**Staff Report**
**Supporting the Policy for the Implementation of the Water Quality Objectives for Temperature**

**PEER REVIEW DRAFT**

**July 1, 2013**

**Peer Review Draft**

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enforcement actions; support of restoration projects; and coordination with other agencies with jurisdiction over controllable factors that influence water temperature.

Continue to implement the Sediment TMDL Implementation Policy as a means of addressing elevated water temperature associated with excess sediment discharges. Implement sediment controls consistent with the approach articulated in the Sediment TMDL Implementation Policy to address temperature concerns associated with sediment in areas not impaired by sediment. 30

Examine and address temperature impacts when developing permits or programs for nonpoint source activities. Consider and implement, where applicable, all available measures to prevent and control the elevation of water temperatures in permit or program development. Such measures shall include, but are not limited to, sediment Best Management Practices and cleanups, memoranda of understanding or agreement with other agencies, prohibitions against waste discharges, management of riparian areas to retain shade, and mitigation of tailwater and impoundments. Where appropriate, include monitoring requirements for incorporation into permits, programs, and other orders to confirm management actions required to prevent or reduce elevated temperatures are implemented and effective. 31

Address factors that contribute to elevated water temperatures when issuing 401 certifications, NPDES permits, Waste Discharge Requirements, or Waivers of Waste Discharge Requirements. 32

Use other regulatory, executive, and enforcement tools, as appropriate, to address elevated water temperatures and preserve existing cold water resources. 33

Support and encourage restoration projects that are designed to eliminate, reduce, or mitigate existing sources of temperature impairments. Administer, encourage, and support the use of grant funds to facilitate projects that address elevated water temperature concerns. Pursue non-regulatory actions with organizations, landowners and individuals to encourage the control of elevated water temperatures, watershed restoration, and protection activities. 33

Continue to coordinate with the Division of Water Rights by participating in the water right application and petition process, providing monitoring recommendations, joint compliance inspections, submittal of data in support of 401 certifications related to water diversions and/or facilities regulated by the Federal Energy Regulatory Commission, and any other appropriate means to help ensure that the terms of water right permits and licenses are consistent with the water quality objectives for temperature. 34

Coordinate with the Division of Water Rights on the development of instream flow studies and flow objectives, as appropriate. 35

## 1.0 INTRODUCTION

This document presents the background information and rationale that supports the North Coast Regional Water Board's proposed *Policy for the Implementation of the Water Quality Objectives for Temperature* and *Action Plan for the Implementation of the Water Quality Objectives for Temperature*. The *Policy for the Implementation of the Water Quality Objectives for Temperature* and *Action Plan for the Implementation of the Water Quality Objectives for Temperature* are proposed as a single amendment to chapter 4, (Implementation Plans) of the Basin Plan.

### 1.1 Background and Purpose

Approximately sixty-three percent of the area of the North Coast Region is listed as temperature impaired, per Section 303(d) of the Clean Water Act, because the water quality of those rivers and streams does not meet the temperature water quality objectives. Temperature impairments in the watersheds of the North Coast Region are predominantly associated with nonpoint sources of pollution, such as timber operations, agriculture, streambed alteration, land conversion and other construction activities. Temperature impairments are also associated with activities which do not generally involve waste discharge, such as vegetation alteration, water withdrawal, and hydromodification. Temperature Total Maximum Daily Load (TMDL) analyses of 13 watersheds in the north coast found the same factors to be responsible for elevated water temperatures: increased exposure to solar radiation due to loss of stream shade, physical stream channel alteration in response to elevated sediment loads, engineered stream channel alteration, and alteration of hydrology resulting from impoundments, water diversions, hydromodification, and landscape alteration. The widespread temperature impairments and common source factors within the North Coast Region point to the need for a region-wide approach for addressing temperature issues. The establishment and implementation of this Policy will provide a common approach to ensuring attainment of the water quality objective for temperature. Similarly, the establishment and implementation of such a policy will ensure that high quality waters are also protected.

On January 19, 2012, the Regional Water Board adopted resolution R1-2012-0013 titled "*Policy Statement for Implementation of the Water Quality Objective for Temperature in the North Coast Region*" (Policy Statement)[1]. The Policy Statement describes the water quality objectives for temperature, identifies common activities that have the potential to elevate water temperatures in excess of water quality objectives, and identifies the regulatory mechanisms at the disposal of the Regional Water Board used to control waste discharges and associated activities in a comprehensive and consistent manner. The Policy Statement also provides direction to staff developing and implementing permits and evaluating the water

[1] Resolution R1-2012-0013 can be downloaded at: http://www.waterboards.ca.gov/northcoast/board_decisions/adopted_orders/pdf/2012/120127_12_0013_Resolution_Temperature.pdf

quality impacts of proposed actions, clarification to the public regarding what is required to comply with the objective, and direction to staff to incorporate a Temperature Implementation Policy into the Basin Plan.

## 2.0 TEMPERATURE WATER QUALITY OBJECTIVES

The Basin Plan includes both narrative and numeric water quality objectives which describe the ambient water quality conditions necessary to protect beneficial uses. The Basin Plan contains two separate water quality objectives for temperature. The first objective is the intrastate temperature objective. This objective applies to all waters of the state.

The intrastate temperature objective is a narrative objective with associated numeric criteria and reads:

> The natural receiving water temperature of intrastate waters shall not be altered unless it can be demonstrated to the satisfaction of the Regional Water Board that such alteration in temperature does not adversely affect beneficial uses.
>
> At no time or place shall the temperature of any COLD water be increased by more than 5°F above natural receiving water temperature.
>
> At no time or place shall the temperature of WARM intrastate waters be increased more than 5°F above natural receiving water temperatures.

The second water quality objective for temperature is the interstate temperature objective contained in the state wide *Water Quality Control Plan for Control of Temperature In the Coastal and Interstate Waters and Enclosed Bays and Estuaries of California* (Thermal Plan). The Thermal Plan, as adopted by the State Water Board, is incorporated by reference in the Basin Plan (see Appendix 3 of the Basin Plan). The "Cold Interstate Waters" objective is as follows:

> Elevated temperature waste discharges into cold interstate waters are prohibited.

"Elevated Temperature Waste" is defined as:

> Liquid, solid, or gaseous material including thermal waste discharged at a temperature higher than the natural temperature of receiving water. Irrigation return water is not considered elevated temperature waste for the purpose of this plan.

The interstate objective applies to waters that cross or define the state border. The interstate temperature objective augments, but does not supersede, the intrastate temperature objective.

For those waterbodies which do not attain the ambient water quality conditions described by the water quality objectives, the federal Clean Water Act (CWA) requires an evaluation of the sources of pollution contributing to the impairment and the calculation of the reduced pollutant loads necessary to attain objectives. For waters impaired by elevated temperatures, CWA section 303(d)(1)(D) specifically requires that states estimate "the total maximum daily thermal load required to assure protection and propagation of a balanced, indigenous population of shellfish, fish, and wildlife."

Finally, the State Water Board adopted Resolution No. 68-16, "Statement of Policy with Respect to Maintaining High Quality of Waters in California", commonly known as the Antidegradation Policy. The Antidegradation Policy states:

> "Whenever the existing quality of water is better than the quality established in policies as of the date on which such policies become effective, such existing high quality will be maintained until it has been demonstrated to the State that any change will be consistent with maximum benefit to the people of the State, will not unreasonably affect present and anticipated beneficial use of such water and will not result in water quality less than that prescribed in the policies." (State Water Board Resolution 68-16)

Accordingly, all waters in the North Coast Region with ambient water temperatures representing natural conditions are identified as high quality waters. There is a current scarcity of waterbodies with temperatures that fully support the Region's COLD beneficial use, as indicated in part by the listing of red-legged frogs and several Pacific salmonids as threatened or endangered, and others designated as species of special concern (e.g., southern torrent salamanders and summer-run steelhead). The implication of the Antidegradation Policy is that waterbodies with temperatures that are cold enough to support these sensitive organisms during their temperature sensitive life stages, or colder, represent high quality waters regardless of their temperature status, and that any proposal likely to result in the elevation of water temperatures must be able to make the demonstrations spelled out in the Antidegradation Policy. This application of the Antidegradation Policy to temperature is supported by the Basin Plan on page 3-2.00, which states:

> "Where water quality is better than the minimum necessary to support instream uses, the federal [antidegradation] policy requires that quality to be maintained and protected unless the state finds, after ensuring public participation, that:
>
> 1) Such activity is necessary to accommodate important economic or social development in the area in which the waters are located,
> 2) Water quality is adequate to protect existing beneficial uses fully, and

3) The highest statutory and regulatory requirements for all new and existing point source discharges and all cost-effective and reasonable best management practices for non point source control are achieved."

## 3.0 INTERPRETATION AND IMPLEMENTATION OF THE WATER QUALITY OBJECTIVES FOR TEMPERATURE

The interstate temperature objective is written in the form of a prohibition preventing the discharge of elevated temperature waste. Interpretation of the interstate objective is relatively simple, requiring the determination of whether a discharge meets the robust definition of "elevated thermal waste" presented above.

The intrastate temperature objective requires the maintenance of natural ambient temperature conditions, with certain flexibility afforded at the discretion of the Regional Water Board. The intrastate temperature objective is a narrative objective with associated numeric criteria that allows for its interpretation in the context of specific beneficial uses. Figure 1 presents a decision tree representing the logical process of interpreting the intrastate objective. The intrastate objective is interpreted at both the watershed scale and at discrete locations such as a stream reach or pond.

As seen in Figure 1, the first test in interpreting the intrastate objective is whether water temperature is altered from natural conditions. If temperatures have already been altered or could be altered by a proposed project, then a demonstration must be made (to the satisfaction of the Board) that (1) the alteration in ambient water temperature has been or would be less than 5 $^{o}$F above natural receiving water temperatures and (2) any elevated ambient water temperatures do not adversely affect beneficial uses. The assessment of natural temperature conditions is discussed in Section 3.1, below.

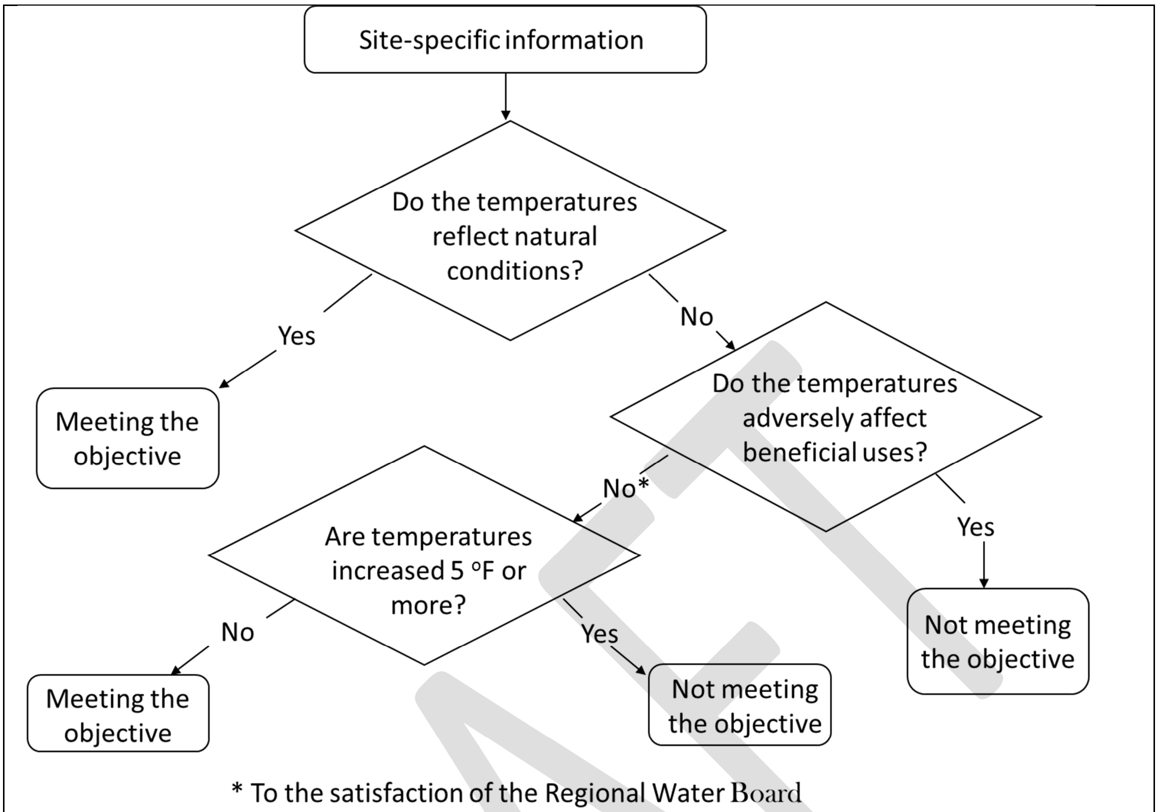


Figure 1: Decision tree representing the logical process for determining attainment of the Intrastate Water Quality Objective for Temperature

In the absence of a demonstration that a given temperature alteration won't adversely affect beneficial uses or increase temperatures by 5 °F or more, the default objective is no change in temperature. The language of the objective clearly places the burden of proof on the proponent of the action that has potential to alter the temperature. Accordingly, Regional Water Board staff establishes permit conditions that are expected to result in no alteration of temperature. The Regional Water Board may authorize an increase in temperature of up to 5 °F, if appropriate.

The determination of adverse effects on beneficial uses is based on the thermal requirements of the most sensitive beneficial use present. In most cases in the north coast region, the cold freshwater habitat beneficial use (COLD) is the most sensitive beneficial use. Cold water ecosystems in the north coast region support fish, amphibians, macroinvertebrates, and other organisms with specific thermal tolerances. Therefore, interpreting the intrastate temperature objective nearly always involves comparing the temperature conditions being considered relative to the temperature conditions that fully support one or more of these organisms.

In situations in which temperatures exceed the biological temperature requirements for full support of the beneficial uses present, no increase in temperature can occur without adverse effects.

The development of temperature TMDLs in the north coast region requires interpretation of the intrastate objective, and thus the application of the logical process shown in Figure 1. The temperature TMDLs have also identified and defined conditions necessary to achieve the objective at a watershed scale, as required by law, drawing on the results of temperature modeling and peer-reviewed scientific literature.

## 3.1 Estimation of Natural Stream Temperatures

Natural receiving water temperatures are either estimated using standard techniques as described below, or assumed where the factors controlling stream temperature (e.g., shade, sediment deposition, and flow) represent natural conditions.

Natural receiving water temperatures are the temperatures that occur when the factors controlling water temperature, including shade, flow, and channel morphology, are equivalent to their natural condition. Accordingly, the Regional Water Board issues permits to achieve environmental conditions that control stream temperature that are equivalent to thermal impacts associated with natural conditions (e.g., restoration of site potential shade, restoration of natural hydrologic form and function, and control of erosion to natural rates).

The control of shade on the surface of waters of the state is a major focus of the Regional Water Board's efforts to meet the intrastate water quality objective for temperature. All Temperature TMDLs developed in the Region assign load allocations for shade, with the allocated amount equivalent to natural conditions, and referred to as site-potential shade. Site–potential shade refers to the amount of shade that can be provided by vegetation at a site, given the species of vegetation present, and taking into consideration the growing conditions at the site. The temperature TMDLs and load allocations are discussed in detail in section 4.0 and 4.2, below.

The intrastate water quality objective for temperature references natural receiving water temperatures. Natural receiving water temperatures are those that result when the factors that drive water temperatures are consistent with natural conditions. An accurate interpretation of the intrastate water quality objective for temperature then relies in part on the assessment of natural temperatures. In such an assessment, all anthropogenic factors that may cumulatively act on a stream to alter its temperatures must be considered, including:

- upstream flow alterations,
- past canopy removal, either mechanically or as a result of increased sediment loads or other types of disturbance; and,
- alteration of channel characteristics such as width, depth, and streambed permeability, either from engineered alterations or those associated with geomorphic changes caused by hydromodification or altered sediment loads.

Often the temperature of a waterbody in question has been altered in the past. In this case, the degree of temperature alteration must be evaluated to determine:

- the existing temperatures meet the intrastate water quality objective for temperature,
- what beneficial uses may have been supported prior to alteration of the temperature; and,
- how much temperature increase can occur without exceeding the intrastate water quality objective for temperature.

A variety of common techniques are available for estimation of natural stream temperatures at a given site. Reasonable estimates of natural temperatures can be developed by comparison with reference streams, simple calculations, or use of computer models, depending on the situation. Though a number of techniques may be applied, the most appropriate technique will depend on the site-specific conditions of the location of interest. Factors that may necessitate a more in-depth analysis are:

- significant alteration of shade conditions,
- significant alteration of natural hydrologic conditions,
- unique hydrologic features such as springs or cold tributaries,
- estuarine environments; and,
- thermal stratification.

<u>Defining the alteration of thermal influences</u>
The first step in estimating natural stream temperatures is to identify the thermal factors that have been altered from natural conditions. Once the altered thermal factors have been identified, the effects of those alterations can be assessed using the tools described below.

<u>Comparison with reference streams</u>
Reference streams can be helpful for estimating natural temperatures if the reference stream closely resembles the location of interest in a natural state. Headwater stream reaches and mainstem trunk stream reaches are two types of stream environments that are particularly suited for this type of analysis, if shade and meteorological conditions are comparable.

Headwater streams are suited to these types of comparisons because they are close to the stream source, most often groundwater or melting. Groundwater is fairly constant year round, and generally defines the lower temperature limit for streams in the summer months. The lowest reaches of mainstem trunk streams, such as the mainstem Eel River at Alderpoint, are also suited to these types of comparisons because they typically represent temperatures that are in equilibrium with heat sources and sinks. Maximum stream temperatures of the lower reaches of major rivers are typically very similar in the summer months. Stream reaches in between the headwaters and lower mainstem stream reaches are only suited for comparison with reference streams if the riparian, hydrologic, and meteorologic conditions are comparable from the headwaters to the location of interest.

Simple Calculations

The use of simple calculations can be useful in estimating natural stream temperatures. The mixing equation, $Q_{ds}*T_{ds} = Q_{us}*T_{us} + Q_{trib}*T_{trib}$ (where the Qs represent flows, Ts represent temperatures, ds denotes downstream, us denotes upstream, and trib denotes tributary temperatures and flows) is a helpful equation for calculating the change in temperature downstream of a confluence of two streams. Similarly, Brown's equation, a simple equation representing the relationship of flow, channel geometry, and solar radiation, gives a reasonable estimate of temperature change due to alteration of solar exposure for short stream reaches, where the conditions in the reach are homogeneous (Brown 1970).

Computer models

Many computer models have been developed with the ability to calculate stream temperatures. Some of these models were developed for other purposes and only calculate temperature in order to calculate other water quality related processes, while others were specifically developed with stream temperature applications in mind. Either type of model can be used to estimate stream temperatures if all the relevant processes and factors are accounted for in the model. For instance, some models do not take into account riparian shade, while others do.

One of the more commonly used simple stream temperature models is SSTEMP, maintained by the USGS. SSTEMP is considered a simple model because it requires no compiler or complicated input files. The calculation scheme is also simple, relying on daily average input data to estimate daily average stream temperatures for a single reach. Accordingly, SSTEMP is well-suited for simple thermal situations. It can be used to evaluate the effects of changes in channel geometry, vegetation, meteorological conditions, and changes in flow. A limitation of the SSTEMP model is that the averaging period of the data used to run the model must be approximately equal to the travel time of the reach being modeled. Also, the SSTEMP model does not perform well if the reach in question encompasses drastic differences in shade, flow, channel geometry, or meteorological conditions within it.

Deterministic computer models are useful in situations where a reach of stream, or a stream network, requires a more sophisticated analysis. These models are designed to accommodate variable conditions in time and space, which requires that those variables be defined in time and space. The definition of those conditions requires large amounts of data. To use a deterministic model to estimate natural temperatures, the natural condition of each factor that influences stream temperatures must be estimated over for the entire temporal and spatial extent of the analysis.

The Klamath TMDL temperature analysis is an example of the use of deterministic models to estimate natural temperatures. In that analysis natural temperatures were estimated by defining the estimated natural conditions of the Klamath River and calculating the temperatures that would result from those conditions using the RMA model (Tetra Tech 2009). Estimates of natural flows from Upper Klamath Lake and downstream tributaries were used to represent natural hydrologic conditions. Similarly, the natural, un-dammed geometry of the Klamath River was characterized to define the natural channel geometry. Finally, existing mainstem shade and meteorological conditions were assumed to be comparable to natural conditions.

<u>3.2 Site-specific Implementation</u>

Interpretation of the intrastate water quality objective for temperature at the project scale requires consideration of the particular conditions present in each situation. The drivers of elevated water temperature are well understood[2], however the site-specific impacts of those drivers in any specific setting are best evaluated for each situation. There are a few reasons why this is the case.

In order to evaluate whether water temperatures in a given waterbody represent natural conditions, the natural state of temperature drivers must be assessed. For instance, a riparian area with a history of canopy removal may provide the same level of solar attenuation as another undisturbed riparian area with low levels of canopy due to sub-optimal growing conditions, with resulting temperatures that are nearly identical. In the first case, the site may not be meeting the intrastate water quality objective for temperature because the levels of solar radiation are unnaturally high due to past canopy removal activities resulting in unnaturally elevated water temperatures, whereas the same temperatures in the second stream would meet the objective if the other drivers were also consistent with natural conditions. Similarly, a project that removes riparian vegetation may or may not increase solar radiation loading in the stream depending on the geometry of the vegetation relative to the stream and surrounding topography. Finally, the relative temperature condition is another factor that must be considered when evaluating whether a project will cause exceedence of the intrastate water quality objective for temperature. For instance, a stream that is cold relative to air temperatures, such as a spring-fed inland stream near its source, will be much more sensitive to additional heat loads than a stream that is already warm and near the equilibrium temperature. Similarly, a relatively cold stream with reduced flows will be less resilient to heat loads than a relatively warm stream that is near the equilibrium temperature.

<u>3.3 Implementation in Impaired vs Unimpaired Waterbodies</u>

Waterbodies that are not meeting the water quality objective for temperature are considered impaired, and are identified on the 303(d) list of impaired water bodies as such. Many, but not all waterbodies impaired by elevated water temperatures

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[2] The drivers are discussed in section 4.0 and associated subsections in relation to TMDL analyses, and section 6.0 and associated subsections, generally.

have had TMDLs developed for them. The development of temperature TMDLs in the North Coast Region is discussed in Section 4.0. When waterbodies are not meeting the temperature objectives, either because their water temperatures have been elevated above a temperature threshold associated with a beneficial use, or because they have temperatures elevated above 5 $^{o}$F, no additional temperature increase can be accommodated.

Because temperature impaired waterbodies cannot accommodate any increase in temperatures, the intrastate water quality objective for temperature requires that permitted conditions result in natural conditions in these waterbodies. In the case of shade, natural conditions are defined as site-potential conditions, as discussed in section 3.1, above. Thus, the approach to regulating impaired waterbodies must be consistent, regardless of whether a TMDL has been developed

The actions necessary to recover a water body that is temperature impaired due to alteration of the drivers of water temperature are the same types of actions that prevent a waterbody from becoming temperature impaired by such alterations. For instance, in the case of a stream with elevated temperatures caused by increased solar radiation resulting from vegetation removal, the action necessary to recover the natural temperature regime is to allow the riparian vegetation to grow back (or actively restore the vegetation conditions) to the degree that the natural shade condition is once again achieved. In the case of an unimpaired stream with unaltered temperatures, the riparian management action necessary to prevent the elevation of water temperatures is to prevent increases in solar radiation by maintaining sufficient riparian vegetation. In both cases, the riparian vegetation must be maintained and allowed to persist. The difference is that some amount of increased solar radiation exposure may be allowed in the unimpaired stream if it can be demonstrated to the Regional Water Board's satisfaction that:

- any temperature change won't adversely affect beneficial uses;
- water temperatures are not increased by 5 $^{o}$F or more at any time or place; and,
- the Antidegradation Policy is not violated.

The Regional Water Board establishes permit conditions that are expected to result in no alteration of temperature, as explained in section 3.0, above. Accordingly, it is appropriate for the Regional Water Board to establish permit conditions consistent with natural conditions, including site-potential shade. Dischargers and project proponents seeking a relaxation of this requirement should submit an analysis that satisfies the requirements described in the paragraph above.

In order to prevent future impairments and address existing temperature impairments, the regulatory approach to managing riparian vegetation for the protection of unimpaired temperatures and the regulatory approach to managing riparian vegetation to correct elevated water temperatures should be consistent throughout the region. Further, the regulatory approach should be based on implementation of both the intrastate water quality objective for temperature and the Antidegradation Policy, as described above.

3.4 Regulation of Shade as a Controllable Factor

The Regional Water Boards regulate the thermal impacts associated with increased solar radiation loads and the shade provided by riparian vegetation in the context of other types of discharges. The Porter-Cologne Water Quality Control Act (Act) authorizes the State and Regional Water Boards to control the discharges of waste to waters of the state through issuance of permits and by prohibiting certain activities. Solar radiation loads are not a discharge of waste, as defined by the Act. However, the Act states in Section 13263, Requirements for Discharge:

> "The regional water board, after any necessary hearing, shall prescribe requirements as to the nature of any proposed discharge, existing discharge, or material change in existing discharge…with relation to the conditions existing in the disposal area or receiving waters upon, or into which, the discharge is made or proposed. The requirements shall implement any relevant water quality control plans that have been adopted, and shall take into consideration the beneficial uses to be protected, the water quality objectives reasonably required for that purpose, other waste discharges, the need to prevent nuisance, and the provisions of Section 13241[3]." (emphasis added.)

The act defines "water quality control" as follows:

> "Water quality control" means the regulation of any activity or factor which may affect the quality of the waters of the state and includes the prevention and correction of water pollution and nuisance. [Section 13050(i)]

The Basin Plan is a water quality control plan. Thus, the Act authorizes the Regional Water Board to "prescribe requirements", including requirements related to "any activity or factor which may affect the quality of the waters of the state", that implement the Basin Plan and its programs of implementation. Controllable water quality factors are explicitly addressed in the Basin Plan. The Basin Plan states on page 3-1.00:

> "Controllable water quality factors shall conform to the water quality objectives contained herein. When other factors result in the degradation of water quality beyond the levels or limits established herein as water quality objectives, then controllable factors shall not cause further degradation of water quality. Controllable water quality factors are those actions, conditions, or circumstances resulting from

[3] Section 13241 pertains to the establishment of water quality objectives.

man's activities that may influence the quality of the waters of the State and that may be reasonably controlled."

The Porter-Cologne Act establishes the authority of Regional Water Boards to adopt waste discharge requirements and prohibitions to control the discharge of waste to waters of the State in order to achieve water quality objectives that support beneficial uses, as defined in the Basin Plan. This proposed amendment to the Basin Plan clarifies that the alteration of shade caused by human activities is a controllable water quality factor that must be addressed, as appropriate, in waste discharge requirements issued by the Regional Water Board, and regulatory actions by other state agencies. This is not a new interpretation, nor is it a change in Regional Water Board practice. However, identifying shade as a controllable water quality factor in the Basin Plan makes clear the importance of addressing shade to other agencies, dischargers, and other interested parties.

## 4.0 NORTH COAST TEMPERATURE TMDL ANALYSES

A necessary step in the development of Total Maximum Daily Loads is the interpretation of water quality objectives. The intrastate water quality objective for temperature is the only temperature objective applicable to all of the TMDLs developed, and thus has been the focus of temperature TMDL development in the north coast region. The temperature TMDL analyses have consistently found that the shade provided by riparian vegetation has a dramatic beneficial effect on stream temperatures, and that achieving the intrastate water quality objective for temperature requires riparian shade consistent with natural conditions. This concept is the basis of TMDL load allocations prescribed in every north coast temperature TMDL. Similarly, north coast temperature TMDLs have also identified the alteration of channel geometry caused by elevated sediment loads as a factor that must be controlled in order to meet the intrastate water quality objective for temperature. Load allocations for sediment are absent from many north coast temperature TMDLs due to the fact that sediment TMDLs were developed concurrently for the same waterbodies. In those cases, the control of elevated sediment loads was identified in the temperature TMDL margins of safety. Additionally, some north coast temperature TMDLs have identified the role of hydrologic alteration as a causative factor that must be addressed in order to meet the intrastate water quality objective for temperature.

The technical approach to developing load allocations meeting the water quality objectives for temperature in north coast temperature TMDLs has varied among the 13 temperature source analyses, based on the situations present. However, the 13 temperature TMDL analyses share common elements. All of the temperature TMDLs have made use of temperature models to investigate temperature dynamics using locally derived data. Most temperature TMDLs have also made use of shade models that predict the incidence of shade on stream segments. Table 1 summarizes information pertaining to the development of the 13 temperature TMDLs completed in the north coast region to date.

4.1 Identification of Drivers of Elevated Water Temperature

The sensitivity and response of stream temperatures to factors that drive them have been evaluated in temperature TMDL analyses completed in the north coast region. Figure 2 presents an example of such sensitivity analyses. Similar analyses were developed for the Mattole, Salmon, and Upper Lost River TMDLs. These sensitivity analyses were conducted using reach-scale temperature models and data representing site-specific conditions.

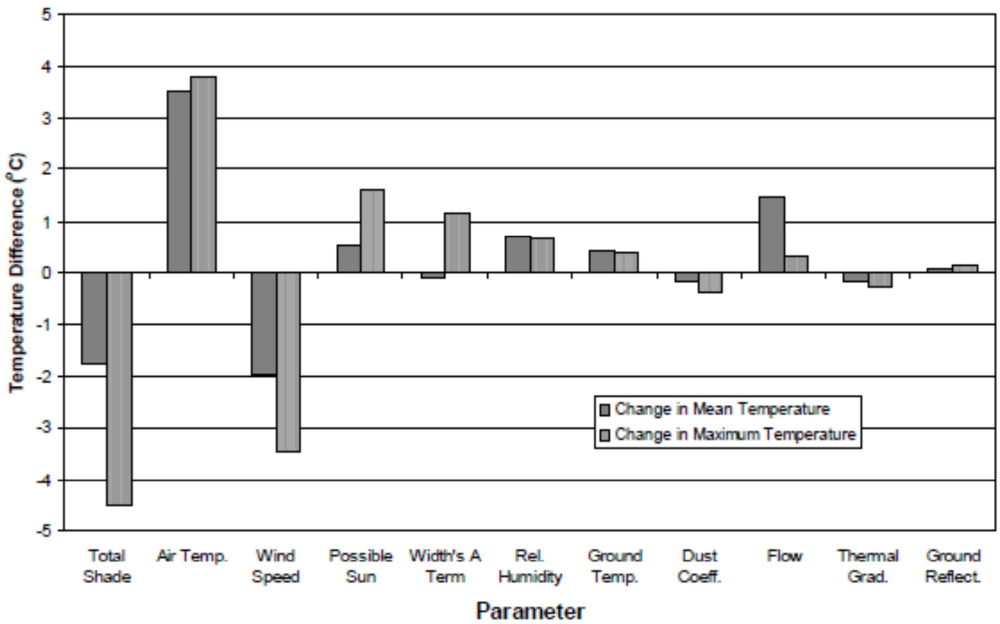


Figure 2: Results of a sensitivity analysis from the Navarro River temperature TMDL ranking temperature drivers (Source: NCRWQCB 2000)

The investigation of elevated stream temperatures in north coast streams points to a limited number of stream temperature factors that are directly affected by management activities. Figure 2 presents the results of an analysis examining the sensitivity of stream temperatures to the various factors acting to drive water temperature dynamics in the Navarro River watershed (NCRWQCB 2000). Of the factors that determine stream temperatures, shade and flow can be most directly affected by management activities. Air temperature, relative humidity, wind speed, ground temperature, width-to-depth ratio, Manning's n (a measure of channel roughness that affects the travel time of water), and ground reflectivity can be indirectly affected by management activities, but do not cause substantial temperature alteration in response to changes in the magnitude of values over the range that management actions can create.

| TMDL Assessment | South Fork Eel River | Navarro River | Mattole River | North Fork Eel River | Middle Fork Eel River | Upper Main Eel River | Middle Main Eel River | Lower Main Eel River | Upper Lost River | Salmon River | Scott River | Shasta River | Klamath River |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Year | 1999 | 1999 | 2001 | 2002 | 2003 | 2004 | 2005 | 2007 | 2004 | 2005 | 2005 | 2006 | 2009 |
| Temperature Model | BasinTemp | SSTEMP | SSTEMP | Q2ESHADE | Q2ESHADE | Q2ESHADE | Q2ESHADE | Q2ESHADE | SSTEMP | SSTEMP | Heat Source | TVA | RMA-2, RMA-11, CE-QUAL-W2 |
| Shade Model | Topquad | RipTopo | RipTopo | Q2ESHADE | Q2ESHADE | Q2ESHADE | Q2ESHADE | Q2ESHADE | n/a | SSTEMP | Heat Source | n/a | n/a |
| Vegetation Data Source | Klamath Bioregional Mapping Project | Klamath Bioregional Mapping Project | Calveg | Calveg | Calveg | Calveg | Calveg | Calveg | measured values | measured values | Calveg | measured values | n/a |
| Factors Identified | Shade, Sediment | Shade, Sediment, Flow | Shade, Sediment | Shade, Sediment | Shade, Sediment | Shade, Sediment | Shade, Sediment | Shade, Sediment | Delisted | Shade, Sediment | Shade, Sediment, Flow | Shade, Flow, Ag Return Flows | Shade, Sediment, Impoundments |
| Concurrent Sediment TMDL? | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | No | No | Yes | No | No |
| Lead agency (development) | USEPA | NCRWQCB | NCRWQCB | USEPA | USEPA | USEPA | USEPA | USEPA | NCRWQCB | NCRWQCB | NCRWQCB | NCRWQCB | NCRWQCB, ODEQ, USEPA |

Table 1: Summary of North Coast Temperature TMDL development information

## 4.2 Shade Analyses

Shade models have been used in the development of north coast temperature TMDLs to quantify the difference between current and potential stream shade conditions on both a watershed and reach scale. The products of the watershed-scale shade models - spatial databases of current and potential shade condition approximations - were used as the basis of TMDL load allocations (loads that meet the intrastate water quality objective for temperature). The watershed-scale shade models used in the development of north coast temperature TMDLs are simplified applications of the approach presented by Chen and others (1998a & 1998b), who developed the approach for the Upper Grand Ronde River (Oregon) Temperature TMDL.

The shade models used to determine north coast temperature TMDLs determine whether sunlight reaches a given segment of stream based on the location of the stream channel, the surrounding topography, attributes of the surrounding vegetation, and the path of the sun in the sky. The models calculate shade using readily available data describing ground elevations, stream hydrography, and vegetation present on the landscape (Boyd and Kasper 2003, Kennedy et al. 2005, Tetra Tech 2002). Information describing bankfull channel dimensions and the relationship of tree diameter to tree height was also collected and incorporated into the spatially explicit shade models.

The shade models used in the development of north coast temperature TMDLs provide a relative index of shade values in a spatially explicit manner. The models calculate the incidence of sunlight on a stream channel for each hour of the day, by determining whether sunlight is blocked by topography or vegetation at a given site and time of day. The daily score is the sum of the hourly scores, weighted by the relative magnitude of the solar load for each hour of the day.

The determination of whether sunlight is blocked by riparian vegetation is partly based on the assumed height of the vegetation, which in turn is based on relationships of diameter-at-breast-height (dbh) to tree height for the species of vegetation present. Information describing the species of vegetation at a given site is based on remotely sensed data describing vegetation distributions. Current vegetation heights were approximated based on the dbh of the species present in each grid cell, whereas the potential vegetation heights were based on the assumed mature height for the same species. The remotely sensed data used for these analyses include the Timber Task Force Klamath Province habitat database developed as part of the Klamath Region Vegetation Mapping Project and the CALVEG database developed by the USFS.

The first temperature TMDL developed in the north coast region was the South Fork Eel River Temperature TMDL (USEPA 1999). The temperature source analysis was conducted by Stillwater Sciences under contract to the USEPA and utilized a temperature model called the Stillwater Sciences Temperature Model, which in turn relied on a geographic information system (GIS) based method to calculate solar radiation reductions resulting from riparian vegetation and topography (Stillwater Sciences 1999). The solar radiation loads were then incorporated into a one-dimensional heat balance model (ibid). Figure 3 presents a graphical representation of the stream shade modeling approach.

The results of the South Fork Eel River temperature TMDL analysis demonstrated the importance of the shade provided by riparian vegetation for achievement of the intrastate water quality objective for temperature.

Figure 3.2 Features of tree height and solar radiation prediction model for a hypothetical north-south oriented channel

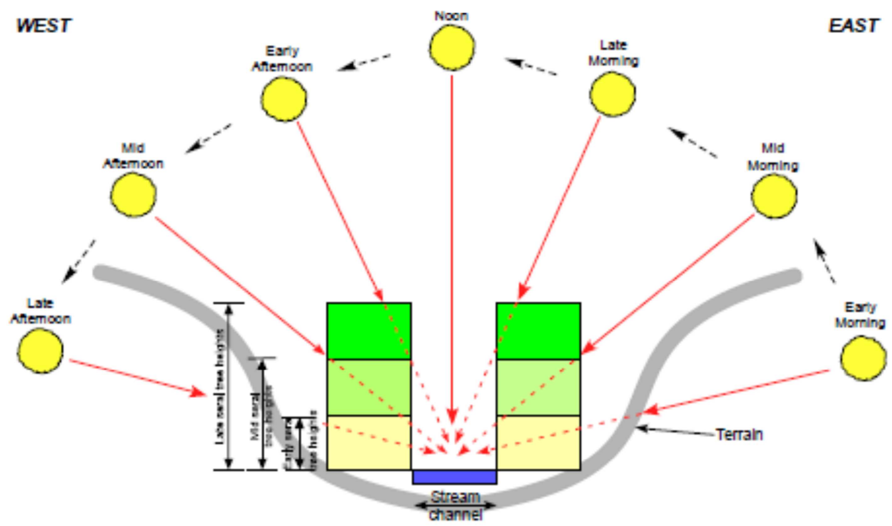


Figure 3: conceptual representation of riparian shade model. (Allen 2008)

The second temperature TMDL developed in the north coast region was the Navarro River Temperature TMDL (Navarro TMDL; USEPA 2000). The Navarro River temperature source analysis also identified the importance of shade provided by riparian vegetation for protection of stream temperatures. The Navarro River temperature source analysis was conducted by the NCRWQCB with assistance from the UC Davis Information Center for the Environment. The temperature source analysis utilized a riparian shade model called RipTopo, a GIS-based model much like the model developed by Stillwater Sciences for the South Fork Eel River Temperature TMDL (Kennedy et al. 2005). The Navarro TMDL also relied on the use of the USGS stream reach temperature model SSTEMP as a screening tool, as discussed above. The TMDL load allocations were set at the effective shade levels that represent potential vegetation conditions, based on the screening analysis conclusions. The RipTopo shade modeling results were the basis of the TMDL load allocations (NCRWQCB 2000, USEPA 2000).

The RipTopo model was later used for the Mattole River Temperature TMDL (NCRWQCB 2002, USEPA 2002a) and the Scott River Temperature TMDL (NCRWQCB 2005) in the same manner (defining TMDL load allocations) as in the Navarro TMDL. However, the Mattole River Temperature TMDL source analysis also estimated current and potential temperatures in nine tributary and three mainstem reaches using the SSTEMP model (NCRWQCB 2002), while the Scott River Temperature TMDL made use of the Heat Source temperature model to calculate stream shade and temperature approximations for the Scott River mainstem and three tributaries (Boyd and Kasper 2003, NCRWQCB 2005). The more sophisticated modeling approach was employed for the Scott River Temperature TMDL due to the more complex hydrology (i.e., effects of surface diversions, groundwater-surface water dynamics) present in that watershed. The Mattole River and Scott River temperature TMDLs also assigned temperature load allocations at levels corresponding to shade conditions representing potential vegetation conditions (USEPA 2003, NCRWQCB 2005).

Five of the six of the Eel River basin temperature TMDL source analyses were developed by Tetra Tech, Inc., under contract to the USEPA (USEPA 2002b, USEPA 2003, USEPA 2004, USEPA 2005, USEPA 2007). Tetra Tech developed a modeling system called Q2ESHADE for use in the temperature TMDL process (Tetra Tech 2002). The Q2ESHADE model combines the USEPA-supported QUAL2E hydrodynamic and water quality model with a shade modeling routine called SHADE, a GIS-based model formulated based on the model developed by Chen et al. (1998a) and applied to the Upper Grande Ronde River watershed (Chen et al. 1998b). The Q2ESHADE modeling system calculates hourly shade-attenuated solar radiation at various locations based on riparian vegetation characteristics and topographic relief, and utilizes these solar radiation loads to predict in-stream temperatures throughout a stream network (Tetra Tech 2002). The six temperature TMDLs developed in the Eel River basin assigned temperature load allocations at levels corresponding to shade conditions representing potential vegetation conditions based on the results of the modeling analysis (USEPA 2002b, USEPA 2003, USEPA 2004, USEPA 2005, USEPA 2007).

The Klamath River temperature TMDL analysis also evaluated the impacts of shade on tributary temperatures. The Klamath tributary analysis relied on principles of stream thermal dynamics supported by scientific literature and the analyses and conclusions of previous temperature TMDLs, particularly those developed for the Salmon, Scott, and Shasta River, and assigned load allocation for effective shade at levels corresponding to shade conditions representing potential vegetation conditions accordingly (NCRWQCB 2010).

### 4.3 Hydrologic Analyses

The evaluation of temperature impacts associated with changes in hydrology was a major focus of both the Shasta River Temperature TMDL (Shasta TMDL) and Klamath River Temperature TMDL (Klamath TMDL). The Shasta TMDL analysis evaluated the effects of stream diversions, irrigation tailwater return flows, impoundments, and riparian vegetation on temperatures of the Shasta River. The analysis of impacts relied on an application of the Tennessee Valley Authority's River Modeling System (TVA-RMS) temperature model originally developed for the Shasta Valley Resource Conservation District's Shasta River Flow and Temperature Modeling Project (Deas et al. 2003, Deas 2005). The shade values depicting current vegetation conditions and represented in the model were based on riparian vegetation inventories and measurements conducted by UC Davis, Watercourse Engineering, and Regional Water Board staff. Potential solar transmittance values representing potential vegetation conditions were developed by Regional Water Board staff, with consideration of existing vegetation, channel geometry, and soil conditions (NCRWQCB, 2006). The effects of tailwater return flows and stream diversions were also evaluated using the TVA-RMS model. Temperature load allocations corresponding to potential shade conditions, increased cold water flows of 45 $ft^3/s$, and zero thermal loading from tailwater returns were assigned based on the modeling exercise.

The Klamath TMDL analysis evaluated the effects of flow alteration and impoundments using a package of riverine hydrodynamic and water quality models (RMA-2 and RMA-11, respectively), coupled with a reservoir model (CE Qual-W2). The Klamath TMDL analysis evaluated the temperature impacts of altered tributary flows, altered mainstem flows, point sources, and reservoir operations on mainstem Klamath River temperatures. The analysis evaluated the effects of current and historic tributary flows on the temperature of the Klamath mainstem and determined that the tributary flows are too small to substantially alter the temperature of the much larger Klamath River in either the current or historic situation. The impacts of reduced flows from Upper Klamath Lake, the origin of the Klamath River, were also evaluated and found to have no appreciable effect on temperatures at the California-Oregon border.

The Upper Main Eel River Temperature TMDL and Middle Main Eel River Temperature TMDL also included an explicit evaluation of temperature effects associated with the Potter Valley Project, a Pacific Gas and Electric project that alters hydrologic conditions in the Eel River (USEPA 2004, USEPA 2005). That analysis determined that the impacts of the flow alteration were not impacting beneficial uses because the flows during the summer months under the 2004 FERC/NMFS flow schedule are of the same magnitude as unimpaired flows. EPA found that the current FERC/NMFS summer flow schedule likely results in stream temperatures cooler or nearly equal to the possible natural stream temperatures, and thus the FERC/NMFS flow schedule is projected to attain water quality standards.

The Scott River temperature TMDL source analysis explicitly evaluated the stream temperature impacts of reduced groundwater accretion. Regional Water Board staff used the Heat Source model to evaluate changes in stream temperature associated with both increases and decreases in the magnitude of groundwater accretion values based on measured flows and mass balances. The results of the analysis showed that the temperatures of the Scott River, which is primarily a groundwater dominated stream from July-September, are driven in part by the amount of groundwater entering the river as diffuse accretion.

### 4.4 Microclimate

Air temperature, wind speed, and relative humidity interact with one another to create microclimates associated with riparian corridors, and thus can affect stream temperatures. However, while these conditions are demonstrated to be factors indirectly affected by human activities, the information describing the magnitude of effects of human activities on microclimates indicate changes are relatively small and difficult to quantify (Bartholow 2000, Brosofske 1997, Chen et al. 1993, Chen et al. 1999, Dong et al. 1998, Ledwith 1996). Additionally, the types of changes in air temperature, wind speed, and relative humidity anticipated to arise from disturbance of riparian areas do not all act to increase stream temperatures. For instance, decreased relative humidity and increased wind speed, a likely result of riparian zone disturbances, act in concert to remove heat from a stream surface by increasing evaporation (Moore et al. 2005). Conversely, increased air temperatures that may result from riparian disturbances act to increase stream temperatures.

The magnitude of stream temperature impacts associated with changes in microclimate was explicitly evaluated in the Scott River TMDL analysis. In that TMDL analysis, a modeling exercise was conducted that evaluated the change in stream temperature resulting from a combination of changes in air temperature, relative humidity, and wind speed of magnitudes reported in the literature. The micro climate changes were represented in three scenarios that span the range of changes reported in the literature. The analysis results, presented in Figure 4, indicate that the magnitude of temperature alteration would be small, on the order of 0.5 $^{o}$C or less, whereas the temperature alteration associated with changes in vegetative shade could result in changes of up to 1.5 $^{o}$C over the same reach.

The impacts of elevated sediment loads are another factor identified as having the potential to elevate water temperatures. The impacts of elevated sediment loads, while not directly addressed in the sensitivity analysis presented in Figure 2, indirectly impacts many of the factors evaluated by the sensitivity analysis. For instance, elevated sediment loads can result in increased channel widths. Increases in channel widths result in a shallower stream for a given flow condition, which results in more of the water being accessible to solar radiation incidence. Conversely, narrower channels have less of their surface exposed to solar radiation. Elevated sediment loads can also lead to the removal of vegetation that shades a watercourse, as well as fill in deep pools that may thermally stratify in low flow conditions.

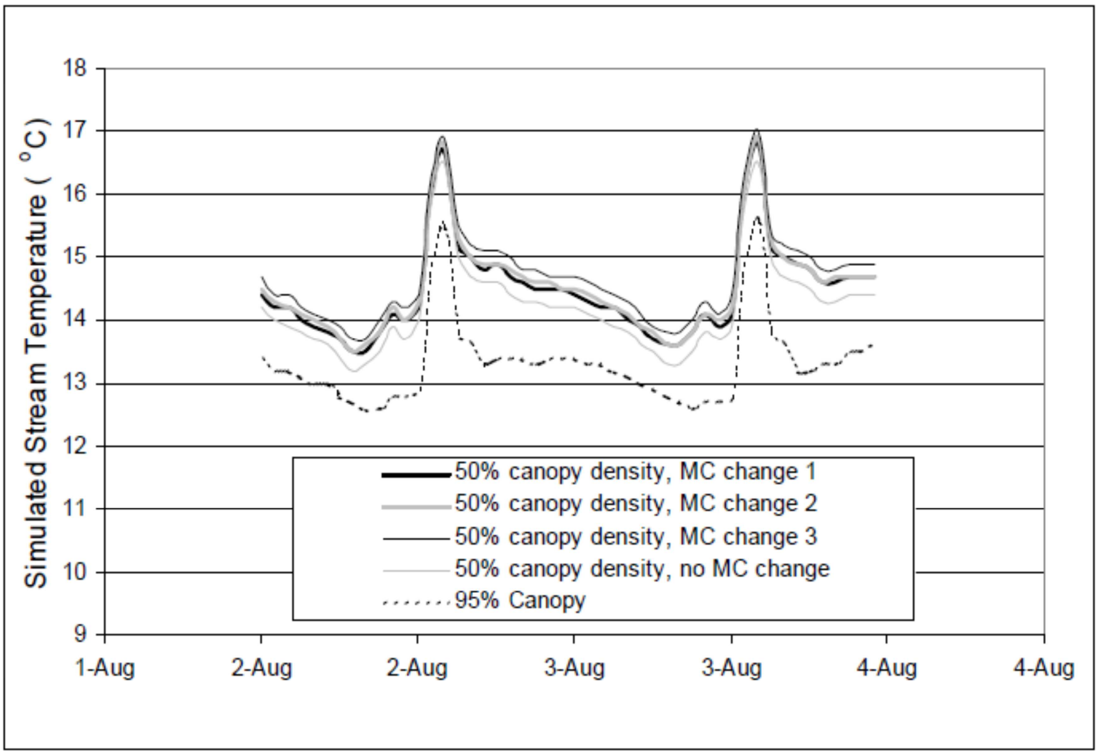


Figure 4: Temperature modeling analysis results showing theoretical impacts of microclimate relative to impacts of canopy removal (Source: NCRWQCB 2005).

Based on the analyses described above and the available literature, the implementation strategies developed to achieve TMDLs and the intrastate water quality objective for temperature have focused on a common set of pollutant discharges and controllable factors that have the potential to elevate water temperatures. These controllable factors and discharges are shade, flow, and sediment load.

## 5.0 FACTORS IDENTIFIED IN THE POLICY TO IMPLEMENT THE WATER QUALITY OBJECTIVES FOR TEMPERATURE

The proposed Policy identifies a number of land use activities and other actions (factors) that have potential to elevate water temperatures. The Policy identifies these general factors as those the Regional Water Board will address through implementation of regulatory programs and collaboration with partners to attain and maintain the intrastate and interstate water quality objectives for temperature. The factors were identified based on the conclusions and insights developed during the development of temperature TMDL analyses, as explained in Section 6.0. The factors are:

1. Land use activities with the potential to reduce riparian shade;
2. Land use activities with the potential to increase sediment delivery;
3. The quality, quantity, location and timing of effluent, storm water, and agricultural return flow discharges;

4. The location, size, and operation of in-channel impoundments with the potential to alter the natural hydrograph;
5. Actions with the potential to change stream channel geometry;
6. Land use activities with the potential to reduce instream summer flows or reduce specific sources of cold water, including cold water refugia, in COLD designated waterbodies (e.g., springs and seeps).

The factors identified above represent a range of land use activities and actions. Many of the factors come under the direct permitting authority of the Regional Water Board, while others are regulated through the authorities of other agencies.

## 6.0 JUSTIFICATION OF THE POLICY FACTORS

The justification and scientific rationale for each of the identified factors is presented below. Each of the Policy Factors is also represented in Figure 5, a conceptual model originally developed for the Klamath River temperature TMDL which graphically represents the drivers of temperature alteration, the resulting physical changes to environmental conditions, and consequent impacts to beneficial uses.

### 6.1 Land use activities with the potential to reduce riparian shade

Direct solar radiation is the primary factor influencing stream temperatures in summer months. The energy added to a stream from solar radiation far outweighs the energy lost or gained from evaporation or convection (Beschta et al. 1987, Johnson 2004, Sinokrot and Stefan 1993). At a given location, incoming solar radiation is a function of position of the sun, which in turn is determined by latitude, day of the year, and time of day. During the summer months, when solar radiation levels are highest and streamflows are low, shade from streamside forests and vegetation can be a significant control on direct solar radiation reaching streams (Beschta et al. 1987). Because shade limits the amount of direct solar radiation reaching the water, it provides a direct control on the amount of heat energy the water receives. At a workshop convened by the state of Oregon's Independent Multidisciplinary Science Team, 21 scientists reached consensus that solar radiation is the principal energy source that causes stream heating (Independent Multidisciplinary Science Team 2000).

Although the dominance of solar radiation is well accepted (Johnson 2004, Johnson 2003, Sinokrot and Stefan 1993, Theurer et al. 1984), some studies have indicated that air temperatures are the prime determinant of stream temperatures. These studies have based their conclusions on correlation rather than causation (Johnson 2003). Air and water temperatures are generally well correlated; however correlation does not imply causation. Heat budgets developed to track heat exchange consistently demonstrate that solar radiation is the dominant source of heat energy in stream systems (Johnson 2004, ODEQ 2002, Sinokrot and Stefan 1993). Stream temperature modeling conducted in support of north coast temperature TMDLs (see section 4.2, above) confirmed that solar radiation is the dominant heat exchange process in the north coast region.

The conclusion that solar radiation is the dominant source of stream temperature increases is supported by studies that have demonstrated both temperature increases following removal of shade-producing vegetation, and temperature decreases in response to riparian planting. Johnson and Jones (2000) documented temperature increases following shade reductions by timber harvesting and debris flows, followed by temperature reductions as riparian vegetation became re-established. Shade loss caused by debris flows and high waters of the flood of 1997 led to temperature increases in some Klamath National Forest streams (de la Fuente and Elder 1998). Riparian restoration efforts by the Coos Watershed Association reduced the maximum value of the weekly average temperature of Willanch Creek by 2.8 $^{o}$C (6.9 $^{o}$F) over a six-year period (Coos Watershed Association undated). Miner and Godwin (2003) reported similar successes following riparian planting efforts.

Shade is created by vegetation and topography; however, vegetation typically provides more shade to rivers and streams than topography in streams that are not wide relative to the height of vegetation. In these streams the shade provided by vegetation has a dramatic, beneficial effect on stream temperatures. The removal of vegetation can decrease shade, which increases solar radiation levels, which, in turn, increases both average and maximum stream temperatures, and leads to large daily temperature variations (see Figure 5). Additionally, the removal of vegetation increases ambient air temperatures, can result in bank erosion, and can result in a wider and shallower stream channel geometry, all of which also increase water temperatures.

<u>6.2 Land use activities with the potential to increase sediment delivery</u>

Increased sediment loads and associated changes in channel morphology can affect stream temperature conditions in multiple ways. These effects can manifest at both large (watershed-wide) and small (individual reach) scales. Sediment is defined as any inorganic or organic earthen material, including but not limited to: soil, silt, sand, clay, and rock (NCRWQCB 2007). The sizes of sediment that present a temperature concern are those that may result in pool filling, increased channel width, decreased channel depth, and/or a reduction of hyporheic (i.e. intergravel) flow.

Increased sediment loads may also reduce heat exchange associated with hyporheic processes through simplification of the bed topography and reduced permeability due to increases in fine sediment deposition. Hyporheic exchange occurs when surface waters infiltrate into the interstitial spaces of stream beds. As surface water passes through the porous sediment, heat is lost (or gained) through conduction with the sediments. In some settings, streambed conduction can be a significant heat sink that buffers daily maximum temperatures in the summer season (Loheide and Gorelick 2006).

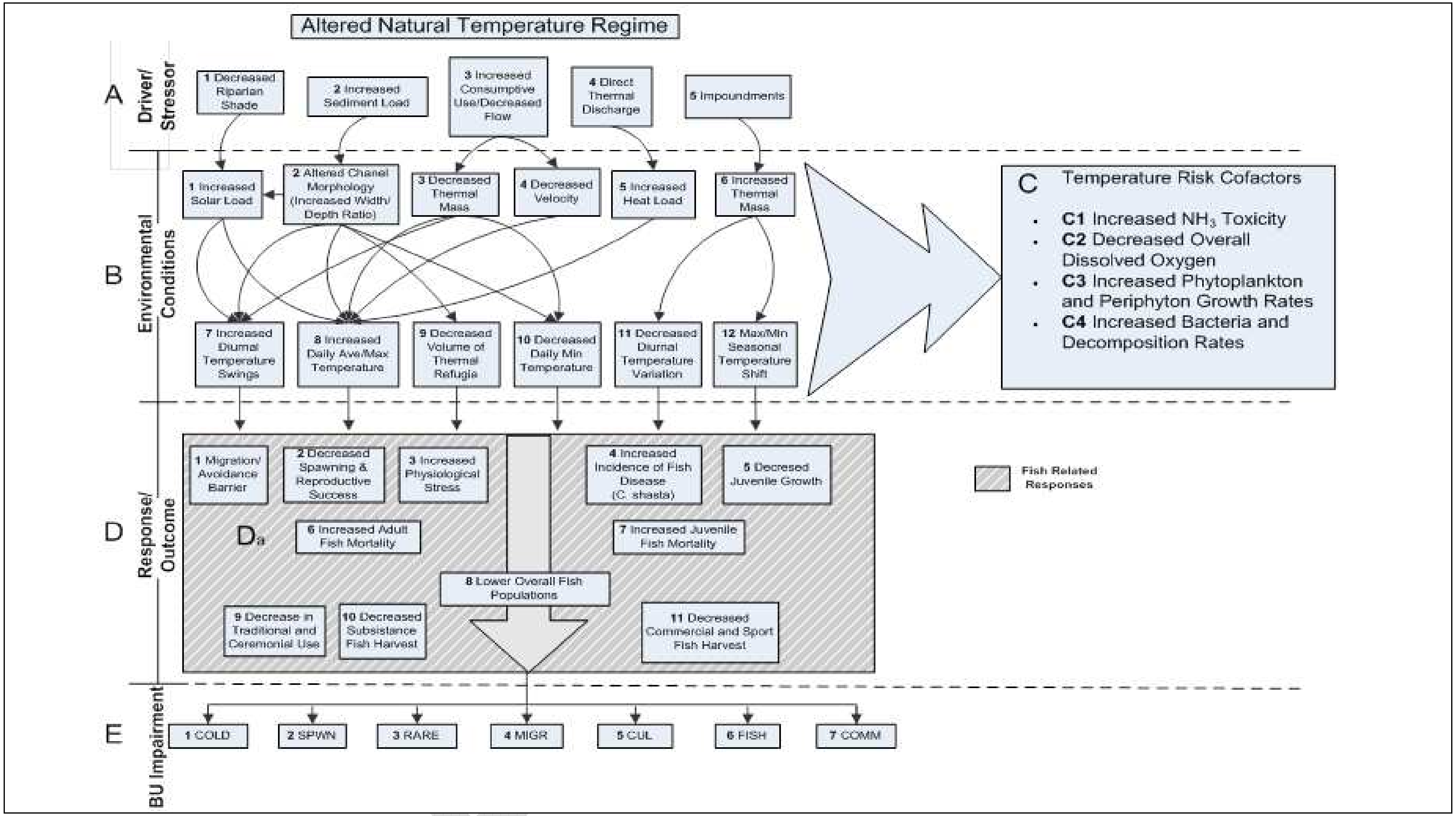


Figure 5: Conceptual representation of the causes and effects of temperature alteration and associated impacts to beneficial uses. (Source: NCRWQCB 2010)

Several published studies describe mechanisms of heat transfer dependent on permeability of bed sediments, effects of sediment on stream channel morphology, and stream channel characteristics related to thermal refugia. Vaux (1968) demonstrated that hyporheic exchange is dependent on the topographic complexity of the bed surface and permeability of the sediments. Lisle (1982) reported a simplification of streambed complexity associated with aggradation at stream gauge sites following the 1964 flood. He observed that gauging sites went from a pool-like form prior to aggradation, to a riffle-like form with flat cross-sectional profiles following aggradation. Wondzell and Swanson (1999) similarly evaluated the effects of large events on channel form. They specifically evaluated changes in the hyporheic zone resulting from large flood events and demonstrated that simplification of stream channel geometry, including loss of step-pool sequences, decreases intra-gravel exchange rates.

More recently, researchers have quantified the reduction in surface stream temperatures attributable to hyporheic exchange. In a study of Deer Creek in northern California, Tompkins (2006) found that reduced daily maximum water temperatures in hyporheic seeps on the order of 3.5 $^{o}$C (6.3 $^{o}$F) created thermal refugia for salmonids. In a study similar to Tomkins', Loheide and Gorelick (2006) documented daily maximum temperature reductions on the order of 2 $^{o}$C (3.8 $^{o}$F) in study of a 1.7 km (1.1. mi) stream reach of Cottonwood Creek in Plumas County, California.

Temperature and sediment concerns are often addressed together through careful management of riparian areas. The establishment of riparian buffers for temperature protection is an effective and important management measure for the control of some types of sediment discharges (Rashin et al. 2006). Maintenance of a vegetated buffer provides a control on the discharge of sediment mobilized by surface erosion (Brandow et al. 2006). Also, the retention of mature trees (and their roots) along a stream bank provides bank stability, reducing the discharge of sediment associated with stream bank landslides and debris flows (Cafferata et al. 2005). Maintenance of a vegetated buffer along streams also can ensure a supply of large woody debris to the stream channel, which is critical for metering of sediment, channel forming processes, and fish habitat.

<u>6.3 Actions with the potential to change stream channel geometry</u>

A wider and shallower channel gains and loses heat more readily than a narrow and deep channel. This principal is true for any stream. A stream's width-to-depth ratio influences stream heating processes by determining the relative proportion of the wetted perimeter in contact with the atmosphere versus the streambed. Water in contact with the streambed exchanges heat via conduction. Conductive heat exchange with the streambed has a moderating influence, reducing daily temperature fluctuations. Water in contact with the atmosphere exchanges heat via evaporation, convection, solar radiation, and long-wave radiation. However, wide and shallow channels have a greater surface area per unit of volume in contact with the atmosphere than a narrower, deeper channel. Heat exchange from solar radiation far outweighs heat exchange from evaporation, convection, and long-wave radiation, unless the stream is significantly shaded. The net effect of changes in width-to-depth ratios is that streams that are wide and shallow heat and cool faster than streams that are narrow and deep (Poole and Berman 2001).

The effects of a wider and shallower channel are similar to the effects of increased solar loading, in part because channel widening results in increased solar loading. Both changes lead to increases in daily average and maximum temperatures, increased diurnal fluctuations, and may lead to decreased daily minimum temperatures.

### 6.4 The quality, quantity, location and timing of effluent, storm water, and agricultural return flow discharges

Discharges of waste such as wastewater effluent, cooling water, stormwater runoff, and irrigation return flows can elevate the temperature of receiving waterbodies through the direct discharge of warmer water.

Flood irrigation is a common irrigation practice in parts of the Klamath basin, including the Klamath Project area and the Shasta River watershed. When irrigation water is applied to a field in this manner, it generally flows across the field as a thin sheet or in shallow rivulets. As the irrigation water runs across the ground it absorbs heat. When irrigation flows return to a stream, they carry with them the increased heat load added as they passed through the irrigated lands. Regional Water Board staff deployed temperature monitoring devices at several Shasta Valley locations with irrigation return flows. Upon review of the monitoring results, it was difficult to determine when the temperature monitoring probes were exposed to irrigation return flow versus when they were exposed to the air, indicating that the temperature of the tailwater return flows was generally at equilibrium with the air temperature. The net effect of direct thermal discharges is an increase in both daily average and maximum temperatures. The thermal impact of a direct discharge to a stream can be calculated using the mixing equation discussed in section 3.1, above.

### 6.5 The location, size, and operation of in-channel impoundments with the potential to alter the natural hydrograph

The water stored behind a dam functions as thermal mass, storing heat. Because larger volumes of water heat and cool slower than smaller volumes, the large volume of water behind an impoundment acts as a temperature buffer, reducing daily temperature variations downstream. Similarly, large volumes of water resist seasonal changes in temperature, and thus delay seasonal temperature changes, resulting in colder temperatures in the spring and warmer temperatures in the fall. In the Klamath River, these effects extend 190 miles downstream to the Pacific Ocean under certain conditions (Bartholow et al. 2005). The effects are most pronounced immediately downstream of Iron Gate Dam, diminishing in the downstream direction.

The expected biological implications of the changes in diurnal temperature patterns caused by dams are mixed. The decreased diurnal temperature variations associated with dams lead to reduced peak temperatures, thereby reducing the most acutely harmful temperatures. Conversely, the increased daily low temperatures associated with dams could reduce the time available for fish to leave thermal refugia to feed. Also, higher daily low temperatures may lead to higher temperatures at the bottom of thermally stratified pools (Nielsen et al. 1994).

The analysis of the impacts of the four impoundments associated with the Klamath Hydropower Project on river temperatures conducted as part of the Klamath River temperature TMDL found that those effects were significant (NCRWQCB 2010). The seasonal temperature changes caused by the dams have biological implications. The results of the Klamath TMDL analysis are consistent with the findings of Bartholow et al. (2005), who evaluated the thermal effects of the Klamath River dams on downstream reaches and determined that the dams delay the seasonal temperature patterns by approximately 18 days on an annual basis.

The physical implication of an 18-day shift in the seasonal temperature pattern is that the river is cooler in the springtime when juvenile salmonids are migrating to the ocean, and warmer in the fall when adults are migrating upstream and spawning, and eggs are incubating in the gravels. Cooler temperatures are known to reduce juvenile salmonid growth rates; however this effect may be mitigated by the benefit gained by reduced incidence of stressfully high temperatures during outmigration. Warmer temperatures in the summer period may reduce the nocturnal feeding opportunities of juvenile salmonids that persist at thermal refugia, thereby reducing their ability to withstand stressfully high daytime temperatures (National Research Council of the National Academies 2004). Warmer temperatures in the fall may delay adult migration or lead to stressfully high temperatures when adults are present or eggs are incubating in gravels.

<u>6.6 Land use activities with the potential to reduce instream summer flows or reduce specific sources of cold water, including cold water refugia, in COLD designated waterbodies (e.g., springs and seeps)</u>

Surface water diversions decrease the volume of water in the stream, and thereby alter a stream's response to heat inputs. When water is removed from a stream the thermal mass and velocity of the water is decreased. Thermal mass refers to the ability of a body to resist changes in temperature. Basically, less water heats or cools faster than more water. Decreases in velocity increase the time required to travel a given distance, and thus increases the time heating and cooling processes can act on the water. These principles are true for any stream, and work in concert with other heat exchange processes to determine the overall temperature of a stream.

The increase in the rate of heating that accompanies a decrease in the volume of flow in a stream can have significant temperature effects. A decrease in thermal mass results in higher daily high and lower daily low temperatures, as well as higher daily average temperatures. Reduced velocities also result in higher daily average temperatures.

Thermal refugia are typically identified as areas of cool water created by inflowing tributaries, springs, seeps, upwelling hyporheic flow, stratified pools, and/or groundwater in an otherwise warm stream channel offering refuge habitat to cold-water fish and other cold water aquatic species (NCRWQCB 2007). Thermal refugia are often the only environments in north coast streams that are habitable to salmonids during the hot summer months (Nielsen and others 1994, Watercourse Engineering 2006, Belchik 1997).

Thermal refugia are often formed in deep pools or pockets of water sheltered from mixing during low flow periods. Nielsen et al. (1994) demonstrated the relationship that pool volume and flow have on the determination of whether a pool stratifies. Simply put, in order for a pool to stratify in the absence of physical features that separate cold water inputs from the main stream flow, the volume of the pool must be large relative to the flow, resulting in extremely low velocities. In these situations, the bottom temperature is determined by the daily low temperature. Activities that either raise the daily minimum temperature or decrease the volume of the pool can impact these stratified pools.

Thermal refugia also can form in areas of a stream separated from currents where cold water sources such as springs, tributaries, or intergravel flows enter the stream (Nielsen and others 1994, Belchik 1997). These refugial areas can be impacted by activities that discharge fine sediments (decreasing intergravel flow), reduce or warm cold tributary or spring flows, or reduce the topographic complexity of stream channels.

Morphological changes associated with increased sediment loads can also eliminate or result in a decreased volume of thermal refugia in a stream or river and impede access to thermal refugia provided by tributaries. Refugial volume can be reduced or eliminated when deep pools fill with sediment, when side channels are buried, or when cold tributary flows percolate into aggraded tributary deltas or gravel bars before entering the river. Similarly, access to refugial tributaries can be reduced or eliminated when sediment loads result in aggradation and cause a tributary to percolate before entering the mainstem and thus become disconnected from the mainstem or become too shallow for fish to swim. Aggradation has impacted the mouths of Hunter, Turwar, Independence, Walker, Oneil, Portuguese and Grider Creeks (Klamath River tributaries), as well as 14 of 17 small Lower Klamath tributaries surveyed by the Yurok Tribe (De La Fuente and Elder 1998, Kier Associates 1999). Finally, refugia can be eliminated when tributary temperatures increase beyond salmonid thresholds due to the other effects of increased sediment loads discussed above.

## 7.0 ACTIONS TO ACHIEVE AND MAINTAIN WATER QUALITY OBJECTIVES

The following are actions identified in the proposed *Action Plan to Implement the Water Quality Objectives for Temperatures* (Action Plan). The actions are intended to achieve water quality objectives for temperature and implement temperature TMDLs, including EPA-established TMDLs. The Action Plan language is presented in bold print, with a discussion following.

**Restore and maintain site potential shade conditions through nonpoint source control programs; individual permits and waivers, grants and loans, and enforcement actions; support of restoration projects; and coordination with other agencies with jurisdiction over controllable factors that influence water temperature.**

This action directs Regional Water Board staff to consider all opportunities to restore and maintain riparian shade, including both regulatory and non-regulatory means. This direction incorporates the concept of shade as a controllable factor into the water pollution control plan, and in so doing strengthens the Regional Water Board's authority to address riparian shade when establishing waste discharge requirements.

<u>Nonpoint Source Permitting, Permits, and Waivers</u>

The Regional Water Board has developed nonpoint source permitting programs to address water quality concerns associated with a range of activities. To date, permitting programs involving waste discharge requirements, waivers of waste discharge requirements, or a combination of both have been developed for private timber activities, USFS activities, dairy operations, implementation of the Scott and Shasta River TMDLs, and management of county roads. Regional Water Board staff are currently in the process of developing a permitting program to address water quality concerns associated with agricultural operations, and participating in a multi-regional effort to develop a framework for a permitting program addressing grazing-related water quality concerns.

An example of the incorporation of shade concerns in nonpoint source permitting is the *Waiver of Waste Discharge Requirements for Nonpoint Source Discharges Related to Certain Federal Land Management Activities on National Forest System Lands in the North Coast Region* (USFS Waiver). The USFS Waiver establishes conditions designed to prevent water quality impacts associated with USFS management activities, such as those related to the management of riparian areas for the purposes of controlling sediment discharges and preserving riparian shade. The USFS Waiver conditions address temperature concerns by requiring the protection, maintenance, and enhancement of riparian conditions and shade.

Another example of the implementation of shade concerns is in the implementation of the *General Waste Discharge Requirements for Discharges Related to Timber Activities on Non-Federal Lands in the North Coast Region* (Timber GWDRs). Timber harvest activities have the potential to impact water temperature, depending on how the activities are conducted. For timber harvest activities on private lands, the Regional Water Board incorporates the California Board of Forestry's *Forest Practice Rules* into water quality permits for ease of reference, for consistent terminology, and to avoid duplicative processes to the degree possible.

The California Department of Forestry and Fire Protection (CAL FIRE), as the lead agency in approving timber harvest activities on private lands, convenes a multi-agency team that includes CAL FIRE, the California Department of Fish and Wildlife, the California Regional Water Quality Control Boards, the California Geological Survey, and other agencies as needed, to conduct a review of a timber harvest plan (THP). Each agency may recommend incorporating mitigating measures into the THP to reduce adverse impacts of the operation on timberland resources, including the beneficial uses of water. Through this process, Regional Water Board staff have an opportunity to make specific THP recommendations and clarify Basin Plan requirements, if needed, so that the final THP is eligible for enrollment in the timber GWDRs or waivers.

Under the *Forest Practice Rules*, timber operations within designated watercourse and lake protection zones must adhere to canopy retention standards to address stream temperature issues, sediment and nutrient loading, and recruitment of large woody debris. Recent modifications to the *Forest Practice Rules* to address anadromous fish habitat (Anadromous Salmonid Protection rules) have resulted in canopy retention standards that are generally protective of shade and water temperatures in the areas where they apply. Compliance with the intrastate water quality objective for temperature may in some instances require additional canopy protections, particularly in areas outside the range of anadromy and in streams that support aquatic habitat other than fish (i.e., streams identified in the *Forest Practice Rules* as Class II streams).

The *Timber GWDRs* contain a provision that all water quality requirements must be met to qualify for enrollment in the *Timber GWDRs*. As defined, water quality requirements include water quality objectives (narrative or numeric), prohibitions, TMDL implementation plans, policies, or other requirements contained in a water quality control plan adopted by the Regional Water Board and approved by the State Water Board, and all other applicable plans or policies adopted by the Regional Water Board or State Water Board, including, but not limited to, the State Water Board Resolution No. 68-16: *Statement of Policy with Respect to Maintaining High Quality Waters in California*. This proposed Policy and Action Plan would require that timber harvest plans be consistent with this Policy and Action Plan in order to qualify for enrollment in the *Timber GWDRs*. In application, this policy directs staff to continue implementing temperature load allocations through *Timber GWDRs* enrollments in areas subject to existing temperature TMDLs, including EPA-established temperature TMDLs. It also directs staff to implement similar shade controls through *Timber GWDRs* enrollments in areas listed as impaired for temperature, as appropriate, and region-wide, as appropriate and necessary, to prevent future impairments and ensure compliance with the intrastate water quality objective for temperature.

Grants and Loans and Support of Restoration Projects
The Regional Water Board administers programs that include loan and grant funding for construction of municipal sewage and water recycling facilities, remediation of underground storage tank releases, watershed protection and restoration projects, and nonpoint source pollution control projects. These funds can be used for projects that preserve and/or enhance riparian shade, such as riparian fencing, alternative stock watering systems, riparian planting, beaver management, and bioengineered bank stabilization projects. California's Clean Water State Revolving Funds are typically used to fund municipal wastewater infrastructure. However, it's possible that these types of projects could involve aspects that relate to riparian shade also, such as projects involving the upgrading of treatment systems that are adjacent to riparian areas.

Enforcement Actions
The Regional Water Board often takes enforcement actions to address the impacts associated with unpermitted activities causing discharges of waste and associated impacts to riparian areas, including removal or destruction of riparian vegetation. In such cases, the Regional Water Board issues orders, such as a cleanup and abatement order, that require the remediation of impacts to waters of the state,including impacts to riparian vegetation. Remediation of such impacts typically involves the restoration of vegetation that has been removed or destroyed.

Coordination with Other Agencies with Jurisdiction Over Controllable Factors that Influence Water Temperature
The Regional Water Board has the authority to issue permits for the discharge of waste to waters of the state. Temperature impacts are often caused by factors that are not associated with discharges of waste, but are instead caused by activities coming under the direct authority of other agencies. An example of this is the near stream activities that come under the land use planning authority of cities and counties. Cities and counties develop ordinances and define appropriate land uses through the adoption of land use plans and zoning. Sonoma County has established riparian setbacks in their general and area specific plans that call for restricted activities within certain defined distances from streams.

**Continue to implement the Sediment TMDL Implementation Policy as a means of addressing elevated water temperature associated with excess sediment discharges. Implement sediment controls consistent with the approach articulated in the Sediment TMDL Implementation Policy to address temperature concerns associated with sediment in areas not impaired by sediment.**

This action directs staff to pursue the existing *Sediment TMDL Implementation Policy* as a means of addressing sediment loads for the benefit of temperature conditions.

The *Sediment TMDL Implementation Policy* directs staff to use existing authorities to strengthen regulatory controls of nonpoint source discharges of sediment. Implementation of that Sediment Policy also partially implements the intrastate water quality objective for temperature insofar as the control of sediment discharges partially addresses elevated water temperatures.

The *Sediment TMDL Implementation Policy* is very similar to this proposed policy and reads, in part:

> "The Sediment TMDL Implementation Policy states that the Regional Water Board shall address sediment waste discharges on a watershed-specific basis and directs staff to take the following actions to control sediment waste discharges:
> 1. Rely on the use of existing permitting and enforcement actions. These actions are consistent with the NPS Policy.
> 2. Rely on the use of existing prohibitions, including any future amendments.
> 3. Pursue non-regulatory actions, such as Memoranda of Understanding, with other agencies and organizations.
> 4. Work with local governments and non-profit organizations to develop sediment control strategies, such as grading ordinances.
> 5. Encourage organizations and individuals to control sediment waste discharges and conduct watershed restoration activities.
> 6. Focus on public outreach and education.
> 7. Develop a guidance document on sediment waste discharge control.
> 8. Develop a sediment TMDL implementation monitoring strategy." (Basin Plan, page 4-36)

The implementation of the *Sediment TMDL Implementation Policy* has been largely achieved to date through the same nonpoint source permitting programs identified above. For instance, the Timber GWDRs require the development of erosion control plans and mitigation of all controllable sediment discharge sites within the timber harvest plan area during the life of the plan (usually 5 years).

**Examine and address temperature impacts when developing permits or programs for nonpoint source activities. Consider and implement, where applicable, all available measures to prevent and control the elevation of water temperatures in permit or program development. Such measures shall include, but are not limited to, sediment Best Management Practices and cleanups, memoranda of understanding or agreement with other agencies, prohibitions against waste discharges, management of riparian areas to retain shade, and mitigation of tailwater and impoundments. Where appropriate, include monitoring requirements for incorporation into permits, programs, and other orders to confirm management actions required to prevent or reduce elevated temperatures are implemented and effective.**

This action directs staff to incorporate elements that address temperature concerns when developing nonpoint source control programs. Regional Water Board staff is currently in the process of developing a permitting program to address water quality concerns associated with cultivated agricultural operations, and participating in a multi-regional effort to develop a framework for a permitting program addressing grazing-related water quality concerns.

There are a wide range of practices that can be employed to address temperature impacts associated with nonpoint sources. These include the designation of riparian management zones that are managed differently than surrounding lands, as well as the avoidance of other factors like tailwater discharges and the removal of vegetation that provides shade to a waterbody. In many cases the development of a water quality management plan is a preferred framework for identifying areas that require special management considerations to prevent water quality impacts, as well as the management practices employed, and documentation of the effectiveness of the practices.

This action also directs Regional Water Board staff to incorporate monitoring requirements into permits to ensure that actions taken to address temperature concerns are effective. The types of monitoring that might accomplish this span a range of monitoring types. For instance, photo point monitoring could be used to verify that best management practices are effective at maintaining riparian vegetation. Similarly, instream temperature monitoring could be required to verify that required conditions of an NPDES permits are achieved.

**Address factors that contribute to elevated water temperatures when issuing 401 certifications, NPDES permits, Waste Discharge Requirements, or Waivers of Waste Discharge Requirements.**

This action envisions conditioning individual waste discharge requirements, waivers of waste discharge requirements, or 401 water quality certifications to address any factors that contribute to elevated water temperatures.

The Clean Water Act delegates the authority to issue permits for dredge and fill activities within waters of the US to the US Army Corps of Engineers (USACE) and USEPA. The authority to issue such permits is declared in section 404 of the Clean Water Act, and these permits are often called 404 permits. Section 401 of the Clean Water Act requires applicants for 404 permits to obtain certification from the state verifying that the activity will comply with state water quality standards. These certifications are often called 401 water quality certifications, or just 401 certifications.

The scope of the State's jurisdiction is more broad than the USACE and USEPA's dredge and fill permitting jurisdiction. The federal authority is limited to waterbodies (i.e.,streams, wetlands, and tidal areas) that are navigable, or have a clear nexus to a navigable waterway (e.g. a wetland that has a surface connection to a navigable stream). The State's authority applies to all waterbodies within the borders of the State. For this reason, the Regional Water Board often issues waste discharge requirements for some dredge and fill activities through a general waste discharge requirement permit for dredge and fill activities. However, the same concerns and considerations are addressed, regardless of the permit.

Regional Water Board staff routinely issue 401 certifications and dredge and fill permits for projects such as bridge maintenance and retrofitting, streambank restoration, road construction and maintenance, as well as one-time projects such as pipeline and communication line crossings, flood channel maintenance, and land developments in areas with wetlands. The Regional Water Board has also issued 401 certifications for unique projects such as the Trinity River Restoration Program and the Highway 101 Willits bypass.

The 401 certifications issued by the Regional Water Board set conditions to address concerns associated with temperature factors such as reductions in shade, changes in cross sectional configuration, temporary dewatering impacts, and/or sediment deliveries.

**Use other regulatory, executive, and enforcement tools, as appropriate, to address elevated water temperatures and preserve existing cold water resources.**

This action calls for approaches that can be employed to address temperature concerns that don't involve the development and administration of permitting processes. Other regulatory, executive, and enforcement tools include basin planning exercises, memoranda of understanding and/or agreement with tribes or other agencies, and enforcement orders, such as cleanup and abatement orders and cease and desist orders.

Other regulatory actions include those that arise from the Regional Water Board's basin planning authority, such as the establishment of beneficial uses and water quality objectives. For instance, the establishment of a riparian ecology beneficial use could be contemplated as an appropriate beneficial use that warrants incorporation into the Basin Plan. Similarly, the Board has the authority to "establish prohibitions that specify certain conditions or areas where the discharge of waste, or certain types of waste, will not be permitted" (P-C, Section 13243).

Executive tools such as memoranda of understanding with states, tribes, or other agencies can be utilized to establish agreements relative to the administration of their authorities and programs for the benefit of water temperature and other water quality conditions.

**Support and encourage restoration projects that are designed to eliminate, reduce, or mitigate existing sources of temperature impairments. Administer, encourage, and support the use of grant funds to facilitate projects that address elevated water temperature concerns. Pursue non-regulatory actions with organizations, landowners and individuals to encourage the control of**

**elevated water temperatures, watershed restoration, and protection activities.**

Restoration is an important tool for achieving water quality conditions sufficient to protect and restore beneficial uses, and may be particularly necessary to address some temperature impairments. This action directs staff to encourage and promote restoration through the administration of grant funds and collaboration with organizations and individuals as a tool to achieve the water quality objectives for temperature. The Regional Water Board administers a number of grant programs that fund restoration, including the 319(h) and 205(j) grant programs, and sometimes proposition bond funds. However, most of the grant funded projects that address temperature concerns in the north coast region are funded through grant programs administered by other agencies, such as the California Department of Fish and Wildlife, US Fish and Wildlife Service, or Natural Resource Conservation Service. This action identifies the role the Regional Water Board can play in the promotion of individual projects funded through grant programs administered by the Regional Water Board, as well as those funded through other funding programs.

Some examples of restoration projects addressing temperature concerns that have been or could be funded through grants are the following:

- the planting of riparian vegetation in areas slow to recover from the legacy effects of past management activities,
- infrastructure, such as fences, stock watering systems, and shade structures to reduce impacts of livestock on riparian vegetation;
- projects that conserve water, resulting in reduced diversion of cold water from springs, streams, and aquifers in connection with surface waters;
- projects that lead to improved understanding of groundwater and surface water dynamics in areas where the interaction of these waters has been identified as a factor contributing to elevated water temperatures; and,
- water storage projects that result in reduced diversion of water during the drier months.

**Continue to coordinate with the Division of Water Rights by participating in the water right application and petition process, providing monitoring recommendations, joint compliance inspections, submittal of data in support of 401 certifications related to water diversions and/or facilities regulated by the Federal Energy Regulatory Commission, and any other appropriate means to help ensure that the terms of water right permits and licenses are consistent with the water quality objectives for temperature.**

This action directs staff to make use of the processes available for interacting with the State Water Resources Control Board's Division of Water Rights in all official capacities the Regional Water Board's authority provides. The State Water Board's Division of Water Rights (Division of Water Rights) issues water right permits for the diversion of surface waters, and Regional Water Board staff often work with Division of Water Rights staff to ensure Basin Plan requirements are reflected in water right permits and other water right orders. The *Policy for Maintaining Instream Flows in Northern California Coastal Streams* (May 4, 2010) specifically calls for involvement by Regional Water Boards to help ensure adequate consideration of water quality concerns. The Division of Water Rights also issues 401 water quality certifications for projects requiring a Federal Energy Regulatory Commission (FERC) license. Regional Water Board staff provides recommendations and identify water quality conditions that are necessary to ensure that the activity will comply with water quality standards. This action directs Regional Water Board staff to continue to work with the Division of Water Rights to ensure that temperature and other water quality concerns are identified and addressed in the water right permitting process in all waterbodies.

**Coordinate with the Division of Water Rights on the development of instream flow studies and flow objectives, as appropriate.**

This action directs staff to coordinate with the Division of Water Rights on the development of instream flow studies. Instream flow studies are sometimes necessary to determine the dynamics of hydrologic systems, including the sources and losses of water, and to understand the amount and distribution of water necessary to support beneficial uses.

This action also directs staff to coordinate with the Division of Water Rights on the development of flow objectives. The development of flow objectives may be appropriate in cases where the instream flow requirements for support of beneficial uses are defined. For instance, a watershed hydrology objective that describes narrative goals for the timing, quantity, and distribution of water could be incorporated into the Basin Plan, as could a numeric flow objective for a particular watershed where specific flow related thresholds are understood.

**Provide cities, counties, and state and federal agencies guidance and recommendations on compliance with the water quality objectives for temperature. Work with local governments to develop strategies to address the prevention, reduction, and mitigation of elevated water temperatures, including, but not limited to, riparian ordinances, general plans, and other management policies.**

This action directs staff to communicate guidance and recommendations, such as comment letters or face-to-face meetings with state, federal, and local government officials and planning staff, to advise and assist them in developing policies and plans that comply with and support the water quality objectives for temperature. Regional Water Board staff often submits water quality comments to cities and counties during the development of their ordinances and general plans. Section 13247 of the Porter-Cologne Water Quality Control Act states:

> "State offices, departments, and boards, in carrying out activities which may affect water quality, shall comply with water quality control plans approved or adopted by the state board unless otherwise directed or authorized by statute, in which case they shall indicate to the regional boards in writing their authority for not complying with such plans."

An example of the Regional Water Board providing guidance and recommendations to another state agency is the input the board has provided the California Board of Forestry regarding the revision and implementation of the *Forest Practice Rules*. Regional Water Board staff regularly attend Board of Forestry meetings in which changes in the rules are contemplated, and have submitted comment letters on rule changes to ensure the Board of Forestry is aware of Basin Plan considerations. Similarly, Regional Water Board staff participated in Cal Fire's Section V Technical Advisory Committee that developed a guidance document for foresters wishing to make use of that relatively recent section of the *Forest Practice Rules,* which involves timber operations within the riparian zone.

State guidelines require that local general plans should incorporate water quality policies from Basin Plans to the extent they are relevant. The planning and land use authorities entrusted to cities and counties include the authority to limit impacts from land uses to waters of the state and other natural resources. This action directs staff to continue to provide guidance and recommendations to cities and counties on compliance with the water quality objectives for temperature and work with local governments to develop strategies to address the prevention, reduction, and mitigation of elevated water temperatures, including, but not limited to, riparian ordinances, general plans, and other management policies.

**Identify statewide policies under development with implications for water temperature, collaborate with State Water Board counterparts, and provide recommendations and guidance with respect to this policy.**

This action directs staff to collaborate with State Water Board and other state agencies in the development of statewide policies that may have implications for water temperature. An example of such a policy is the Wetland and Riparian Area Protection Policy currently being developed by the State Board. Similarly, the State and Regional Water Boards are collaborating on the development of regulatory strategies that Regional Water Boards can implement to increase efficiency towards addressing impairments driven all or in part by impacts due to grazing.

**Develop and implement a region-wide water temperature trend monitoring program to assist the Regional Water Board in determining whether this Policy is effectively reducing and preventing elevated temperatures over the long-term.**

This action directs staff to develop a monitoring plan to track regional temperature trends to understand whether the actions identified in this Policy are effective at controlling stream temperatures.

**Develop and maintain a temperature implementation workplan consistent with the Policy to prioritize efforts, track progress, and identify specific action to address elevated water temperatures. The temperature implementation workplan shall describe actions that will be taken throughout the North Coast Region and set watershed priorities for addressing elevated water temperatures at a watershed-specific level. The temperature implementation workplan shall be presented to the Regional Water Board on a triennial basis.**

This action directs staff to develop and maintain a temperature implementation workplan similar to the *Work Plan to Control Excess Sediment in Sediment Impaired Watershed* (NCRWQCB 2008), which identifies the actions and tasks Regional Water Board staff should take to control human-caused excess sediment in the sediment-impaired water bodies of the North Coast Region over a ten year time frame. The temperature implementation workplan should identify both regional and watershed-specific tasks Regional Water Board staff intend to execute to control elevated temperatures in the North Coast Region. This action also mandates review of the work plan by the Regional Water Board every three years.

## 8.0 SUMMARY

The staff of the Regional Water Board is proposing a Basin Plan amendment that will establish a Policy to Control Elevated Water Temperatures in the north coast region. The Policy identifies land use and discharge factors that have potential to elevate water temperatures, and directs staff to use all available tools and approaches, both regulatory and non-regulatory, to ensure water temperature concerns are addressed. The land use and discharge factors have been identified during the development of north coast temperature TMDLs. The amendment includes an Action Plan that identifies actions staff will undertake to address those factors that may prevent the attainment of the water quality objectives for temperature. The Action Plan was developed so that implementation of the Action Plan both implements load allocations established in temperature TMDLs, and maintains compliance with the water quality objectives for temperature in waterbodies not already impaired by elevated water temperatures.

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