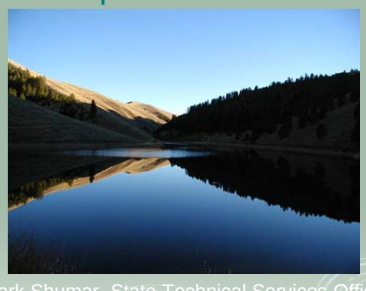
Potential Natural Vegetation Temperature TMDLs



Mark Shumar, State Technical Services Office,
Idaho Department of Environmental Quality

Objectives

- Present steps used to produce a temperature TMDL based on riparian shade.
- Discuss the Priest Lake Subbasin PNV temperature TMDLs.

Components of a Stream

- Channel, Riparian Zone, Alluvial Aquifer
- Interactions between external drivers and these components ultimately affect stream temperature.

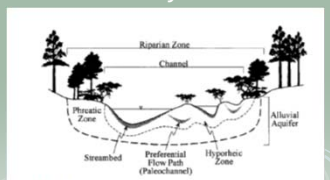
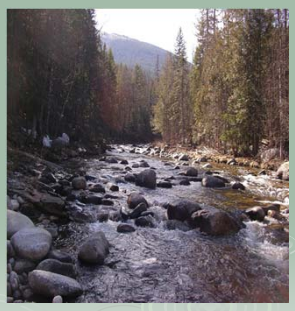


Figure 1. Structural components of a stream system (not all features exist in all streams.)

Potential Natural Vegetation

- Expected stream-side, shade producing natural plant community with some natural level of age class distribution.
- Provides the appropriate amount of shade or target shade (along with topography).



Potential Natural Vegetation

- Produces natural stream temperatures (assuming no anthropogenic sources of heat).
- Equates to natural background conditions in Idaho WQS.

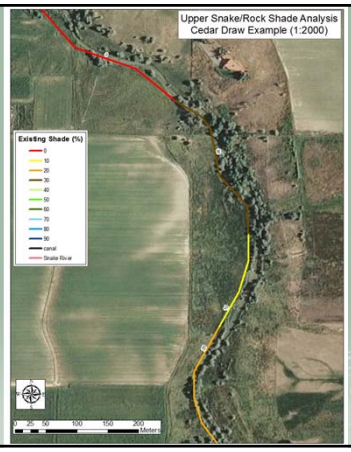
TMDL Target

- Shade Target
  - Based on stream-side shade producing plant community and channel width.
- WQ Criteria
  - 19° / 22° C – summer
  - 9° / 13° C – spring/fall spawning

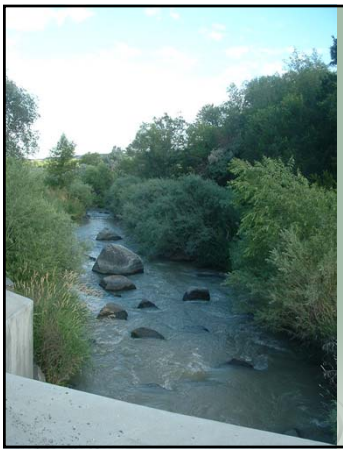
Temperature TMDL

- Loading Capacity = Solar Load under PNV aka target shade
- Existing Load = Solar Load under current (existing) shade
- Load Reduction = PNV Load – Existing Load

Existing Shade (aerial interpretation)

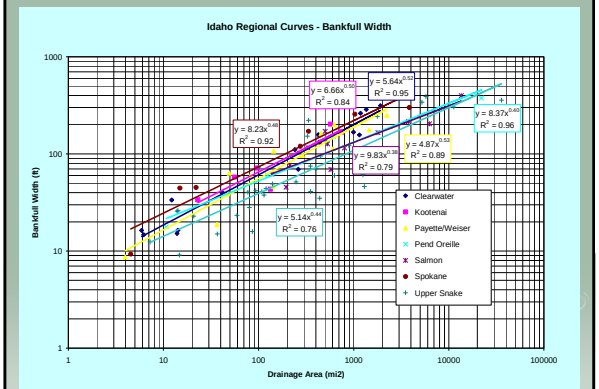


Existing Shade Field Verification



Channel Width

natural & existing



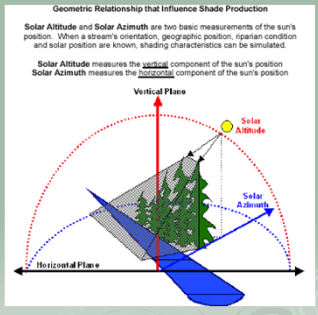
Bankfull Width Estimation

Location	area (sq mi)	Spokane (m)	Kootenai (m)	PendOreille (m)	Clearwater (m)	BURP Data (m)
Kent Creek @ mouth	3.71	5	4	4	3	
South Fork Lion Creek @ mouth	4.58	5	4	5	4	
Lucky Creek @ mouth	1.66	3	3	3	2	
Lion Creek @ mouth	28.48	13	11	10	10	17.2
Lion Cr ab Lucky Creek	26.39	12	10	9	9	
Lion Cr ab South Fork Lion Cr	21.04	11	9	9	8	
Lion Cr ab 6th tributary	15.86	9	8	8	7	
Lion Cr ab 2nd tributary	11.7	8	7	7	6	
Lion Cr ab Kent Creek	7.23	6	5	6	5	
Lion Cr ab 1st tributary	3.04	4	4	4	3	

Target Shade

Shade Calculator
(Shade.xls, WA DOE)

Shade Production



Forest Shade Curves

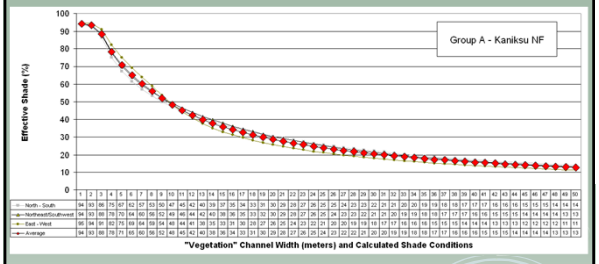


Table 1. VRU/HTG Assessment Groups in the Pend Oreille Basin (KPIZ 2003)

Assessment Group	Description
Group A: VRU 1/HTG 1 (Warm/Dry), VRU 2/HTG 2 (Moderately Warm/Dry), and VRU 3/HTG 3 (Moderately Warm/ Moderately Dry).	This group contains the more warm and dry habitat types with VRU 1 being the warmest and driest to the more moderate conditions of VRU 3. These sites include warm, dry grasslands to moderately cool and dry upland sites. The dry, lower elevation open ridges are composed of mixed Douglas-fir and ponderosa pine in well-stocked and fairly open-grown conditions. Moderately moist, upland sites and dense draws also include larch and lodgepole pine, with lesser amounts of ponderosa pine. Tree regeneration occurs in patches and is largely absent in the understory, particularly in the driest sites. Annual precipitation ranges from 14" to 30", about 75% of that falling as rain. While the growing season is fairly long, high solar input and moderately shallow soils often result in soils that dry out early in the growing season, which results in low to moderate site productivity.
Group B: VRU 4/HTG 4 (Moderately Warm/Moist), VRU 5/HTG 5 (Moderately Cool/Moist), and VRU 6/HTG 6 (Moderately Cool/Wet).	This group occupies most of the moist sites along benches and stream bottoms. The moderating effects of the inland maritime climate ecologically influence this group. This group includes the more moderate sites of VRU 4 and scattered riparian and wet sites of VRU 6. This group is widespread throughout the forest and has the most biological productivity. Precipitation is moderate to high ranging from 30" to 55" per year.
Group C: VRU 7/HTG 7 (Cool/Moist) and VRU 8/HTG 8 (Cool/Wet).	This group occurs in the moist, lower subalpine forest setting and is common on northwest to east facing slopes, riparian and poorly drained subalpine sites, and moist frost pockets. This landscape is typically bordered by warmer sites (Group B) and cool, drier subalpine sites (Group D). This group includes characteristics of each. Average precipitation is estimated between 35" and 55" per year, less than half as rain. Vegetative productivity is moderate to high as a result of the high moisture-holding capacity and nutrient productivity of loess deposits, adequate precipitation, and a good growing season.
Group D: VRU 9/HTG 9 (Cool/ Moderately Dry), HTG 10 (Cold/Moderately Dry) and HTG 11 (Cold).	This group is typified by cool and moderately dry conditions with moderate solar input. The climate is characterized by a short growing season with early summer frosts. Annual precipitation ranges from 35"-70", mostly in the form of snow. Due to generally shallow soils (low water holding capacity), slope position, and aspect, soil moisture is often limited during late summer months. It is generally found on rolling, ridges and upper reaches of convex mountain slopes.

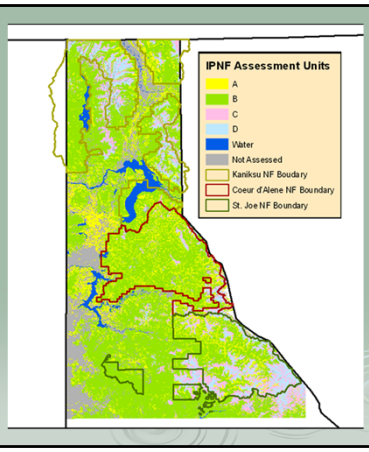


Table 4. IPNF Historical Forest Vegetation Composition Estimates

Assessment Group	PP	WP	WL	DF	GF/WH	WRC	LP	SAF	WBP
Kaniksu NF									
Warm/Dry (Group A)	67%	- -	10%	15%	- -	- -	8%	- -	- -
Moist (Group B)	1%	39%	27%	13%	5%	7%	4%	5%	- -
Cool/Moist (Group C)	- -	13%	12%	1%	- -	- -	12%	63%	- -
Cool/Dry (Group D)	- -	- -	- -	- -	- -	- -	18%	63%	19%

Table 7. IPNF Historical Forest Vegetation Size Class Structure Estimates

Assessment Group	% of Area	Shrub/Seed/ SAP	Small/ Pole	Medium/ Immature	Large/ Mature	"Oldest"
Kaniksu NF						
Warm/Dry (Group A)	11%	21%	10%	13%	16%	41%
Moist (Group B)	62%	22%	13%	22%	22%	20%
Cool/Moist (Group C)	19%	21%	12%	22%	24%	21%
Cool/Dry (Group D)	7%	22%	13%	22%	23%	20%

Forest Vegetation Height -

Tree height conditions for the individual trees which comprise each forest were calculated using a component of the Forest Vegetation Simulator (FVS), which is an individual tree growth and yield model . Tree heights are calculated by the FVS based on size class information provided in Table 10. Two variants of this model were used during this analysis

Idaho Panhandle, Clearwater, and Nez Perce National Forests - The "Northern Idaho/Inland Empire" Height-Diameter relationship variants were used to estimate tree heights for forest vegetation in the Idaho Panhandle, Clearwater, and Nez Perce National Forests. Specifically, tree height was calculated as: HT = 4.5 + e^[a + b/(dbh+1)]; where HT is the total tree height in feet, dbh is the tree diameter at breast height, and a and b are species specific coefficients ...

Table 10. Summary size class information associated with Range of Variability Analysis

Summary Information							Target		
IPNF[1]			CWNF/NPNF[2]		BNF/PNF/SNF[3]		IPNF	CWNF NPNF	BNF PNF SNF
Size Class	Year Class	dbh	Size Class	Year Class	Size Class	dbh	dbh	dbh	dbh
Seed/Sap	0 - 40	0–5	0 – 6" dbh	1 - 40	Seed/Sap	0.1 – 5	3"	3"	3"
Small	40 – 70	5–10	6 – 14" dbh	41 – 100	Small	5 – 12	8"	10"	9"
Medium	70 - 100	10–15	- -	- -	Medium	12 – 20	13"	- -	16"
Large	100 +	> 15	Mature	101 - 150	Large	> 20	19"	19"	24"
"Oldest"[4]	- -	- -	Over-mature	150 +	- -	- -	24"	24"	- -

Table 12. Height (feet) based on Height-Diameter Relationships in the NI Variant.

Common Name	dbh (Inches) 3	8	10	13	19	24
Western white pine	22	69	83	98	119	130
Western larch	31	73	83	94	108	115
Douglas-fir	24	59	68	78	90	97
Grand fir	24	64	75	87	103	112
Western hemlock	23	63	73	85	100	109
Western red cedar	21	57	67	78	92	100
Lodgepole pine	31	61	67	74	82	87
Engelmann spruce	22	59	69	80	95	103
Subalpine fir	22	55	63	73	85	91
Ponderosa pine	18	54	64	75	91	100
Mountain hemlock	16	47	56	66	79	87
Whitebark pine	31	73	83	94	108	115
Limber pine	23	42	46	50	56	58
Subalpine larch	22	55	63	73	85	91
Pinyon pine	23	42	46	50	56	58
Rocky Mountain Juniper	23	42	46	50	56	58
Pacific Yew	23	42	46	50	56	58
Quaking Aspen	21	46	51	58	66	70
Cottonwood	21	46	51	58	66	70
Rocky Mountain maple	21	46	51	58	66	70
Paper birch	21	46	51	58	66	70
Other hardwoods	21	46	51	58	66	70
Other softwoods	16	47	56	66	79	87

Table 13. Vegetation Height Summary Condition for Kaniksu National Forest.

Alpha Code – Common Name	*Vegetation Size Class Groups* *Sapping*	*Small*	*Medium*	*Large*	*Oldest*
Group A (Warm/Dry)					
PP - Ponderosa Pine	2.5	3.6	6.6	9.8	27.4
WP - Western White Pine	- -	- -	- -	- -	- -
WL - Western Larch	0.7	0.7	1.2	1.7	4.7
DF - Douglas Fir	0.8	0.9	1.5	2.2	5.9
GF/WH - Grand Fir/ Western Hemlock	- -	- -	- -	- -	- -
WRC - Western Red Cedar	- -	- -	- -	- -	- -
LP - Lodgepole Pine	0.5	0.5	0.8	1.1	2.8
SAF - Subalpine Fir	- -	- -	- -	- -	- -
WBP - White Bark Pine	- -	- -	- -	- -	- -
Group A Height Sub-Totals	4.5	5.7	10.1	14.7	40.9
Total					**76**
Group B (Moist)					
PP - Ponderosa Pine	0.0	0.1	0.2	0.2	0.2
WP - Western White Pine	1.9	3.5	8.4	10.2	10.1
WL - Western Larch	1.8	2.5	5.6	6.4	6.2
DF - Douglas Fir	0.7	1.0	2.2	2.6	2.5
GF/WH - Grand Fir/ Western Hemlock	0.3	0.4	0.9	1.1	1.1
WRC - Western Red Cedar	0.3	0.5	1.2	1.4	1.4
LP - Lodgepole Pine	0.3	0.3	0.7	0.7	0.7
SAF - Subalpine Fir	0.2	0.4	0.8	0.9	0.9
WBP - White Bark Pine	- -	- -	- -	- -	- -
Group B Height Sub-Totals	5.6	8.7	20.0	23.5	23.1
Total					**81**

Canopy Cover

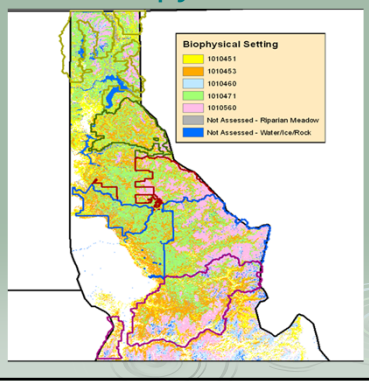


Table 19 (continued). Weighted Average Canopy Cover for Biophysical Setting Groups

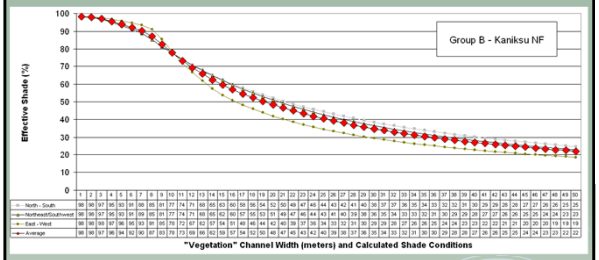
Biophysical Setting 1010460
Northern Rocky Mountain Subalpine Woodland and Parkland

Description	Composition (%)	Canopy Cover Low Range	Canopy Cover High Range	Target - 75th Percentile Value	Weighted Condition
Early Development	20	0	100	75	15
Mid Development Closed	40	31	100	83	33
Mid Development Open	15	0	30	23	3
Late Development Open	5	0	40	30	2
Late Development Closed	20	41	100	85	17
				Total	**70**

Biophysical Setting 1010471
Northern Rocky Mountain Mesic Montane Mixed Conifer Forest

Description	Composition (%)	Canopy Cover Low Range	Canopy Cover High Range	Target - 75th Percentile Value	Weighted Condition
Early Development	15	0	100	75	11
Mid Development Closed	30	61	100	90	27
Mid Development Open	5	0	60	45	2
Late Development Open	10	0	60	45	5
Late Development Closed	40	61	100	90	36
				Total	**81**

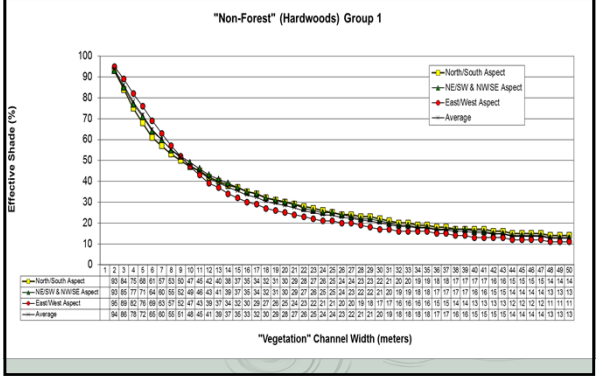
Forest Shade Curves



Non-Forest ("Hardwood") Type

Common Name	Canopy Cover (CC)	Constancy	Weighted CC[a]	System Potential SP) Height[b]	Weighting Factor[c]	Weighted SP Height
YRU 3C (n = 43 Ecodata plots)						
Grand Fir	20	51	10	100	14%	14
Engelmann Spruce	16	33	5	90	9%	8
Black Cottonwood	15	30	5	100	8%	8
Douglas Fir	8	35	3	91	10%	9
Western Redcedar	30	40	12	87	11%	10
Western Hemlock	19	56	11	85	16%	13
Rocky Mountain Maple	8	65	5	30	18%	5
Mountain Alder	21	21	4	30	6%	2
Sitka Alder	11	28	3	30	8%	2
Total			**58**	**Total**		**72**
YRU 4C (n = 34 Ecodata plots)						
Grand Fir	6	35	2	100	10%	10
Subalpine Fir	5	18	1	63	5%	3
Paper Birch	40	9	4	70	3%	2
Engelmann Spruce	13	44	6	90	13%	11
Balsam Poplar	30	3	1	80	1%	1
Black Cottonwood	16	24	4	100	7%	7
Douglas Fir	16	50	8	91	14%	13
Western Red Cedar	32	26	8	87	7%	6
Western Hemlock	5	26	1	85	7%	6
Rocky Mountain Maple	11	56	6	30	16%	5
Mountain Alder	34	35	12	30	10%	3
Sitka Alder	21	24	5	30	7%	2
Total			**58**	**Total**		**70**

Non-Forest Group 1



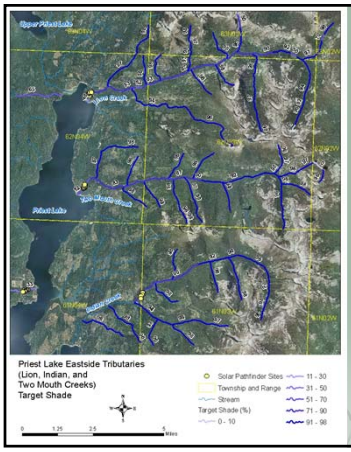
http://www.deq.idaho.gov/media/528731-pnv_temp_tmdl_manual_revised_1009.pdf

Revised
October 2009

The Potential Natural Vegetation (PNV) Temperature Total Maximum Daily Load (TMDL) Procedures Manual

January 2009

Prepared by:
Mark Shumar and Jessica de Varona

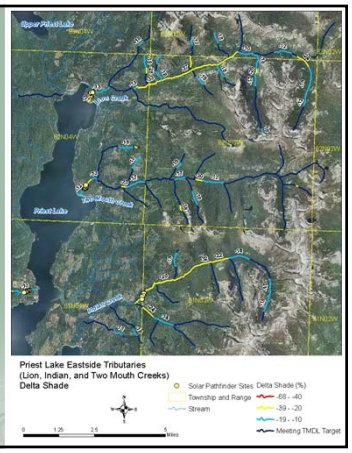


Target Shade (%)

Lion Creek Loading Table

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m²/day)	Segment Width (m)	Segment Area (m²)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
013_02	Lion Creek	1	360	Lake	0%	5.70	240	86,400	492,000	0%	5.70	240	86,400	492,000	0	0%
013_02	Lion Creek	2	1200	Group D	96%	0.23	2	2,000	500	90%	0.57	2	2,000	1,000	500	-6%
013_02	Lion Creek	3	290	Group D	52%	0.46	4	1,000	500	80%	1.14	4	1,000	1,000	500	-12%
013_02	Lion Creek	4	2100	Group C	94%	0.34	4	8,000	3,000	80%	1.14	4	8,000	9,000	6,000	-14%
013_02	Lion Creek	5	890	Group C	94%	0.34	4	3,000	1,000	70%	1.71	4	3,000	5,000	4,000	-24%
013_02	Lion Creek	6	390	Avalanche/Rock	50%	2.85	5	2,000	6,000	50%	2.85	5	2,000	6,000	0	0%
013_02	Lion Creek	7	1000	Group C	92%	0.46	5	5,000	2,000	80%	1.14	5	5,000	6,000	4,000	-12%
013_02	Lion Creek	8	1200	Group C	90%	0.57	6	7,000	4,000	90%	0.57	6	7,000	4,000	0	0%
013_02	Lion Creek	9	920	Group B	90%	0.57	7	6,000	3,000	80%	1.14	7	6,000	7,000	4,000	-10%
013_02	Lion Creek	10	4860	Group B	87%	0.74	8	40,000	30,000	50%	2.85	8	40,000	100,000	70,000	-37%
013_02	Lion Creek	11	1140	Group B	83%	0.97	9	10,000	10,000	50%	2.85	9	10,000	30,000	20,000	-33%
013_02	Lion Creek	12	450	Nonforest	52%	2.74	9	4,000	10,000	30%	3.99	9	4,000	20,000	10,000	-22%
013_02	Lion Creek	13	160	Group B	83%	0.97	9	1,000	1,000	70%	1.71	9	1,000	2,000	1,000	-13%
013_02	Lion Creek	14	1500	Group B	83%	0.97	9	10,000	10,000	80%	1.14	10	20,000	20,000	10,000	-3%
013_02	Lion Creek	15	360	Group B	83%	0.97	10	3,600	3,500	70%	1.71	12	4,300	7,400	3,900	-13%
013_02	Lion Creek	16	1130	Group B	83%	0.97	10	11,000	11,000	70%	1.71	17	19,000	32,000	21,000	-13%
013_02	Lion Creek	17	230	Nonforest	48%	2.96	10	2,300	6,800	20%	4.56	20	4,600	21,000	14,000	-28%
							Totals		590,000					760,000	170,000	

Shade Deficit (%)



Implementation

- Prioritize with Shade Deficit.
- Field Verification – nature of problem and pathfinder shade.
- Problem identification – beaver ponds, lack of water, plant community, channel width, disturbance (natural vs. human-caused).
- Real opportunities for rehabilitation.