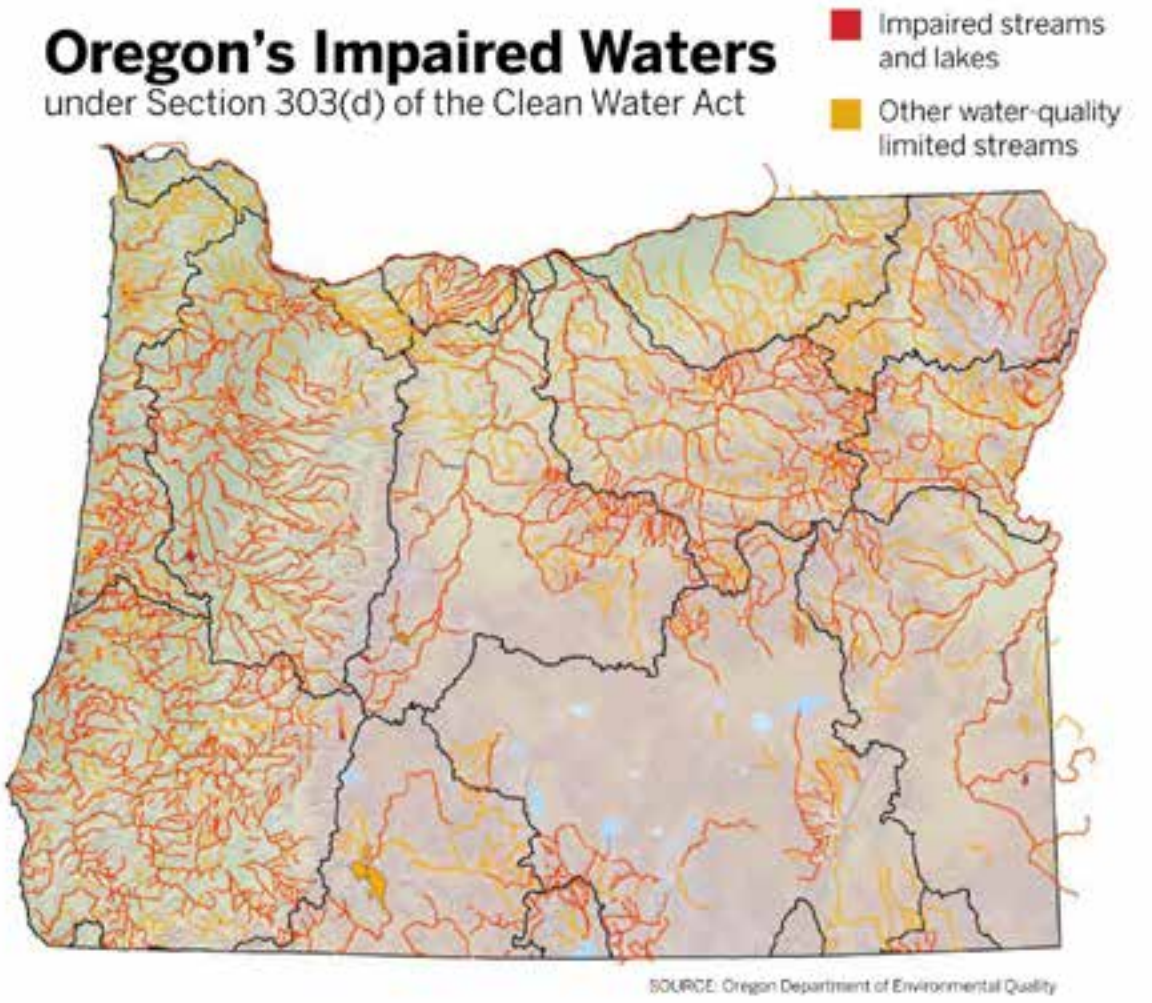
The Freshwater Trust®

Changing the course of conservation.

Quantifying the Thermal Benefits of Riparian Restoration using Computer Modeling and GIS

Gus Monteverde, *GIS Manager- gus@thefreshwatertrust.org*

The Problem



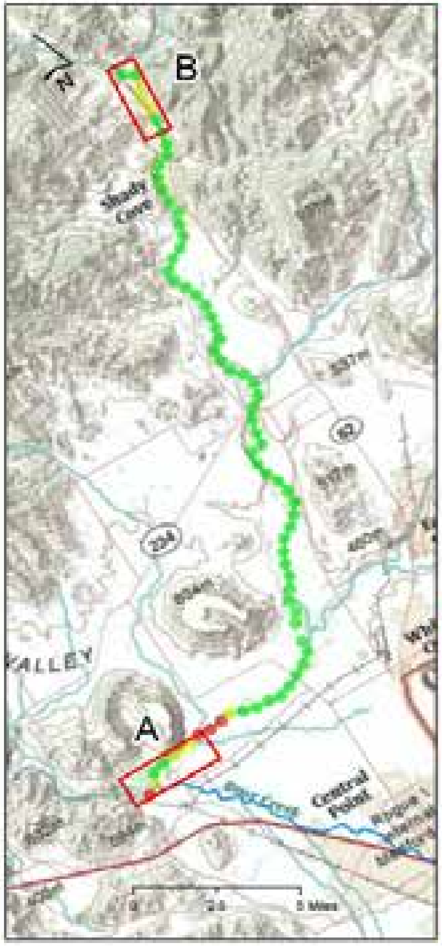
- In Oregon, we currently implement 300-500 restoration projects each year, benefiting 100-300 stream miles. At that pace, it will take centuries to fix them all. **We must accelerate.**

Exploring solutions: Quantified Conservation

- Quantifying the environmental benefits of restoration actions –also called “uplift” – can provide a more robust picture of a project’s value

The Role of GIS

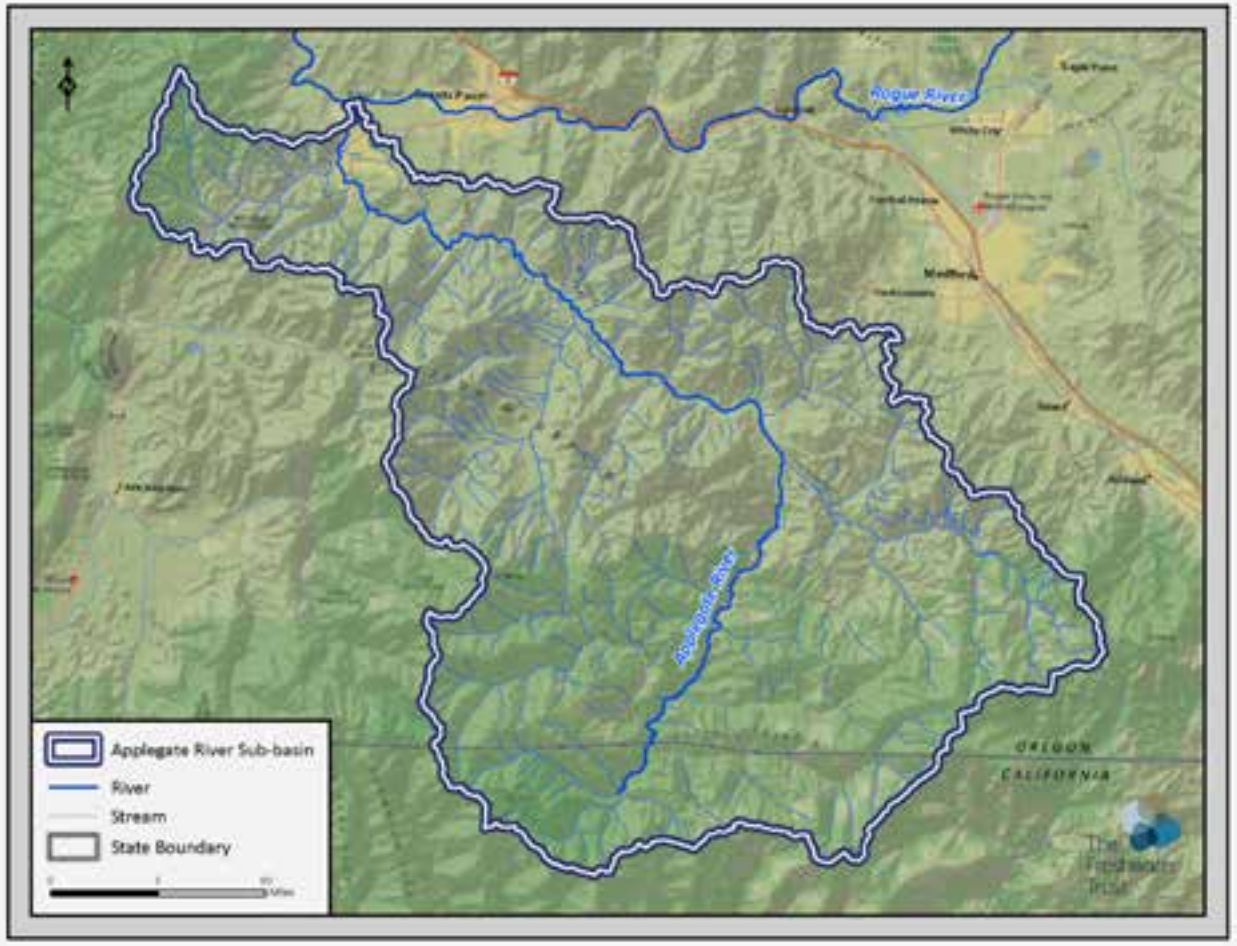
To Assess: Viability, Quality and Quantity of restoration opportunities and their crediting potential



Class	Breaks	# points per class	Avg per mi	Miles by Potential Category	% Miles by Potential Category	Achievable Solar Load Reductions Kcal/day
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	78%	180,088,761
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	73,120,403
High	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	103,726,401
				[illegible]	100%	356,933,565

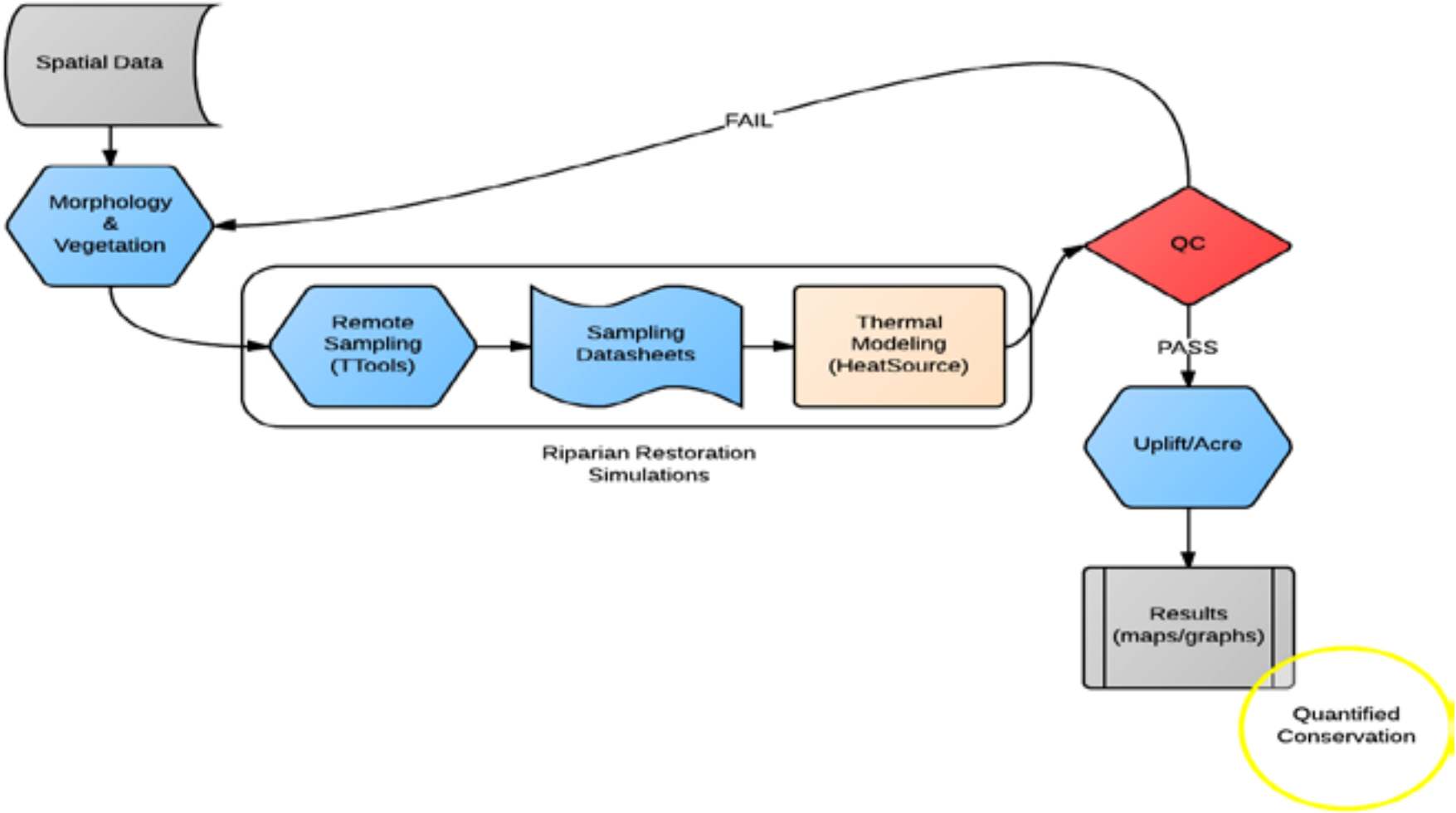
Average Uplift Potential figures are based on Solar Load Change as calculated by DEQ's Heatsource model. Solar Load Change = NTP (Natural Thermal Potential) - CCC (Current Calibrated Conditions). For the purposes of this analysis Potential is 25% of Solar Load Change to account for mortality, bank accessibility issues, as well as risk and uncertainty. Potential is expressed in units of kilocalories per mile per day (Kcal/mile/day).

Example Case: Applegate River, OR



- **Length:** 51 mi (36.5 mi modeled, mouth to lake)
- **Basin Area:** 698 sq. mi
- **Discharge:** 720 cu ft./s

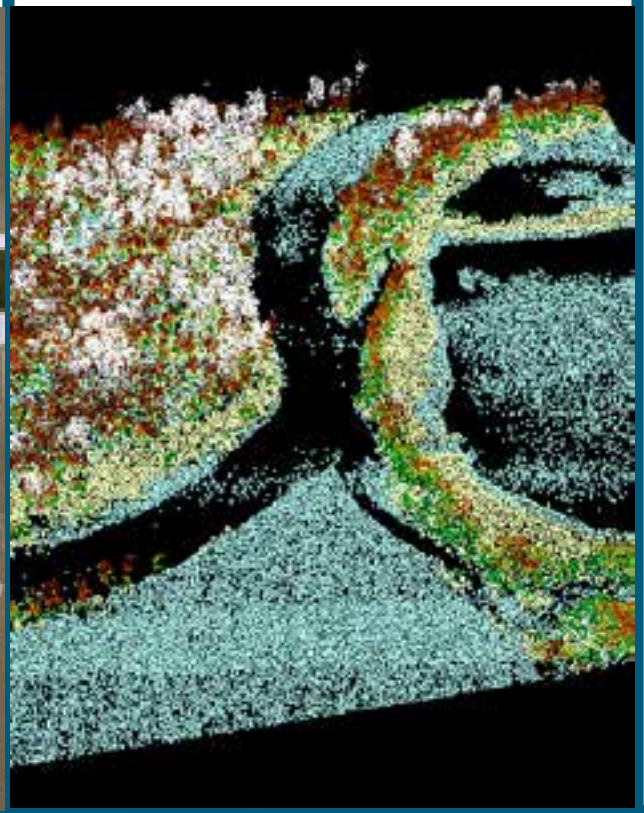
Methods Overview



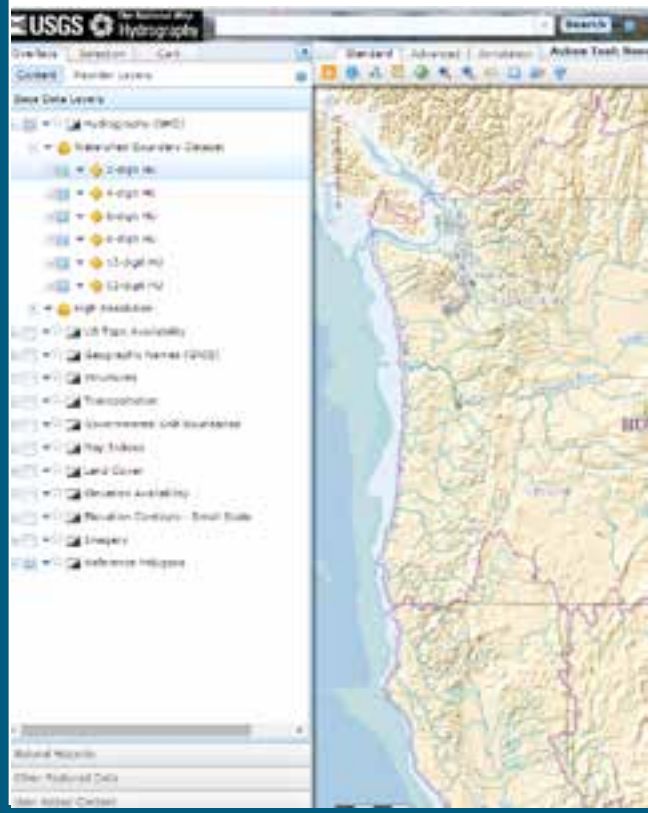
Data Collection

Aerial Photography (High resolution)

LiDAR data (HH-BE)



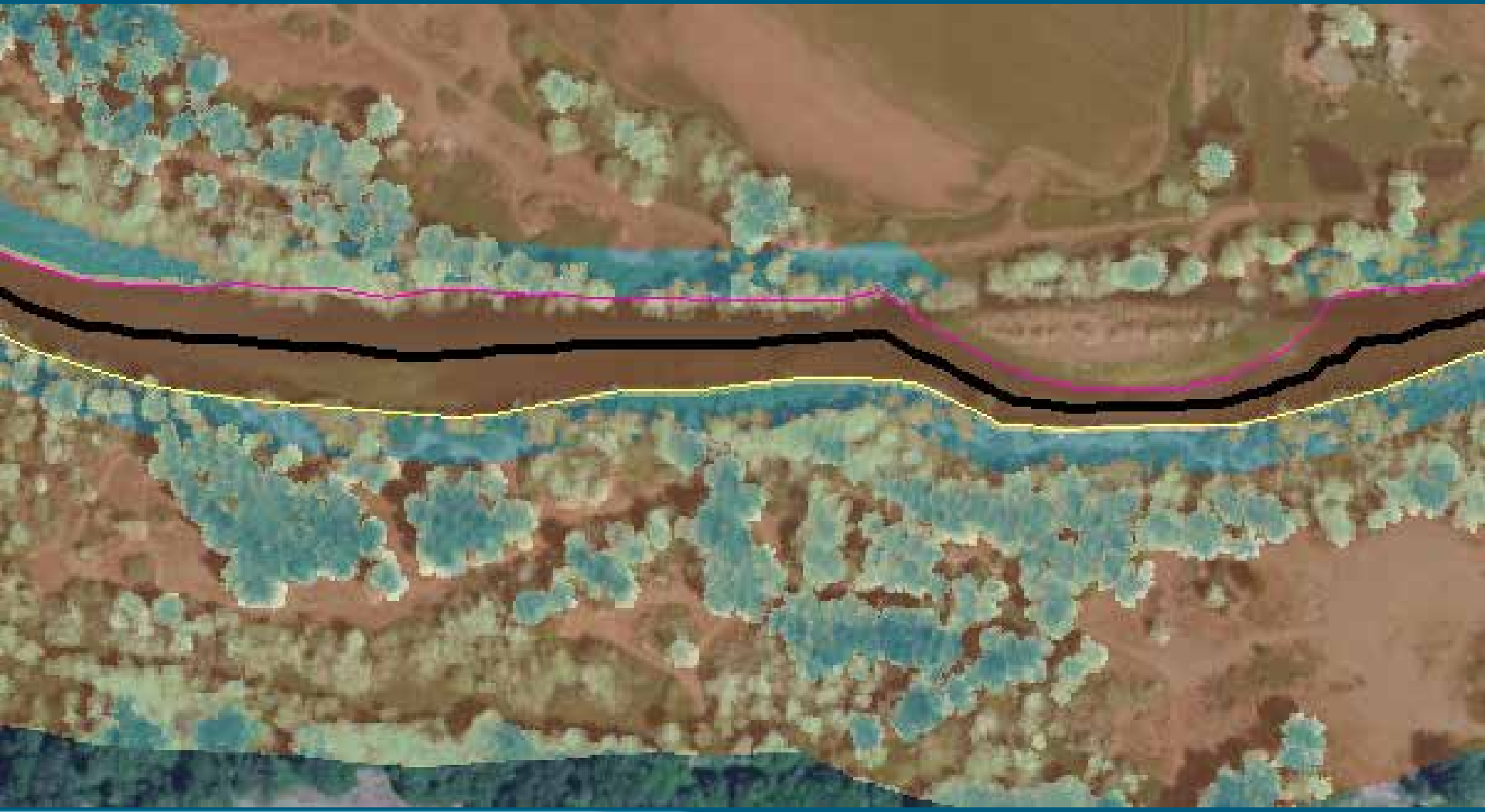
Streams (NHD)



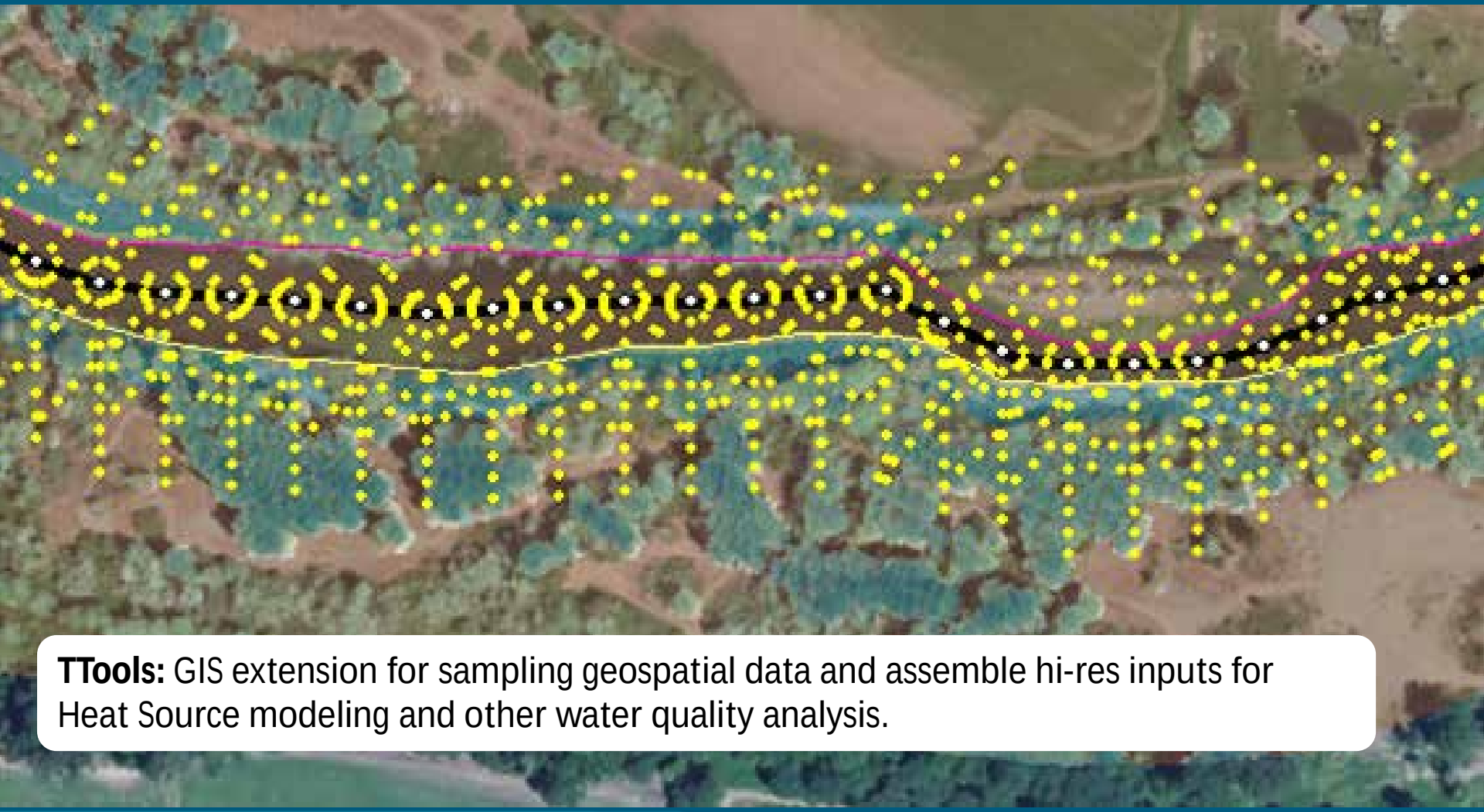
Channel Morphology

Current Vegetation Conditions

Restored Vegetation Conditions



Sampling Vegetation Heights Using TTools

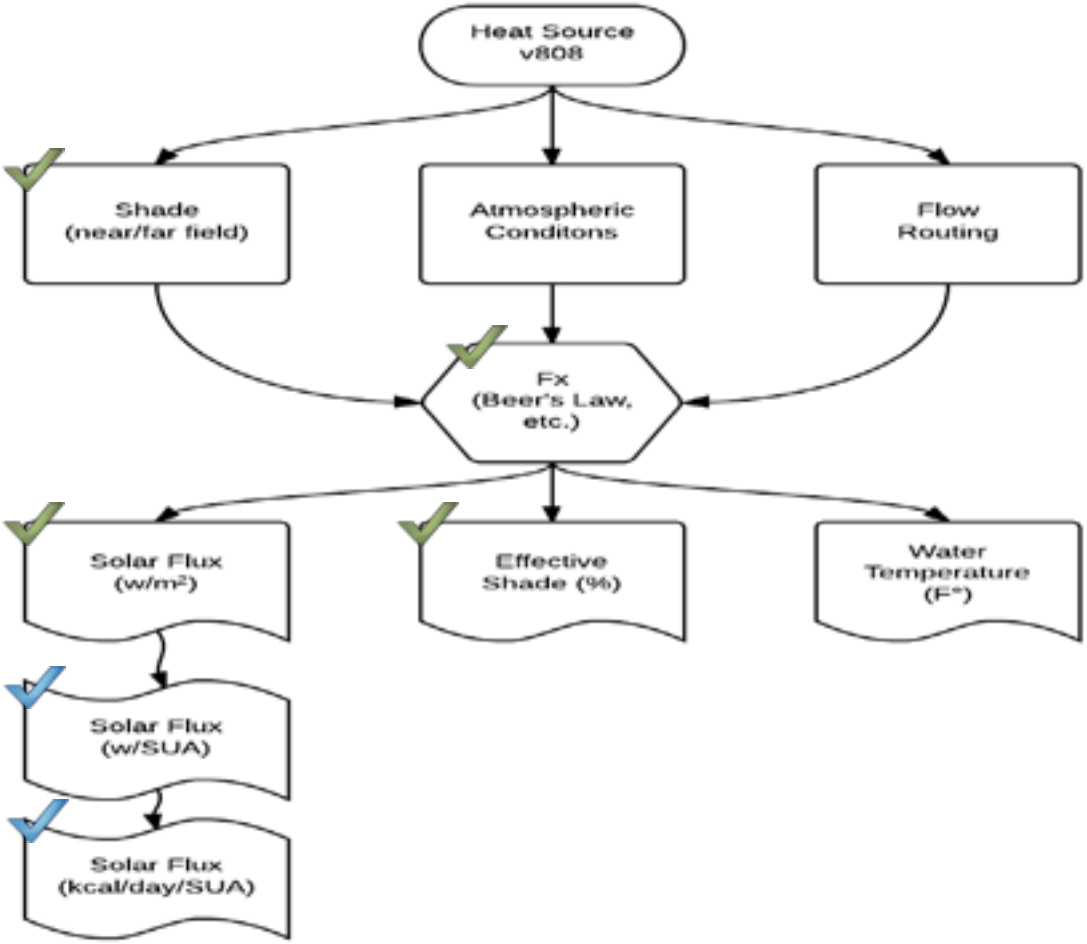


TTools: GIS extension for sampling geospatial data and assemble hi-res inputs for Heat Source modeling and other water quality analysis.

TTools Samples Table

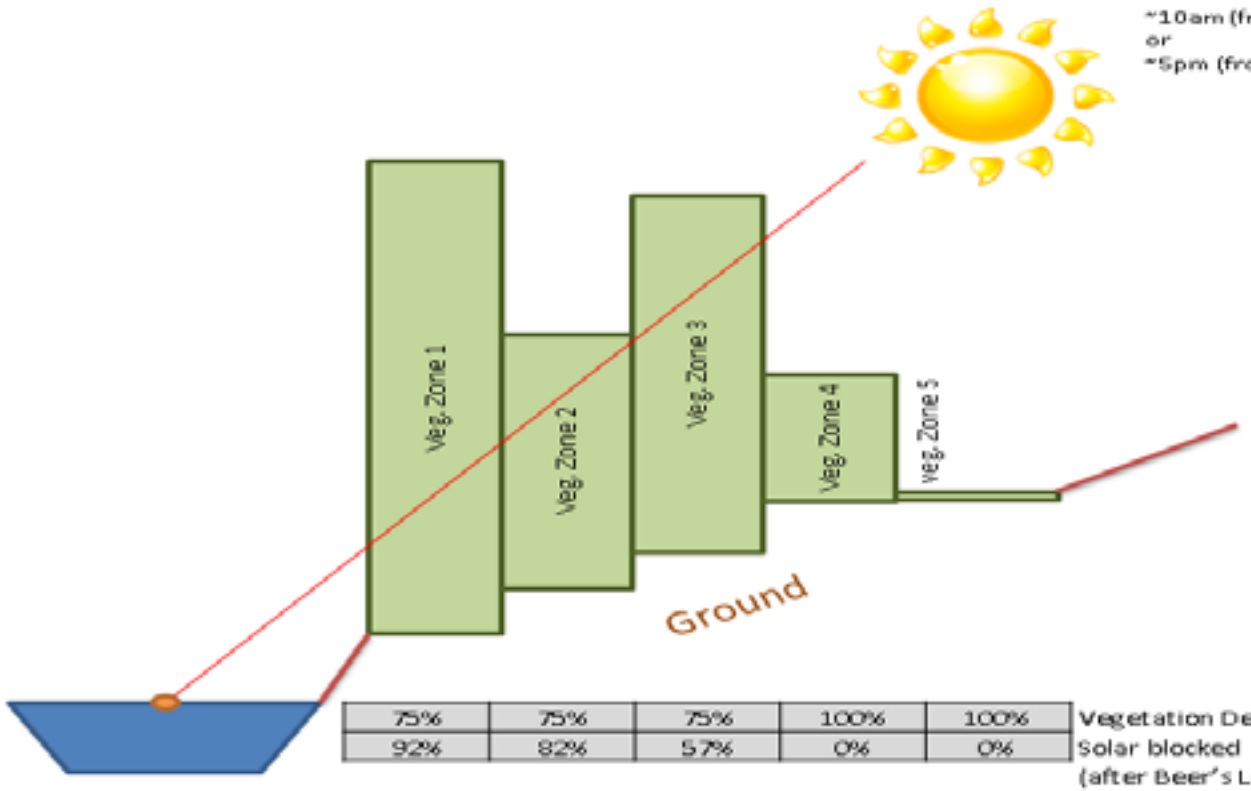
ASPECT	CHAN_WID	RIGHTDIST	LEFTDIST	ELEVATION	GRADIENT	Veg1_NE	Veg2_NE	Veg3_NE	Veg4_NE
343.705822	26.703678	13.372018	13.33166	258.156316	0.000242	0	0	0	0
351.430914	25.034517	12.489236	12.545282	258.157079	0.000242	0	0	0.118858	0.188975
345.42572	26.639273	12.710308	13.928965	258.163135	0.000242	0.006083	0.121909	0.088385	1.642877
344.054767	28.601999	14.369613	14.232387	258.16919	0.008293	0.045727	0.060964	0.088404	0.051811
347.969269	26.227047	13.20162	13.025427	258.376526	0.006535	0.060945	0.024389	0.10364	0.045727
346.429278	28.290424	14.168287	14.122137	258.387205	0.006535	0	0.143266	0.085334	5.739389
11.310425	29.845612	14.678727	15.166885	258.550587	0.006535	0	0.112775	5.145026	9.701771
352.404978	30.173072	14.983778	15.189294	258.713969	0.006535	0.091436	0.079251	4.7244	5.492484
330.57196	27.242321	12.818285	14.424037	258.877351	0.000042	0.219466	7.8486	4.145291	0.12496
341.565051	32.132579	15.82976	16.302819	258.878393	0.000823	0.073168	0.030473	4.815836	0.70712
346.7294	32.852168	16.5914	16.260768	258.901759	0.000823	0.124978	0.018287	6.233164	0.313953
340.641297	29.672001	14.307709	15.364292	258.922344	0.000823	0.091436	1.063768	7.330436	0.1524
342.854476	38.126528	18.940288	19.186241	258.942929	0.000114	0.045727	0	0.164585	5.394964
344.291470	36.167131	18.352351	17.814779	258.965327	0.000114	0.115025	0.02132	5.160262	2.667
348.959076	34.430628	16.894861	17.535767	258.968183	0.000114	0.109742	0.060964	5.196836	2.837687
349.380461	32.40343	16.60346	15.799971	258.971039	0.000114	0.04876	0.073149	0.920502	3.285753
347.307324	34.231582	17.203389	17.028193	258.973894	0.000114	0.094487	0.039625	0.646193	7.196323
346.577899	38.453654	19.235863	19.21779	258.97675	0.01211	0.063996	0.067066	0.213364	1.237487
346.414208	37.796286	19.243985	18.552301	259.279494	0.01211	0.051811	0.02744	0	0.246887
346.487341	35.015743	16.70255	18.313194	259.582239	0.000452	0.033542	0.05488	2.950462	0.17984
339.805442	32.457439	16.108268	16.349171	259.810597	0.000452	0.079251	0.116876	0.490742	2.246375

Heat Source Modules



SUA = Stream Unit Area

Heat Source Under the Hood



75%	75%	75%	100%	100%	Vegetation Density
92%	82%	57%	0%	0%	Solar blocked (after Beer's Law* is applied)

Beer's Law
PL: path length
W: width of the vegetation zone
θ_{SA}: solar altitude
Ψ: shade density
VD: vegetation density
Φ: direct beam solar radiation

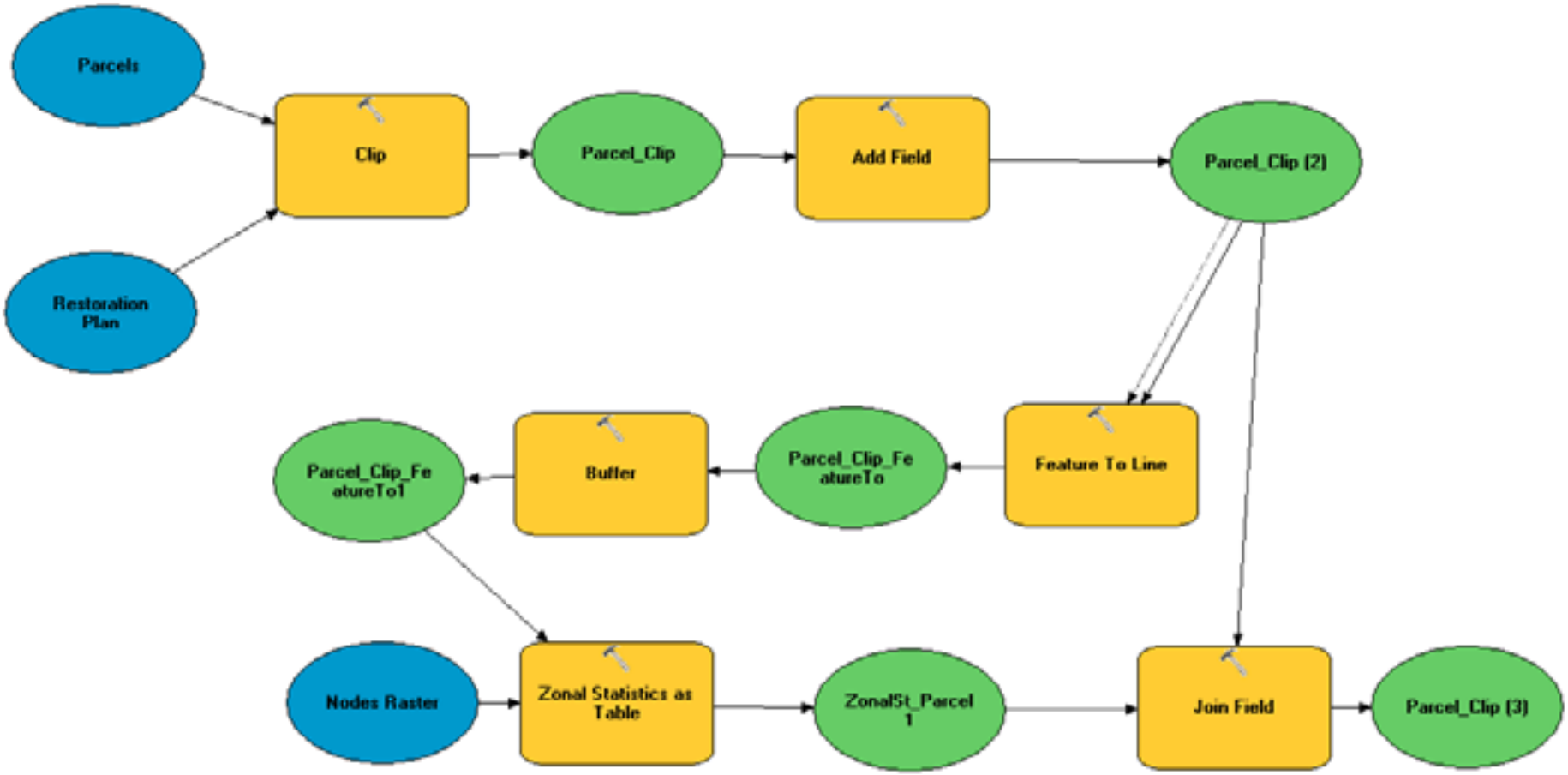
$$PL = \frac{W}{Cos\ (\theta_{SA})}$$

$$\Psi = 1 - Exp\left(\frac{Log(1-VD)}{10} \times PL\right)$$

$$\Phi_{out} = \Phi_{in}(1-\Psi)$$

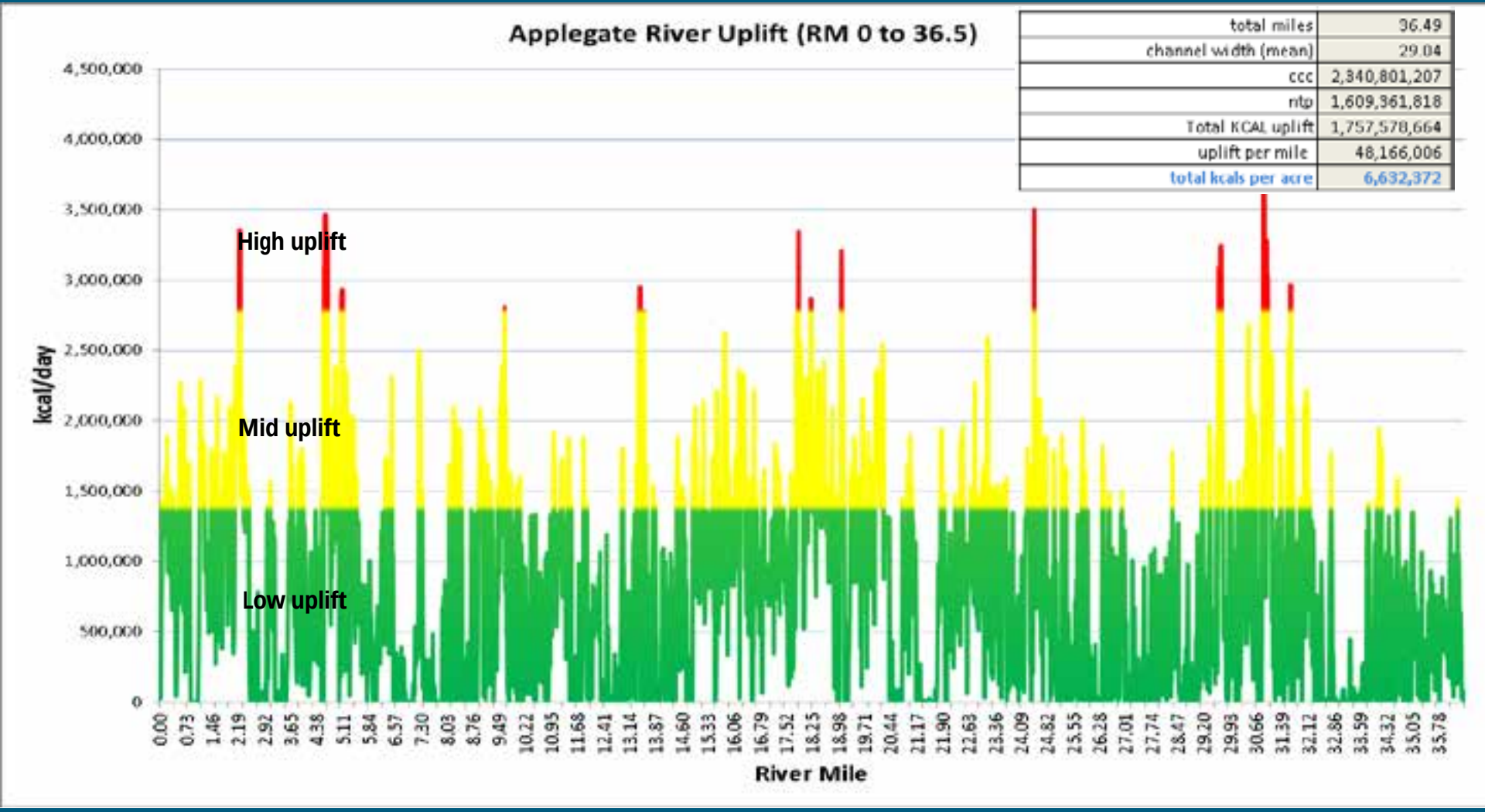
Stream Nodes (kcal/day)

Attributing Parcels with Uplift Values

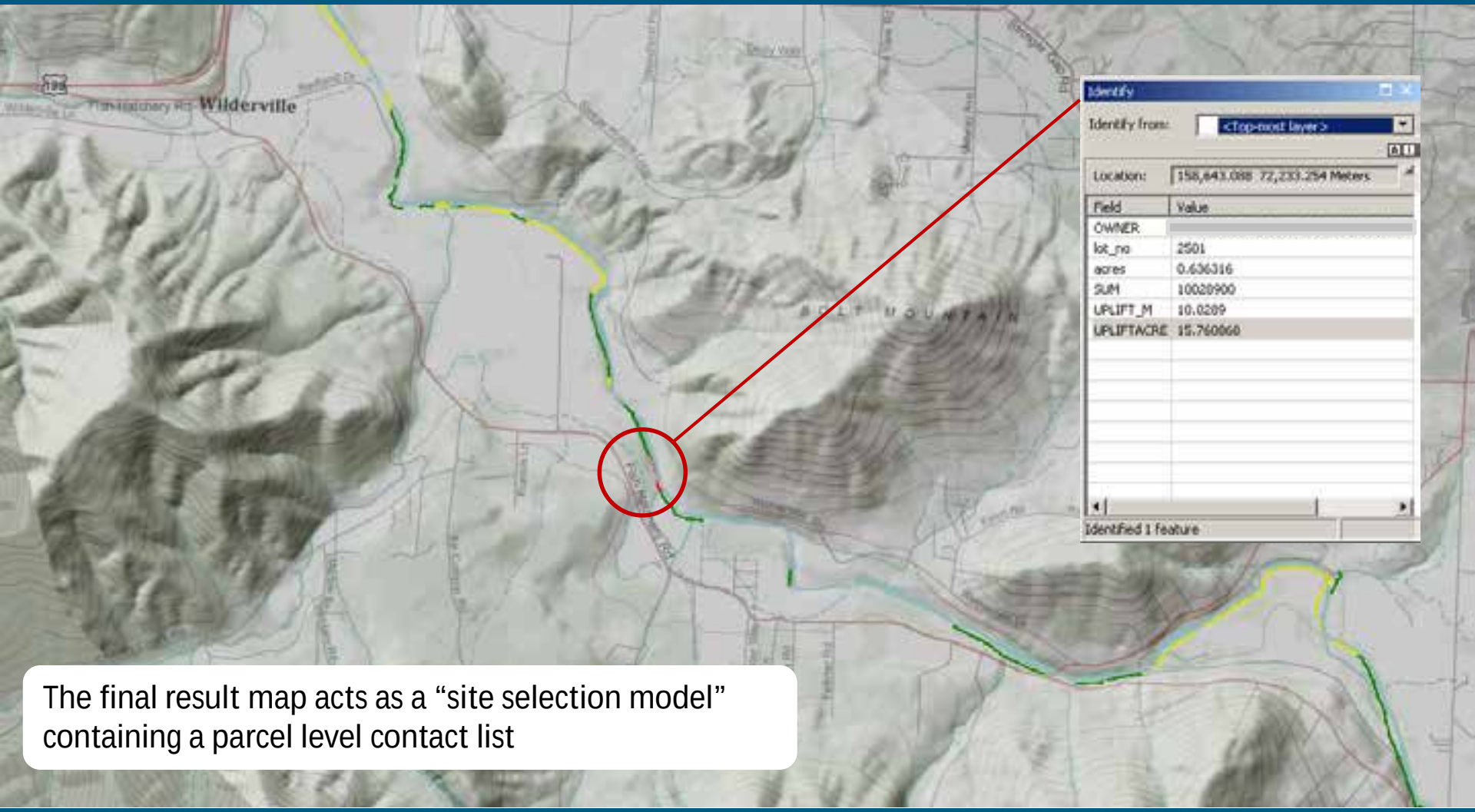


Parcels (kcal/day/acre)

Results: Uplift Profile



Results: Outreach Map



The final result map acts as a “site selection model” containing a parcel level contact list

Limitations & Future Work

Limitations

- Only assesses surface flux/irradiance centerline
- Doesn't account for cloudiness factor

Future Work

- Add variable veg density
- Expand to other credit types:
  - Nutrients (APEX, NTT)
  - Flow (W3T)

Questions?

Sources:

- Applegate River TMDL documents
- Heat Source 7 Manual
- OR DEQ models and tools library

Acknowledgements: