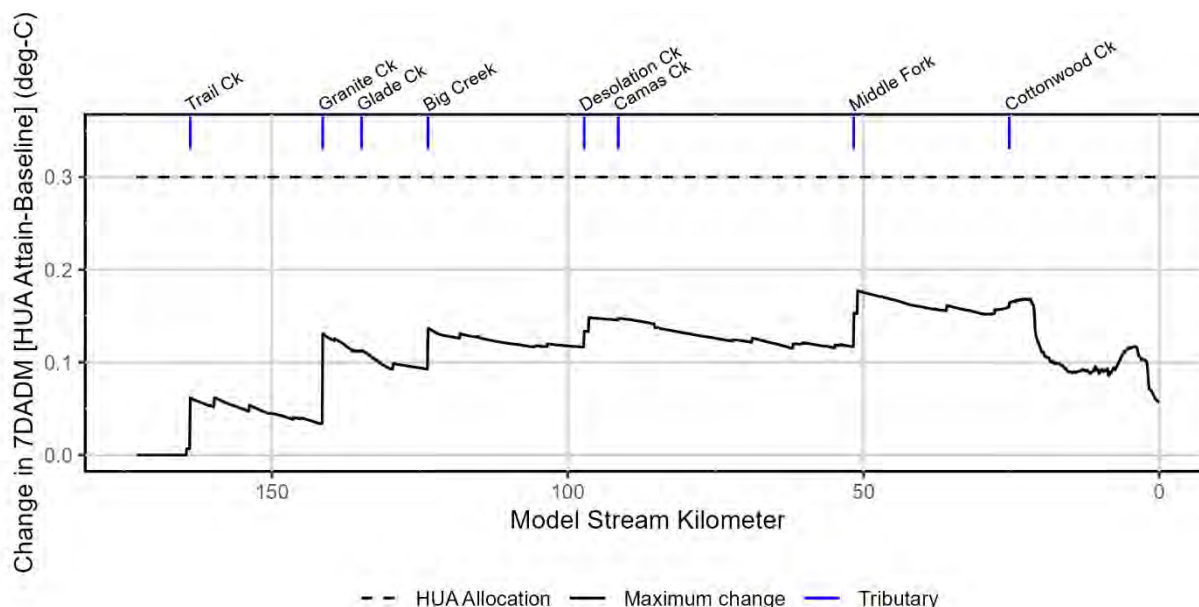


Figure 4-31: Change in maximum 7DADM stream temperatures between the HUA Attainment and HUA Baseline model scenarios for the North Fork John Day River over the entire model period and extent when the temperatures exceeded the BBNC. Positive values indicate warming under the HUA Attainment scenario relative to the HUA Baseline, whereas negative values indicate the scenario causes cooling.

4.3 Middle Fork John Day River

Table 4-35 summarizes the 7DADM stream temperatures predicted at the mouth and at the POMI of the Middle Fork John Day River for all model scenarios.

Table 4-36 daily maximum stream temperatures predicted at the mouth of the Middle Fork John Day River for all model scenarios.

Table 4-35: Summary of maximum 7DADM stream temperature at the mouth of the Middle Fork John Day River for all model scenarios over the entire model period.

Temperature Metric	Scenario	Stream Temperature (°C)	Location
7DADM	Calibration	31.09	Outlet
7DADM	Restored Vegetation A	29.30	Outlet
7DADM	Restored Vegetation B	29.39	Outlet
7DADM	Restored Flow	30.52	Outlet
7DADM	1% Consumptive Use	30.52	Outlet
7DADM	Tributary Temperature A		Outlet
7DADM	Tributary Temperature B	31.09	Outlet
7DADM	Channel Morphology	27.80	Outlet
7DADM	Attainment	28.45	Outlet
7DADM	Background	26.39	Outlet

Table 4-36: Summary of daily maximum stream temperature at the mouth of the Middle Fork John Day River for all model scenarios over the entire model period.

Temperature Metric	Scenario	Stream Temperature (°C)	Location
Daily maximum	Calibration	33.22	Outlet
Daily maximum	Restored Vegetation A	31.24	Outlet
Daily maximum	Restored Vegetation B	31.35	Outlet
Daily maximum	Restored Flow	32.48	Outlet
Daily maximum	1% Consumptive Use	32.49	Outlet
Daily maximum	Tributary Temperature A		Outlet
Daily maximum	Tributary Temperature B	33.22	Outlet
Daily maximum	Channel Morphology	29.08	Outlet
Daily maximum	Attainment	30.23	Outlet
Daily maximum	Background	26.39	Outlet

4.3.1 Vegetation scenarios

This section summarizes the temperature and shade impacts of vegetation current conditions, restored vegetation conditions, and topographic shading. The Restored Vegetation A scenario examines the temperature impacts of restoring all vegetation to the system potential. The maximum 7DADM stream temperature change is calculated as Current Condition Calibration minus Restored Vegetation A. Positive values indicate cooling under the Restored Vegetation A scenario relative to the Current Condition Calibration, whereas negative values indicate warming under this scenario.

Table 4-37 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Restored Vegetation A scenarios for the Middle Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 3.74°C, indicating 3.74°C of cooling under the Restored Vegetation A scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 6.62°C, indicating 6.62°C of cooling under the Restored Vegetation A scenario, and occurs at stream model km 107.95.

Figure 4-32 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Restored Vegetation A model scenarios for the Middle Fork John Day River over the entire model.

Table 4-37: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Restored Vegetation A model scenarios for the Middle Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	3.74	outlet
107.95	6.62	POMI

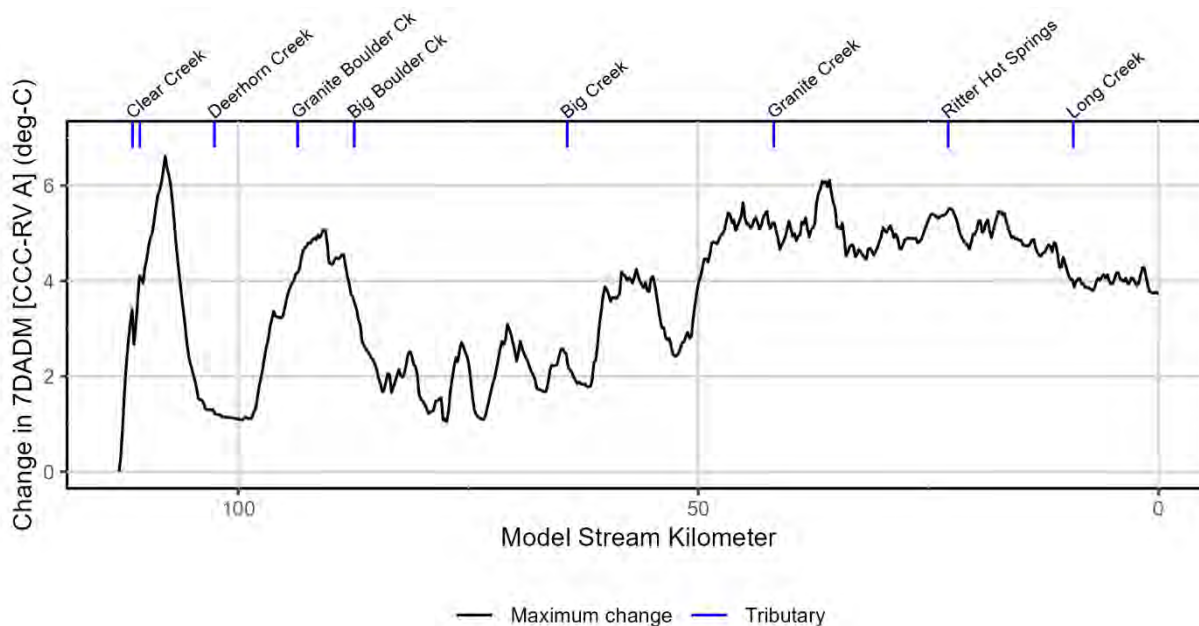


Figure 4-32: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Restored Vegetation A (RV A) model scenarios for the Middle Fork John Day River over the entire model period and extent when temperatures exceed the BBNC. Positive values indicate cooling under the Restored Vegetation A scenario relative to Current Condition Calibration, whereas negative values would indicate the scenario causes warming.

The Restored Vegetation B scenario examines the temperature impacts of restoring all vegetation to the system potential, except for existing infrastructure (i.e. buildings and roads). The maximum 7DADM stream temperature change is calculated as Current Condition Calibration minus Restored Vegetation B. Positive values indicate cooling under the Restored Vegetation B scenario relative to the Current Condition Calibration, whereas negative values indicate warming under this scenario.

Table 4-38 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Restored Vegetation B scenarios for the Middle Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 3.62°C, indicating 3.62°C of cooling under the Restored Vegetation B scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 6.62°C, indicating 6.62°C of cooling under the Restored Vegetation B scenario, and occurs at stream model km 107.95.

Figure 4-33 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Restored Vegetation B model scenarios for the Middle Fork John Day River over the entire model period and extent when the temperatures exceed the BBNC.

Table 4-38: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Restored Vegetation B model scenarios for the Middle Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	3.62	outlet
107.95	6.62	POMI

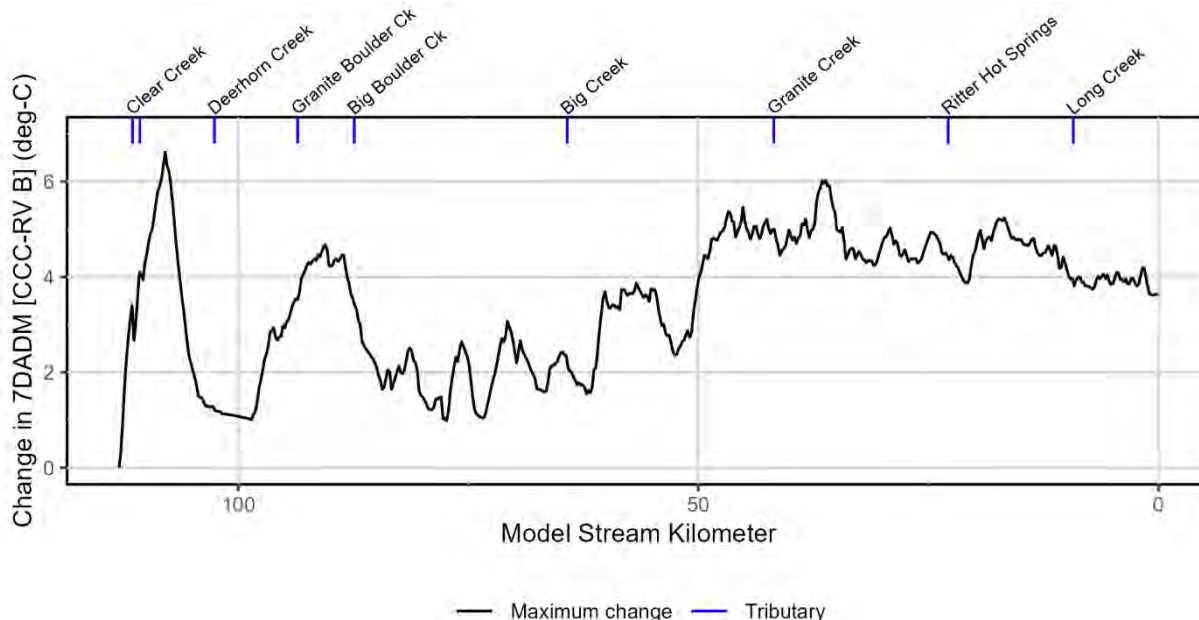


Figure 4-33: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Restored Vegetation B (RV B) model scenarios for the Middle Fork John Day River over the entire model period and extent when temperatures exceed the BBNC. Positive values indicate cooling under the Restored Vegetation B scenario relative to Current Condition Calibration, whereas negative values would indicate the scenario causes warming.

Comparing the Restored Vegetation B scenario to the Restored Vegetation A scenario examines the temperature impacts of transportation corridors (such as roads and highways) and urban, residential, commercial or industrial development (buildings). The comparison is calculated as the Restored Vegetation B scenario minus the Restored Vegetation A scenario. Positive values indicate warming under the Restored Vegetation B relative to the Restored Vegetation A scenario, whereas negative values indicate cooling in this scenario.

Table 4-39 summarizes the maximum 7DADM stream temperature change between the Restored Vegetation B and Restored Vegetation A scenarios for the Middle Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.13°C, indicating 0.13°C of warming in the Restored Vegetation B scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 1.21°C, indicating 1.21°C of warming in the Restored Vegetation B scenario, and occurs at stream model km 22.75.

Figure 4-34 shows the change in the maximum 7DADM stream temperatures between the Restored Vegetation B and restored Vegetation A model scenarios for the Middle Fork John Day River over the entire model period and extent when the temperatures exceed the BBNC.

Table 4-39: Summary of maximum 7DADM stream temperature change between Vegetation B and Vegetation A model scenarios for the Middle Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.13	outlet
22.75	1.21	POMI

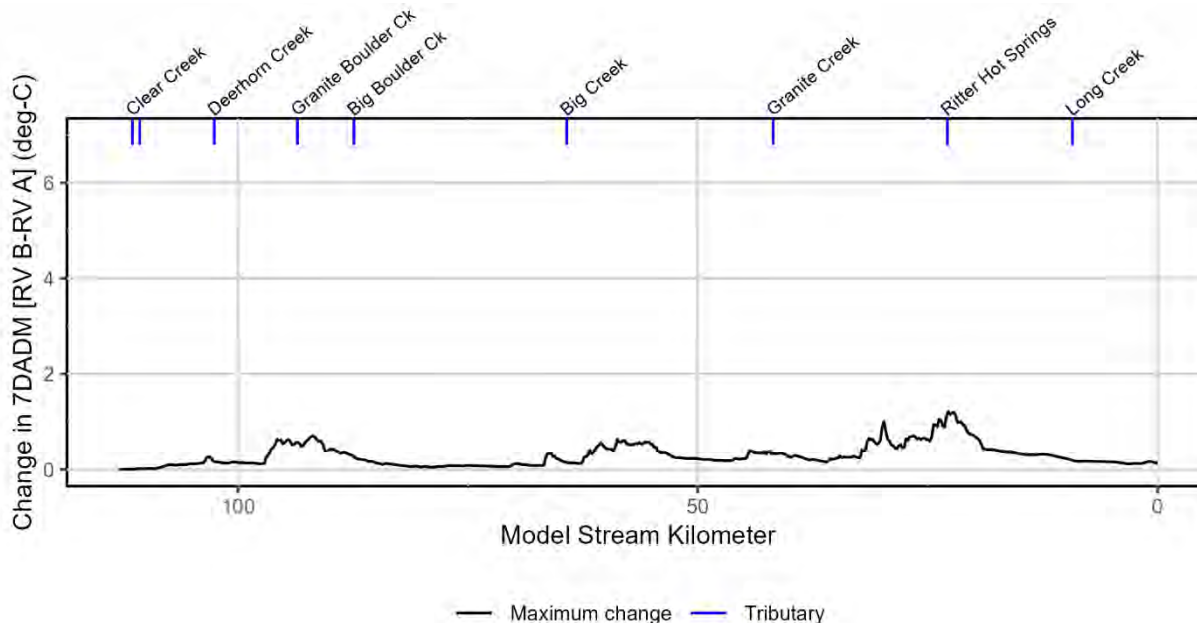


Figure 4-34: Change in maximum 7DADM stream temperatures between the Restored Vegetation B (RV B) and Restored Vegetation A (RV A) model scenarios for the Middle Fork John Day River over the entire model period and extent when temperatures exceed the BBNC. Positive values indicate warming under the Restored Vegetation B scenario relative to Restored Vegetation A, whereas negative values would indicate the Restored Vegetation A causes warming.

The HUA assigned to solar loading from existing transportation corridors (such as roads and highways) and urban, residential, commercial or industrial development (buildings) along the Middle Fork John Day River is 0.10°C. The model results show that if all infrastructure is retained along the Middle Fork John Day River, then the HUA will be exceeded. The results can be used to inform management decisions, as the comparison describes both the location of maximum required reduction as well as the location of maximum warming due to solar loading from infrastructure.

Table 4-40 summarizes the mean effective shade for the Calibration, Current 2023 Condition, Restored Vegetation A, and Topographic Shade scenarios for the Middle Fork John Day River. The difference in mean effective shade between the Restored Vegetation A and Current 2023 Condition scenarios is equal to 26.45 percentage points.

Figure 4-35 and **Figure 4-36** compare effective shade predictions from the Restored Vegetation A and Current 2023 Condition scenarios for the North Fork John Day River. **Figure 4-37** compare effective shade predictions from the Current 2023 Condition and Topographic Shade scenarios for the North Fork John Day River.

Table 4-40: Summary of mean effective shade for the Calibration, Current Condition, Restored Vegetation A, and Topographic Shade scenarios for the Middle Fork John Day River.

Scenario	Mean effective shade (%)
Calibration	15.48
Current 2023 Condition	11.52
Restored Vegetation	37.98
Shade Gap (Restored – Current 2023)	26.45
Topographic Shade	6.86

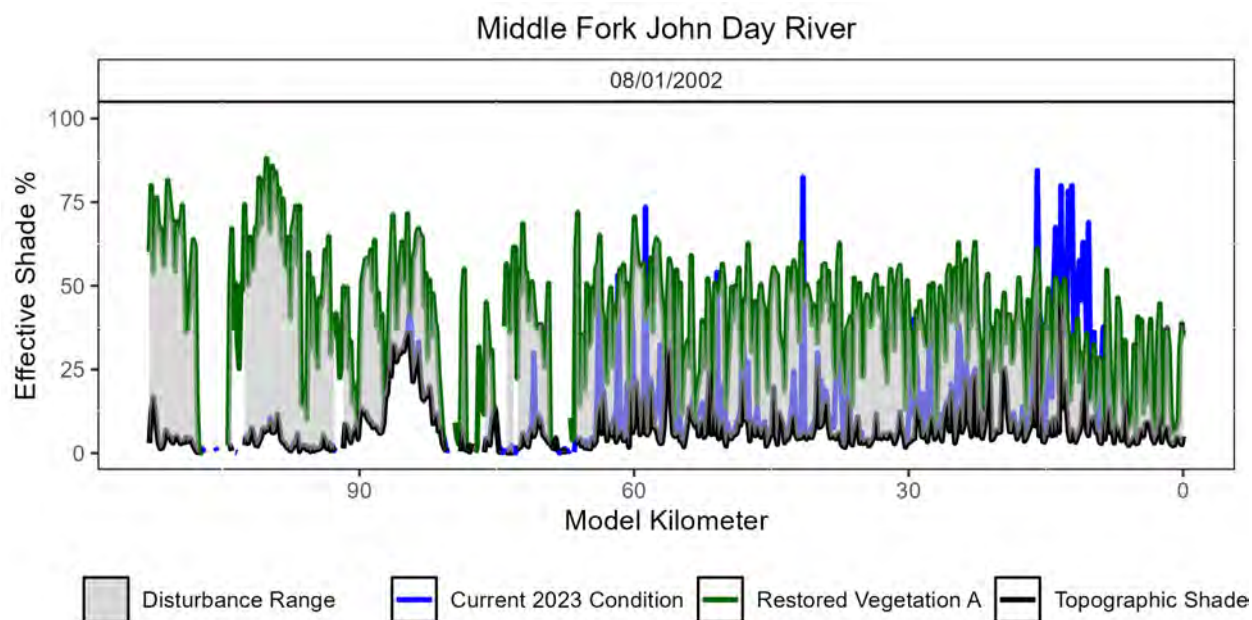


Figure 4-35: Comparison of effective shade from the Current 2023 Condition, Restored Vegetation A, and Topographic Shade scenarios for the Middle Fork John Day River. Missing values indicate that the shade difference is negative due to instances of higher effective shade in the Current Condition scenario versus the Restored Vegetation scenario.

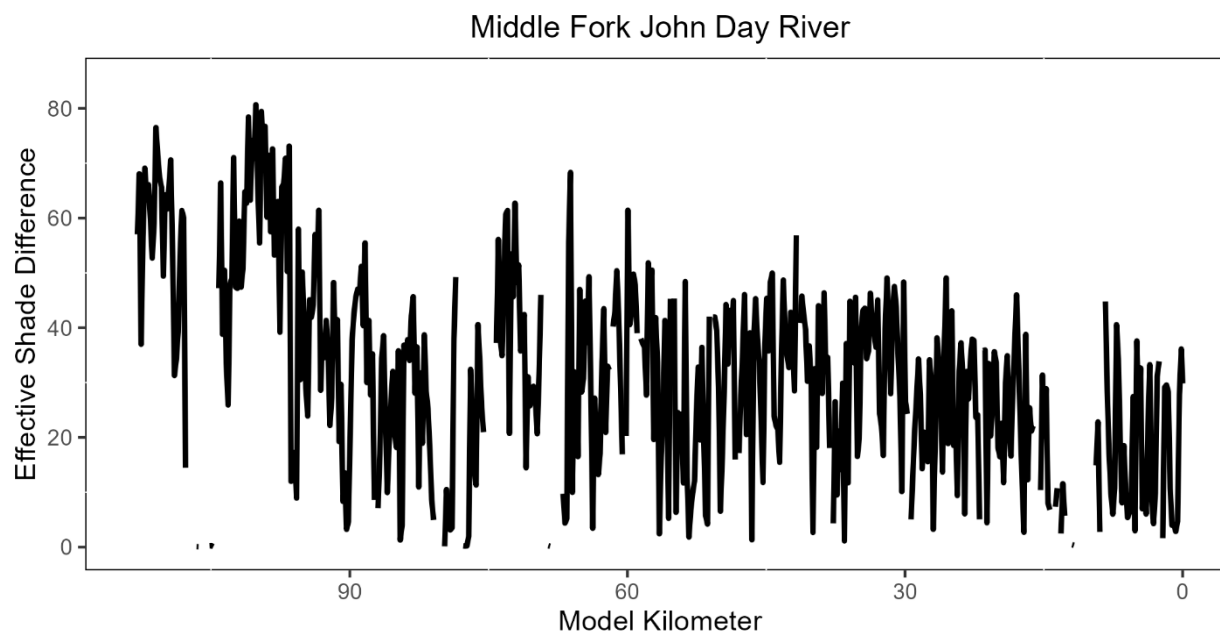


Figure 4-36: Percentage point difference between effective shade from the Restored Vegetation A and Current 2023 Condition scenarios for the Middle Fork John Day River. Missing values indicate that the shade difference is negative due to instances of higher effective shade in the Current 2023 Condition scenario versus the Restored Vegetation A scenario.

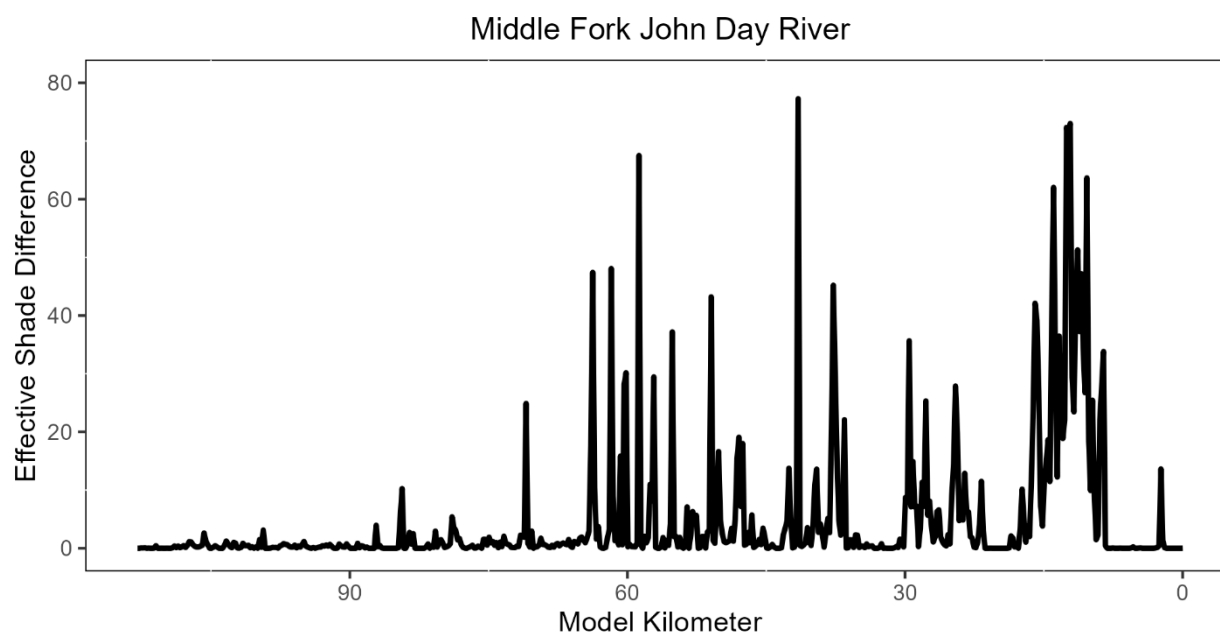


Figure 4-37: Percentage point difference between effective shade from the Current 2023 Condition and Topographic Shade scenarios for the Middle Fork John Day River. Missing values indicate that the shade difference is negative due to instances of higher effective shade in the Topographic Shade scenario versus the Current 2023 Condition shade scenario.

4.3.2 Flow scenarios

This section summarizes the temperature impacts of changes to flow regimes, including restored flows and changes to consumptive use.

The Restored Flow scenario evaluates the temperature impacts from flow deviations from natural conditions. The temperature impact of restored flows is calculated as maximum 7DADM change in Current Condition Calibration minus Restored Flow scenario. Positive values indicate cooling under the Restored Flow scenario relative to the Current Condition Calibration, whereas negative values indicate warming.

Table 4-41 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Restored Flow scenarios for the Middle Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 2.75°C, indicating 2.75°C of cooling under the Restored Flow scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 2.97°C, indicating 2.97°C of cooling under the Restored Flow scenario, and occurs at stream model km 2.55.

Figure 4-38 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Restored Flow model scenarios for the Middle Fork John Day River over the entire model period and extent when the temperatures exceed the BBNC.

Table 4-41: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Restored Flow model scenarios for the Middle Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	2.75	outlet
2.55	2.97	POMI

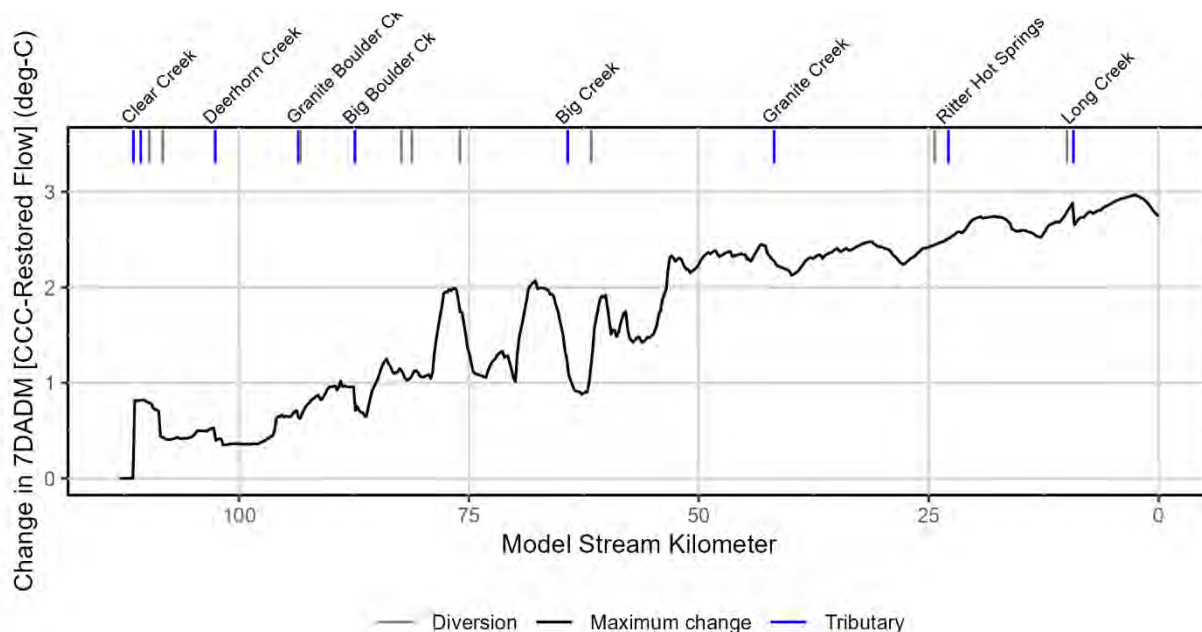


Figure 4-38: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Restored Flow scenarios for the Middle Fork John Day River over the entire model period and extent when the temperatures exceeded the BBNC. Positive values indicate cooling under the Restored Flow scenario relative to Current Condition Calibration, whereas negative values would indicate the Restored Flow scenario causes warming.

The Consumptive Use scenario evaluates the effect of water withdrawals (1% of consumptive use) on temperature, calculated as the 1% Consumptive Use scenario minus the Restored Flow scenario. Positive values indicate warming under the 1% Consumptive Use scenario relative to the Restored Flow scenario, whereas negative values would indicate cooling.

Table 4-42 summarizes the maximum 7DADM stream temperature change between the 1% Consumptive Use and Restored Flow scenarios for the Middle Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.045°C, indicating 0.045°C of warming under the 1% Consumptive Use scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 0.047°C, indicating 0.047°C of warming under the 1% Consumptive Use scenario, and occurs at stream model km 2.55.

Figure 4-39 shows the change in the maximum 7DADM stream temperatures between the 1% Consumptive Use and Restored Flow model scenarios for the Middle Fork John Day River over the entire model period and extent when the temperatures exceed the BBNC.

Table 4-42: Summary of maximum 7DADM stream temperature change between Natural Flow and 10% Consumptive Use model scenarios for the Middle Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.045	outlet
2.55	0.047	POMI

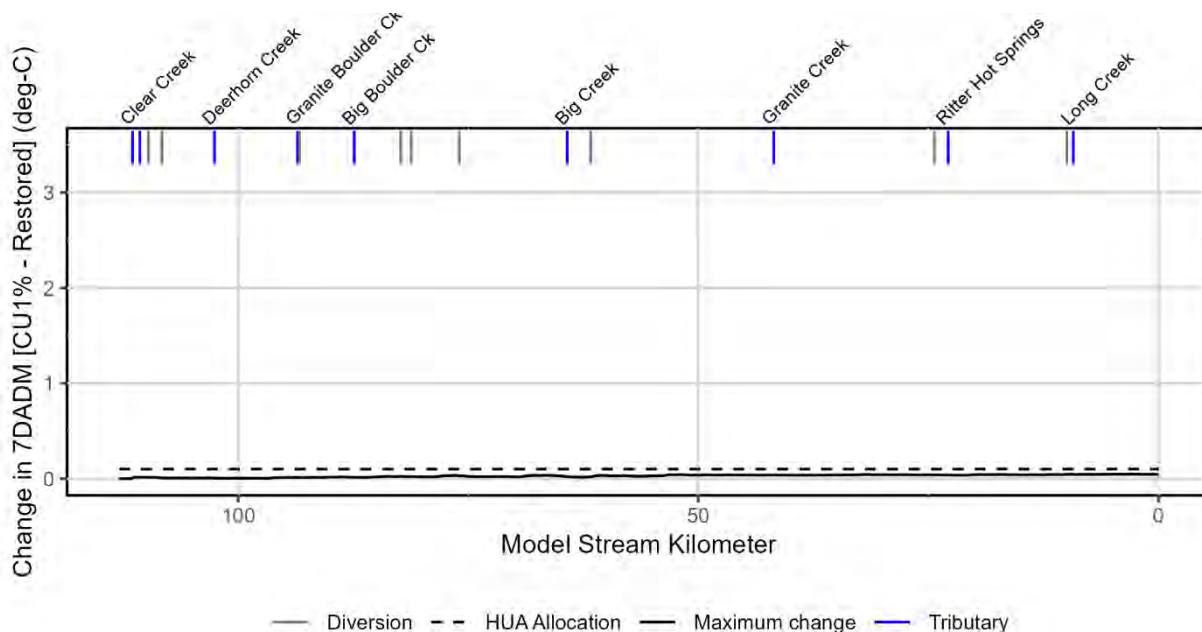


Figure 4-39: Change in maximum 7DADM stream temperatures between the 1% Consumptive Use (CU1%) and Restored Flow (Restored) scenarios for the Middle Fork John Day River over the entire model period. Positive values indicate warming under the 1% Consumptive Use scenario relative to the Restored Flow scenario, whereas negative values would indicate the 1% Consumptive Use scenario causes cooling.

4.3.3 Tributary temperature

This section summarizes the temperature impacts of tributary temperatures. Tributary Temperature A scenario examines exceedances of the water quality standards at the tributaries by setting the tributary temperature to the applicable criteria. The maximum 7DADM stream temperature change is calculated as Current Condition Calibration minus Tributary Temperature A scenario. Positive values indicate cooling under the Tributary Temperature A scenario relative to the Current Condition Calibration, whereas negative values indicate the scenario causes warming.

Table 4-43 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Tributary Temperature A scenarios for the North Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 1.43°C, indicating 1.43°C of cooling under the Tributary Temperature A scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 7.77°C, indicating 7.77°C of cooling under the Tributary Temperature A scenario, and occurs at stream model km 108.55.

Figure 4-40 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Tributary Temperature A model scenarios for the Middle Fork John Day River over the entire model period and extent when temperatures exceed the BBNC.

Table 4-43: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and Tributary Temperature A model scenarios for the Middle Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	1.43	outlet
108.55	7.77	POMI

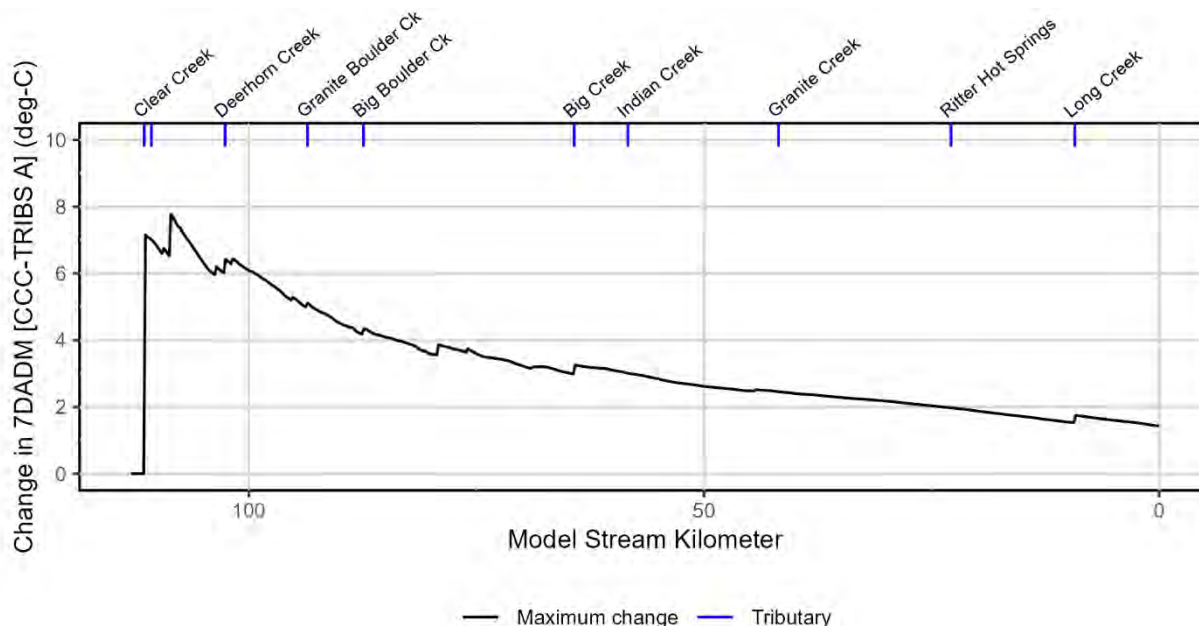


Figure 4-40: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Tributary Temperature A (TRIBS A) model scenarios for the North Fork Middle Fork John Day River over the entire model period. Positive values indicate cooling under the Tributary Temperature A scenario relative to Current Condition Calibration, while negative values indicate the scenario causes warming.

Tributary Temperature B scenario examines the temperature impacts of increasing the modeled tributary temperatures by the proposed HUA on those tributaries. In this scenario, modeled tributary temperatures are increased by 0.30°C to represent full utilization of the HUA, including reserve capacity. This scenario is designed to evaluate the change in mainstem temperatures resulting from applying the full HUA to tributaries, it does not assume or imply that attaining the HUA in tributaries will cause warmer temperatures in the Middle Fork John Day River. The maximum 7DADM change is calculated as Tributary Temperature B minus Current Condition Calibration. Because the HUA restricts cumulative warming from point sources and nonpoint sources to no more than 0.30°C, increasing tributary temperatures by 0.30°C allows evaluation of whether mainstem temperature attainment is maintained if the HUA is fully utilized by the tributaries. Positive values indicate the degree of warming from HUA attainment relative to the base (Current Condition Calibration), whereas negative values indicate cooling.

Table 4-44 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Tributary Temperature B scenarios for the Middle Fork John Day

River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.08°C, indicating 0.08°C of warming under the Tributary Temperature B scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 0.18°C, indicating 0.18°C of warming under the Tributary Temperature B scenario, and occurs at stream model km 87.35.

Figure 4-41 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Tributary Temperature B model scenarios for the Middle Fork John Day River over the entire model period and extent when temperatures exceed the BBNC.

Table 4-44: Summary of maximum 7DADM stream temperature change between Tributary Temperature B (HUA=0.30) and Current Conditions Calibration model scenarios for the Middle Fork John Day River over the entire model period.

Model KM	Stream Temperature (°C)	Location
0	0.08	outlet
87.35	0.18	POMI

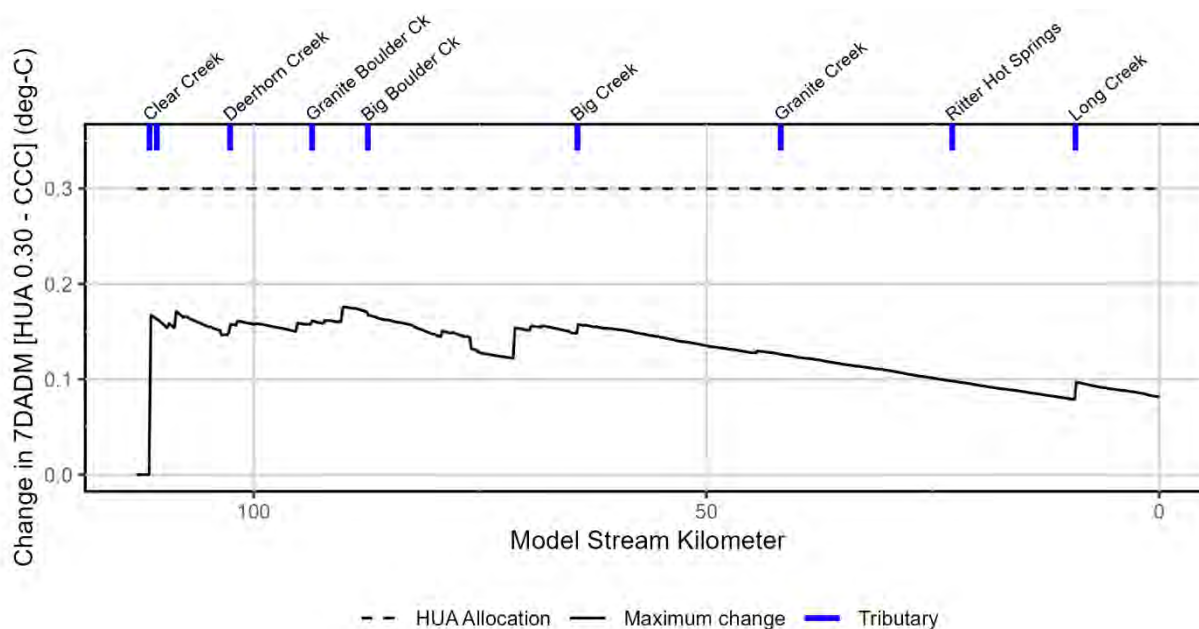


Figure 4-41: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and Tributary Temperature B (HUA = 0.30°C; 0.30 HUA) model scenarios for the Middle Fork John Day River over the entire model period and extent when the temperatures exceed the BBNC. Positive values indicate warming under the Tributary Temperature B scenario relative to the Current Condition Calibration, whereas negative values indicate cooling.

The TMDL allocations to warming from Middle Fork John Day River tributaries are presented in the main TMDL report (See Section 9.1.1). The Tributary Temperature B model analysis results support that the categorical HUA portions assigned to thermal sources on modeled Middle Fork John Day River tributaries will be achieved when those sources attain their applicable Load Allocations and Wasteload Applications.

4.3.4 Channel Morphology

This section summarizes the temperature impacts of restoring bankfull width towards a more natural, narrower channel. The Channel Morphology scenario reduced the bankfull width by a defined percentage, i.e. the 30% Channel Morphology scenario is a 30% reduction in measured bankfull width. The Channel Morphology scenarios are compared to the Current Condition Calibration, calculated as Current Condition Calibration minus the Channel Morphology scenario. Positive values indicate cooling under the Channel Morphology scenarios, whereas negative values indicate warming.

Table 4-45 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and 30% Channel Morphology scenarios for the Middle Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 3.35°C, indicating 3.35°C of cooling under the 30% Channel Morphology scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 4.08°C, indicating 4.08°C of cooling under the 30% Channel Morphology scenario, and occurs at stream model km 52.95.

Figure 4-42 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and 30% Channel Morphology model scenarios for the Middle Fork John Day River over the entire model period and extent when temperatures exceed the BBNC.

Table 4-45: Summary of maximum 7DADM stream temperature change between the Current Conditions Calibration and Channel Morphology (30%) model scenarios for the Middle Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	3.35	outlet
52.95	4.08	POMI

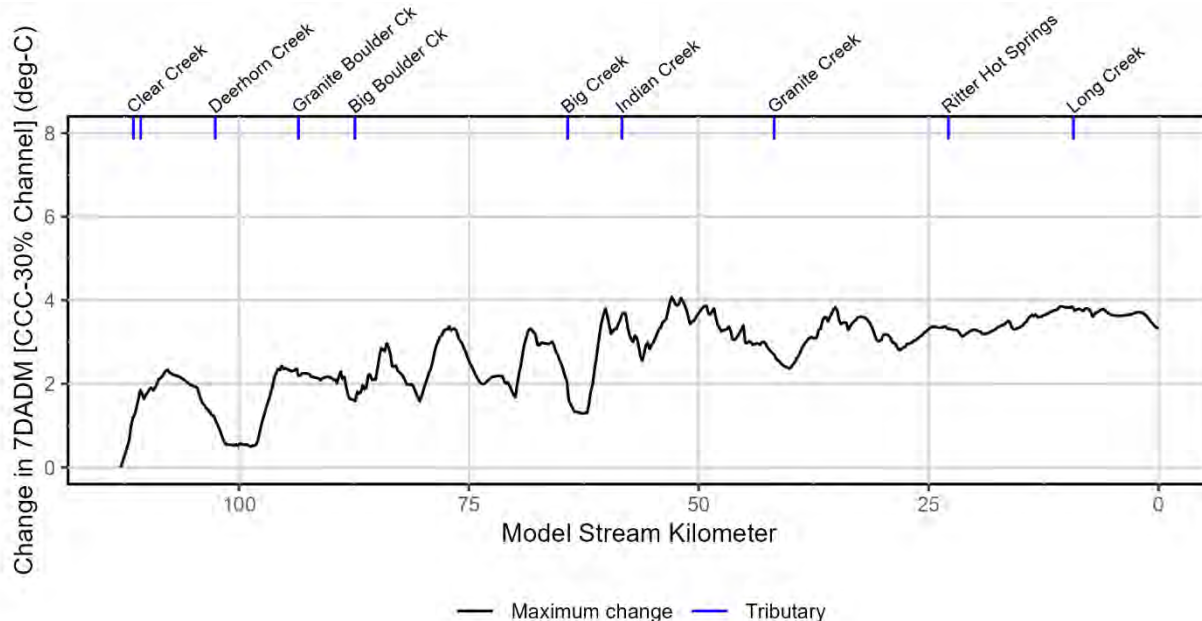


Figure 4-42: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and 30% Channel Morphology (30%Channel) scenarios for the Middle Fork John Day River over the entire model period. Positive values indicate cooling under the 30% Channel Morphology scenario, whereas negative values indicate warming.

Table 4-46 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and each Channel Morphology scenario for the Middle Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) ranges from 2.93°C under the 20% Channel Morphology scenario to 5.18°C under the 50% Channel Morphology scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) ranges from 3.36°C under the 20% Channel Morphology scenario to 6.29°C under the 50% Channel Morphology scenario. The POMI for all the iterations of Channel Morphology scenarios occurs at stream model km 52.95.

Figure 4-43 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and all iterations of the Channel Morphology model scenarios for the Middle Fork John Day River over the entire model period and extent when temperatures exceed the BBNC.

Table 4-46: Summary of maximum 7DADM stream temperature change between Current Condition Calibration and the Channel Morphology model scenarios (10% to 50%) for the Middle Fork John Day River over the entire model period

Channel Morphology Reduction	Maximum Change in Stream Temperature (°C) at Outlet	Maximum Change in Stream Temperature (°C) at POMI (km 52.95)	POMI Location (model km)
10%	4.55	4.57	1.55
20%	2.93	3.36	52.95
30%	3.35	4.08	52.95
40%	4.19	5.26	52.75

Channel Morphology Reduction	Maximum Change in Stream Temperature (°C) at Outlet	Maximum Change in Stream Temperature (°C) at POMI (km 52.95)	POMI Location (model km)
50%	5.18	6.29	51.75

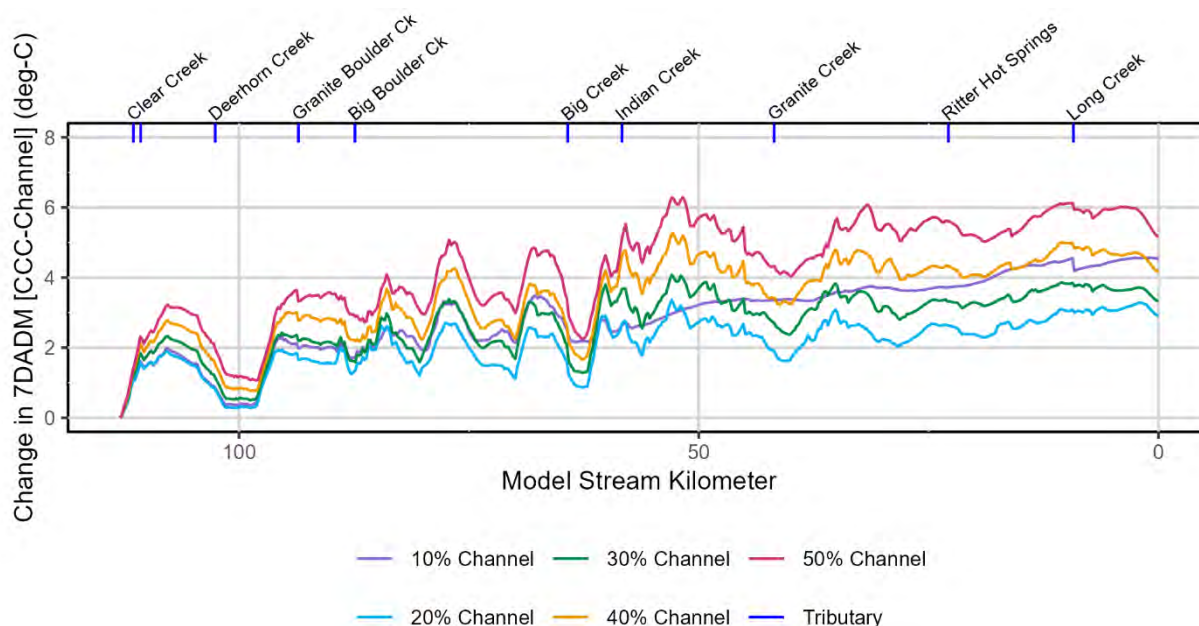


Figure 4-43: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration (CCC) and all iterations of the Channel Morphology scenarios for the Middle Fork John Day River over the entire model period. Positive values indicate cooling under the different Channel Morphology scenarios, whereas negative values indicate warming.

4.3.5 Background

This scenario summarizes the temperature impacts of background conditions, calculated as Current Condition Calibration minus Background. Positive values indicate cooling under the Background scenario relative to the Current Condition Calibration, whereas negative values would indicate the Background scenario causes warming.

Table 4-47 summarizes the maximum 7DADM stream temperature change between the Current Condition Calibration and Background scenarios for the Middle Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 7.11°C, indicating 7.11°C of cooling under the Background scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 8.59°C, indicating 8.59°C of cooling under the Background scenario, and occurs at stream model km 23.75.

Figure 4-44 shows the change in the maximum 7DADM stream temperatures between the Current Condition Calibration and Background model scenarios for the Middle Fork John Day River over the entire model period and extent when the temperatures exceed the BBNC.

Table 4-47: Summary of maximum 7DADM stream temperature change between the Current Conditions Calibration and Background (30%) model scenarios for the Middle Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	7.11	outlet
23.75	8.59	POMI

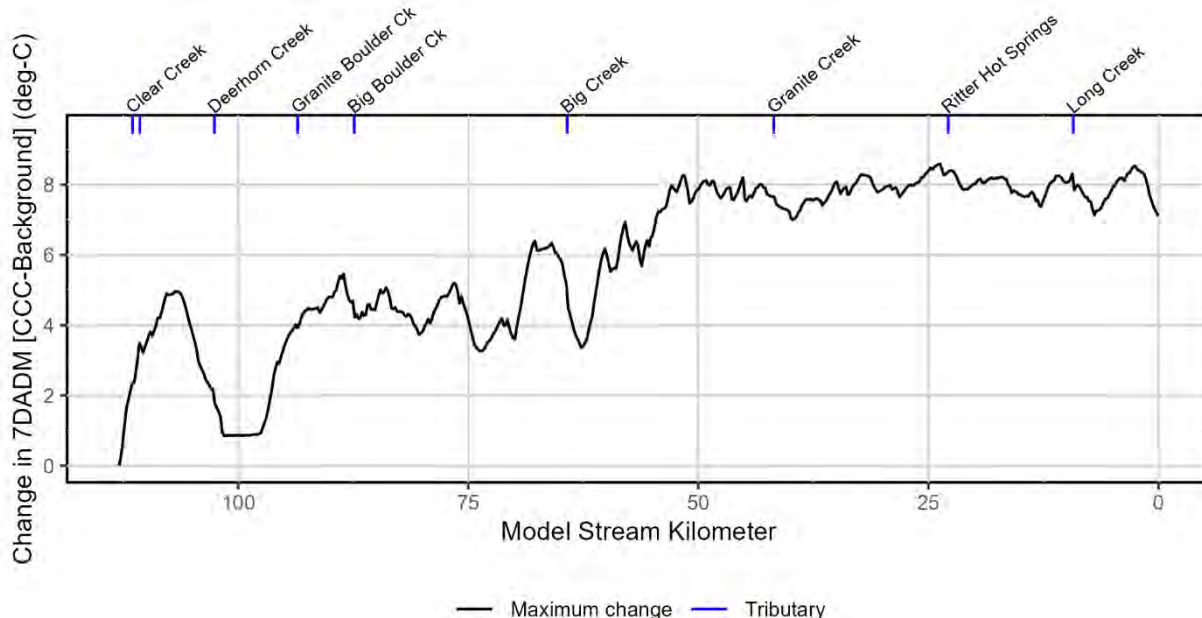


Figure 4-44: Change in maximum 7DADM stream temperatures between the Current Conditions Calibration and Background model scenarios for the Middle Fork John Day River over the entire model period. Positive values indicate cooling under the Background scenario, relative to the Current Condition Calibration. Negative values indicate warming under the Background scenario.

The Background scenario to the BBNC which describes the Background amount of excess thermal load attributed to background sources. This scenario is calculated as the Background scenario minus the BBNC. Positive values indicate warming under the Background scenario relative to the BBNC, whereas negative values would indicate cooling.

Table 4-48 summarizes the maximum 7DADM stream temperature change between the Background scenario and the BBNC for the Middle Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 7.25°C, indicating 7.25°C of warming under the Background scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 14.32°C, indicating 14.32°C of warming under the Background scenario, and occurs at stream model km 112.95.

Figure 4-45 shows the change in the maximum 7DADM stream temperatures between the Background model scenario and the BBNC for the Middle Fork John Day River over the entire model period and extent when the temperatures exceed the BBNC.

Table 4-48: Summary of maximum 7DADM stream temperature change between the Background model scenario and the BBNC for the North Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	7.25	outlet
112.95	14.32	POMI

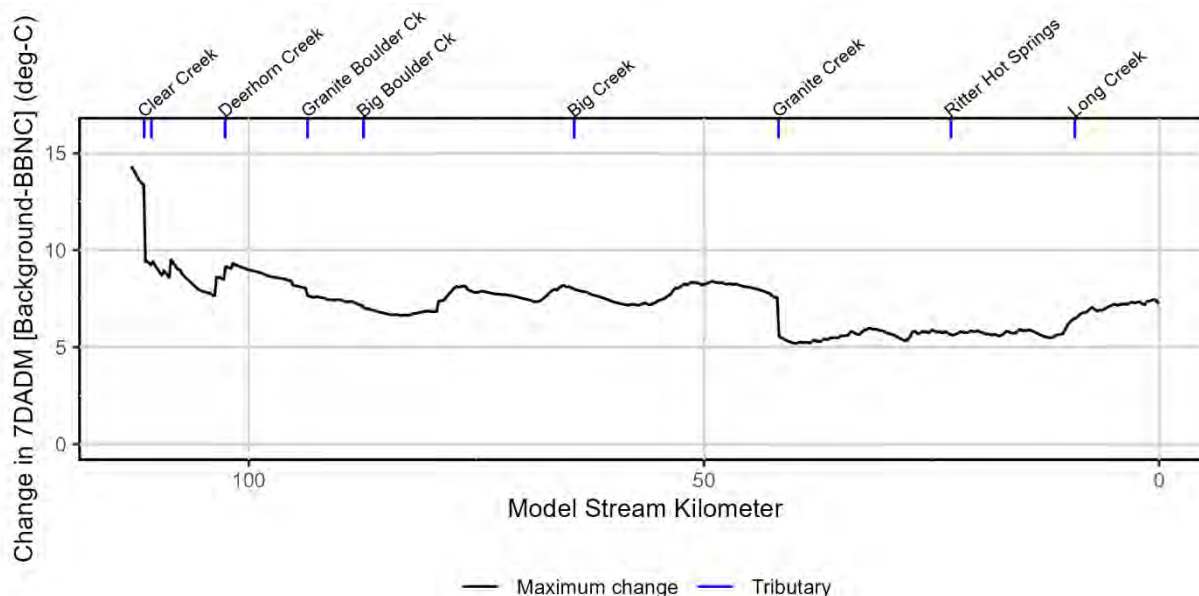


Figure 4-45: : Change in maximum 7DADM stream temperatures between the Background model scenario and the BBNC for the Middle Fork John Day River over the entire model period and extent when the temperatures exceeded the BBNC. Positive values indicate warming under the Background scenario relative to the BBNC, whereas negative values would indicate cooling .

4.3.6 HUA Attainment

This section summarizes the temperature impacts on the North Fork John Day River of the proposed load allocations and wasteload allocations, as applicable. The HUA Attainment scenario determines if the modeled thermal sources achieve their allocated portion of the HUA. To determine this, results from the HUA Attainment scenario and the HUA Baseline were compared. **Table 4-49** summarizes the HUA Attainment scenario model set up.

Table 4-49: HUA Attainment model scenario set up for the Middle Fork John Day River.

Model input variable	Attainment scenario setup description
Riparian landcover	Set to system potential vegetation conditions.
Tributary temperatures	Hourly tributary temperatures were increased by the assigned allocations on each tributary; hourly temperatures were increased by 0.25°C which is the total proposed HUA less the reserve capacity.
Tributary flow	Equivalent to tributary flows in Current Condition Calibration scenario.

Model input variable	Attainment scenario setup description
Boundary condition temperature	Equivalent to boundary condition temperatures used in Current Condition Calibration scenario.
Boundary condition flow	Equivalent to boundary condition flows used in Current Condition Calibration scenario.
Withdrawals	Equivalent to withdrawals used in Current Condition Calibration scenario.
NPDES point sources	There are no NPDES point source discharges within the model extent, the allocation assigned to point sources is 0.00°C.
Nonpoint source dam and reservoir operations	There are no dam or reservoir operations within the model extent, though there is an allocation assigned to this source of 0.00°C.
Solar loading from existing infrastructure	Solar loading from existing infrastructure was modeled but not included in attainment scenario, an allocation was assigned separately.

The HUA Attainment scenario was then compared to the HUA Baseline. The HUA Baseline scenario is the same as the Restored Vegetation A scenario. The scenario is calculated as the HUA Attainment scenario minus the HUA Baseline scenario. Positive values indicate warming under the HUA Attainment scenario relative to the HUA Baseline, whereas negative values would indicate cooling.

Table 4-50 summarizes the maximum 7DADM stream temperature change between the Attainment and Background scenarios for the Middle Fork John Day River. It shows the maximum 7DADM temperature difference at the most downstream node (the outlet) is equal to 0.03°C, indicating 0.03°C of warming under the HUA Attainment scenario. In addition, the greatest maximum 7DADM temperature difference between the two scenarios (POMI) is equal to 0.24°C, indicating 0.24°C of warming under the HUA Attainment scenario, and occurs at stream model km 60.75.

Figure 4-46 shows the change in the maximum 7DADM stream temperatures between the Attainment and Background model scenarios for the Middle Fork John Day River over the entire model period and extent when the temperatures exceed the BBNC.

Table 4-50: Summary of maximum 7DADM stream temperature change between the HUA Attainment and HUA Baseline model scenarios for the Middle Fork John Day River over the entire model period.

Model KM	Maximum Change in Stream Temperature (°C)	Location
0	0.03	outlet
60.75	0.24	POMI

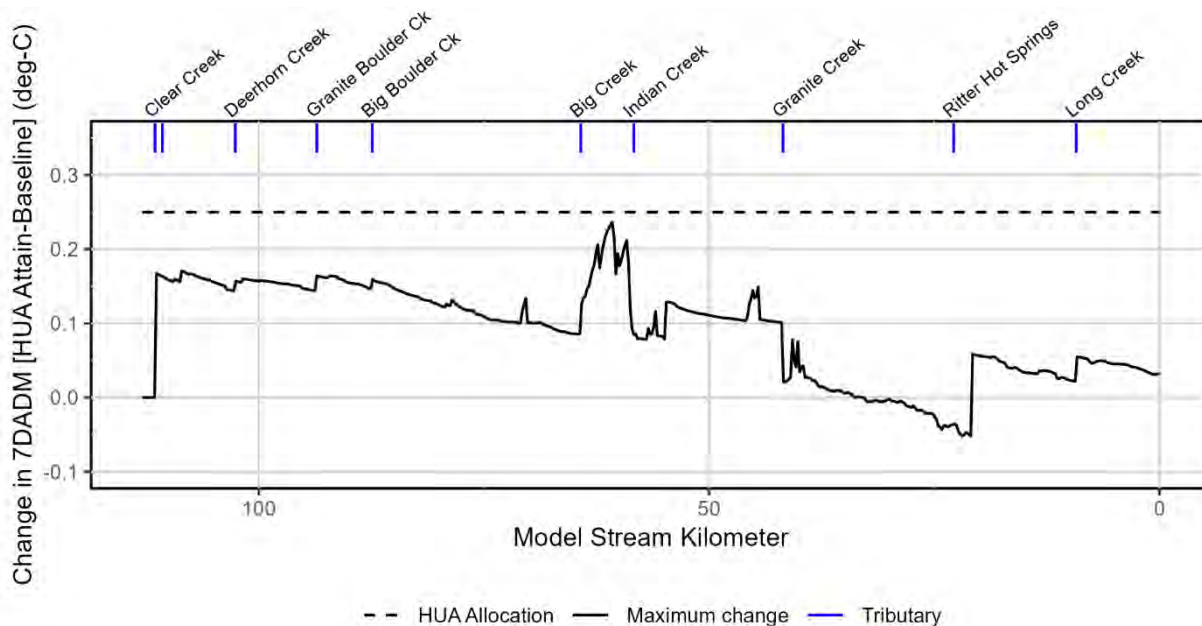


Figure 4-46: Change in maximum 7DADM stream temperatures between the HUA Attainment and HUA Baseline model scenarios for the Middle Fork John Day River over the entire model period and extent when the temperatures exceeded the BBNC. Positive values indicate warming under the HUA Attainment scenario relative to the HUA Baseline, whereas negative values indicate the scenario causes cooling.

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