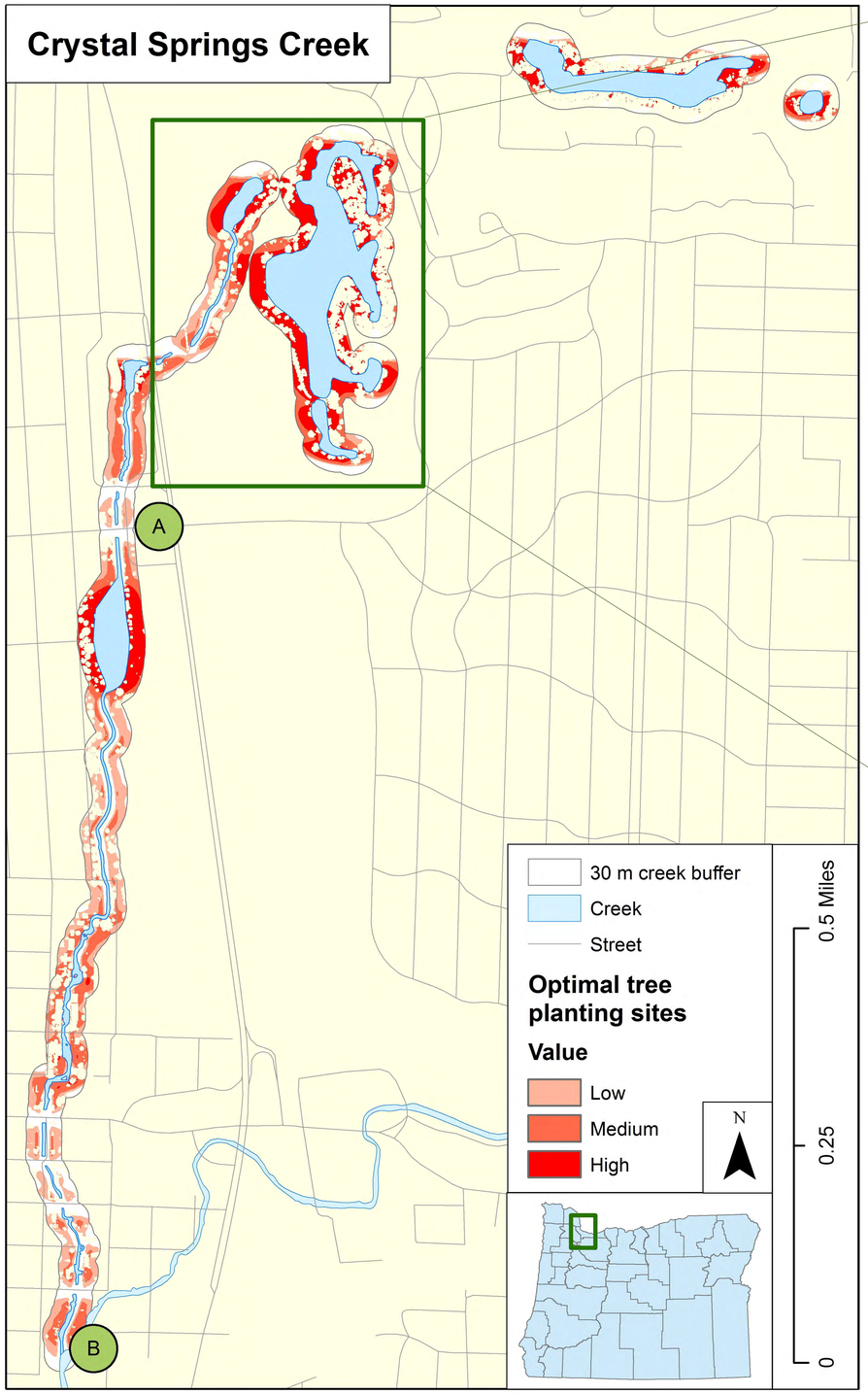
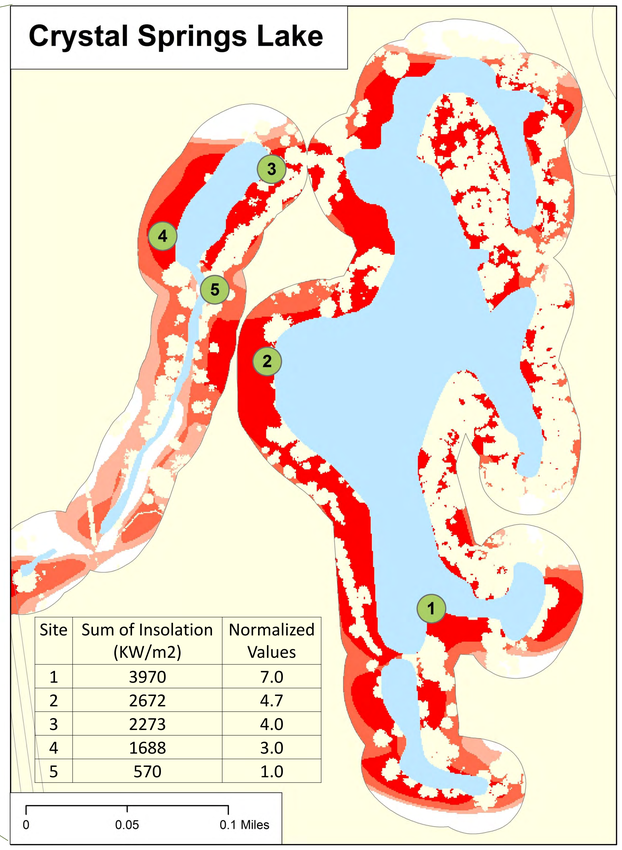
Shade Analysis of Crystal Springs Creek, Portland, OR

Optimal Placement of Trees for Maximum Water Temperature Reduction

Jen Memhard, 3/18/2014



Map date: 3/18/2014
Sources: ESRI; City of Portland, Bureau of Planning / Puget Sound LiDAR Consortium; Metro Data Resource Center



Site	Sum of Insolation (KW/m2)	Normalized Values
1	3970	7.0
2	2672	4.7
3	2273	4.0
4	1688	3.0
5	570	1.0

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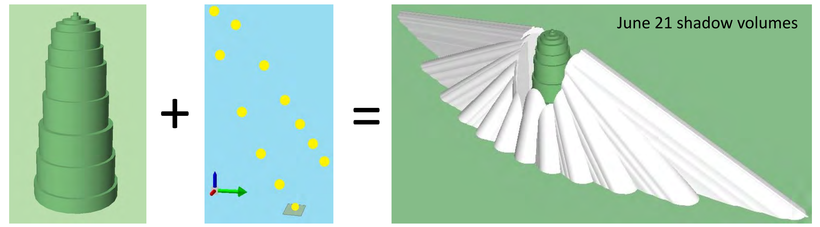
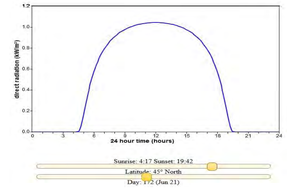


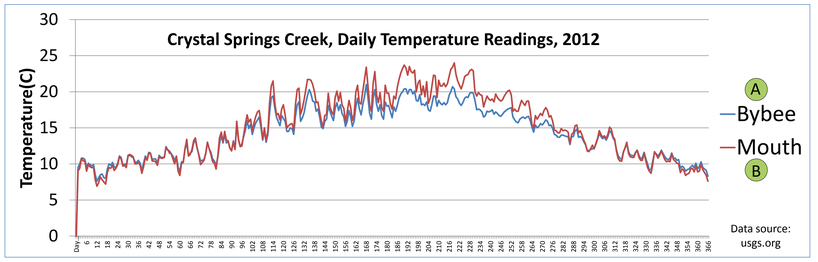
Stylized western red cedar

June 21 hourly Sun positions

Weighted shadow map, June 21
Used for weighted neighborhood analysis



June 21 insolation
Source: PVEducation.org



Temperatures in Crystal Springs Creek (at points A and B, left), from April through September, are consistently above temperatures suitable for spawning (13°C), incubation (13°C) and rearing (16°C) of endangered anadromous fish. The most effective way to reduce water temperatures is to plant shade trees, but they need to be sited carefully for maximum impact.

For this analysis, I created a multipatch object in Google SketchUp representing a stylized mature western red cedar, 120 ft tall, 56 ft wide. Using a Python script from ESRI, Create Sun Skymap, I generated sun positions at hourly intervals for June 21st, from 7 AM to 7 PM. Using ESRI's Skyline and Skyline barrier tools, I created 12 shadow volumes representing where shade from the tree would fall at each hour. With data derived from an online solar calculator, I weighted the shadows according to the insolation at that time of day. The weighted hourly shadow maps were summed to create a one-day total shadow map. This map was exported to ASCII format and used as a kernel file to perform a weighted (focal statistics) neighborhood analysis, which was clipped to a 30m buffered region around the creek. Existing shade-producing vegetation (and structures) 4m and higher were eliminated using a mask created from a 1m DEM feature-height raster. For ease of viewing, the final output was reclassified using 4 quantiles, of which the top three are indicated.

Results indicate the key factor influencing planting site impact is the width of the creek. The table on the close up lists (a) the sum of the raw (hourly) insolation totals received at each of 5 points, and (b) those values normalized by point 5's data. A tree planted at point 1 (1st quantile) will have approximately 7 times the shading impact of one planted at point 5 (3rd quantile).

For maximum reduction of water temperature along the entire length of the creek, tree-planting should be focused around Crystal Springs Lake. Trees planted along the narrower sections of the creek will have much less impact.