Thermal Uplift Estimates

CH2M Hill performed an analysis of the temperature benefits from wetlands and ponds at the West Boise WWTP. That analysis indicates that the cooling potential of wetlands and ponds will not be sufficient to meet the needs of the West Boise WWTP for the entire year. Wetlands and ponds provide a sufficient cooling benefit during the summer, but not the spring and fall (see Table 1). The Freshwater Trust expanded the riparian shade analysis to determine whether the remaining thermal exceedance could be met with riparian shade credits.

Table 1. The wetlands modeling indicates that the West Boise WWTP thermal exceedance cannot be completely met with wetlands. The outstanding temperature reductions and their corresponding thermal load exceedance are listed below.

Time Period	Max Temperature (°C)	Thermal Exceedance (Mkcal/day)
March	1.3	192
April	5.8	856
May	6.4	945
June 1 – July 15	0.0	0
July 16 – September 30	2.3	338
November 1 – February 28	0.0	0

The additional analysis is shown in Figure 1. Riparian shade does not provide the same thermal load reduction benefit in the spring as it does in the summer and fall. The difference in loading is a result of different sun angles, length of day, and presence of leaves on the trees. These different factors will affect the amount of solar radiation that can be blocked by riparian vegetation.

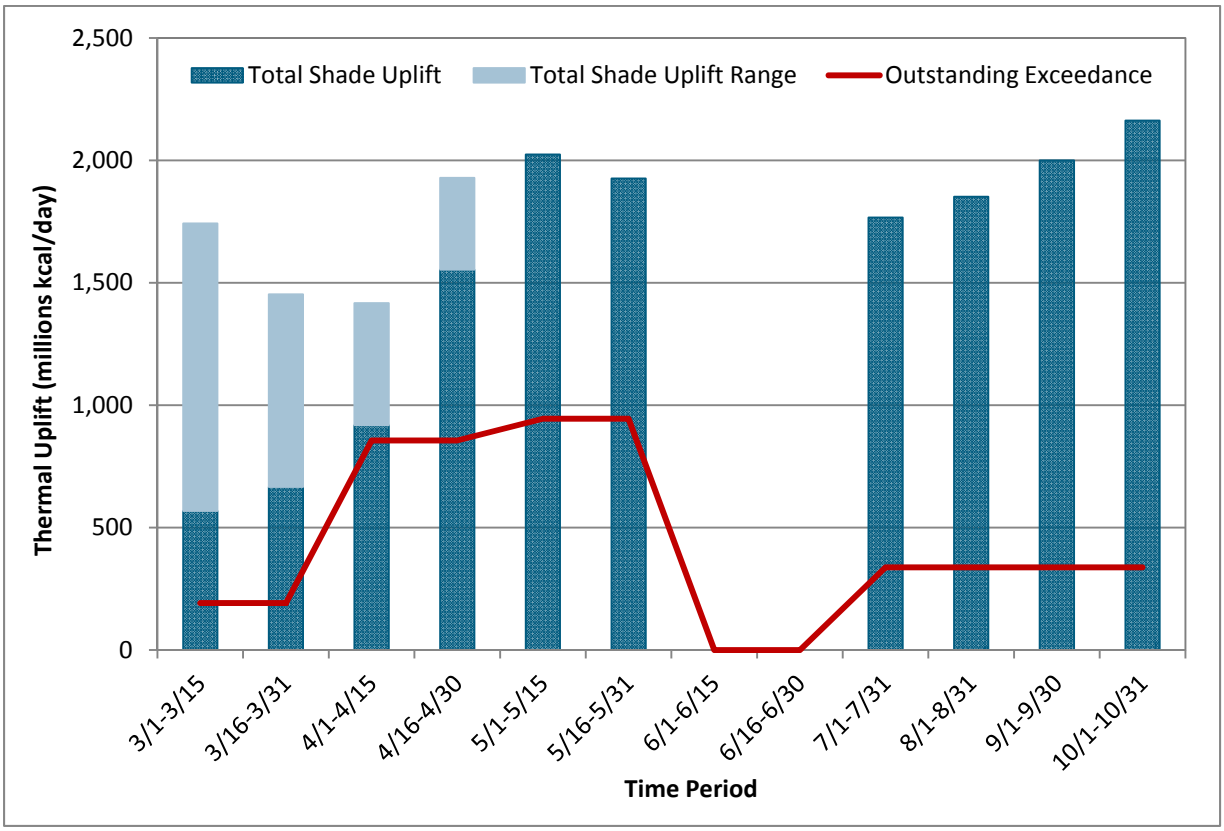

Figure 1. The graph documents the potential thermal uplift from riparian shade along the mainstem of the Lower Boise River and three tributaries. The Outstanding Exceedance represents the remaining thermal load reduction that is not met by wetlands, but could be met through riparian shade.

The potential uplift range in the spring represents the range of possible reductions. Additional information from riparian experts and local reference sites is required to refine this range. Any additional riparian data will also refine the estimates for the summer and fall.

May 8, 2013 Update

The Freshwater Trust has selected three sites from those provided by Karl Gebhardt (Hydrologist, Resource Systems, Inc.) on behalf of the Boise River Enhancement Network[1]. Enhancement opportunities were evaluated for thermal uplift potential; the top ten sites were ranked numerically. Sites 1, 5, and 9 (*see Figures 3, 4, 5 at the end of this document*) represent a range of ecological restoration priorities for the river as well as high, medium, and low thermal load abatement potential in October. The Freshwater Trust modeled the thermal load abatement (thermal credit generation) potential on each site at all critical times of the year (May-October). For reference, each site was modeled in January to gauge the winter contribution to thermal abatement. The programmatic thermal uplift potential previously mentioned (Figure 1) was broken down to uplift per mile and is provided for comparison between site specific and program level estimates. The results are summarized graphically in Figure 2, and numerically in Table 2.

[1] Available at http://api.ning.com/files/nvN2ZQoUdiXt2NqSjIR9IWKNeVCKCewxxxrPQ41sbENmk9xr*NvDGDBP7JOyrM8wv77QsVKAdINYuLGqdamKtw__/BoiseRiverProtectionEnhancement.kmz

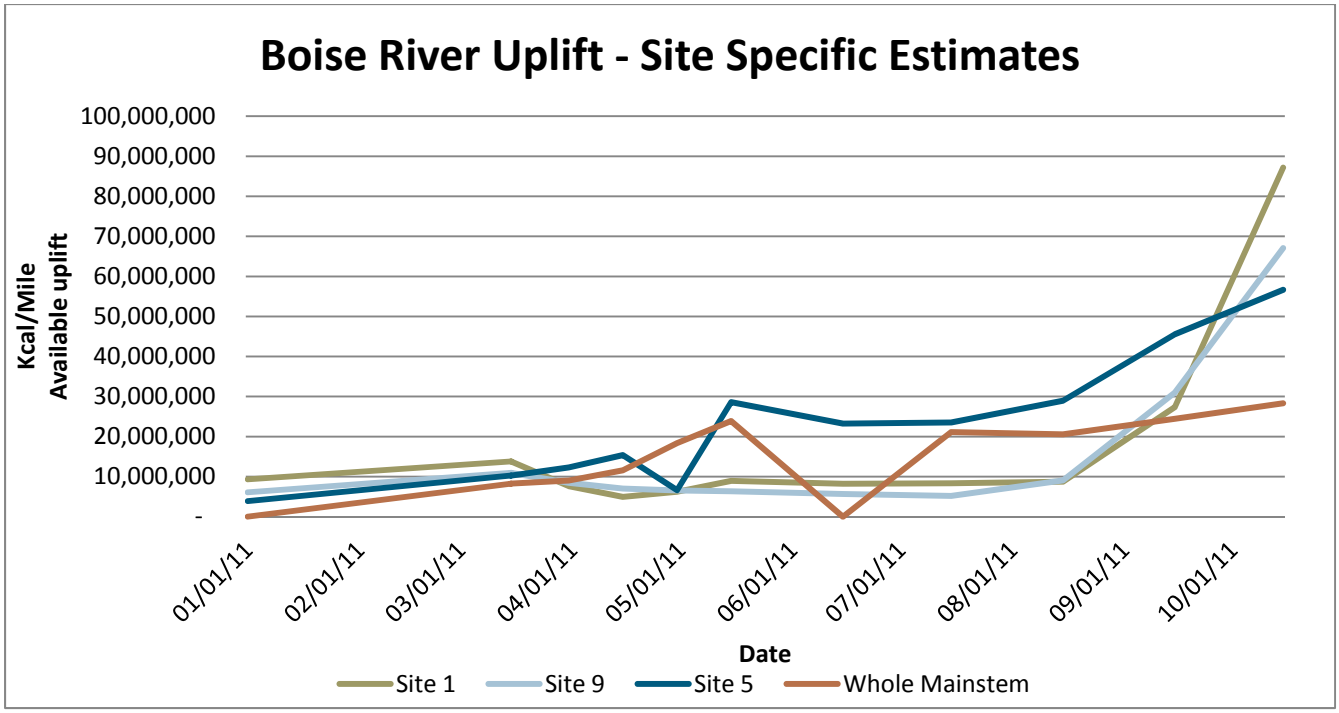

Figure 2: Thermal uplift per mile estimated on site specific and programmatic scale.

Table 2: Thermal uplift (kcal/mile) on site specific and programmatic scale.

Date	Site 1 (kcal/mile)	Site 9 (kcal/mile)	Site 5 (kcal/mile)	Whole Mainstem (kcal/mile)	Modeled Canopy Density
01/01/11	9,318,392	6,109,413	3,878,563	-	5%
03/15/11	13,787,672	10,960,059	10,276,337	8,264,510	10%
03/31/11	7,637,244	8,461,924	12,287,959	9,040,895	15%
4/15/2011	4,962,994	7,022,748	15,376,450	11,596,990	25%
04/30/11	6,232,757	6,531,650	6,632,016	18,354,882	50%
5/15/2011	8,957,079	6,362,501	28,605,809	23,903,245	75%
06/15/11	8,209,629	5,657,849	23,237,859	-	75%
7/15/2011	8,343,796	5,210,521	23,516,813	21,134,158	75%
08/15/11	8,763,045	9,066,861	28,954,078	20,570,269	75%
9/15/2011	27,366,979	31,003,468	45,543,603	24,454,862	75%
10/15/11	87,173,374	67,070,154	56,636,240	28,339,455	75%

Site specific modeling shows variation in uplift potential throughout the year. There are many factors that affect the thermal abatement potential of a site including aspect, width of the adjacent river reach, and existing riparian vegetation (baseline) condition. From the examined sites, there is clear potential for riparian shade to contribute to the thermal mitigation targets for the city of Boise. In general, uplift is as high as or higher than program estimates when modeled on a site specific level. In particular, CH2M Hill has identified the effluent temperature limitations during the period of March through May as being extremely challenging. While riparian canopy is not at its maximum density during this time, its contribution can augment other alternative solutions and is worth quantifying on a program scale.

For the purposes of this refined analysis, The Freshwater Trust only examined three sites identified by Karl Gebhardt for the Boise River Enhancement Network. Partnering with an established, local conservation agency can speed the pace of implementation. Selecting sites from BREN's priority areas supports ancillary ecological benefits as well as thermal load abatement. However, sites outside of priority areas will likely be chosen as well and continued analysis could show some of the differences in uplift potential in those areas.

Riparian shade provides the most thermal load abatement during October when the canopy is fully leafed out and orientation between the trees and sun creates long shadows throughout the day. Average available uplift per mile in the mainstem is 28,339,455 kilocalories per mile in October. On the tributaries (only Indian Creek and Mason Creek for the purposes of this analysis), it is estimated to be slightly lower: 20,981,632 kilocalories per mile. The total target number of kilocalories to offset with thermal credits at a 2:1 ratio is 676,000,000 kilocalories in October. The Freshwater Trust has identified approximately 50 miles along the mainstem Boise River that would benefit from riparian restoration and generate thermal credits. Along the tributaries, there are approximately 30 miles available. With average uplift, approximately 24 miles of riparian restoration would be required along the mainstem to meet the target kilocalorie offset. If credits were only generated in the tributaries, 32 miles of restoration (an unattainable number) would be required to meet the target. The Freshwater Trust would anticipate a mix of sites along the mainstem and in the tributaries would be contracted to meet thermal load abatement requirements. Below is a table showing the estimated miles in mainstem and tributary areas and the kilocalorie generation as well as the associated costs of thermal credit generation. The possible range of associated costs is included for reference as well.

Table 3: Implementation of thermal credits will occur on a mix of tributary and mainstem sites. The table below highlights how that breakdown might occur.

Miles	Kcals Generated	Percentage of Miles Required
20 Mainstem, 5.21 Tributary	676,103,400 (566,789,097 Main, 109,314,303 Trib)	38.6% Mainstem, 15.7% Tributary
15.52 Mainstem, 11.26 Tributary	676,081,516 (439,828,339 Main, 236,253,177 Trib)	30% Mainstem, 33.9% Tributary
13.26 Mainstem, 14.31 Tributary	676,028,326 (375,781,171 Main, 300,247,154 Trib)	25.65% Mainstem, 43.1% Tributary
10 Mainstem, 18.71 Tributary	675,960,884 (283,394,548 Main, 392,566,335 Trib)	19.3% Mainstem, 56.3% Tributary

The site-specific modeling shows that for the three sites specified, October uplift was 2 to 3.1 times higher than average for the entire Boise River. *Reductions in total mileage of restoration (and hence total program cost) below what is depicted in Table 3 could be reasonably expected in a thermal credit trading program as estimates go from coarse averages to refined credit calculations, which make a trading program more feasible.*

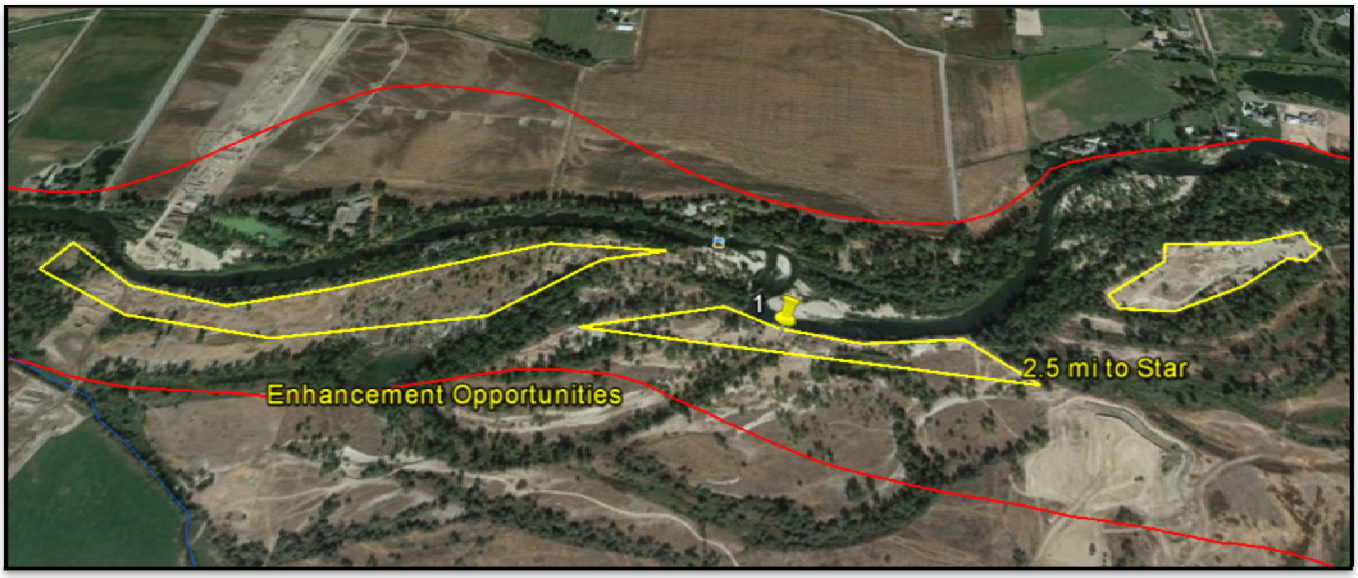

*Figure 3: **"Site 1"** from BREN's target enhancement area .kmz file*

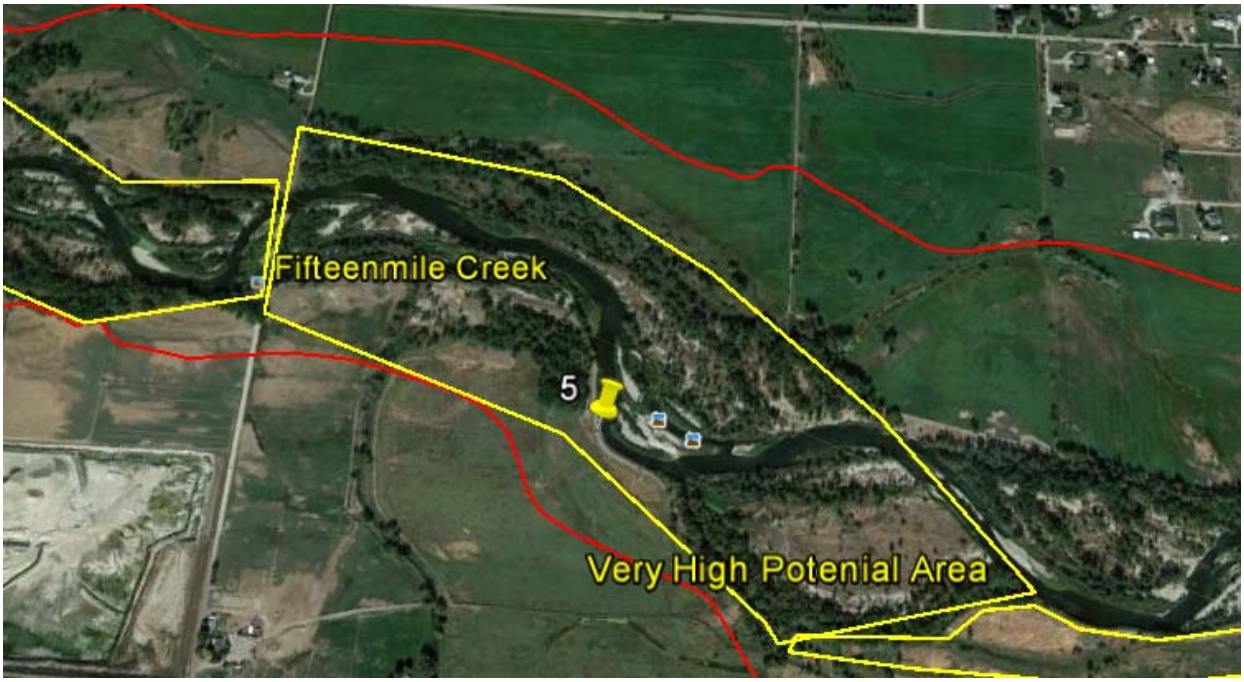

*Figure 4: **"Site 5"** from BREN's target enhancement area .kmz file*

*Figure 5: **"Site 9"** from BREN's target enhancement area .kmz file*