# Appendix A: Development and Application of the Q2ESHADE Temperature Modeling System to the Middle Main Eel River

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## A.1 Background

The Middle Main Eel River (MME) is located in northwest California.  Its basin stretches across Mendocino, Trinity, and Humboldt counties.  The MME has been identified as an important habitat for cold-water fish populations such as the salmonid species.  One of the major water quality concerns for these fish species is increased water temperature, which can severely impair their survival and reproduction.  Increased temperatures caused the MME to be placed on California's Clean Water Act Section 303(d) list of impaired waterbodies.

A major factor contributing to elevated stream temperatures, especially in the tributary stream networks, is the reduction in stream shading caused by the removal of riparian vegetation.  To predict temperatures throughout the MME system and to assess relationships with riparian vegetation characteristics and topography, a QUAL2E-SHADE temperature modeling system was developed.  This modeling system is comprised of a Geographical Information System (GIS) - based SHADE model linked to a modified QUAL2E receiving water model (Q2ESHADE).  The components of the modeling system are summarized in Figure A-1.

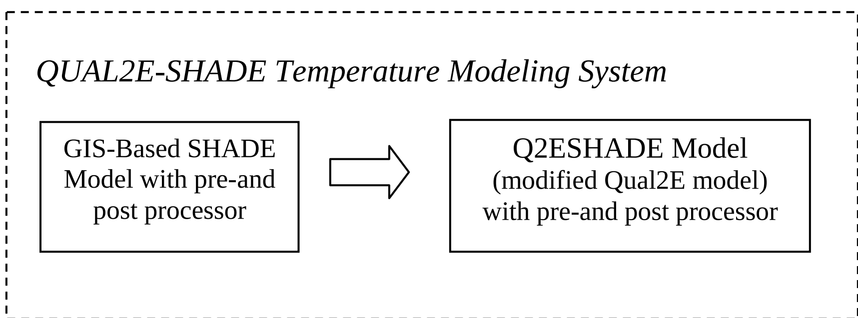


Figure A-1.  QUAL2E-SHADE temperature modeling system

QUAL2E is a USEPA-supported, public-domain receiving water model.  It has undergone extensive peer review over the past several decades and has been widely used in numerous watersheds throughout the world.  The SHADE model linked to QUAL2E is a simplified version of the model developed by Chen et al. (1998a) and applied to the Upper Grande Ronde watershed (Chen et al., 1998b).

The modeling system has been modularized such that the user can run the SHADE model alone or in conjunction with Q2ESHADE.  Independently, the SHADE model can provide a screening level view of the influence of shade on in-stream temperatures.  Coupled with the QUAL2E model, it provides the ability to simulate all or selected reaches within a particular watershed.  This allows more flexibility during modeling and supports the exclusion of reaches that are not considered hydrologically important (i.e., no flow during the summer).

When operated in tandem, the Q2ESHADE modeling system calculates hourly shade-attenuated solar radiation at various locations based on riparian vegetation characteristics, topographic relief, and initial flow conditions and subsequently predicts in-stream temperatures throughout a stream network. The maximum value of the 7-day running average of all recorded temperatures (max7daat) is then calculated from the model output. The effects of riparian-zone vegetation management strategies on stream temperatures during low-flow/critical conditions can also be evaluated. To further understand the factors contributing to stream temperature in the watershed, Q2ESHADE can predict the impact of headwater flow conditions by varying the flow rate and initial temperature value.

There were four separate modeling analyses performed for the MME (Table A-1). The integrated Q2ESHADE modeling system was applied to two tributary stream networks, Dobbyn Creek and Chamise Creek, and the main stem of the Upper and Middle Eel Rivers beginning upstream of Outlet Creek and terminating downstream of Cherry Creek (referred to as the Upper Eel River [UER] extension throughout the remainder of this document). Dobbyn Creek and Chamise Creek are illustrated in Figure A-2 and the areas included in the UER extension are illustrated in Figure A-3. These three models were calibrated using observed temperature monitoring data provided by the Humboldt County Resource Conservation District (RCD).

The fourth modeling analysis was performed to determine the influence of shade along the MME main stem. For this analysis, the SHADE model (independent of QUAL2E) was applied to the entire length of the main stem (referred to as the main stem SHADE model throughout the remainder of this document). After all of the models were configured and calibrated, scenarios were performed to support TMDL development. The scenarios included the simulation of various vegetation conditions for Dobbyn Creek, Chamise Creek, and the main stem SHADE model as well as several flow conditions for the UER extension (Table A-1).

Table A-1. Modeling Analyses Performed to Support the Middle Main Eel River Temperature TMDL

| Study Area | Model Applied | Scenarios Performed |
|---|---|---|
| Main Stem SHADE Model | SHADE Model | Vegetation Scenarios |
| Chamise Creek | Q2ESHADE (QUAL2E + SHADE Models) | Vegetation Scenarios |
| Dobbyn Creek | Q2ESHADE (QUAL2E + SHADE Models) | Vegetation Scenarios |
| UER Extension | Q2ESHADE (QUAL2E + SHADE Models) | Flow Scenarios |

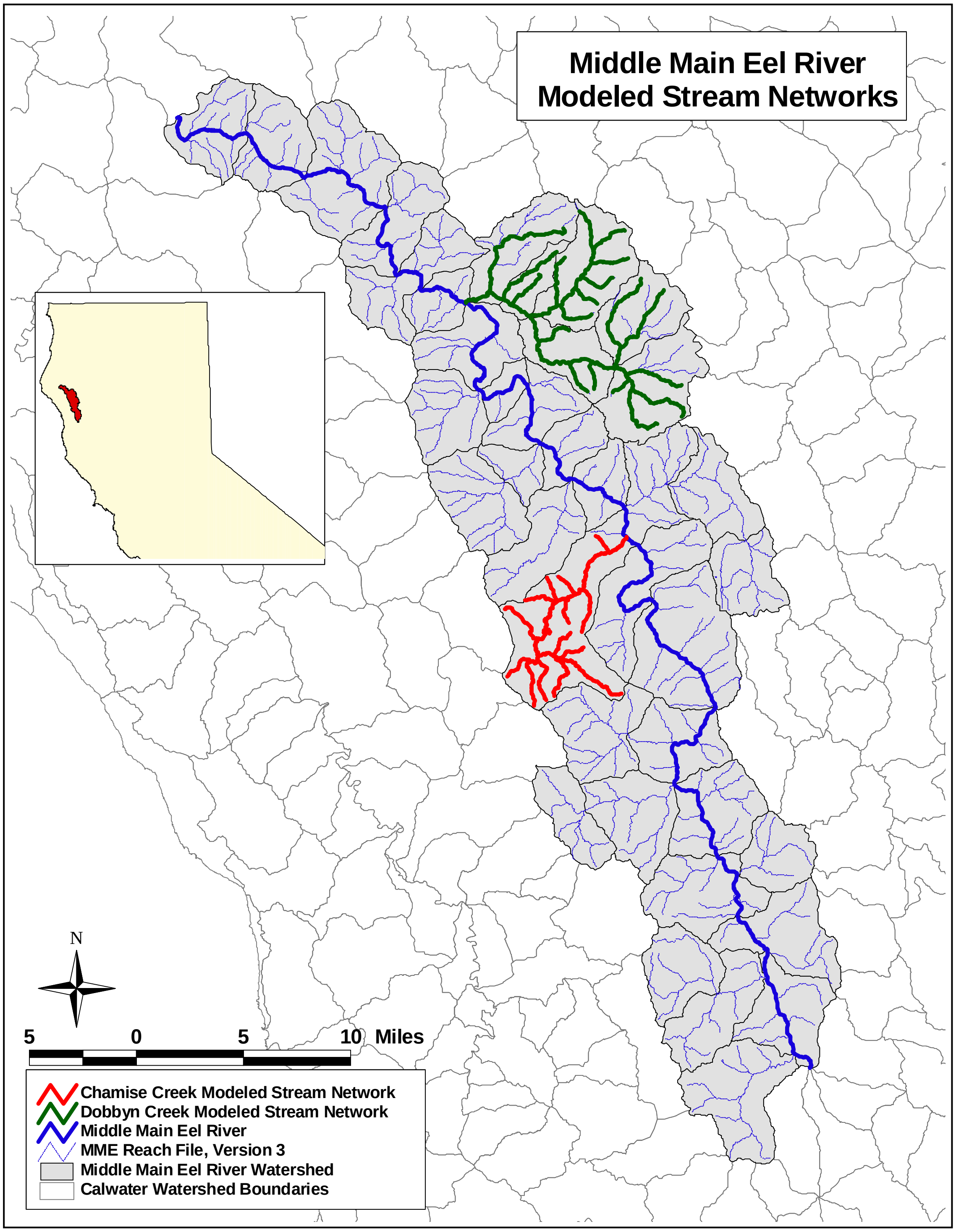


Figure A-2.  Middle Main Eel river modeled watersheds and stream networks

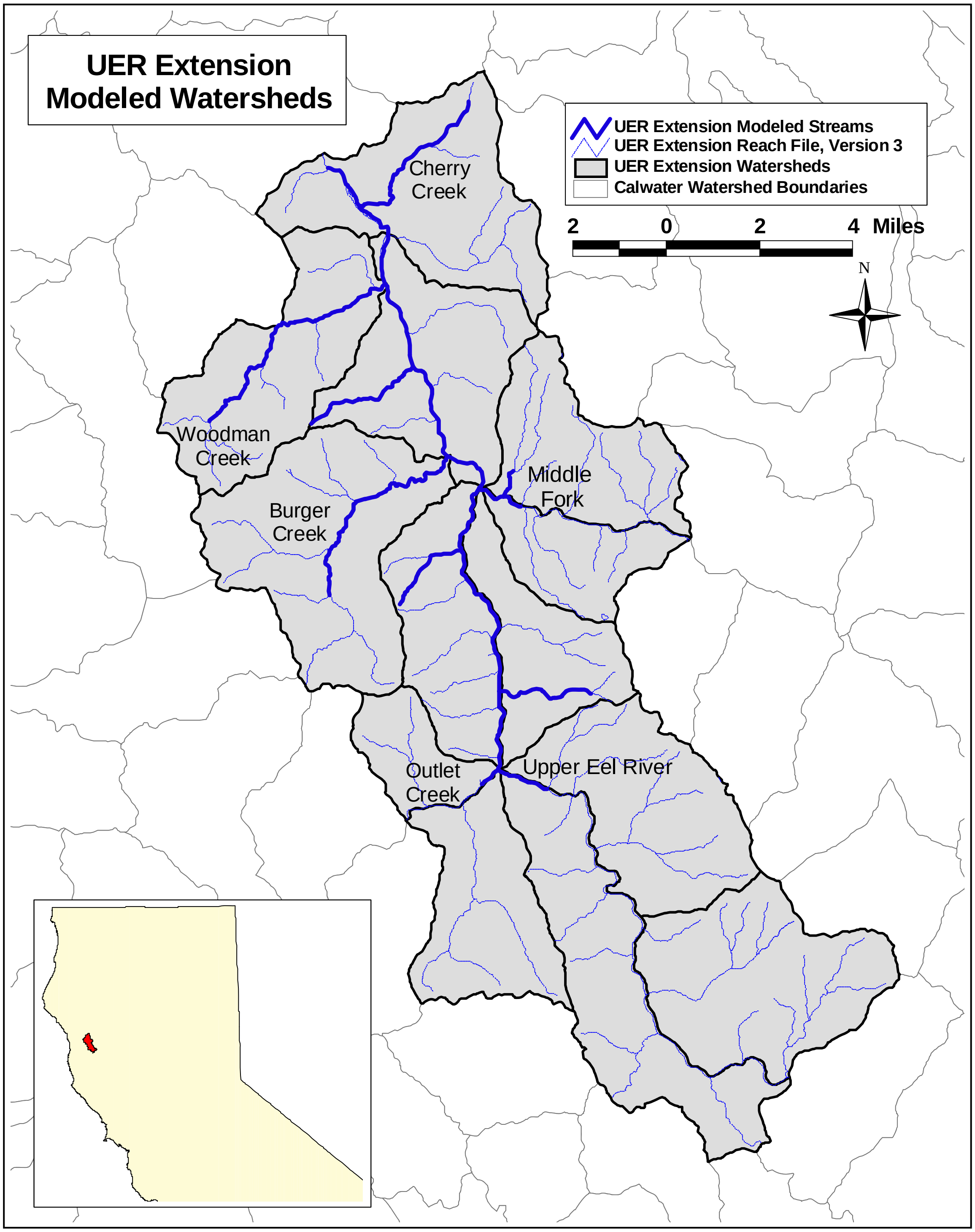


Figure A-3. Upper Eel River extension modeled watersheds

## A.2 GIS-Based SHADE Model

The GIS-Based SHADE model, which was applied to all four modeling analyses in this study (Table A-1), consists of two major components: the underlying SHADE model algorithms and a GIS-based preprocessor for the SHADE model. The methodology and data used to parameterize and run the SHADE preprocessor and model are presented in the next two sections and illustrated in Figure A-4.

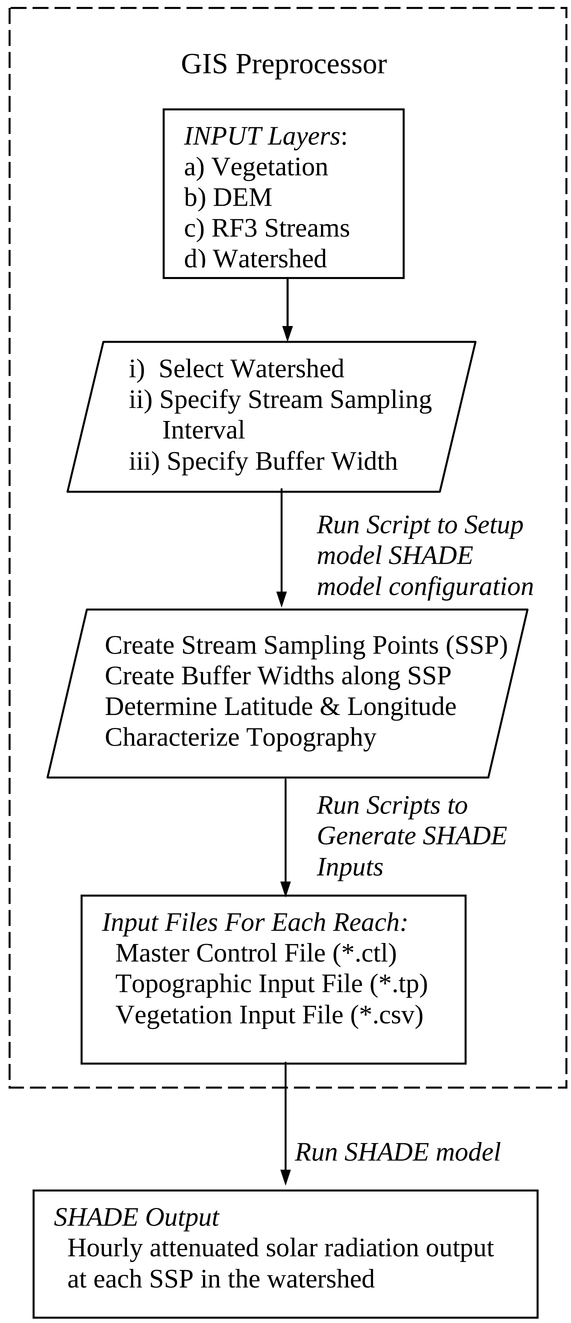


Figure A-4. SHADE GIS Preprocessor

## A.2.1 SHADE GIS Preprocessor

A preprocessor was developed using a GIS platform to generate three input files required by the SHADE model. User-supplied input data include digital elevation model (DEM) data, site-specific vegetation data, streams (USEPA Reach File, Version 3 [RF3]), time zones, and watershed boundaries. The site-specific data used to represent the MME watersheds and the preprocessing steps are described below and presented in Figure A-4.

### A.2.1.1 Data Requirements and Sources

Digital Elevation Model (DEM)

Elevation values were obtained from the 30-meter DEM data distributed by the United States Geological Survey (USGS). These data were used in determining the topographic shading.

Vegetation Data

The California Vegetation theme (CALVEG) from the United States Forest Service (USFS) was used to determine the vegetation related parameters. This data set was chosen due to its completeness and because it contained the required information to parameterize the SHADE model. The wildlife habitat relationships (WHR) classification system incorporated in the vegetation data provides information on general tree habitat classes (Table A-2), diameter-at-breast height (DBH), and canopy closure classes (Table A-3). The CALVEG vegetation layer was used to derive the tree height and density data layers, which are necessary inputs to the SHADE model to predict solar radiation.

Table A-2. Tree Size Classes

| Size Class | DBH Range (inches) | DBH Range (centimeters) |
|---|---|---|
| 0 | 0 – 0.9 | 0 – 2.4 |
| 1 | 1 – 4.9 | 2.5 – 12.6 |
| 2 | 5 – 11.9 | 12.7 – 30.4 |
| 3 | 12 – 23.9 | 30.5 – 60.9 |
| 4 | 24 – 39.9 | 61 – 101.5 |
| 5 | ≥ 40 | ≥ 101.6 |

Table A-3. Canopy Closure Classes

| Closure Class | Canopy Closure (%) |
|---|---|
| 0 | 0-9 |
| 1 | 10-19 |
| 2 | 20-29 |
| 3 | 30-39 |
| 4 | 40-49 |

| Closure Class | Canopy Closure (%) |
|---|---|
| 5 | 50-59 |
| 6 | 60-69 |
| 7 | 70-79 |
| 8 | 80-89 |
| 9 | 90-100 |

Watershed Boundary

The CALWTR 2.2 watershed boundaries available from the State of California were used to represent the watershed boundaries.  The watershed boundary was used to define the geographic extent of the study areas:  the Dobbyn Creek, Chamise Creek, UER extension, and main stem SHADE model watersheds.  All streams within the selected watersheds can be simulated or, as in the case for the MME simulations, specific streams can be selected during preprocessing.

Stream Network

The RF3 provided by USEPA was used to represent the stream network.  This shapefile provides detailed stream connectivity and lengths, which are necessary to ensure that the stream numbering scheme is generated properly for use by both SHADE and Q2ESHADE.  This layer was also used to select the specific streams simulated in the model watersheds (Figure A-2 and Figure A-3).

The stream layers were amended to include the stream-wetted width at the start and end of each simulated reach.  Stream width information for each reach is necessary to calculate the surface area for individual reaches and account for the total solar radiation received at the stream surface.  Data were available for several locations throughout the MME study areas.  Table A-4 details the data sources utilized to assign widths to all model reaches.

Table A-4.  Source of Wetted Width Information for each Study Area

| Study Area | Source of Wetted Width Information |
|---|---|
| Main Stem SHADE Model | ▪ Several measurements from Humboldt County RCD monitoring stations<br>▪ Additional measurements from a California Department of Water Resources (CDWR) report (including cross sections for several locations from Outlet Creek to below the North Fork (CDWR, 1972)<br>▪ Widths between measured locations were estimated using linear extrapolation |
| Chamise Creek | ▪ Stream measurements (including wetted width, depth, velocity, and flow) were collected at four locations in August and September (Pacific Watershed Associates [PWA], 2005)<br>▪ Unit-area weighting was used to estimate widths for small/unmeasured tributaries |
| Dobbyn Creek | ▪ Low flow widths available for several locations from the California Department of Fish and Game (CDFG) Stream Inventory Reports for Dobbyn Creek, North Dobbyn Creek, and South Dobbyn Creek (CDFG, 1995a, 1995b, 1995c)<br>▪ Unit-area weighting was used to estimate widths for small/unmeasured tributaries |
| UER Extension | ▪ Several measurements from Humboldt County RCD monitoring stations<br>▪ Additional measurements from a CDWR report (including cross sections for several locations from Outlet Creek to below the North Fork (CDWR, 1972)<br>▪ Widths between measured locations were estimated using linear extrapolation |

Time Zone

The USGS time zone GIS layer was incorporated into the SHADE model to determine the standard time zone meridian (longitude) of the MME watershed.

### A.2.1.2 Preprocessor Methodology

To generate the SHADE model files, the preprocessor creates stream sampling points (SSP) and buffers for each SSP.  The distance between SSPs and the buffer widths are user-specified values, which depend on the spatial variability and level of detail desired. Table A-5 identifies the SSP distance and buffer widths for the four MME study areas. The SSP and buffer configurations for Dobbyn Creek, Chamise Creek, the UER extension, and the main stem SHADE model are shown in Figure A-5 through Figure A-8, respectively.

Table A-5.  Stream Sampling Point Distances and Buffer Widths

| Study Area | SSP Distance | Buffer Width |
|---|---|---|
| Main Stem SHADE Model | 500 meters (1,640 feet) | 300 meters (984 feet) |
| Chamise Creek | 250 meters (820 feet) | 300 meters (984 feet) |
| Dobbyn Creek | 500 meters (1,640 feet) | 300 meters (984 feet) |
| UER Extension | 500 meters (1,640 feet) | 300 meters (984 feet) |

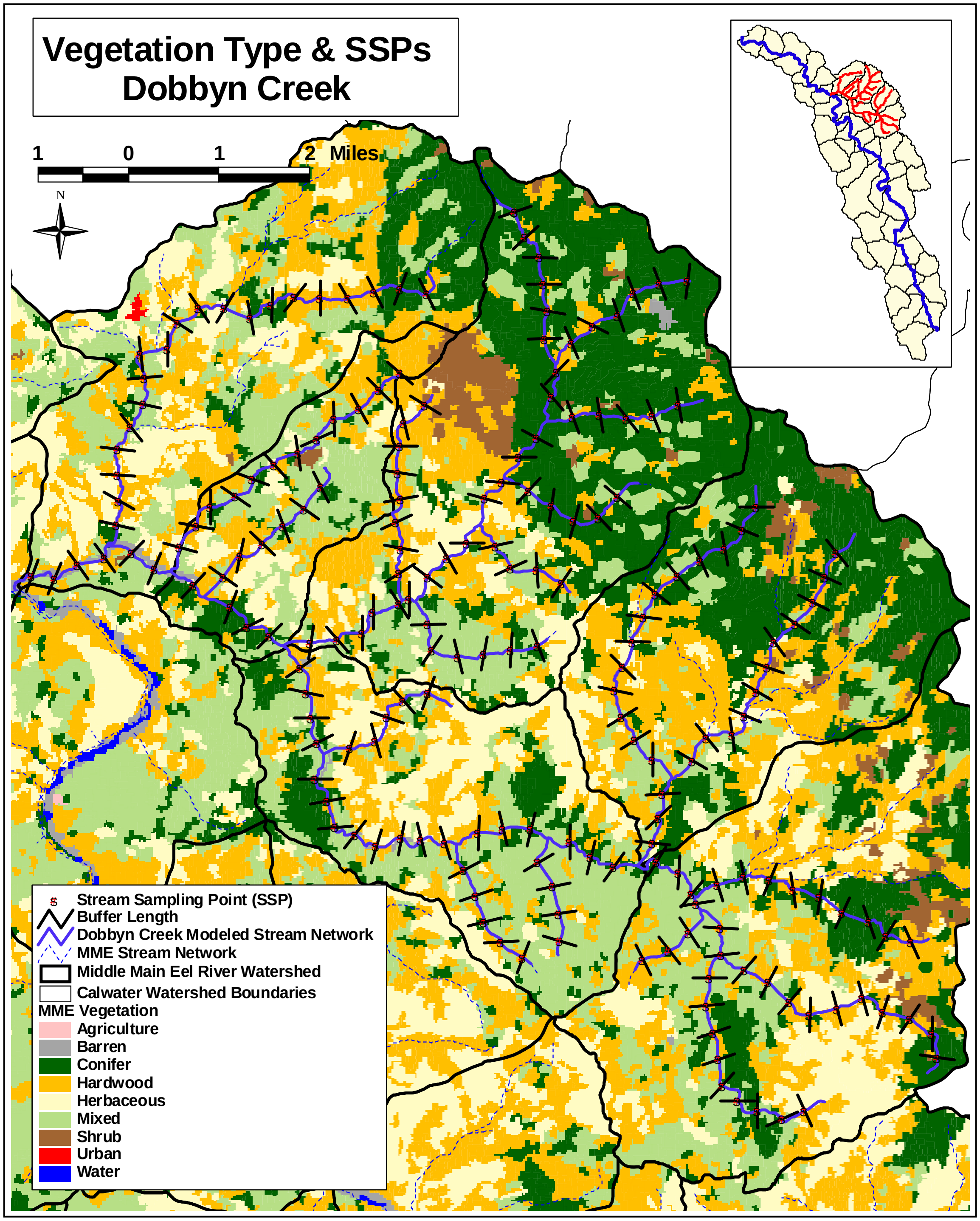


Figure A-5.  Stream sampling points and vegetation types for Dobbyn Creek

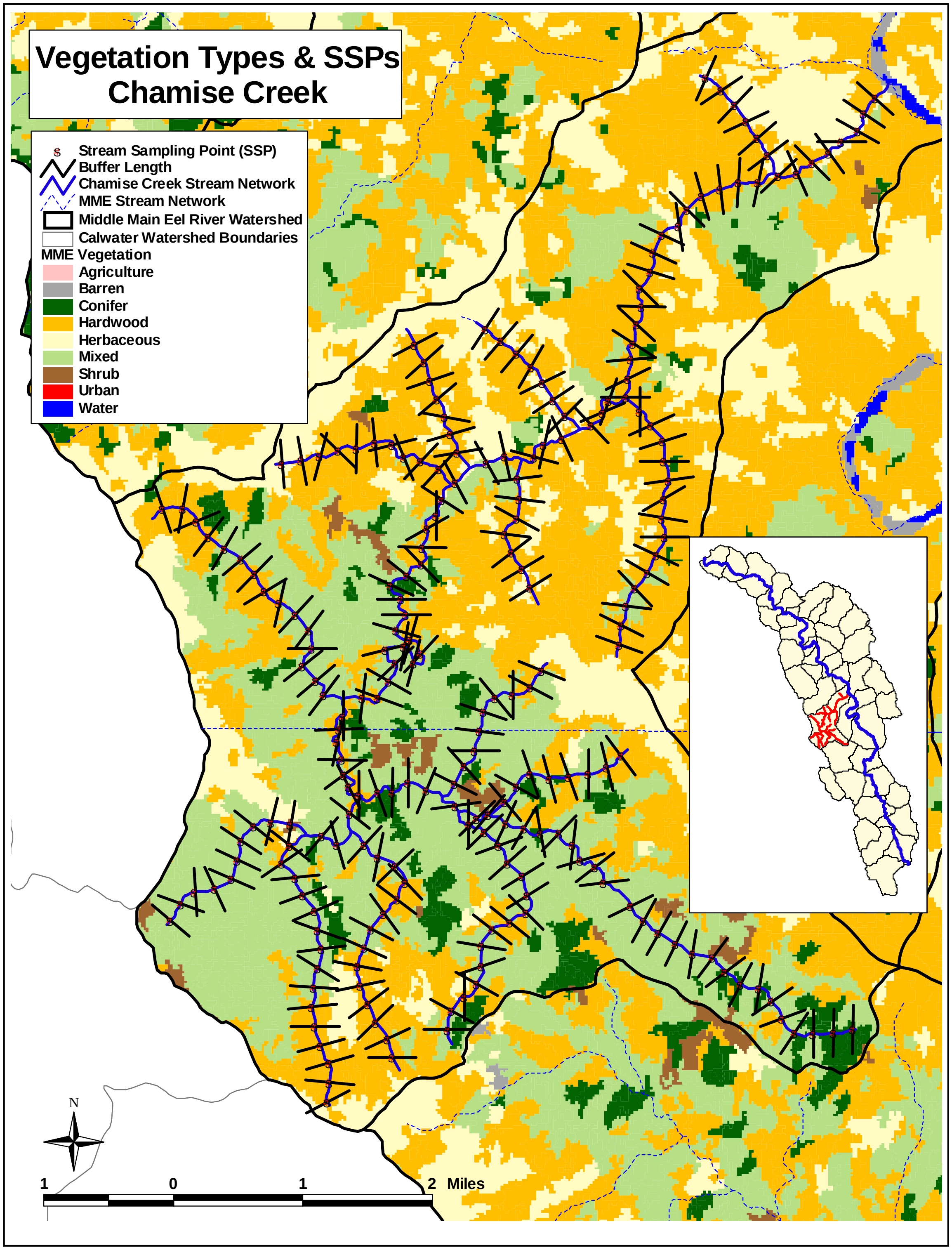


Figure A-6. Stream sampling points and vegetation types for Chamise Creek

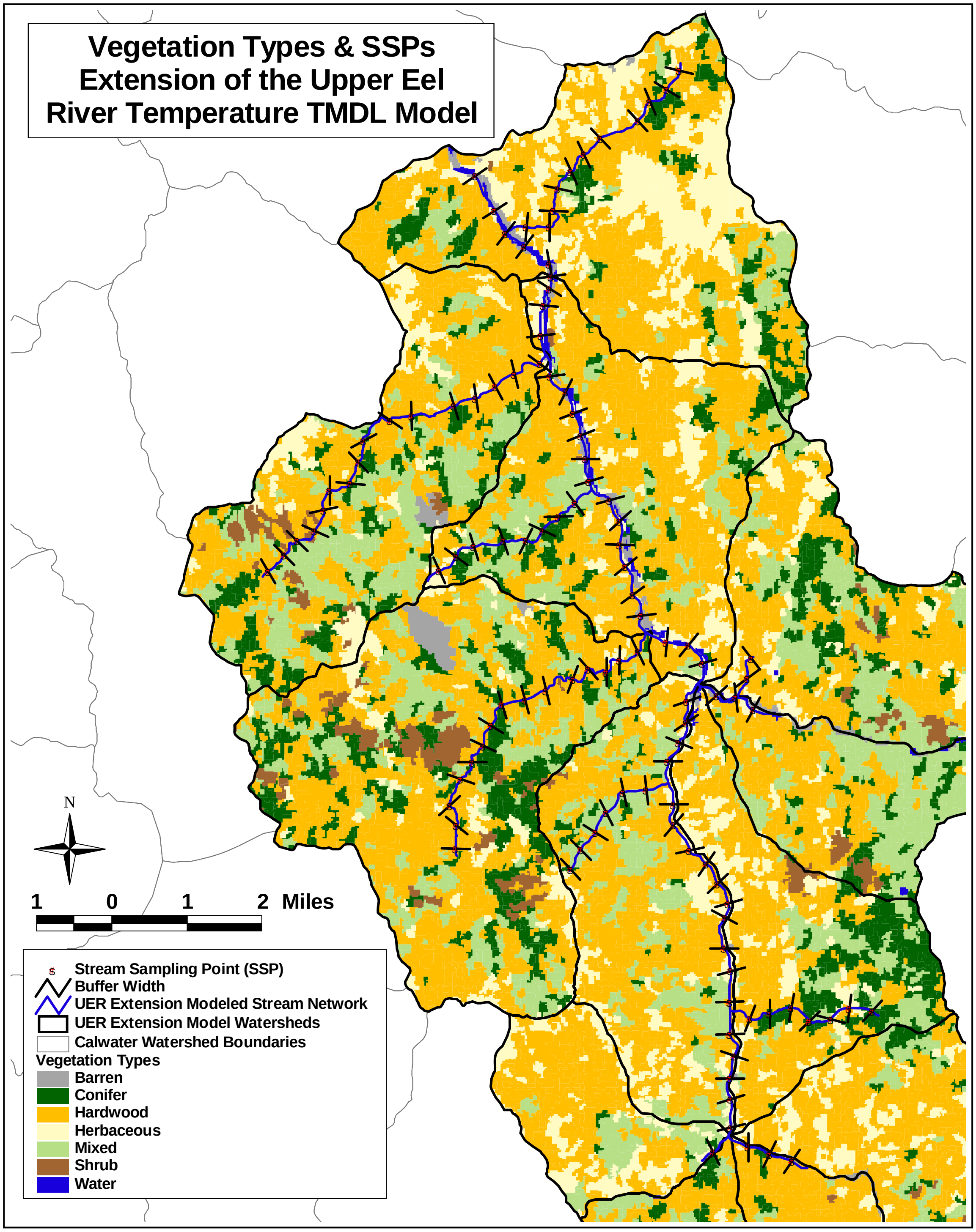


Figure A-7. Stream sampling points and vegetation types for the UER Extension

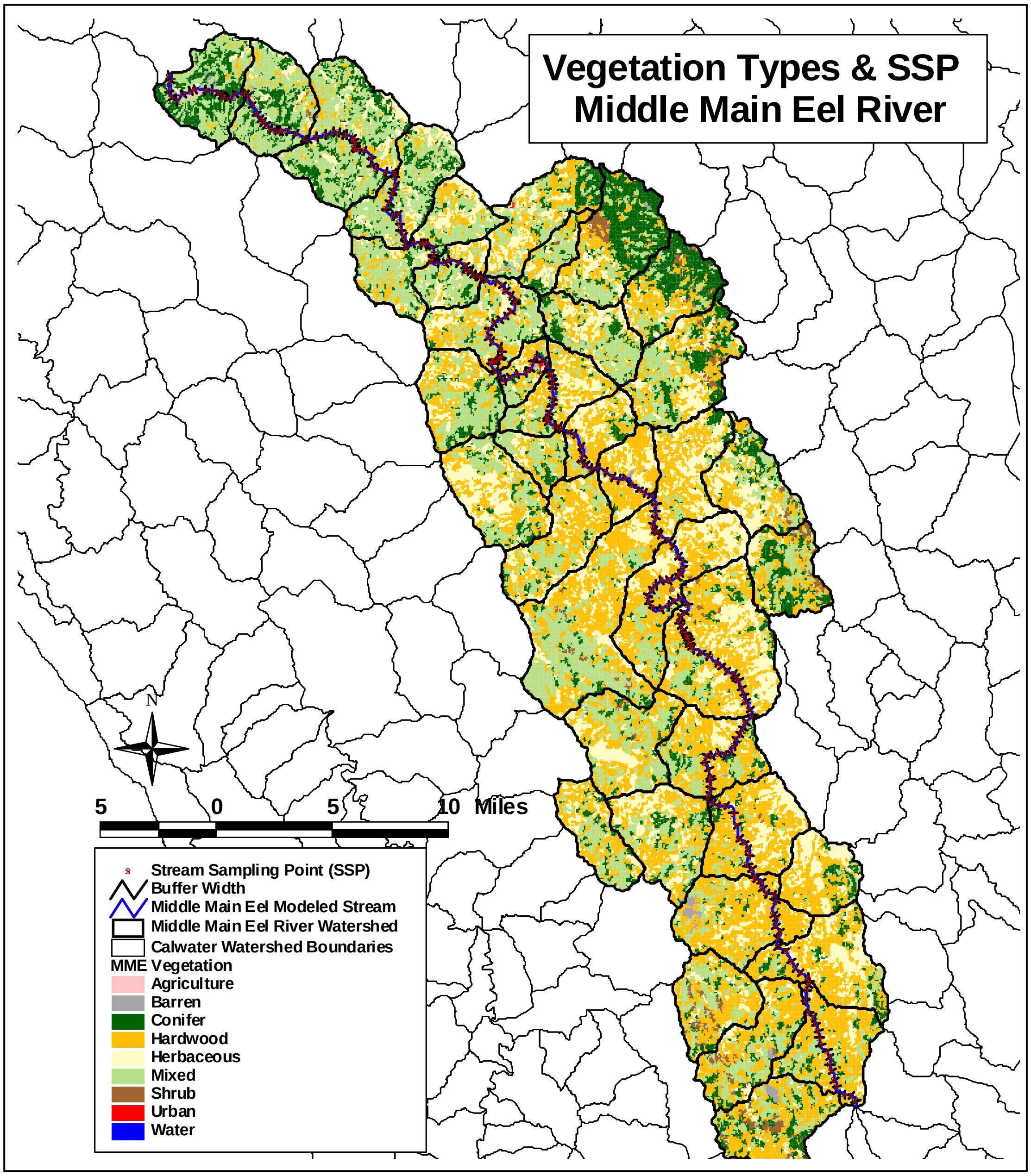


Figure A-8.  Stream sampling points and vegetation types for the main stem of the Middle Main Eel River

SSPs are automatically identified using an upstream to downstream numbering scheme that is compatible with the Q2ESHADE model. After extracting the latitude and longitude and numbering each SSP, the preprocessor was used to characterize the topography and generate vegetation height and density layers required by the SHADE model.

Tree heights were derived using the asymptotic height-diameter regression equations developed for 24 tree species in Oregon (Garman et al., 1995). Generalized DBH versus tree height relationships were developed for two distinct categories of tree species identified in the California vegetation data layer, conifers and hardwoods. The general form of the asymptotic height-diameter equation is presented in Equation 1:

$$\textit{Height (m)} = 1.37 + (b_0[1 - \exp(b_1 \cdot \mathrm{DBH})]^{b_2}) \qquad (1)$$

where, $b_0$, $b_1$, and $b_2$ are regression coefficients, which are dependent on the type of tree species and site class. The parameter $b_0$ is the asymptote or maximum height coefficient, $b_1$ is the steepness parameter coefficient, and $b_2$ is the coefficient for the curvature parameter.

To determine watershed-specific regression coefficients, the CALVEG vegetation data were first summarized to identify the dominant coniferous and hardwood tree species in the MME watershed. The most dominant conifer was determined to be the Douglas Fir and the most dominant hardwood tree species was the Oregon White Oak. DBH and height data for Douglas Firs and Oregon White Oaks in the MME watershed were queried from the Pacific Northwest-Forest Inventory Analysis (PNW-FIA) Integrated Database (Pacific Northwest Research Station, 2004). These data were fit to the asymptotic height-diameter equation (Equation 1) to determine localized regression coefficients for both conifers and hardwoods (Table A-6), which were applied to all four MME study areas. The data included from the PNW-FIA Integrated Database and the resulting height-diameter relationships are presented in Figure A-9 and Figure A-10 for conifers and hardwoods, respectively.

Table A-6. Height-Diameter Coefficients

| Vegetation Type | $b_0$ | $b_1$ | $b_2$ |
|---|---|---|---|
| Conifers | 96.2433 | -0.00389 | 0.737505 |
| Hardwoods | 14.65627 | -0.09894 | 2.799586 |

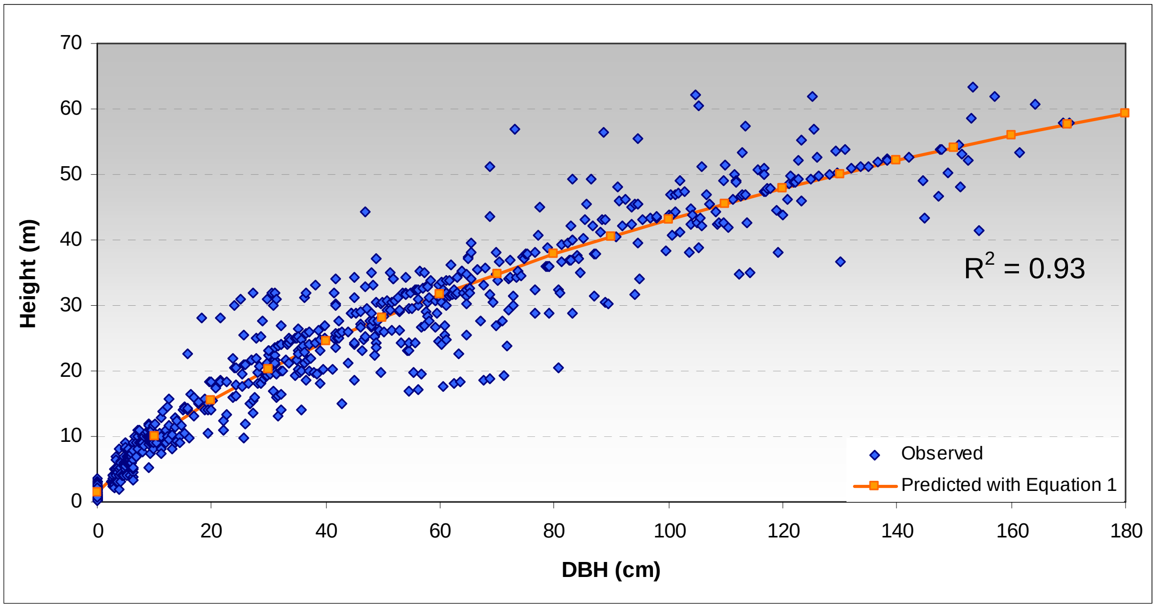


Figure A-9. Tree height-diameter for various site classes of Douglas Fir (conifer)

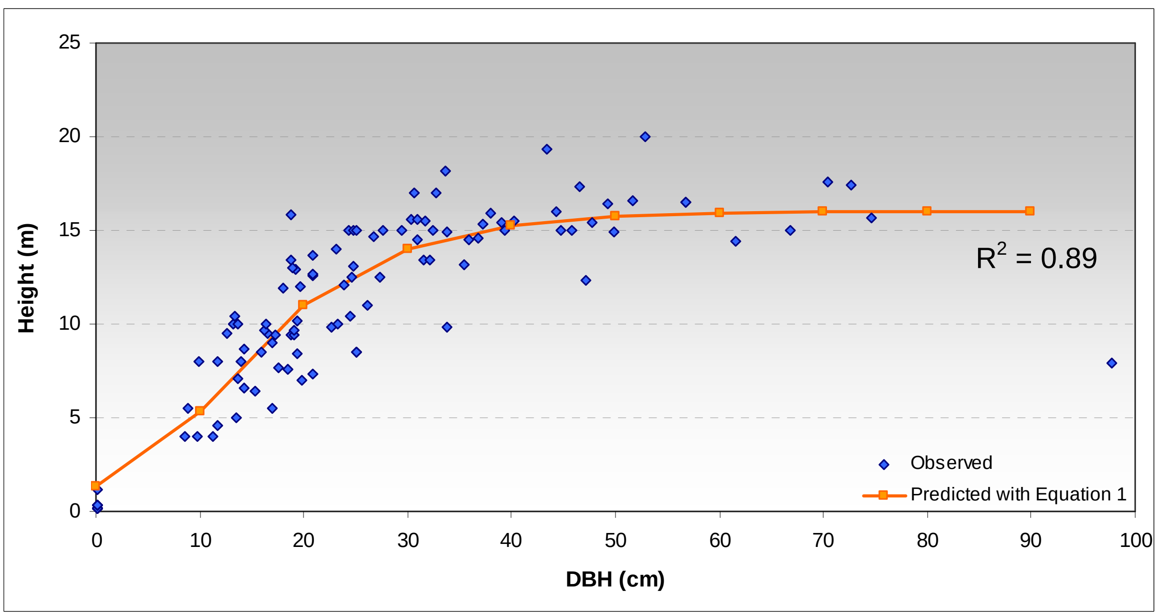


Figure A-10. Tree height-diameter for various site classes of Oregon White Oak (hardwood)

To test the coefficients, computed tree heights are compared with the observed data. The height-diameter equation resulted in conifer and hardwood heights well within the observed ranges. Table A-7 summarizes the tree heights observed in the PNW-FIA

Integrated Database and computed by incorporating the coefficients in Table A-6 into Equation 1 for the maximum DBH included in the SHADE models (maximum DBH = 101.6 centimeters [cm] or 40 inches).  As indicated in the table, the computed Douglas Fir was within the range of observed tree heights for similar DBHs.  For the Oregon White Oaks, the observed maximum DBH was 97.6 cm.  The computed height at a DBH of 101.6 cm was well within the range of observed heights in the watershed (maximum height was 20 meters), as illustrated in Figure A-10.

Table A-7.  Computed and Observed Tree Heights at the Maximum DBH

| Tree Type | Computed Height at maximum DBH (101.6 cm [40 in]) | Observed Range at DBH = 101.6 cm (±1 cm) | |
|---|---|---|---|
| | | Low | High |
| Douglas Fir | 43.5 meters (142.7 feet) | 40.8 m (133.8 ft) | 49.1 m (161.0 ft) |
| Oregon White Oak | 16.02 meters (52.5 feet) | none | 20 m (65.6 ft) |

Each vegetation cell in the vegetation layer is assigned a height based on its vegetation type (i.e. conifer, hardwood, herbaceous, etc.) and size class.  The vegetation height for each conifer and hardwood grid cell is calculated by applying Equation 1 with the appropriate regression coefficients.  The size class field in the vegetation coverage identifies the DBH value (see Table A-2) that is included in Equation 1 to calculate tree height.  To address other vegetation types in the MME watershed, a constant minimum height of 0.5 meter (1.6 feet) was assigned to herbaceous plants and 1 meter (3.3 feet) was assigned to other deciduous species.

Vegetation density is an additional parameter required by the SHADE model.  The tree density was determined by assigning the appropriate average density based on the canopy closure ranges (Table A-3) for each closure class in the vegetation layer.  The vegetation layer was also used to determine the two-character vegetation cover code required for the vegetation shade input file (*.csv).  This code is generated automatically based on the cover type in the vegetation layer.

The result of the above processing is the generation of three required input files that supply the SHADE model with information on each reach (Figure A-4).  These files include master input files (*.inp), topographic input files (*.tp), and vegetation input files (*.csv).

### A.2.2 SHADE Model

Chen et al. (1998a, 1998b) have incorporated a series of computational procedures identifying the geometric relationships among sun position, stream location, and orientation, riparian shading characteristics into a computer program called SHADE. This model has the capability of predicting shade–attenuated solar radiation on a watershed scale.

#### A.2.2.1 SHADE Model Inputs

The output files from the SHADE GIS preprocessor (Section A.2.1) are incorporated directly into the SHADE model. In addition to this information, SHADE requires daily solar radiation data. Hourly solar radiation data for several stations near the MME were available from the California Data Exchange Center (CDEC), which is operated by the California Department of Water Resources (CDEC, 2005). Table A-8 identifies the solar radiation stations assigned to each study area while Figure A-11 illustrates the stations. A daily time series containing cloud attenuated solar radiation for the modeling period was generated for each weather station, as per SHADE model requirements. All SHADE model inputs are summarized in Table A-9.

Table A-8. Solar Radiation Stations

| Study Area | Solar Radiation Station |
|---|---|
| Main Stem SHADE Model | Eel River Camp (ERC) |
| Chamise Creek | Eel River Camp (ERC) |
| Dobbyn Creek | Mad River (MDF) |
| UER Extension | Alder Springs (ADS) |

Table A-9. SHADE Model Inputs

| Input Parameter | Description |
|---|---|
| Watershed location | ▪ Watershed latitude<br>▪ Watershed longitude<br>▪ Time zone standard meridian where the watershed is located |
| Stream width | Wetted stream width at the start and end of each reach |
| SSP coordinates | Universal Transverse Mercator (UTM) coordinates of all stream sampling points (topographic and vegetation shading characteristics will be defined at each of these locations) |
| Topographic shading characteristics | Topographic shade angles (degrees) measured from the stream surface to up to the topographic features that obstruct the sunbeam (Input in 12 standard azimuth directions at each SSP) |
| Vegetation shading characteristics | Includes vegetation characteristics at each SSP:<br>▪ Distance from the edge of the stream to riparian buffer (m)<br>▪ Average absolute height of vegetation canopy (m)<br>▪ Average height of vegetation canopy with respect to the stream surface (m)<br>▪ Average canopy density (%) |
| Global solar radiation | Time series of daily global solar radiation at watershed location (Langleys) for entire simulation period |

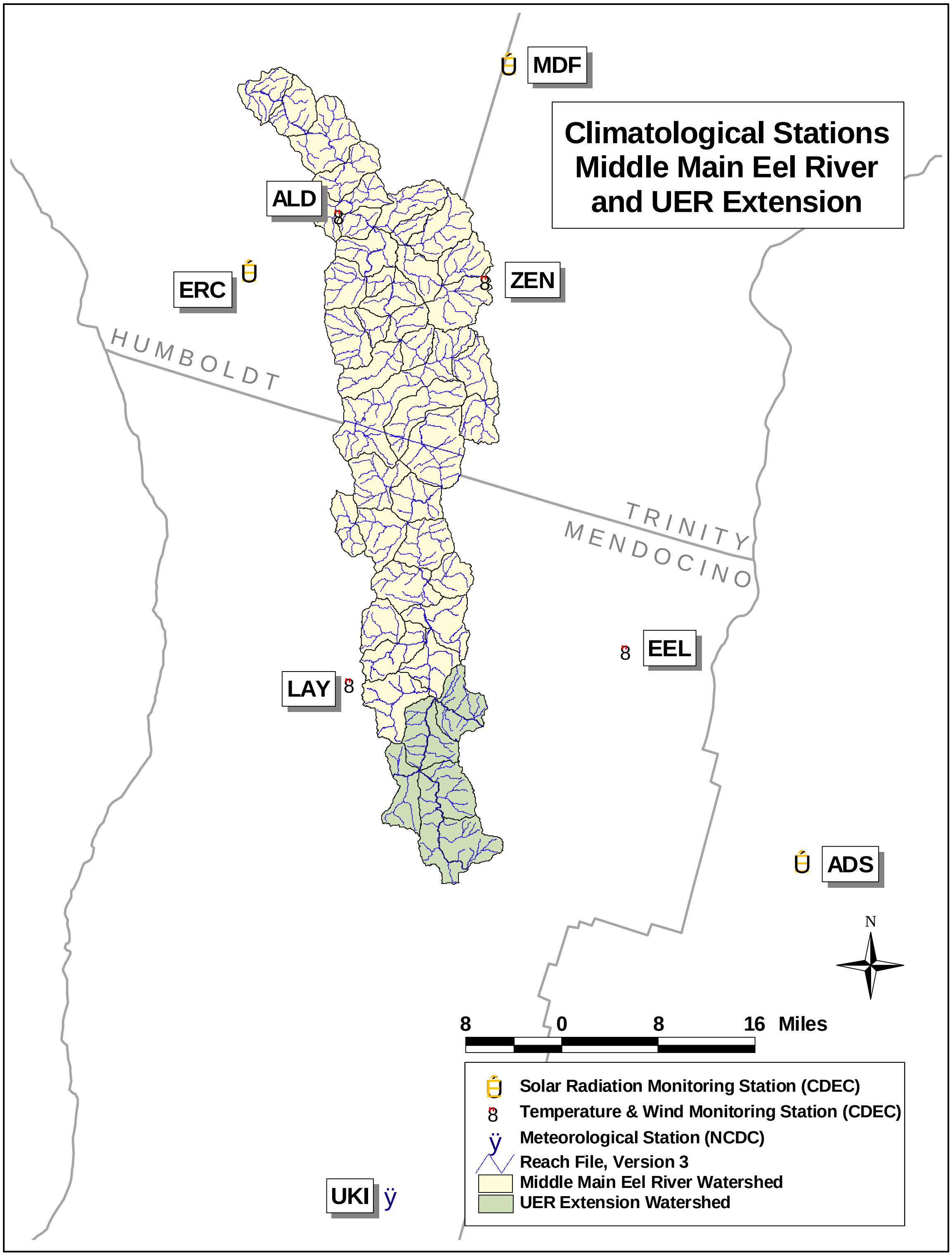


Figure A-11. Climatological stations near the Middle Main Eel river and UER Extension watersheds

#### A.2.2.2 SHADE Model Methodology

SHADE computes a time-series of the effective solar radiation reaching the stream surface after accounting for the effects of riparian vegetation and topography.  A detailed description of the SHADE model can be found in the paper *Streams Temperature Simulation of Forested Riparian Areas*: I.  Watershed-Scale Model Development (Chen et.al.,1998a).  The methodology employed in SHADE is summarized below:

1. A watershed's location is determined by latitude and longitude.  The latitude is used to compute the solar path (the sun's position over the day defined by two angles: the solar altitude and the solar zenith) and half-day length at a location.  The longitude and standard meridian where the watershed time zone is centered is used to convert standard time to local time in the watershed.

2. The daily global radiation is disaggregated into hourly direct-beam and diffuse radiation based on the watershed latitude using a number of theoretical considerations and empirical relationships.

3. Using an hourly time step, the topographic and vegetation shading effects on direct-beam radiation are computed from sunrise to sunset by relating the solar path geometry to shade angles provided by the topography and vegetation.  Computations are performed at every SSP.  The final direct-beam radiation with shading effects is calculated as a function of the stream width.

4. Shading effects on diffuse radiation are assumed to be controlled by sky openness (the fraction of the sky not blocked by riparian vegetation or topography), which is considered constant over time and estimated at each SSP from topographic and vegetation shade angles.

5. Direct-beam and diffuse radiation are further reduced by the albedo (reflectivity) of the moving water surface.  The albedo of direct-beam radiation is assumed to be a function of the solar zenith angle, while a constant value is assumed for diffuse radiation albedo.

6. Direct-beam and diffuse radiation are summed to obtain the effective solar radiation absorbed by the stream water at each SSP. The solar radiation factor (effective radiation for heating divided by the incoming radiation) is also computed at each SSP.

Using this methodology, the SHADE model can be used to evaluate various riparian management scenarios, such as logging and fire management.

#### A.2.2.3 SHADE Model Output and Post-Processing

SHADE calculates adjusted global solar radiation and a solar radiation factor, which are used by the Q2ESHADE model.  These output parameters are described in Table A-10.

Table A-10.  SHADE Model Output

| Output Parameter | Description |
|---|---|
| Adjusted global solar radiation | Time series of hourly (and daily) global solar radiation (Langleys) reaching the stream surface and available for elevating the stream temperature |
| Solar radiation factor | Ratio (dimensionless) of effective radiation for stream heating divided by the incoming radiation on the top of the channel valley |

To evaluate data at each SSP, a post-processing tool was developed to generate a statistical summary of the maximum, minimum, and average shade attenuated solar radiation for the simulation period at each SSP.  These values were then used to estimate the amount of effective shade at each SSP (i.e. the percent reduction in solar radiation after being attenuated by the topography and vegetation).  Post-processing tools also calculated an average heat load for the entire watershed (Langley/day).

The output of the SHADE model can be evaluated independently or incorporated into the Q2ESHADE model to calculate stream temperatures, as described in Section A.3.  The SHADE model output was directly evaluated for the main stem SHADE model (Table A-1).  The results of this analysis and the associated scenarios are presented in Section A.4.1.  In addition, the SHADE model output was input to the Q2ESHADE model for further analyses in Dobbyn Creek, Chamise Creek, and the UER extension (Table A-1).  The Q2ESHADE methodology is described in Section A.3.

## A.3 Q2ESHADE Model

A customized SHADE version of USEPAs QUAL2E (Brown, et. al., 1987) in-stream model was developed (Q2ESHADE) and applied to the Dobbyn Creek, Chamise Creek, and UER extension watersheds (Table A-1). The Q2ESHADE model uses all the underlying algorithms of QUAL2E and is linked with the SHADE model. The Q2ESHADE enhancements provide interpretation of hourly solar radiation time series data from the SHADE GIS model output, as well as heat balance calculations. A preprocessor was developed to reformat SHADE hourly solar radiation data into a format that can be read by Q2ESHADE. The Q2ESHADE model along with its post-processing features and required data files are discussed below and illustrated in Figure A-12.

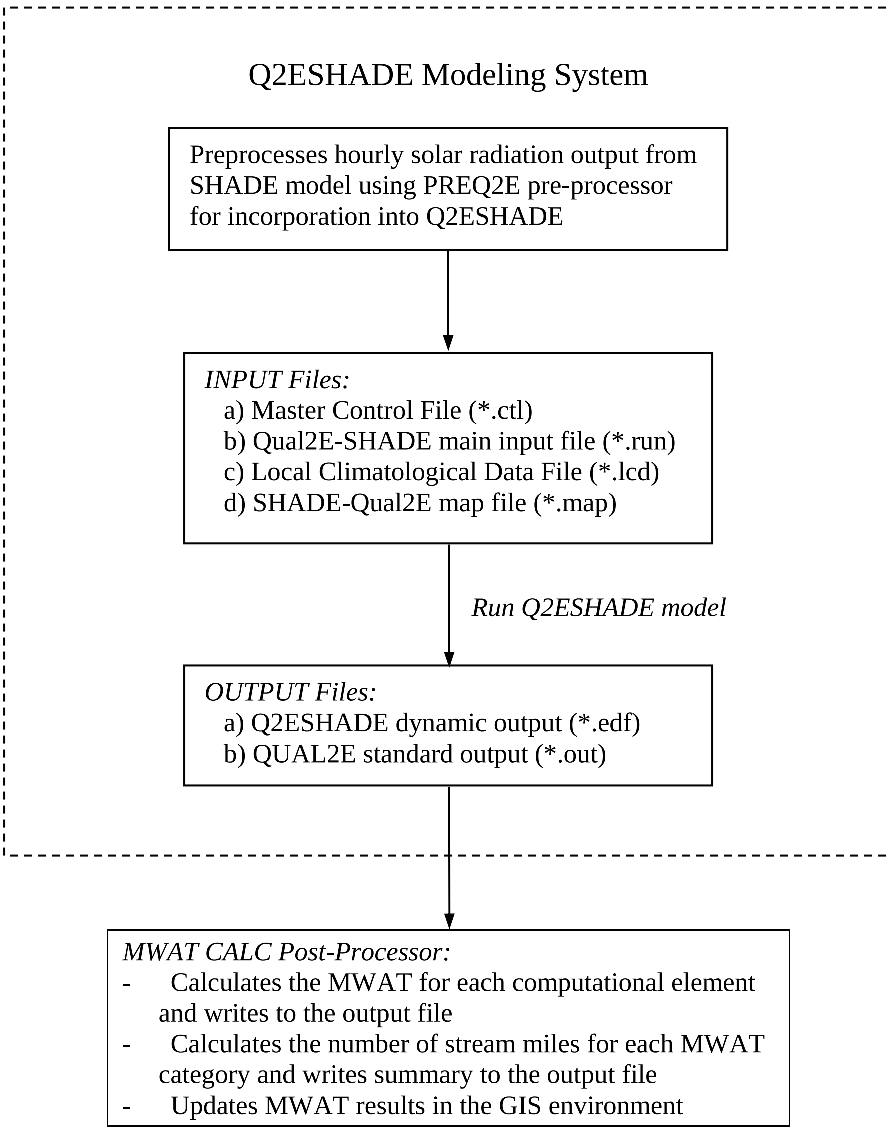


Figure A-12. Q2ESHADE Model Functionality

### A.3.1 Q2ESHADE Development and Methodology

The Q2ESHADE model was used to predict in-stream temperatures at different segments throughout the stream network. The model is applicable to dendritic streams that are well mixed and assume a constant stream flow at the headwaters. Q2ESHADE is a one-dimensional model in which the main transport mechanisms are significant only in the major direction of flow. Because the highest temperature conditions are typically observed during low-flow periods, the model is suitable for critical condition temperature modeling.

In Q2ESHADE, the stream is conceptualized as a series of computational elements (completely mixed batch reactors) that have the same hydrogeometric properties within a reach. Flow is routed via transport and dispersion mechanisms and mass balance is performed for the constituent of concern. A link is made with the SHADE model by keeping the computational element spacing identical to the SHADE SSP spacing.

Although the in-stream model algorithms are used to represent a single flow condition, the model can be operated quasi-dynamically to simulate temperature fluctuations. Based on available hourly local climatological data, the model can update the source/sink term for the heat balance over time. Therefore, the diurnal response of the steady-state hydraulic system to changing temperature conditions can be simulated.

The model can also be parameterized to simulate the impact of different headwater conditions by modifying the flow rate and initial temperature values. Model simulations can then be performed to determine the impact to in-stream water temperature from various background conditions. These simulations can be performed in conjunction with different vegetation scenarios to further characterize past, present, and future conditions in the watershed.

For constant headwater inflows, the model can currently simulate temperature dynamically for a period of 31 days (744 hours). This limitation was stipulated because the model stores hourly solar radiation in memory for each computational element, and the array size grows very large as the length of time modeled increases. One month was determined to be reasonable since the model is not dynamic with respect to flow. This time period appropriately represents the critical period (July 15, 2003 through August 14, 2003) with regard to temperature (constant low flow conditions).

### A.3.2 Q2ESHADE Data Requirements

Q2ESHADE utilizes SHADE model output with channel hydraulics, stream temperature, and climatological data during its simulation process. These data sources are described below.

Channel Hydraulics

Because Q2ESHADE is a steady-state model, it requires a constant stream flow at all headwaters. Headwater flows were estimated using area-weighted averages based on critical period flow measurements at available USGS gages (Table A-11) and other discrete flow measurement locations (Kubicek, 1977). In addition, for the UER extension, the headwater associated with the main stem Eel River was assigned the average predicted flow (7.77 cubic feet per second [cfs]) for the last SSP in the UER temperature TMDL model and the Middle Fork was assigned the average flow at USGS gage 11473900 for July 15 through August 14 for the entire period of record (50.9 cfs). Some of the tributary flows were adjusted during model calibration, but the value for the main stem and Middle Fork in the UER extension remained unchanged.

Table A-11. USGS Gage Data used for Model Configuration and Calibration

| Stream Name | USGS Gage Number | USGS Gage Description | Period of Record |
|---|---|---|---|
| Dobbyn Creek | 11475100 | Dobbyn Creek near Fort Seward, CA | October 1972 – September 1976 |
| Chamise Creek | 11474700 | Chamise Creek near Island Mountain, CA | October 1972 – September 1976 |
| Outlet Creek | 11472200 | Outlet Creek near Longvale, CA | October 1956 – November 1994 |
| Middle Fork | 11473900 | Middle Fork Eel River near Dos Rios, CA | October 1965 – September 2004 |
| Eel River (upstream of Outlet Creek) | 11472150 | Eel River near Dos Rios, CA | October 1966 – December 1994 |
| Eel River (upstream of Dos Rios) | 11472500 | Eel River above Dos Rios, CA | April 1951 – September 1965 |

To describe the hydraulic characteristics of the system, the functional representation option within Q2ESHADE was used. This involved calculating the velocity and depth for the system using power equations. The power equations are in the form of $v = aQ^b$ and $d = cQ^d$; where:

$v$ = velocity,
$d$ = depth,
$Q$ = flow,
$a$ and $c$ = coefficients, and
$b$ and $d$ = exponents.

Coefficients $a$, $c$ and exponents $b$, $d$ were derived from different sources for the three Q2ESHADE study areas, as identified in Table A-12. Rating curves were established using these coefficients and exponents and were subsequently adjusted during model calibration to ensure that the range of summer base flow conditions were covered for all modeled watersheds.

Table A-12.  Channel Hydraulics Information Sources

| Study Area | Source of Channel Hydraulics Information |
| --- | --- |
| Dobbyn Creek | Flow and depth measurements from the CDFG Stream Inventory Reports (CDFG, 1995a, 1995b, 1995c) |
| Chamise Creek | Stream measurements (flow, velocity, and depth) collected by Pacific Watershed Associates on 8/16/05 and 9/7/05 (PWA, 2005) |
| UER Extension | Velocity and flow values provided in time of travel study (United States Department of the Interior, 1967) |

Climatological Data

The Q2ESHADE model requires time-series climatological data including atmospheric pressure, dry bulb temperature, wet bulb temperature, wind speed, and cloud cover data for simulating the diurnal variation in the temperature.  A complete dataset with hourly time-series data by month was available for the Ukiah, California weather station (UKI) for the summer of 2003 from the National Climatic Data Center (NCDC) of the National Oceanic and Atmospheric Administration (NOAA) (see Figure A-11 for a map of climatological stations).  This station is located approximately 78 miles (125.5 kilometers [km]) south of Dobbyn Creek, 64 miles (103 km) from Chamise Creek, and 43 miles (69.2 km) from the center of the UER extension watersheds.  Data from UKI were supplemented with more localized air temperature and wind speed data, where available (Table A-13).

Dobbyn Creek is influenced by coastal fog in the morning and evening hours, but not during periods of peak sun with the highest temperatures.  Therefore, the Ukiah (UKI) NCDC station was used for the entire suite of climatological parameters except for air temperature.  To provide more local information, air temperature data for the Zenia CDEC station (ZEN), which is located in the southern-most subwatershed, was used to represent dry bulb temperature in the southern-most Dobbyn Creek subwatersheds.  Alder Point (ALD) (just three miles west/northwest of the mouth of Dobbyn Creek) was used for the subwatersheds near the confluence with the Eel River.  For subwatersheds in the center of the Dobbyn Creek watershed, an average hourly air temperature based on ALD and ZEN was applied.  These areas include the North Dobbyn Creek, Mud Creek, and Bluford Creek subwatersheds.  In addition, the wet bulb temperature at ALD was calculated based on the relative humidity, dry bulb temperature, and atmospheric pressure.  These data replaced the UKI wet bulb temperatures for both ALD and ZEN.

Chamise Creek is generally not influenced by coastal fog; therefore, data from UKI was used to represent the entire suite of climatological parameters where local data was unavailable.  The Laytonville (LAY) CDEC station (21 miles [33.8 km] south of the center of the watershed) was used to provide more localized dry bulb temperature, wet bulb temperature, and wind speed data.  The dry bulb temperature and wind speed were directly measured at LAY; however, the wet bulb temperature was calculated using relative humidity, dry bulb temperature, and atmospheric pressure.

Similar to the tributary models, weather data for the UER extension incorporated values from the UKI NCDC station, supplemented by local temperature and wind data. Specifically, the LAY and Eel River (EEL) CDEC stations (6.5 miles [10.5 km] and 16.5 miles [26.6 km] from the center of the UER extension watersheds, respectively) were used to represent certain reaches in the study area. As described previously for other weather stations, the dry bulb temperature and wind speed were directly measured; however, the wet bulb temperature was calculated using measured parameters.

The Q2ESHADE model allows for the clear-sky solar radiation to be adjusted by the observed cloud cover. However, since solar radiation used in the SHADE model was cloud cover attenuated (and not clear sky), this option was disabled.

Table A-13. Local Weather Stations

| Study Area | Local Weather Station(s)* | Data Included in Q2ESHADE Model (*to replace UKI values*) |
|---|---|---|
| Dobbyn Creek | Zenia (ZEN) | Dry Bulb Temperature<br>Wet Bulb Temperature (calculated based on ALD) |
| | Alder Springs (ALD) | Dry Bulb Temperature<br>Wet Bulb Temperature (calculated) |
| | ZEN + ALD | Dry Bulb Temperature (average of ZEN + ALD)<br>Wet Bulb Temperature (calculated based on ALD) |
| Chamise Creek | Laytonville (LAY) | Dry Bulb Temperature<br>Wet Bulb Temperature (calculated)<br>Wind Speed |
| UER Extension | Laytonville (LAY) | Dry Bulb Temperature<br>Wet Bulb Temperature (calculated)<br>Wind Speed |
| | Eel River (EEL) | Dry Bulb Temperature<br>Wet Bulb Temperature (calculated)<br>Wind Speed |

*The location of each weather station is illustrated in Figure A-11.

Temperature Data

Similar to the channel hydraulics information, Q2ESHADE requires constant water temperatures at the headwaters. For the Dobbyn and Chamise Creek models, the headwater temperatures were based on the 2003 average annual air temperature at the climatological station assigned to each headwater reach (Table A-14).

For the UER extension, headwater temperatures were estimated based on the closest or most representative 2003 temperature monitoring station (Humboldt County RCD) or data presented in other applicable reports (CDFG, 1995a, 1995b, 1995c; Kubicek, 1977). In addition, the headwater associated with the main stem Eel River was assigned the average predicted temperature (26.06$^{o}$C) for the last SSP in the UER temperature TMDL model.  Some of the tributary temperatures were adjusted during model calibration, but the value for the main stem in the UER extension remained unchanged.

Table A-14.  Headwater Temperatures for Dobbyn and Chamise Creek Watersheds

| Study Area | Local Weather Station(s) | Headwater Temperature (deg C) |
|---|---|---|
| Dobbyn Creek – Headwaters of South Dobbyn Creek | Zenia (ZEN) | 11.19 |
| Dobbyn Creek – Mud Creek, Bluford Creek, and North Dobbyn Creek | Average of ZEN + ALD | 12.23 |
| Dobbyn Creek – Dobbyn Creek and South Dobbyn Creek near the confluence with Dobbyn Creek | Alder Springs (ALD) | 13.26 |
| Chamise Creek | Laytonville (LAY) | 13.22 |

### A.3.3 Q2ESHADE Model Output and Post-Processing

The Q2ESHADE model creates two output files: the Q2ESHADE dynamic output file (*.edf) and the QUAL2E standard model output (*.out). To evaluate the time series Q2ESHADE model output at each SSP, post-processors were developed to quantify and summarize the time series data for TMDL analysis (Figure A-12).

The post-processors read the output data and then generate the max7daat during the critical period at each SSP. In addition to producing max7daat values, the stream mileage associated with different stream temperature categories is calculated. These categories include: Good <15$^{o}$C, Fair 15$^{o}$C – 16.99$^{o}$C, Marginal 17$^{o}$C – 18.99$^{o}$C, Stressful 19$^{o}$C – 23.99$^{o}$C, and Lethal Conditions >24$^{o}$C.

The output of the Q2ESHADE model was evaluated for Chamise Creek, Dobbyn Creek, and the UER extension (Table A-1). The results of these analysis and their associated scenarios are presented in Sections A.4.2, A.4.3, and A.4.4, respectively.

## A.4 Model Calibration and Scenarios

After the SHADE and Q2ESHADE models were configured, model simulations were performed for baseline conditions (described in Sections A.2.1.1, A.2.1.2, A.2.2.1, and A.3.2), which were used for calibrating the Q2ESHADE models, and several different flow and vegetation scenarios. SHADE and Q2ESHADE can be used to perform scenarios to quantify the change to stream shading and/or in-stream temperature. SHADE parameters are modified to simulate vegetation-specific scenarios, while Q2ESHADE is used to model flow-related scenarios. The vegetation and flow scenarios are described below.

<u>Vegetation Scenarios</u>

The SHADE model allows the user to simulate changes to stream shading and in-stream temperatures by altering the vegetation characteristics. Scenarios varying the DBH and resulting tree height conditions were simulated for Chamise Creek, Dobbyn Creek, and the main stem SHADE model (Table A-1). The four vegetation scenarios are: no vegetation (topographic shading only), 18 inch DBH, 24 inch DBH, and 48 inch DBH. Table A-15 identifies the DBH and vegetation heights associated with each vegetation scenario and the process used to determine the heights is described below:

- Conifer and hardwood heights associated with each scenario were calculated by changing the DBH in Equation 1.
- Shrub and herbaceous heights remained unchanged from baseline conditions, except for the no vegetation (topographic shading only) scenario.
- The heights presented in Table A-15 were assigned to all respective vegetation types, regardless of seral stage in the watershed.
- Tree density remained unchanged from baseline conditions.

Table A-15. Tree Heights Associated with Vegetation Scenarios

| Scenario Name | Conifer Height | Hardwood Height | Shrub Height | Herbaceous Height |
|---|---|---|---|---|
| No Vegetation (Topographic Shading Only) | 0 meters (0 feet) | 0 meters (0 feet) | 0 meters (0 feet) | 0 meters (0 feet) |
| Private Land Management with 18 inch (45.7 cm) DBH | 26.6 meters (87.3 feet) | 15.6 meters (51.1 feet) | 1 meter (3.3 feet) | 0.5 meter (1.6 feet) |
| Private Land Management with 24 inch (61 cm) DBH | 31.9 meters (104.7 feet) | 15.9 meters (52.3 feet) | 1 meter (3.3 feet) | 0.5 meter (1.6 feet) |
| Natural Vegetation (48 inch [121.9 cm] DBH) | 48.3 meters (158.4 feet) | 16.03 meters (52.6 feet) | 1 meter (3.3 feet) | 0.5 meter (1.6 feet) |

<u>Flow Scenarios</u>

Modifying the Q2ESHADE *.run file allows the user to simulate changes to in-stream temperatures using different flow and temperature conditions. Eight scenarios varying the UER extension boundary conditions were simulated (Table A-1). These scenarios were based on the very wet year conditions simulated for the UER temperature TMDL (Tetra Tech, Inc., 2004). The flow and temperatures associated with the eight scenarios are presented in Table A-16 and the process used to determine these boundary conditions are described below:

- The average predicted flow and temperature at the final SSP for the four UER TMDL very wet year flow scenarios (Tetra Tech, Inc., 2004) were assigned as boundary conditions for the main stem (representing conditions from upstream of Outlet Creek in the Upper Eel River watershed).
- Two flow conditions were simulated for the Middle Fork: average flow of 50.9 cfs [1.44 cubic meters per second or cms] and high flow of 80 cfs [2.27 cms]).
- The Middle Fork temperature remained unchanged from baseline conditions.
- The two Middle Fork flow conditions were simulated for each very wet year flow scenario.
- Vegetation conditions remained unchanged from baseline conditions.

Table A-16. Stream Flow and Temperature Associated with Flow Scenarios

| Scenario Name | | Main Stem Flow | Main Stem Temperature |
|---|---|---|---|
| *Average Middle Fork Flow 50.9 cfs (1.44 cms)* | FERC/NMFS Very Wet Condition (30 cfs at 20.9°C downstream of Cape Horn Dam) | 30.67 cfs (0.8685 cms) | 24.91°C |
| | Natural Very Wet Conditions – Lower (50 cfs at 22.5°C downstream of Cape Horn Dam) | 50.68 cfs (1.435 cms) | 24.45°C |
| | Natural Very Wet Conditions – Lower (60 cfs at 22.5°C downstream of Cape Horn Dam) | 50.68 cfs (1.435 cms) | 24.77°C |
| | Natural Very Wet Conditions – Upper (50 cfs at 23.5°C downstream of Cape Horn Dam | 60.67 cfs (1.718 cms) | 24.18°C |
| *High Middle Fork Flow 80 cfs (2.27 cms)* | FERC/NMFS Very Wet Condition (30 cfs at 20.9°C downstream of Cape Horn Dam) | 30.67 cfs (0.8685 cms) | 24.91°C |
| | Natural Very Wet Conditions – Lower (50 cfs at 22.5°C downstream of Cape Horn Dam) | 50.68 cfs (1.435 cms) | 24.45°C |
| | Natural Very Wet Conditions – Lower (60 cfs at 22.5°C downstream of Cape Horn Dam) | 50.68 cfs (1.435 cms) | 24.77°C |
| | Natural Very Wet Conditions – Upper (50 cfs at 23.5°C downstream of Cape Horn Dam) | 60.67 cfs (1.718 cms) | 24.18°C |

Table A-1 identifies the model and scenario types for each study area. Model calibration (for the Q2ESHADE models), baseline results, and scenario results for the main stem SHADE model, Chamise Creek, Dobbyn Creek, and the UER extension are presented in Sections A.4.1, A.4.2, A.4.3, and A.4.4, respectively.

### A.4.1 Main Stem SHADE Model

As shown in Table A-1, the SHADE model was run for the entire main stem of the MME. Subsequent to the initial model run using the baseline conditions described in Sections A.2.1.1, A.2.1.2, and A.2.2.1, four vegetation scenarios were simulated: no vegetation (topographic shading only), 18 inch DBH, 24 inch DBH, and 48 inch DBH (Table A-15 and Section A.4).

Table A-17 presents the average percent shading results for the vegetation scenarios compared to baseline conditions for the main stem SHADE model. Figure A-13 presents the percent average shading associated with baseline conditions (see Sections A.2.1.1, A.2.1.2, and A.2.2.1) for the main stem, while Figure A-14 through Figure A-17 illustrate the percent average shading at each SSP for the four vegetations scenarios described above (Table A-15). As expected, the percent average shading for the vegetations scenarios do not vary significantly from baseline conditions because the MME main stem is very wide for much of its length, so tree height has a smaller impact on temperature than overall topographic shading.

Table A-17. Model Results for Vegetation Scenarios for the main stem SHADE model

| Model Result | Baseline Conditions | Topographic Shading | 18 Inch DBH | 24 Inch DBH | 48 Inch DBH |
|---|---|---|---|---|---|
| Percent Average Shading | 23.24% | 16.93% | 22.69% | 22.94% | 23.92% |

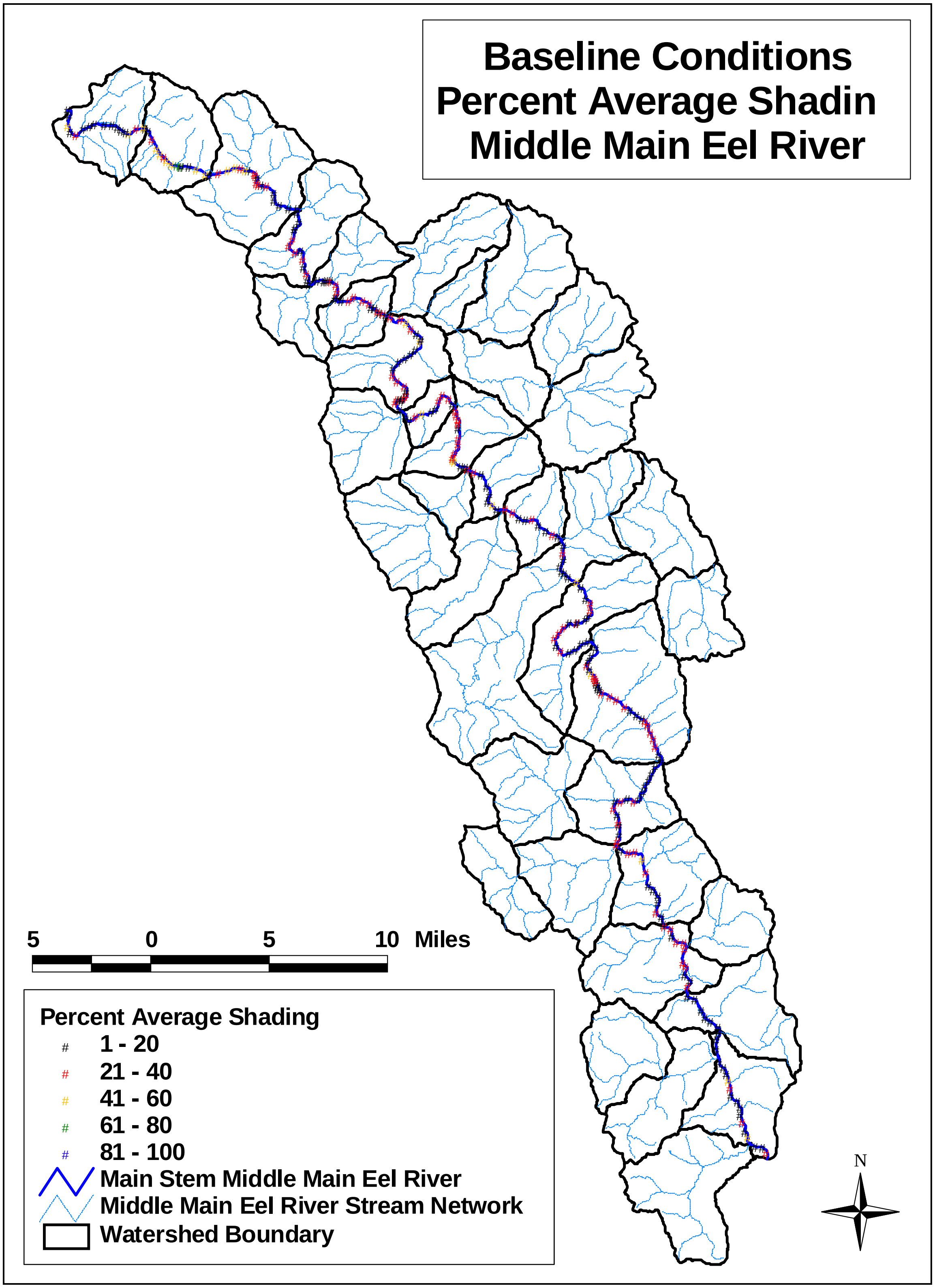


Figure A-13.  Percent average shading for baseline conditions in the main stem SHADE model

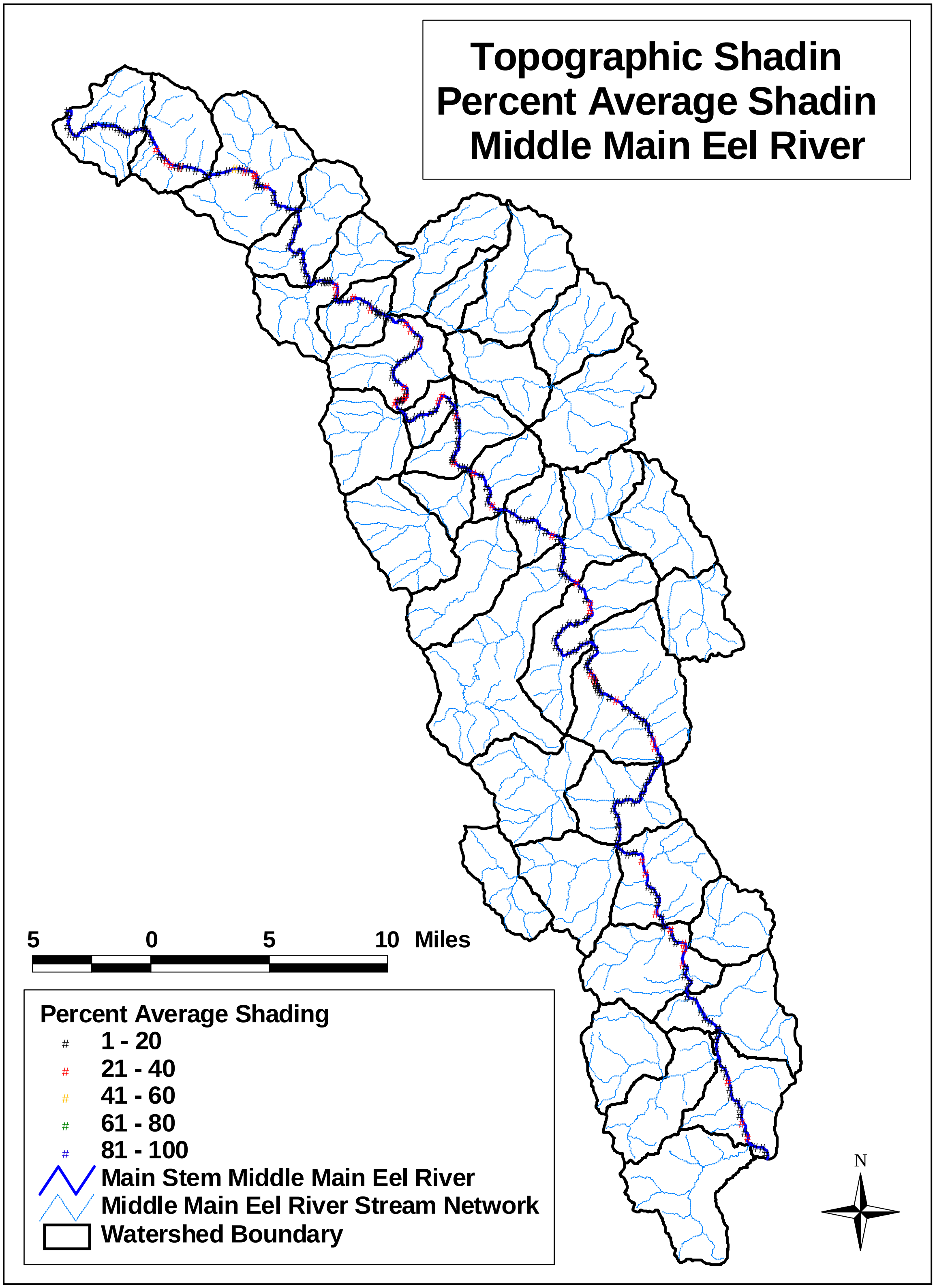


Figure A-14. Percent average shading for the topographic shading scenario for the main stem SHADE model

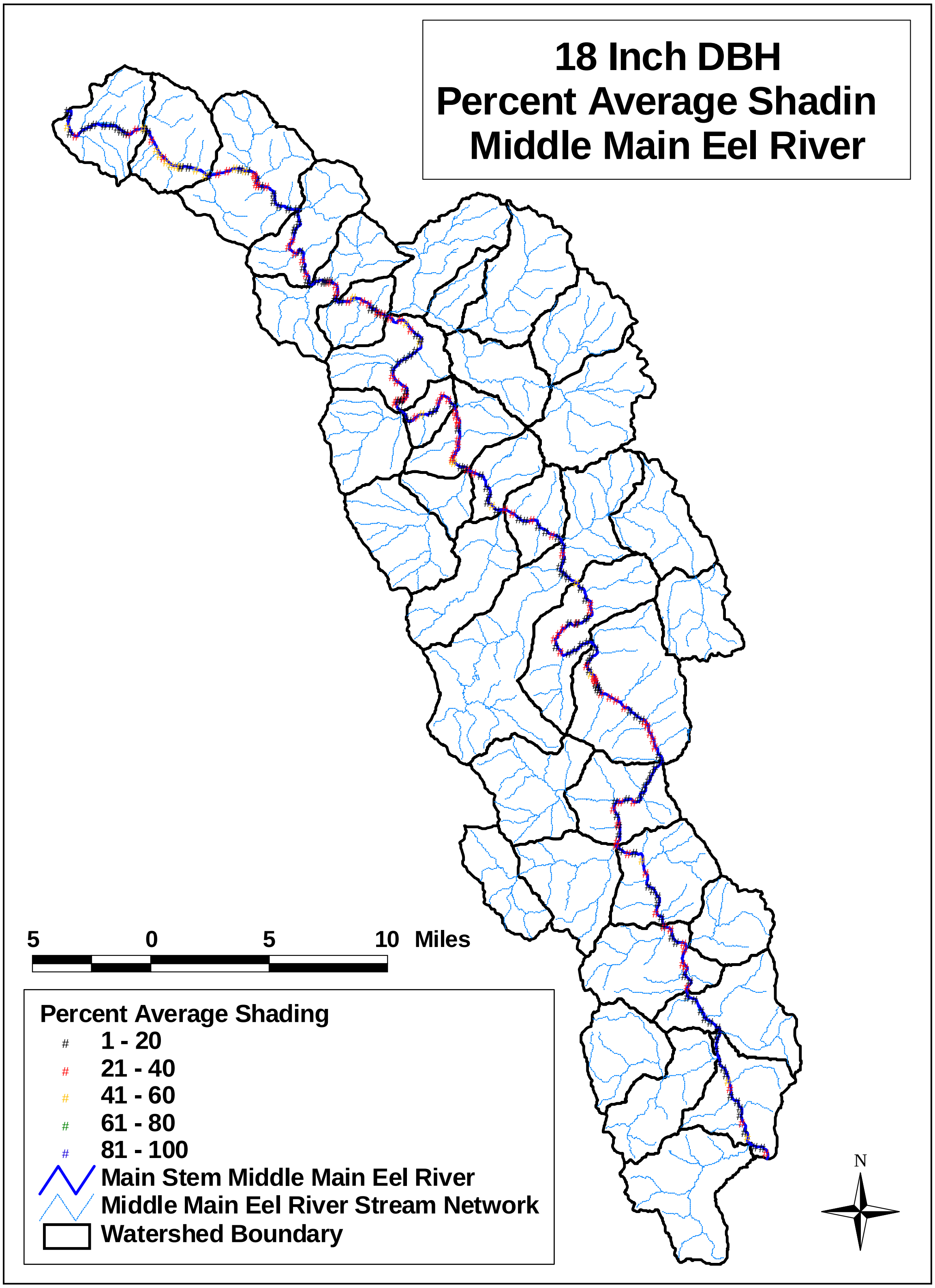


Figure A-15. Percent average shading for the 18 inch DBH vegetation scenario for the main stem SHADE model

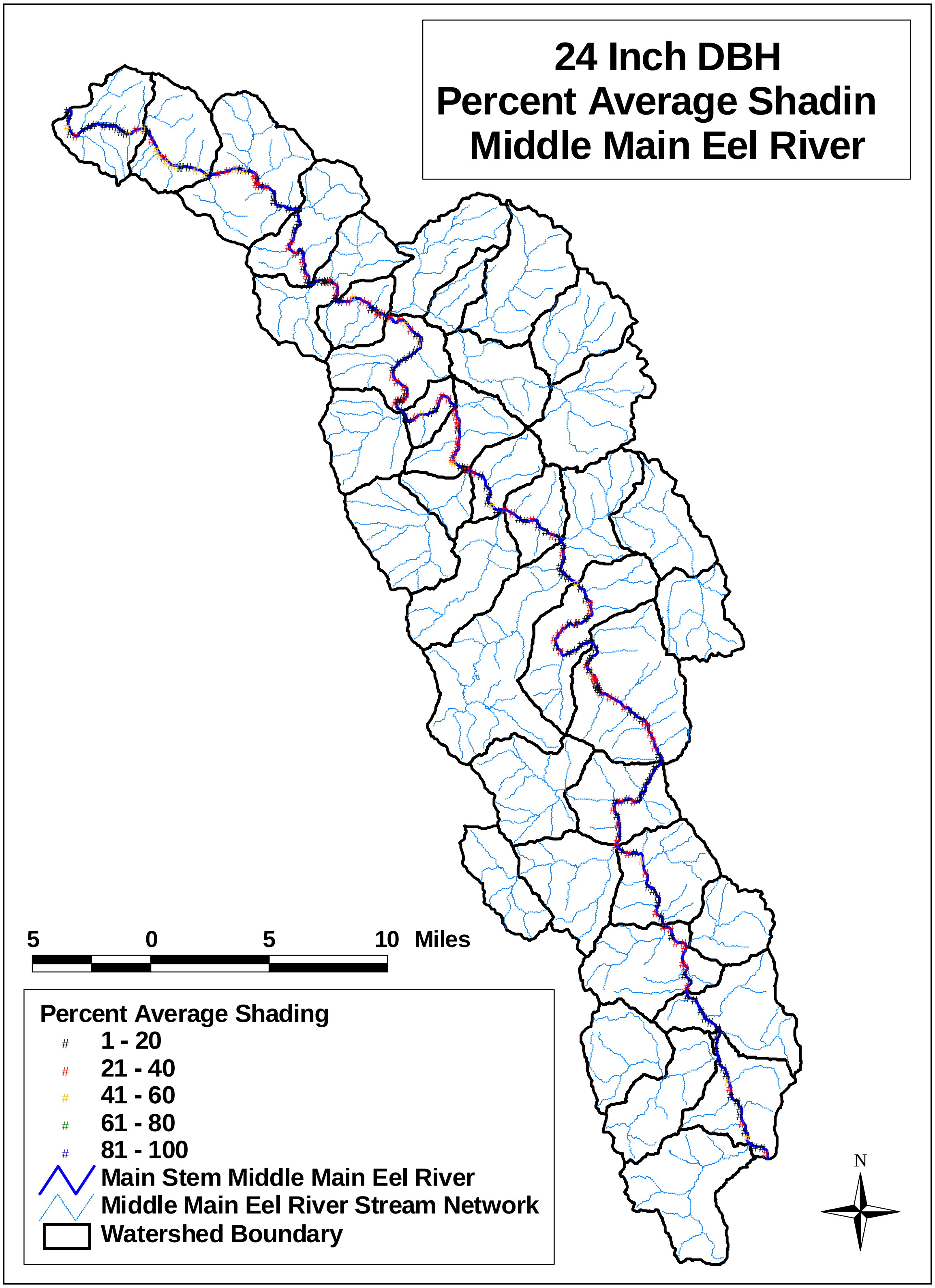


Figure A-16. Percent average shading for the 24 inch DBH vegetation scenario for the main stem SHADE model

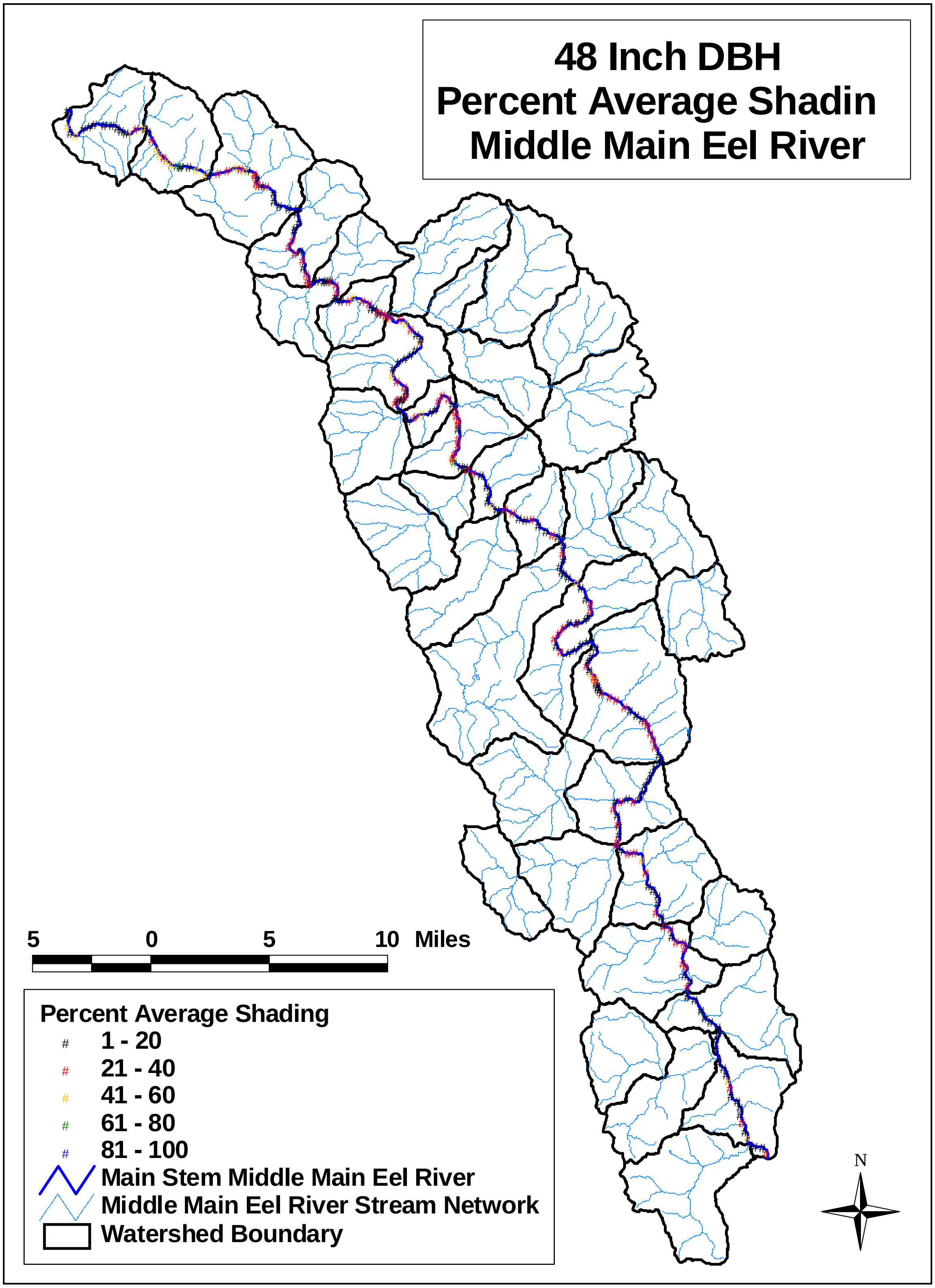


Figure A-17. Percent average shading for the 48 inch DBH vegetation scenario for the main stem SHADE model

### A.4.2 Chamise Creek Q2ESHADE Model

As shown in Table A-1, the Q2SHADE model was run for the Chamise Creek stream network. Subsequent to the initial model run using the baseline conditions described in Sections A.2.1.1, A.2.1.2, A.2.2.1, and A.3.2, model calibration was performed. The 2003 temperature monitoring data from the Humboldt County RCD were used for calibration. One station was available in the Chamise Creek watershed (Figure A-18). Max7daats were calculated for the temperature monitoring data for July 15, 2003 through August 14, 2003 and were compared with the max7daats predicted by the model for the same time period. Model calibration results are presented in Table A-18. The average percent error was –0.01% for Chamise Creek.

Table A-18. Model Calibration Results for Chamise Creek

| Station ID | Location | Observed Temperature max7daat (deg C) | Predicted Temperature max7daat (deg C) | Percent Error |
|---|---|---|---|---|
| 1527 | Chamise Creek | 24.30 | 24.30 | -0.01% |

Table A-19 presents the number of stream miles associated with different max7daat categories, the solar radiation, and the average percent shade for baseline conditions in Chamise Creek. In addition, Figure A-19 and Figure A-20 illustrate the average percent shading and max7daat values for baseline conditions throughout the Chamise Creek watershed.

Table A-19. Baseline Model Results for Chamise Creek

| Temperature Category | Chamise Creek | |
|---|---|---|
| | Stream Miles | % of Total |
| Good (max7daat < 15°C) | 0.3 | 0% |
| Fair (15°C < max7daat < 17°C) | 2.8 | 4% |
| Marginal (17°C < max7daat < 19°C) | 16.5 | 23% |
| Stressful (19.1°C < max7daat < 20°C) | 10.9 | 15% |
| Stressful (20.1°C < max7daat < 21°C) | 8.1 | 11% |
| Stressful (21.1°C < max7daat < 22°C) | 7.8 | 11% |
| Stressful (22.1°C < max7daat < 23°C) | 9.0 | 12% |
| Stressful (23.1°C < max7daat < 24°C) | 4.3 | 6% |
| Lethal (max7daat > 24°C) | 12.4 | 17% |
| TOTAL | 72.1 | 100% |
| Solar Radiation (Langley/day) | 221.9 | |
| % Shade | 65.1% | |

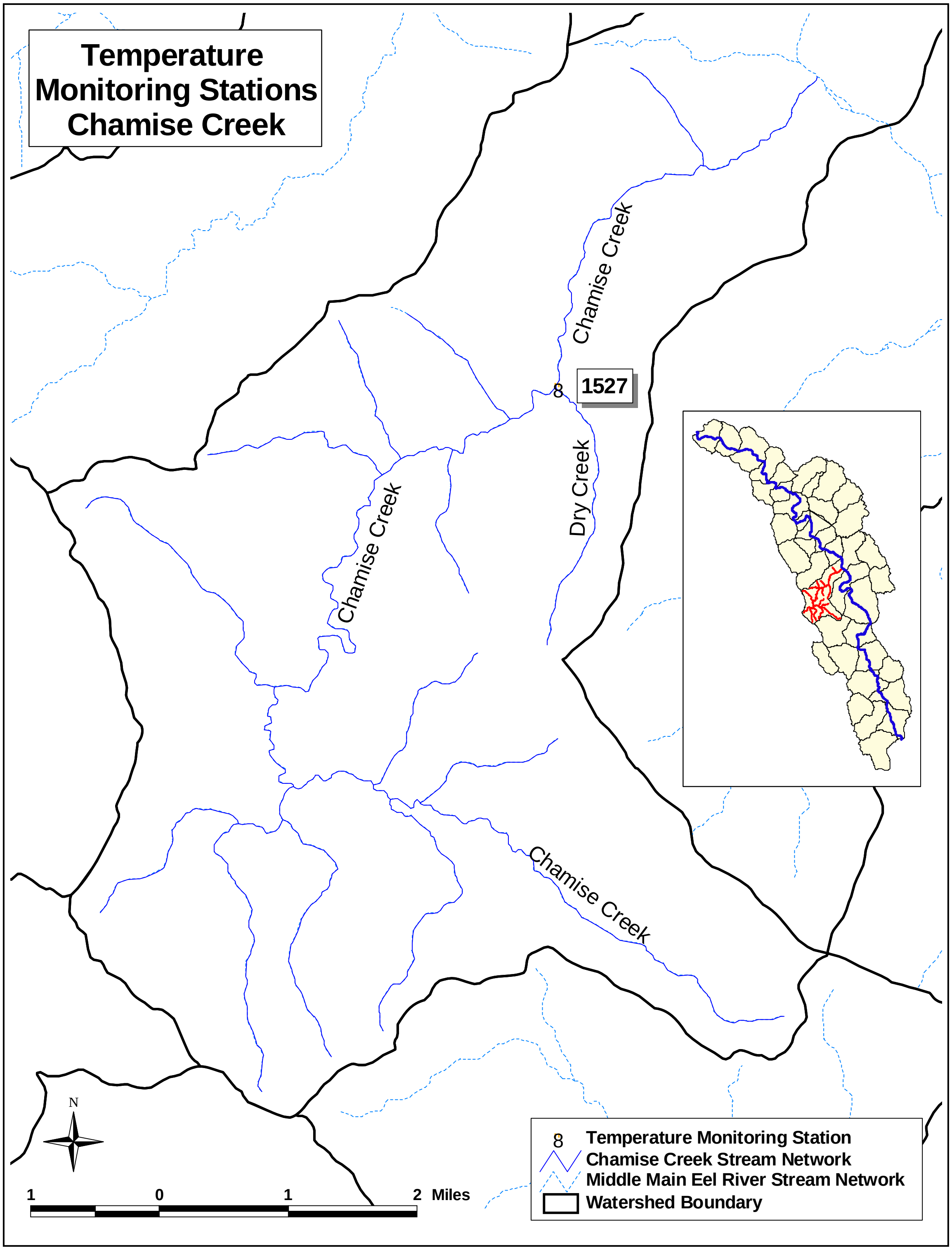


Figure A-18. Monitoring station used for calibration in the Chamise Creek watershed

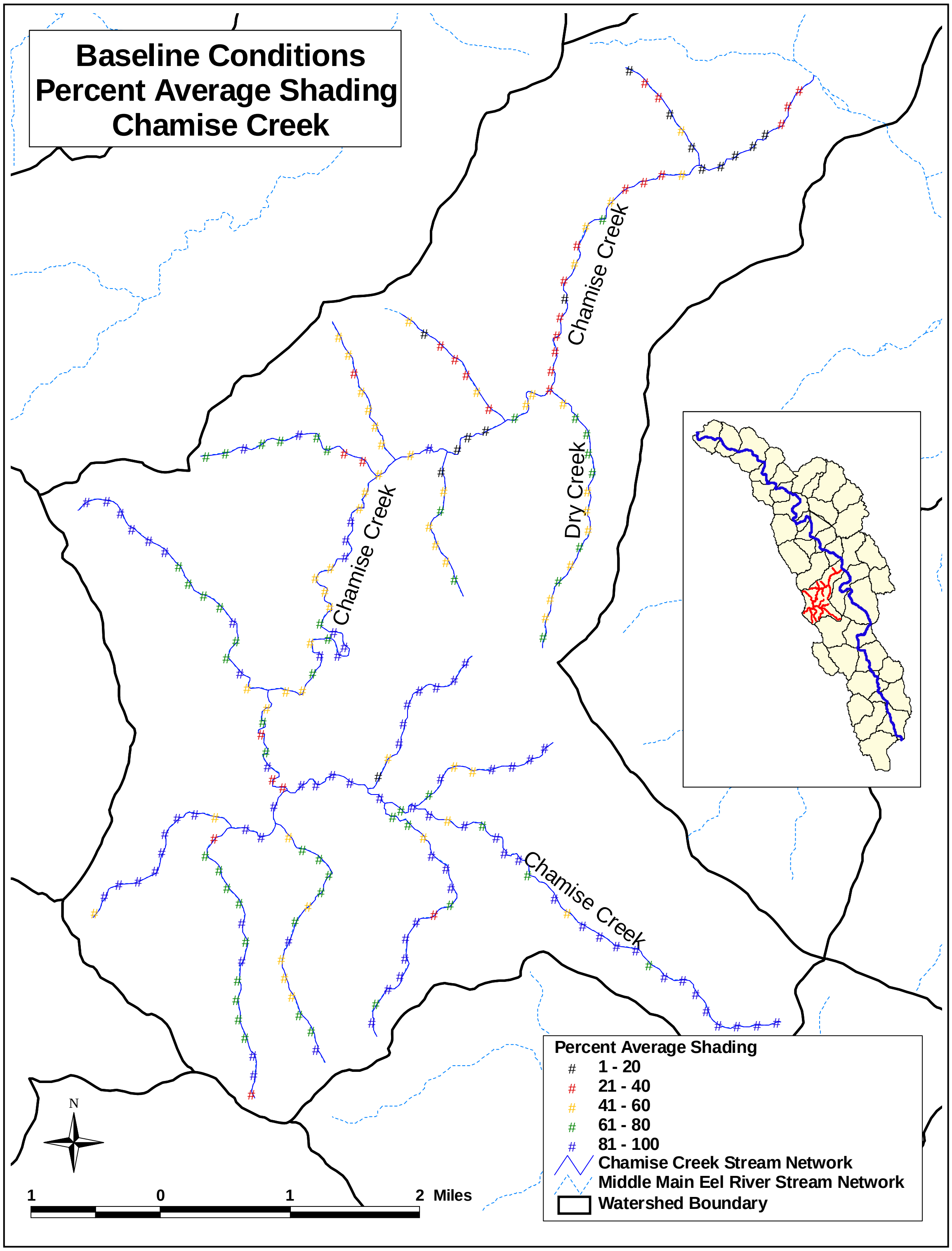


Figure A-19. Percent average shading for baseline conditions at Chamise Creek

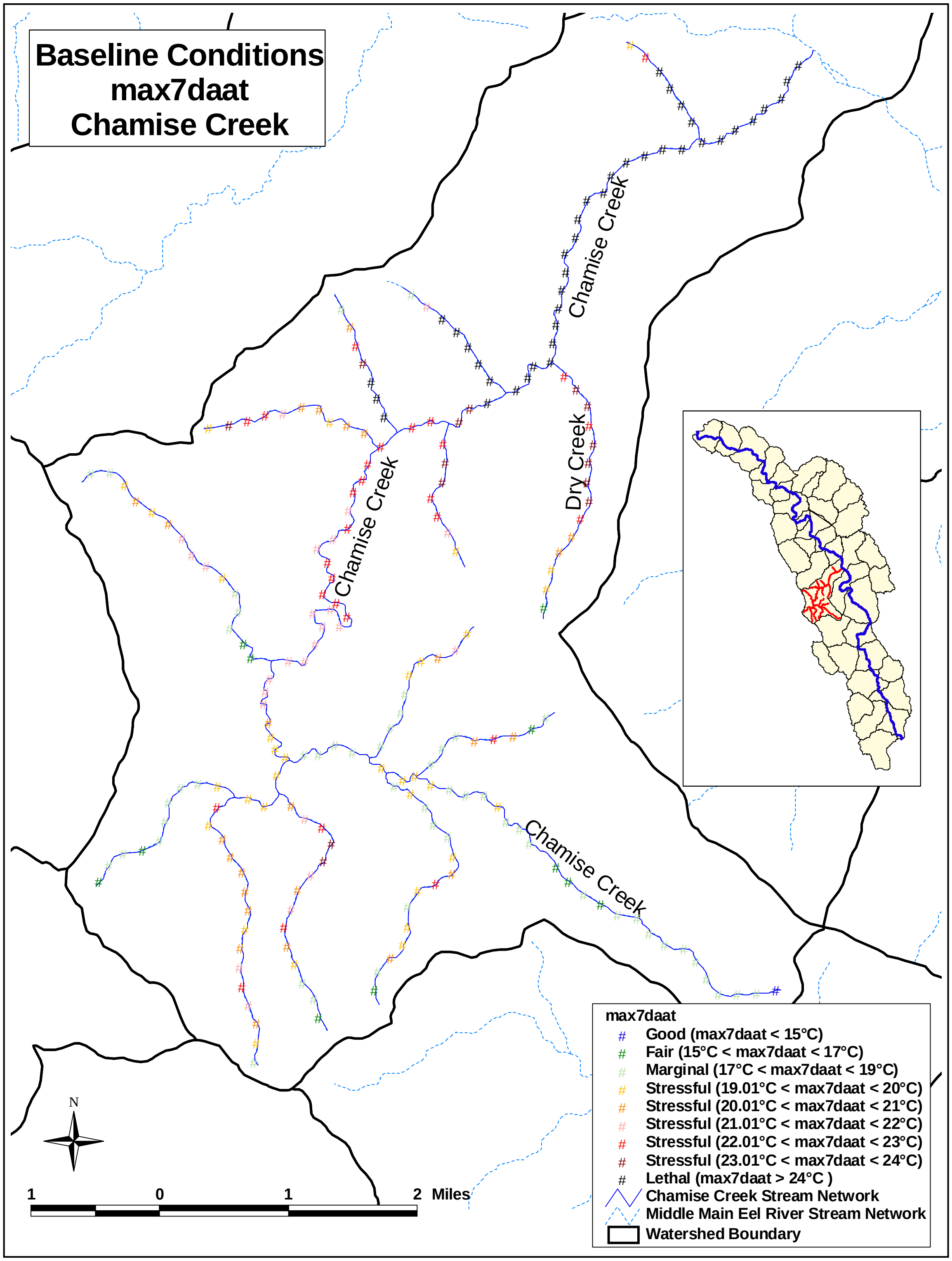


Figure A-20. Max7daat values for baseline conditions at Chamise Creek

Using the calibrated model, the four vegetation scenarios described in Section A.4 were simulated: no vegetation (topographic shading only), 18 inch DBH, 24 inch DBH, and 48 inch DBH (Table A-15). Table A-20and Table A-21 present model results for the vegetation scenarios at Chamise Creek, as compared to the baseline conditions (see Sections A.2.1.1, A.2.1.2, A.2.2.1, and A.3.2). Table A-20 includes the stream miles associated with different max7daat categories, the solar radiation, and average percent shading, while Table A-21 identifies the specific max7daat value associated with each SSP along Chamise Creek (see Figure A-22 for an illustration of the stream reach identification numbers in Chamise Creek). Figure A-21 illustrates the stream miles associated with each vegetation scenario and Figure A-23 graphically compares max7daats for the baseline conditions and the vegetation scenarios presented in Table A-21. Figure A-24 through Figure A-27 illustrate the average percent shading at each SSP for vegetation scenarios described above (Table A-15).

Table A-20. Model Results for Vegetation Scenarios at Chamise Creek

| Temperature Category | Baseline Conditions | | Topographic Shading | 18 Inch DBH | 24 Inch DBH | 48 Inch DBH | |
|---|---|---|---|---|---|---|---|
| | Stream Miles | % of Total | Stream Miles | Stream Miles | Stream Miles | Stream Miles | % of Total |
| Good (max7daat < 15°C) | 0.3 | 0% | 0.0 | 0.3 | 0.3 | 0.3 | 0% |
| Fair (15°C < max7daat < 17°C) | 2.8 | 4% | 0.0 | 1.2 | 1.6 | 6.5 | 9% |
| Marginal (17°C < max7daat < 19°C) | 16.5 | 23% | 0.6 | 11.8 | 14.6 | 19.9 | 28% |
| Stressful (19.1°C < max7daat < 20°C) | 10.9 | 15% | 2.8 | 8.4 | 11.2 | 8.1 | 11% |
| Stressful (20.1°C < max7daat < 21°C) | 8.1 | 11% | 0.9 | 11.8 | 9.3 | 10.6 | 15% |
| Stressful (21.1°C < max7daat < 22°C) | 7.8 | 11% | 0.6 | 8.4 | 8.1 | 7.8 | 11% |
| Stressful (22.1°C < max7daat < 23°C) | 9.0 | 12% | 0.9 | 9.0 | 9.9 | 4.0 | 6% |
| Stressful (23.1°C < max7daat < 24°C) | 4.3 | 6% | 2.8 | 7.5 | 4.0 | 5.0 | 7% |
| Lethal (max7daat > 24°C) | 12.4 | 17% | 63.4 | 13.7 | 13.0 | 9.9 | 14% |
| TOTAL | 72.1 | 100% | 72.0 | 72.1 | 72.0 | 72.1 | 100% |
| Solar Radiation (Langley/day) | 221.9 | | 499.1 | 240.1 | 229.7 | 201.7 | |
| % Shade | 65.1% | | 22.1% | 62.3% | 63.9% | 68.2% | |

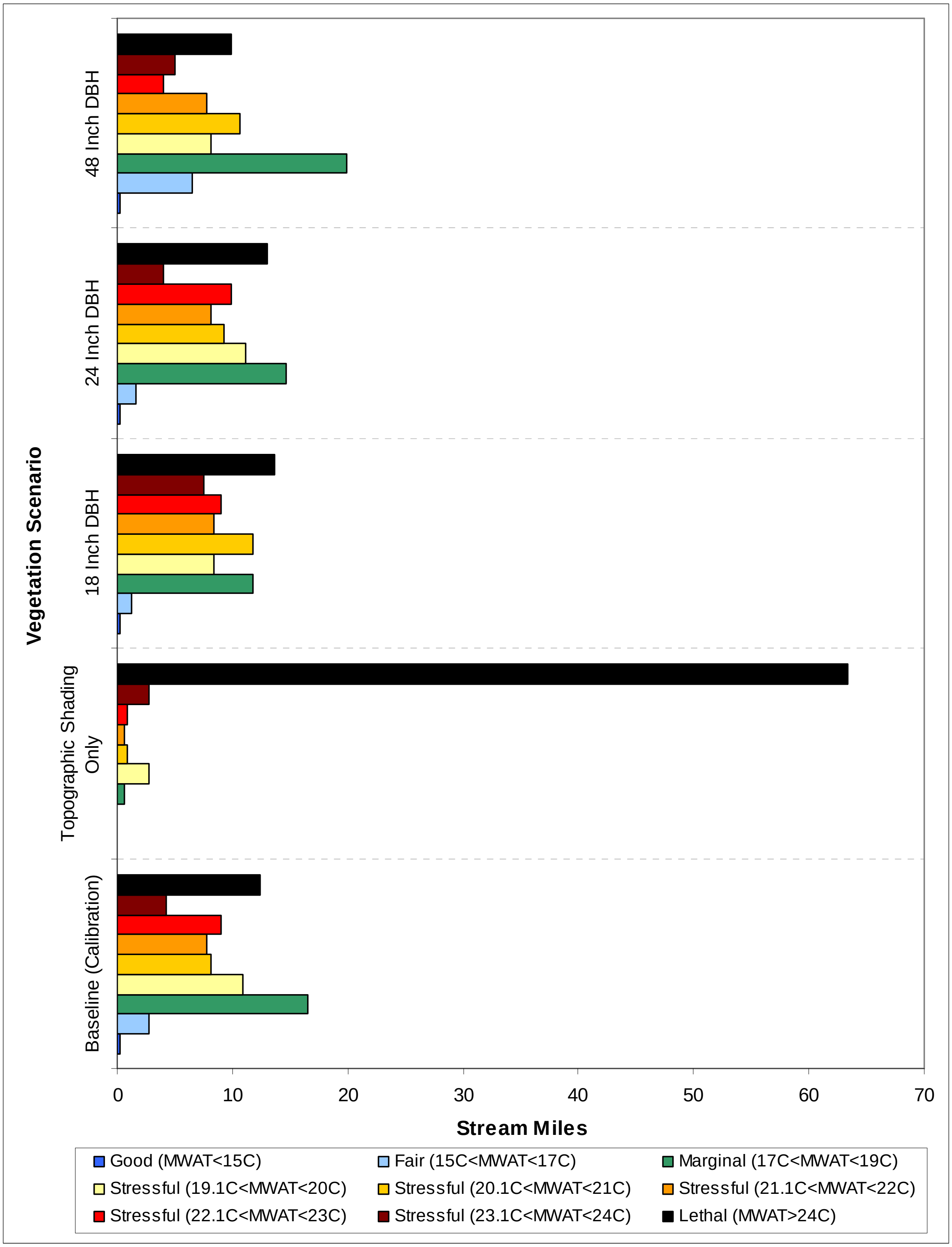


Figure A-21.  Stream miles associated with each vegetation scenario in Chamise Creek

Table A-21. Max7daat Values (degC) for Vegetation Scenarios at Each SSP Along Chamise Creek

| Q2ESHADE Identification Number | Reach Identification Number | Baseline Conditions (Calibration) | Topographic Shading | 18 Inch DBH | 24 Inch DBH | 48 Inch DBH |
|---|---|---|---|---|---|---|
| 1 | 1 | 14.5 | 19.26 | 14.61 | 14.5 | 14.49 |
| 2 | 1 | 17.72 | 22.52 | 18.06 | 17.84 | 17.32 |
| 3 | 1 | 17.57 | 24.44 | 17.65 | 17.34 | 17.21 |
| 4 | 1 | 17.54 | 25.54 | 17.98 | 17.56 | 17.16 |
| 5 | 1 | 18.06 | 25.95 | 18.37 | 18.08 | 17.65 |
| 6 | 1 | 18.25 | 26.34 | 18.92 | 18.5 | 17.44 |
| 7 | 1 | 18.97 | 26.67 | 19.81 | 19.11 | 18.55 |
| 8 | 1 | 18.59 | 26.86 | 19.59 | 18.88 | 17.9 |
| 9 | 1 | 18.34 | 27.02 | 19.74 | 18.49 | 17.87 |
| 10 | 1 | 17.98 | 27.08 | 19.74 | 18.64 | 17.62 |
| 11 | 1 | 17.35 | 27.11 | 18.72 | 17.84 | 17.08 |
| 12 | 1 | 16.94 | 27.13 | 18.18 | 17.44 | 16.71 |
| 13 | 1 | 17.02 | 27.22 | 18.15 | 17.52 | 16.84 |
| 14 | 1 | 17 | 27.17 | 18.1 | 17.49 | 16.85 |
| 15 | 1 | 16.66 | 27.03 | 17.78 | 17.17 | 16.54 |
| 16 | 2 | 17.24 | 27.33 | 18.82 | 18.16 | 17.07 |
| 17 | 2 | 18.79 | 27.59 | 20.29 | 19.65 | 18.31 |
| 18 | 2 | 18.33 | 27.72 | 19.82 | 19.15 | 17.76 |
| 19 | 2 | 19.31 | 27.75 | 20.74 | 20.09 | 18.5 |
| 20 | 2 | 18.55 | 27.81 | 20.32 | 19.61 | 17.91 |
| 21 | 2 | 18.44 | 28.05 | 19.87 | 19.28 | 17.94 |
| 22 | 2 | 18.64 | 28.12 | 20.07 | 19.46 | 17.92 |
| 23 | 2 | 19.32 | 28.14 | 20.68 | 20.09 | 18.42 |
| 24 | 3 | 17.02 | 20.02 | 16.84 | 16.93 | 17.11 |
| 25 | 3 | 16.85 | 23.78 | 17.02 | 16.89 | 16.75 |
| 26 | 3 | 20.33 | 25.85 | 20.15 | 19.94 | 19.42 |
| 27 | 3 | 22.37 | 27.03 | 22.41 | 22.29 | 21.84 |
| 28 | 3 | 20.06 | 27.38 | 20.52 | 20.25 | 19.71 |
| 29 | 3 | 18.86 | 27.54 | 19.45 | 19.19 | 18.58 |
| 30 | 3 | 18.77 | 27.51 | 19.71 | 19.28 | 18.1 |
| 31 | 3 | 18.73 | 27.29 | 19.95 | 19.37 | 17.76 |
| 32 | 4 | 19.24 | 28.2 | 20.6 | 19.97 | 18.19 |
| 33 | 4 | 19.19 | 29.2 | 20.65 | 19.95 | 17.95 |
| 34 | 5 | 15.3 | 19.54 | 15.81 | 15.53 | 15.03 |
| 35 | 5 | 18.09 | 23.34 | 18.49 | 18.27 | 17.75 |
| 36 | 5 | 20.63 | 25.42 | 20.88 | 20.72 | 20.18 |
| 37 | 5 | 19.66 | 26.53 | 20.32 | 19.97 | 18.88 |
| 38 | 5 | 19.57 | 26.87 | 20.54 | 20.04 | 18.47 |
| 39 | 5 | 19 | 26.78 | 20.23 | 19.61 | 17.63 |
| 40 | 5 | 19.34 | 27.11 | 20.82 | 20.05 | 18.01 |
| 41 | 5 | 22.19 | 27.23 | 23.1 | 22.64 | 21.24 |
| 42 | 5 | 20.46 | 27.23 | 21.3 | 20.82 | 19.82 |
| 43 | 5 | 19.57 | 26.96 | 20.54 | 20 | 18.89 |
| 44 | 5 | 18.38 | 26.72 | 20.07 | 19.4 | 17.87 |
| 45 | 5 | 17.51 | 26.68 | 18.98 | 18.33 | 17.13 |
| 46 | 5 | 17.1 | 26.53 | 18.5 | 17.85 | 16.65 |
| 47 | 5 | 19.15 | 26.73 | 20.55 | 19.9 | 18.39 |
| 48 | 5 | 18.08 | 26.89 | 19.2 | 18.66 | 17.46 |
| 49 | 6 | 19.25 | 29.89 | 20.03 | 19.29 | 17.54 |
| 50 | 7 | 19.19 | 19.19 | 19.19 | 19.19 | 19.19 |
| 51 | 7 | 21.53 | 22.84 | 21.52 | 21.52 | 21.4 |
| 52 | 7 | 20.64 | 25 | 21.02 | 20.82 | 20.11 |
| 53 | 7 | 19.51 | 26.22 | 20.07 | 19.78 | 19.01 |
| 54 | 7 | 19.03 | 26.93 | 19.79 | 19.37 | 18.5 |
| 55 | 7 | 18.35 | 27 | 19.29 | 18.78 | 17.79 |
| 56 | 7 | 17.84 | 26.99 | 18.93 | 18.34 | 17.25 |
| 57 | 7 | 17.72 | 27.05 | 18.94 | 18.28 | 17.24 |
| 58 | 7 | 17.98 | 27.2 | 19.45 | 18.66 | 16.87 |
| 59 | 8 | 18.66 | 29.06 | 19.58 | 18.89 | 17.32 |
| 60 | 8 | 18.67 | 29.19 | 19.64 | 18.96 | 17.33 |
| 61 | 8 | 18.56 | 29.44 | 19.35 | 18.75 | 17.11 |
| 62 | 8 | 18.44 | 29.59 | 19.19 | 18.65 | 17.17 |
| 63 | 9 | 16.08 | 18.07 | 16.09 | 16.08 | 15.92 |
| 64 | 9 | 17.89 | 21.38 | 17.9 | 17.9 | 17.64 |
| 65 | 9 | 18.95 | 23.67 | 18.96 | 18.95 | 18.63 |
| 66 | 9 | 19.9 | 25.07 | 19.9 | 19.9 | 19.44 |
| 67 | 9 | 20.8 | 25.95 | 20.8 | 20.8 | 20.39 |
| 68 | 9 | 22.01 | 26.43 | 21.62 | 21.62 | 21.6 |
| 69 | 9 | 21.67 | 26.88 | 21.83 | 21.62 | 20.88 |
| 70 | 9 | 20.37 | 26.95 | 20.82 | 20.49 | 19.65 |
| 71 | 9 | 21.72 | 27.22 | 22.04 | 21.8 | 21.1 |
| 72 | 9 | 23.18 | 27.45 | 23.4 | 23.23 | 22.66 |

| Q2ESHADE Identification Number | Reach Identification Number | Baseline Conditions (Calibration) | Topographic Shading | 18 Inch DBH | 24 Inch DBH | 48 Inch DBH |
|---|---|---|---|---|---|---|
| 73 | 9 | 23.97 | 27.55 | 24.13 | 24.01 | 23.55 |
| 74 | 9 | 22.61 | 27.67 | 23 | 22.77 | 22.19 |
| 75 | 9 | 22 | 27.79 | 22.12 | 21.78 | 20.95 |
| 76 | 9 | 20.83 | 27.86 | 21.16 | 20.73 | 20.06 |
| 77 | 10 | 17 | 19.35 | 17.42 | 17.18 | 16.7 |
| 78 | 10 | 17.47 | 22.55 | 18.43 | 17.95 | 16.73 |
| 79 | 10 | 17.17 | 24.6 | 18.12 | 17.61 | 16.48 |
| 80 | 10 | 16.82 | 25.95 | 17.71 | 17.29 | 16.29 |
| 81 | 10 | 17.68 | 26.65 | 18 | 17.38 | 16.11 |
| 82 | 10 | 17.3 | 26.79 | 17.96 | 17.3 | 15.95 |
| 83 | 10 | 17.04 | 26.78 | 17.94 | 17.23 | 15.86 |
| 84 | 10 | 17.27 | 27.04 | 18.27 | 17.57 | 16.28 |
| 85 | 10 | 17.36 | 27.3 | 18.16 | 17.62 | 16.55 |
| 86 | 10 | 19.29 | 27.52 | 20.54 | 19.82 | 17.88 |
| 87 | 11 | 17.43 | 18.57 | 17.43 | 17.43 | 17.36 |
| 88 | 11 | 19.24 | 21.97 | 19.24 | 19.24 | 19.1 |
| 89 | 11 | 20.62 | 24.11 | 20.62 | 20.62 | 20.34 |
| 90 | 11 | 21.38 | 25.45 | 21.38 | 21.38 | 21.11 |
| 91 | 11 | 22.02 | 26.19 | 22.02 | 22.02 | 21.72 |
| 92 | 11 | 21.08 | 26.63 | 21.57 | 21.31 | 20.51 |
| 93 | 11 | 20.68 | 26.94 | 21.44 | 21.05 | 19.79 |
| 94 | 11 | 19.99 | 27.06 | 20.89 | 20.42 | 19.17 |
| 95 | 11 | 20.23 | 27.19 | 21.32 | 20.77 | 19.07 |
| 96 | 11 | 20.54 | 27.26 | 21.94 | 21.23 | 19.27 |
| 97 | 11 | 20.85 | 27.33 | 22.33 | 21.65 | 19.49 |
| 98 | 11 | 20.84 | 25.81 | 22.28 | 21.62 | 19.39 |
| 99 | 11 | 20.06 | 26.61 | 21.86 | 21.19 | 18.95 |
| 100 | 11 | 19.22 | 26.91 | 21.02 | 20.25 | 18.13 |
| 101 | 11 | 22.16 | 27.56 | 23.4 | 22.88 | 21.24 |
| 102 | 12 | 20 | 27.57 | 21.17 | 20.63 | 19.05 |
| 103 | 12 | 19.39 | 27.64 | 20.6 | 20.04 | 18.44 |
| 104 | 13 | 19.06 | 27.59 | 20.07 | 19.5 | 18.28 |
| 105 | 14 | 19.43 | 28.96 | 20.24 | 19.72 | 18.4 |
| 106 | 14 | 19.79 | 29.33 | 20.56 | 20.07 | 18.8 |
| 107 | 14 | 19.64 | 29.6 | 20.44 | 19.94 | 18.61 |
| 108 | 14 | 20.58 | 30.04 | 21.33 | 20.87 | 19.59 |
| 109 | 14 | 21.44 | 30.4 | 22 | 21.71 | 20.49 |
| 110 | 15 | 21.8 | 30.42 | 22.32 | 22.05 | 20.89 |
| 111 | 15 | 21.7 | 30.37 | 22.16 | 21.85 | 20.57 |
| 112 | 16 | 17.5 | 19.4 | 17.5 | 17.5 | 17.35 |
| 113 | 16 | 18.08 | 23.16 | 18.08 | 18.08 | 17.73 |
| 114 | 16 | 19.56 | 25.33 | 19.6 | 19.6 | 19.05 |
| 115 | 16 | 20.52 | 26.43 | 20.58 | 20.57 | 19.97 |
| 116 | 16 | 19.54 | 27.15 | 19.75 | 19.67 | 19.19 |
| 117 | 16 | 20.57 | 27.61 | 20.72 | 20.66 | 20.14 |
| 118 | 16 | 21.1 | 27.34 | 21.21 | 21.16 | 20.61 |
| 119 | 16 | 21.49 | 27.33 | 21.57 | 21.54 | 21 |
| 120 | 16 | 21.47 | 27.34 | 21.55 | 21.52 | 20.96 |
| 121 | 16 | 19.73 | 27.34 | 20 | 19.88 | 19.4 |
| 122 | 16 | 18.53 | 27 | 18.96 | 18.7 | 18.3 |
| 123 | 16 | 18.15 | 27.02 | 18.73 | 18.37 | 17.99 |
| 124 | 16 | 17.44 | 26.97 | 18.17 | 17.7 | 17.31 |
| 125 | 16 | 16.93 | 27.07 | 17.81 | 17.24 | 16.82 |
| 126 | 16 | 16.75 | 27.08 | 17.76 | 17.15 | 16.52 |
| 127 | 17 | 21.54 | 30.22 | 22.02 | 21.7 | 20.53 |
| 128 | 17 | 21.95 | 30.45 | 22.42 | 22.11 | 21 |
| 129 | 17 | 21.65 | 30.6 | 22.24 | 21.9 | 20.75 |
| 130 | 17 | 21.37 | 30.69 | 21.99 | 21.64 | 20.43 |
| 131 | 17 | 21.27 | 30.75 | 21.83 | 21.47 | 20.26 |
| 132 | 17 | 21.68 | 30.95 | 22.22 | 21.87 | 20.69 |
| 133 | 17 | 21.94 | 31.09 | 22.22 | 21.76 | 20.49 |
| 134 | 17 | 22.47 | 31.24 | 22.82 | 22.38 | 21.15 |
| 135 | 17 | 22.91 | 31.34 | 23.24 | 22.83 | 21.65 |
| 136 | 17 | 22.78 | 31.49 | 23.17 | 22.74 | 21.51 |
| 137 | 17 | 22.54 | 31.55 | 23.02 | 22.56 | 21.22 |
| 138 | 17 | 22.16 | 31.59 | 22.75 | 22.28 | 20.9 |
| 139 | 17 | 21.89 | 31.69 | 22.52 | 22.02 | 20.7 |
| 140 | 17 | 21.86 | 31.78 | 22.66 | 22.11 | 20.74 |
| 141 | 17 | 22.14 | 31.87 | 22.92 | 22.39 | 21.03 |
| 142 | 17 | 21.92 | 31.93 | 22.8 | 22.26 | 20.82 |
| 143 | 17 | 22.03 | 32.01 | 22.86 | 22.36 | 20.96 |
| 144 | 17 | 22.26 | 32.04 | 23.05 | 22.57 | 21.21 |
| 145 | 17 | 22.47 | 32.1 | 23.27 | 22.79 | 21.38 |

| Q2ESHADE Identification Number | Reach Identification Number | Baseline Conditions (Calibration) | Topographic Shading | 18 Inch DBH | 24 Inch DBH | 48 Inch DBH |
|---|---|---|---|---|---|---|
| 146 | 18 | 19.29 | 20.11 | 19.29 | 19.29 | 19.14 |
| 147 | 18 | 23.13 | 24.27 | 23.13 | 23.13 | 22.91 |
| 148 | 18 | 22.15 | 26.07 | 22.15 | 22.15 | 21.8 |
| 149 | 18 | 22.03 | 26.8 | 22.03 | 22.03 | 21.65 |
| 150 | 18 | 21.07 | 27.29 | 21.07 | 21.07 | 20.65 |
| 151 | 18 | 20.74 | 27.48 | 20.74 | 20.74 | 20.27 |
| 152 | 18 | 20.98 | 27.6 | 20.98 | 20.98 | 20.53 |
| 153 | 18 | 19.61 | 27.69 | 21.1 | 20.81 | 19.33 |
| 154 | 18 | 20.18 | 27.65 | 21.12 | 20.94 | 19.87 |
| 155 | 18 | 20.38 | 27.66 | 20.98 | 20.87 | 20.03 |
| 156 | 19 | 22.66 | 31.59 | 23.37 | 22.96 | 21.68 |
| 157 | 20 | 17.48 | 19.45 | 17.48 | 17.48 | 17.3 |
| 158 | 20 | 20.31 | 23.19 | 20.31 | 20.31 | 20.04 |
| 159 | 20 | 22.89 | 25.32 | 22.89 | 22.89 | 22.67 |
| 160 | 20 | 23.97 | 26.47 | 23.97 | 23.97 | 23.73 |
| 161 | 20 | 25.54 | 27.45 | 25.54 | 25.54 | 25.25 |
| 162 | 20 | 24.81 | 27.34 | 24.81 | 24.81 | 24.47 |
| 163 | 20 | 24.75 | 27.31 | 24.75 | 24.75 | 24.39 |
| 164 | 21 | 22.46 | 31.26 | 23.14 | 22.75 | 21.51 |
| 165 | 21 | 22.61 | 31.21 | 23.25 | 22.89 | 21.7 |
| 166 | 22 | 19.65 | 20.29 | 19.65 | 19.65 | 19.53 |
| 167 | 22 | 21.37 | 23.69 | 21.37 | 21.37 | 21.12 |
| 168 | 22 | 22.33 | 25.56 | 22.33 | 22.33 | 22.03 |
| 169 | 22 | 22.93 | 26.41 | 22.93 | 22.93 | 22.62 |
| 170 | 22 | 23.37 | 26.87 | 23.37 | 23.37 | 23.04 |
| 171 | 22 | 23.65 | 26.94 | 23.65 | 23.65 | 23.34 |
| 172 | 22 | 22.97 | 27.03 | 23.41 | 23.19 | 22.3 |
| 173 | 23 | 23.04 | 30.95 | 23.65 | 23.31 | 22.18 |
| 174 | 23 | 23.55 | 30.98 | 24.12 | 23.8 | 22.73 |
| 175 | 23 | 24.02 | 31.03 | 24.56 | 24.25 | 23.24 |
| 176 | 24 | 18.72 | 19.96 | 18.72 | 18.72 | 18.55 |
| 177 | 24 | 21.87 | 23.98 | 21.87 | 21.87 | 21.6 |
| 178 | 24 | 24.47 | 26.16 | 24.47 | 24.47 | 24.28 |
| 179 | 24 | 25.5 | 27.08 | 25.5 | 25.5 | 25.37 |
| 180 | 24 | 26.64 | 27.94 | 26.64 | 26.64 | 26.46 |
| 181 | 24 | 27.28 | 28.35 | 27.28 | 27.28 | 27.09 |
| 182 | 24 | 26.24 | 28.04 | 26.24 | 26.24 | 26.08 |
| 183 | 25 | 24.17 | 30.88 | 24.66 | 24.38 | 23.44 |
| 184 | 25 | 24.3 | 30.91 | 24.77 | 24.51 | 23.6 |
| 185 | 25 | 24.29 | 30.97 | 24.81 | 24.53 | 23.54 |
| 186 | 26 | 16.96 | 19.45 | 16.96 | 16.96 | 16.69 |
| 187 | 26 | 19.25 | 23.18 | 19.25 | 19.25 | 18.82 |
| 188 | 26 | 19.97 | 25.28 | 20.42 | 20.02 | 19.78 |
| 189 | 26 | 20.17 | 26.5 | 21.47 | 20.83 | 20.08 |
| 190 | 26 | 20.56 | 26.92 | 21.38 | 20.98 | 20.27 |
| 191 | 26 | 22.55 | 27.17 | 23.12 | 22.82 | 22.19 |
| 192 | 26 | 23.85 | 27.32 | 24.18 | 24.01 | 23.5 |
| 193 | 26 | 23.9 | 27.13 | 24.1 | 23.99 | 23.53 |
| 194 | 26 | 23.09 | 26.93 | 23.21 | 23.15 | 22.72 |
| 195 | 26 | 23.36 | 26.92 | 23.44 | 23.4 | 23.03 |
| 196 | 26 | 22.73 | 26.95 | 22.78 | 22.75 | 22.27 |
| 197 | 26 | 23.29 | 26.91 | 23.32 | 23.3 | 22.88 |
| 198 | 26 | 23.72 | 27.03 | 23.74 | 23.73 | 23.4 |
| 199 | 26 | 22.34 | 27.09 | 22.36 | 22.35 | 21.99 |
| 200 | 27 | 24.3 | 30.78 | 24.78 | 24.52 | 23.57 |
| 201 | 27 | 24.41 | 30.79 | 24.88 | 24.63 | 23.71 |
| 202 | 27 | 24.58 | 30.82 | 25.03 | 24.79 | 23.89 |
| 203 | 27 | 24.74 | 30.84 | 25.17 | 24.94 | 24.06 |
| 204 | 27 | 24.79 | 30.84 | 25.21 | 24.98 | 24.13 |
| 205 | 27 | 24.64 | 30.83 | 25.05 | 24.83 | 24 |
| 206 | 27 | 24.73 | 30.8 | 25.12 | 24.91 | 24.1 |
| 207 | 27 | 24.87 | 30.82 | 25.25 | 25.04 | 24.25 |
| 208 | 27 | 24.94 | 30.84 | 25.31 | 25.11 | 24.34 |
| 209 | 27 | 25.05 | 30.87 | 25.4 | 25.21 | 24.45 |
| 210 | 27 | 25.29 | 30.92 | 25.63 | 25.45 | 24.71 |
| 211 | 27 | 25.45 | 30.95 | 25.79 | 25.61 | 24.89 |
| 212 | 27 | 25.6 | 30.98 | 25.93 | 25.75 | 25.06 |
| 213 | 27 | 25.74 | 31 | 26.06 | 25.89 | 25.21 |
| 214 | 27 | 25.88 | 31.03 | 26.19 | 26.03 | 25.36 |
| 215 | 27 | 26.05 | 31.05 | 26.34 | 26.19 | 25.53 |
| 216 | 28 | 19.33 | 19.59 | 19.33 | 19.33 | 19.27 |
| 217 | 28 | 22.02 | 23.19 | 22.02 | 22.02 | 21.91 |
| 218 | 28 | 24.98 | 25.76 | 24.98 | 24.98 | 24.9 |

| Q2ESHADE Identification Number | Reach Identification Number | Baseline Conditions (Calibration) | Topographic Shading | 18 Inch DBH | 24 Inch DBH | 48 Inch DBH |
|---|---|---|---|---|---|---|
| 219 | 28 | 25.72 | 26.8 | 25.72 | 25.72 | 25.65 |
| 220 | 28 | 26.14 | 27.37 | 26.14 | 26.14 | 26.08 |
| 221 | 28 | 27.12 | 28.07 | 27.12 | 27.12 | 27.03 |
| 222 | 29 | 26.02 | 30.71 | 26.29 | 26.15 | 25.54 |
| 223 | 29 | 25.94 | 30.52 | 26.2 | 26.06 | 25.47 |
| 224 | 29 | 25.84 | 30.33 | 26.1 | 25.96 | 25.39 |
| 225 | 29 | 25.84 | 30.18 | 26.09 | 25.95 | 25.4 |
| 226 | 29 | 25.84 | 30.04 | 26.09 | 25.96 | 25.42 |
| 227 | 29 | 25.85 | 29.91 | 26.08 | 25.96 | 25.44 |
| 228 | 29 | 25.86 | 29.79 | 26.08 | 25.96 | 25.46 |
| 229 | 29 | 25.86 | 29.68 | 26.08 | 25.96 | 25.47 |

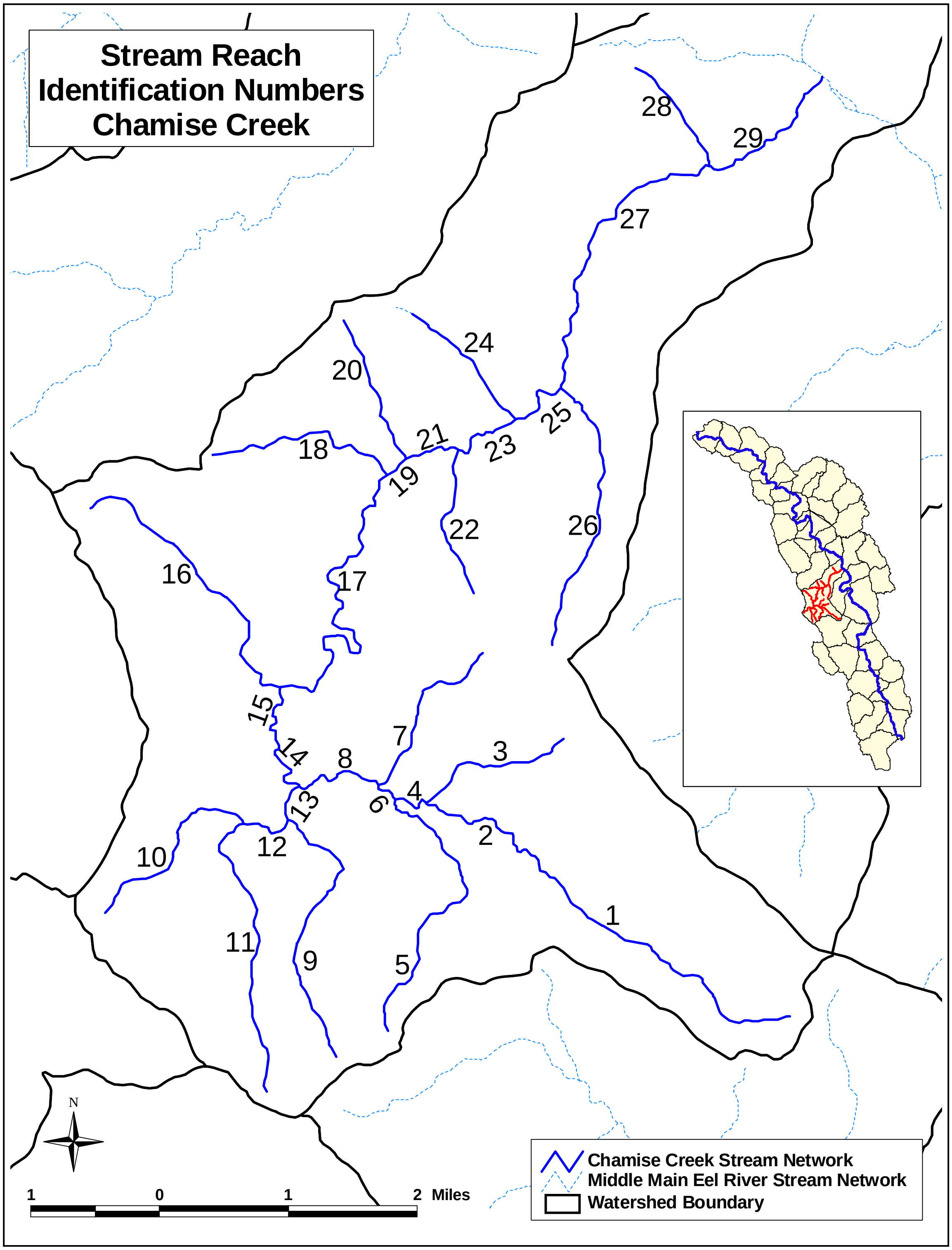


Figure A-22.  Stream reach identification numbers in Chamise Creek

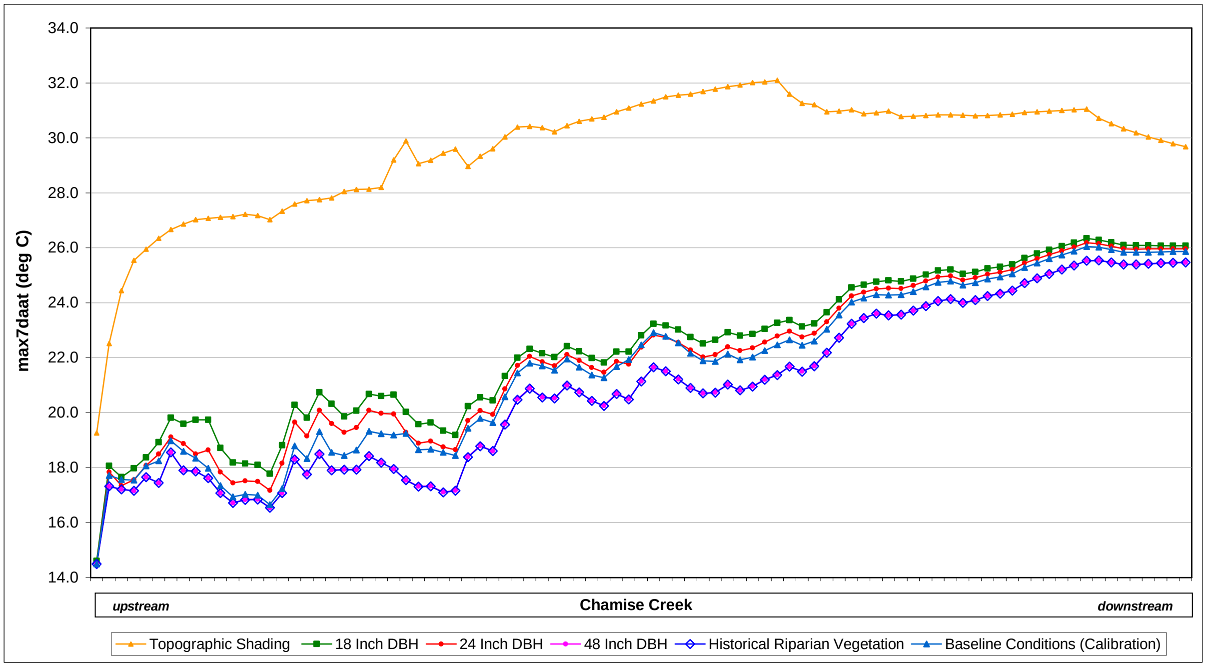


Figure A-23.  Max7daat values for vegetation scenarios at each SSP on Chamise Creek

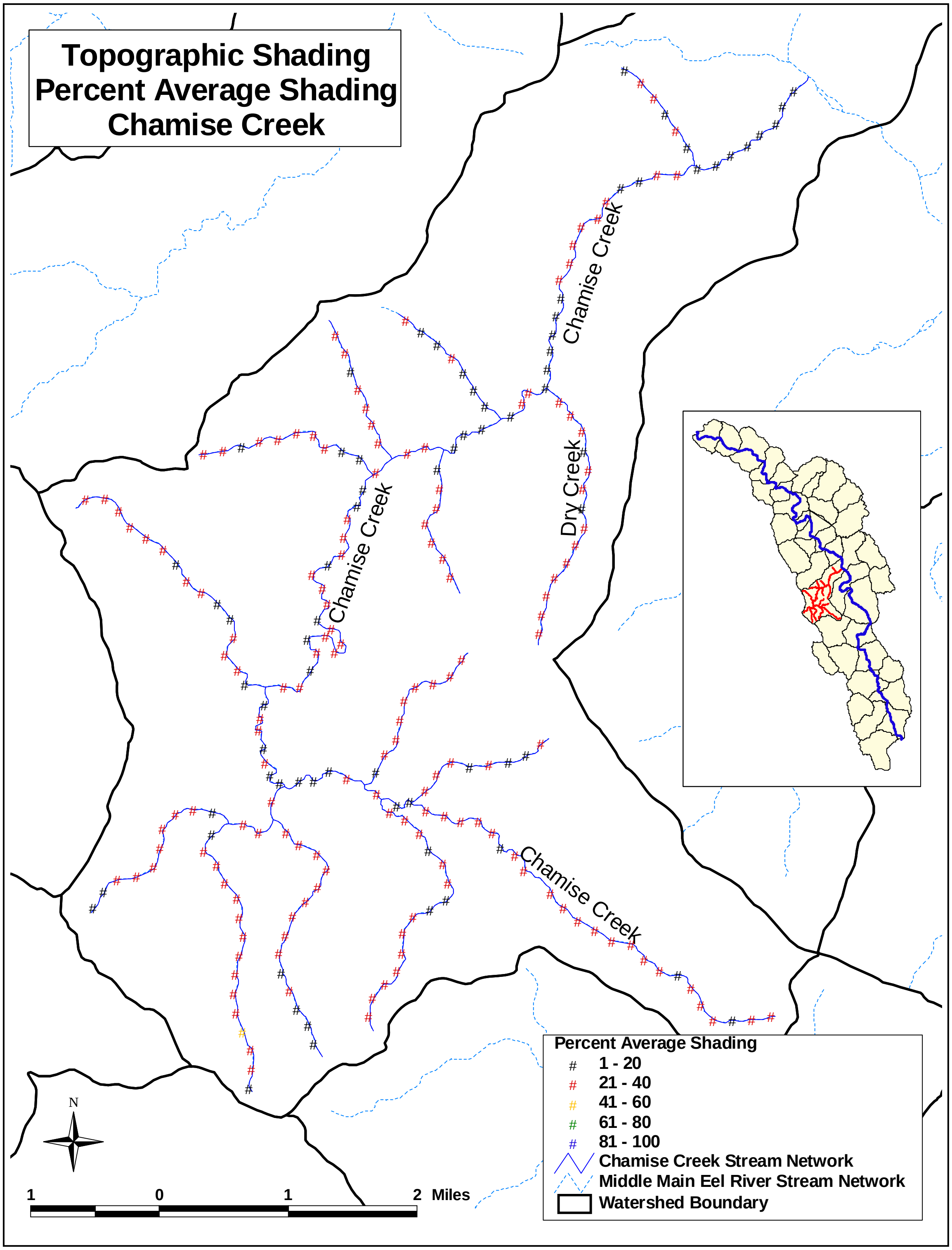


Figure A-24.  Percent average shading for the topographic shading scenario at Chamise Creek

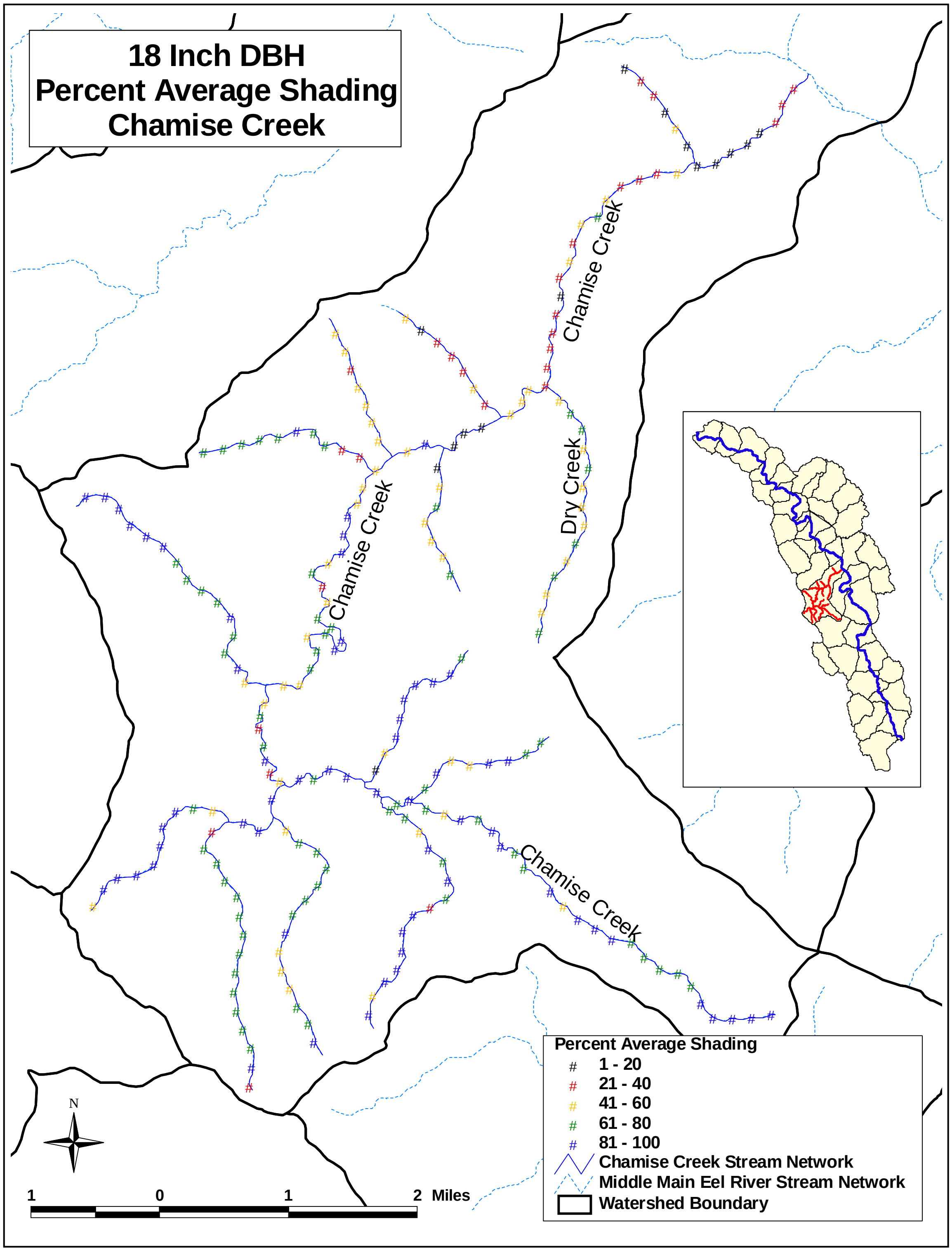


Figure A-25. Percent average shading for the 18 inch DBH vegetation scenario at Chamise Creek

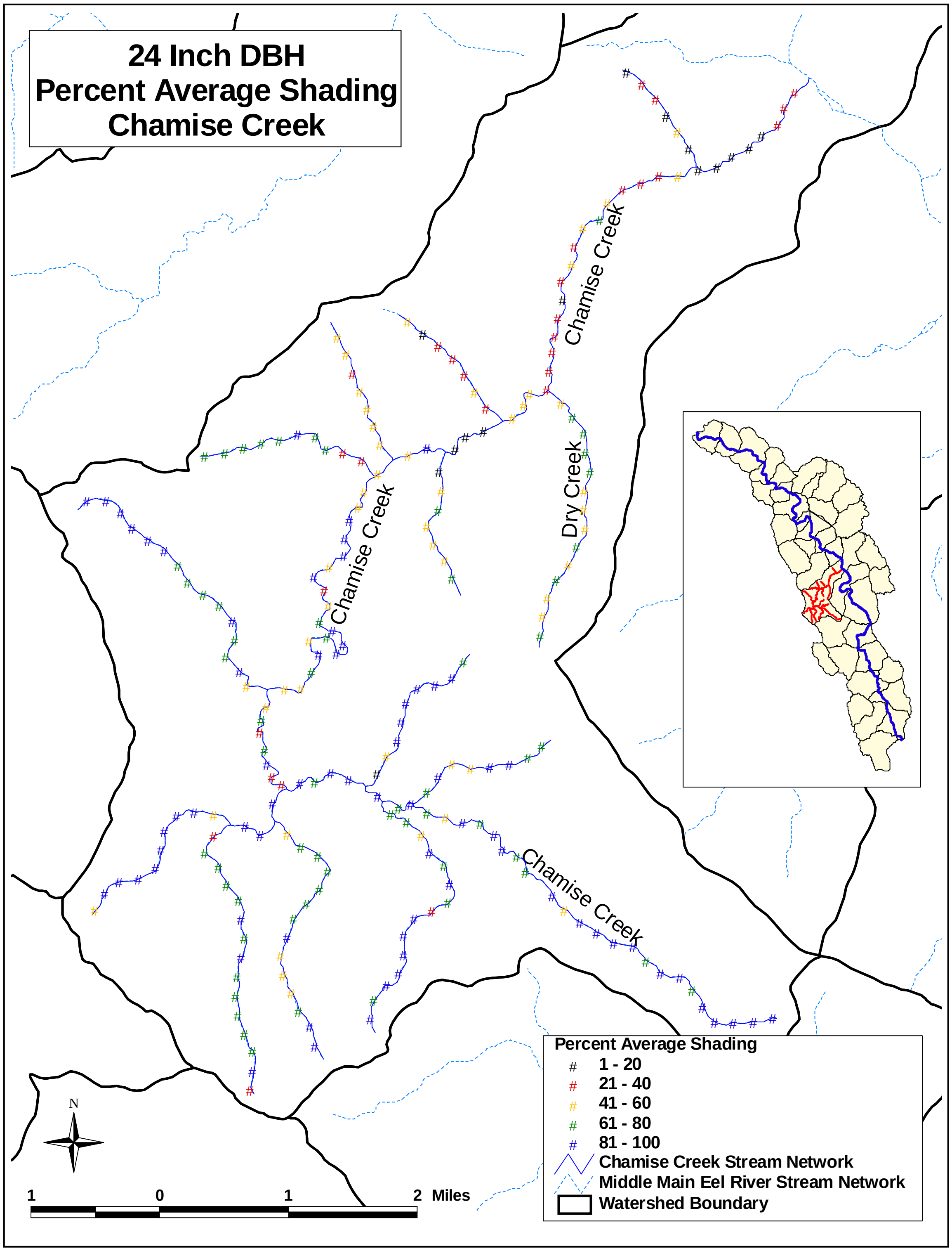


Figure A-26. Percent average shading for the 24 inch DBH vegetation scenario at Chamise Creek

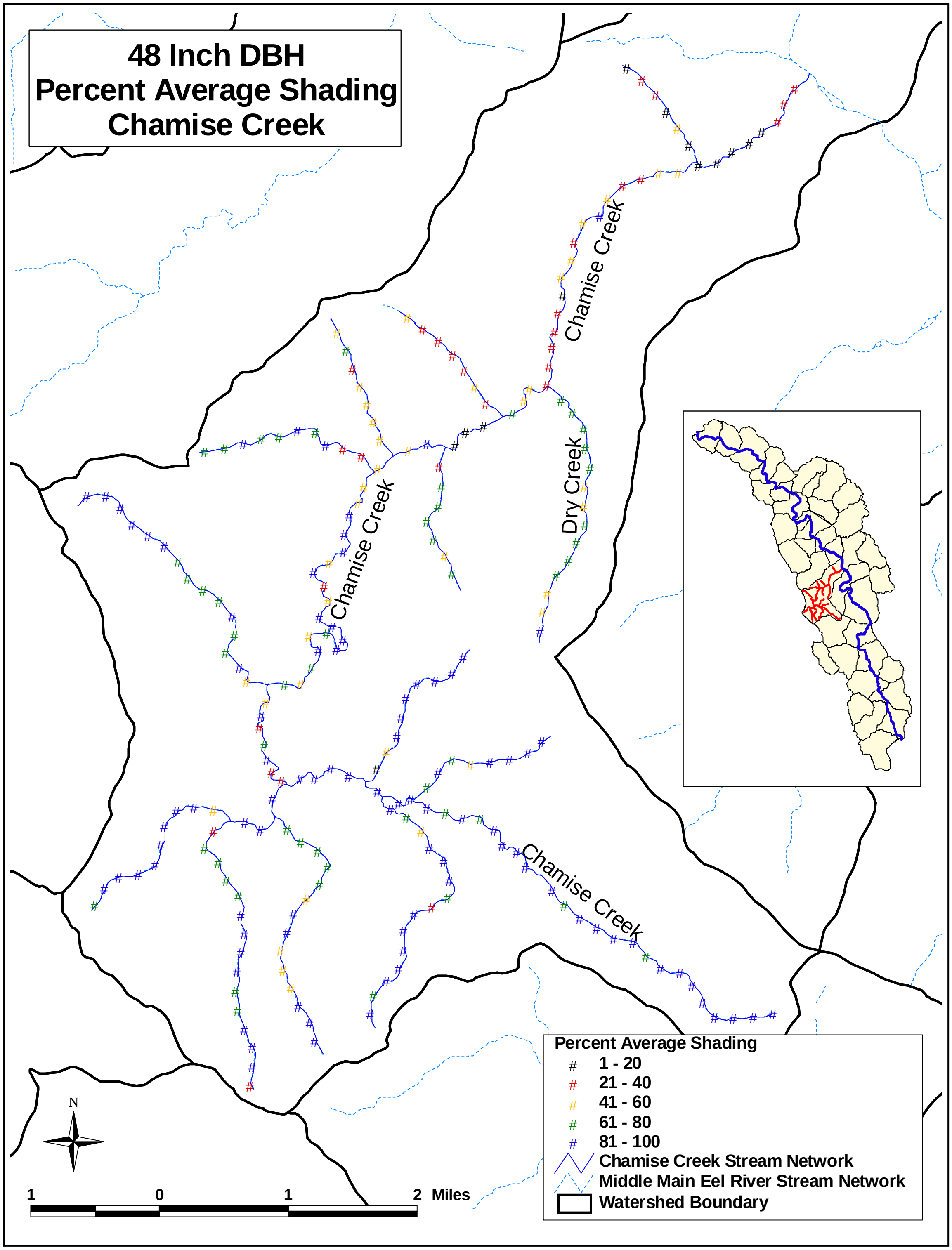


Figure A-27. Percent average shading for the 48 inch DBH vegetation scenario at Chamise Creek

### A.4.3 Dobbyn Creek Q2ESHADE Model

As shown in Table A-1, the Q2SHADE model was run for the Dobbyn Creek stream network. Subsequent to the initial model run using the baseline conditions described in Sections A.2.1.1, A.2.1.2, A.2.2.1, and A.3.2, model calibration was performed. The 2003 temperature monitoring data from the Humboldt County RCD were used for calibration. Three stations were available in the Dobbyn Creek watershed (Figure A-28). Max7daats were calculated for the temperature monitoring data for July 15, 2003 through August 14, 2003 and were compared with the max7daats predicted by the model for the same time period. Model calibration results are presented in Table A-22. The average percent error was -1.12% for Dobbyn Creek (percent error ranged from –2.60% to 1.61%).

Table A-22. Model Calibration Results for Dobbyn Creek

| Station ID | Location | Observed Temperature max7daat (deg C) | Predicted Temperature max7daat (deg C) | Percent Error |
|---|---|---|---|---|
| 1437 | South Dobbyn Creek | 23.57 | 23.39 | -0.76% |
| 1595 | North Dobbyn Creek | 21.50 | 21.23 | -1.25% |
| 1667 | Conley Creek | 18.83 | 18.48 | -1.84% |

Table A-23 presents the number of stream miles associated with different max7daat categories, the solar radiation, and the average percent shade for baseline conditions (see Sections A.2.1.1, A.2.1.2, A.2.2.1, and A.3.2) in Dobbyn Creek. In addition, Figure A-29and Figure A-30 illustrate the average percent shading and max7daat values for baseline conditions throughout the Dobbyn Creek watershed.

Table A-23. Baseline Model Results for Dobbyn Creek

| Temperature Category | Dobbyn Creek | |
|---|---|---|
| | Stream Miles | % of Total |
| Good (max7daat < 15°C) | 3.1 | 5% |
| Fair (15°C < max7daat < 17°C) | 5.0 | 8% |
| Marginal (17°C < max7daat < 19°C) | 13.0 | 21% |
| Stressful (19.1°C < max7daat < 20°C) | 8.4 | 13% |
| Stressful (20.1°C < max7daat < 21°C) | 8.4 | 13% |
| Stressful (21.1°C < max7daat < 22°C) | 6.8 | 11% |
| Stressful (22.1°C < max7daat < 23°C) | 5.6 | 9% |
| Stressful (23.1°C < max7daat < 24°C) | 4.7 | 7% |
| Lethal (max7daat > 24°C) | 7.8 | 12% |
| TOTAL | 62.8 | 100% |
| Solar Radiation (Langley/day) | 299.8 | |
| % Shade | 58.4% | |

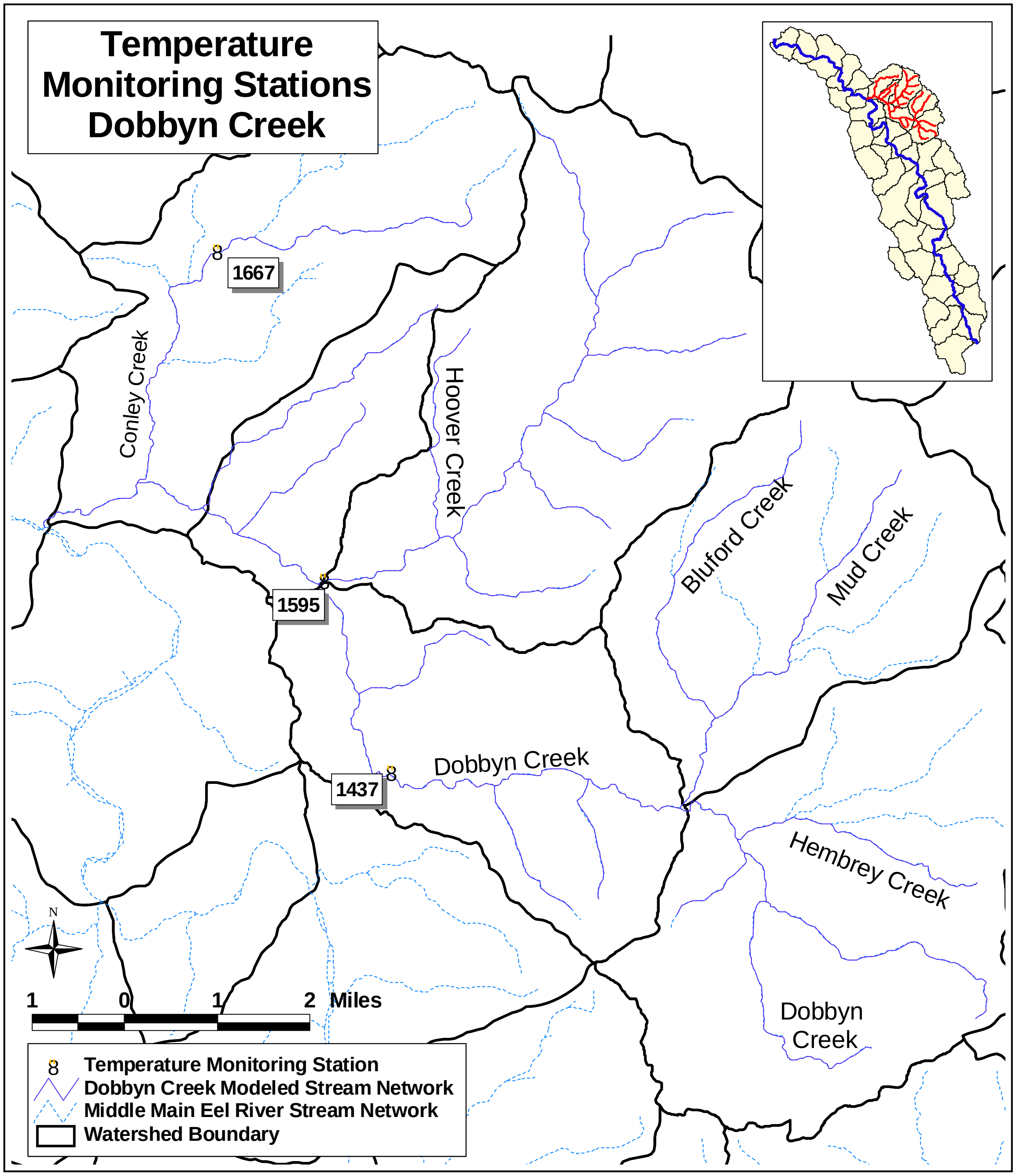


Figure A-28.  Monitoring stations used for calibration in the Dobbyn Creek watersheds

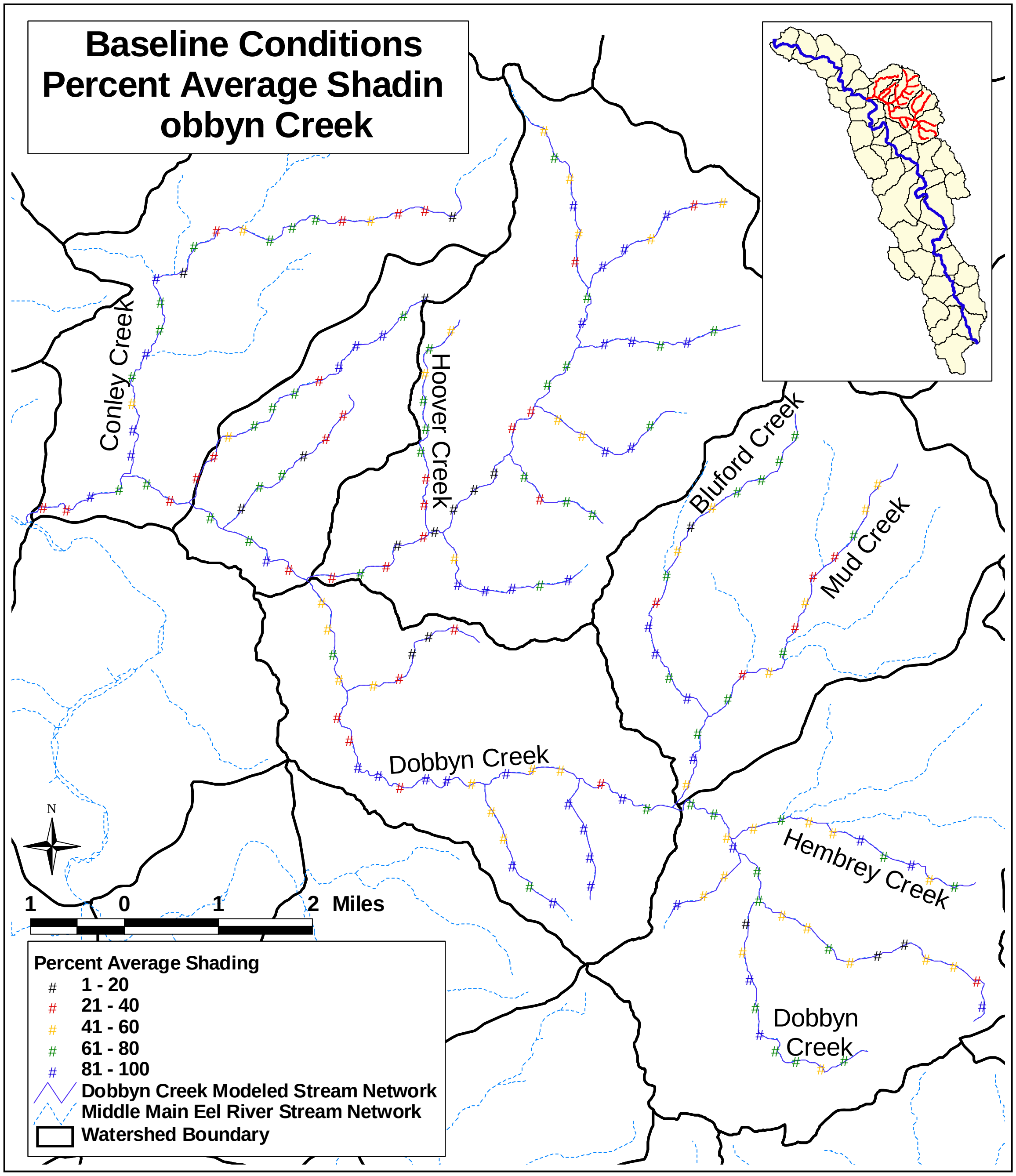


Figure A-29. Percent average shading for baseline conditions at Dobbyn Creek

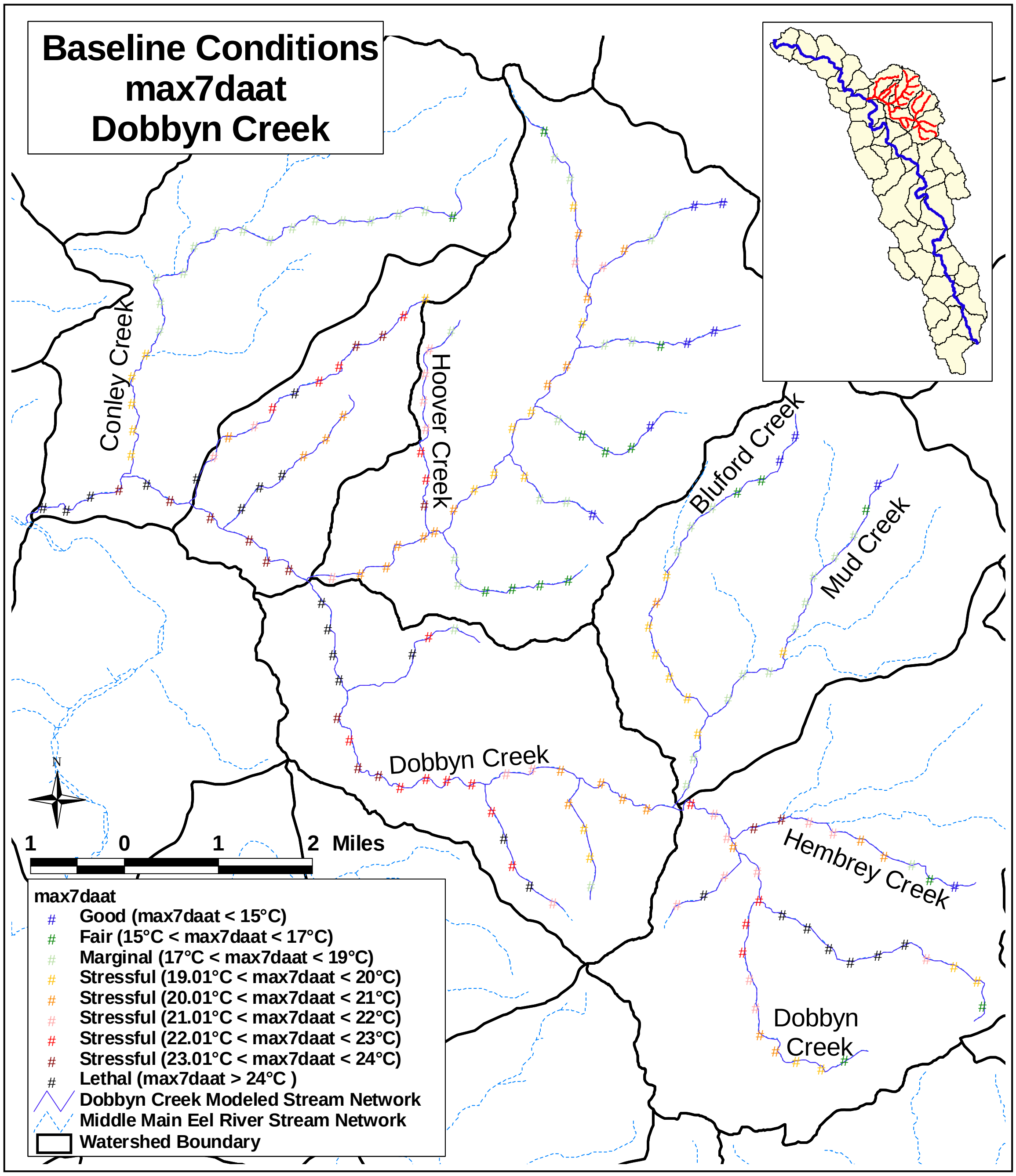


Figure A-30. Max7daat values for baseline conditions at Dobbyn Creek

Using the calibrated model, the five vegetation scenarios described in Section A.4 were simulated: no vegetation (topographic shading only), 18 inch DBH, 24 inch DBH, and 48 inch DBH (Table A-15). Table A-24 and Table A-25 present model results for the vegetation scenarios at Dobbyn Creek, as compared to the baseline conditions (see Sections A.2.1.1, A.2.1.2, A.2.2.1, and A.3.2). Table A-24 includes the stream miles associated with different max7daat categories, the solar radiation, and average percent shading, while Table A-25 identifies the specific max7daat value associated with each SSP along Dobbyn Creek (see Figure A-32 for an illustration of the stream reach identification numbers in Dobbyn Creek). Figure A-31 illustrates the stream miles associated with each vegetation scenario and Figure A-33 graphically compares max7daats for the baseline conditions and the vegetation scenarios presented in Table A-25. Figure A-34 through Figure A-37 illustrate the average percent shading at each SSP for vegetation scenarios described above (Table A-15).

Table A-24. Model Results for Vegetation Scenarios at Dobbyn Creek

| Temperature Category | Baseline Conditions | | Topographic Shading | 18 Inch DBH | 24 Inch DBH | 48 Inch DBH | |
|---|---|---|---|---|---|---|---|
| | Stream Miles | % of Total | Stream Miles | Stream Miles | Stream Miles | Stream Miles | % of Total |
| Good (max7daat < 15°C) | 3.1 | 5% | 0.0 | 2.2 | 2.2 | 3.1 | 5% |
| Fair (15°C < max7daat < 17°C) | 5.0 | 8% | 1.9 | 3.4 | 5.0 | 7.8 | 12% |
| Marginal (17°C < max7daat < 19°C) | 13.0 | 21% | 2.8 | 14.0 | 14.3 | 16.5 | 26% |
| Stressful (19.1°C < max7daat < 20°C) | 8.4 | 13% | 2.5 | 5.0 | 6.2 | 8.1 | 13% |
| Stressful (20.1°C < max7daat < 21°C) | 8.4 | 13% | 5.0 | 10.6 | 9.0 | 9.0 | 14% |
| Stressful (21.1°C < max7daat < 22°C) | 6.8 | 11% | 5.9 | 7.5 | 7.1 | 3.7 | 6% |
| Stressful (22.1°C < max7daat < 23°C) | 5.6 | 9% | 1.6 | 4.7 | 5.0 | 6.2 | 10% |
| Stressful (23.1°C < max7daat < 24°C) | 4.7 | 7% | 5.3 | 5.3 | 5.9 | 3.7 | 6% |
| Lethal (max7daat > 24°C ) | 7.8 | 12% | 37.9 | 10.3 | 8.1 | 4.7 | 7% |
| TOTAL | 62.8 | 100% | 62.9 | 63.0 | 62.8 | 62.8 | 100% |
| Solar Radiation (Langley/day) | 299.8 | | 607.9 | 322.1 | 308.5 | 265.0 | |
| % Shade | 58.4% | | 16.1% | 55.4% | 57.3% | 63.2% | |

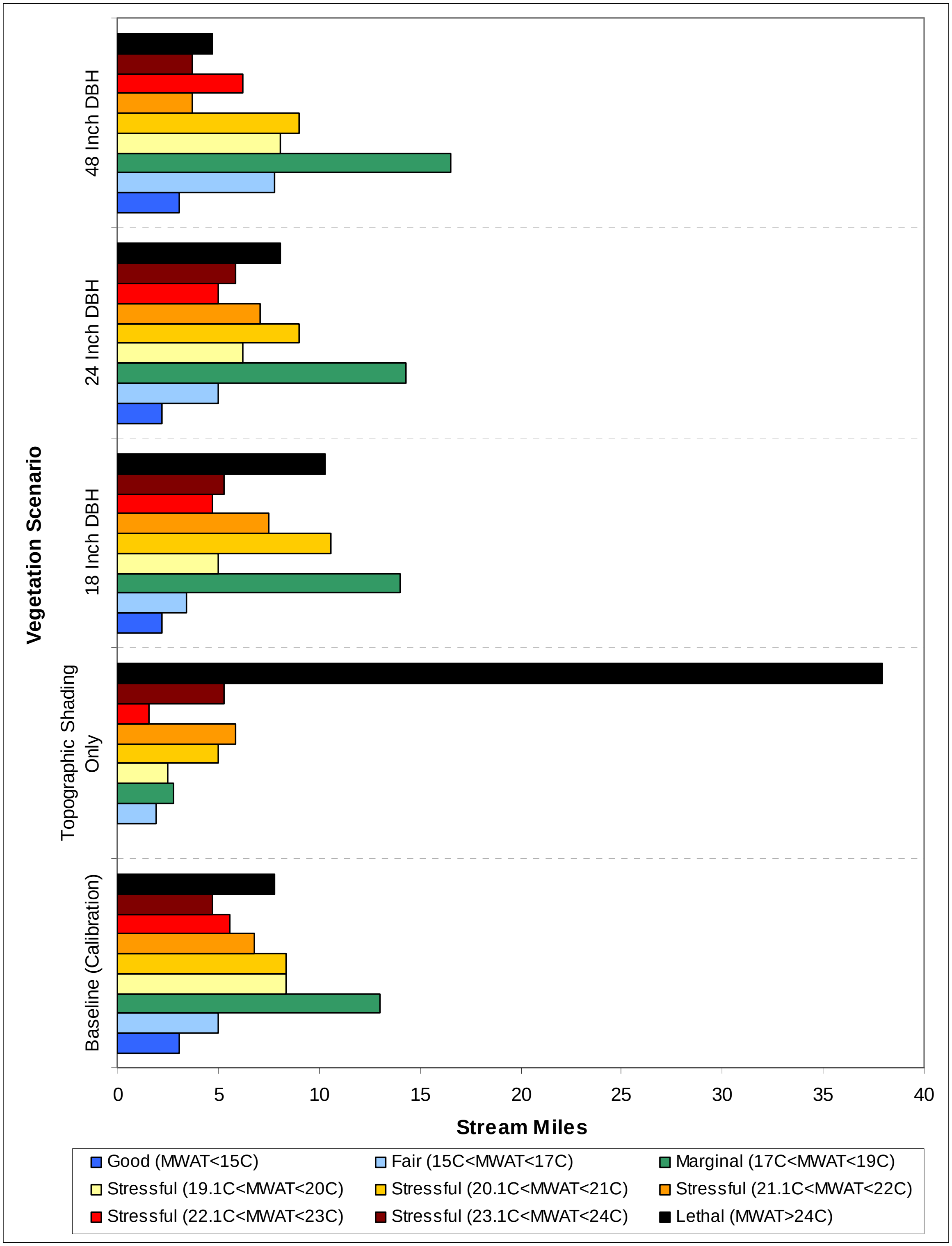


Figure A-31.  Stream miles associated with each vegetation scenario in Dobbyn Creek

Table A-25.  Max7daat Values (degC) for Vegetation Scenarios at Each SSP Along Dobbyn Creek

| Q2ESHADE Identification Number | Reach Identification Number | Baseline Conditions (Calibration) | Topographic Shading | 18 Inch DBH | 24 Inch DBH | 48 Inch DBH |
|---|---|---|---|---|---|---|
| 1 | 1 | 16.98 | 17.18 | 17.03 | 17.01 | 16.89 |
| 2 | 1 | 19.12 | 21.42 | 19.24 | 19.19 | 18.77 |
| 3 | 1 | 19.16 | 24.39 | 19.20 | 18.98 | 18.24 |
| 4 | 1 | 20.52 | 26.39 | 20.67 | 20.46 | 19.49 |
| 5 | 1 | 20.55 | 26.72 | 20.70 | 20.35 | 19.39 |
| 6 | 1 | 21.10 | 28.10 | 21.35 | 21.05 | 19.93 |
| 7 | 1 | 21.47 | 29.14 | 21.79 | 21.55 | 20.55 |
| 8 | 1 | 22.80 | 30.00 | 23.03 | 22.86 | 22.05 |
| 9 | 1 | 22.87 | 30.62 | 23.04 | 22.90 | 22.21 |
| 10 | 2 | 16.24 | 18.83 | 17.08 | 16.84 | 16.07 |
| 11 | 2 | 19.77 | 23.51 | 20.75 | 20.38 | 18.85 |
| 12 | 2 | 19.71 | 26.03 | 21.24 | 20.62 | 18.89 |
| 13 | 2 | 21.53 | 27.96 | 22.51 | 22.13 | 20.79 |
| 14 | 2 | 25.27 | 29.26 | 25.88 | 25.65 | 24.75 |
| 15 | 2 | 27.72 | 30.13 | 28.10 | 27.97 | 27.39 |
| 16 | 2 | 27.29 | 30.60 | 27.57 | 27.48 | 26.71 |
| 17 | 2 | 27.28 | 31.02 | 27.33 | 27.23 | 26.39 |
| 18 | 2 | 28.39 | 31.17 | 28.46 | 28.40 | 27.90 |
| 19 | 2 | 25.57 | 30.95 | 25.87 | 25.71 | 24.94 |
| 20 | 3 | 22.22 | 28.85 | 22.33 | 22.18 | 21.52 |
| 21 | 3 | 21.59 | 28.26 | 21.70 | 21.61 | 21.12 |
| 22 | 4 | 21.76 | 25.32 | 22.00 | 21.89 | 21.10 |
| 23 | 4 | 25.11 | 30.73 | 26.10 | 25.65 | 23.91 |
| 24 | 4 | 21.51 | 30.81 | 22.36 | 21.92 | 20.53 |
| 25 | 5 | 20.14 | 27.93 | 20.47 | 20.23 | 19.50 |
| 26 | 6 | 14.41 | 16.24 | 14.41 | 14.41 | 14.26 |
| 27 | 6 | 15.86 | 20.25 | 16.27 | 16.04 | 15.35 |
| 28 | 6 | 18.31 | 23.20 | 18.81 | 18.54 | 17.53 |
| 29 | 6 | 20.74 | 25.41 | 21.26 | 21.04 | 20.10 |
| 30 | 6 | 20.58 | 27.03 | 21.53 | 21.24 | 19.95 |
| 31 | 6 | 21.79 | 28.30 | 22.51 | 22.29 | 20.98 |
| 32 | 6 | 21.40 | 29.24 | 22.55 | 22.13 | 20.59 |
| 33 | 6 | 23.36 | 30.02 | 23.93 | 23.50 | 22.07 |
| 34 | 6 | 23.58 | 30.58 | 23.93 | 23.44 | 22.01 |
| 35 | 7 | 21.26 | 28.75 | 21.52 | 21.22 | 20.14 |
| 36 | 7 | 21.30 | 28.89 | 21.60 | 21.31 | 20.11 |
| 37 | 7 | 22.26 | 29.01 | 22.60 | 22.34 | 21.24 |
| 38 | 8 | 13.91 | 16.38 | 14.29 | 14.08 | 13.40 |
| 39 | 8 | 16.30 | 18.29 | 16.47 | 16.29 | 15.58 |
| 40 | 8 | 17.06 | 19.29 | 17.18 | 17.06 | 16.55 |
| 41 | 8 | 17.09 | 19.94 | 17.24 | 17.12 | 16.56 |
| 42 | 8 | 18.09 | 20.42 | 18.25 | 18.15 | 17.67 |
| 43 | 8 | 18.32 | 20.77 | 18.45 | 18.38 | 17.98 |
| 44 | 8 | 18.57 | 21.00 | 18.68 | 18.62 | 18.29 |
| 45 | 8 | 19.05 | 21.25 | 19.09 | 18.99 | 18.51 |
| 46 | 8 | 18.73 | 21.43 | 18.75 | 18.65 | 18.12 |
| 47 | 8 | 18.77 | 21.59 | 18.79 | 18.70 | 18.16 |
| 48 | 8 | 18.79 | 21.67 | 18.83 | 18.74 | 18.23 |
| 49 | 9 | 13.47 | 17.69 | 14.69 | 14.23 | 13.51 |
| 50 | 9 | 14.79 | 20.33 | 16.14 | 15.50 | 14.39 |
| 51 | 9 | 15.46 | 21.78 | 17.07 | 16.47 | 15.14 |
| 52 | 9 | 15.80 | 22.74 | 17.25 | 16.64 | 15.23 |
| 53 | 9 | 17.67 | 23.38 | 18.83 | 18.32 | 17.10 |
| 54 | 9 | 17.86 | 23.74 | 18.65 | 18.11 | 16.69 |
| 55 | 9 | 18.59 | 24.02 | 19.17 | 18.70 | 17.32 |
| 56 | 9 | 19.90 | 24.33 | 20.38 | 19.98 | 18.86 |
| 57 | 9 | 20.10 | 24.48 | 20.49 | 20.17 | 19.21 |
| 58 | 9 | 19.97 | 24.57 | 20.32 | 20.05 | 19.22 |
| 59 | 9 | 19.74 | 24.71 | 20.20 | 19.96 | 19.03 |
| 60 | 9 | 19.69 | 24.85 | 20.20 | 19.89 | 19.00 |
| 61 | 9 | 19.66 | 24.93 | 20.15 | 19.87 | 18.96 |
| 62 | 10 | 19.16 | 22.82 | 19.34 | 19.21 | 18.60 |
| 63 | 10 | 18.85 | 22.92 | 19.11 | 18.91 | 18.29 |
| 64 | 10 | 18.84 | 23.02 | 19.08 | 18.90 | 18.33 |
| 65 | 11 | 20.60 | 25.61 | 20.87 | 20.67 | 19.90 |
| 66 | 11 | 20.54 | 26.24 | 20.75 | 20.54 | 19.78 |
| 67 | 11 | 20.80 | 26.83 | 21.01 | 20.82 | 20.12 |
| 68 | 12 | 17.49 | 26.34 | 18.23 | 17.84 | 16.55 |
| 69 | 12 | 19.78 | 31.13 | 20.81 | 20.24 | 18.40 |
| 70 | 12 | 19.83 | 32.64 | 21.20 | 20.50 | 17.98 |
| 71 | 12 | 20.73 | 33.30 | 21.04 | 20.46 | 18.08 |

| Q2ESHADE Identification Number | Reach Identification Number | Baseline Conditions (Calibration) | Topographic Shading | 18 Inch DBH | 24 Inch DBH | 48 Inch DBH |
|---|---|---|---|---|---|---|
| 72 | 13 | 20.65 | 27.37 | 20.88 | 20.67 | 19.97 |
| 73 | 13 | 21.08 | 27.90 | 21.31 | 21.10 | 20.40 |
| 74 | 13 | 21.42 | 28.46 | 21.63 | 21.44 | 20.80 |
| 75 | 14 | 21.74 | 26.87 | 21.77 | 21.75 | 21.59 |
| 76 | 14 | 26.02 | 30.88 | 26.04 | 26.03 | 25.69 |
| 77 | 14 | 22.67 | 32.90 | 24.34 | 23.30 | 21.57 |
| 78 | 14 | 24.67 | 33.61 | 24.99 | 24.16 | 20.91 |
| 79 | 14 | 22.91 | 33.92 | 25.31 | 23.42 | 20.02 |
| 80 | 15 | 22.09 | 29.08 | 22.44 | 22.21 | 21.44 |
| 81 | 15 | 22.86 | 29.74 | 23.33 | 23.07 | 22.18 |
| 82 | 15 | 22.68 | 30.30 | 23.23 | 22.95 | 22.03 |
| 83 | 15 | 22.64 | 30.84 | 23.20 | 22.91 | 21.92 |
| 84 | 15 | 23.39 | 31.34 | 23.93 | 23.65 | 22.68 |
| 85 | 15 | 23.17 | 31.79 | 23.75 | 23.45 | 22.42 |
| 86 | 15 | 22.96 | 32.17 | 23.61 | 23.27 | 22.15 |
| 87 | 15 | 23.38 | 32.54 | 24.08 | 23.69 | 22.56 |
| 88 | 16 | 18.16 | 20.91 | 18.16 | 18.16 | 18.07 |
| 89 | 16 | 22.72 | 25.99 | 22.10 | 22.09 | 21.96 |
| 90 | 16 | 27.33 | 29.40 | 26.93 | 26.93 | 26.77 |
| 91 | 16 | 30.35 | 31.66 | 30.09 | 30.09 | 29.98 |
| 92 | 16 | 31.35 | 32.90 | 31.18 | 31.18 | 31.04 |
| 93 | 17 | 24.10 | 32.88 | 24.74 | 24.38 | 23.30 |
| 94 | 17 | 24.59 | 33.26 | 25.19 | 24.84 | 23.78 |
| 95 | 17 | 24.59 | 33.59 | 25.18 | 24.84 | 23.75 |
| 96 | 17 | 25.12 | 33.90 | 25.67 | 25.36 | 24.33 |
| 97 | 18 | 13.51 | 17.30 | 14.27 | 14.04 | 13.53 |
| 98 | 18 | 14.73 | 21.07 | 15.52 | 15.27 | 14.70 |
| 99 | 18 | 16.58 | 23.82 | 17.58 | 17.19 | 16.15 |
| 100 | 18 | 17.02 | 25.80 | 18.40 | 17.90 | 16.56 |
| 101 | 18 | 18.69 | 27.37 | 20.18 | 19.76 | 18.62 |
| 102 | 19 | 13.41 | 17.28 | 14.00 | 13.84 | 13.30 |
| 103 | 19 | 14.79 | 21.02 | 15.81 | 15.55 | 14.53 |
| 104 | 19 | 17.43 | 23.77 | 18.05 | 18.02 | 17.09 |
| 105 | 19 | 17.82 | 25.65 | 18.73 | 18.47 | 17.12 |
| 106 | 19 | 20.82 | 27.21 | 21.53 | 21.32 | 20.25 |
| 107 | 19 | 21.77 | 28.33 | 22.28 | 21.97 | 20.49 |
| 108 | 20 | 15.78 | 16.87 | 15.73 | 15.56 | 15.22 |
| 109 | 20 | 17.81 | 20.41 | 17.71 | 17.35 | 16.57 |
| 110 | 20 | 17.61 | 21.95 | 18.19 | 17.64 | 16.62 |
| 111 | 20 | 19.63 | 24.20 | 19.90 | 19.46 | 18.79 |
| 112 | 20 | 20.08 | 25.87 | 20.14 | 19.45 | 18.61 |
| 113 | 20 | 21.57 | 27.22 | 21.65 | 21.09 | 20.53 |
| 114 | 21 | 20.16 | 25.90 | 20.65 | 20.28 | 19.26 |
| 115 | 21 | 19.96 | 25.46 | 20.27 | 19.92 | 18.77 |
| 116 | 22 | 20.16 | 26.67 | 20.60 | 20.19 | 18.95 |
| 117 | 22 | 20.45 | 27.43 | 21.04 | 20.51 | 19.22 |
| 118 | 23 | 14.36 | 15.96 | 14.45 | 14.32 | 13.99 |
| 119 | 23 | 16.75 | 19.05 | 17.18 | 16.94 | 16.38 |
| 120 | 23 | 16.62 | 21.54 | 17.26 | 16.94 | 16.34 |
| 121 | 23 | 16.96 | 23.48 | 18.04 | 17.53 | 16.58 |
| 122 | 23 | 18.18 | 25.09 | 19.30 | 18.78 | 17.69 |
| 123 | 24 | 19.55 | 25.07 | 20.08 | 19.68 | 18.72 |
| 124 | 24 | 19.42 | 24.02 | 19.83 | 19.51 | 18.72 |
| 125 | 25 | 14.59 | 16.57 | 14.60 | 14.59 | 14.49 |
| 126 | 25 | 17.58 | 20.04 | 17.76 | 17.49 | 17.03 |
| 127 | 25 | 18.47 | 22.64 | 18.81 | 18.51 | 17.77 |
| 128 | 25 | 19.63 | 24.62 | 20.03 | 19.80 | 18.85 |
| 129 | 26 | 19.66 | 23.72 | 20.03 | 19.74 | 19.03 |
| 130 | 26 | 19.93 | 23.52 | 20.30 | 20.04 | 19.38 |
| 131 | 26 | 20.19 | 23.38 | 20.52 | 20.29 | 19.67 |
| 132 | 27 | 15.05 | 16.20 | 15.37 | 15.30 | 15.08 |
| 133 | 27 | 15.67 | 19.42 | 16.13 | 16.01 | 15.46 |
| 134 | 27 | 15.99 | 21.93 | 16.44 | 16.31 | 15.72 |
| 135 | 27 | 16.25 | 23.92 | 16.74 | 16.57 | 15.93 |
| 136 | 27 | 17.25 | 25.60 | 17.84 | 17.58 | 16.75 |
| 137 | 27 | 17.66 | 26.78 | 18.34 | 18.04 | 16.93 |
| 138 | 28 | 20.09 | 23.07 | 20.39 | 20.20 | 19.65 |
| 139 | 29 | 17.82 | 18.71 | 17.82 | 17.82 | 17.81 |
| 140 | 29 | 21.62 | 22.83 | 21.55 | 21.55 | 21.54 |
| 141 | 29 | 21.76 | 25.14 | 21.49 | 21.28 | 20.92 |
| 142 | 29 | 21.25 | 26.76 | 21.44 | 21.18 | 20.47 |
| 143 | 29 | 21.50 | 27.54 | 21.62 | 21.46 | 20.95 |
| 144 | 29 | 22.59 | 28.09 | 22.67 | 22.57 | 22.17 |

| Q2ESHADE Identification Number | Reach Identification Number | Baseline Conditions (Calibration) | Topographic Shading | 18 Inch DBH | 24 Inch DBH | 48 Inch DBH |
|---|---|---|---|---|---|---|
| 145 | 29 | 22.46 | 28.46 | 22.50 | 22.32 | 21.99 |
| 146 | 29 | 23.73 | 28.73 | 23.49 | 23.37 | 23.37 |
| 147 | 30 | 20.47 | 23.59 | 20.74 | 20.57 | 20.06 |
| 148 | 30 | 20.46 | 23.74 | 20.75 | 20.56 | 20.05 |
| 149 | 30 | 20.72 | 23.88 | 21.00 | 20.82 | 20.31 |
| 150 | 30 | 20.99 | 24.02 | 21.23 | 21.06 | 20.57 |
| 151 | 30 | 21.23 | 24.22 | 21.49 | 21.32 | 20.81 |
| 152 | 31 | 23.41 | 30.02 | 23.83 | 23.58 | 22.76 |
| 153 | 31 | 23.21 | 30.24 | 23.66 | 23.40 | 22.57 |
| 154 | 31 | 23.56 | 30.49 | 24.02 | 23.76 | 22.94 |
| 155 | 32 | 20.93 | 21.01 | 20.93 | 20.93 | 20.93 |
| 156 | 32 | 20.54 | 24.84 | 20.41 | 20.26 | 19.75 |
| 157 | 32 | 20.45 | 26.86 | 20.62 | 20.41 | 19.60 |
| 158 | 32 | 24.58 | 27.91 | 24.61 | 24.50 | 24.05 |
| 159 | 32 | 25.99 | 25.59 | 26.16 | 26.08 | 25.83 |
| 160 | 32 | 26.89 | 27.39 | 26.92 | 26.88 | 26.74 |
| 161 | 33 | 23.75 | 30.79 | 24.15 | 23.86 | 22.90 |
| 162 | 34 | 19.30 | 20.79 | 19.54 | 19.39 | 19.01 |
| 163 | 34 | 22.69 | 24.77 | 23.02 | 22.82 | 22.27 |
| 164 | 34 | 23.41 | 26.75 | 23.59 | 23.48 | 23.12 |
| 165 | 34 | 23.10 | 27.85 | 23.20 | 23.14 | 22.86 |
| 166 | 34 | 22.78 | 28.41 | 22.99 | 22.88 | 22.25 |
| 167 | 34 | 22.17 | 28.84 | 22.81 | 22.52 | 20.87 |
| 168 | 34 | 24.59 | 29.25 | 25.31 | 24.97 | 23.21 |
| 169 | 34 | 22.75 | 29.50 | 23.35 | 23.06 | 21.58 |
| 170 | 34 | 21.46 | 29.39 | 22.12 | 21.80 | 20.52 |
| 171 | 34 | 20.24 | 29.52 | 20.85 | 20.50 | 19.47 |
| 172 | 34 | 21.20 | 29.50 | 21.58 | 21.37 | 20.56 |
| 173 | 34 | 24.86 | 29.74 | 25.28 | 25.05 | 24.21 |
| 174 | 35 | 23.83 | 30.93 | 24.24 | 23.95 | 22.91 |
| 175 | 35 | 24.13 | 31.03 | 24.53 | 24.26 | 23.23 |
| 176 | 36 | 16.66 | 17.68 | 16.86 | 16.79 | 16.67 |
| 177 | 36 | 17.05 | 18.46 | 17.32 | 17.22 | 17.06 |
| 178 | 36 | 17.59 | 19.02 | 17.78 | 17.71 | 17.59 |
| 179 | 36 | 17.80 | 19.39 | 17.94 | 17.89 | 17.78 |
| 180 | 36 | 17.84 | 19.66 | 17.94 | 17.91 | 17.80 |
| 181 | 36 | 17.94 | 19.87 | 18.04 | 18.01 | 17.88 |
| 182 | 36 | 18.02 | 20.07 | 18.15 | 18.09 | 17.94 |
| 183 | 36 | 17.98 | 20.24 | 18.10 | 18.05 | 17.90 |
| 184 | 36 | 18.40 | 20.40 | 18.51 | 18.46 | 18.33 |
| 185 | 36 | 18.48 | 20.54 | 18.60 | 18.54 | 18.41 |
| 186 | 36 | 18.77 | 20.67 | 18.87 | 18.80 | 18.61 |
| 187 | 36 | 18.88 | 20.77 | 18.96 | 18.88 | 18.65 |
| 188 | 36 | 18.86 | 20.88 | 18.94 | 18.88 | 18.63 |
| 189 | 36 | 18.86 | 20.96 | 18.93 | 18.88 | 18.65 |
| 190 | 36 | 18.91 | 21.04 | 18.99 | 18.93 | 18.68 |
| 191 | 36 | 19.05 | 21.12 | 19.13 | 19.07 | 18.83 |
| 192 | 36 | 19.11 | 21.20 | 19.20 | 19.14 | 18.88 |
| 193 | 36 | 19.28 | 21.28 | 19.37 | 19.30 | 19.04 |
| 194 | 36 | 19.42 | 21.36 | 19.49 | 19.44 | 19.18 |
| 195 | 36 | 19.66 | 21.48 | 19.73 | 19.67 | 19.43 |
| 196 | 37 | 23.89 | 30.19 | 24.32 | 24.06 | 23.07 |
| 197 | 37 | 24.21 | 30.41 | 24.70 | 24.44 | 23.38 |
| 198 | 37 | 24.06 | 30.60 | 24.59 | 24.31 | 23.25 |
| 199 | 37 | 24.05 | 30.77 | 24.59 | 24.31 | 23.26 |

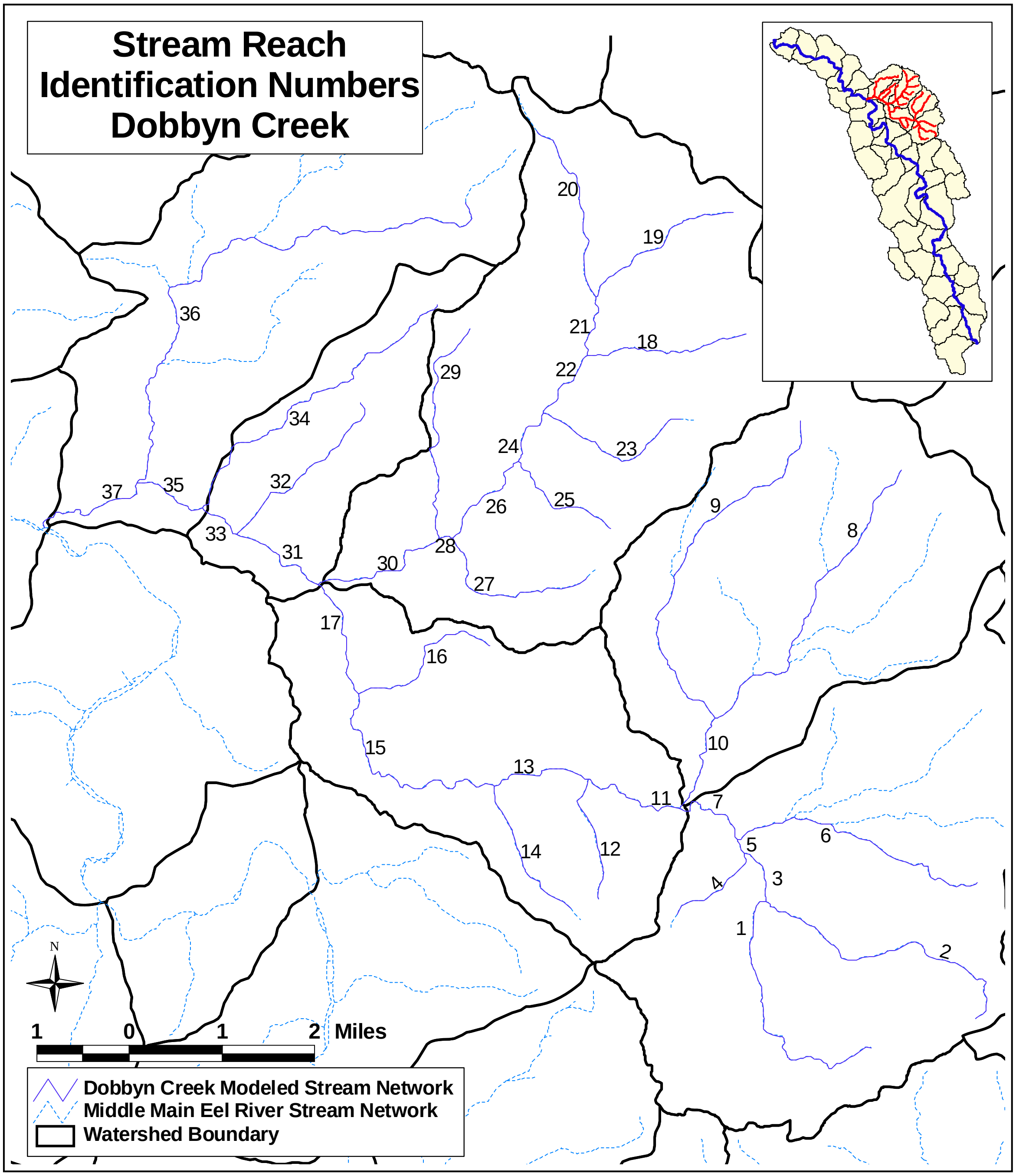


Figure A-32. Stream reach identification numbers for Dobbyn Creek

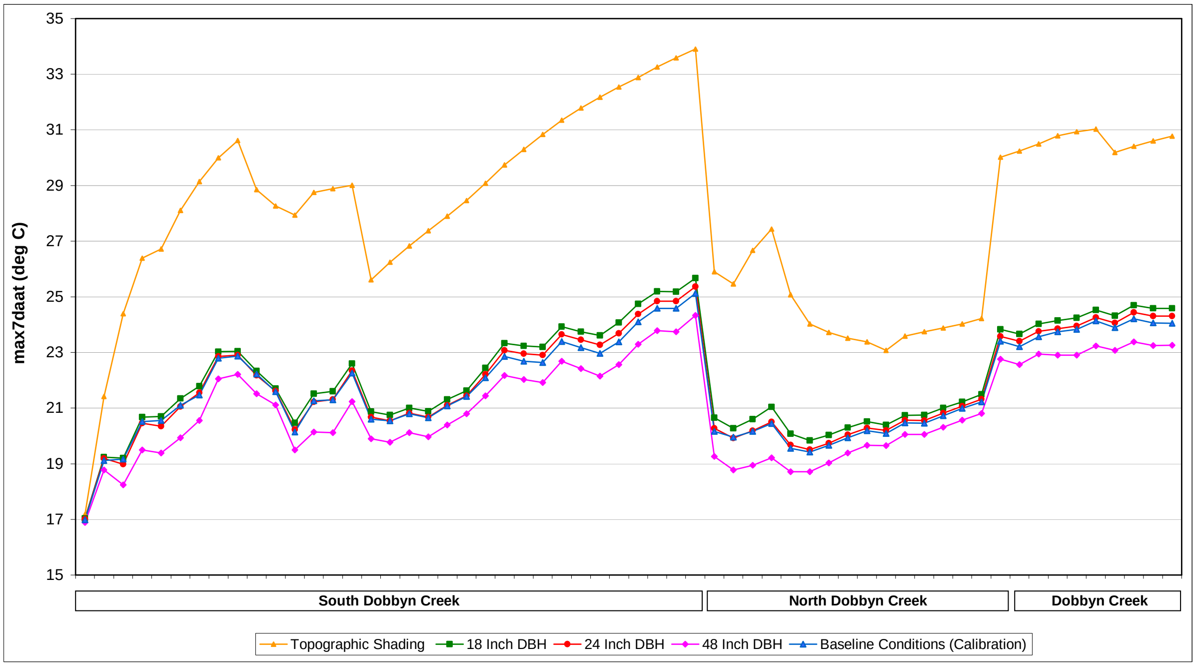


Figure A-33. Max7daat values for vegetation scenarios at each SSP in Dobbyn Creek

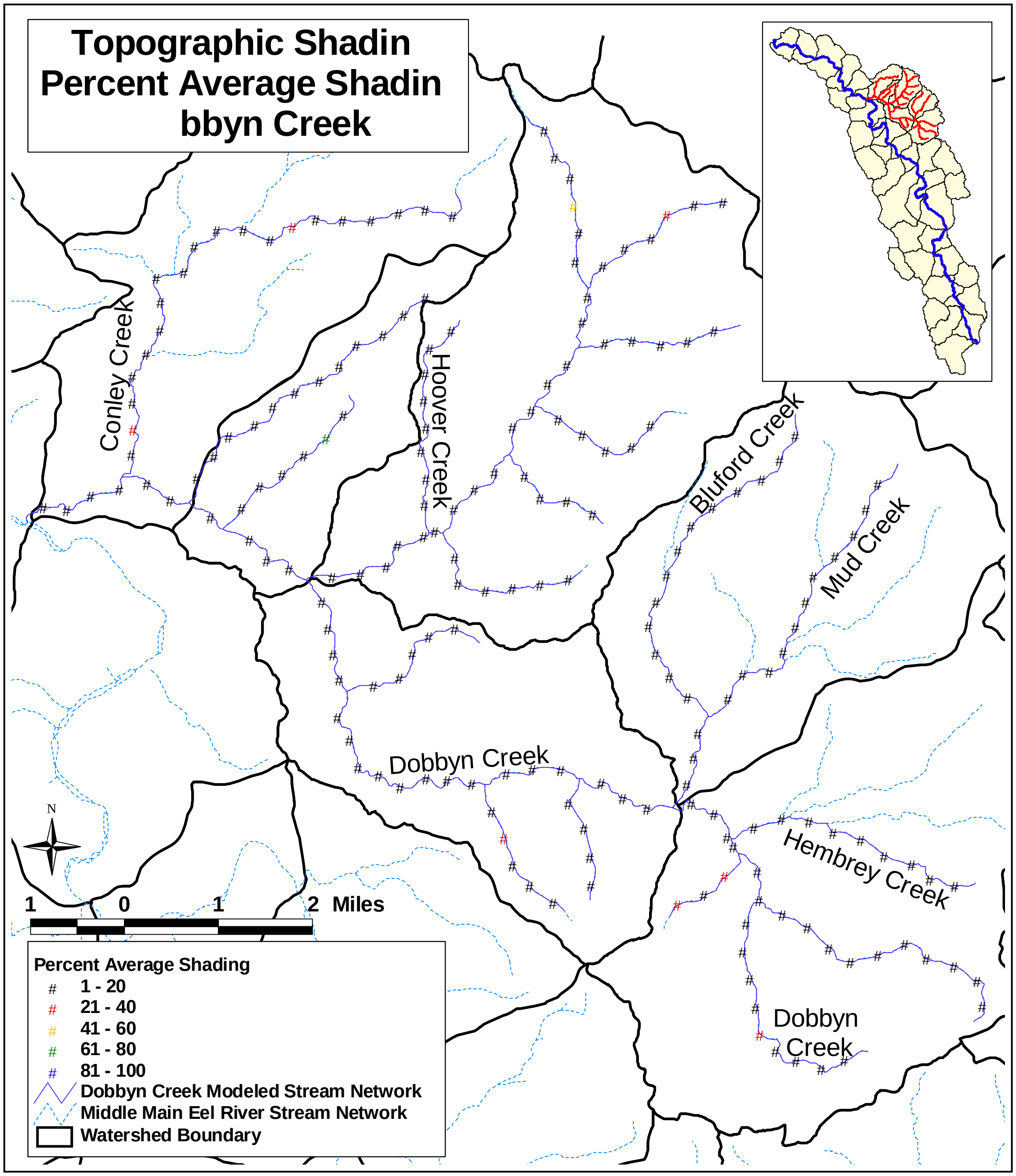


Figure A-34. Percent average shading for the topographic shading scenario at Dobbyn Creek

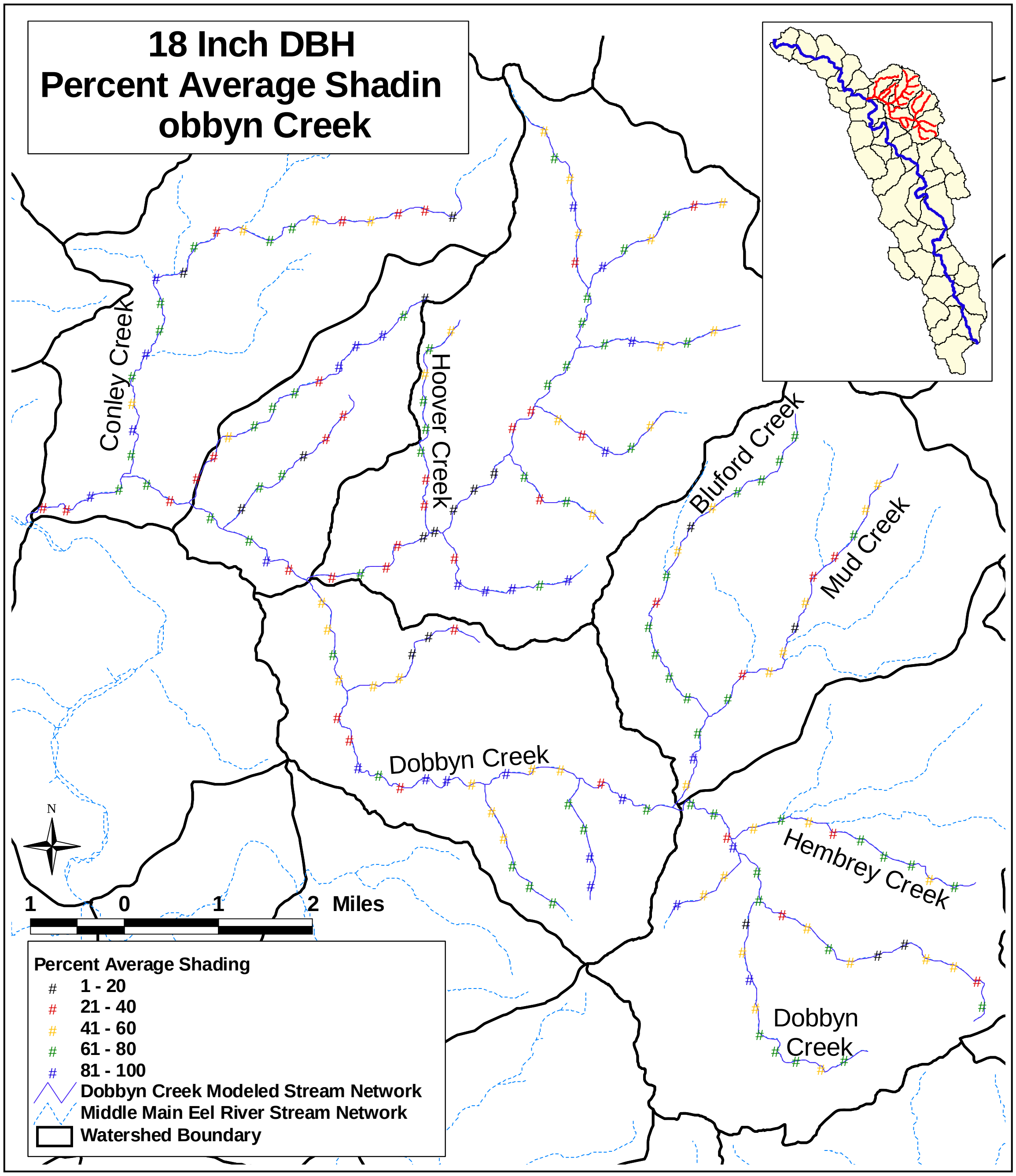


Figure A-35.  Percent average shading for the 18 inch DBH vegetation scenario at Dobbyn Creek

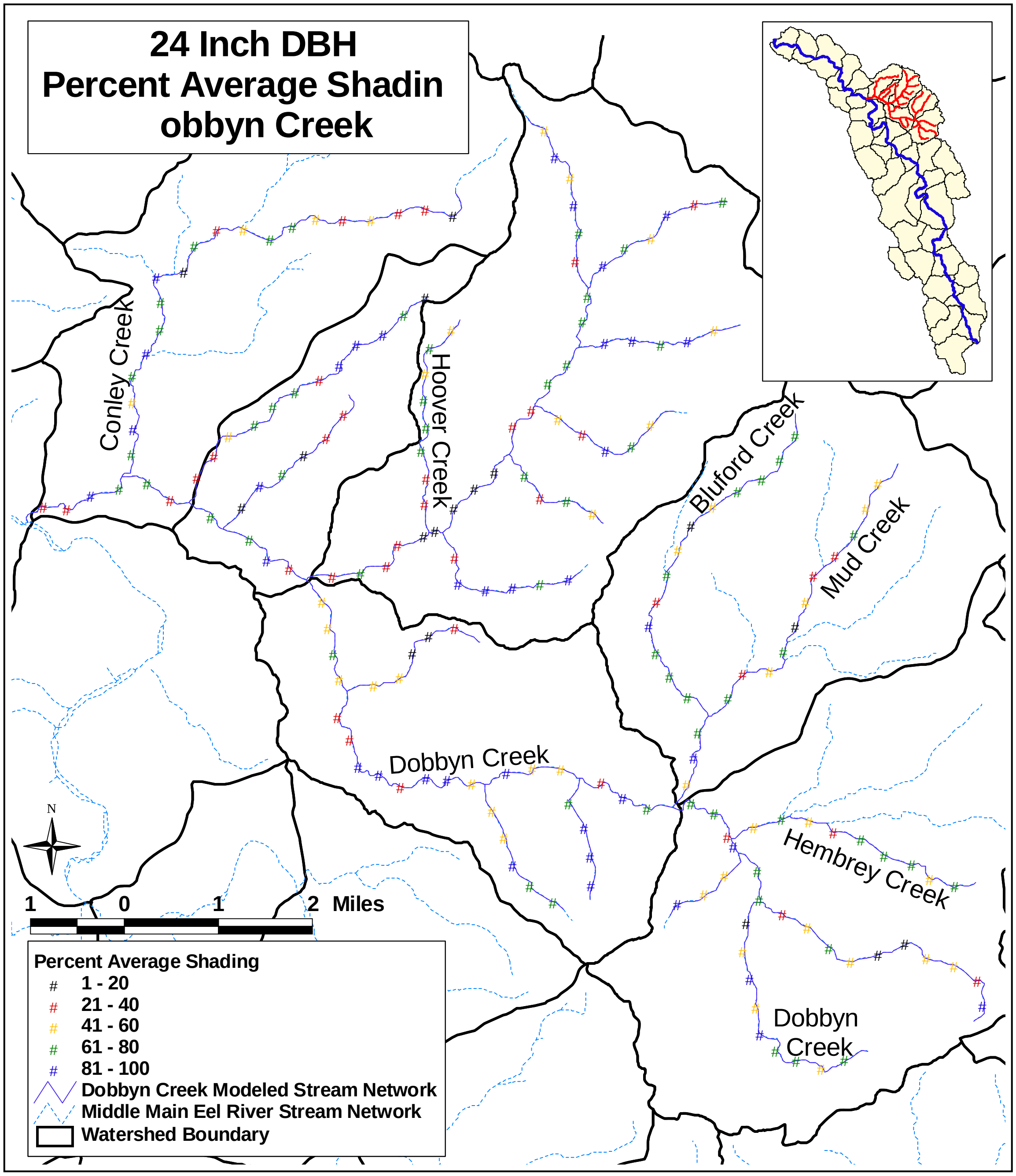


Figure A-36. Percent average shading for the 24 inch DBH vegetation scenario at Dobbyn Creek

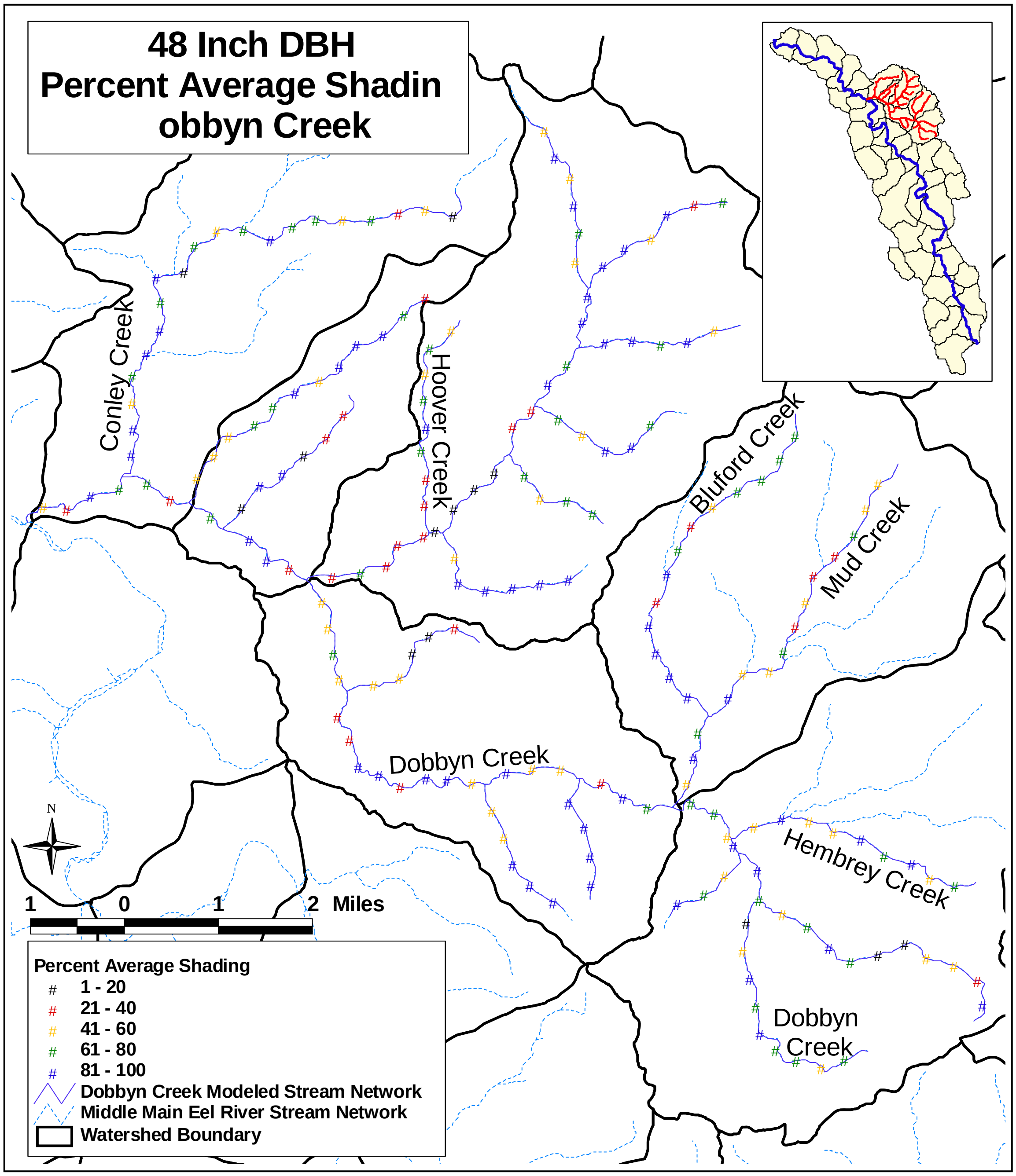


Figure A-37. Percent average shading for the 48 inch DBH vegetation scenario at Dobbyn Creek

### A.4.4 UER Extension Q2ESHADE Model

As shown in Table A-1, the Q2SHADE model was run for the UER extension stream network. The UER extension model was based on the 2004 UER Temperature TMDL model (Tetra Tech, Inc., 2004). To further justify use of this model, model validation was performed for July 15 through August 14, 2004 and model performance was evaluated at three RCD monitoring stations (Eel above Outlet – Station 1452; Emandal Riffle – Station 8005; and Riffle above Tomki – Station 8008). Overall the model validates and predicts hourly stream temperatures well, with relative errors for hourly results ranging from 3.45 – 4.26%. In addition, the average daily values generally fell within the observed range of data. The percent errors between predicted and observed max7daats were –2.1%, –0.23%, and 1.5% at Stations 1452, 8005, and 8008, respectively. Model validation results are available from USEPA upon request.

Subsequent to the model validation for the Upper Eel River, the Q2ESHADE model was run for the extension of the UER. Initial model runs were performed using the baseline conditions described in Sections A.2.1.1, A.2.1.2, A.2.2.1, and A.3.2 and were followed by model calibration. The 2003 temperature monitoring data from the Humboldt County RCD were used for calibration. Eight stations were available in the UER extension watersheds (Figure A-38). Max7daats were calculated for the temperature monitoring data for July 15, 2003 through August 14, 2003 and were compared with the max7daats predicted by the model for the same time period. Model calibration results are presented in Table A-26. The average percent error was 0.25% for the UER extension (percent error ranged from –1.43% to 3.48%).

Table A-26. Model Calibration Results for the UER extension

| Station ID | Location | Observed Temperature max7daat (deg C) | Predicted Temperature max7daat (deg C) | Percent Error |
|---|---|---|---|---|
| 1602 | Outlet Creek | 26.71 | 26.58 | -0.50% |
| 1452 | Eel River (above Outlet) | 27.97 | 27.63 | -1.21% |
| 8025 | Eel River (downstream of Outlet) | 25.94 | 26.84 | 3.48% |
| 8020 | Eel River (downstream of station 8025) | 26.81 | 26.84 | 0.13% |
| 8019 | Middle Fork Eel River (near USGS gage) | 26.89 | 26.50 | -1.43% |
| 1678 | Middle Fork Eel River (near confluence with Eel River) | 26.25 | 26.40 | 0.57% |
| 1550 | Eel River (downstream of Middle Fork Eel River) | 27.01 | 26.83 | -0.66% |
| 1509 | Burger Creek | 24.16 | 24.55 | 1.61% |

Table A-27 presents the number of stream miles associated with different max7daat categories, the solar radiation, and the average percent shade for baseline conditions (see Sections A.2.1.1, A.2.1.2, A.2.2.1, and A.3.2) in the UER extension. In addition, Figure A-39 and Figure A-40 illustrate the average percent shading and max7daat values for baseline conditions throughout the UER extension watersheds.

Table A-27. Baseline Model Results for the UER Extension

| Temperature Category | UER Extension | |
|---|---|---|
| | Stream Miles | % of Total |
| Good (max7daat < 15°C) | 0.0 | 0% |
| Fair (15°C < max7daat < 17°C) | 0.0 | 0% |
| Marginal (17°C < max7daat < 19°C) | 1.2 | 3% |
| Stressful (19.1°C < max7daat < 20°C) | 2.5 | 6% |
| Stressful (20.1°C < max7daat < 21°C) | 3.7 | 9% |
| Stressful (21.1°C < max7daat < 22°C) | 5.3 | 13% |
| Stressful (22.1°C < max7daat < 23°C) | 2.8 | 7% |
| Stressful (23.1°C < max7daat < 24°C) | 2.2 | 5% |
| Lethal (max7daat > 24°C) | 23.0 | 57% |
| TOTAL | 40.7 | 100% |
| Solar Radiation (Langley/day) | 309.8 | |
| % Shade | 47.2% | |

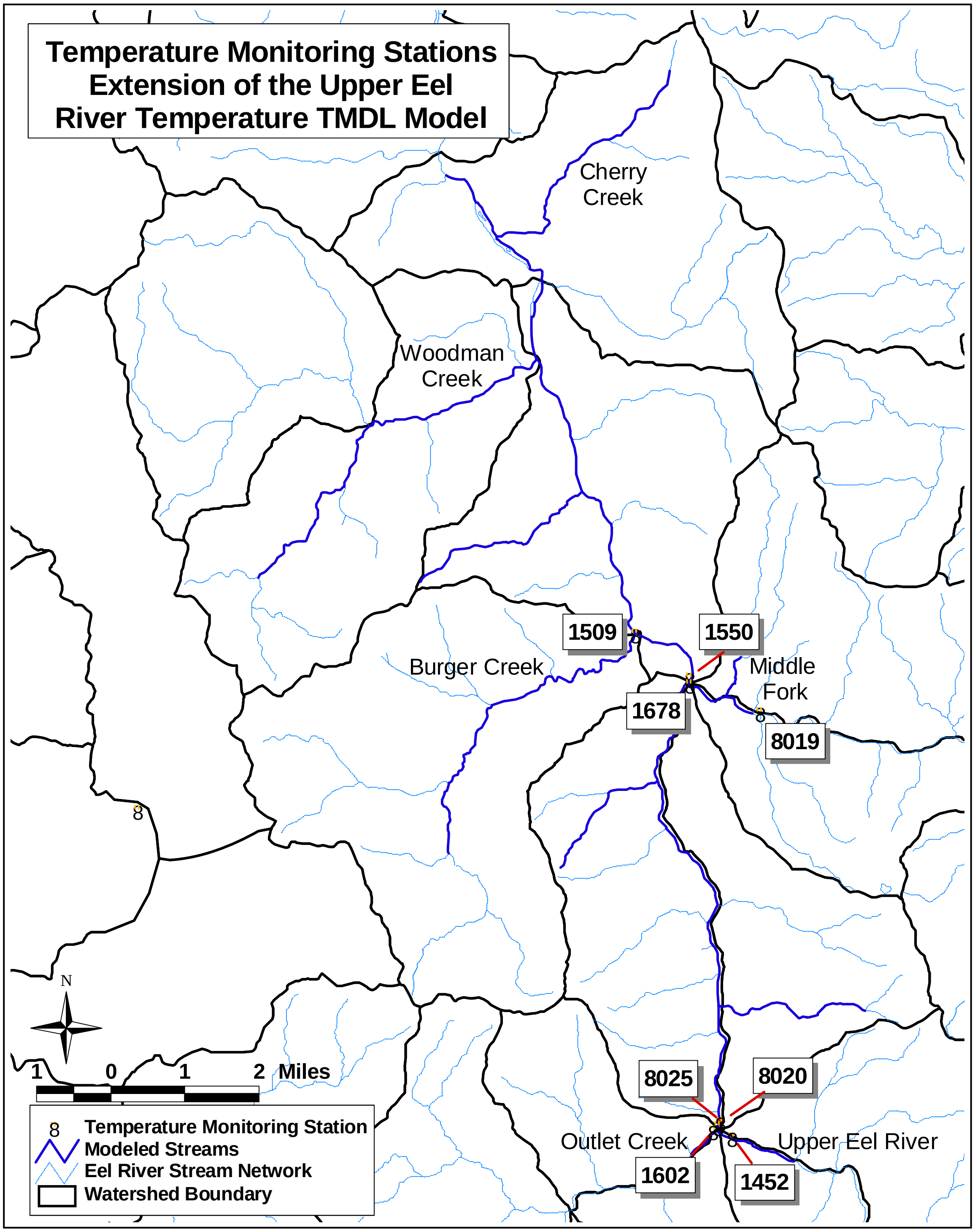


Figure A-38. Monitoring stations used for calibration in the UER extension watersheds

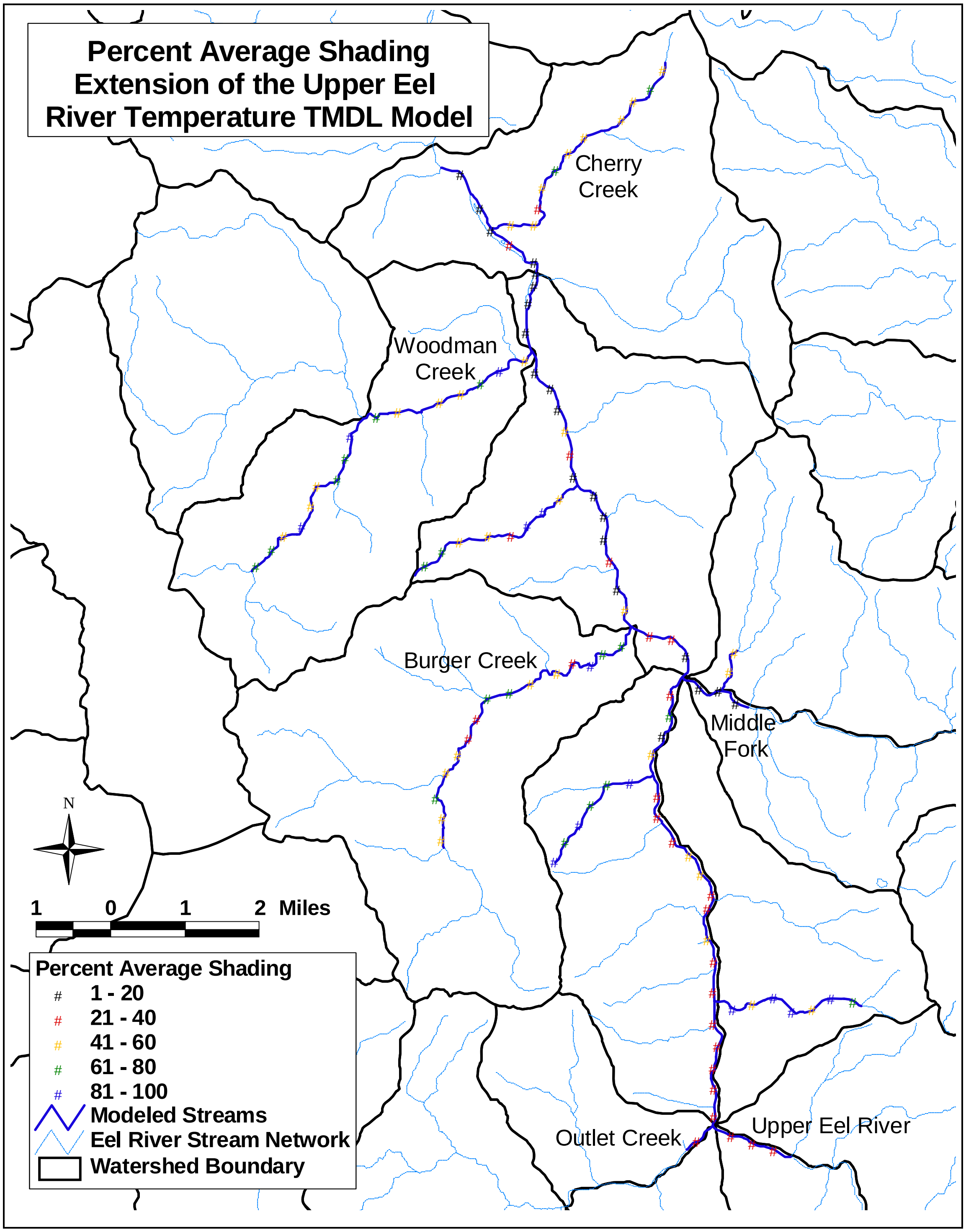


Figure A-39.  Percent average shading for baseline conditions for the UER extension

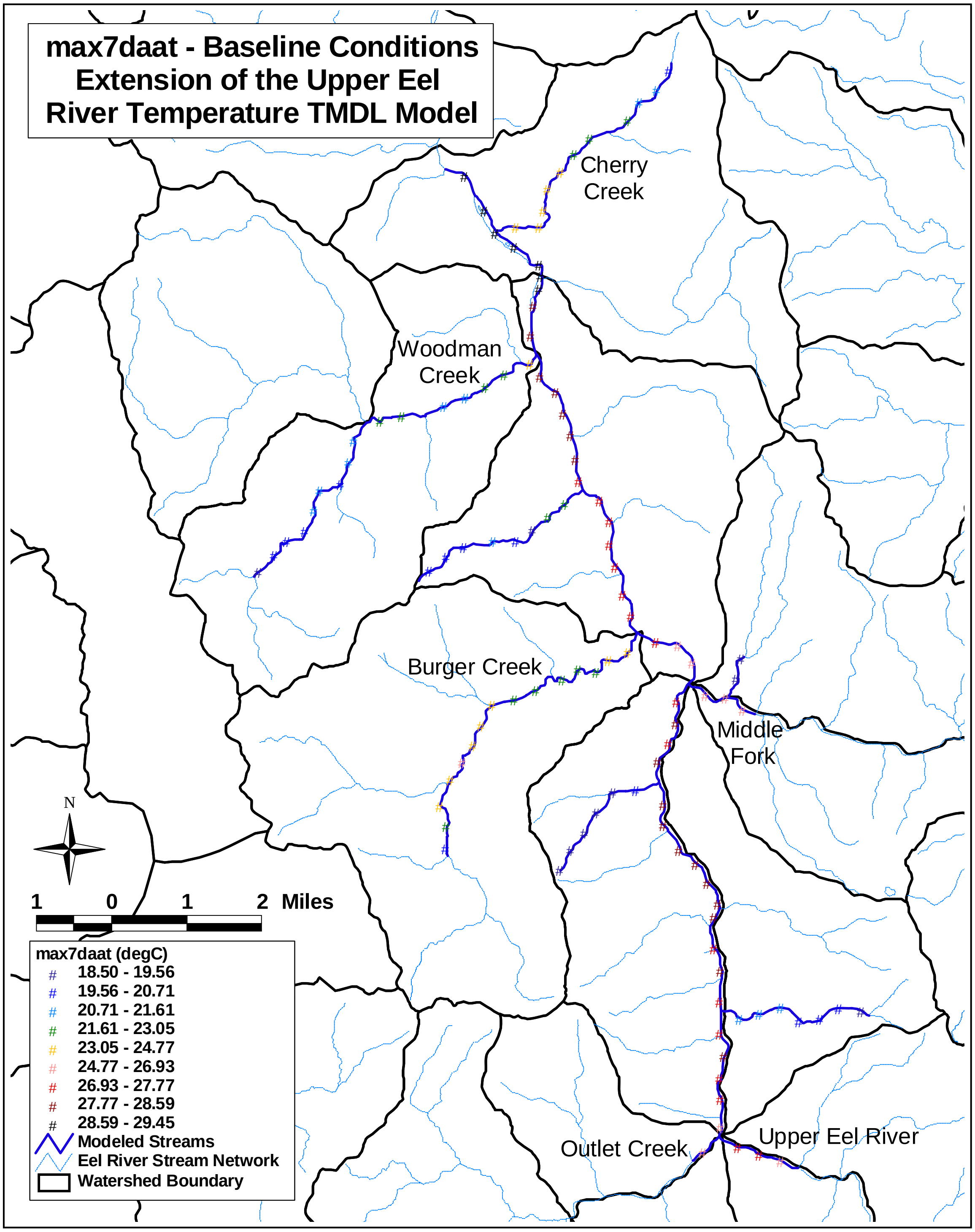


Figure A-40. Max7daat values for baseline conditions for the UER extension

Using the calibrated model, eight very wet year flow scenarios were simulated, as described in Section A.4 and Table A-16.  The stream miles associated with the different max7daat temperature categories, the solar radiation, and the average percent shading for the flow scenarios were identical to the results for baseline conditions (see Sections A.2.1.1, A.2.1.2, A.2.2.1, and A.3.2), which are presented in Table A-27.  These values did not change between scenarios because the majority of SSPs are along the main stem, which had temperatures in the lethal category for all flow scenarios.

Table A-28 and Table A-29 present the model results for the very wet flow scenarios compared to baseline conditions for the UER extension.  Table A-28 presents the max7daat values associated with each SSP for the scenarios using average flow from the Middle Fork (50.9 cfs), while Table A-29 presents the results using high flow from the Middle Fork (80 cfs), as described in Table A-16 (see Figure A-42 for a map identifying the stream reach identification numbers throughout the UER extension).  Figure A-41 graphically illustrates the max7daats for baseline conditions and all eight flow scenarios.  Figure A-43 through Figure A-50 illustrate the distribution of max7daat values throughout the UER extension stream network for all eight very wet flow scenarios.

Table A-28. Max7daat Values (degC) for Very Wet Year Flow Scenarios With Average Middle Fork Flow

| Q2ESHADE ID Number | Reach ID Number | Baseline Conditions (Calibration) | 50.9 cfs Flow from Middle Fork Eel River | | | |
|---|---|---|---|---|---|---|
| | | | FERC/NMFS Very Wet Year (30 cfs at 20.9C) | Natural Very Wet Year - Lower (50 cfs at 22.5C) | Natural Very Wet Year - Upper (50 cfs at 23.5C) | Natural Very Wet Year - Lower (60 cfs at 22.5C) |
| 1 | 1 | 26.74 | 25.13 | 24.59 | 24.9 | 24.3 |
| 2 | 1 | 27.37 | 25.36 | 24.74 | 25.05 | 24.43 |
| 3 | 1 | 27.63 | 25.5 | 24.84 | 25.14 | 24.52 |
| 4 | 2 | 26.58 | 26.57 | 26.56 | 26.56 | 26.56 |
| 5 | 3 | 26.84 | 25.63 | 25.02 | 25.28 | 24.71 |
| 6 | 4 | 27.25 | 25.88 | 25.22 | 25.47 | 24.89 |
| 7 | 4 | 27.74 | 26.2 | 25.47 | 25.72 | 25.13 |
| 8 | 4 | 28.08 | 26.48 | 25.7 | 25.94 | 25.34 |
| 9 | 5 | 27.62 | 26.6 | 25.88 | 26.09 | 25.54 |
| 10 | 6 | 18.5 | 18.5 | 18.5 | 18.5 | 18.5 |
| 11 | 6 | 20.32 | 20.32 | 20.32 | 20.32 | 20.32 |
| 12 | 6 | 20.33 | 20.33 | 20.33 | 20.33 | 20.33 |
| 13 | 6 | 20.15 | 20.15 | 20.15 | 20.15 | 20.15 |
| 14 | 6 | 21.26 | 21.26 | 21.26 | 21.26 | 21.26 |
| 15 | 6 | 21.13 | 21.13 | 21.13 | 21.13 | 21.13 |
| 16 | 6 | 21.61 | 21.61 | 21.61 | 21.61 | 21.61 |
| 17 | 7 | 27.73 | 26.82 | 26.14 | 26.32 | 25.8 |
| 18 | 8 | 27.97 | 27.05 | 26.4 | 26.57 | 26.07 |
| 19 | 9 | 27.74 | 27.05 | 26.45 | 26.61 | 26.14 |
| 20 | 10 | 28.1 | 27.33 | 26.71 | 26.86 | 26.39 |
| 21 | 11 | 28.18 | 27.4 | 26.78 | 26.93 | 26.47 |
| 22 | 11 | 28.03 | 27.36 | 26.77 | 26.91 | 26.46 |
| 23 | 11 | 27.96 | 27.35 | 26.78 | 26.91 | 26.48 |
| 24 | 11 | 28.13 | 27.46 | 26.87 | 27.01 | 26.57 |
| 25 | 12 | 28.13 | 27.5 | 26.93 | 27.06 | 26.63 |
| 26 | 12 | 28.02 | 27.49 | 26.94 | 27.06 | 26.65 |
| 27 | 13 | 19.18 | 19.18 | 19.18 | 19.18 | 19.18 |
| 28 | 13 | 18.79 | 18.79 | 18.79 | 18.79 | 18.79 |
| 29 | 13 | 19.26 | 19.26 | 19.26 | 19.26 | 19.26 |
| 30 | 13 | 18.82 | 18.82 | 18.82 | 18.82 | 18.82 |
| 31 | 14 | 19.06 | 19.06 | 19.06 | 19.06 | 19.06 |
| 32 | 14 | 19.8 | 19.8 | 19.8 | 19.8 | 19.8 |
| 33 | 15 | 27.9 | 27.47 | 26.95 | 27.07 | 26.67 |
| 34 | 15 | 27.6 | 27.34 | 26.87 | 26.99 | 26.61 |
| 35 | 15 | 27.95 | 27.52 | 27.01 | 27.12 | 26.74 |
| 36 | 15 | 27.77 | 27.45 | 26.97 | 27.08 | 26.71 |
| 37 | 16 | 26.5 | 26.5 | 26.5 | 26.5 | 26.5 |
| 38 | 17 | 18.59 | 18.59 | 18.59 | 18.59 | 18.59 |
| 39 | 17 | 19.07 | 19.07 | 19.07 | 19.07 | 19.07 |
| 40 | 18 | 26.18 | 26.18 | 26.18 | 26.18 | 26.18 |
| 41 | 18 | 26.4 | 26.4 | 26.4 | 26.4 | 26.4 |
| 42 | 19 | 26.83 | 26.93 | 26.77 | 26.83 | 26.64 |
| 43 | 19 | 26.93 | 27 | 26.84 | 26.9 | 26.71 |
| 44 | 19 | 27.1 | 27.14 | 26.96 | 27.01 | 26.82 |
| 45 | 20 | 20.17 | 20.17 | 20.17 | 20.17 | 20.17 |
| 46 | 20 | 21.99 | 21.99 | 21.99 | 21.99 | 21.99 |
| 47 | 20 | 23.27 | 23.27 | 23.27 | 23.27 | 23.27 |
| 48 | 21 | 24.5 | 24.5 | 24.5 | 24.5 | 24.5 |
| 49 | 21 | 25.42 | 25.42 | 25.42 | 25.42 | 25.42 |
| 50 | 21 | 24.14 | 24.14 | 24.14 | 24.14 | 24.14 |
| 51 | 21 | 23.52 | 23.52 | 23.52 | 23.52 | 23.52 |
| 52 | 22 | 23.71 | 23.71 | 23.71 | 23.71 | 23.71 |
| 53 | 22 | 22.86 | 22.86 | 22.86 | 22.86 | 22.86 |
| 54 | 22 | 22.37 | 22.37 | 22.37 | 22.37 | 22.37 |
| 55 | 23 | 22.64 | 22.64 | 22.64 | 22.64 | 22.64 |
| 56 | 23 | 22.75 | 22.75 | 22.75 | 22.75 | 22.75 |
| 57 | 23 | 21.84 | 21.84 | 21.84 | 21.84 | 21.84 |
| 58 | 23 | 24.33 | 24.33 | 24.33 | 24.33 | 24.33 |
| 59 | 23 | 24.55 | 24.55 | 24.55 | 24.55 | 24.55 |
| 60 | 24 | 27.19 | 27.21 | 27.02 | 27.08 | 26.89 |
| 61 | 24 | 27.19 | 27.21 | 27.02 | 27.08 | 26.89 |
| 62 | 25 | 27.34 | 27.33 | 27.13 | 27.18 | 26.99 |
| 63 | 25 | 27.42 | 27.39 | 27.19 | 27.24 | 27.04 |
| 64 | 26 | 27.57 | 27.51 | 27.29 | 27.34 | 27.14 |
| 65 | 26 | 27.71 | 27.63 | 27.4 | 27.44 | 27.24 |

| Q2ESHADE ID Number | Reach ID Number | Baseline Conditions (Calibration) | 50.9 cfs Flow from Middle Fork Eel River | | | |
|---|---|---|---|---|---|---|
| | | | FERC/NMFS Very Wet Year (30 cfs at 20.9C) | Natural Very Wet Year - Lower (50 cfs at 22.5C) | Natural Very Wet Year - Upper (50 cfs at 23.5C) | Natural Very Wet Year - Lower (60 cfs at 22.5C) |
| 66 | 27 | 20.17 | 20.17 | 20.17 | 20.17 | 20.17 |
| 67 | 27 | 20.06 | 20.06 | 20.06 | 20.06 | 20.06 |
| 68 | 27 | 20.27 | 20.27 | 20.27 | 20.27 | 20.27 |
| 69 | 28 | 21.41 | 21.41 | 21.41 | 21.41 | 21.41 |
| 70 | 28 | 20.51 | 20.51 | 20.51 | 20.51 | 20.51 |
| 71 | 28 | 19.56 | 19.56 | 19.56 | 19.56 | 19.56 |
| 72 | 28 | 22.05 | 22.05 | 22.05 | 22.05 | 22.05 |
| 73 | 28 | 22.56 | 22.56 | 22.56 | 22.56 | 22.56 |
| 74 | 29 | 27.71 | 27.64 | 27.41 | 27.45 | 27.26 |
| 75 | 29 | 27.85 | 27.75 | 27.51 | 27.55 | 27.35 |
| 76 | 30 | 27.99 | 27.86 | 27.61 | 27.65 | 27.45 |
| 77 | 30 | 28.11 | 27.96 | 27.7 | 27.75 | 27.54 |
| 78 | 30 | 28.23 | 28.06 | 27.79 | 27.83 | 27.62 |
| 79 | 30 | 28.18 | 28.02 | 27.76 | 27.81 | 27.6 |
| 80 | 31 | 19.5 | 19.5 | 19.5 | 19.5 | 19.5 |
| 81 | 31 | 20.56 | 20.56 | 20.56 | 20.56 | 20.56 |
| 82 | 31 | 19.86 | 19.86 | 19.86 | 19.86 | 19.86 |
| 83 | 31 | 20.71 | 20.71 | 20.71 | 20.71 | 20.71 |
| 84 | 31 | 21.01 | 21.01 | 21.01 | 21.01 | 21.01 |
| 85 | 31 | 21 | 21 | 21 | 21 | 21 |
| 86 | 32 | 20.65 | 20.65 | 20.65 | 20.65 | 20.65 |
| 87 | 32 | 21 | 21 | 21 | 21 | 21 |
| 88 | 32 | 21.51 | 21.51 | 21.51 | 21.51 | 21.51 |
| 89 | 33 | 22 | 22 | 22 | 22 | 22 |
| 90 | 33 | 21.93 | 21.93 | 21.93 | 21.93 | 21.93 |
| 91 | 34 | 21.26 | 21.26 | 21.26 | 21.26 | 21.26 |
| 92 | 34 | 21.43 | 21.43 | 21.43 | 21.43 | 21.43 |
| 93 | 34 | 22.24 | 22.24 | 22.24 | 22.24 | 22.24 |
| 94 | 34 | 22.88 | 22.88 | 22.88 | 22.88 | 22.88 |
| 95 | 35 | 24.04 | 24.04 | 24.04 | 24.04 | 24.04 |
| 96 | 36 | 28.34 | 28.17 | 27.9 | 27.94 | 27.73 |
| 97 | 37 | 28.59 | 28.38 | 28.08 | 28.13 | 27.91 |
| 98 | 38 | 28.81 | 28.57 | 28.26 | 28.3 | 28.08 |
| 99 | 39 | 29 | 28.74 | 28.42 | 28.45 | 28.24 |
| 100 | 40 | 29.21 | 28.92 | 28.59 | 28.62 | 28.4 |
| 101 | 41 | 29.22 | 28.93 | 28.61 | 28.64 | 28.42 |
| 102 | 41 | 29.32 | 29.02 | 28.69 | 28.72 | 28.5 |
| 103 | 42 | 20.21 | 20.21 | 20.21 | 20.21 | 20.21 |
| 104 | 42 | 21.23 | 21.23 | 21.23 | 21.23 | 21.23 |
| 105 | 42 | 21.27 | 21.27 | 21.27 | 21.27 | 21.27 |
| 106 | 42 | 21.88 | 21.88 | 21.88 | 21.88 | 21.88 |
| 107 | 43 | 22.37 | 22.37 | 22.37 | 22.37 | 22.37 |
| 108 | 43 | 23.05 | 23.05 | 23.05 | 23.05 | 23.05 |
| 109 | 43 | 24.77 | 24.77 | 24.77 | 24.77 | 24.77 |
| 110 | 43 | 24.55 | 24.55 | 24.55 | 24.55 | 24.55 |
| 111 | 43 | 23.78 | 23.78 | 23.78 | 23.78 | 23.78 |
| 112 | 43 | 24.01 | 24.01 | 24.01 | 24.01 | 24.01 |
| 113 | 43 | 23.81 | 23.81 | 23.81 | 23.81 | 23.81 |
| 114 | 44 | 29.45 | 29.14 | 28.81 | 28.84 | 28.62 |
| 115 | 45 | 28.96 | 28.61 | 28.25 | 28.28 | 28.06 |

Table A-29. Max7daat Values (degC) for Very Wet Year Flow Scenarios with High Middle Fork Flow

| Q2ESHADE ID Number | Reach ID Number | Baseline Conditions (Calibration) | 80 cfs Flow from Middle Fork Eel River | | | |
|---|---|---|---|---|---|---|
| | | | FERC/NMFS Very Wet Year (30 cfs at 20.9C) | Natural Very Wet Year - Lower (50 cfs at 22.5C) | Natural Very Wet Year - Upper (50 cfs at 23.5C) | Natural Very Wet Year - Lower (60 cfs at 22.5C) |
| 1 | 1 | 26.74 | 25.13 | 24.59 | 24.9 | 24.3 |
| 2 | 1 | 27.37 | 25.36 | 24.74 | 25.05 | 24.43 |
| 3 | 1 | 27.63 | 25.5 | 24.84 | 25.14 | 24.52 |
| 4 | 2 | 26.58 | 26.57 | 26.56 | 26.56 | 26.56 |
| 5 | 3 | 26.84 | 25.63 | 25.02 | 25.28 | 24.71 |
| 6 | 4 | 27.25 | 25.88 | 25.22 | 25.47 | 24.89 |
| 7 | 4 | 27.74 | 26.2 | 25.47 | 25.72 | 25.13 |
| 8 | 4 | 28.08 | 26.48 | 25.7 | 25.94 | 25.34 |
| 9 | 5 | 27.62 | 26.6 | 25.88 | 26.09 | 25.54 |
| 10 | 6 | 18.5 | 18.5 | 18.5 | 18.5 | 18.5 |
| 11 | 6 | 20.32 | 20.32 | 20.32 | 20.32 | 20.32 |
| 12 | 6 | 20.33 | 20.33 | 20.33 | 20.33 | 20.33 |
| 13 | 6 | 20.15 | 20.15 | 20.15 | 20.15 | 20.15 |
| 14 | 6 | 21.26 | 21.26 | 21.26 | 21.26 | 21.26 |
| 15 | 6 | 21.13 | 21.13 | 21.13 | 21.13 | 21.13 |
| 16 | 6 | 21.61 | 21.61 | 21.61 | 21.61 | 21.61 |
| 17 | 7 | 27.73 | 26.82 | 26.14 | 26.32 | 25.8 |
| 18 | 8 | 27.97 | 27.05 | 26.4 | 26.57 | 26.07 |
| 19 | 9 | 27.74 | 27.05 | 26.45 | 26.61 | 26.14 |
| 20 | 10 | 28.1 | 27.33 | 26.71 | 26.86 | 26.39 |
| 21 | 11 | 28.18 | 27.4 | 26.78 | 26.93 | 26.47 |
| 22 | 11 | 28.03 | 27.36 | 26.77 | 26.91 | 26.46 |
| 23 | 11 | 27.96 | 27.35 | 26.78 | 26.91 | 26.48 |
| 24 | 11 | 28.13 | 27.46 | 26.87 | 27.01 | 26.57 |
| 25 | 12 | 28.13 | 27.5 | 26.93 | 27.06 | 26.63 |
| 26 | 12 | 28.02 | 27.49 | 26.94 | 27.06 | 26.65 |
| 27 | 13 | 19.18 | 19.18 | 19.18 | 19.18 | 19.18 |
| 28 | 13 | 18.79 | 18.79 | 18.79 | 18.79 | 18.79 |
| 29 | 13 | 19.26 | 19.26 | 19.26 | 19.26 | 19.26 |
| 30 | 13 | 18.82 | 18.82 | 18.82 | 18.82 | 18.82 |
| 31 | 14 | 19.06 | 19.06 | 19.06 | 19.06 | 19.06 |
| 32 | 14 | 19.8 | 19.8 | 19.8 | 19.8 | 19.8 |
| 33 | 15 | 27.9 | 27.47 | 26.95 | 27.07 | 26.67 |
| 34 | 15 | 27.6 | 27.34 | 26.87 | 26.99 | 26.61 |
| 35 | 15 | 27.95 | 27.52 | 27.01 | 27.12 | 26.74 |
| 36 | 15 | 27.77 | 27.45 | 26.97 | 27.08 | 26.71 |
| 37 | 16 | 26.5 | 26.35 | 26.35 | 26.35 | 26.35 |
| 38 | 17 | 18.59 | 18.59 | 18.59 | 18.59 | 18.59 |
| 39 | 17 | 19.07 | 19.07 | 19.07 | 19.07 | 19.07 |
| 40 | 18 | 26.18 | 26.16 | 26.16 | 26.16 | 26.16 |
| 41 | 18 | 26.4 | 26.32 | 26.32 | 26.32 | 26.32 |
| 42 | 19 | 26.83 | 26.75 | 26.65 | 26.7 | 26.56 |
| 43 | 19 | 26.93 | 26.82 | 26.71 | 26.76 | 26.61 |
| 44 | 19 | 27.1 | 26.93 | 26.81 | 26.86 | 26.71 |
| 45 | 20 | 20.17 | 20.17 | 20.17 | 20.17 | 20.17 |
| 46 | 20 | 21.99 | 21.99 | 21.99 | 21.99 | 21.99 |
| 47 | 20 | 23.27 | 23.27 | 23.27 | 23.27 | 23.27 |
| 48 | 21 | 24.5 | 24.5 | 24.5 | 24.5 | 24.5 |
| 49 | 21 | 25.42 | 25.42 | 25.42 | 25.42 | 25.42 |
| 50 | 21 | 24.14 | 24.14 | 24.14 | 24.14 | 24.14 |
| 51 | 21 | 23.52 | 23.52 | 23.52 | 23.52 | 23.52 |
| 52 | 22 | 23.71 | 23.71 | 23.71 | 23.71 | 23.71 |
| 53 | 22 | 22.86 | 22.86 | 22.86 | 22.86 | 22.86 |
| 54 | 22 | 22.37 | 22.37 | 22.37 | 22.37 | 22.37 |
| 55 | 23 | 22.64 | 22.64 | 22.64 | 22.64 | 22.64 |
| 56 | 23 | 22.75 | 22.75 | 22.75 | 22.75 | 22.75 |
| 57 | 23 | 21.84 | 21.84 | 21.84 | 21.84 | 21.84 |
| 58 | 23 | 24.33 | 24.33 | 24.33 | 24.33 | 24.33 |
| 59 | 23 | 24.55 | 24.55 | 24.55 | 24.55 | 24.55 |
| 60 | 24 | 27.19 | 26.99 | 26.87 | 26.91 | 26.77 |
| 61 | 24 | 27.19 | 27 | 26.87 | 26.91 | 26.77 |
| 62 | 25 | 27.34 | 27.1 | 26.96 | 27.01 | 26.86 |
| 63 | 25 | 27.42 | 27.16 | 27.02 | 27.06 | 26.91 |
| 64 | 26 | 27.57 | 27.26 | 27.11 | 27.15 | 27 |
| 65 | 26 | 27.71 | 27.36 | 27.2 | 27.24 | 27.08 |
| 66 | 27 | 20.17 | 20.17 | 20.17 | 20.17 | 20.17 |
| 67 | 27 | 20.06 | 20.06 | 20.06 | 20.06 | 20.06 |

| Q2ESHADE ID Number | Reach ID Number | Baseline Conditions (Calibration) | 80 cfs Flow from Middle Fork Eel River | | | |
|---|---|---|---|---|---|---|
| | | | FERC/NMFS Very Wet Year (30 cfs at 20.9C) | Natural Very Wet Year - Lower (50 cfs at 22.5C) | Natural Very Wet Year - Upper (50 cfs at 23.5C) | Natural Very Wet Year - Lower (60 cfs at 22.5C) |
| 68 | 27 | 20.27 | 20.27 | 20.27 | 20.27 | 20.27 |
| 69 | 28 | 21.41 | 21.41 | 21.41 | 21.41 | 21.41 |
| 70 | 28 | 20.51 | 20.51 | 20.51 | 20.51 | 20.51 |
| 71 | 28 | 19.56 | 19.56 | 19.56 | 19.56 | 19.56 |
| 72 | 28 | 22.05 | 22.05 | 22.05 | 22.05 | 22.05 |
| 73 | 28 | 22.56 | 22.56 | 22.56 | 22.56 | 22.56 |
| 74 | 29 | 27.71 | 27.37 | 27.21 | 27.25 | 27.1 |
| 75 | 29 | 27.85 | 27.47 | 27.3 | 27.34 | 27.19 |
| 76 | 30 | 27.99 | 27.57 | 27.39 | 27.43 | 27.27 |
| 77 | 30 | 28.11 | 27.66 | 27.48 | 27.51 | 27.35 |
| 78 | 30 | 28.23 | 27.75 | 27.56 | 27.59 | 27.43 |
| 79 | 30 | 28.18 | 27.72 | 27.54 | 27.58 | 27.41 |
| 80 | 31 | 19.5 | 19.5 | 19.5 | 19.5 | 19.5 |
| 81 | 31 | 20.56 | 20.56 | 20.56 | 20.56 | 20.56 |
| 82 | 31 | 19.86 | 19.86 | 19.86 | 19.86 | 19.86 |
| 83 | 31 | 20.71 | 20.71 | 20.71 | 20.71 | 20.71 |
| 84 | 31 | 21.01 | 21.01 | 21.01 | 21.01 | 21.01 |
| 85 | 31 | 21 | 21 | 21 | 21 | 21 |
| 86 | 32 | 20.65 | 20.65 | 20.65 | 20.65 | 20.65 |
| 87 | 32 | 21 | 21 | 21 | 21 | 21 |
| 88 | 32 | 21.51 | 21.51 | 21.51 | 21.51 | 21.51 |
| 89 | 33 | 22 | 22 | 22 | 22 | 22 |
| 90 | 33 | 21.93 | 21.93 | 21.93 | 21.93 | 21.93 |
| 91 | 34 | 21.26 | 21.26 | 21.26 | 21.26 | 21.26 |
| 92 | 34 | 21.43 | 21.43 | 21.43 | 21.43 | 21.43 |
| 93 | 34 | 22.24 | 22.24 | 22.24 | 22.24 | 22.24 |
| 94 | 34 | 22.88 | 22.88 | 22.88 | 22.88 | 22.88 |
| 95 | 35 | 24.04 | 24.04 | 24.04 | 24.04 | 24.04 |
| 96 | 36 | 28.34 | 27.85 | 27.66 | 27.69 | 27.53 |
| 97 | 37 | 28.59 | 28.03 | 27.82 | 27.86 | 27.69 |
| 98 | 38 | 28.81 | 28.2 | 27.98 | 28.01 | 27.84 |
| 99 | 39 | 29 | 28.35 | 28.12 | 28.15 | 27.98 |
| 100 | 40 | 29.21 | 28.52 | 28.27 | 28.3 | 28.13 |
| 101 | 41 | 29.22 | 28.54 | 28.3 | 28.33 | 28.15 |
| 102 | 41 | 29.32 | 28.62 | 28.37 | 28.4 | 28.22 |
| 103 | 42 | 20.21 | 20.21 | 20.21 | 20.21 | 20.21 |
| 104 | 42 | 21.23 | 21.23 | 21.23 | 21.23 | 21.23 |
| 105 | 42 | 21.27 | 21.27 | 21.27 | 21.27 | 21.27 |
| 106 | 42 | 21.88 | 21.88 | 21.88 | 21.88 | 21.88 |
| 107 | 43 | 22.37 | 22.37 | 22.37 | 22.37 | 22.37 |
| 108 | 43 | 23.05 | 23.05 | 23.05 | 23.05 | 23.05 |
| 109 | 43 | 24.77 | 24.77 | 24.77 | 24.77 | 24.77 |
| 110 | 43 | 24.55 | 24.55 | 24.55 | 24.55 | 24.55 |
| 111 | 43 | 23.78 | 23.78 | 23.78 | 23.78 | 23.78 |
| 112 | 43 | 24.01 | 24.01 | 24.01 | 24.01 | 24.01 |
| 113 | 43 | 23.81 | 23.81 | 23.81 | 23.81 | 23.81 |
| 114 | 44 | 29.45 | 28.73 | 28.48 | 28.51 | 28.34 |
| 115 | 45 | 28.96 | 28.17 | 27.9 | 27.93 | 27.75 |

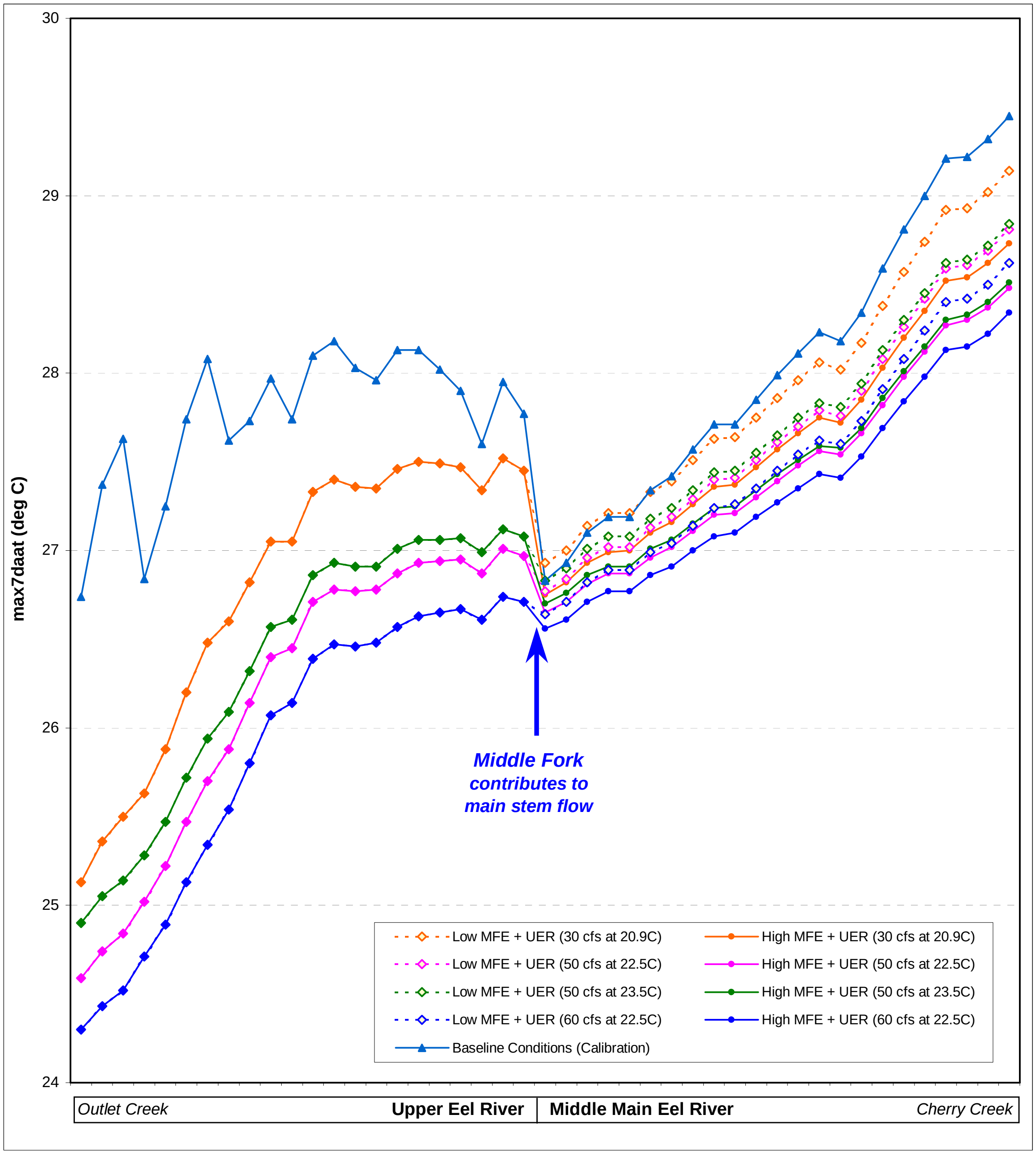


Figure A-41. Max7daat values for very wet year flow scenarios at each SSP in the UER extension

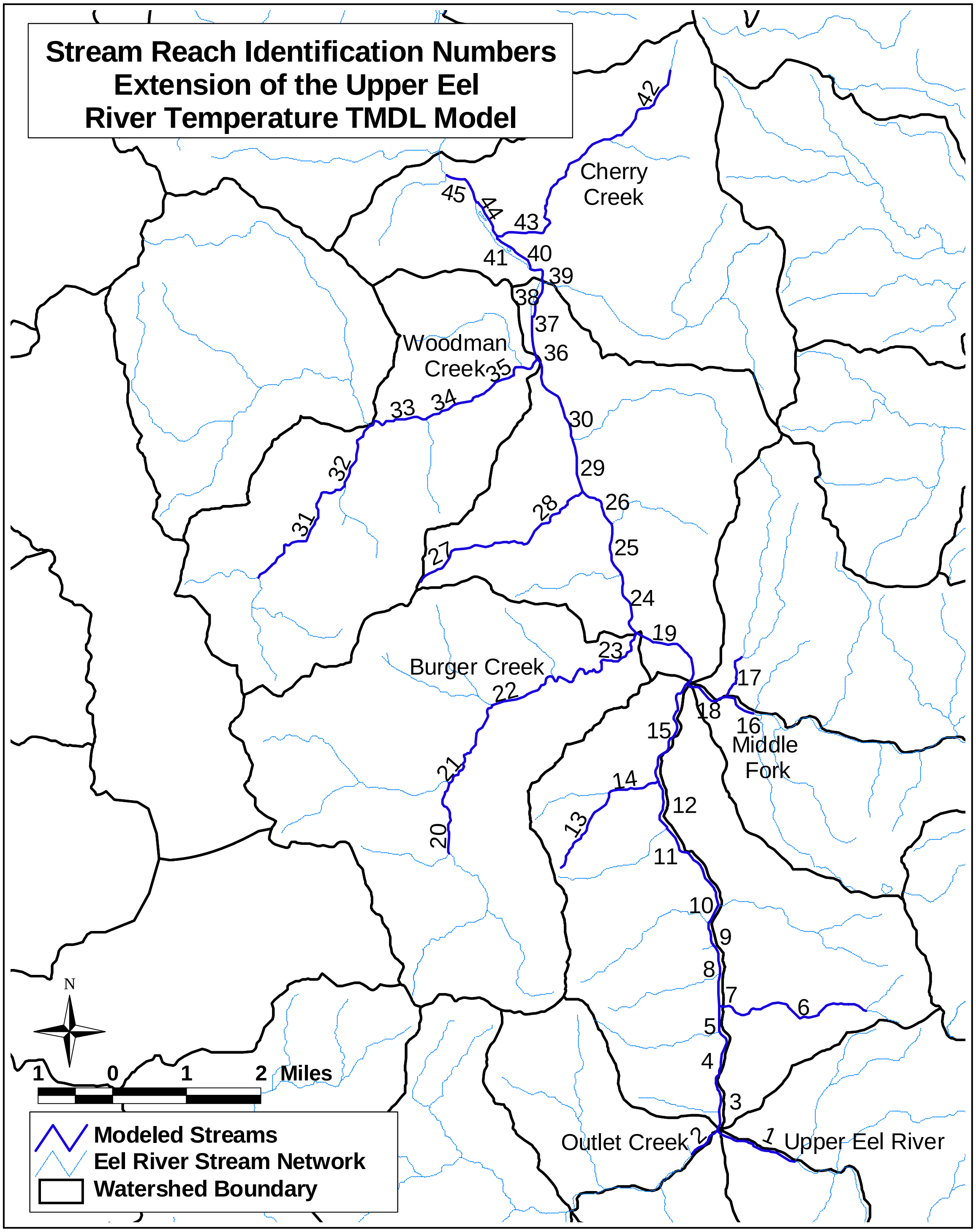


Figure A-42.  Stream reach identification numbers for the UER extension

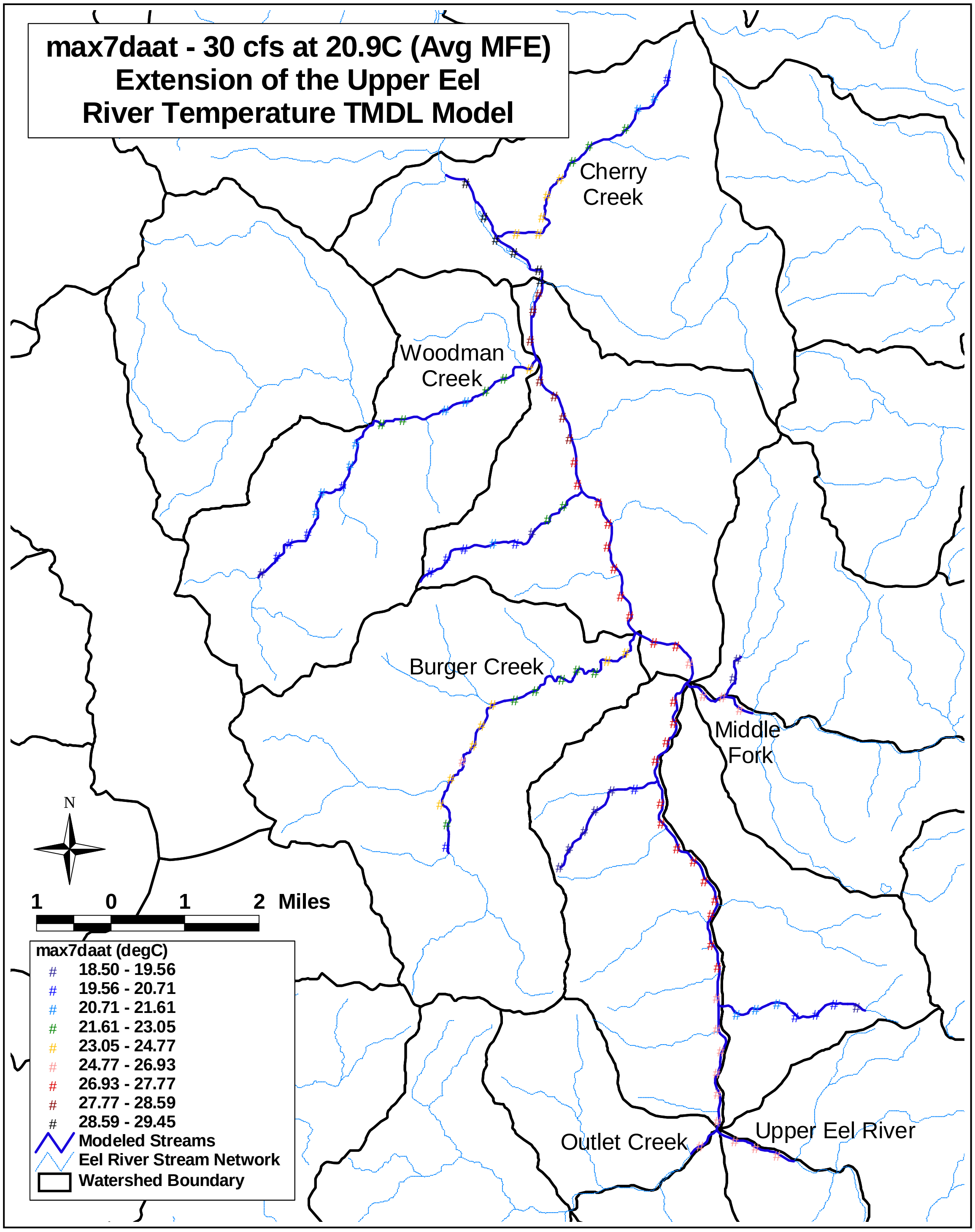


Figure A-43.  Max7daat ranges for the 30 cfs at 20.9°C flow scenario with average Middle Fork flow

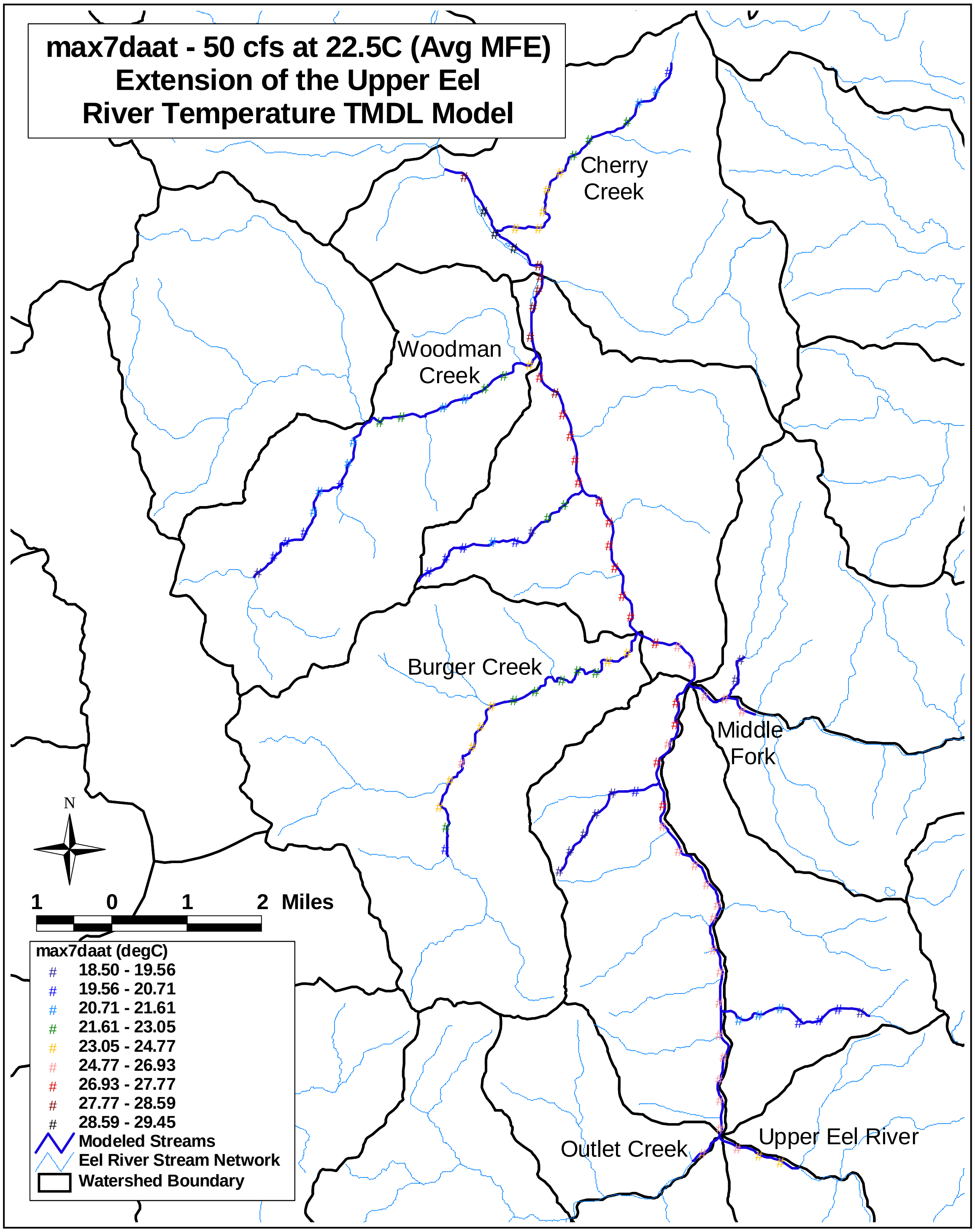


Figure A-44.  Max7daat ranges for the 50 cfs at 22.5°C flow scenario with average Middle Fork flow

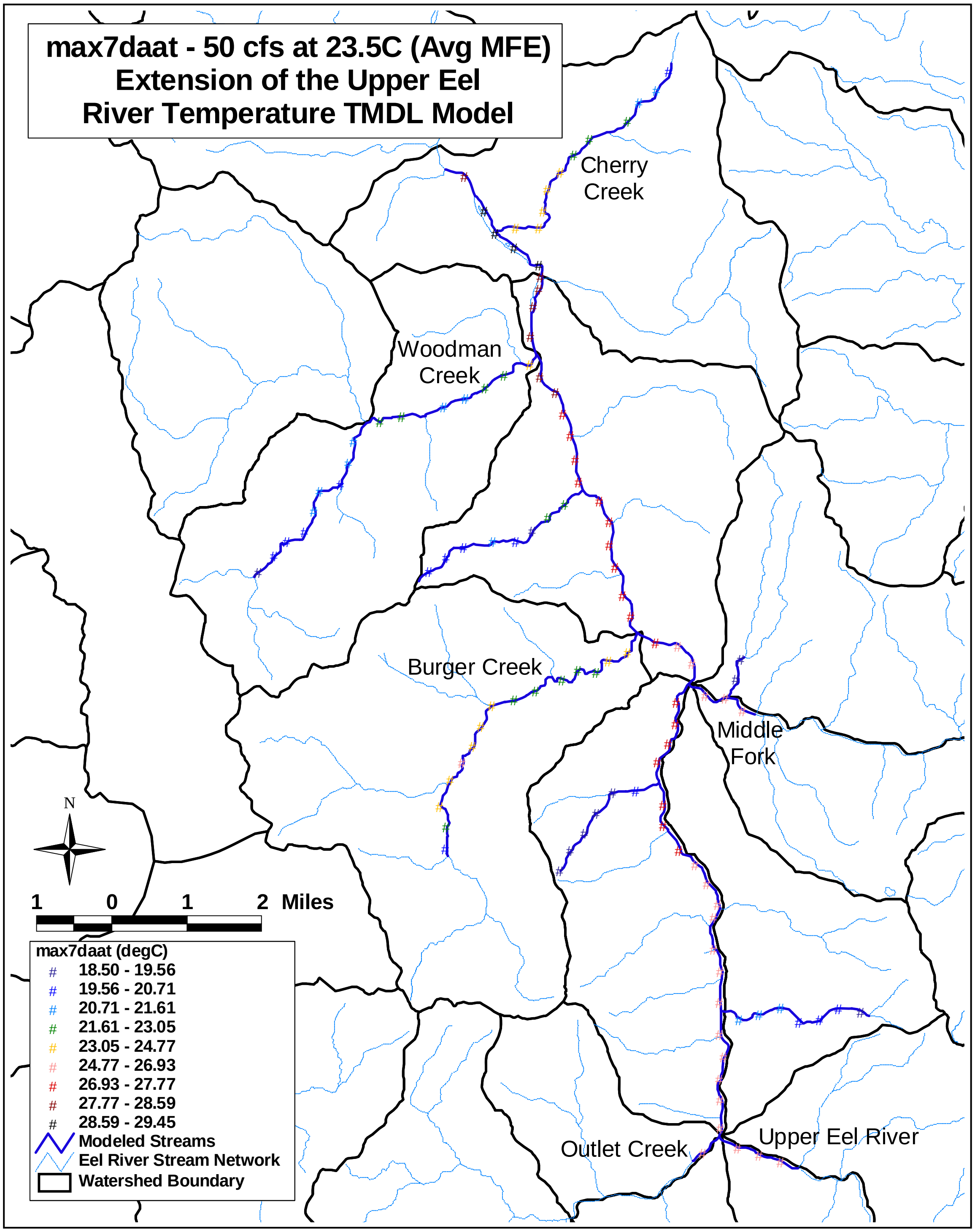


Figure A-45.  Max7daat ranges for the 50 cfs at 23.5°C flow scenario with average Middle Fork flow

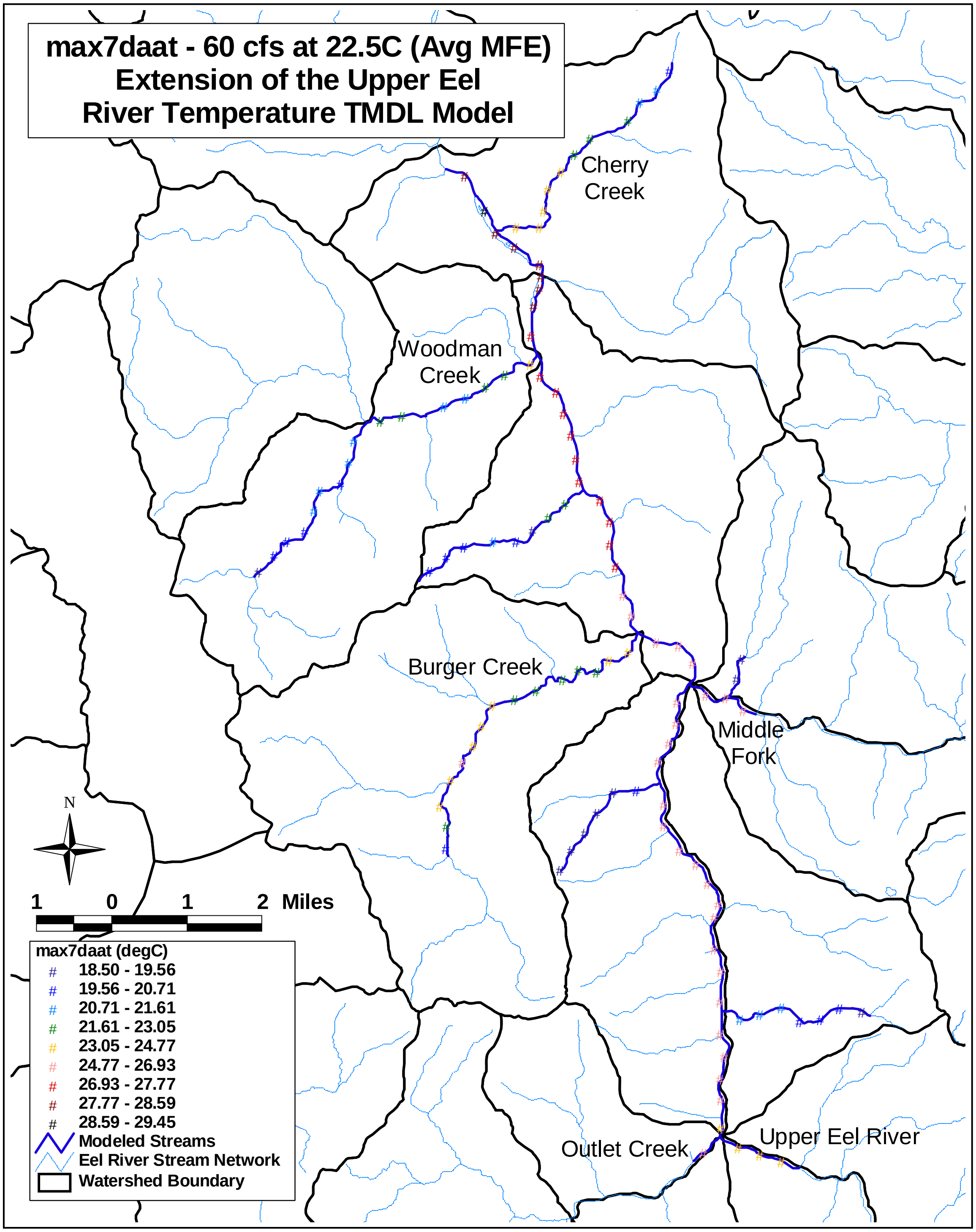


Figure A-46. Max7daat ranges for the 60 cfs at 22.5°C flow scenario with average Middle Fork flow

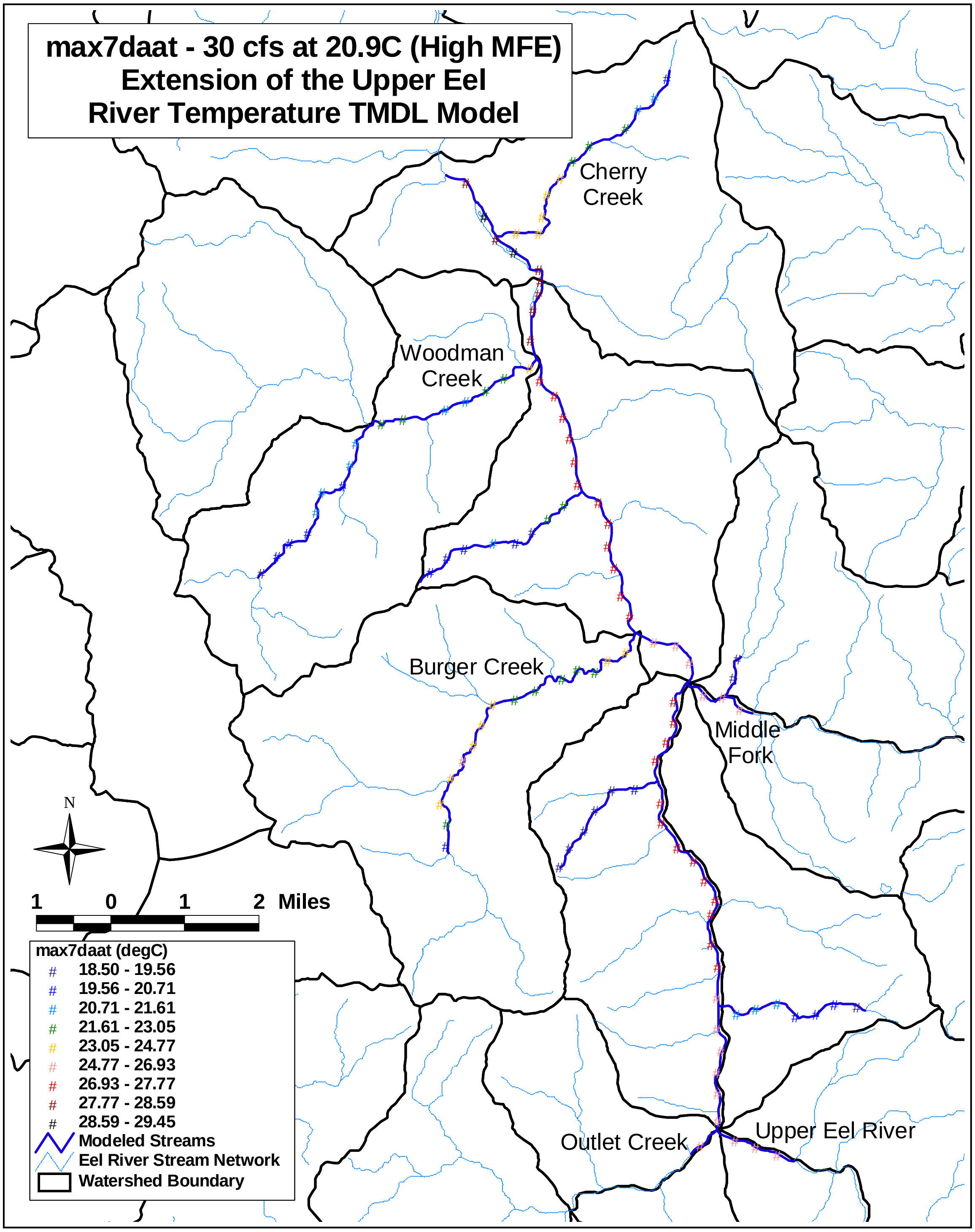


Figure A-47. Max7daat ranges for the 30 cfs at 20.9°C flow scenario with high Middle Fork flow

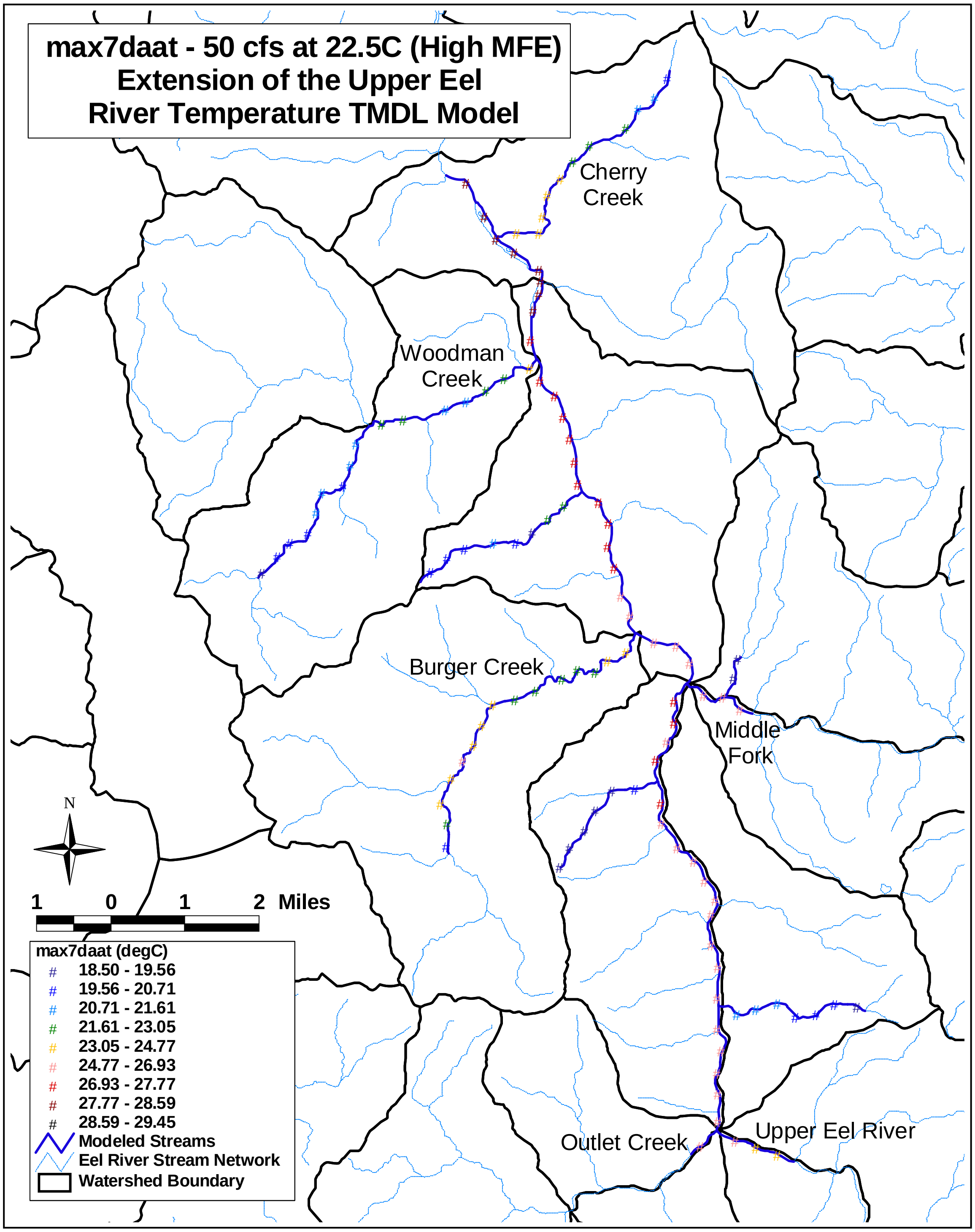


Figure A-48.  Max7daat ranges for the 50 cfs at 22.5°C flow scenario with high Middle Fork flow

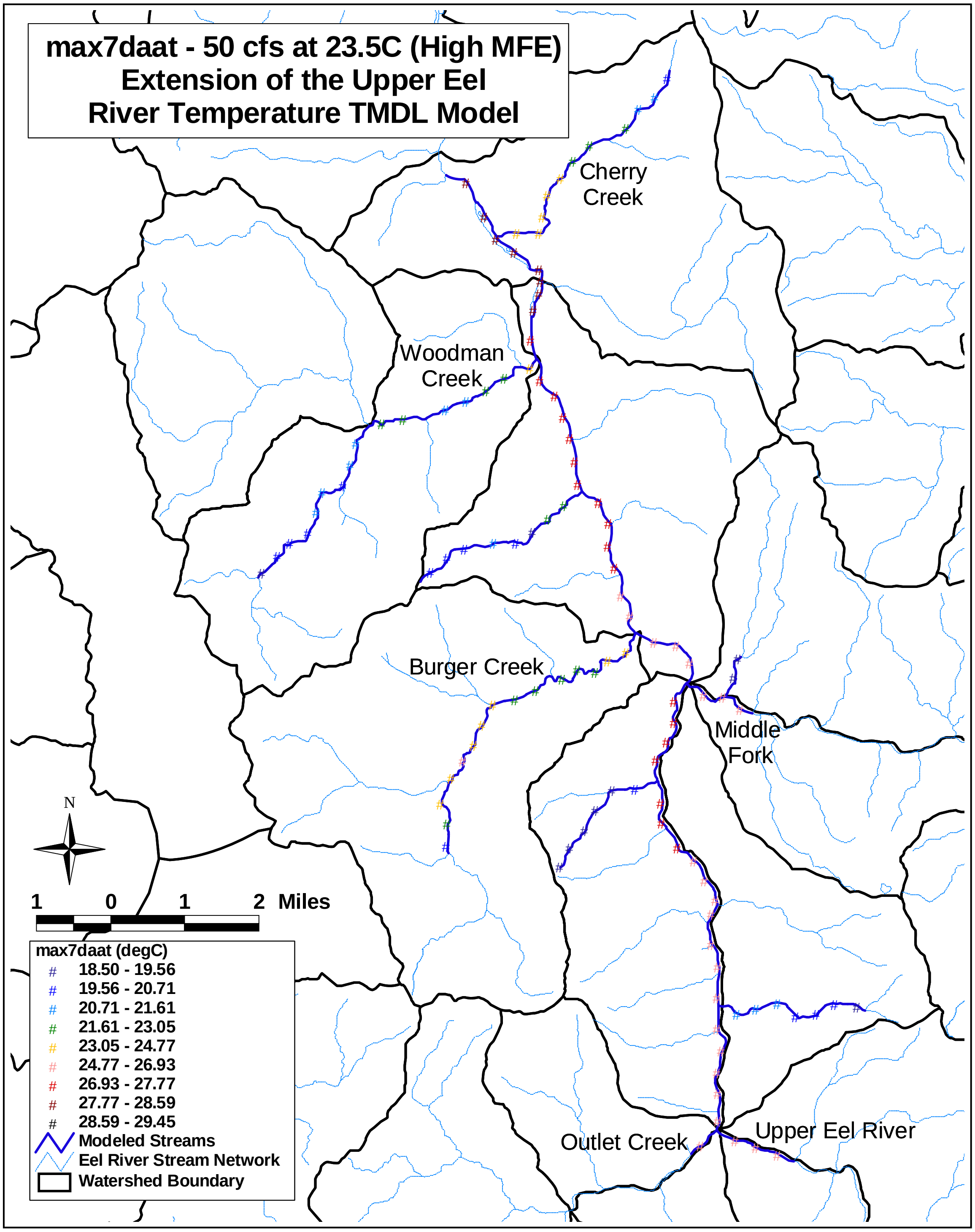


Figure A-49. Max7daat ranges for the 50 cfs at 23.5°C flow scenario with high Middle Fork flow

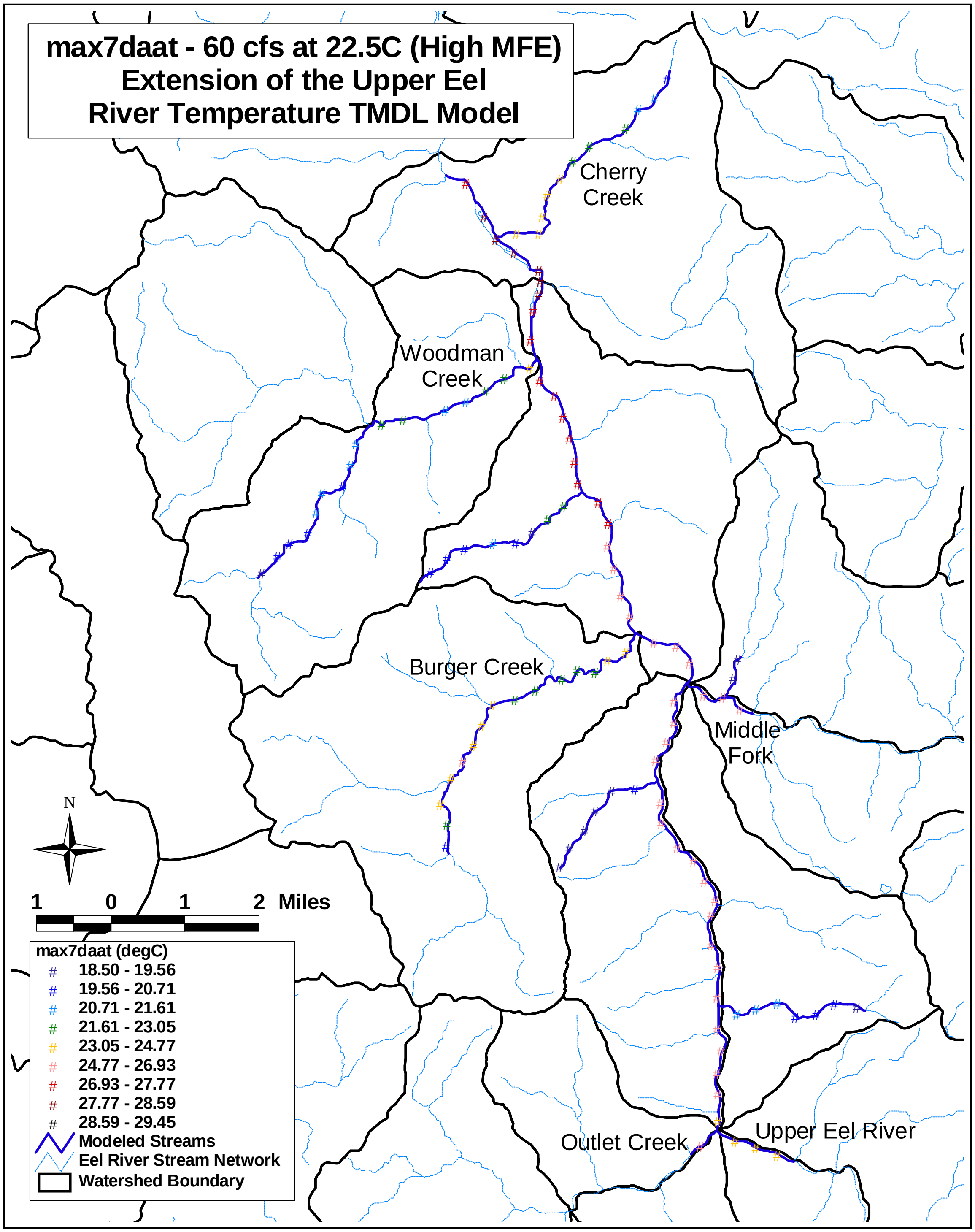


Figure A-50. Max7daat ranges for the 60 cfs at 22.5°C flow scenario with high Middle Fork flow

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