

Table 4.1: Data required for operation of the Heat Source model

Type of data:	Parameter	Comment
Spatially Distributed Data:		
Required at every computational node (every 100 meters in this analysis):		
	Longitude (deg)	Derived from GIS
	Latitude (deg)	Derived from GIS
	Stream Elevation (m)	Derived from GIS
	Aspect (deg)	Derived from GIS
	Topo Shade Angle (deg) - West	Derived from GIS
	Topo Shade Angle (deg) - South	Derived from GIS
	Topo Shade Angle (deg) - East	Derived from GIS
	Gradient	Derived from GIS
	Mannings n	Calibration parameter in this analysis
	W:D Ratio	Based on Rosgen channel type
	Bankfull Width (m)	Digitized from aerial imagery, used
	Channel Angle -z	Channel side slope
	X Factor (0.0-0.5)	Hydraulic storage factor
	Bed Particle Size (mm)	Estimated from habitat typing data and professional judgment, used in hyporheic calculations
	Horizontal Bed Conductivity (mm/s)	Estimated from bed particle sizes, used in hyporheic calculations
	Embeddedness	Estimated from habitat typing data and professional judgment, used in hyporheic calculations
	Valley Aspect (degrees)	Derived from GIS, used in hyporheic calculations
	Accretion Flow (cms)	Developed from flow measurements and FLIR data
	Withdrawal Flows (cms)	Estimated from water rights and discussions with diversion operator
Upstream Boundary Condition:		
Information used to define starting conditions		
	Flow (cms)	Based on flow measurements
	Stream Temperature (*C)	Measured
Continuous Data:		
Required for every hour of simulation		
	Cloudiness (0-1)	Based on solar radiation data
	Wind Speed (m/s)	Measured in some locations, extrapolated to other locations
	Relative Humidity (%)	Measured
	Air Temp (*C)	Measured
	Stream Temp (*C)	Measured
Tributary Information:		
	Inflow Rate (cms)	Estimated based on measurements, drainage areas, or FLIR data
	Inflow Temp (*C)	Most measured, some minor tribs estimated using records from similar streams
Land Cover Information:		
	Height (m)	Estimated from measurements
	Density (%)	Estimated using default values
	Overhang (m)	Set to 0

Table 4.2 : Continuous Data Used in the Development of Temperature Modeling Applications

Modeling Scenario	Water Temperature Sites, Validation Data	Water Temperature Sites, Boundary Conditions	Air Temperature Sites	Relative Humidity Data	Windspeed Data	Flow Data
Scott River: Fay Lane to Klamath River	21 sites: River Mile (RM) 48.3 above French Ck RM 47.9 below French Ck RM 42.4 RM 41.8 RM 39.3 at Eller Lane RM 35.1 at Island Road RM 32.6 above Kidder Creek RM 31.9 below Kidder Creek RM 25.0 at Meamber Bridge RM 23.4 at Meamber Creek RM 21.5 at USGS Gage RM 18.6 at Jones Beach RM 16.1 above Canyon RM 15.8 below Canyon RM 14.2 below Kelsey Creek RM 13.3 at Deep Creek RM 10.8 at Townsend Gulch RM 8.0 below George Allen Gulch RM 4.7 below Big Ferry Creek RM 3.1 below Mill Creek RM 2.3 below Franklin Gulch	11 sites: RM 50.2 Scott River at Fay Ln RM 48.2 French Ck RM 32.5 Kidder Ck RM 16.2 Boulder Ck RM 15.9 Canyon Ck RM 14.7 Kelsey Ck RM 13.2 Deep Ck RM 12.9 Middle Ck RM 11.7 Tompkins Ck RM 10.1 McCarthy Ck RM 3.6 Mill Ck	6 sites: RM 47.9 below French Ck RM 41.8 RM 32.6 above Kidder Ck RM 18.6 at Jones Beach RM 13.2 downstream of Deep Ck RM Tompkins Ck RM 0.6 at Roxbury Bridge	5 sites: RM 47.9 below French Ck RM 41.8 RM 32.6 above Kidder Ck RM 18.6 at Jones Beach RM 13.2 downstream of Deep Ck RM 0.6 at Roxbury Bridge	3 sites: RM 41.8 RM 32.6 above Kidder Ck RM 13.2 Downstream of Deep Ck	Flows were estimated from the continuous gage record at RM 21.5, periodic measurements at 10 other locations, and TIR data.
South Fork Scott River: Blue Jay Creek to Callahan	2 Sites: SF at South Fork Rd SF at Blue Jay Ck	3 Sites: SF upstream of road 41N21Y bridge Fox Creek (no data available, flow and temperatures estimated)	2 sites: Above Blue Jay Ck Callahan weather station at USFS facility	2 sites: Above Blue Jay Ck Callahan weather station at USFS facility	1 site: Callahan weather station at USFS facility	Flows were estimated from the preliminary continuous gage record at

		Boulder Creek (no data available, flow and temperatures estimated)				Callahan, periodic flow measurements above Blue Jay Ck, and TIR data.
East Fork Scott River: Houston Creek to Callahan	3 Sites: EF at Kangaroo Rd EF at Upper Masterson RD bridge EF at Callahan	5 sites: Rail Ck Ditch Grouse Ck Mule Ck Big Mill Ck Little Mill Ck (no data available at these sites, flow and temperatures estimated)	2 sites: Below Houston Ck Callahan weather station at USFS facility	2 sites: Below Houston Ck Callahan weather station at USFS facility	1 site: Callahan weather station at USFS facility	Flows were estimated from preliminary continuous gage record at Callahan, periodic flow measurements below Houston Ck, and TIR data.
Houston/ Cabin Meadows Creeks: Cabin Meadows Creek at Rd 41N10 to Houston Creek, Houston	6 Sites: Cabin Meadows Ck downstream of road 41N03 Cabin Meadows Ck upstream of Houston Creek Houston Ck downstream of Cabin Meadows Ck Houston Ck upstream of Little Houston Ck Houston Ck downstream of Little Houston Ck Houston Creek upstream of	3 sites: Cabin Meadows Ck at rd 41N10 crossing Houston Ck Little Houston Ck	5 Sites: Road 41N10 crossing Downstream of road 41N03 crossing Confluence of Houston and Cabin Meadows Cks Confluence of Houston and Little Houston Cks	5 Sites: Road 41N10 crossing Downstream of road 41N03 crossing Confluence of Houston and Cabin Meadows Cks Confluence of Houston and Little Houston Cks	1 site: Confluence of Houston and Crater Cks	Flows were estimated from measurements where Cabin Meadows Ck crosses roads 41N10 and 41N03, as well as temperatur

Creek to East Fork Scott River	Crater Ck		Confluence of Houston and Crater Cks	Confluence of Houston and Crater Cks		Records at tributary confluences.
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Table 4.3 Measured and Estimated Flows (cubic feet per second)

	River Mile	7/2 2003	7/3 2003	7/16 2003	7/25 2003	7/26 2003	7/28 2003	7/29 2003	7/30 2003	8/25 2003	8/26 2003	8/27 2003	8/28 2003	9/4 2003	9/9 2003	9/10 2003	9/11 2003	9/24 2003	9/25 2003	9/26 2003	10/7 2003	10/8 2003	10/9 2003
Mainstem																							
Scott River at Roxbury bridge	0.6			155		139		123				62				81	81					68	
Scott River at Townsend gulch	10.8			150				122	119				57		79	79		81				67	
Scott River u/s of Middle Creek	13.3												50					67				62	
Scott River at Jones beach	18.7			98				80	77				34		47	47		54			43	44	
Scott River at USGS gage, measured	21.6	310												47								48	
Scott River at USGS gage, rated final	21.6	327	302	154	135	141	121	110	107	42	43	41	39	46	48	48	48	52	52	52	56	58	57
Scott River d/s of Meamber bridge	25.1												27										
Scott River u/s of Kidder	32.5		193		62				49			21				23		30	30			28	
Scott River at Island Road	35.1		195		61				49			21				23		30					
Scott River at Sweazey's Bridge	41.8		179		38				30			15				16		16	16			13	
Scott River d/s of French Creek	47.7		183		51				40			20				22		20	20		11	12	
Scott River u/s of Fay lane	50.3				32				26			11	11			14		13	13			10	
Scott River at Alexander's	53.2		126																				
Scott River u/s of French Ck	48.1		175	67	59																		
Scott River d/s of French Ck	47.9		170	65	57																		
Scott River at Callahan, preliminary	56.9	154	141	72	95	82	49	48	43	24	23	23	23	27	30	28	27	23.2	22.3	22.2			
Tributaries																							
Lower Etna Creek		16.3											2.6										3.8
Upper Etna Creek													3.0					6.4					3.0
Upper East Fork						7.7				4.1							4.1		3.5	3.3			
Upper South Fork						13.4											8.5		8.2	6.6			
Upper Canyon										8.7		5.7						6.2					
Lower Canyon								10.6				7.0			8.0			8.2				5.5	
Kelsey Creek								5.5					3.7	4.1				4.2				2.8	
Kelsey Creek, w/ weir								7.3					4.9	4.1				4.2				2.8	
Kidder Slough			5.0						6.1														
Moffet Ck																			1.7				
Middle Slide Ck																					0.4		

Bold values are based on comparison of with flows at the gage

Italic values are based on a ratio of flows at a nearby site to flows at the site measured at some other time.

Table 4.4: Modeled and measured effective shade, mainstem Scott River

River Kilometer (Mile)	Modeled Effective Shade (%)	Measured Effective Shade (%)	Number of Samples	Difference (%)
80.8 - 80.6 (50.2 - 50.1)	8	8	3	0
67.3 - 66.8 (41.8 - 41.5)	2	2	6	0
56.6 - 56.2 (35.2 - 34.9)	18	17	5	1
52.5 - 52.2 (32.6 - 32.4)	12	12	4	-1
30 - 29.7 (18.6 - 18.5)	36	28	4	8
17.8 - 17.6 (11.1 - 10.9)	25	15	3	9

Table 4.5: Distribution of data used to define meteorological conditions

Site #	Site Name	River Mile	Collector	Wind Speed*	Air Temp. *	Rel. Hum. *
1	Scott River above French Creek	48.03	SRCD	4	4	4
2	Scott River below French Creek	47.73	SRCD	4	4	4
3	Scott River above Sweazey's Bridge	42.35	NCRWQCB	4	4	4
4	Scott River at Sweazey's Bridge	41.79	NCRWQCB	4	4	4
5	Scott River at Eller Lane	39.31	SRCD	4	4	4
6	Scott River at Island Road	35.05	SRCD	7	7	7
7	Scott River above (at) Kidder Creek	32.59	NCRWQCB	7	7	7
8	Scott River below Kidder Creek	31.89	SRCD	7	7	7
9	Scott River at Meamber Bridge	25.04	SRCD	7	7	7
10	Scott River at Meamber Creek	22.67	SRCD	7	7	7
11	Scott River at USGS Gage	21.60	USFS	16	12	12
12	Scott River at Jones Beach	18.80	USFS	16	12	12
13	Scott River above Canyon	16.10	USFS	16	16	16
14	Scott River below Canyon	15.80	USFS	16	16	16
15	Scott River below Kelsey Creek	14.24	USFS	16	16	16
16	Scott River at Deep Creek	13.31	USFS	16	16	16
17	Scott River at Townsend Gulch	10.85	USFS	16	Tompkins	16
18	Scott River Below George Allen Gulch	8.01	USFS	16	Tompkins	16
19	Scott River below Big Ferry Creek	6.31	USFS	16	Tompkins	16
20	Scott River below Pat Ford Creek	4.75	USFS	16	Tompkins	16
21	Scott River below Mill Creek	3.17	USFS	16	23	23
22	Scott River below Franklin Gulch	2.28	USFS	16	23	23
23	Scott River at Roxbury Bridge	0.50	USFS	16	23	23

* Numbers refer to the site where the data was collected.

Table 4.6A: Model Calibration results; Aug 27-Sept 10, 2003.

River Mile	River Kilometer	Site	Mean Absolute Error (C)	Average Bias (C)	Minimum Bias (C)	Maximum Bias (C)	Average Bias - Daily Min (C)	Average Bias - Daily Max (C)	Average Bias - Daily Average (C)
48.3	77.7	Scott River above French Creek	0.7	-0.3	-2.8	1.9	-0.5	-0.7	-0.3
47.8	77	Scott River below French Creek	0.9	-0.3	-2.9	2.4	-0.4	-0.7	-0.3
42.4	68.2	Scott River above Sweazey's Bridge	1.2	0.2	-2.6	3.4	-0.4	-0.3	0.2
41.8	67.3	Scott River at Sweazey's Bridge	1.5	0.7	-2.9	4.3	0.1	-0.1	0.6
39.3	63.3	Scott River at Eller Lane	2.0	0.6	-5.0	4.0	1.1	-0.9	0.6
35.1	56.5	Scott River at Island Road	0.9	0.1	-2.7	2.5	-0.1	0.3	0.1
32.6	52.4	Scott River above Kidder Creek	0.8	-0.4	-3.1	2.0	-0.5	-0.8	-0.4
31.9	51.3	Scott River below Kidder Creek	0.6	-0.4	-2.5	1.7	-0.5	-0.4	-0.4
25.0	40.2	Scott River at Meamber Bridge	1.8	-1.8	-3.3	0.5	-1.7	-1.2	-1.8
23.4	37.6	Scott River at Meamber Creek	2.1	-2.0	-4.0	0.6	-2.6	-1.9	-2.0
21.5	34.6	Scott River at USGS Gage	1.3	-1.2	-3.5	0.9	-2.3	-1.2	-1.2
18.6	30	Scott River at Jones Beach	1.0	-0.4	-3.7	1.6	0.1	-1.9	-0.4
15.8	25.4	Scott River below Canyon	1.3	1.3	-1.7	2.7	1.5	1.2	1.3
14.2	22.9	Scott River below Kelsey Creek	1.4	1.2	-2.4	3.2	1.4	0.5	1.2
13.3	21.4	Scott River at Deep Creek	1.5	1.0	-2.7	3.1	1.5	-0.7	1.0
10.8	17.4	Scott River at Townsend Gulch	1.2	0.8	-2.4	2.8	1.3	-0.7	0.8
8.0	12.9	Scott River Below George Allen Gulch	0.8	0.5	-1.4	2.3	1.2	0.4	0.5
4.7	7.5	Scott River below Big Ferry Creek	0.8	-0.3	-2.8	1.6	0.2	-1.0	-0.3
3.1	5	Scott River below Mill Creek	0.6	-0.4	-1.9	0.7	-0.2	-0.5	-0.4
2.3	3.7	Scott River below Franklin Gulch	0.8	-0.7	-2.2	0.9	-0.6	-0.5	-0.7

A positive value indicates the model underpredicted, a negative value indicates the model overpredicted

Table 4.6B: Model validation results: July 28-Aug 1, 2003

River Mile	River Kilometer	Site	Mean Absolute Error (C)	Average Bias (C)	Minimum Bias (C)	Maximum Bias (C)	Average Bias - Daily Min (C)	Average Bias - Daily Max (C)	Average Bias - Daily Average (C)
48.3	77.7	Scott River above French Creek	0.8	0.2	-1.6	2.4	-0.6	1.1	0.2
47.9	77.1	Scott River below French Creek	0.8	0.3	-1.0	2.3	-0.5	1.0	0.3
42.4	68.2	Scott River above Sweazey's Bridge	1.5	1.4	-0.6	3.8	0.1	1.8	1.4
41.8	67.3	Scott River at Sweazey's Bridge	1.9	1.9	-0.5	4.6	0.5	2.2	1.9
39.3	63.3	Scott River at Eller Lane	2.4	1.3	-2.8	5.4	0.7	0.7	1.3
35.1	56.5	Scott River at Island Road	1.2	1.2	-0.5	2.9	0.3	1.7	1.2
32.6	52.4	Scott River above Kidder Creek	0.7	0.6	-1.0	1.6	0.2	0.6	0.6
31.9	51.3	Scott River below Kidder Creek	0.6	-0.3	-1.5	1.3	-0.7	0.2	-0.3
25.0	40.2	Scott River at Meamber Bridge	1.4	-1.4	-2.7	0.4	-1.9	-0.3	-1.4
23.4	37.6	Scott River at Meamber Creek	2.2	-2.2	-4.2	0.2	-2.7	-0.8	-2.1
21.5	34.6	Scott River at USGS Gage	1.7	-1.7	-3.2	0.3	-2.5	-0.7	-1.7
18.6	30	Scott River at Jones Beach	0.9	-0.8	-2.3	0.7	-0.6	1.1	0.2
15.8	25.4	Scott River below Canyon	0.5	0.4	-0.7	1.2	0.3	-0.1	0.4
14.2	22.9	Scott River below Kelsey Creek	0.6	0.5	-1.0	1.4	0.4	0.3	0.5
13.3	21.4	Scott River at Deep Creek	0.8	0.5	-1.3	1.5	0.6	-0.2	0.5
10.8	17.4	Scott River at Townsend Gulch	0.9	0.8	-0.8	1.6	0.9	-0.2	0.8
0.5	0.81	Scott River at Roxbury Bridge	0.8	0.7	-0.3	1.7	-0.6	1.1	0.2

A positive value indicates the model underpredicted, a negative value indicates the model overpredicted

Table 4.7: 5-day average temperatures at monitored sites along the Scott River, given current and potential vegetation conditions

Stream Kilometer	Site name	Potential	Current (*C)	Difference (*C)	Difference (*F)
77.7	Scott River above French Creek	19.3	20.4	1.1	2.0
77.1	Scott River below French Creek	19.0	20.3	1.3	2.3
68.2	Scott River above Sweazey's Bridge	16.2	20.2	4.0	7.2
67.3	Scott River at Sweazey's Bridge	16.7	21.0	4.3	7.8
63.3	Scott River at Eller Lane	18.0	21.7	3.7	6.7
56.5	Scott River at Island Road	19.1	22.9	3.8	6.8
52.4	Scott River above Kidder Creek	19.5	23.2	3.8	6.8
51.3	Scott River below Kidder Creek	21.2	23.3	2.1	3.8
40.2	Scott River at Meamber Bridge	22.2	23.3	1.1	2.0
37.6	Scott River at Meamber Creek	21.9	22.5	0.5	0.9
34.6	Scott River at USGS Gage	21.9	22.7	0.9	1.6
30	Scott River at Jones Beach	22.1	23.5	1.4	2.5
25.4	Scott River below Canyon	20.8	22.5	1.7	3.1
22.9	Scott River below Kelsey Creek	20.9	22.4	1.6	2.8
21.4	Scott River at Deep Creek	21.2	22.7	1.6	2.8
17.4	Scott River at Townsend Gulch	21.3	22.8	1.5	2.7
0.8	Scott River at Roxbury Bridge	23.0	24.0	1.0	1.8

Table 4.8: South Fork Scott River temperature model calibration and validation results.

Date	Mean	Average Bias (C)	Minimum Bias (C)	Maximum Bias (C)	Average Bias	Average Bias	Average Bias -
	Absolute Error (C)				Daily Min (C)	Daily Max (C)	Daily Average (C)
July 26 - July 31, 2003	0.3	0.05	-1.4	0.9	-0.3	0.3	-0.2
Aug 28 - September 10, 2003	1.0	1.0	-0.3	3.7	-0.5	-1.3	-1.0

A positive value indicates the model underpredicted, a negative value indicates the model overpredicted

Table 4.9: East Fork Scott River temperature model calibration results

Site	Mean Absolute Error (C)	Average Bias (C)	Minimum Bias (C)	Maximum Bias (C)	Average Bias - Daily Min (C)	Average Bias - Daily Max (C)	Average Bias - Daily Average (C)
East Fork at Lower Masterson Road	1.2	-0.4	-1.9	3.2	-0.8	1.4	0.4
East Fork at Callahan	2.5	-2.5	0.0	4.4	2.5	3.3	2.0

A positive value indicates the model underpredicted, a negative value indicates the model overpredicted

Table 4.10: Performance of Houston / Cabin Meadows Creek temperature model.

Site	Mean Absolute Error (C)	Average Bias (C)	Minimum Bias (C)	Maximum Bias (C)	Average Bias - Daily Min (C)	Average Bias - Daily Max (C)	Average Bias - Daily Average (C)
Cabin Meadows Creek downstream of 41N03	0.5	0.0	-1.0	1.3	-0.2	-0.5	0.0
Cabin Meadows Ck upstream of Houston Ck	0.6	0.6	0.0	1.2	0.8	0.8	0.6
Houston Ck downstream of Cabin Meadows Ck	0.3	0.3	-0.1	1.0	0.2	0.7	0.3
Houston Ck upstream of Little Houston Ck	0.2	0.0	-0.9	0.4	0.1	0.0	0.0
Houston Ck downstream of Little Houston	0.2	0.1	-0.6	0.5	0.2	0.2	0.1
Houston Ck upstream of Crater Ck	-1.1	1.9	0.6	0.1	-0.4	0.2	0.1

A positive value indicates the model underpredicted, a negative value indicates the model overpredicted

Table 4.11 Constants used to develop microclimate depictions

	95% Canopy Forest	Microclimate 1	Microclimate 2	Microclimate 3
Wind Multiplier	0.8	1.1	1.2	1.3
Relative Humidity Multiplier	1.1	0.9	0.8	0.7
Air Increase/Decrease	-2	1	2	4

Table 4.12: Summary of stream lengths in shade classes for current and desired vegetation conditions

Shade Class	Stream Length - Current Vegetation Conditions				Stream Length - Desired Vegetation Conditions			
	(miles)	(km)	% Shadier	% of Total	(miles)	(km)	% Shadier	% of Total
0-1	141	227	77.9%	22.1%	33	53	94.8%	5.2%
>1-2	73	117	66.6%	11.3%	29	46	90.3%	4.5%
>2-3	57	91	57.7%	8.8%	26	43	86.2%	4.1%
>3-4	78	126	45.4%	12.3%	36	58	80.5%	5.7%
>4-5	97	157	30.2%	15.2%	43	69	73.9%	6.7%
>5-6	127	204	10.3%	19.9%	76	122	62.0%	11.9%
>6-7	52	83	2.3%	8.1%	103	165	45.9%	16.0%
>7-8	10	17	.6%	1.6%	177	284	18.3%	27.6%
>8-9	3	5	.2%	0.5%	116	186	.2%	18.1%
>9-10	1	2	.0%	0.2%	1	2	.0%	0.2%
Total:	639	1028			639	1028		

% Shadier refers to the percentage of stream length shadier than the upper bound of the corresponding shade class