Potential Natural Vegetation Temperature TMDLs

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Objectives

- Present steps used to produce a temperature TMDL based on riparian shade.
- Discuss the Little Willow Creek PNV temperature TMDL.

Components of a Stream

- Channel, Riparian Zone, Alluvial Aquifer
- Interactions between external drivers (sun, ground water) and these components ultimately affect stream temperature.
- (Poole & Berman, 2001)

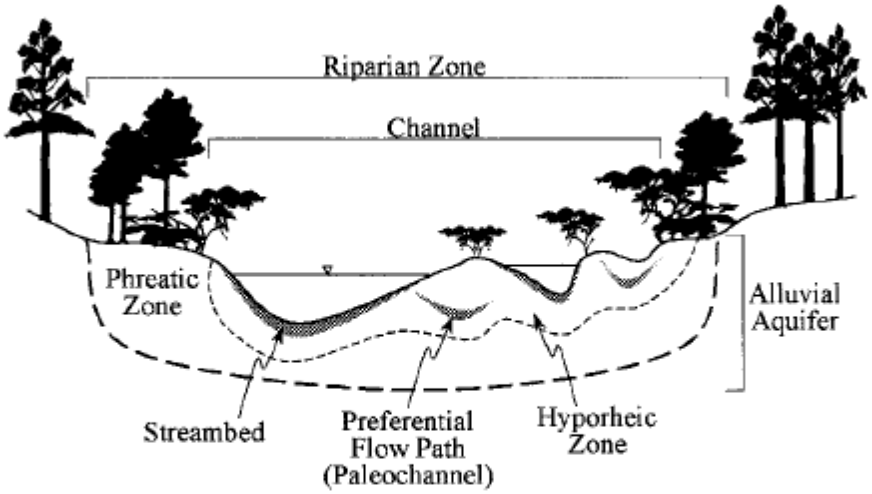
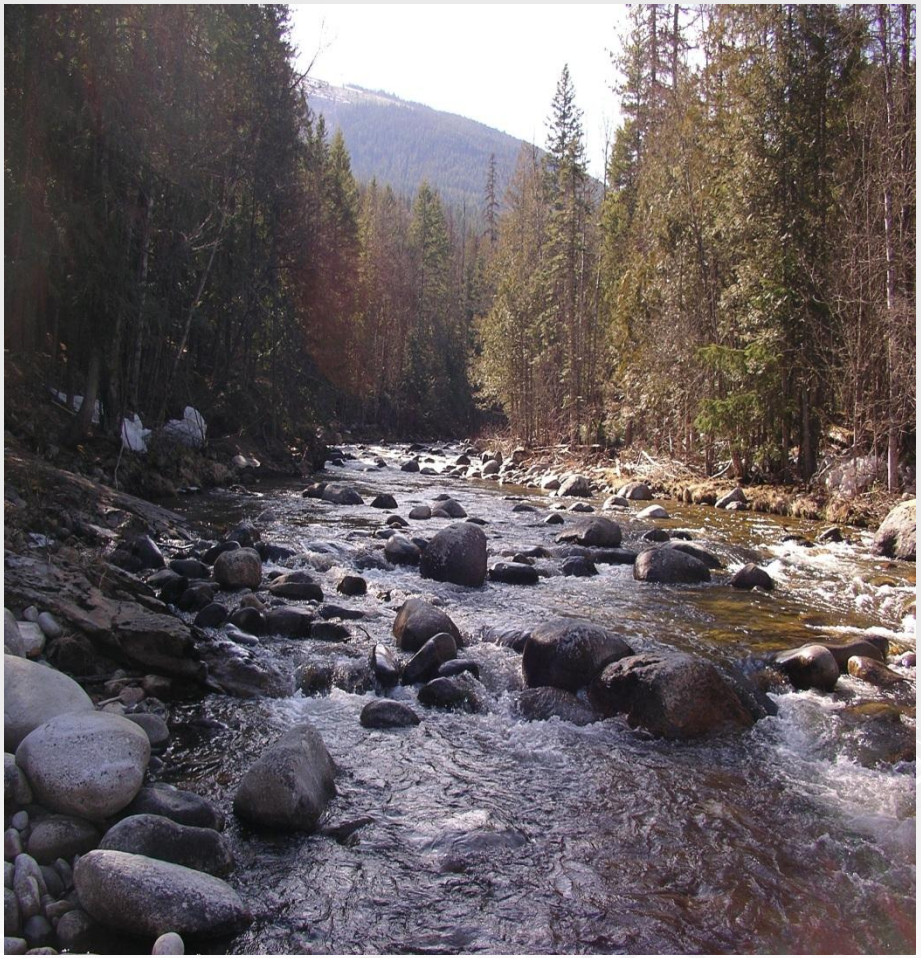


Figure 1. Structural components of a stream system (not all features exist in all streams.)

Potential Natural Vegetation

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



Potential Natural Vegetation

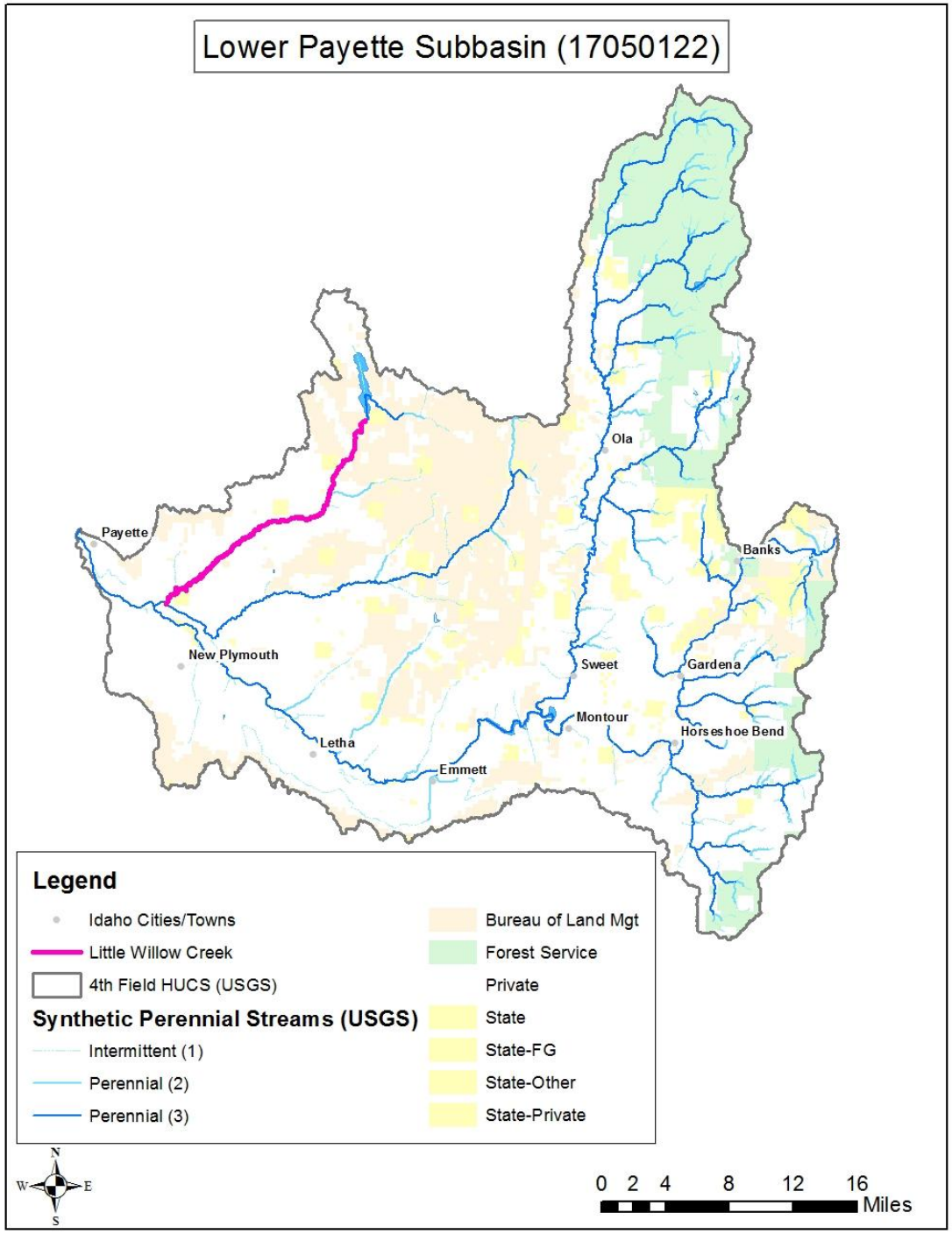
- Produces natural stream temperatures (assuming no point sources of heat).
- Equates to natural background conditions in Idaho WQS.

TMDL Target

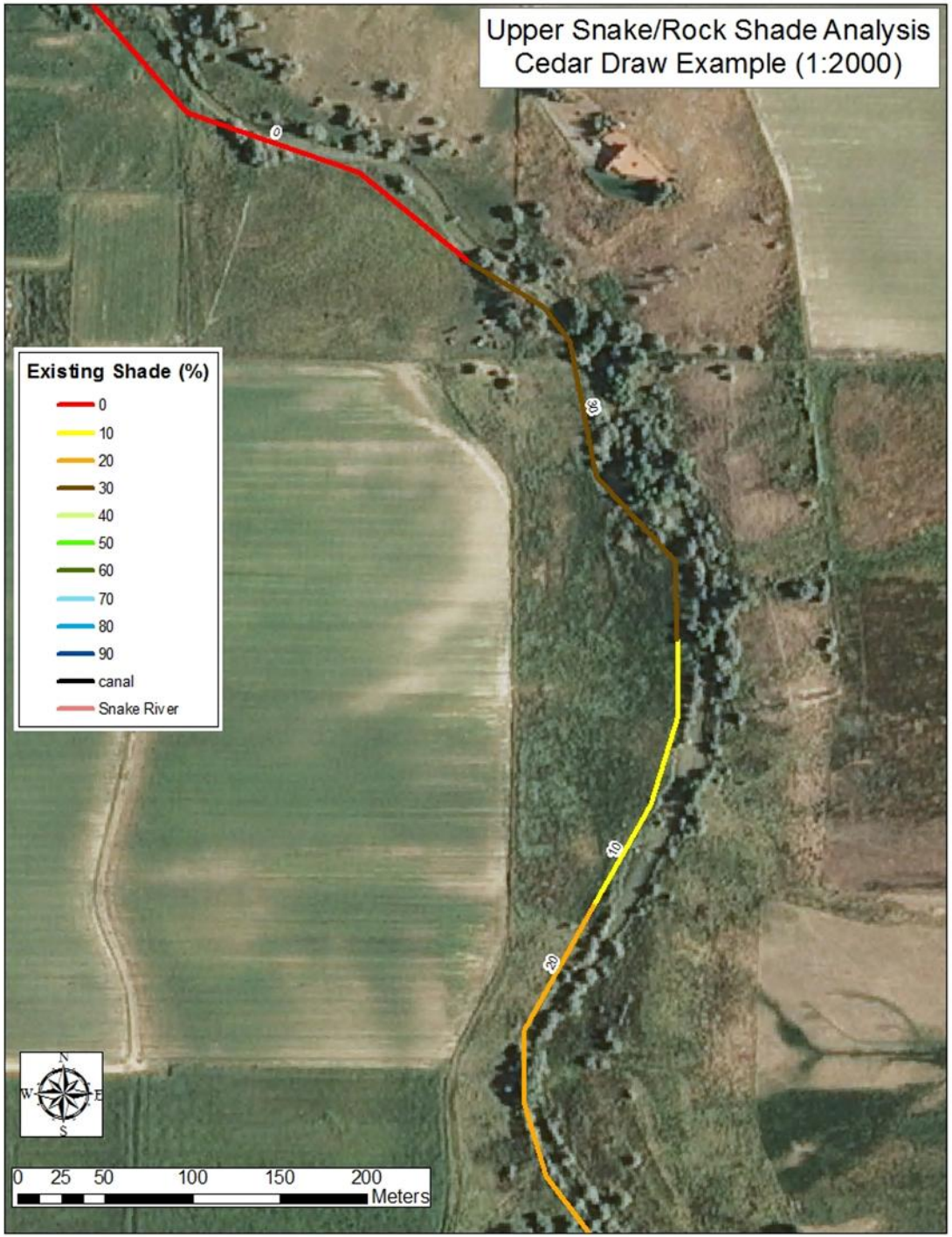
- WQ Criteria
  - 19° / 22° C – summer
  - 9° / 13° C – spring/fall spawning
- Shade Target
  - Based on stream-side shade producing plant community and channel width.

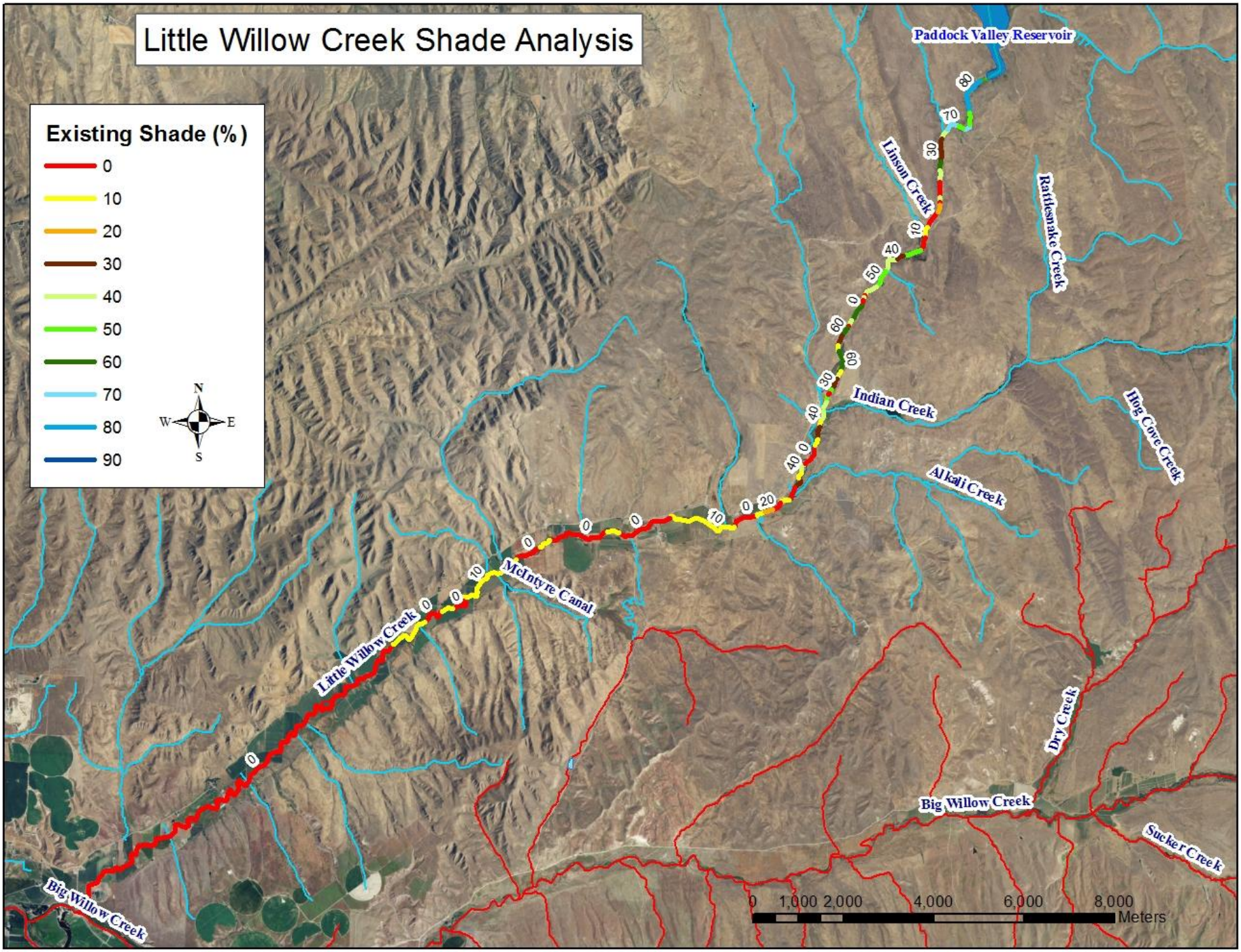
Temperature TMDL

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


Lower Payette Subbasin (17050122)
Ola
Payette
Banks
New Plymouth
Sweet
Gardena
Montour
Horseshoe Bend
Letha
Emmett
Legend
Idaho Cities/Towns
Little Willow Creek
4th Field HUCS (USGS)
Synthetic Perennial Streams (USGS)
Intermittent (1)
Perennial (2)
Perennial (3)
Bureau of Land Mgt
Forest Service
Private
State
State-FG
State-Other
State-Private
N
W
E
S
0 2 4 8 12 16
Miles

Existing Shade (aerial interpretation)




Little Willow Creek Shade Analysis
Existing Shade (%)
0
10
20
30
40
50
60
70
80
90
N
W
E
S
Paddock Valley Reservoir
Linson Creek
Rattlesnake Creek
Indian Creek
Hog Cove Creek
Alkali Creek
McIntyre Canal
Little Willow Creek
Dry Creek
Big Willow Creek
Sucker Creek
Big Willow Creek
0
1,000
2,000
4,000
6,000
8,000
Meters

Existing Shade Field Verification

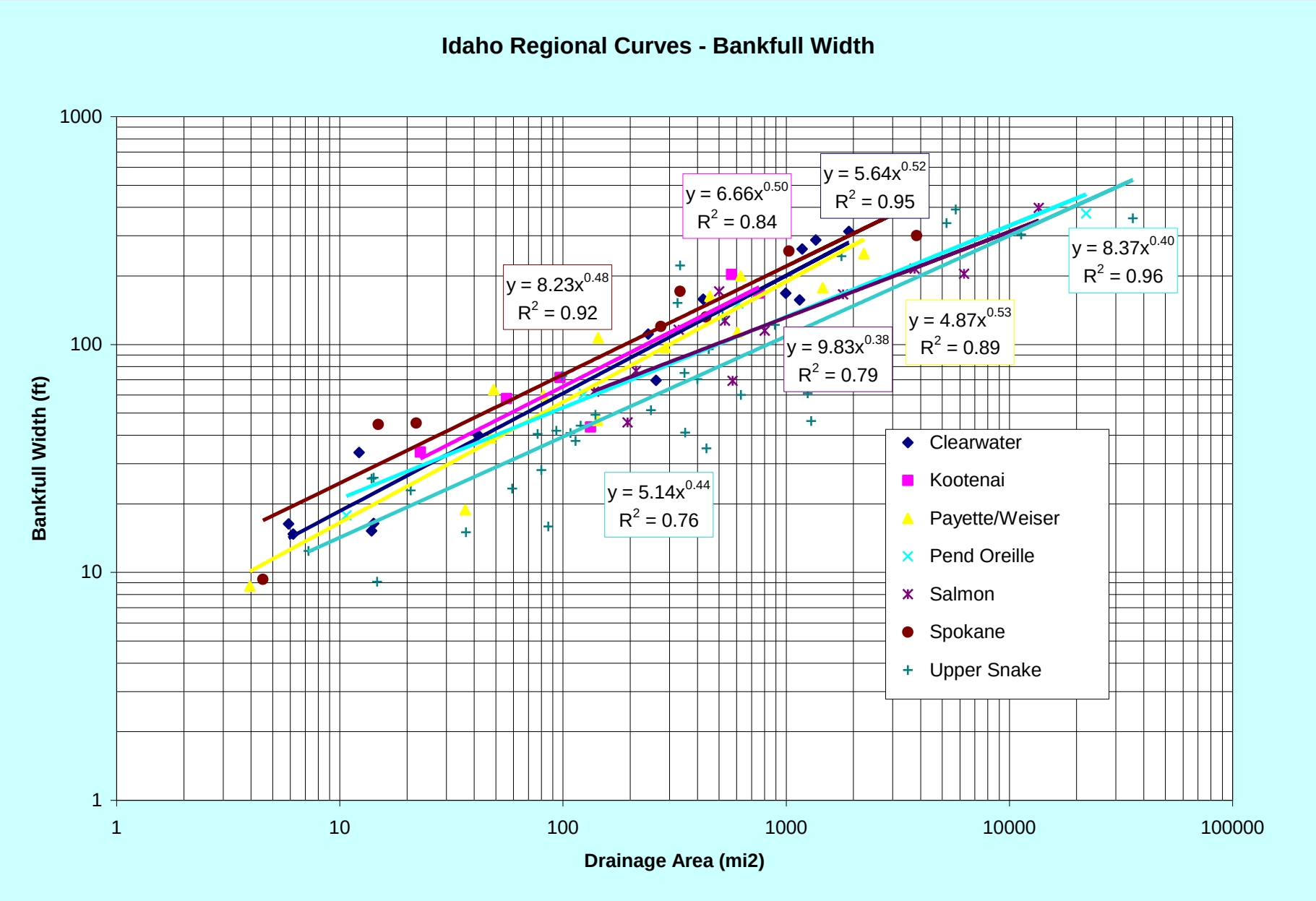
60

Aerial Interpretation Accuracy

aerial class	pathfinder actual	pathfinder class	delta	
0	16.2	10	-10	lemhi1
0	19.8	10	-10	lemhi2
10	19.8	10	0	lemhi3
30	31.5	30	0	lemhi4
20	11.8	10	10	18mile1
10	10	10	0	18mile2
			-2	average
			7.53	std dev
			6.60	95%CI

Channel Width

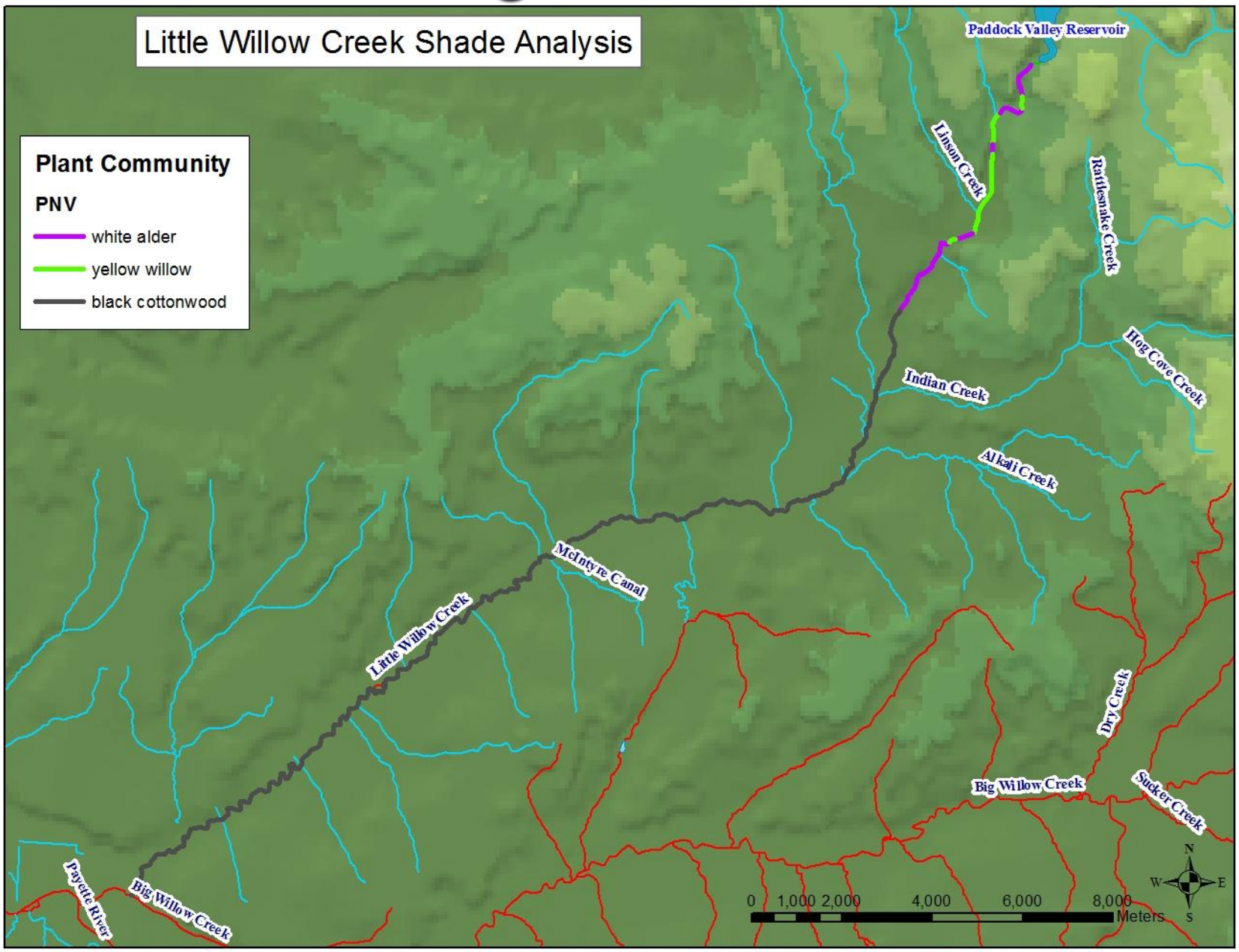
existing & natural


Idaho Regional Curves - Bankfull Width
Bankfull Width (ft)
Drainage Area (mi2)
1000
100
10
1
1
10
100
1000
10000
100000
y = 8.23x^0.48
R^2 = 0.92
y = 6.66x^0.50
R^2 = 0.84
y = 5.64x^0.52
R^2 = 0.95
y = 8.37x^0.40
R^2 = 0.96
y = 4.87x^0.53
R^2 = 0.89
y = 9.83x^0.38
R^2 = 0.79
y = 5.14x^0.44
R^2 = 0.76
Clearwater
Kootenai
Payette/Weiser
Pend Oreille
Salmon
Spokane
Upper Snake

Bankfull Width Estimation

Location	area (sq mi)	Upper Snake (m)	Salmon (m)	Payette/Weiser (m)	aerial (m)
Little Willow Cr @ mouth	153.67	14	20	21	10
Little Willow Cr ab McIntyre Gulch	119.23	13	18	19	8
Little Willow Cr ab Indian Cr	67.83	10	15	14	8
Little Willow Cr ab Linsom Cr	50	9	13	12	7
Little Willow Cr @ Paddock Res. Dam	45.37	8	13	11	6

Target Shade



Target Shade

Shade Calculator - Shade.xls (WA DOE)

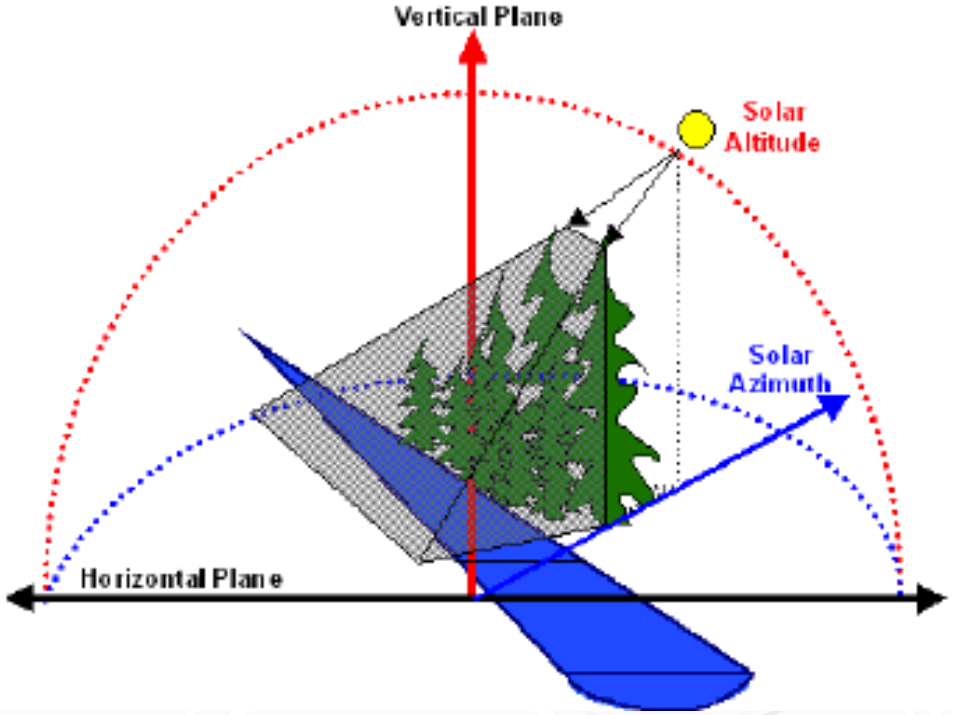
Plant Community Data – Hansen & Hall (2002)

Shade Production

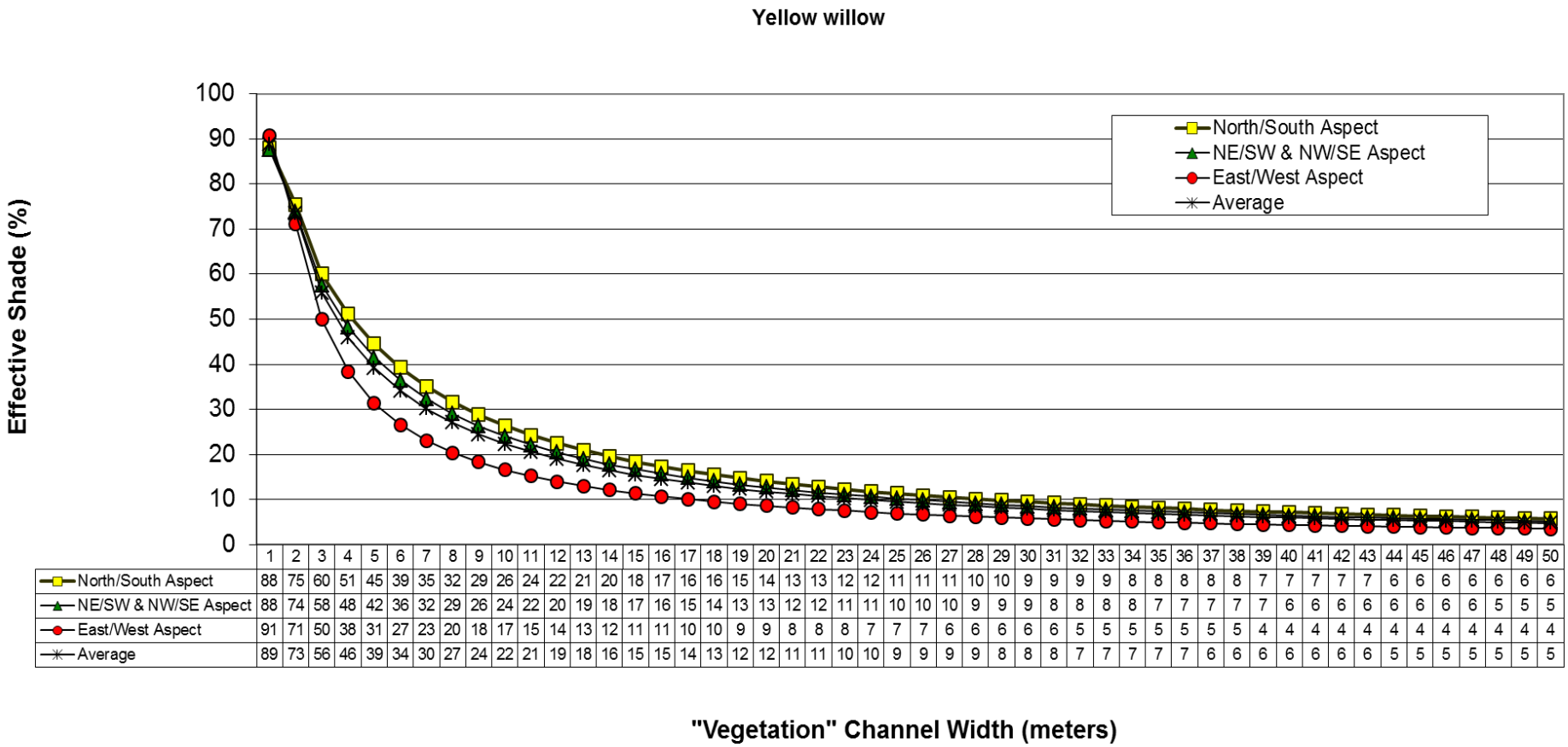
Geometric Relationship that Influence Shade Production

Solar Altitude and **Solar Azimuth** are two basic measurements of the sun's position. When a stream's orientation, geographic position, riparian condition and solar position are known, shading characteristics can be simulated.

Solar Altitude measures the vertical component of the sun's position
Solar Azimuth measures the horizontal component of the sun's position

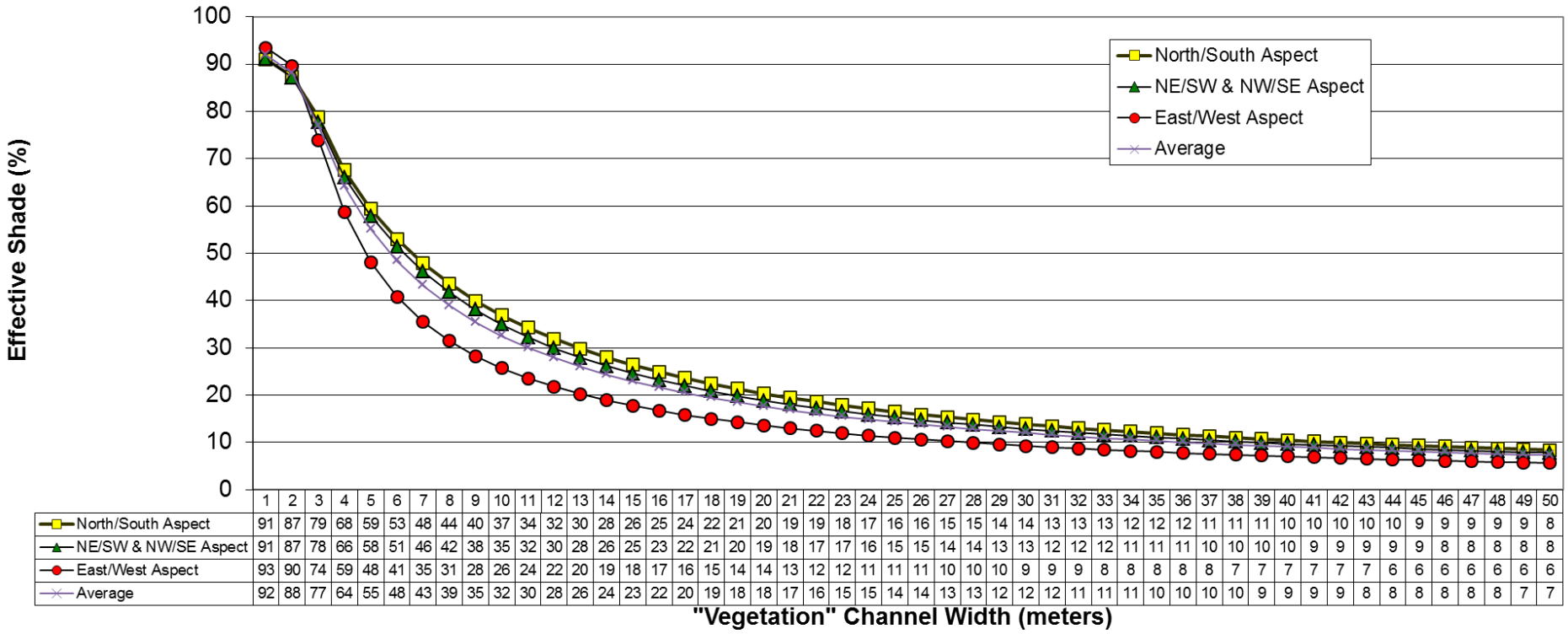


Shade Curves



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	88	75	60	51	45	39	35	32	29	26	24	22	21	20	18	17	16	16	15	14	13	13	12	12	11	11	11	10	10	9	9	9	9	8	8	8	8	8	7	7	7	7	7	6	6	6	6	6	6	6
NE/SW & NW/SE Aspect	88	74	58	48	42	36	32	29	26	24	22	20	19	18	17	16	15	14	13	13	12	12	11	11	10	10	10	9	9	9	8	8	8	8	7	7	7	7	7	6	6	6	6	6	6	6	6	5	5	5
East/West Aspect	91	71	50	38	31	27	23	20	18	17	15	14	13	12	11	11	10	10	9	9	8	8	8	7	7	7	6	6	6	6	6	5	5	5	5	5	5	5	4	4	4	4	4	4	4	4	4	4	4	4
Average	89	73	56	46	39	34	30	27	24	22	21	19	18	16	15	15	14	13	12	12	11	11	10	10	9	9	9	9	8	8	8	7	7	7	7	7	6	6	6	6	6	6	6	5	5	5	5	5	5	5

Water Birch



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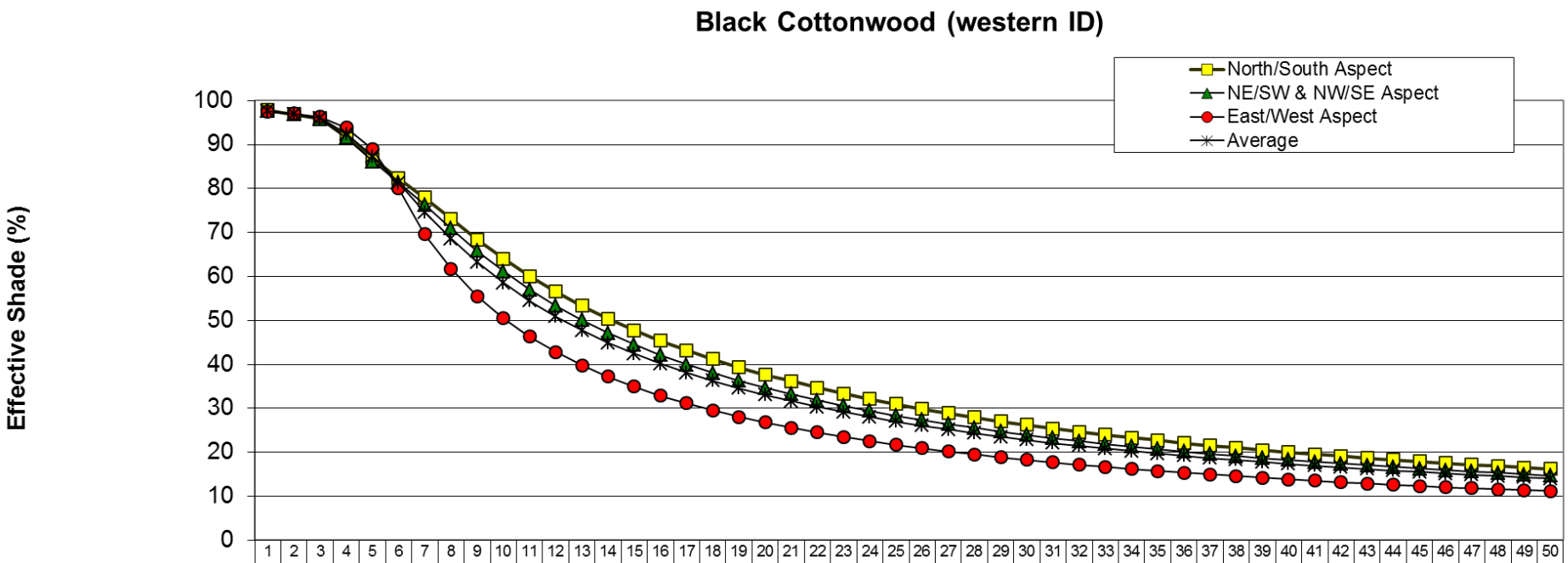
North/South Aspect	91	87	79	68	59	53	48	44	40	37	34	32	30	28	26	25	24	22	21	20	19	19	18	17	16	16	15	15	14	14	13	13	13	12	12	12	11	11	11	10	10	10	10	10	9	9	9	9	9	8
NE/SW & NW/SE Aspect	91	87	78	66	58	51	46	42	38	35	32	30	28	26	25	23	22	21	20	19	18	17	17	16	15	15	14	14	13	13	12	12	12	11	11	11	10	10	10	10	9	9	9	9	9	8	8	8	8	8
East/West Aspect	93	90	74	59	48	41	35	31	28	26	24	22	20	19	18	17	16	15	14	14	13	12	12	11	11	11	10	10	10	9	9	9	8	8	8	8	8	7	7	7	7	7	7	6	6	6	6	6	6	6
Average	92	88	77	64	55	48	43	39	35	32	30	28	26	24	23	22	20	19	18	18	17	16	15	15	14	14	13	13	12	12	12	11	11	11	10	10	10	10	9	9	9	9	8	8	8	8	8	8	7	7



	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50
North/South Aspect	98	97	96	92	87	82	78	73	68	64	60	56	53	50	48	45	43	41	39	38	36	35	33	32	31	30	29	28	27	26	25	25	24	23	23	22	22	21	20	20	20	19	19	18	18	18	17	17	16	16
NE/SW & NW/SE Aspect	98	97	96	92	86	81	76	71	66	61	57	53	50	47	45	42	40	38	36	35	33	32	31	29	28	27	26	26	25	24	23	23	22	21	21	20	20	19	19	18	18	17	17	17	16	16	16	15	15	15
East/West Aspect	97	97	96	94	89	80	70	62	56	50	46	43	40	37	35	33	31	30	28	27	26	24	23	23	22	21	20	20	19	18	18	17	17	16	16	15	15	15	14	14	14	13	13	13	12	12	12	12	11	11
Average	98	97	96	92	87	81	75	69	63	59	54	51	48	45	42	40	38	36	35	33	32	30	29	28	27	26	25	24	24	23	22	21	21	20	20	19	19	18	18	17	17	17	16	16	16	15	15	15	14	14

"Vegetation" Channel Width (meters) and Calculated Shade Conditions

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

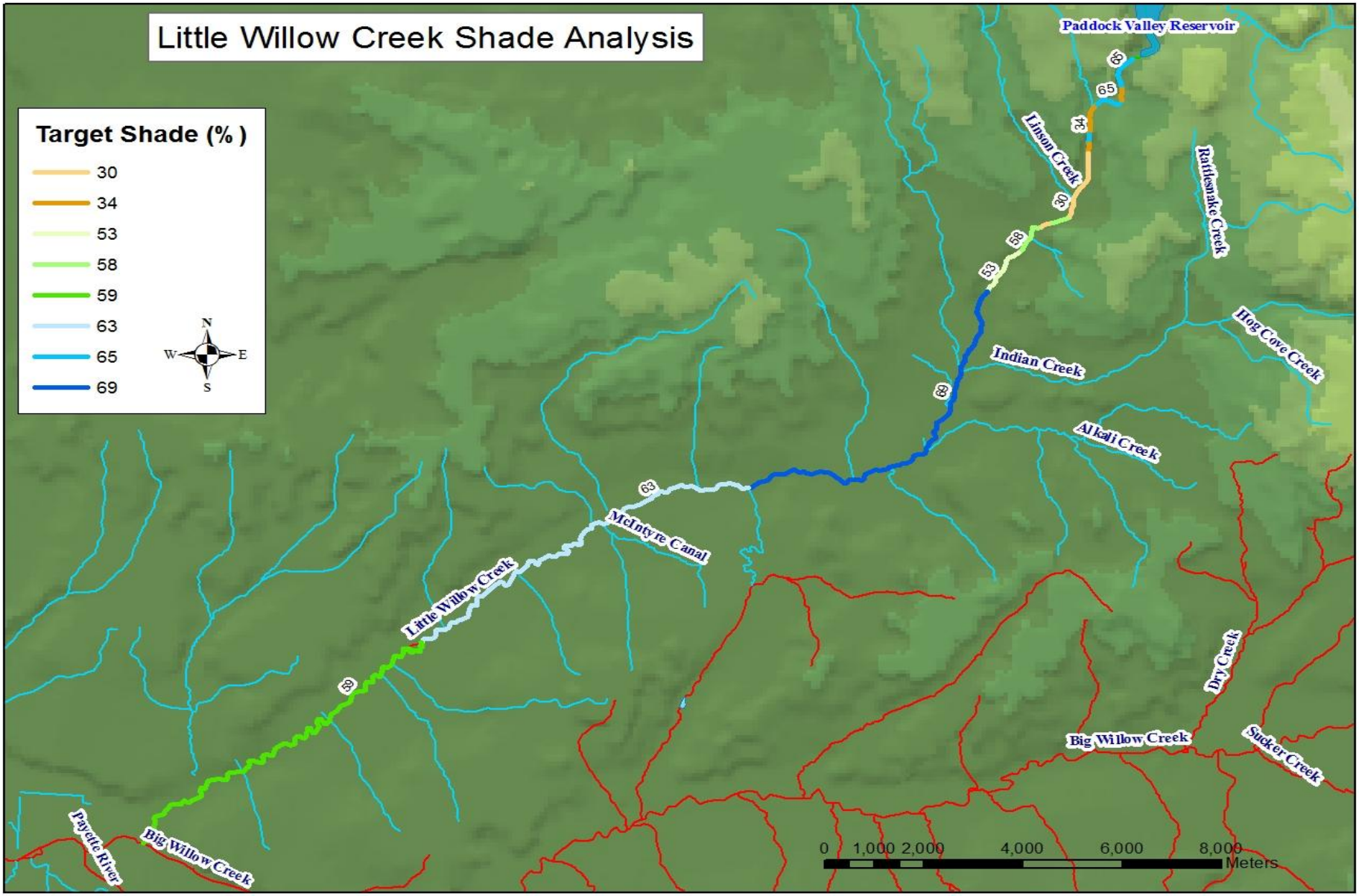
Revised
October 2009

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 (%)

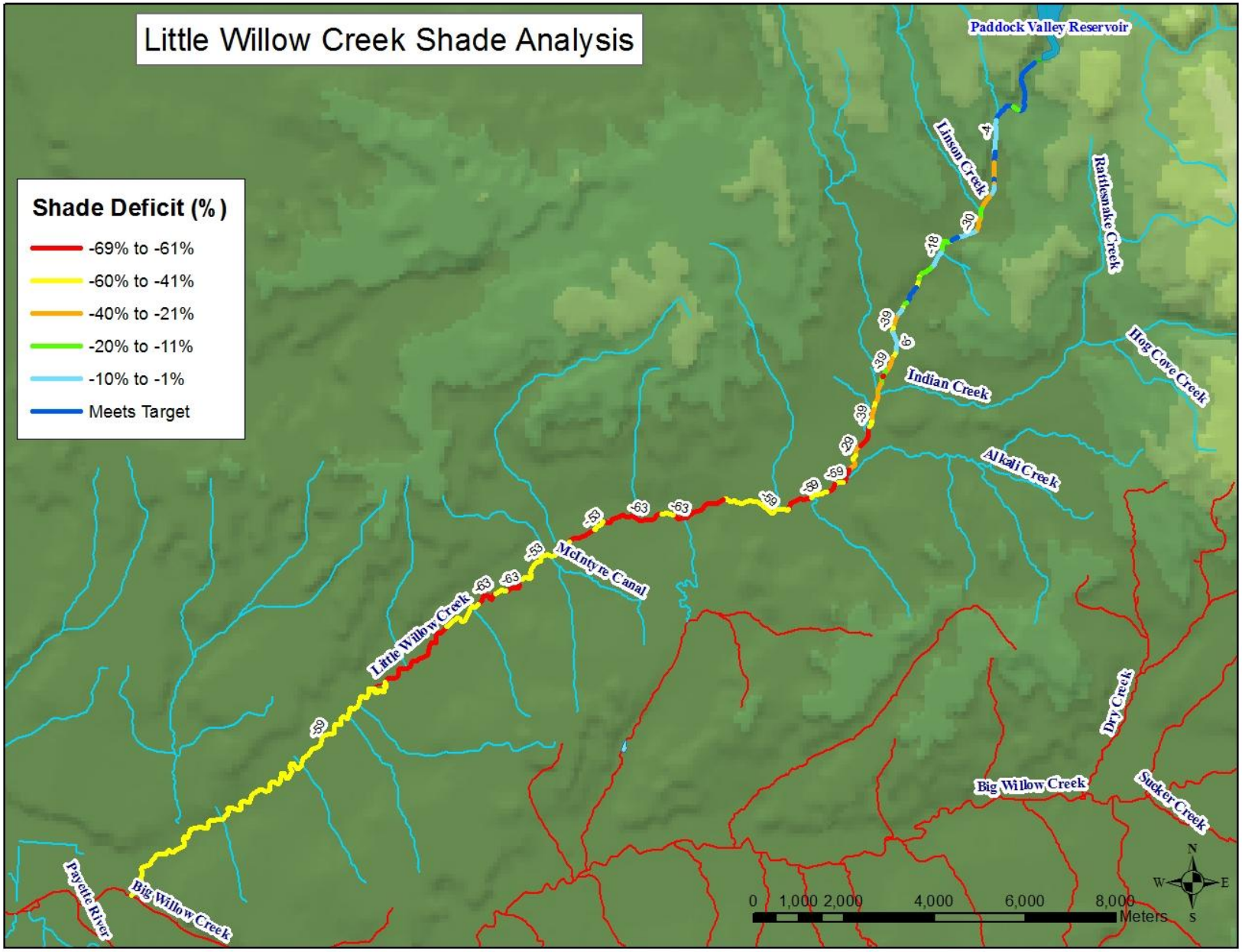


Little Willow Creek Load Tables

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
018_03	Little Willow Creek	1	60	white alder	65%	2.23	6	400	900	80%	1.28	6	400	500	(400)	0%
018_03	Little Willow Creek	2	760	white alder	65%	2.23	6	5,000	10,000	80%	1.28	6	5,000	6,000	(4,000)	0%
018_03	Little Willow Creek	3	260	willow	34%	4.21	6	2,000	8,000	50%	3.19	6	2,000	6,000	(2,000)	0%
018_03	Little Willow Creek	4	210	white alder	65%	2.23	6	1,000	2,000	70%	1.91	6	1,000	2,000	0	0%
018_03	Little Willow Creek	5	110	white alder	65%	2.23	6	700	2,000	50%	3.19	6	700	2,000	0	-15%
018_03	Little Willow Creek	6	300	white alder	65%	2.23	6	2,000	4,000	70%	1.91	6	2,000	4,000	0	0%
018_03	Little Willow Creek	7	110	willow	34%	4.21	6	700	3,000	40%	3.83	6	700	3,000	0	0%
018_03	Little Willow Creek	8	150	willow	34%	4.21	6	900	4,000	40%	3.83	6	900	3,000	(1,000)	0%
018_03	Little Willow Creek	9	500	willow	34%	4.21	6	3,000	10,000	30%	4.47	6	3,000	10,000	0	-4%
018_03	Little Willow Creek	10	210	white alder	65%	2.23	6	1,000	2,000	60%	2.55	6	1,000	3,000	1,000	-5%
018_03	Little Willow Creek	11	240	willow	34%	4.21	6	1,000	4,000	40%	3.83	6	1,000	4,000	0	0%
018_03	Little Willow Creek	12	340	willow	30%	4.47	7	2,000	9,000	0%	6.38	7	2,000	10,000	1,000	-30%
018_03	Little Willow Creek	13	120	willow	30%	4.47	7	800	4,000	40%	3.83	7	800	3,000	(1,000)	0%
018_03	Little Willow Creek	14	50	willow	30%	4.47	7	400	2,000	0%	6.38	7	400	3,000	1,000	-30%
018_03	Little Willow Creek	15	150	willow	30%	4.47	7	1,000	4,000	20%	5.10	7	1,000	5,000	1,000	-10%
018_03	Little Willow Creek	16	430	willow	30%	4.47	7	3,000	10,000	0%	6.38	7	3,000	20,000	10,000	-30%
018_03	Little Willow Creek	17	71	willow	30%	4.47	7	500	2,000	10%	5.74	7	500	3,000	1,000	-20%
018_03	Little Willow Creek	18	170	willow	30%	4.47	7	1,000	4,000	10%	5.74	7	1,000	6,000	2,000	-20%
018_03	Little Willow Creek	19	300	willow	30%	4.47	7	2,000	9,000	0%	6.38	7	2,000	10,000	1,000	-30%
018_03	Little Willow Creek	20	410	white alder	58%	2.68	7	3,000	8,000	50%	3.19	7	3,000	10,000	2,000	-8%
018_03	Little Willow Creek	21	160	willow	30%	4.47	7	1,000	4,000	30%	4.47	7	1,000	4,000	0	0%
018_03	Little Willow Creek	22	450	white alder	58%	2.68	7	3,000	8,000	40%	3.83	7	3,000	10,000	2,000	-18%
018_03	Little Willow Creek	23	430	white alder	58%	2.68	7	3,000	8,000	50%	3.19	7	3,000	10,000	2,000	-8%
018_03	Little Willow Creek	24	330	white alder	53%	3.00	8	3,000	9,000	40%	3.83	8	3,000	10,000	1,000	-13%
018_03	Little Willow Creek	25	37	white alder	53%	3.00	8	300	900	0%	6.38	8	300	2,000	1,000	-53%
018_03	Little Willow Creek	26	78	white alder	53%	3.00	8	600	2,000	40%	3.83	8	600	2,000	0	-13%
018_03	Little Willow Creek	27	120	white alder	53%	3.00	8	1,000	3,000	0%	6.38	8	1,000	6,000	3,000	-53%
018_03	Little Willow Creek	28	410	white alder	53%	3.00	8	3,000	9,000	60%	2.55	8	3,000	8,000	(1,000)	0%
018_03	Little Willow Creek	29	140	white alder	53%	3.00	8	1,000	3,000	40%	3.83	8	1,000	4,000	1,000	-13%
018_03	Little Willow Creek	30	49	white alder	53%	3.00	8	400	1,000	0%	6.38	8	400	3,000	2,000	-53%
018_03	Little Willow Creek	31	210	cottonwood	69%	1.98	8	2,000	4,000	60%	2.55	8	2,000	5,000	1,000	-9%
018_03	Little Willow Creek	32	230	cottonwood	69%	1.98	8	2,000	4,000	30%	4.47	8	2,000	9,000	5,000	-39%
018_03	Little Willow Creek	33	120	cottonwood	69%	1.98	8	1,000	2,000	10%	5.74	8	1,000	6,000	4,000	-59%
018_03	Little Willow Creek	34	480	cottonwood	69%	1.98	8	4,000	8,000	60%	2.55	8	4,000	10,000	2,000	-9%
018_03	Little Willow Creek	35	120	cottonwood	69%	1.98	8	1,000	2,000	10%	5.74	8	1,000	6,000	4,000	-59%
018_03	Little Willow Creek	36	66	cottonwood	69%	1.98	8	500	1,000	40%	3.83	8	500	2,000	1,000	-29%
018_03	Little Willow Creek	37	260	cottonwood	69%	1.98	8	2,000	4,000	30%	4.47	8	2,000	9,000	5,000	-39%
018_03	Little Willow Creek	38	110	cottonwood	69%	1.98	8	900	2,000	50%	3.19	8	900	3,000	1,000	-19%
018_03	Little Willow Creek	39	35	cottonwood	69%	1.98	8	300	600	0%	6.38	8	300	2,000	1,000	-69%
018_03	Little Willow Creek	40	170	cottonwood	69%	1.98	8	1,000	2,000	50%	3.19	8	1,000	3,000	1,000	-19%
018_03	Little Willow Creek	41	140	cottonwood	69%	1.98	8	1,000	2,000	40%	3.83	8	1,000	4,000	2,000	-29%
018_03	Little Willow Creek	42	110	cottonwood	69%	1.98	8	900	2,000	50%	3.19	8	900	3,000	1,000	-19%
								Totals	180,000					230,000	51,000	

Segment Details					Target					Existing					Summary	
AU	Stream Name	Number (top to bottom)	Length (m)	Vegetation Type	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Shade	Solar Radiation (kWh/m^2/day)	Segment Width (m)	Segment Area (m^2)	Solar Load (kWh/day)	Excess Load (kWh/day)	Lack of Shade
018_04	Little Willow Creek	1	230	cottonwood	69%	1.98	8	2,000	4,000	40%	3.83	8	2,000	8,000	4,000	-29%
018_04	Little Willow Creek	2	130	cottonwood	69%	1.98	8	1,000	2,000	10%	5.74	8	1,000	6,000	4,000	-59%
018_04	Little Willow Creek	3	280	cottonwood	69%	1.98	8	2,000	4,000	30%	4.47	8	2,000	9,000	5,000	-39%
018_04	Little Willow Creek	4	130	cottonwood	69%	1.98	8	1,000	2,000	10%	5.74	8	1,000	6,000	4,000	-59%
018_04	Little Willow Creek	5	280	cottonwood	69%	1.98	8	2,000	4,000	0%	6.38	8	2,000	10,000	6,000	-69%
018_04	Little Willow Creek	6	200	cottonwood	69%	1.98	8	2,000	4,000	0%	6.38	8	2,000	10,000	6,000	-69%
018_04	Little Willow Creek	7	260	cottonwood	69%	1.98	8	2,000	4,000	40%	3.83	8	2,000	8,000	4,000	-29%
018_04	Little Willow Creek	8	130	cottonwood	69%	1.98	8	1,000	2,000	10%	5.74	8	1,000	6,000	4,000	-59%
018_04	Little Willow Creek	9	300	cottonwood	69%	1.98	8	2,000	4,000	30%	4.47	8	2,000	9,000	5,000	-39%
018_04	Little Willow Creek	10	190	cottonwood	69%	1.98	8	2,000	4,000	0%	6.38	8	2,000	10,000	6,000	-69%
018_04	Little Willow Creek	11	110	cottonwood	69%	1.98	8	900	2,000	0%	6.38	8	900	6,000	4,000	-69%
018_04	Little Willow Creek	12	220	cottonwood	69%	1.98	8	2,000	4,000	10%	5.74	8	2,000	10,000	6,000	-59%
018_04	Little Willow Creek	13	250	cottonwood	69%	1.98	8	2,000	4,000	0%	6.38	8	2,000	10,000	6,000	-69%
018_04	Little Willow Creek	14	180	cottonwood	69%	1.98	8	1,000	2,000	20%	5.10	8	1,000	5,000	3,000	-49%
018_04	Little Willow Creek	15	200	cottonwood	69%	1.98	8	2,000	4,000	10%	5.74	8	2,000	10,000	6,000	-59%
018_04	Little Willow Creek	16	620	cottonwood	69%	1.98	8	5,000	10,000	0%	6.38	8	5,000	30,000	20,000	-69%
018_04	Little Willow Creek	17	200	cottonwood	69%	1.98	8	2,000	4,000	10%	5.74	8	2,000	10,000	6,000	-59%
018_04	Little Willow Creek	18	1400	cottonwood	69%	1.98	8	10,000	20,000	10%	5.74	8	10,000	60,000	40,000	-59%
018_04	Little Willow Creek	19	1000	cottonwood	69%	1.98	8	8,000	20,000	0%	6.38	8	8,000	50,000	30,000	-69%
018_04	Little Willow Creek	20	260	cottonwood	63%	2.36	9	2,000	5,000	0%	6.38	9	2,000	10,000	5,000	-63%
018_04	Little Willow Creek	21	270	cottonwood	63%	2.36	9	2,000	5,000	10%	5.74	9	2,000	10,000	5,000	-53%
018_04	Little Willow Creek	22	550	cottonwood	63%	2.36	9	5,000	10,000	0%	6.38	9	5,000	30,000	20,000	-63%
018_04	Little Willow Creek	23	890	cottonwood	63%	2.36	9	8,000	20,000	0%	6.38	9	8,000	50,000	30,000	-63%
018_04	Little Willow Creek	24	270	cottonwood	63%	2.36	9	2,000	5,000	10%	5.74	9	2,000	10,000	5,000	-53%
018_04	Little Willow Creek	25	630	cottonwood	63%	2.36	9	6,000	10,000	0%	6.38	9	6,000	40,000	30,000	-63%
018_04	Little Willow Creek	26	620	cottonwood	63%	2.36	9	6,000	10,000	10%	5.74	9	6,000	30,000	20,000	-53%
018_04	Little Willow Creek	27	1300	cottonwood	63%	2.36	9	10,000	20,000	10%	5.74	9	10,000	60,000	40,000	-53%
018_04	Little Willow Creek	28	440	cottonwood	63%	2.36	9	4,000	9,000	0%	6.38	9	4,000	30,000	20,000	-63%
018_04	Little Willow Creek	29	280	cottonwood	63%	2.36	9	3,000	7,000	10%	5.74	9	3,000	20,000	10,000	-53%
018_04	Little Willow Creek	30	600	cottonwood	63%	2.36	9	5,000	10,000	0%	6.38	9	5,000	30,000	20,000	-63%
018_04	Little Willow Creek	31	180	cottonwood	63%	2.36	9	2,000	5,000	10%	5.74	9	2,000	10,000	5,000	-53%
018_04	Little Willow Creek	32	850	cottonwood	63%	2.36	9	8,000	20,000	10%	5.74	9	8,000	50,000	30,000	-53%
018_04	Little Willow Creek	33	1500	cottonwood	63%	2.36	9	10,000	20,000	0%	6.38	9	10,000	60,000	40,000	-63%
018_04	Little Willow Creek	34	660	cottonwood	63%	2.36	9	6,000	10,000	0%	6.38	9	6,000	40,000	30,000	-63%
018_04	Little Willow Creek	35	550	cottonwood	59%	2.62	10	5,500	14,000	0%	6.38	10	5,500	35,000	21,000	-59%
018_04	Little Willow Creek	36	650	cottonwood	59%	2.62	10	6,500	17,000	0%	6.38	10	6,500	41,000	24,000	-59%
018_04	Little Willow Creek	37	370	cottonwood	59%	2.62	10	3,700	9,700	0%	6.38	10	3,700	24,000	14,000	-59%
018_04	Little Willow Creek	38	1200	cottonwood	59%	2.62	10	12,000	31,000	0%	6.38	10	12,000	77,000	46,000	-59%
018_04	Little Willow Creek	39	2200	cottonwood	59%	2.62	10	22,000	58,000	0%	6.38	10	22,000	140,000	82,000	-59%
018_04	Little Willow Creek	40	2800	cottonwood	59%	2.62	10	28,000	73,000	0%	6.38	10	28,000	180,000	110,000	-59%
018_04	Little Willow Creek	41	1700	cottonwood	59%	2.62	10	17,000	44,000	0%	6.38	10	17,000	110,000	66,000	-59%
018_04	Little Willow Creek	42	95	cottonwood	59%	2.62	10	950	2,500	0%	6.38	10	950	6,100	3,600	-59%
							Totals		520,000					1,400,000	850,000	

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.

From this …

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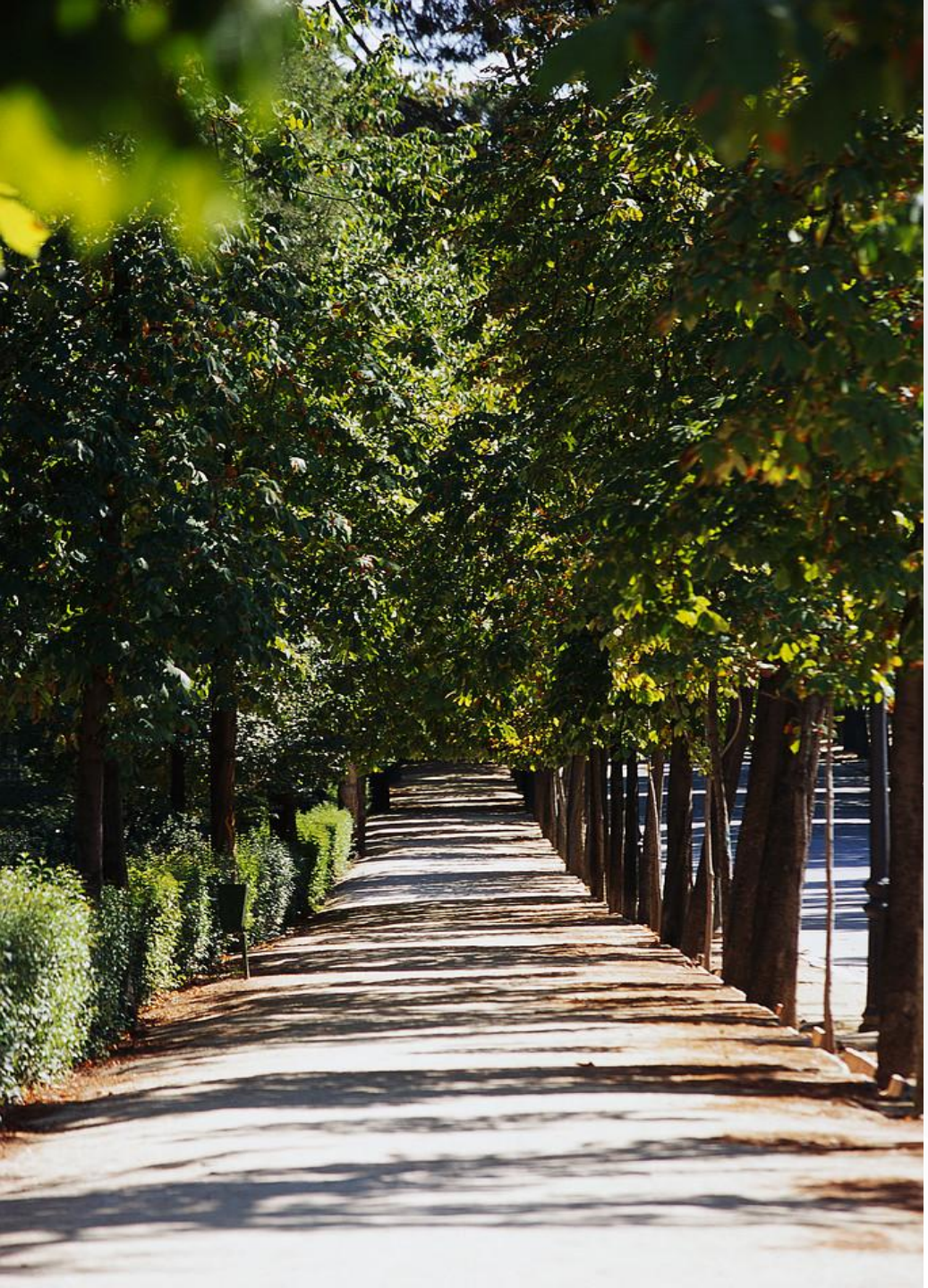

Questions/ Comments?