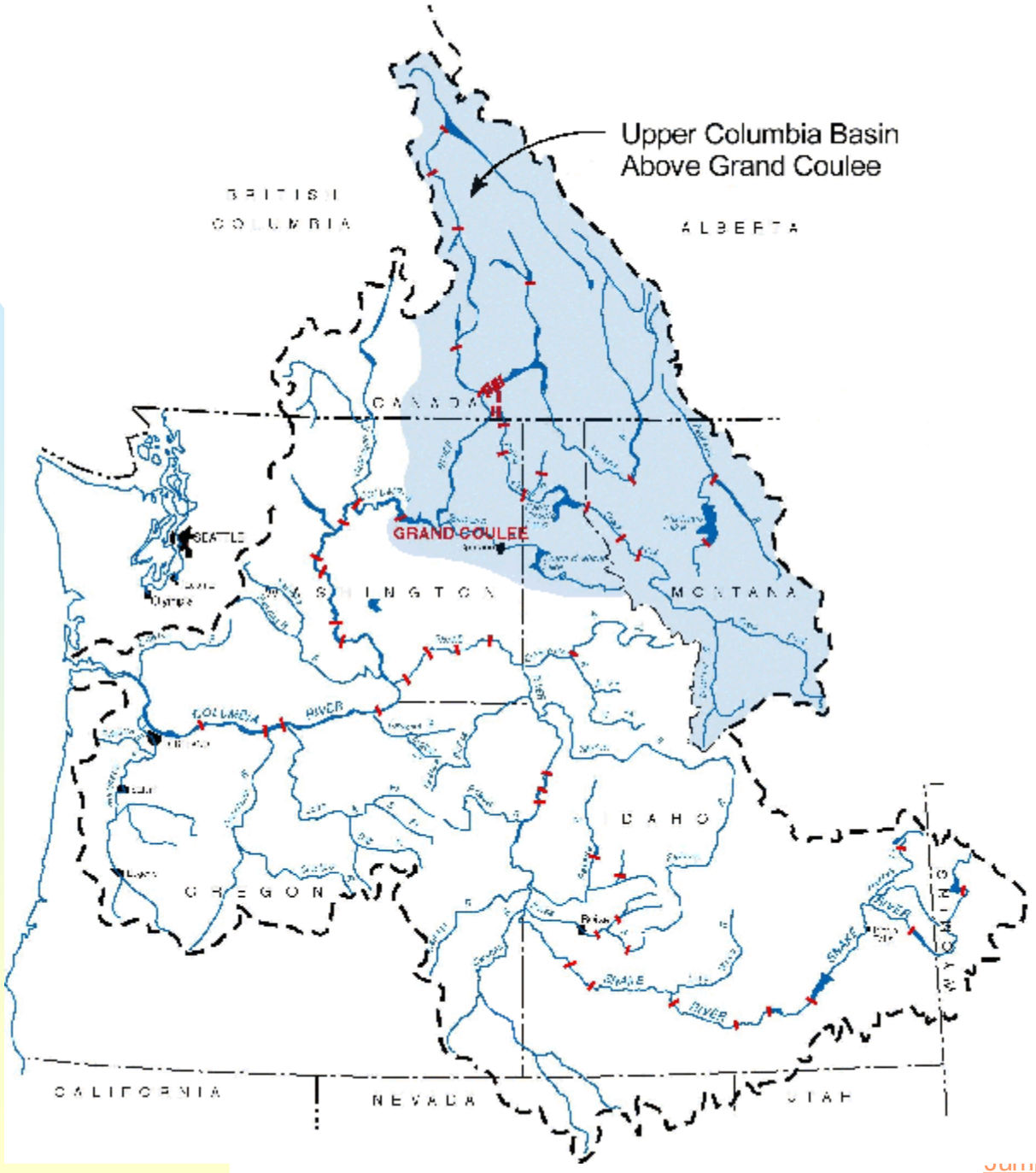
Columbia/Snake River Mainstem TMDL

Toward Ecosystem Based Management Conference

Spokane, Washington

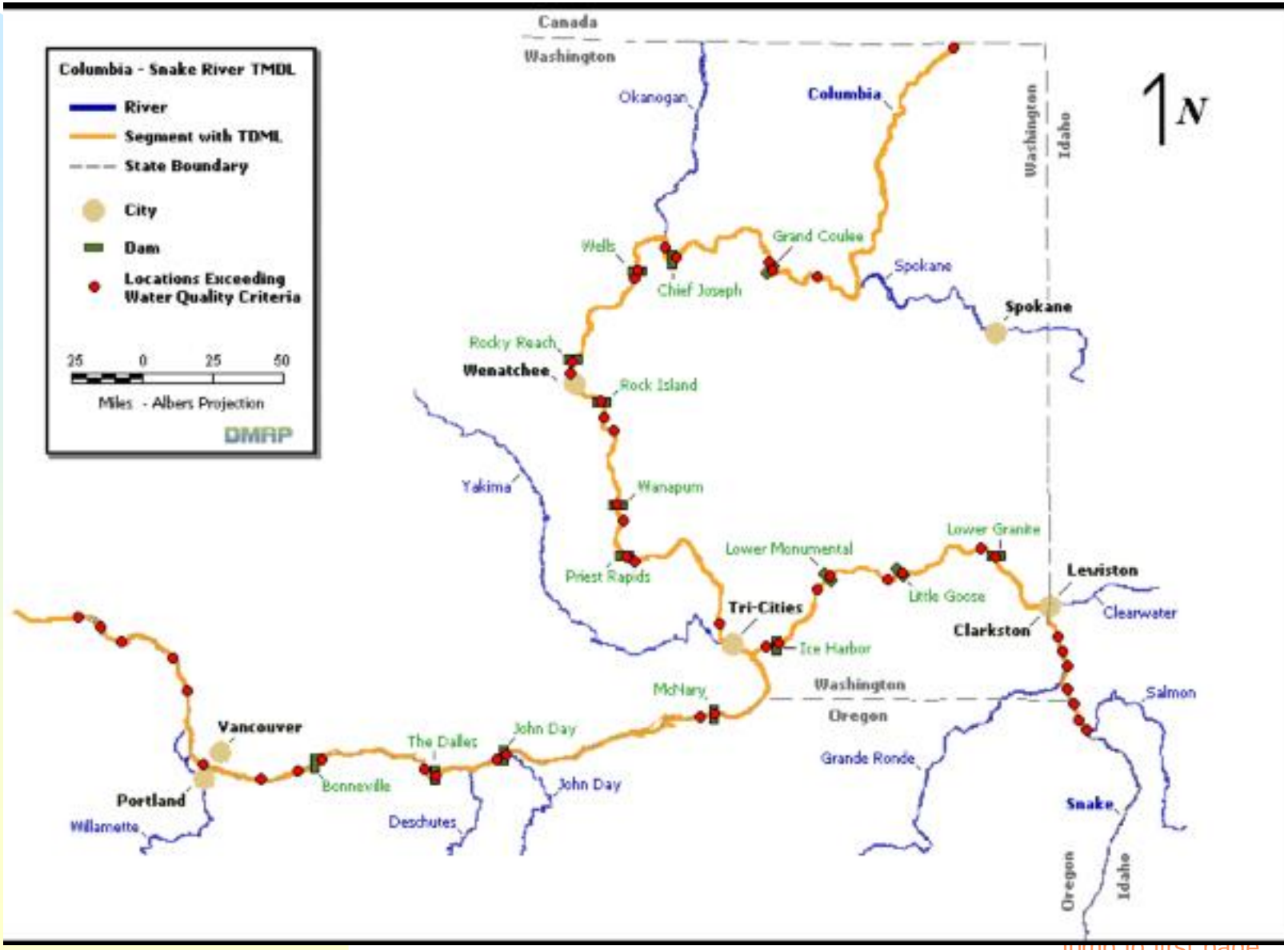
April 28, 2002

Jump to first page



Jump to first page

Geographic Scope



Jump to first page

TMDL Development

- **Model Development ☸**
- **Problem Assessment ☸**
- **TMDL 🗁**

Jump to first page

Problem Assessment

Does water temperature in the Columbia and Snake Rivers exceed Water Quality Standards?

Jump to first page

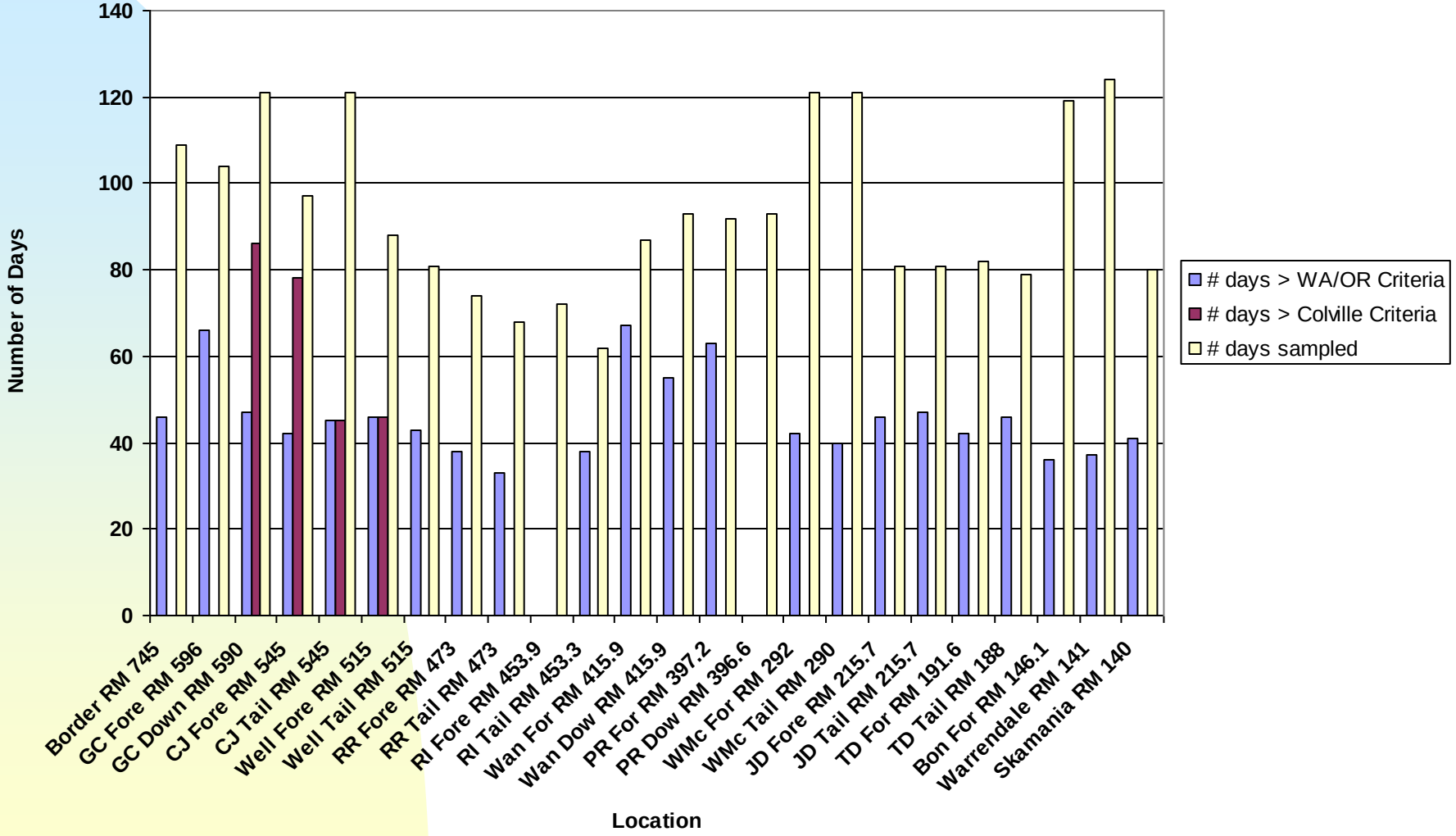
Problem Assessment

1) Does temperature exceed the Water Quality Criteria?

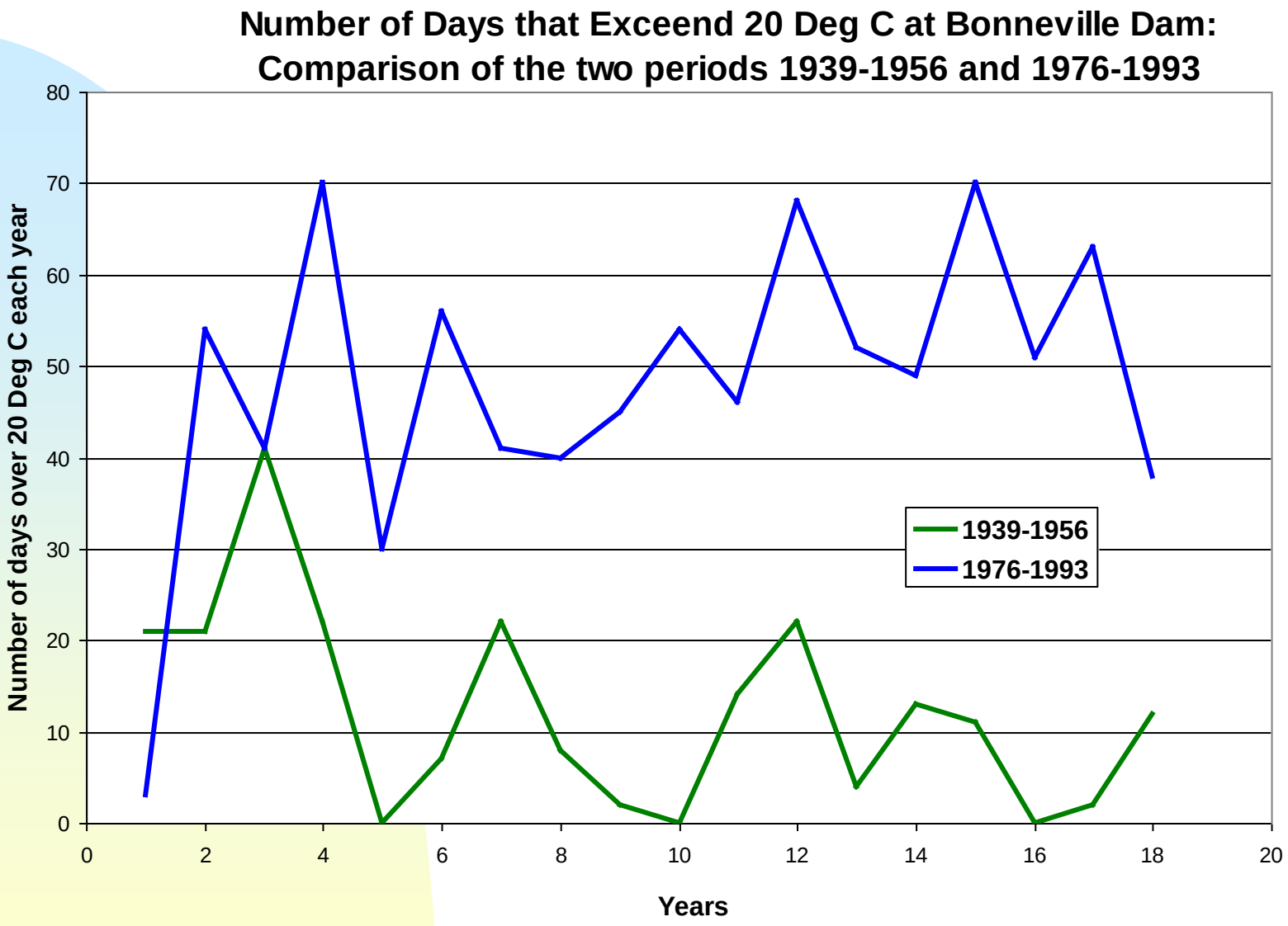
2) Does temperature exceed the Water Quality Criteria due to human activities?

Jump to first page

July Through October, 2000 - Number of Days during which Water Temperature along the Columbia River Exceeded Water Quality Criteria



Jump to first page



Jump to first page

Problem Assessment

- A significant cause for the altered temperature regime in the rivers is the presence of the dams.
- Climate change likely contributes to the trend to a lesser extent.
- Non-point and point sources contribute to a small extent.

Jump to first page

TMDL Development

1) Determine Target Temperatures

2) Establish Loading Capacity

3) Allocate Available Load

Jump to first page

Important Points

- Site Potential Temperatures
- Target Temperatures = Average Site Potential + increment from WQS
- The downstream WQS are more restrictive and drive the TMDL target temperatures in the mid-Columbia.
- The Load is expressed as Temperature
- The Loading Capacity = the Target Temperature
- Temperature available for allocation is the WQS increment.
- There are many ways to allocate Target Temperature among the sites.

Water Quality Standards

The WQS for this TMDL are the natural temperatures of the Columbia and Snake main stems plus small incremental increases due to human activity.

Jump to first page

Water Quality Standards

Columbia Main Stem from Coast to OR/WA Border:

"Temperature shall not exceed 20 C (68 F) due to human activities. When natural conditions exceed 20 C (68 F) no temperature increases will be allowed which will raise the receiving water temperature by greater than 0.3 C (0.5 F) nor shall such temperature increases at any time exceed 0.3 (0.5 F) due to a single source or 1.1 C (2.0 F) due to all such activities combined."

Water Quality Standards

Natural stream temperatures for this TMDL are those that would occur in the main stems within the TMDL study area in the absence of human activity within the main stems in the study area.

They are termed <u>site potential</u> temperatures in this TMDL.

Water Quality Standards

OR - allow an increase of 0.14 C when the SP > criteria,

- allow increase up to criteria when SP < criteria.

WA & Colvilles

- allow an increase of 0.3 C when the SP > criteria,

-allow reach dependent increases when SP < criteria. Eg t=23/(T+5) is the increase allowed in L. Roosevelt.

Snake River Target Temperatures

River Reach	Criterion	SP<Criterion	SP>Criterion
Salmon River to OR/WA Border			
	12.8/17.8 C	Up to Criterion	SP + 0.14 C
OR/WA Border to Clearwater River			
	20 C	SP +1.1 C	SP + 0.3 C
Clearwater River to Mouth			
	20 C	SP + 34/(T+9)	SP + 0.3 C

Columbia River Target Temperatures

River Reach	Criterion	SP<Criterion	SP>Criterion
Canadian Border to Grand Coulee			
	16 C	SP + 23/(T+5)	SP + 0.3 C
Grand Coulee to Chief Joseph			
	16 C	SP + 23/(T+5)	SP + 0.3 C
Chief Joseph to Priest Rapids			
	18 C	SP + 28/(T+7)	SP + 0.3 C
Priest Rapids to OR/WA Border			
	20 C	SP + 34/(T+9)	SP + 0.3 C
OR/WA Border to the Mouth			
	20 C	**SP + 1.1 C**	**SP + 0.14 C**

Determine Target Temperatures

1. Determine the Site Potential (SP) Temperatures

2. Apply the WQS for each reach.

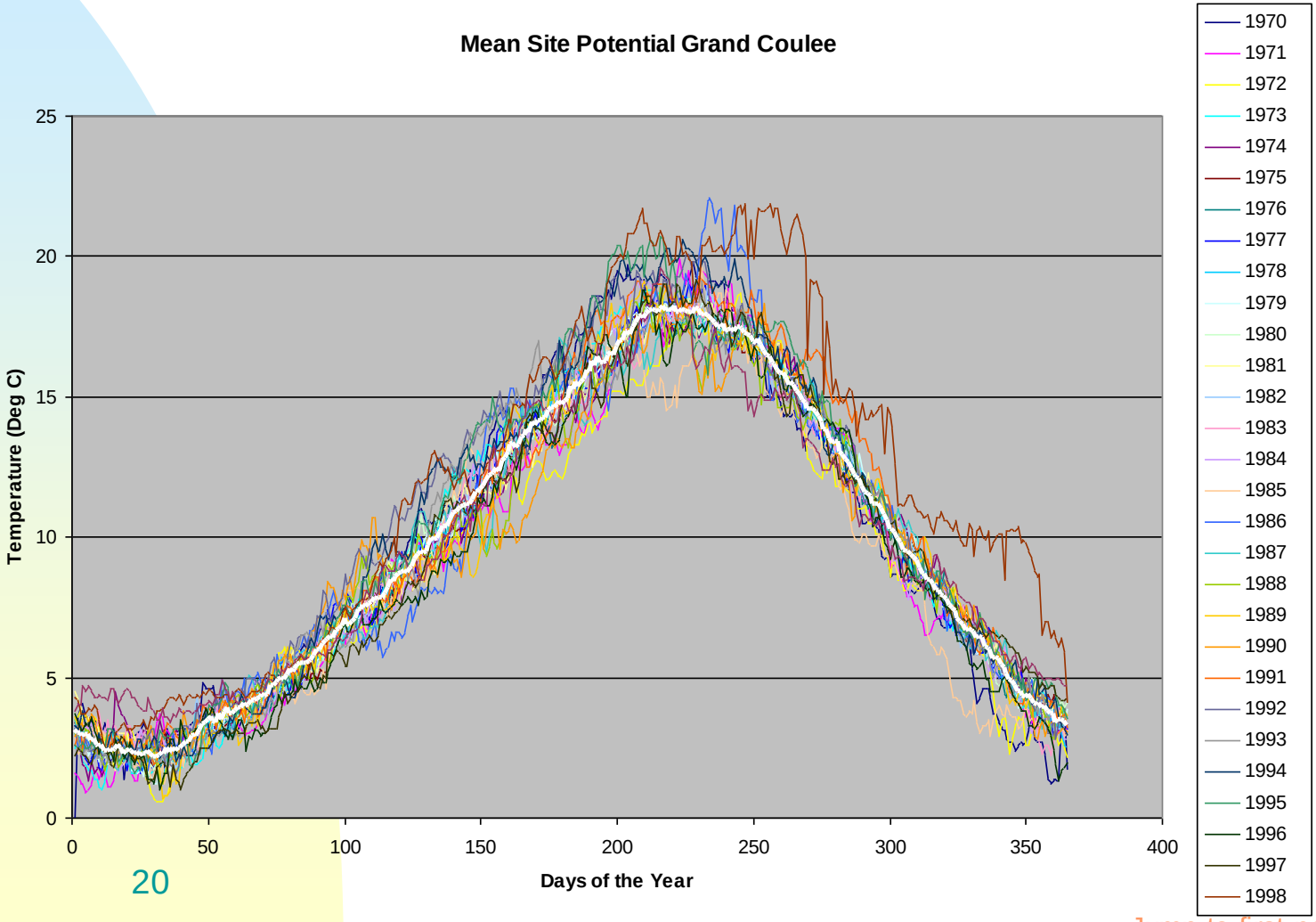
Jump to first page

Site Potential Temperatures

The site potential temperatures vary temporally and geographically. They vary from day to day and from year to year and they vary along the length of the river.

Jump to first page

To account for this variability we utilize the mean daily site potential temperatures based on 30 years of simulations using actual weather and flow data.



Jump to first page

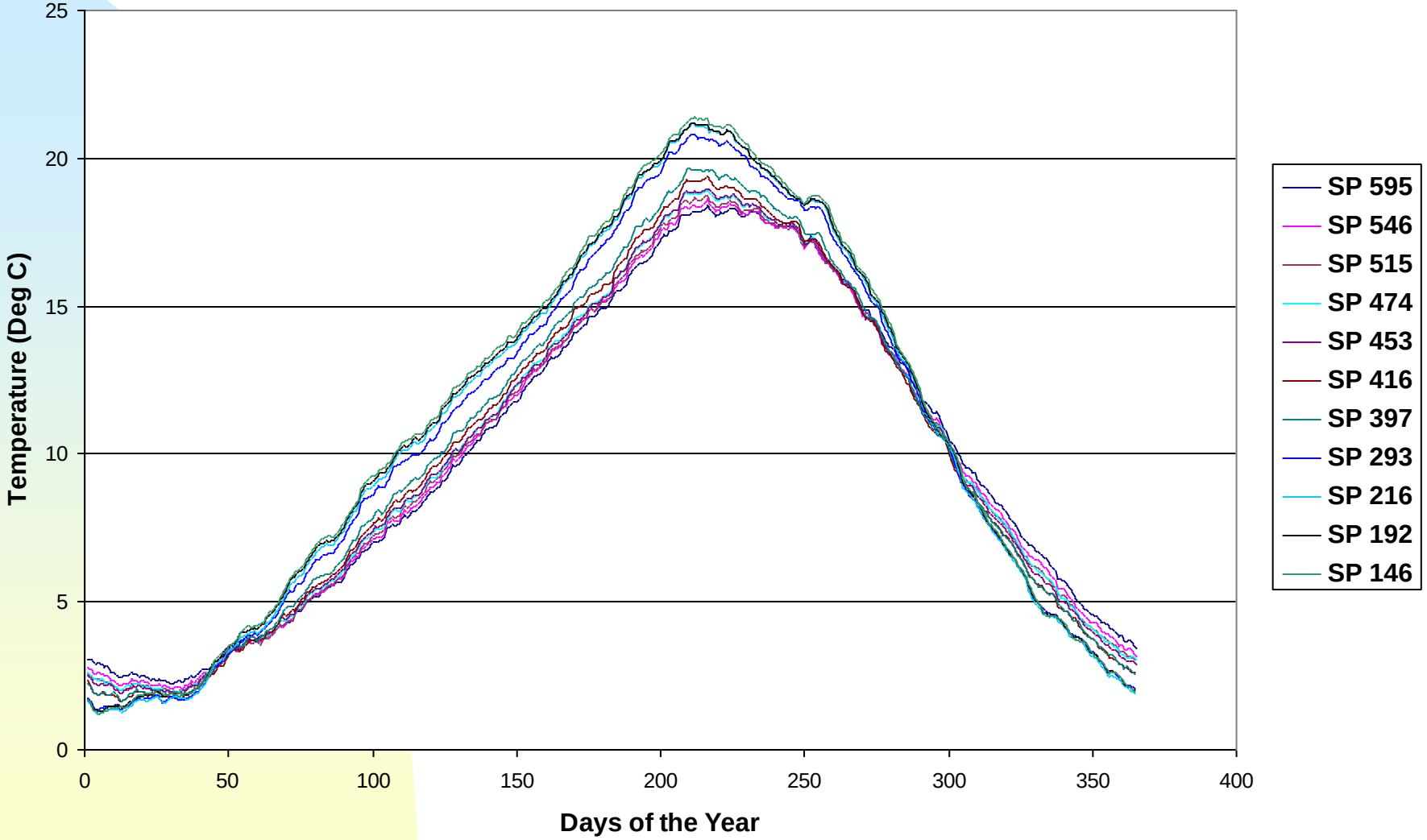
Site Potential Temperatures

•We have simulated Site Potential Temperatures for River Reaches.

•The reaches are defined by the dams. There are 15 reaches. The target site for each reach is in the tailrace of the dam at the foot of the reach.

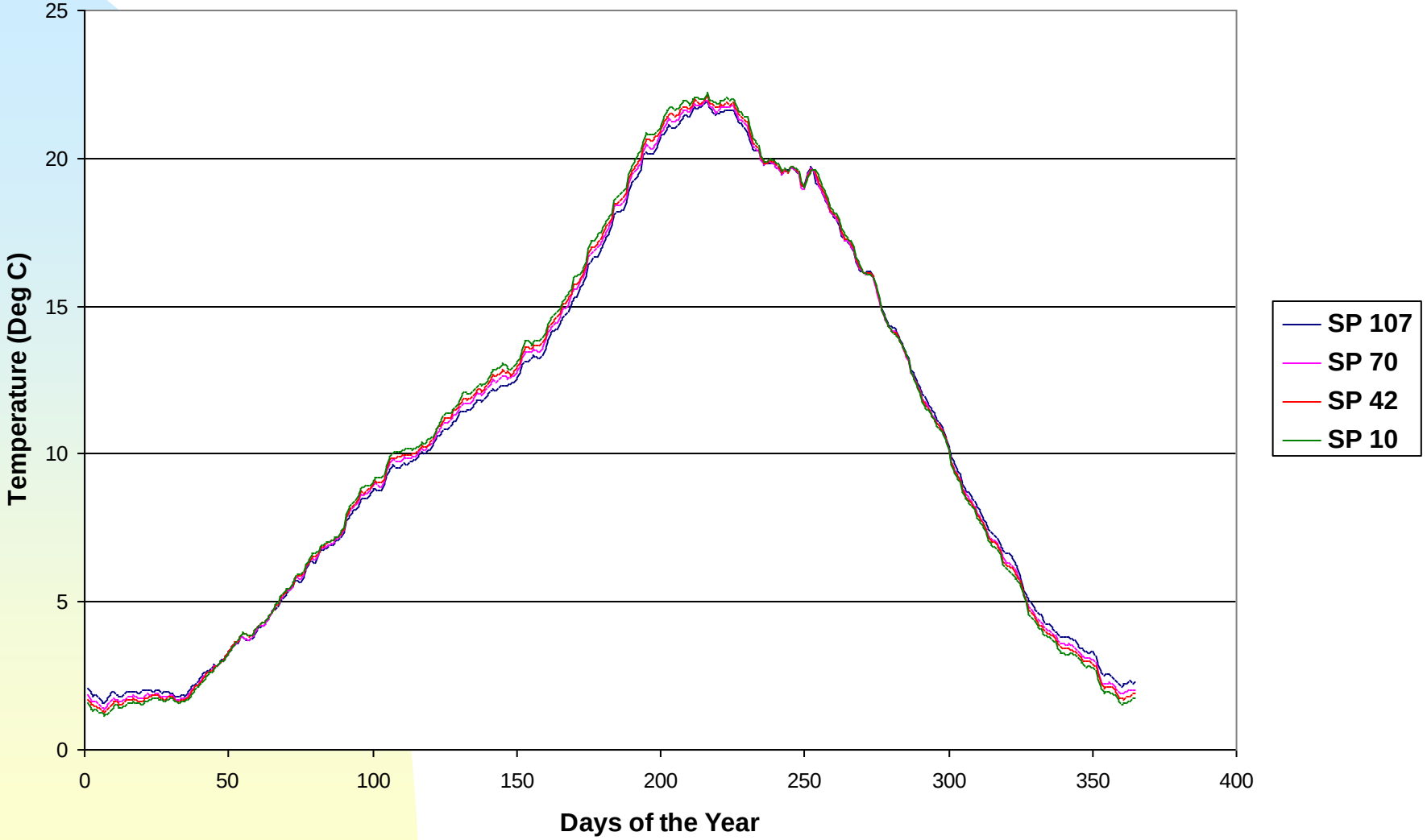
•We have calculated the mean site potential (30 year mean) for each day of the year at each target site.

Columbia River Site Potential Temperatures at Each Target Site



Jump to first page

Snake River Site Potential Temperatures at Each Target Site



Jump to first page

Target Temperatures

- Apply Target Temperatures to the Average SP Reach by Reach.
- SP in the formulas = the 30 year average site potential for each day of the year.

Jump to first page

Target Temperatures

But…….

There’s a catch!

Jump to first page

Target Temperatures

If we apply the WQS reach by reach to determine the target temperatures reach by reach we will exceed the target temperatures in the downstream reach.

Jump to first page

Columbia River Target Temperatures

River Reach	Criterion	SP<Criterion	SP>Criterion
Canadian Border to Grand Coulee			
	16 C	SP + 23/(T+5)	SP + 0.3 C
Grand Coulee to Chief Joseph			
	16 C	SP + 23/(T+5)	SP + 0.3 C
Chief Joseph to Priest Rapids			
	18 C	SP + 28/(T+7)	SP + 0.3 C
Priest Rapids to OR/WA Border			
	20 C	SP + 34/(T+9)	SP + 0.3 C
OR/WA Border to the Mouth			
	20 C	**SP + 1.1 C**	**SP + 0.14 C**

Target Temperature

•We need to meet the more stringent WQS: in this case the standards in the lower reach along the border.

•So we need to determine the target temperature in the upstream reaches that will allow achievement of the target temperature in the lower reach.

•Ie: We have to allocate temperature among the upstream sources.

Target Temperatures

There are many ways to allocate the target temperature:

1. Give all the target reaches the same incremental increase above SP so that the downstream WQS are achieved.

2. Base the incremental increase for a reach on impacts to temperature in the reach.

3. Base the incremental increase for a reach on the length of the reach.

4. Give the sources above the OR/WA border a "bubble allocation". The target temperature at the beginning of the reach has to be .14 above SP. Let the sources allocate that among themselves.

Jump to first page

Target Temperature - Approach 1

	Site Potential < Criteria	Site Potential > Criteria
Same Increase at all Target Sites	**0.15°C**	**0.02°C**

Jump to first page

Target Temperature Approach 2

Columbia Sites	Site Potential < Criteria	Site Potential > Criteria
Grand Coulee	0.80 °C	0.107 °C
Chief Joseph	0.10 °C	0.013 °C
Wells	0.02 °C	0.003 °C
Rocky Reach	0.03 °C	0.004 °C
Rock Island	0.01 °C	0.002 °C
Wanapum	0.02 °C	0.002 °C
Priest Rapids	0.01 °C	0.001 °C
McNary	0.03 °C	0.004 °C
John Day	0.18 °C	0.025 °C
The Dalles	0.03 °C	0.004 °C
Bonneville	0.03 °C	0.004 °C

Jump to first page

Target Temperatures Approach 2

Snake Sites	Site Potential < Criteria	Site Potential > Criteria
Lower Granite	0.26	0.034
Little Goose	0.33	0.044
Lower Monum	0.20	0.027
Ice Harbor	0.20	0.027

Target Temperatures Approach 3

Columbia Sites	Site Potential < Criteria	Site Potential > Criteria
Grand Coulee	0.46	0.061
Chief Joseph	0.16	0.021
Wells	0.09	0.012
Rocky Reach	0.13	0.017
Rock Island	0.06	0.008
Wanapum	0.12	0.015
Priest Rapids	0.06	0.008
McNary	0.32	0.043
John Day	0.24	0.031
The Dalles	0.07	0.010
Bonneville	0.14	0.019

Jump to first page

Target Temperatures Approach 3

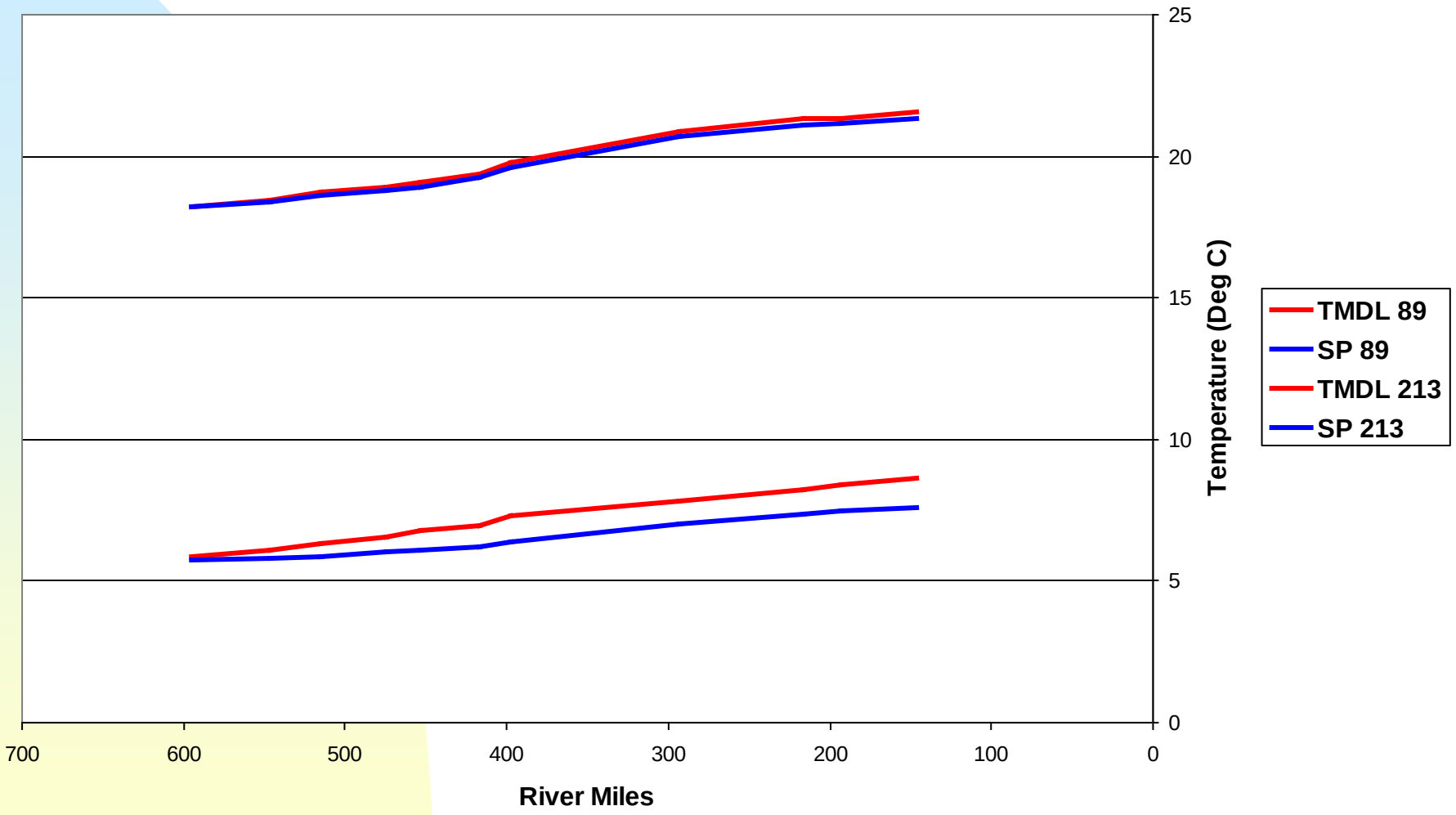
Snake Sites	Site Potential < Criteria	Site Potential > Criteria
Lower Granite	0.10	0.013
Little Goose	0.11	0.015
Lower Monum	0.09	0.012
Ice Harbor	0.10	0.013

Target Temperatures Approach 1

- Target Temperature @ Grand Coulee Target Site =
  - SP + 0.15 C when SP < Criteria
  - SP + 0.02 C when SP > Criteria

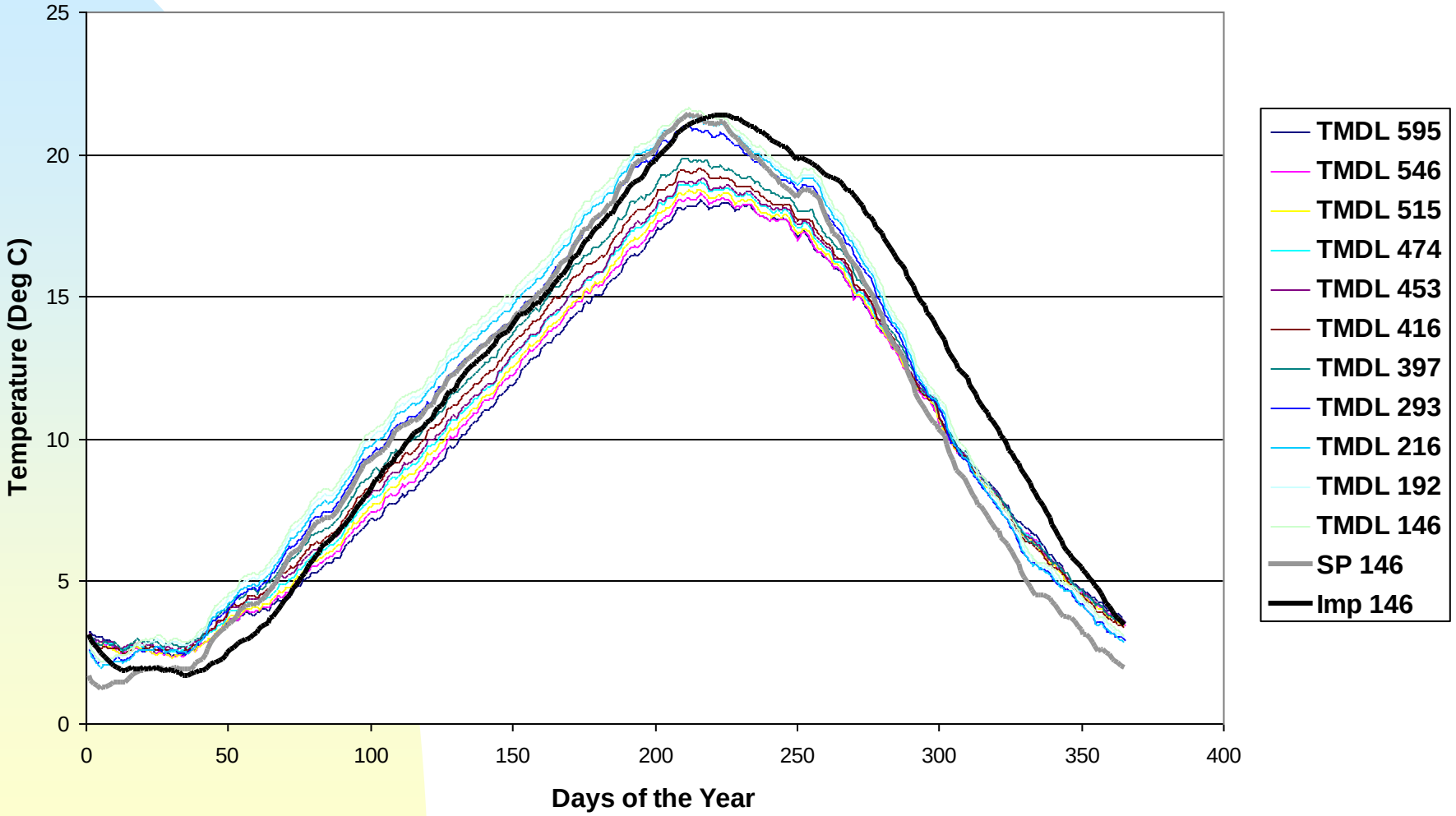
- Target Temperature at each subsequent target site =
  - Upstream Temperature + 0.15 C when SP < Criteria
  - Upstream Temperature + 0.02 C when SP > Criteria

Target and Site Potential Temperatures Along the Columbia - March 30 and August 1



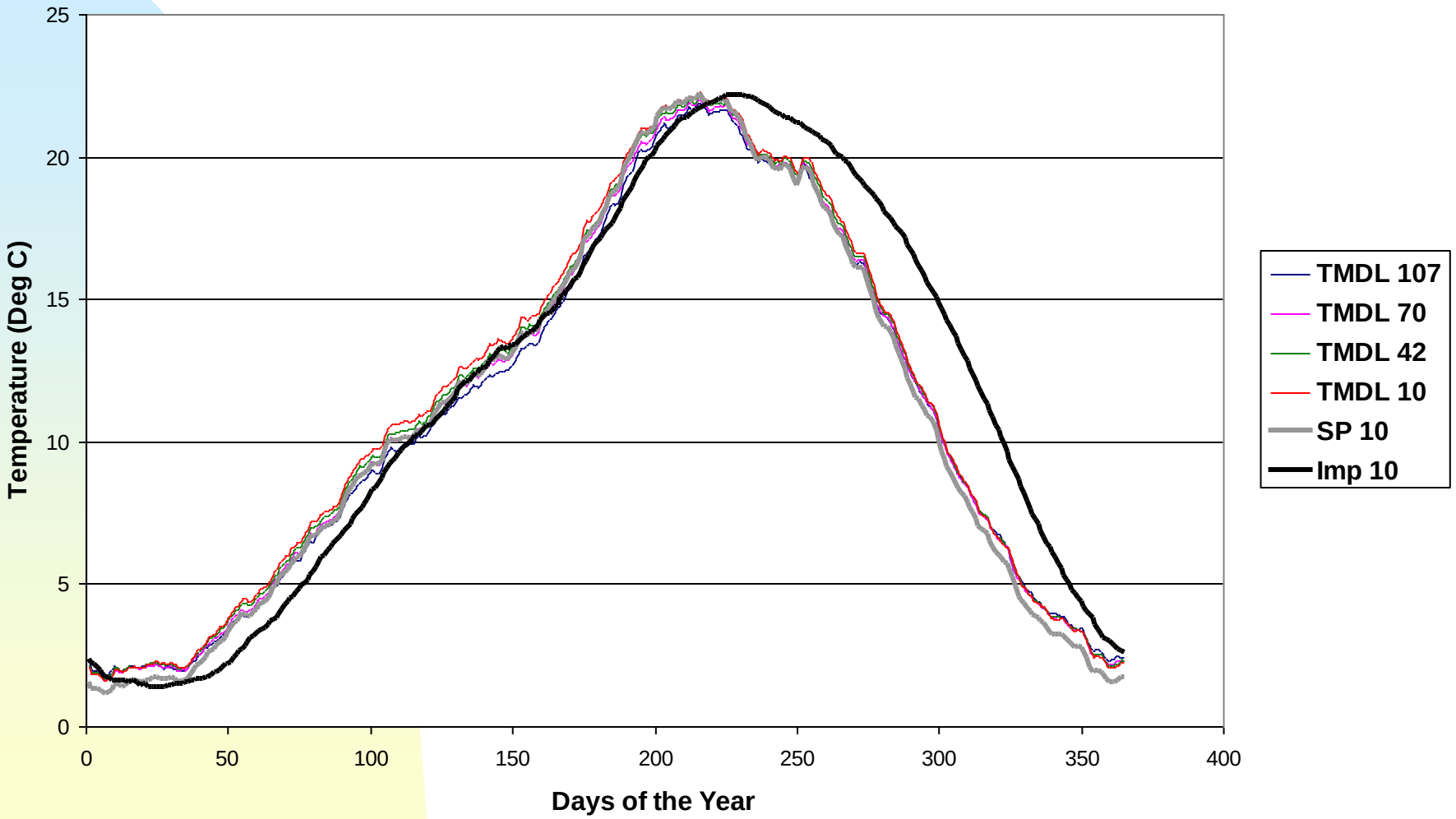
Jump to first page

Columbia River TMDL Temperatures at Each Target Site with Bonneville Site Potential and Impounded Temperatures



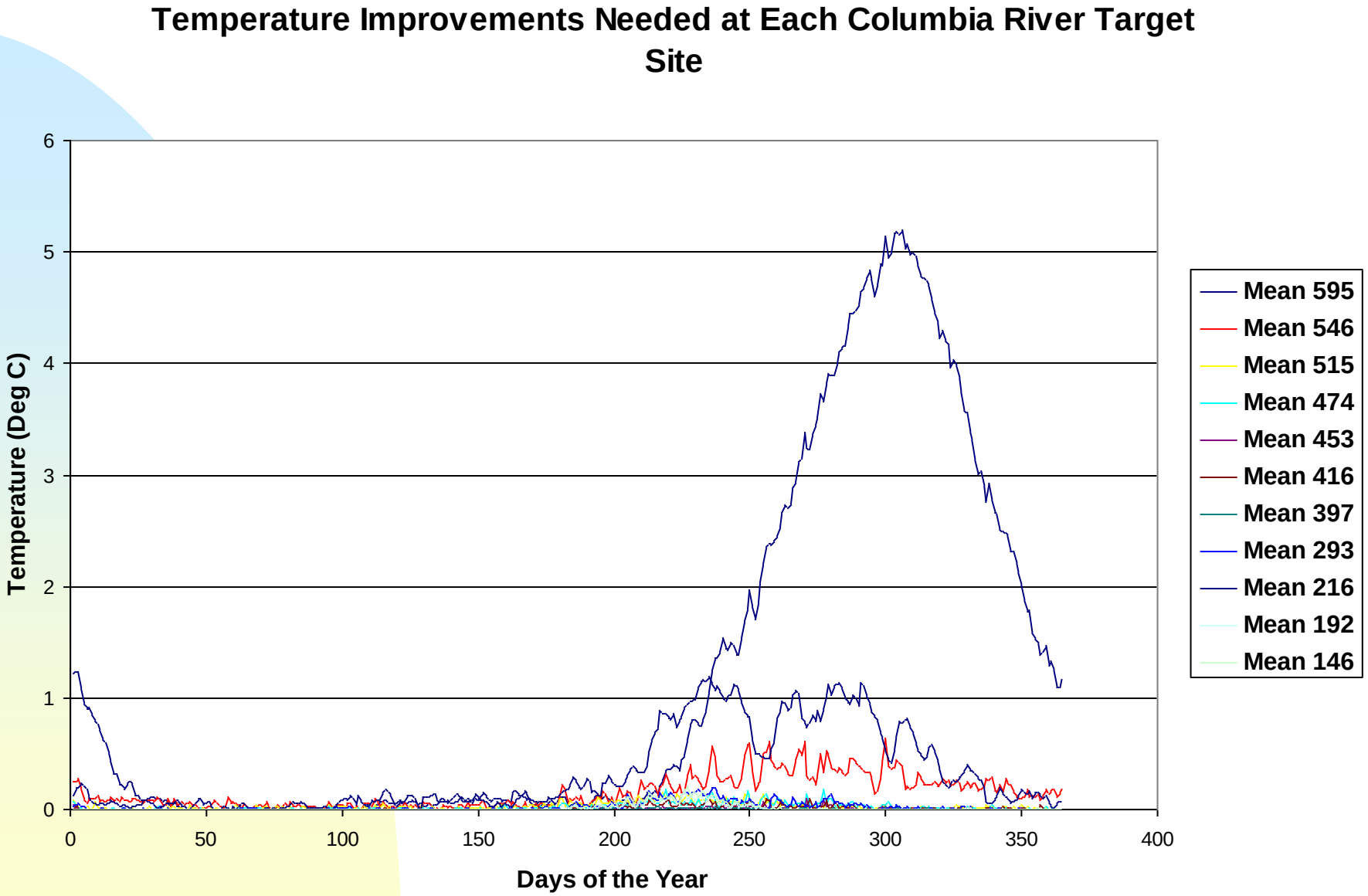
Jump to first page

Snake River TMDL Temperatures at Each Target Site with Ice Harbor Site Potential and Impounded Temperatures



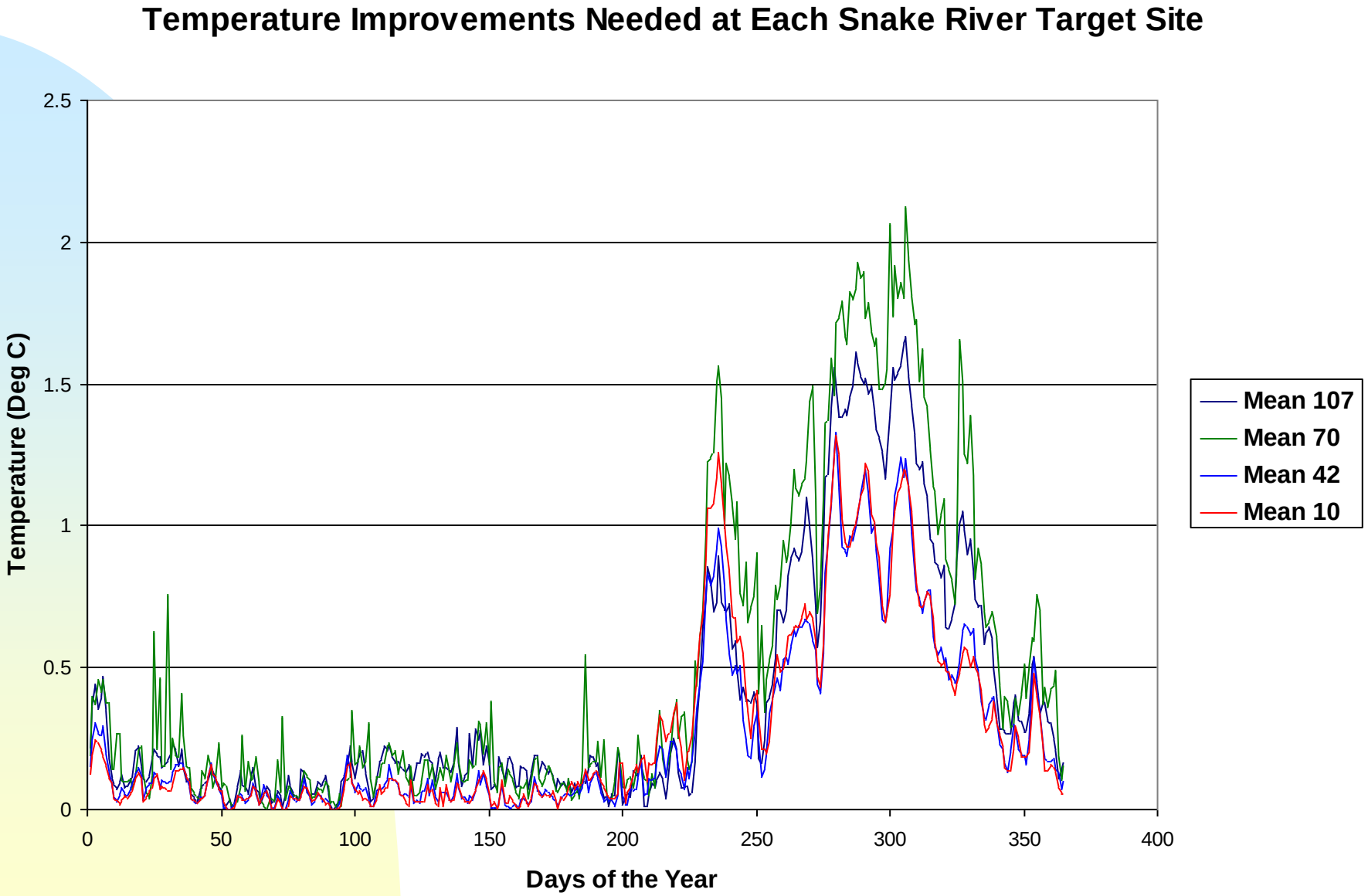
Jump to first page

Approach 1



Jump to first page

Approach 1



Jump to first page

TMDL Development

1) Determine Target Temperatures ❄

2) Establish Loading Capacity

3) Allocate Available Load

Jump to first page

Establish Loading Capacity

- Loading Capacity in this TMDL is in terms of Temperature rather than thermal load.
- Temperature is being used as “another appropriate measure” as per the regulations.
- Thermal load is not used because the dams are the most significant causes of temperature change but they do not discharge a thermal load to the river and they can alter load without affecting temperature.

Establish Loading Capacity

For this TMDL the Loading Capacity is the Target Temperature.

Jump to first page

Allocate Available Load

The load available for allocation to dams, point sources, non-point sources, and future growth is the incremental increase allowed at each target site to achieve the target temperature:

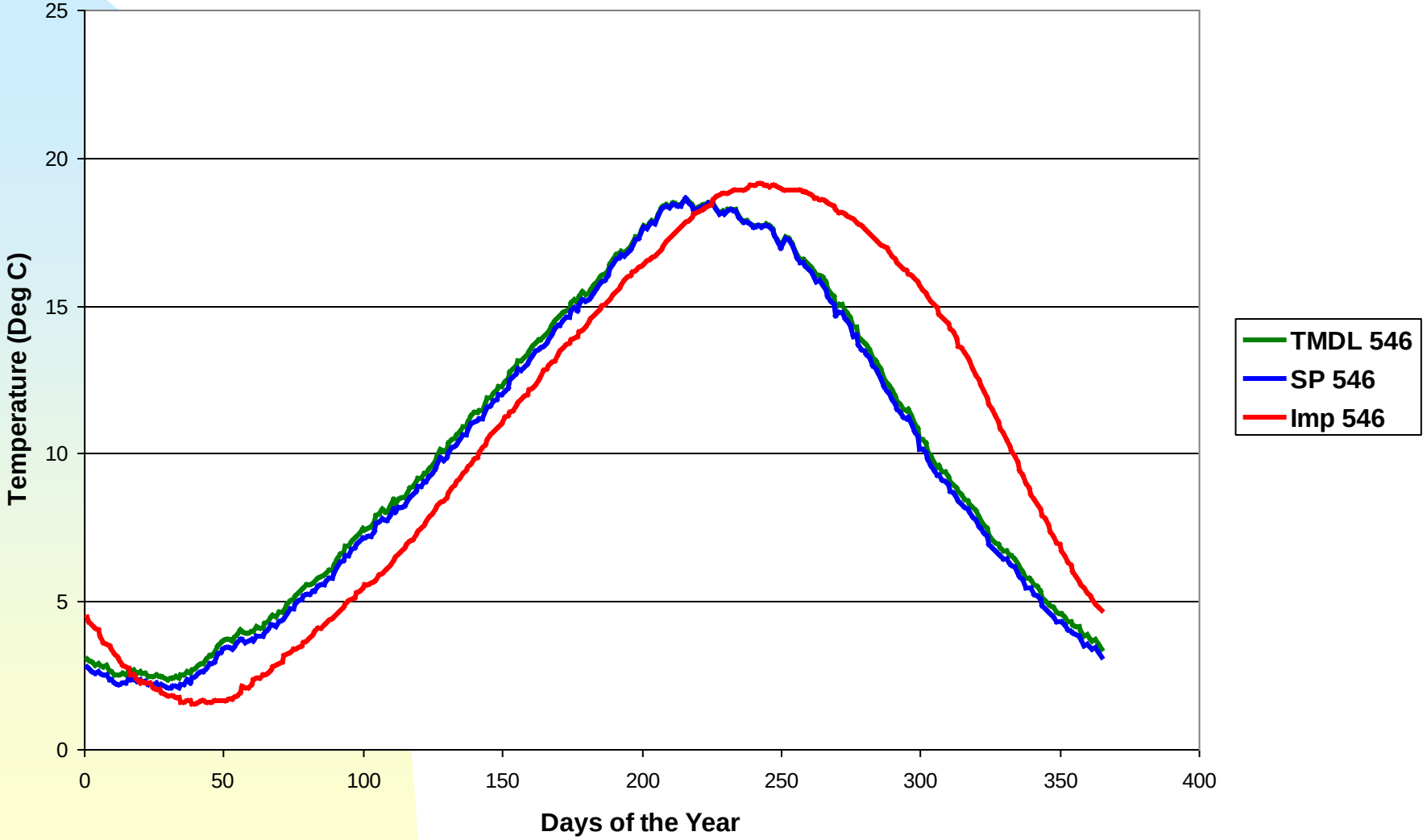
- 0.02 C when the SP > criteria (Approach 1)
- 0.15 C when the SP < criteria (Approach 1)

Jump to first page

Allocation Table - Chief Joseph

Day	Upstream LC (°C)	LC (°C)	Increment (°C)	Dams Allocation (°C)	Other Sources (°C)	Future Growth (°C)
89	5.89	6.04	.15	.14	.005	.005
199	17.29	17.31	.02	.01	.005	.005

Chief Joseph Target, Site Potential and Impounded Temperatures



Jump to first page

Allocate Available Load

- What do these small allocations mean?
- Do they pass the laugh test?

- They mean that essentially no measurable increase in temperature due to human activity is allowed at each target site.

Jump to first page

Point Sources

- 78 Point Sources
- Most cause less than 0.014 C increase.

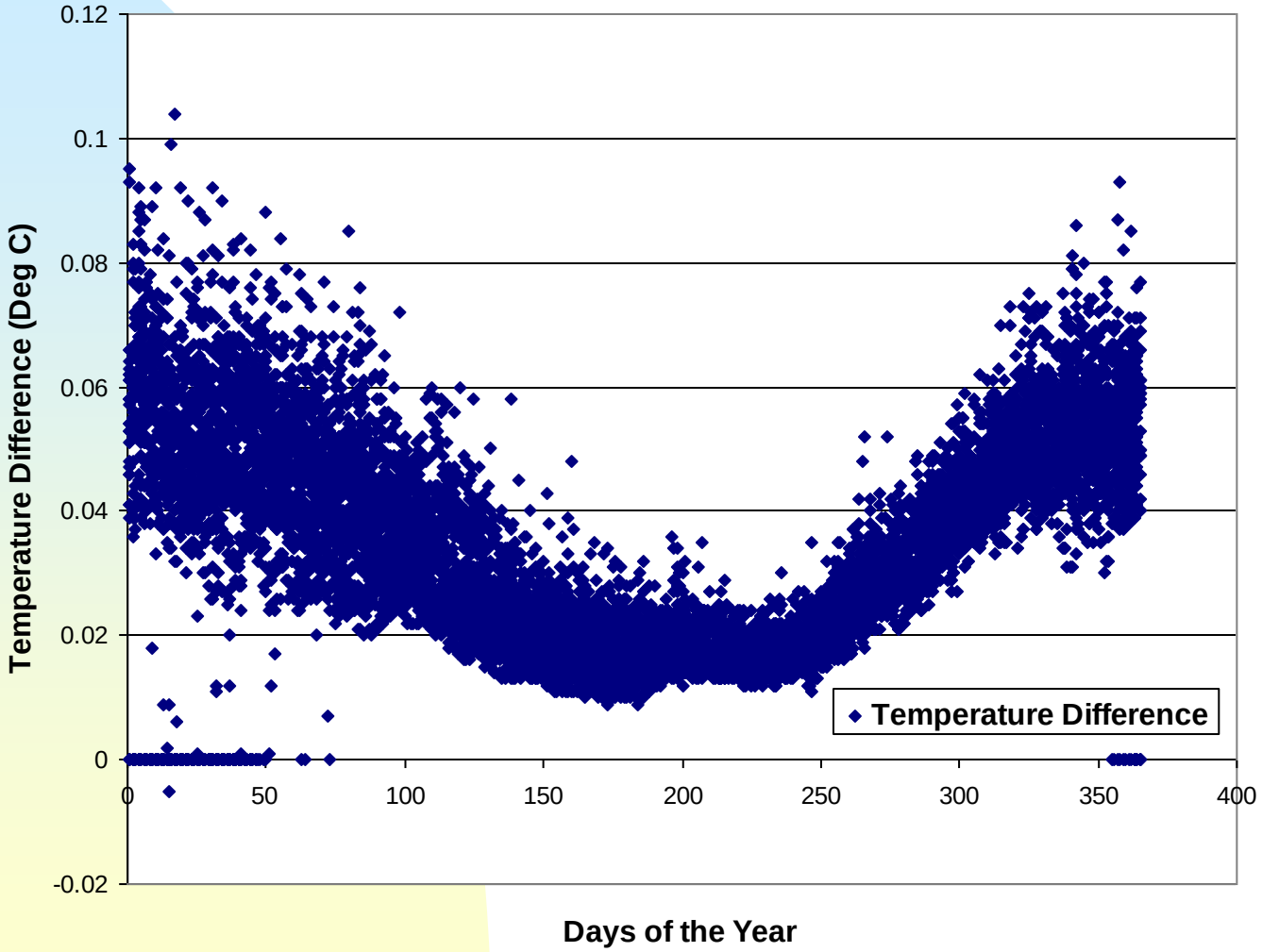
  Bubble allocation for these
- 13 Point Sources cause > 0.014 C increase.
- These will get individual allocations.

Jump to first page

Point Sources

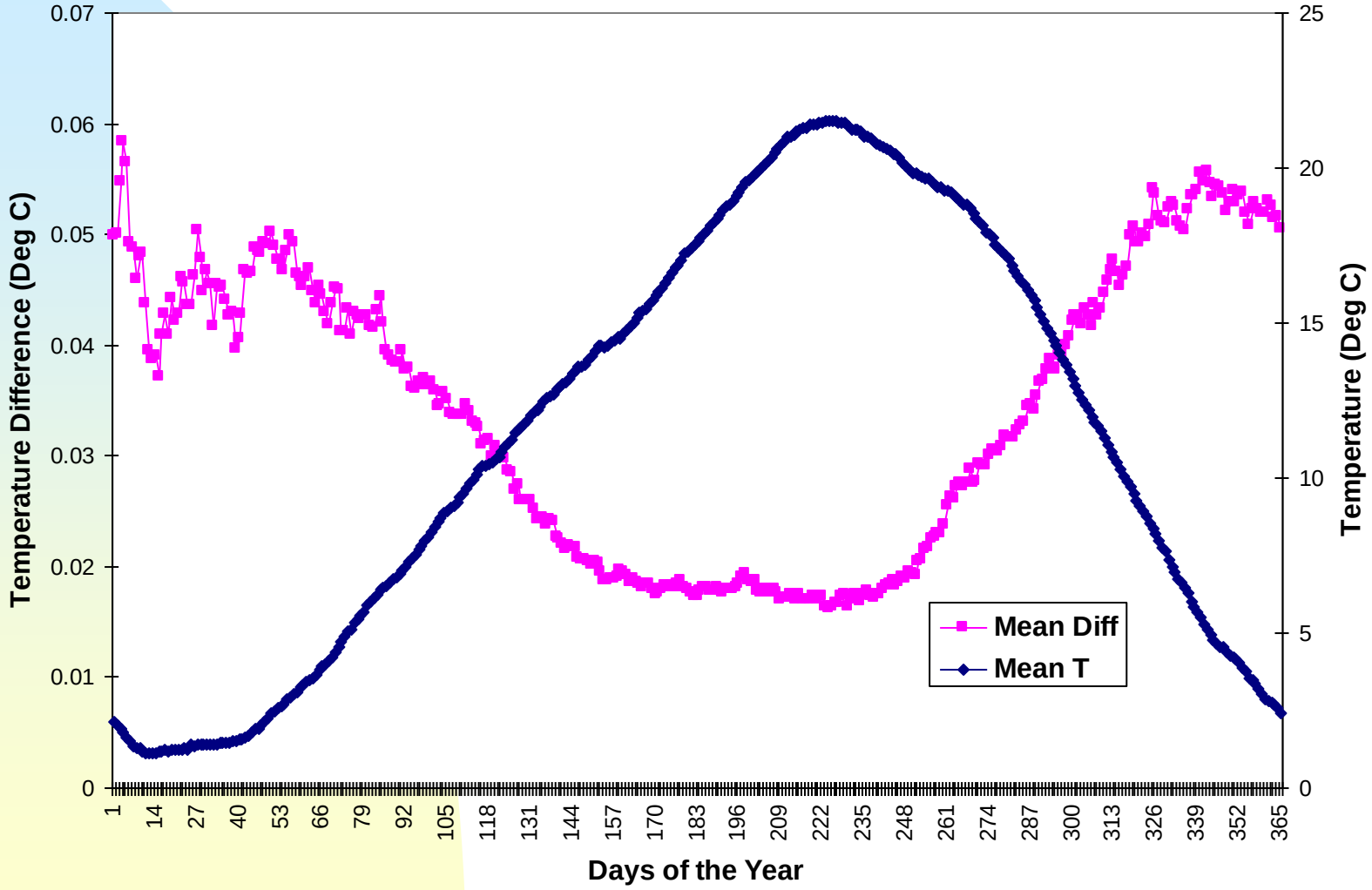
- We used the model to simulate water temperature with all the point sources discharging and with none of them discharging.
- The difference between the two simulations represents the effect of the point sources on temperature.
- Recall that the Water Quality Standards limit the amount that any sources can raise water temperature.
  - 0.14 C when site potential exceeds criteria
  - 1.1 C when site potential is less than criteria

Simulated Difference in Temperature in the Impounded River at McNary Dam due to Point Sources



Jump to first page

McNary Dam: Simulated Mean Temperature and Simulated Mean Difference due to Point Sources in the Impounded River



Jump to first page

Point Sources

The simulations indicate that while the point sources cause temperature increases that approach the WQS standards (0.14 C and 1.1 C) they do not exceed them.

They do, however, cause increases greater than the 0.02 increase at each target site that would be allowed under Approach 1 for allocating target temperature.

The simulations indicate that a fifth approach to the allocations could be developed in which sufficient capacity is allocated to each reach to accommodate the discharges of the point sources.

Point Sources

If the WLA for point sources is based on existing discharge will have the following caveats:

•WLA will be based on actual discharge, not worst case estimates of thermal load or excess capacity in mixing zones

•Mixing zones will be assessed. Compliance at the edge of the mixing zone may, in some cases, constrain permits beyond the WLA in the TMDL.

•Sources will be required to meet the minimum levels of technology such as "All Known Available and Reasonable Technology" in WA.

Point Sources

Current thinking is that the first analysis will be conducted for the TMDL. We are looking at the historical discharges of the facilities and will develop recommendations for the WLA.

The TMDL will identify the resulting WLA as the maximum that the sources could expect. During the permit process, the mixing zone assessment and the technology assessment will be conducted and they could result in lower effluent limits than the WLA.

Tributaries

One Tributary, the Umatilla River, has a TMDL for Temp. It will get its TMDL allocations in this TMDL.

188 Tribs do not have TMDLs. They will get their existing loads. Small Tributaries with no data may get bubble loads.

Jump to first page

Tributaries

- Essentially this TMDL is based on site potential in the main-stems.
- Water flowing into the TMDL from tributaries and boundary conditions is not at site potential.
- Improvement in temperature in the tributaries or at the boundary conditions could lower the site potential of the main-stems.
- We are doing an analysis of tributary temperature effects on main-stem site potential to develop thresholds of ΔT in the tributaries that would warrant re-opening this TMDL.

Jump to first page

Columbia Tributaries

	ΔT to Lower SP by 0.5 °C	ΔT to Lower SP by 0.14 °C
Spokane R.	7.0	1.9
Okanagan	17	4.9
Yakima R.	17	4.8

Columbia Tributaries

	ΔT to Lower SP by 0.5 °C	ΔT to Lower SP by 0.14 °C
Deschutes	16	4.6
Willamette	3.2	0.92

Jump to first page

Snake Tributaries

	ΔT to Lower SP by 0.5 °C	ΔT to Lower SP by 0.14 °C
Grande Ronde	6.0	1.7

Jump to first page

Measuring Compliance

Long Term System Level Compliance:

•Compliance with the target temperatures. That is, mean water temperature at the target sites equals the target temperatures.

Jump to first page

Important Points

- Site Potential Temperatures
- Target Temperatures = Average Site Potential + increment from WQS
- The downstream WQS are more restrictive and drive the TMDL target temperatures in the mid-Columbia.
- The Load is expressed as Temperature
- The Loading Capacity = the Target Temperature
- Temperature available for allocation is the WQS increment.
- There are many ways to allocate Target Temperature among the sites.

Jump to first page