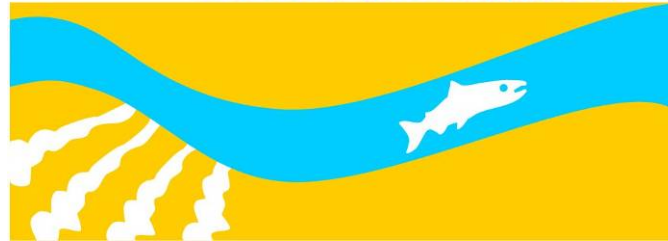


SAN JOAQUIN RIVER
RESTORATION PROGRAM



HEC-5Q Water Temperature Model in Post-Settlement Conditions

Katrina Harrison

Restoration Goal Technical Feedback

Group Meeting

March 21, 2013



Temperature Purposes

- Maintain temperatures for different life stages of fish
 - Temperature Thresholds (handout)
 - Observations and Predictions
 - Management Actions

Temperature Thresholds

Habitat Parameter	Metric	Target Location (s)	Sept-Nov	Dec	Jan	Feb	Mar	Apr	May	June
Spawning and egg incubation	Daily maximum water temp < 13°C	Reach 1	X	X	X	X	X			
Juvenile migration	Daily maximum water temp < 20°C	Reaches 1-5				X	X	X	X	
Juvenile migration	3-day running average daily average water temp < 17°C	Reaches 1-5				X	X	X	X	
Juvenile smoltification	Daily maximum water temp < 12°C	Reaches 1-5		X	X	X	X	X	X	
Juvenile rearing	Daily average water temp 13-15°C	Reach 1A	X	X	X	X	X	X	X	X
Juvenile rearing	Daily average water temp 13-15°C	Reaches 1-5				X	X	X	X	
Juvenile rearing	3-day running average daily average water temp 15-18°C	Reaches 1-5				X	X	X	X	
Adult passage	>25% of wetted width greater than 0.8 ft deep	Reaches 1-5	X				X	X	X	X
Adult passage	Daily maximum water temp < 20°C	Reaches 1-5	X				X	X	X	X
Adult attraction	10-day daily average flow > 775 cfs just above Merced River confluence	Reach 5	X				X	X	X	X
Floodplain inundation	1.0 < depth < 3.3 ft Velocity < 1.5 ft/sec	Reaches 1-5				X	X	X	X	
Juvenile stranding	Daily stage drop < 0.5 ft/day	Reaches 1-5				X	X	X	X	
Redd dewatering	Water depth over redd > 0.8 ft	Reach 1	X	X	X	X	X			

Predictions

- Modeling
 - River Temperature
 - Reservoir Temperatures
- Monitoring
 - Temperature transducers
 - Targeted Studies



Informing the Restoration Goal

- Phase 1 and 2 projects
 - Gravel Pit Isolation
 - Floodplain

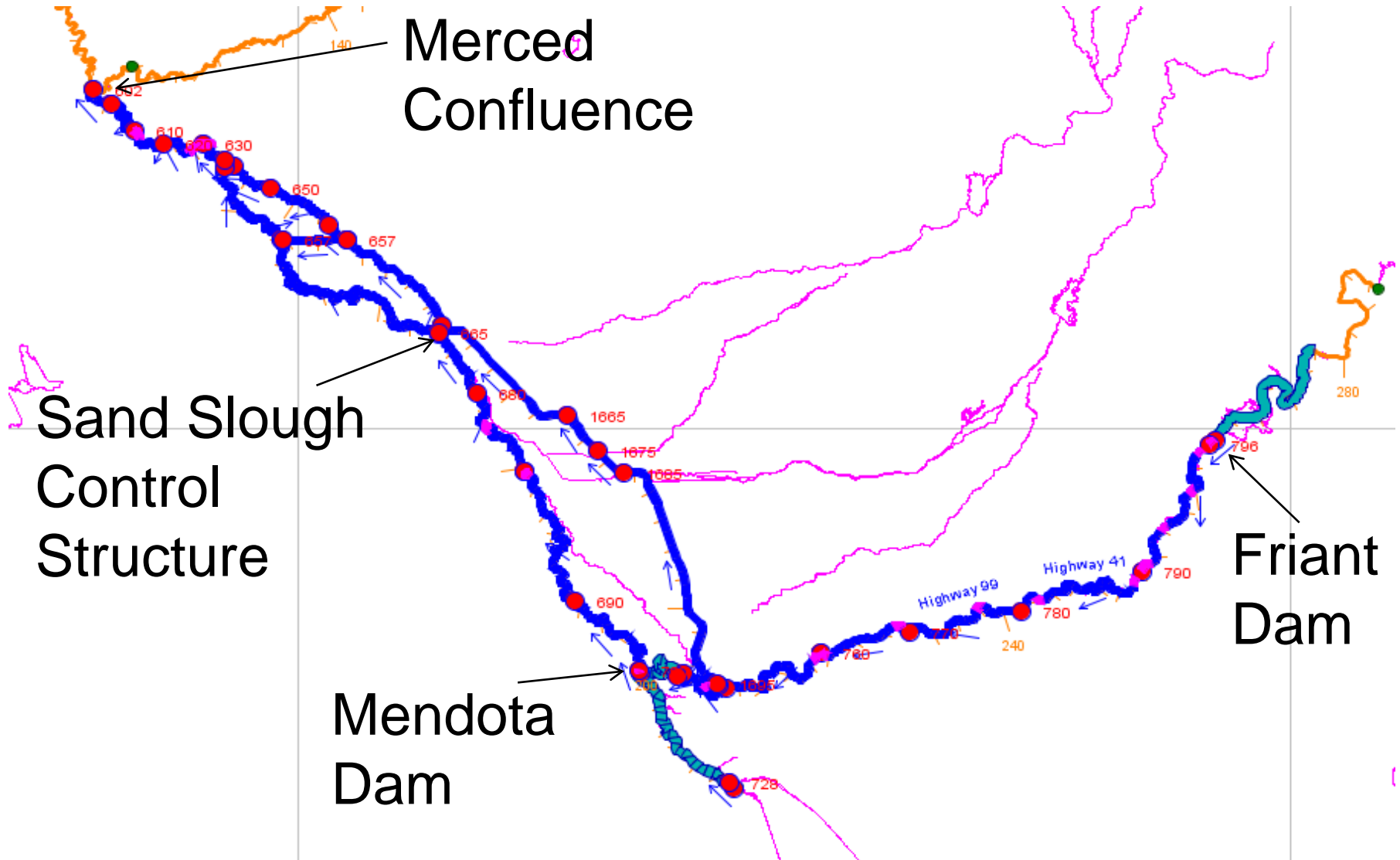
- Flow Releases
 - Cold Water Pool Management
 - Providing for passage



HEC-5Q Validation Purpose

- Verify temperature predictions given additional available data with Restoration Flows
- The existing HEC-5Q model (SJR5Q) was developed in 2006.
- The updated model includes hydrologic and meteorologic data collected through 2010.

HEC-5Q Model Area and Nodal Points





Original SJR5Q Model Comparison to Observed Data – Upper Reaches, Spring

River Mile (location)	Bias (F) in Temperature					
	Jan	Feb	Mar	Apr	May	June
225.41 (Gravelly Ford)	0.11	0.38	0.35	-0.68	-0.97	-1.4
238.09 (Donny Bridge)	-0.67	-0.34	-0.77	-1.34	-2.05	-2.07
242.97 (Millburn Unit)	-0.9	-0.43	-0.8	-1.31	-1.79	-2.2
251.63 (Highway 41)	-1.16	-0.99	-0.63	-0.98	-1.21	-0.86
252.41 (Highway 41)	-1.18	-1.24	-1.01	-1.4	-1.84	-1.58
256.15 (Willow Unit)	-1.78	-1.6	-0.96	-0.66	-0.52	-0.25
260.15 (Lost Lake)	-2.14	-1.54	-0.33	-0.04	-0.01	0.27



Original SJR5Q Model Comparison to Observed Data – Upper Reaches, Fall

River Mile (location)	Bias (F) in Temperature					
	Jul	Aug	Sep	Oct	Nov	Dec
225.41 (Gravelly Ford)	-1.74	-0.37	1.04	1.97	2.07	1.63
238.09 (Donny Bridge)	-2.81	-1.52	-0.2	0.34	0.7	0.24
242.97 (Millburn Unit)	-2.38	-2.23	-1.23	-0.95	0.09	-0.18
251.63 (Highway 41)	-0.83	-1.03	-0.22	-0.16	0	-0.15
252.41 (Highway 41)	-1.76	-1.92	-0.95	-0.54	-0.12	-0.05
256.15 (Willow Unit)	-0.23	-0.67	-0.66	-0.9	-0.83	-0.52
260.15 (Lost Lake)	0.31	-0.1	-0.24	-0.75	-1.04	-1.05



Original SJR5Q Model Comparison to Observed Data – Lower Reaches, Spring

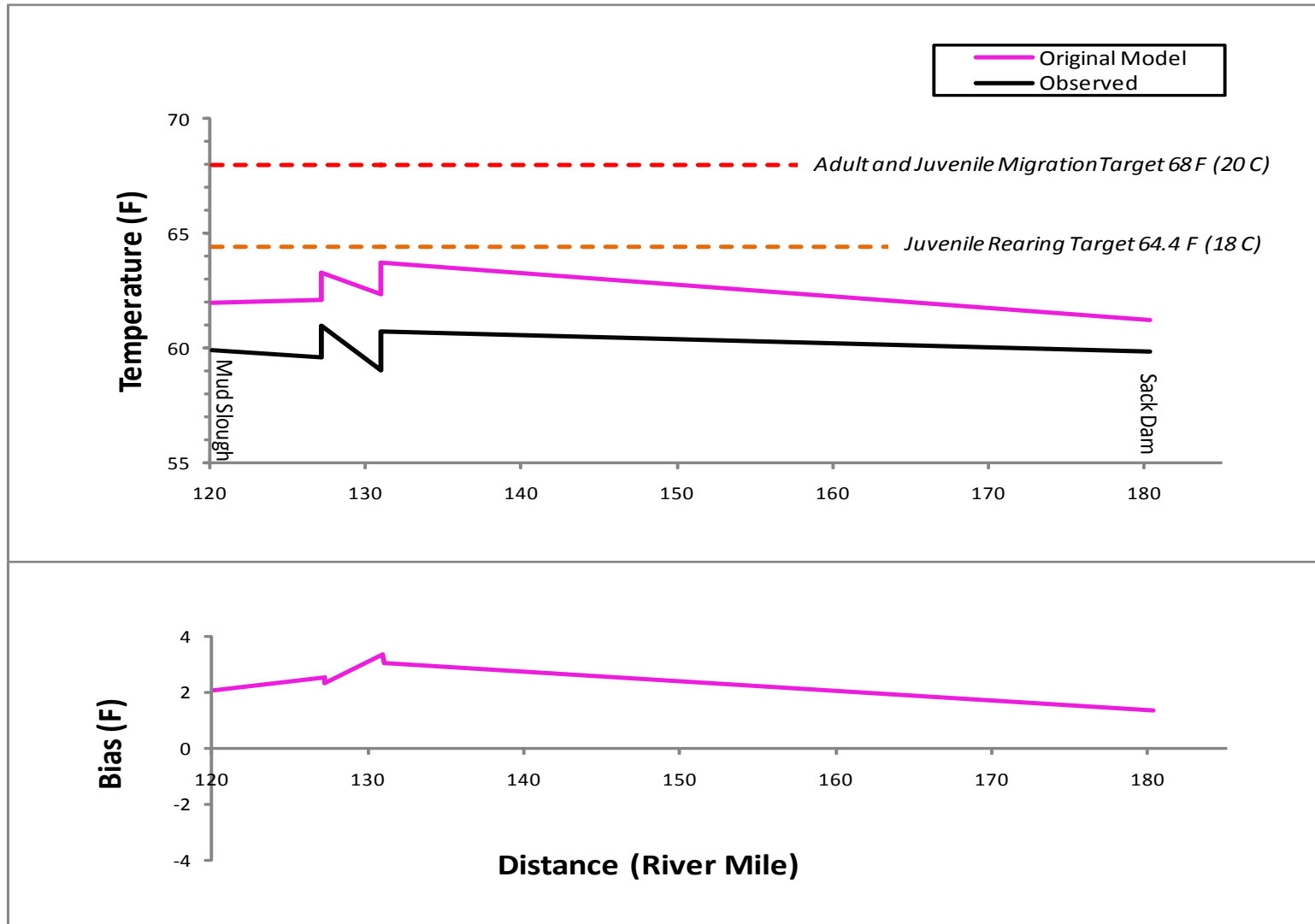
River Mile (location)	Bias (F) in Temperature					
	Jan	Feb	Mar	Apr	May	June
120.15 (Mud Slough)	-1.67	1.01	2.06	1.56	1.33	2.26
127.19 (Salt Slough)	-1.37	1.33	2.54	2.05	1.82	2.09
127.21 (Salt Slough)	-0.86	1.11	2.3	2.02	1.33	0.9
130.99 (Stevinson Bridge)	-0.92	1.77	3.32	2.88	2.6	2.79
131.01 (Stevinson)	-1.63	1.42	3.05	2.07	1.05	1.07
180.31 (Sack Dam)	-0.79	0.91	1.34	1.76	1.52	1.6



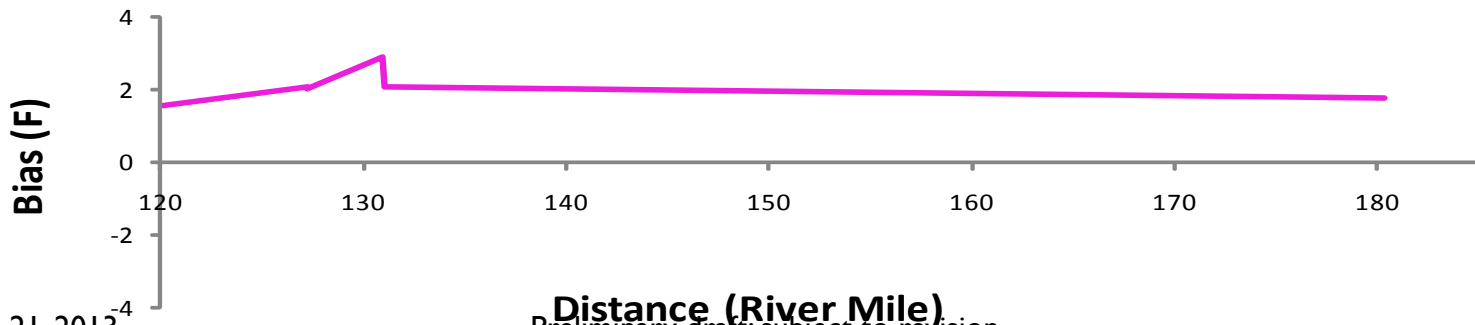
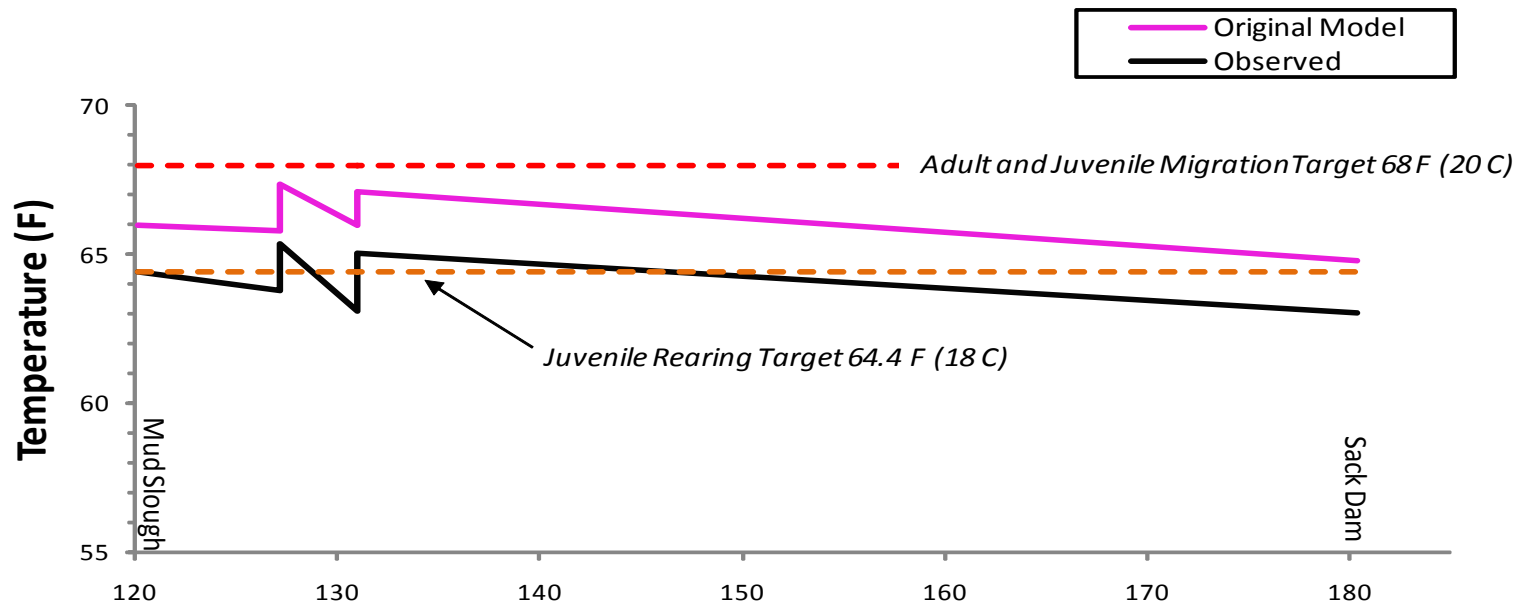
Original SJR5Q Model Comparison to Observed Data – Lower Reaches, Fall

River Mile (location)	Bias (F) in Temperature					
	Jul	Aug	Sep	Oct	Nov	Dec
120.15 (Mud Slough)	1.68	2.29	3.57	2.43	1.83	-1.61
127.19 (Salt Slough)	2.02	3.15	3.43	3.1	2.36	-1.32
127.21 (Salt Slough)	0.91	1.66	2.35	2.21	1.71	-0.91
130.99 (Stevinson Bridge)	3.64	4.35	4.72	3.64	2.23	-1.32
131.01 (Stevinson)	1.29	2.12	2.93	2.32	1.48	-1.28
180.31 (Sack Dam)	1.6	2.14	2.33	2.6	2.13	-1.61

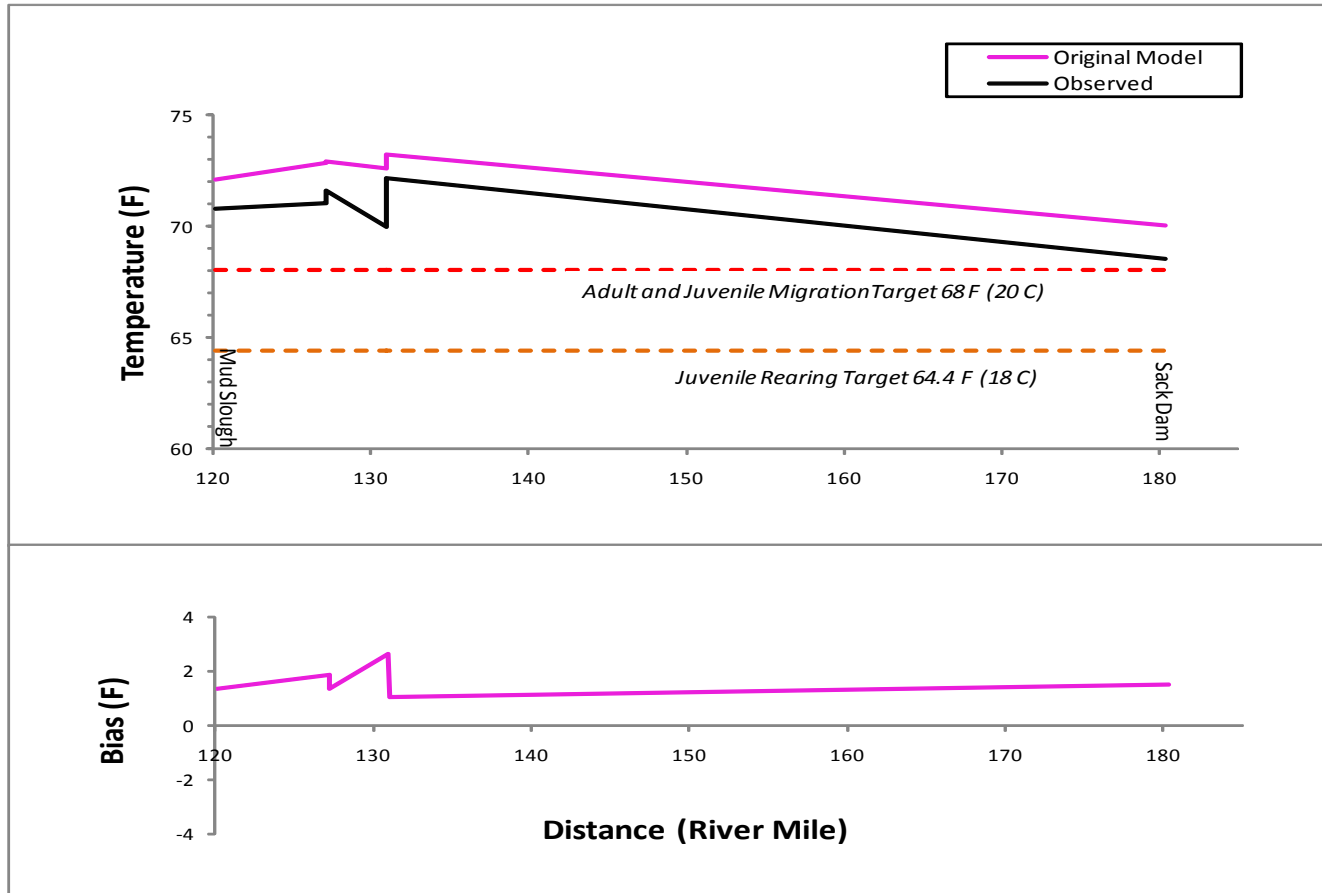
Model Results – Average March Water Temperature in Lower Reaches



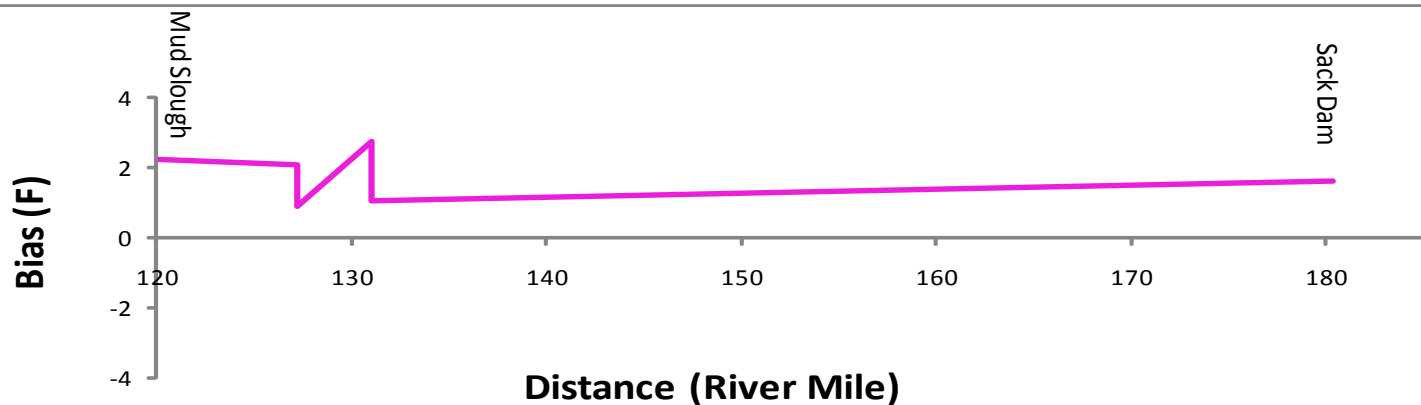
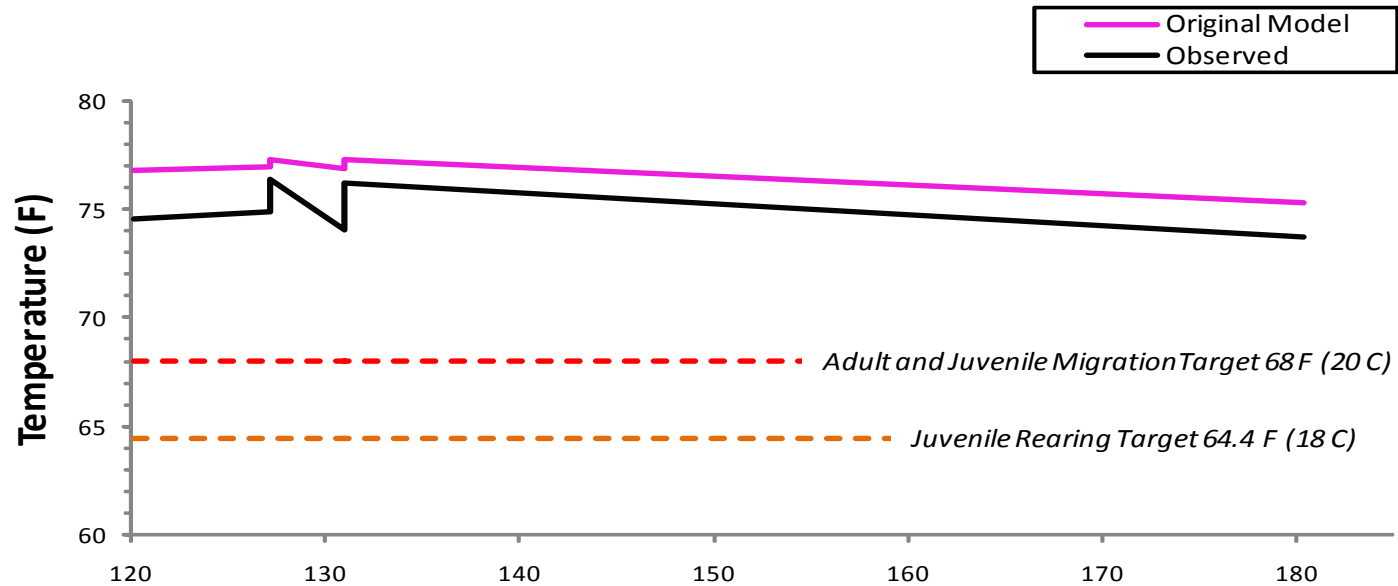
Model Results – Average April Water Temperature in Lower Reaches



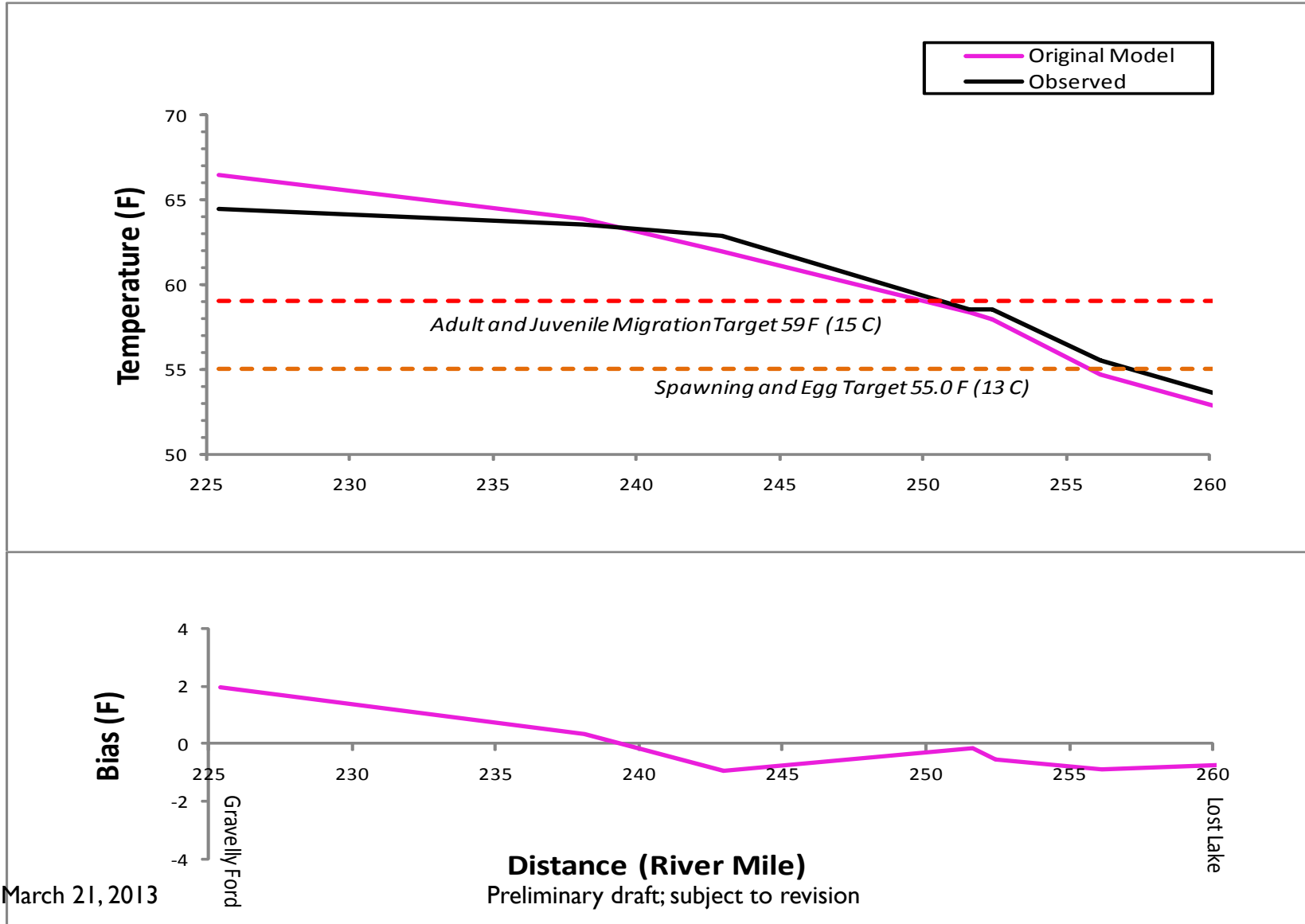
Model Results – Average May Water Temperature in Lower Reaches



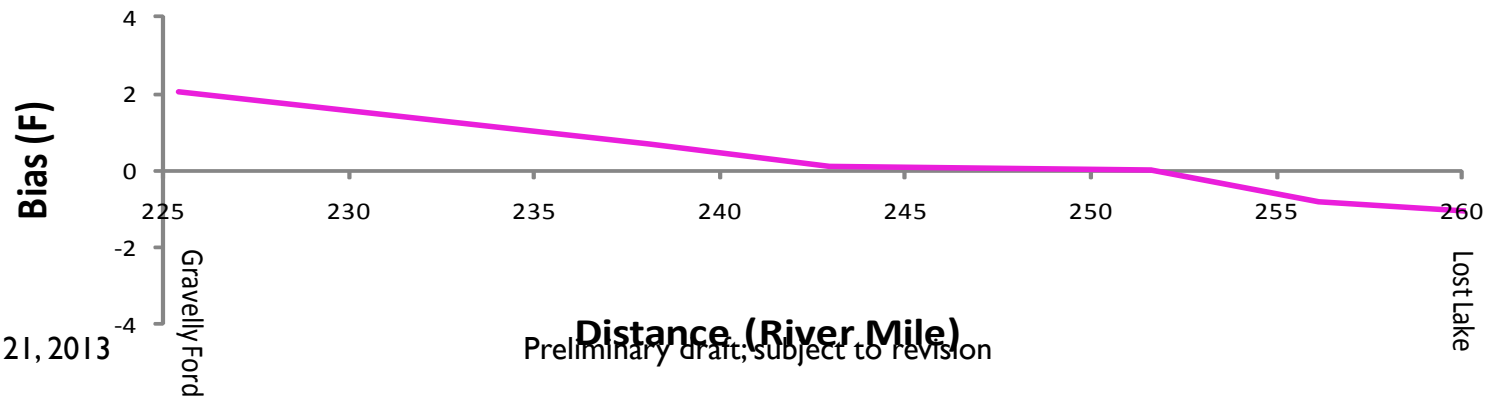
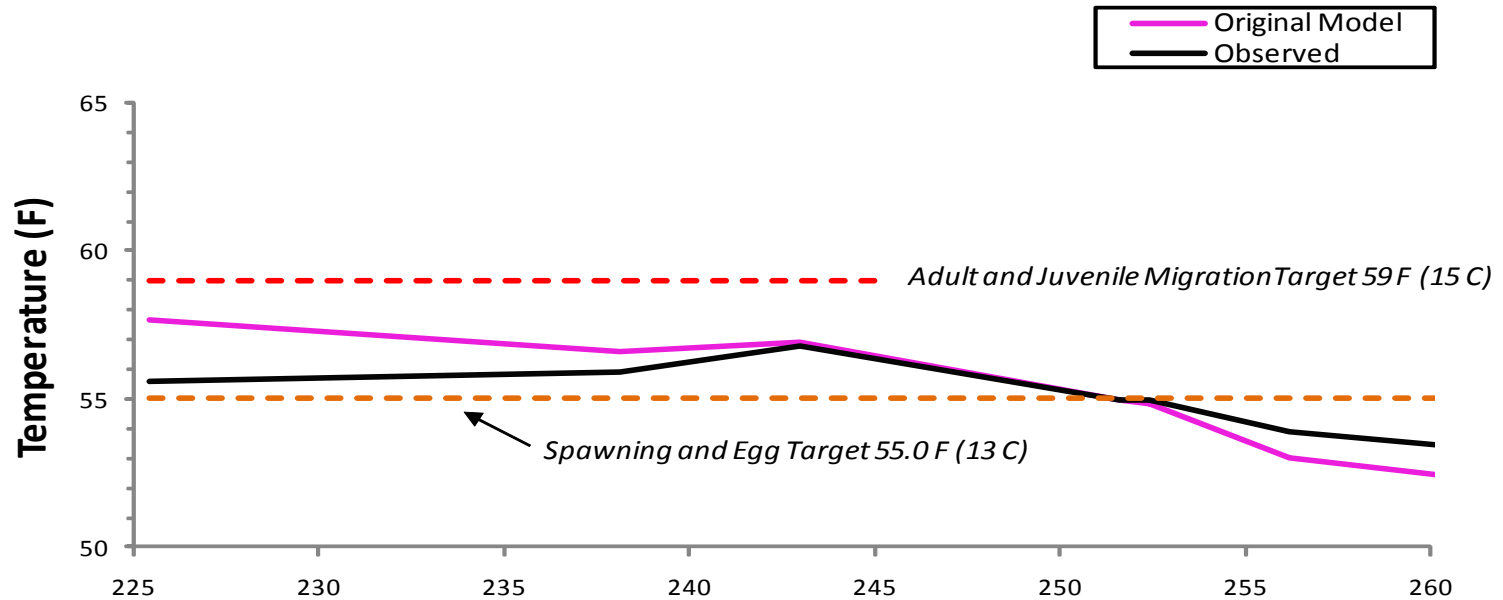
Model Results – Average June Water Temperature in Lower Reaches



Model Results – Average October Water Temperature in Upper Reaches

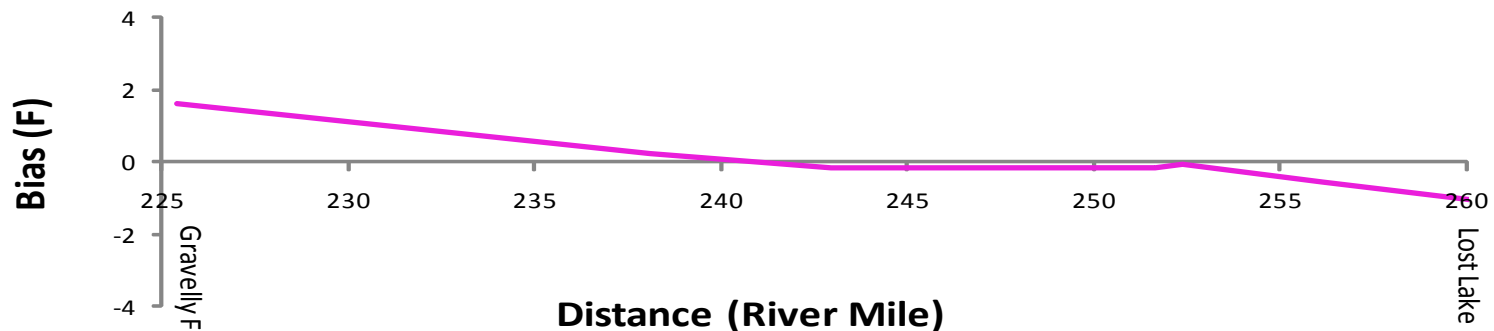
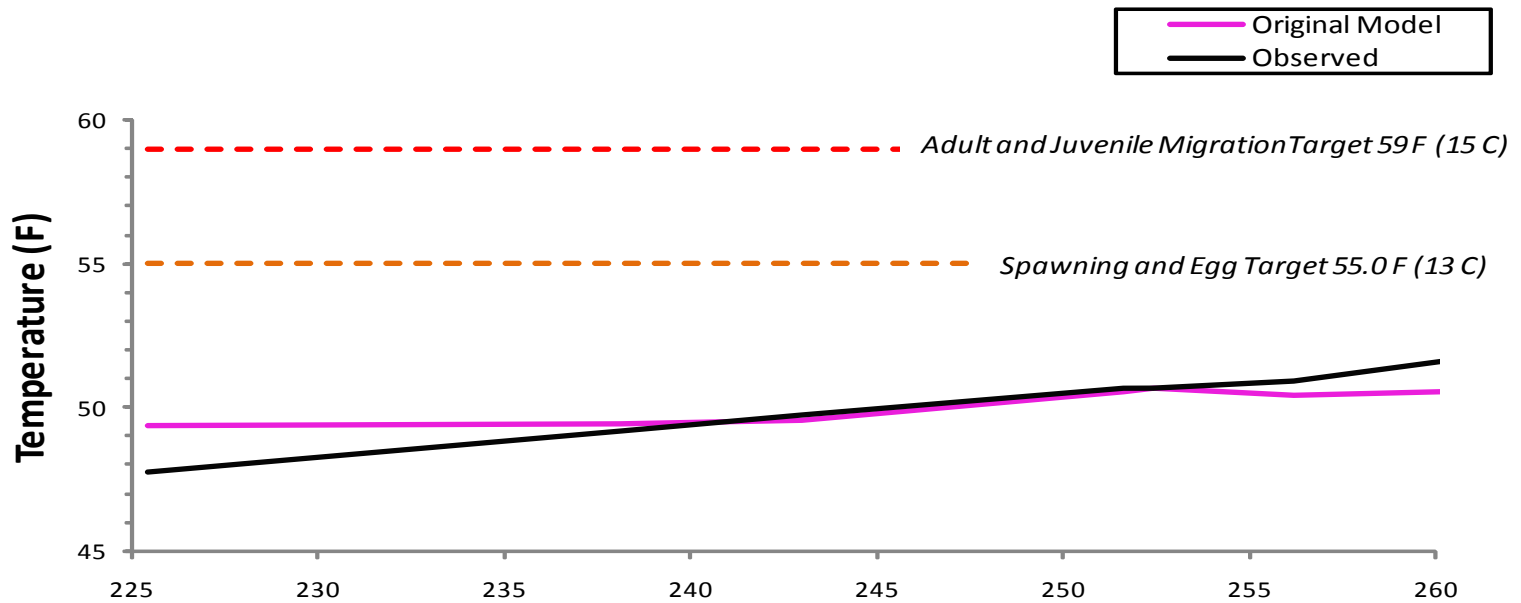


Model Results – Average November Water Temperature in Upper Reaches



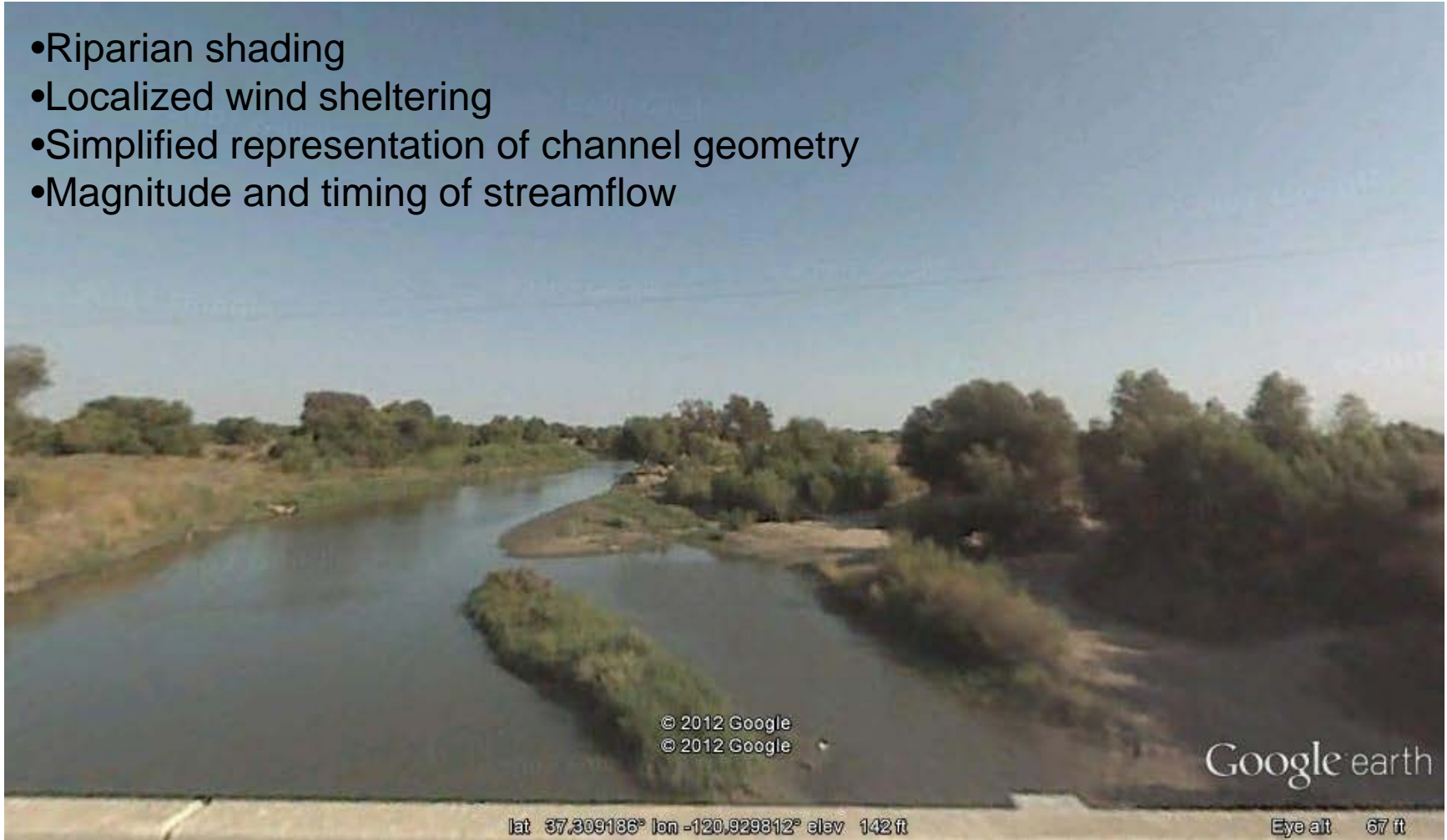


Model Results – Average December Water Temperature in Upper Reaches



Observed vs. Modeled Temperatures

- Riparian shading
- Localized wind sheltering
- Simplified representation of channel geometry
- Magnitude and timing of streamflow



San Joaquin River at Stevinson Bridge, Looking

upstream, 2013

Preliminary draft; subject to revision

Bias Correction

$$EQTm = Kt1 + Kt2 * EQTc$$

where: ***EQTm*** = equilibrium temperature adjusted for environmental conditions

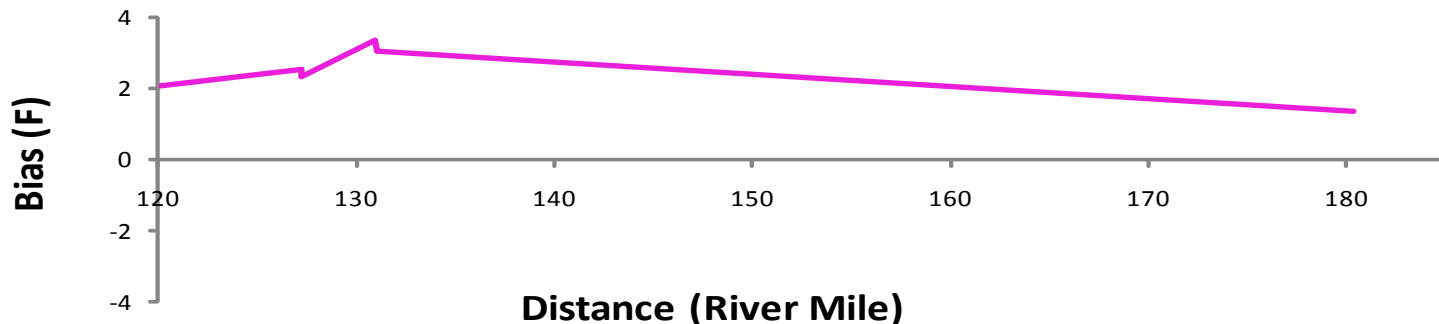
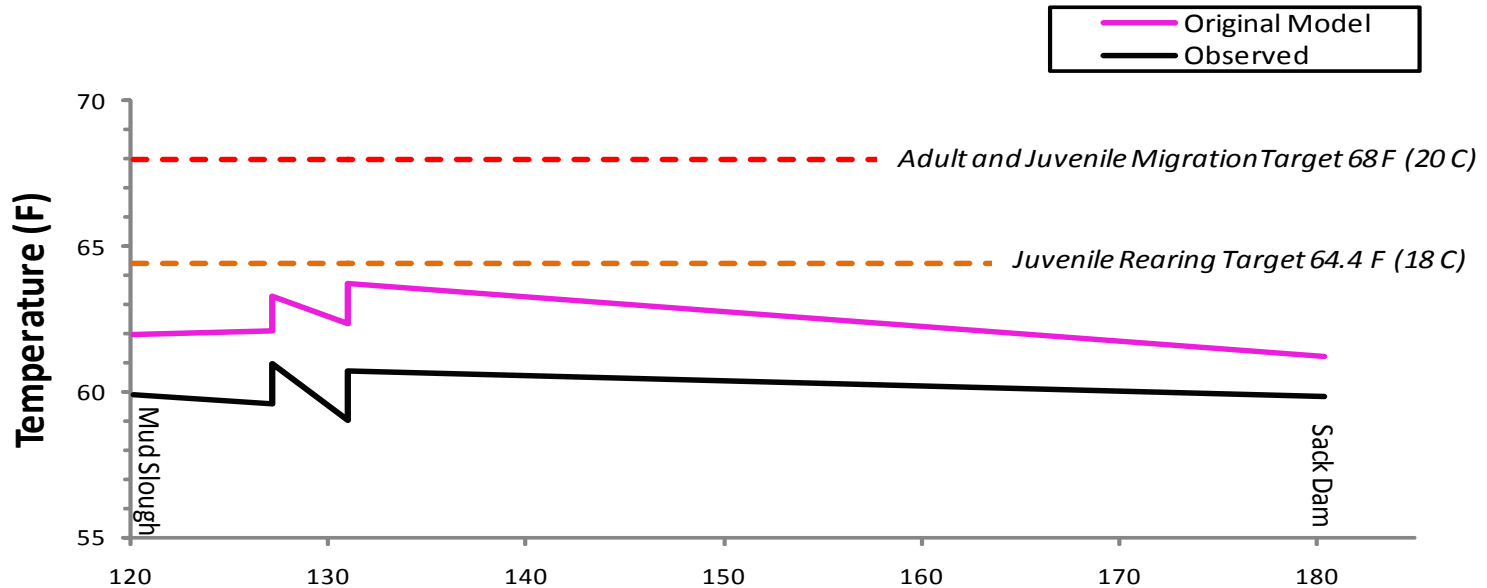
Kt1 = offset (***EQTm*** = ***Kt1*** when ***EQTc*** = 0)

Kt2 = proportionality coefficient (slope)

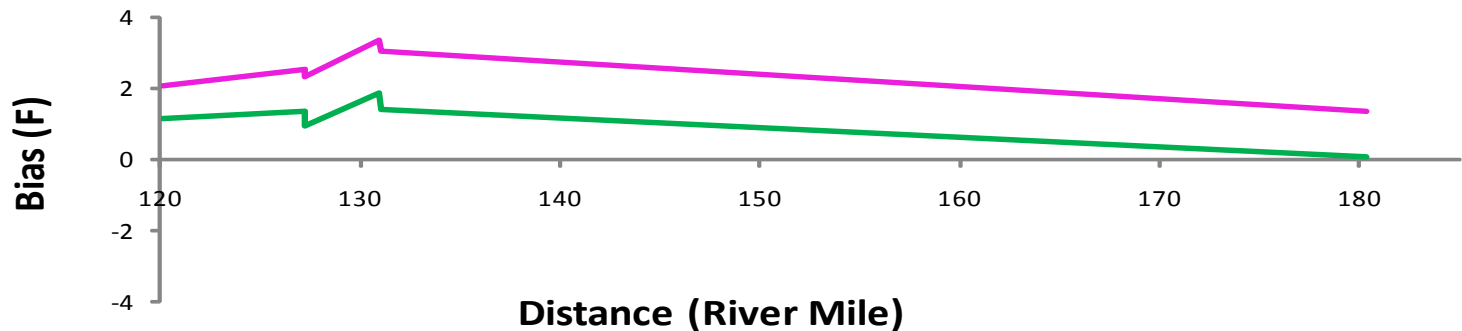
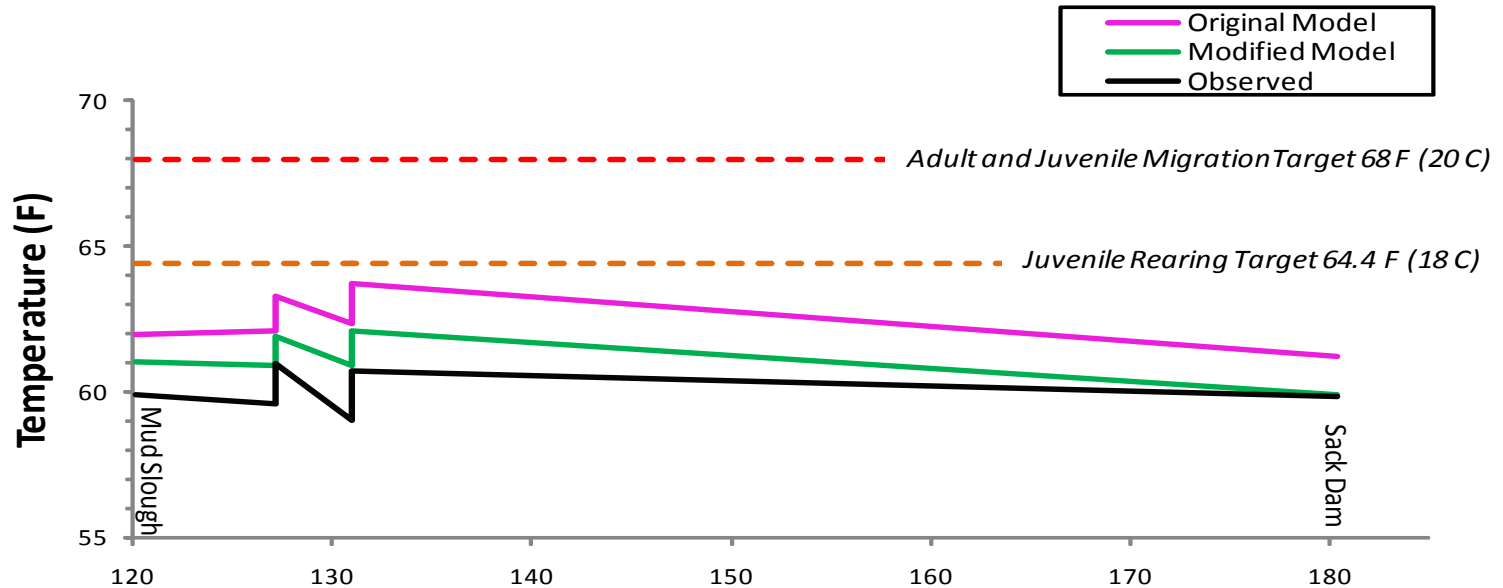
EQTc = Equilibrium temperature computed from CIMIS data.

These coefficients (***Kt1*** and ***Kt2***) are determined by calibration.

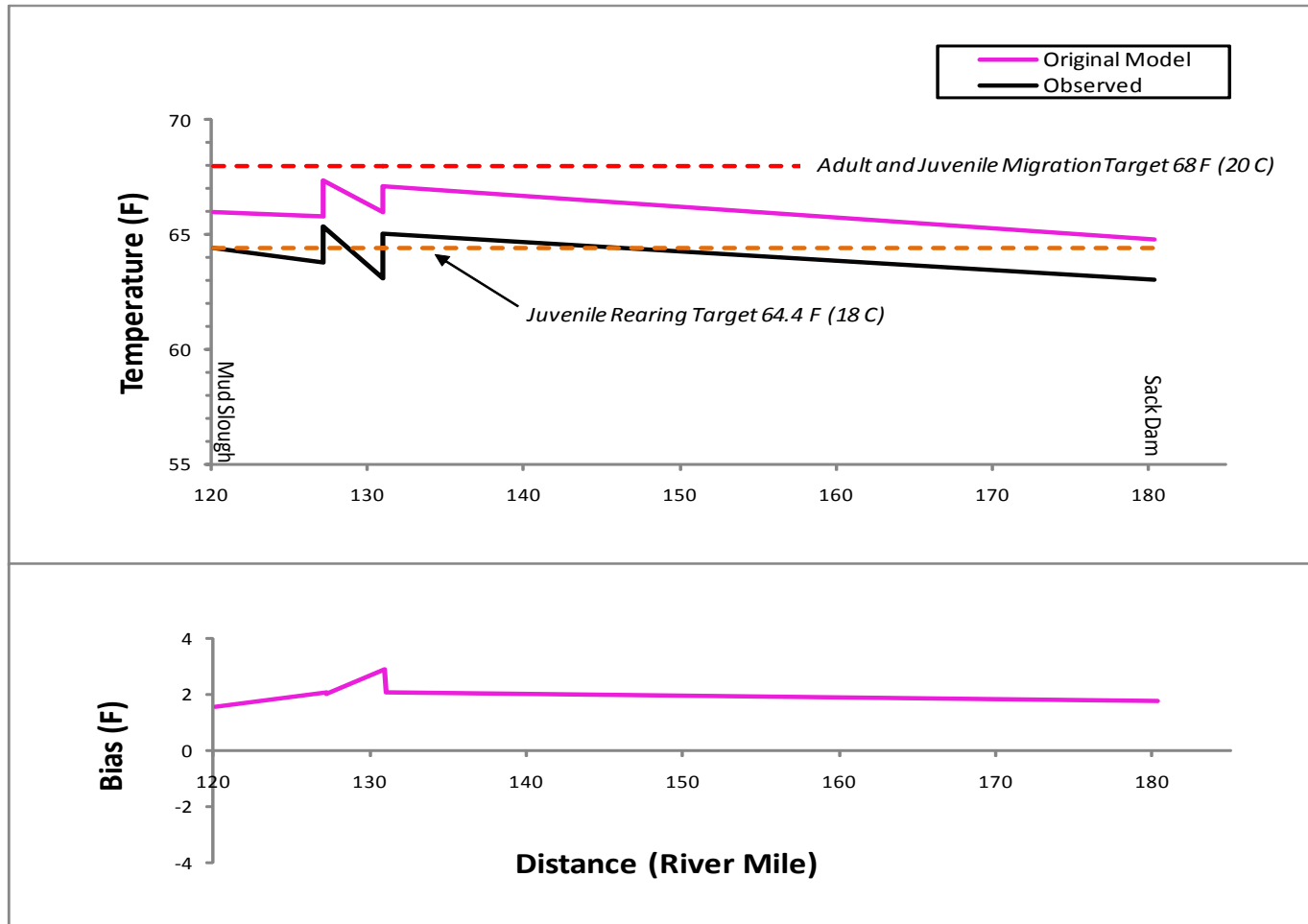
Model Results – Average March Water Temperature in Lower Reaches



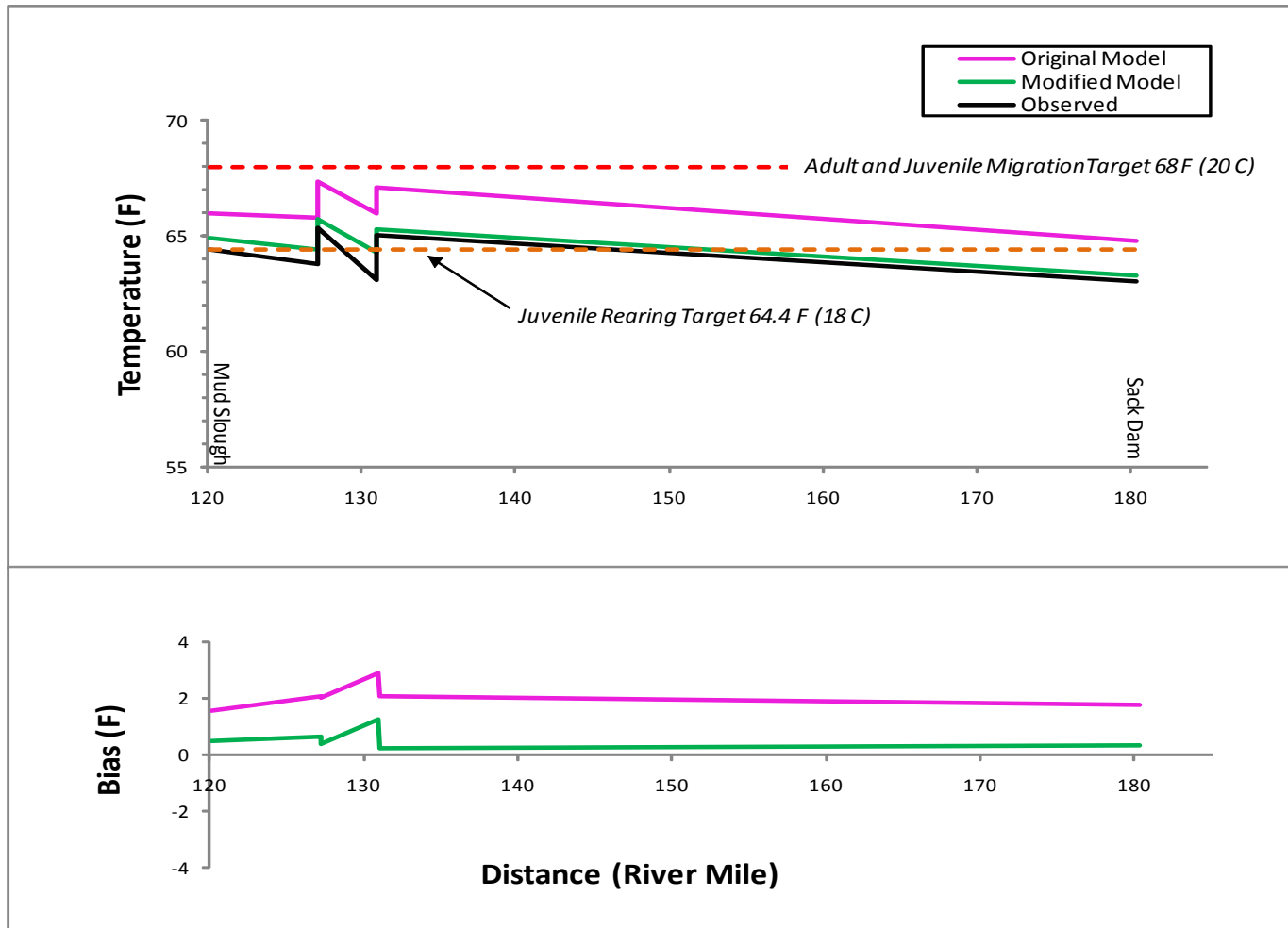
Model Results – Average March Water Temperature in Lower Reaches



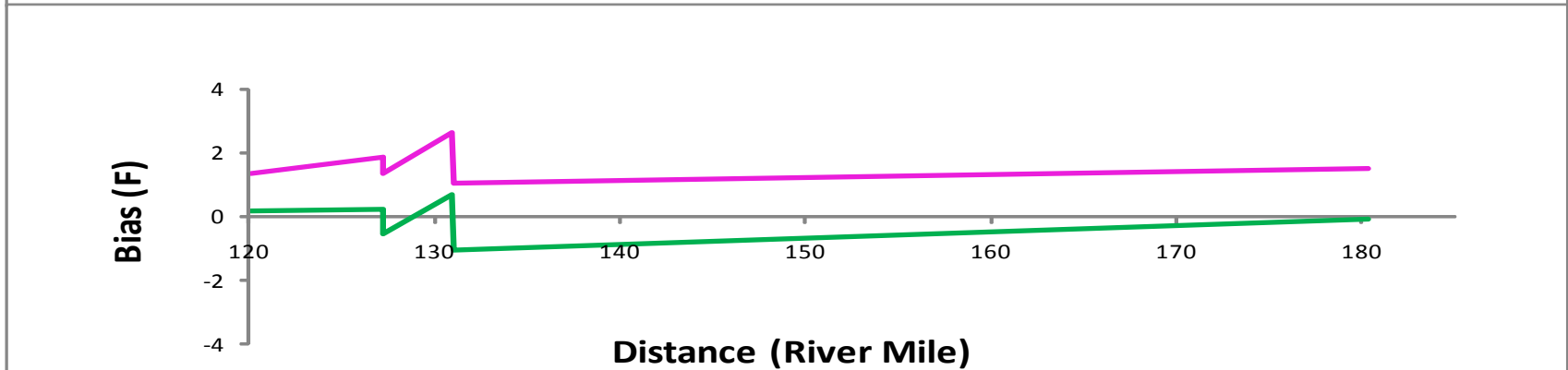
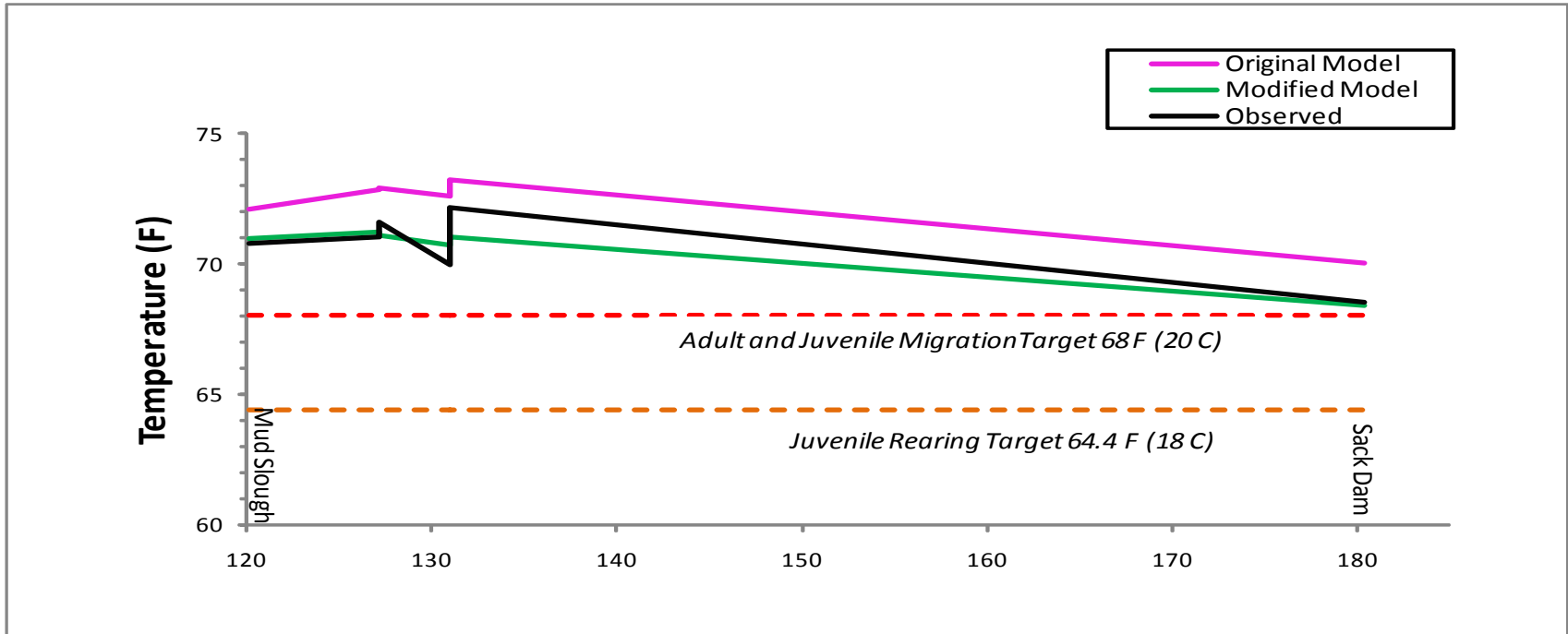
Model Results – Average April Water Temperature in Lower Reaches



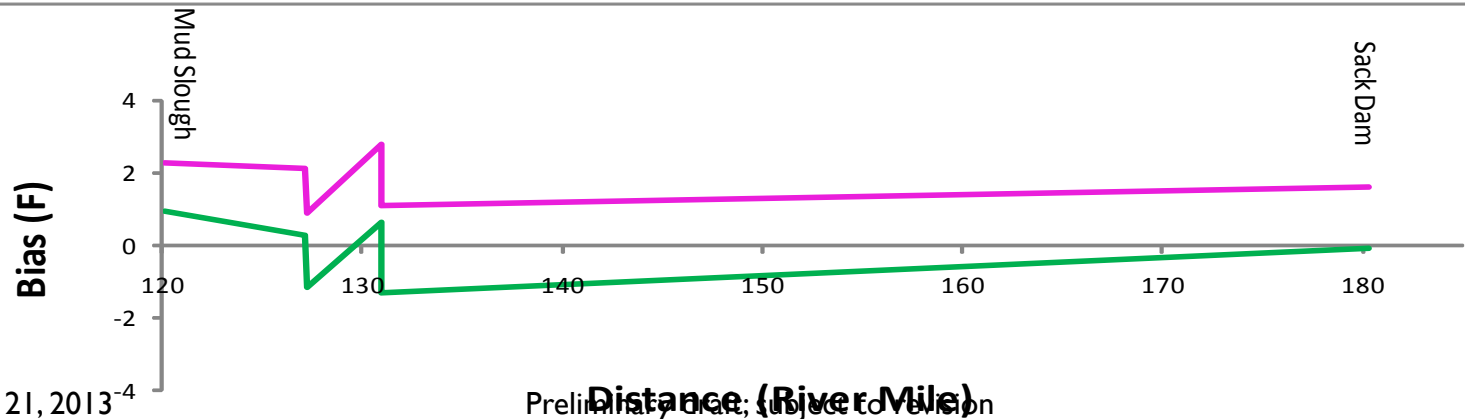
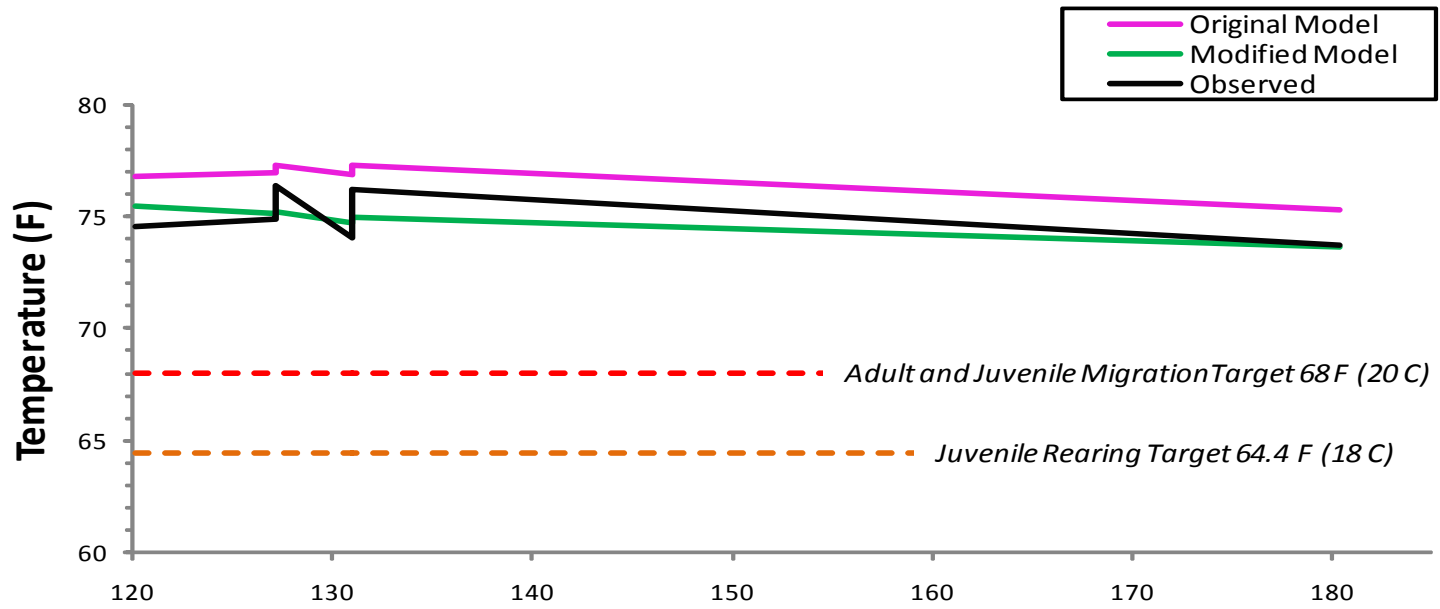
Model Results – Average April Water Temperature in Lower Reaches



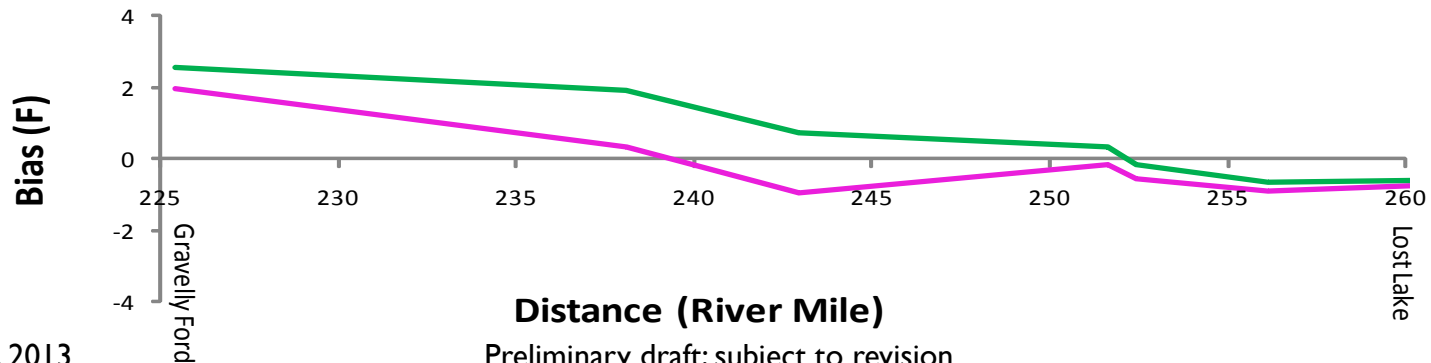
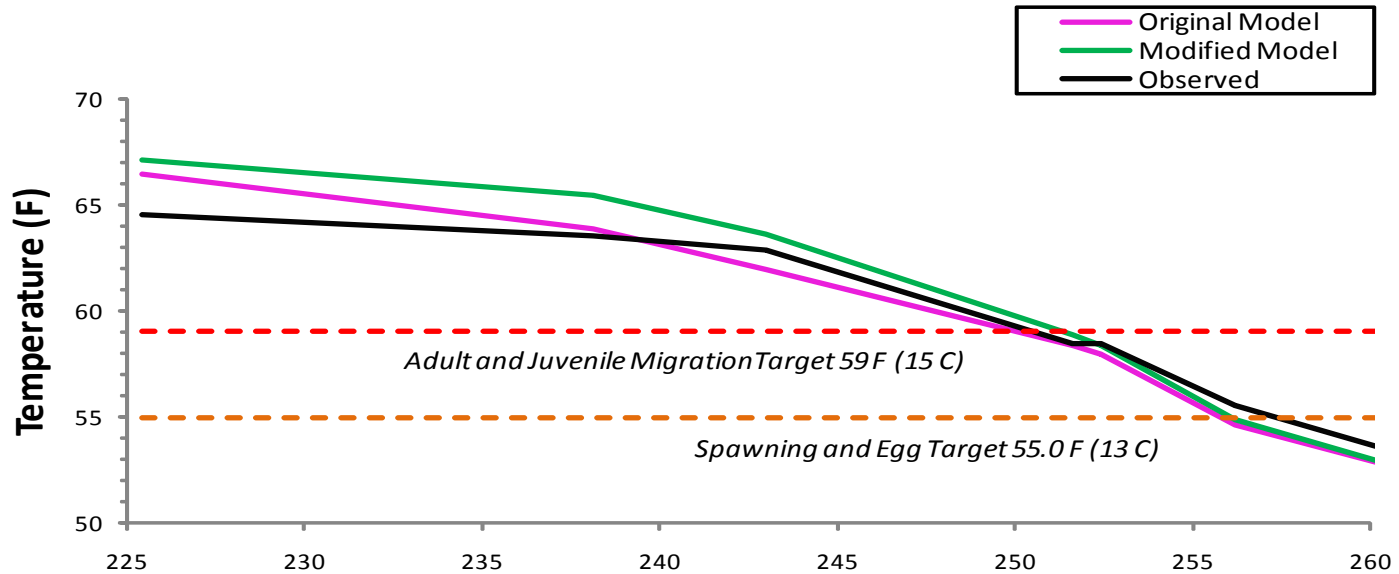
Model Results – Average May Water Temperature in Lower Reaches



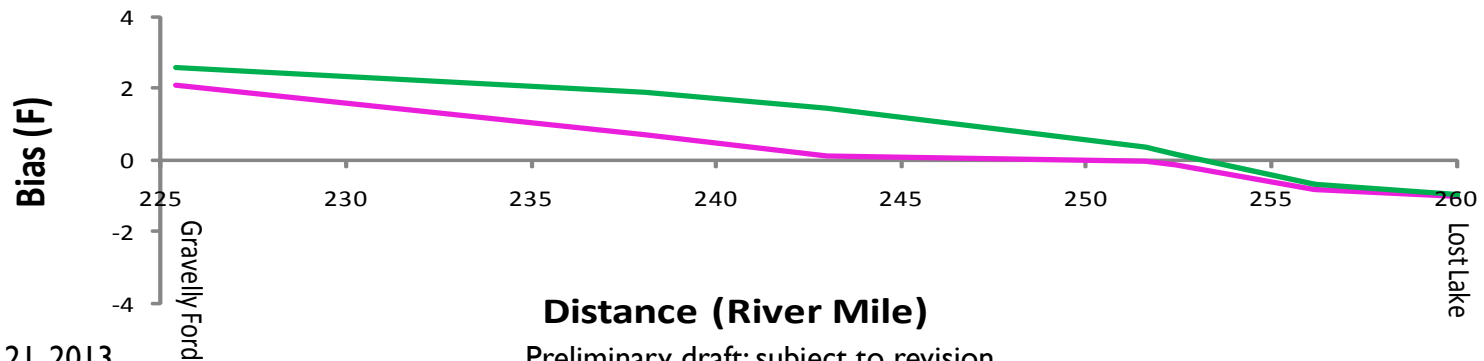
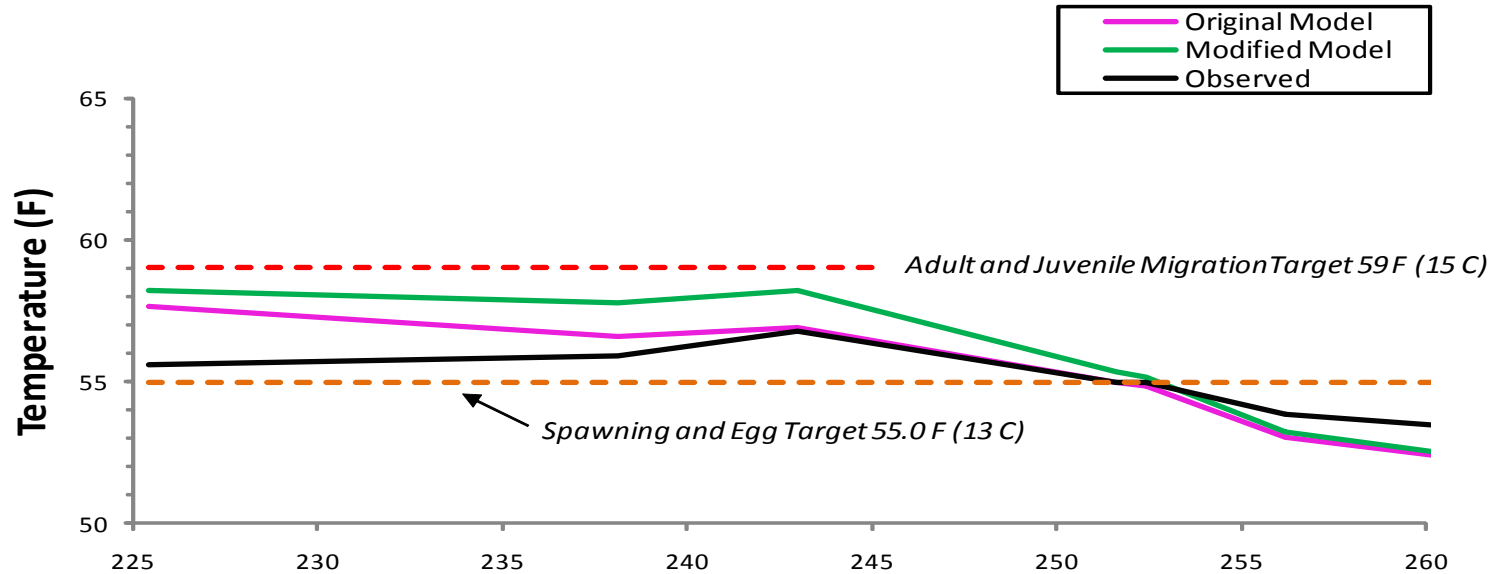
Model Results – Average June Water Temperature in Lower Reaches



Model Results – Average October Water Temperature in Upper Reaches

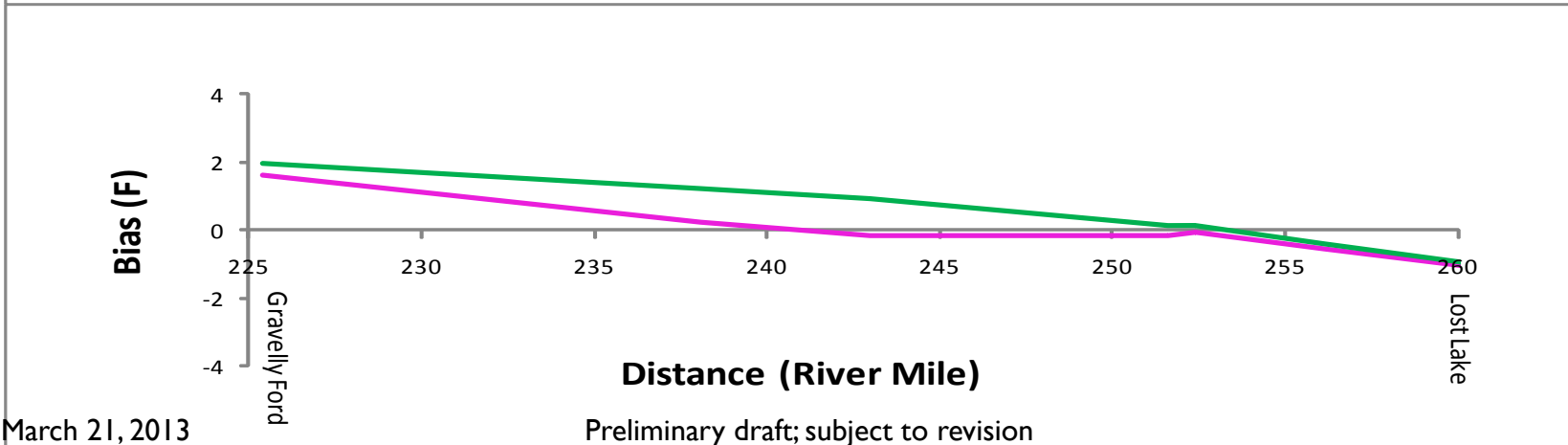
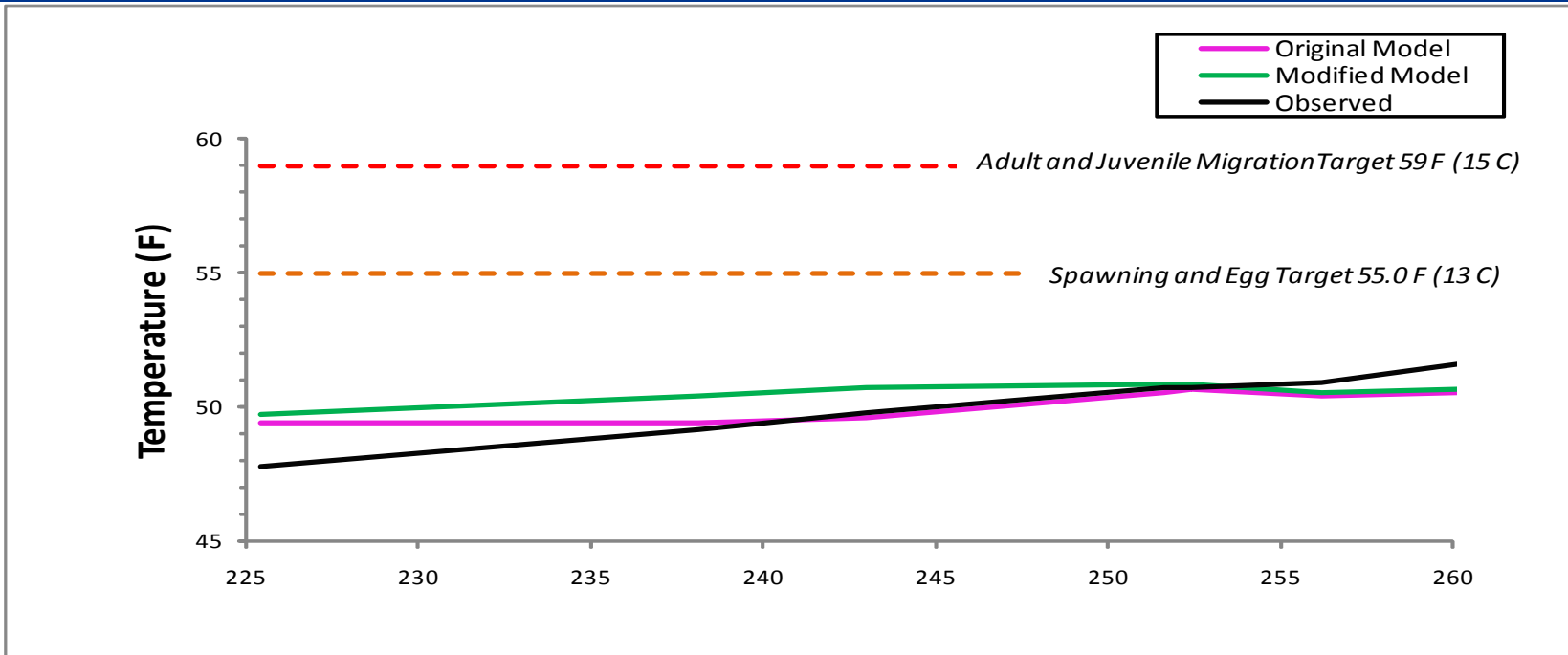


Model Results – Average November Water Temperature in Upper Reaches

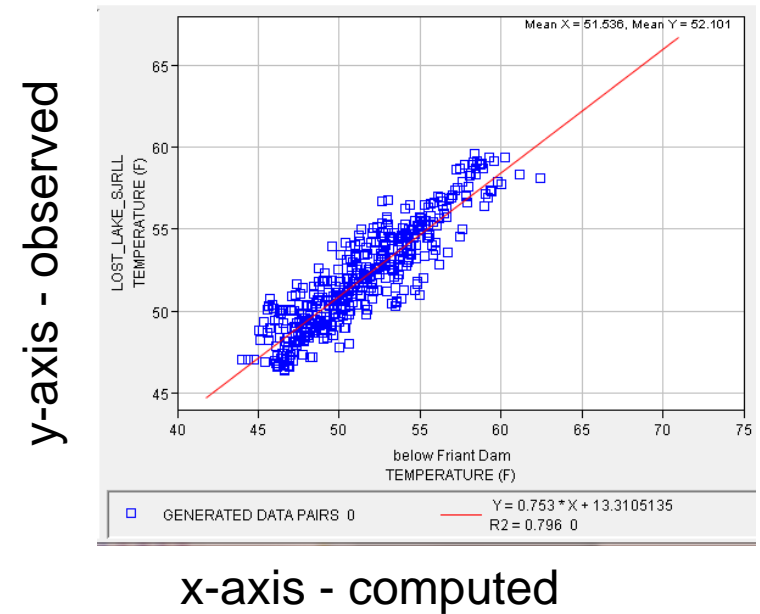
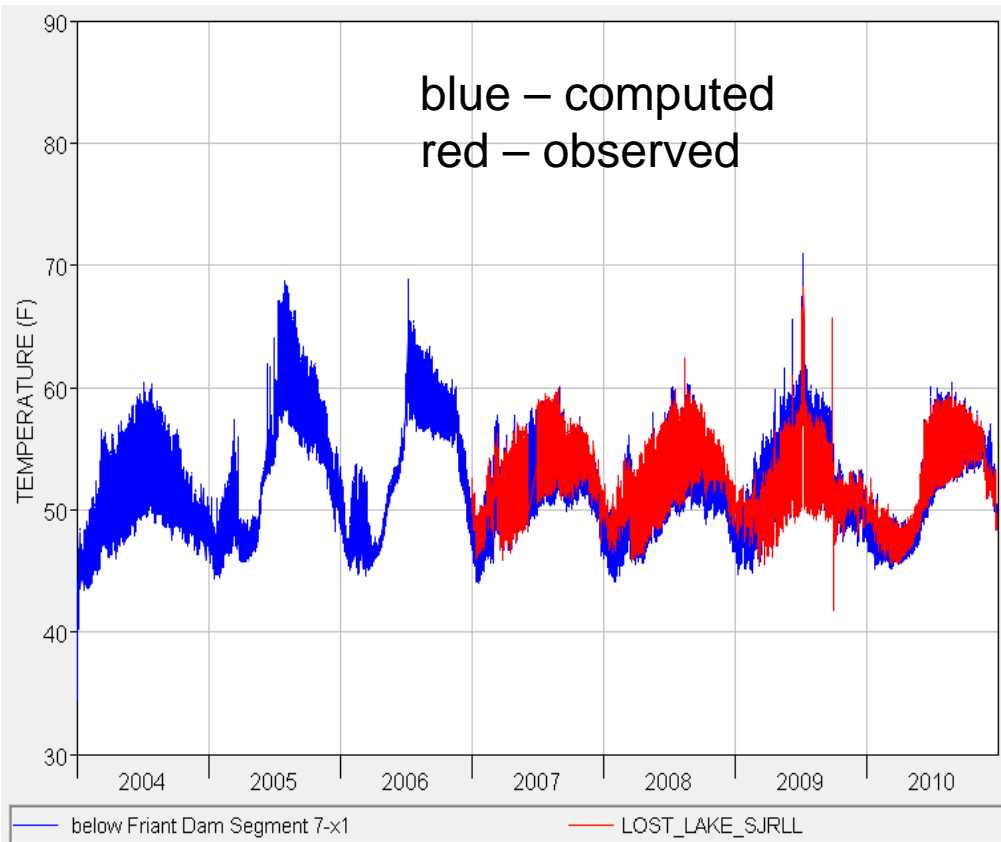




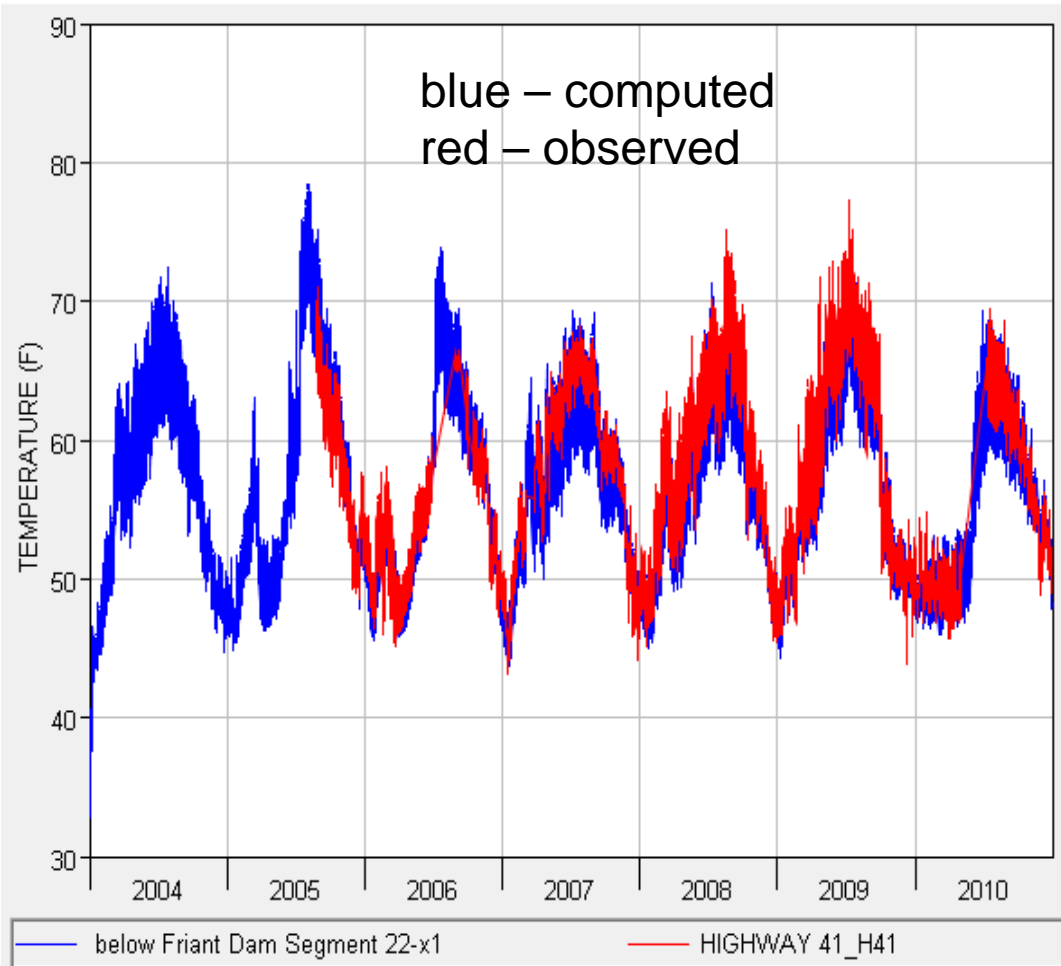
Model Results – Average December Water Temperature in Upper Reaches



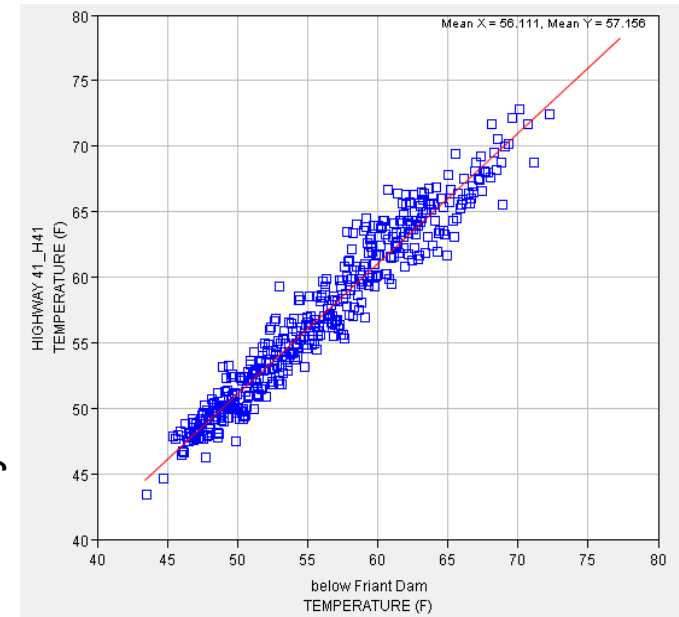
Lost Lake (CDFG SJRLL)



Highway 41 (CDEC H41)

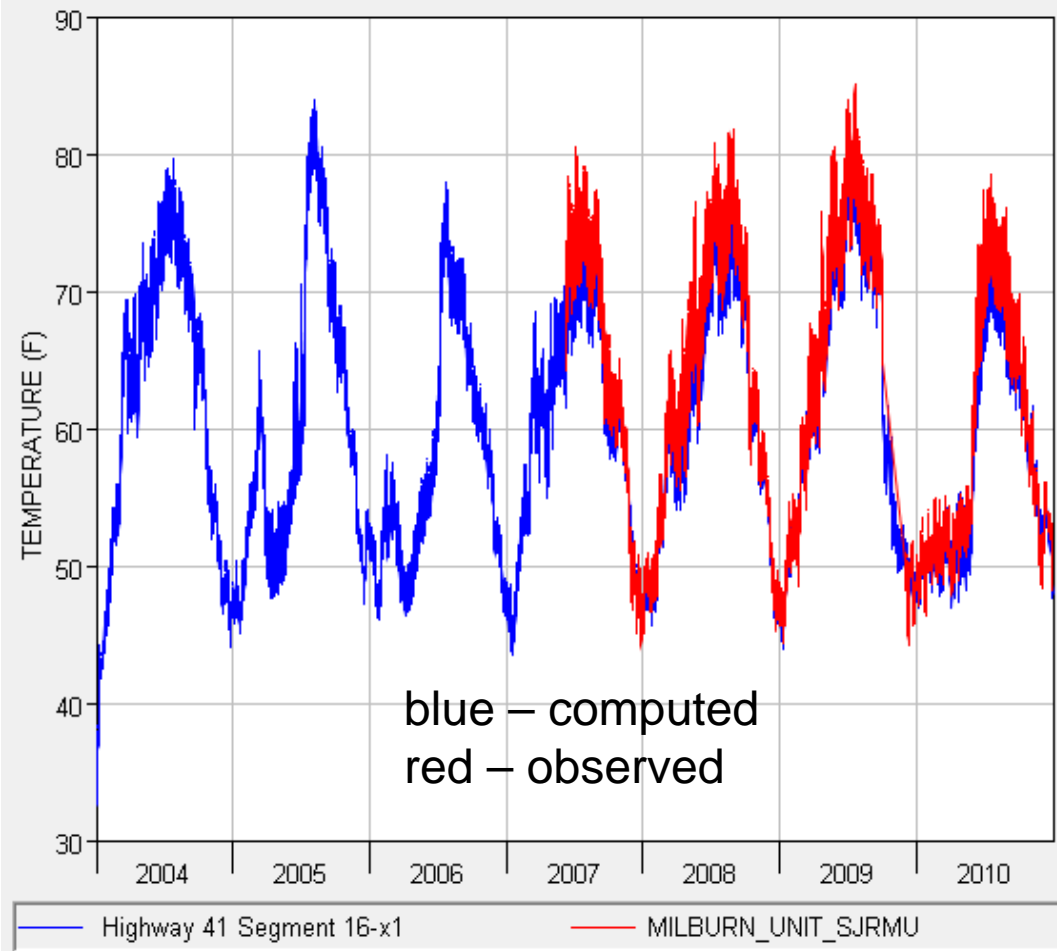


y-axis - observed

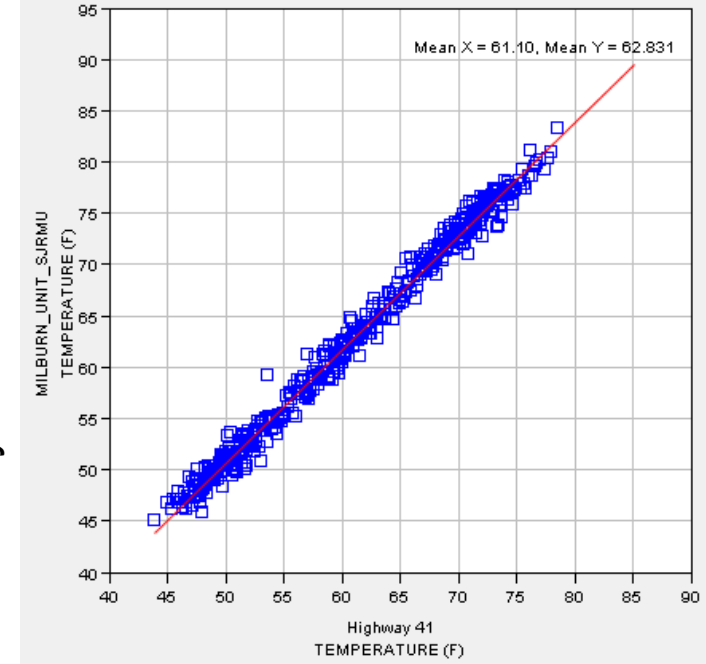


x-axis - computed

Milburn Unit (CDFG SJRMU)

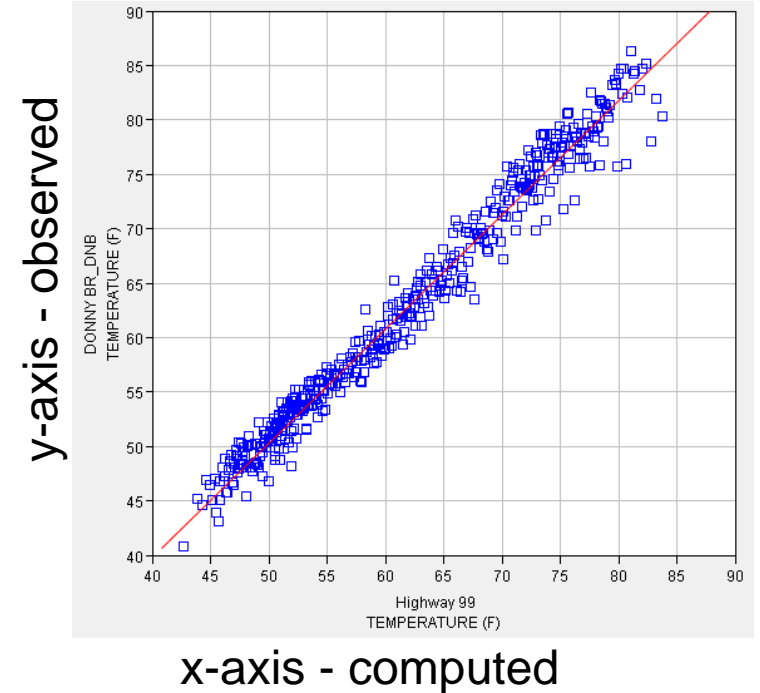
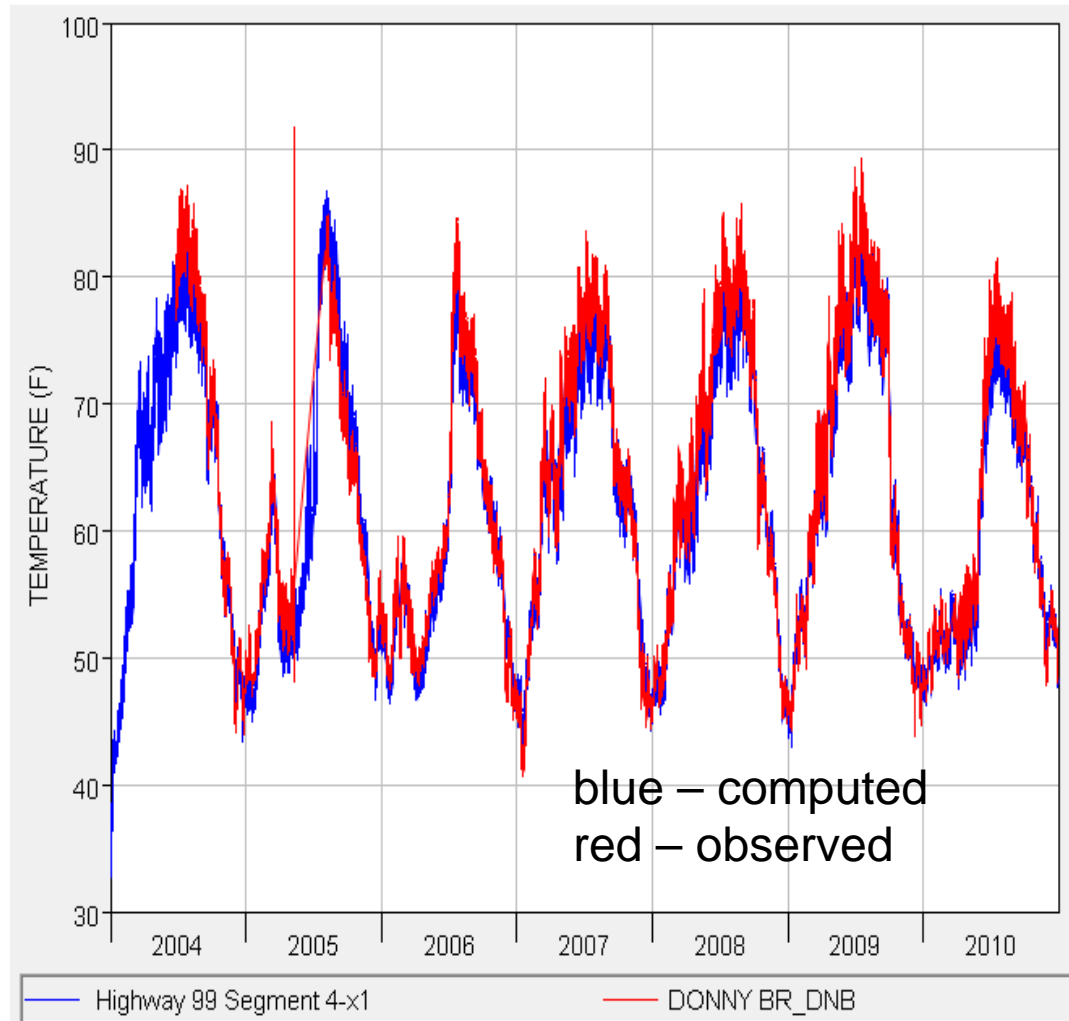


y-axis - observed



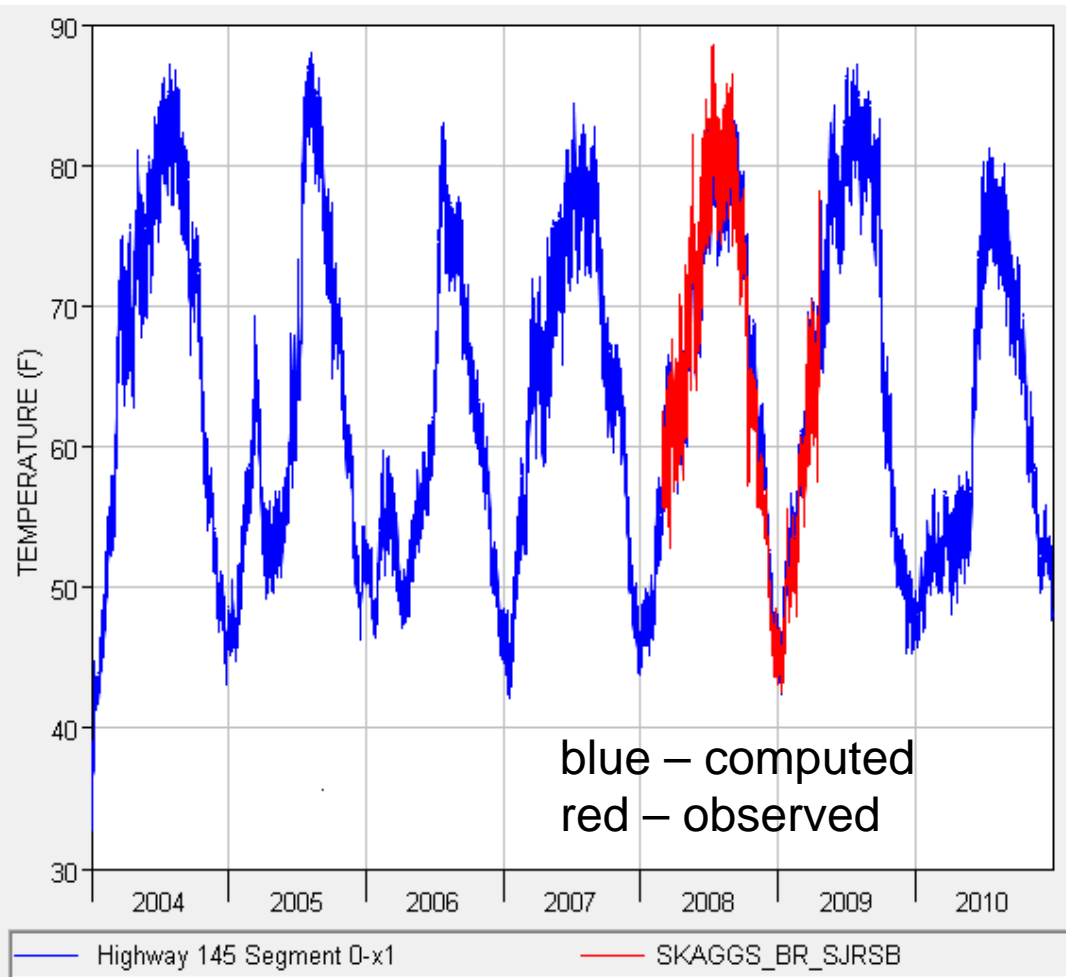
x-axis - computed

Donny Bridge (CDEC DNB)

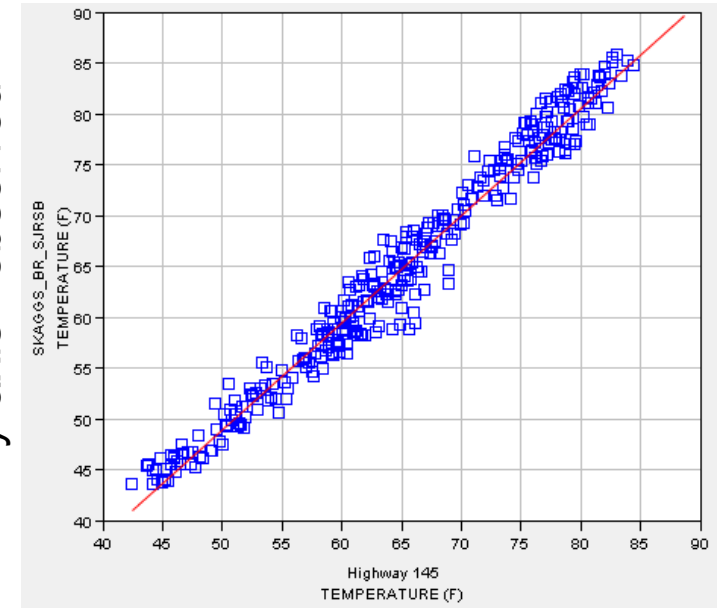




Skaggs Bridge (CDFG SJRSB)

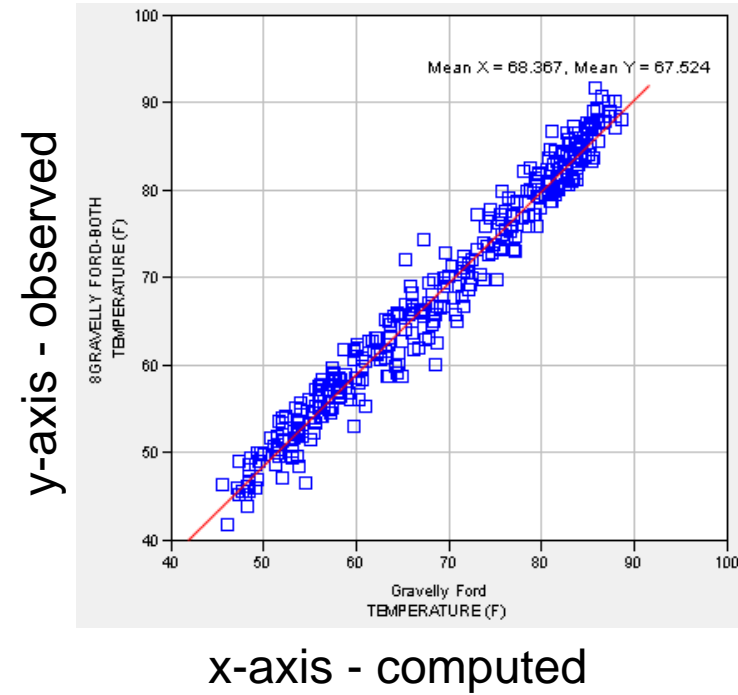
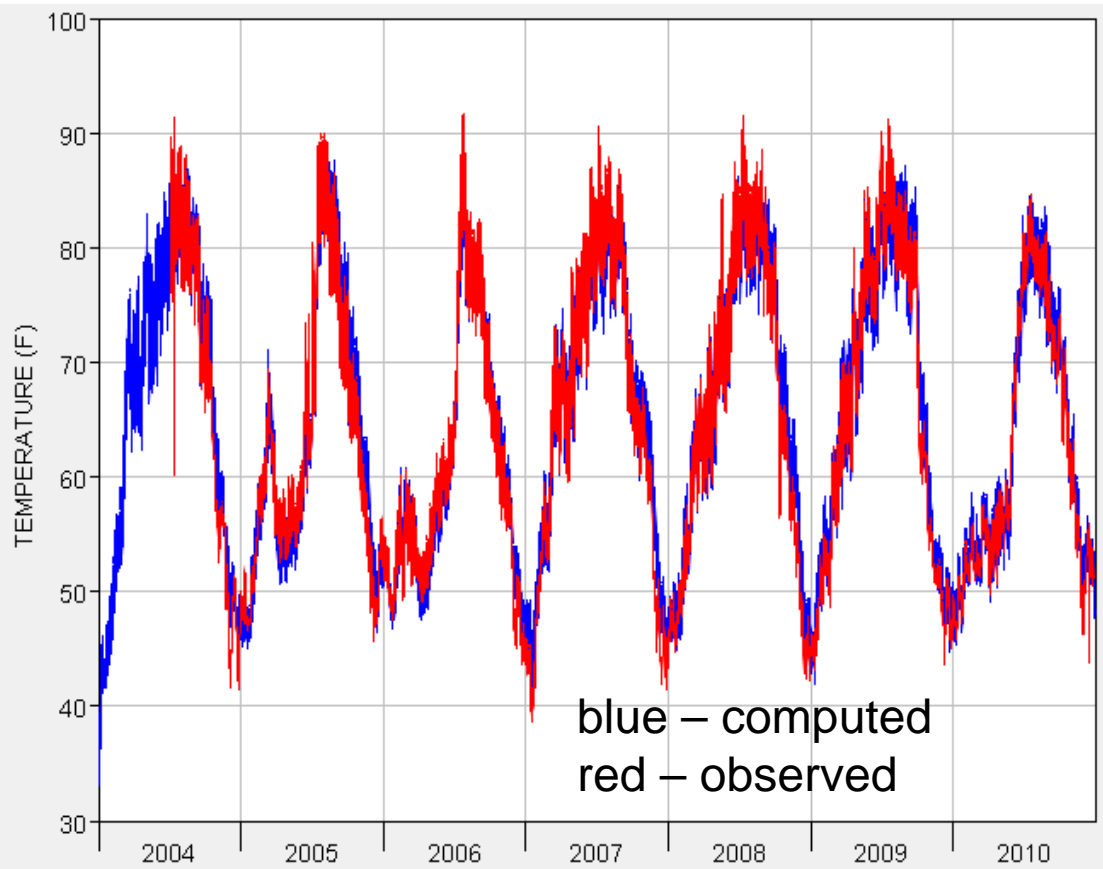


y-axis - observed

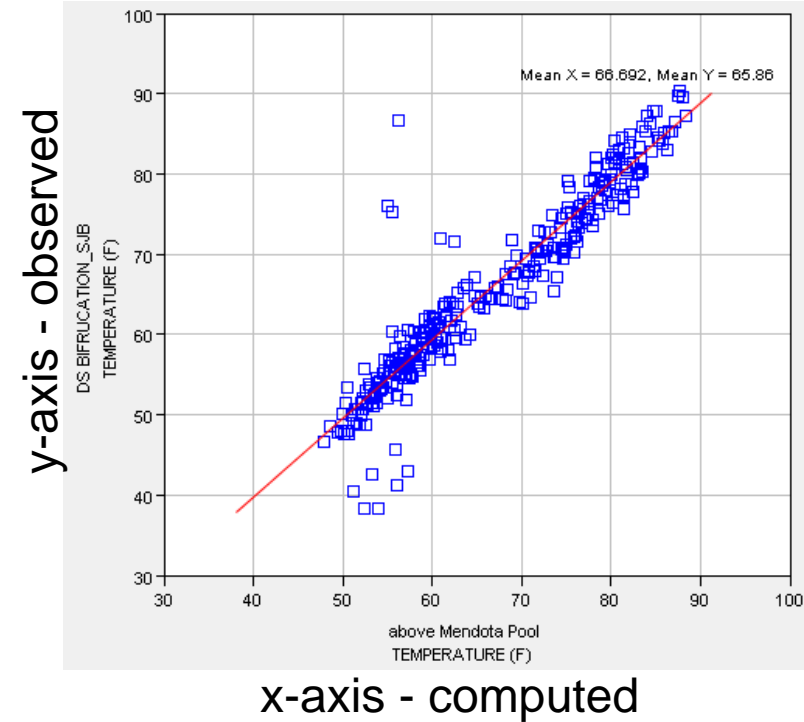
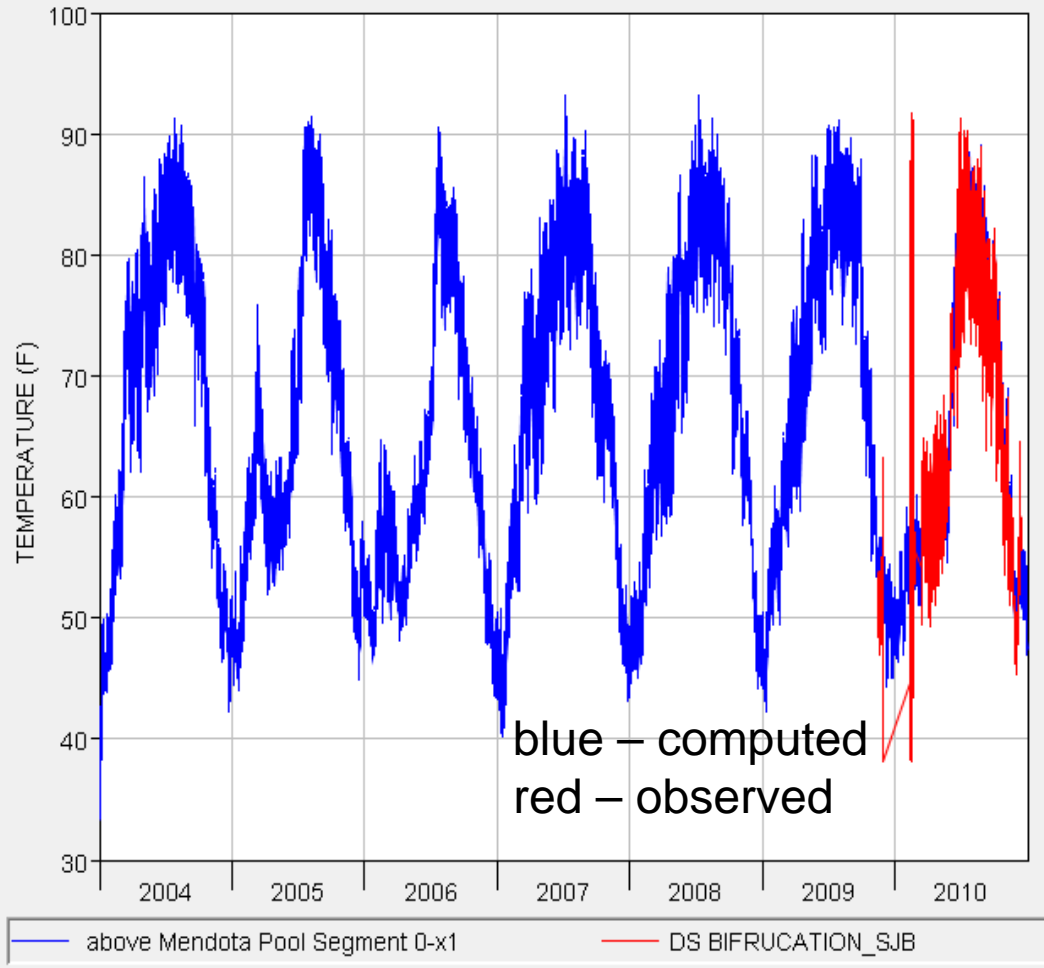


x-axis - computed

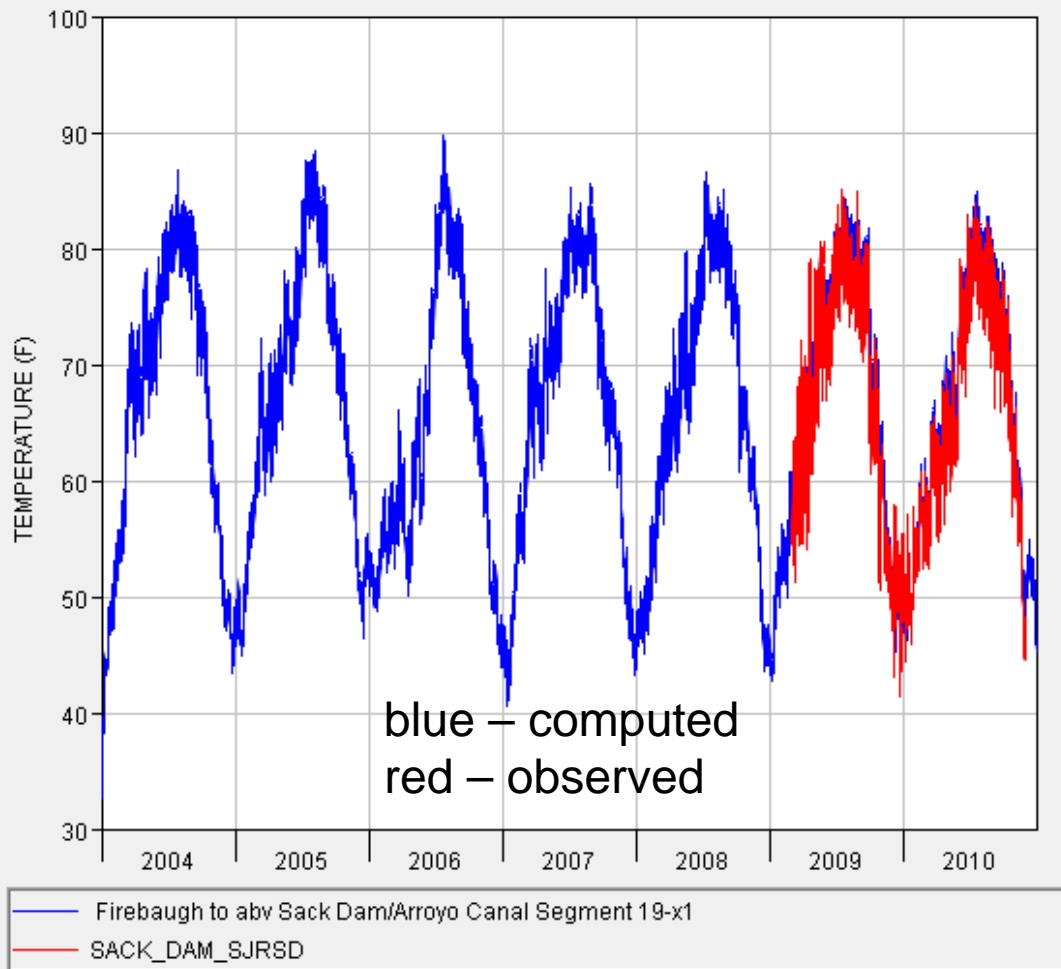
Gravelly Ford (CDFG + CDEC GRF)



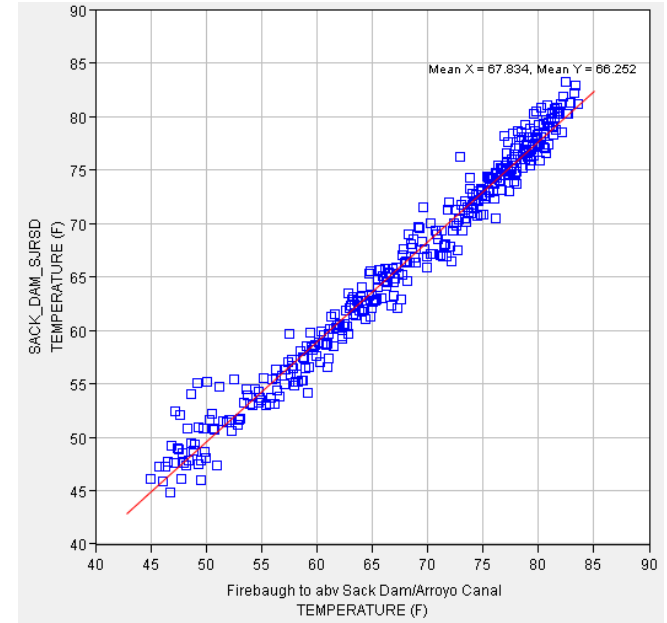
Downstream Bifurcation (CDEC SJB)



Sack Dam (CDFG SJRSD)



y-axis - observed



x-axis - computed

Conclusion

- The simulated temperatures were found to be within 3 deg F of the observed data.
- Adjustment of heat exchange rates reduced the seasonal bias about 1 deg F for months March-June, but increased the seasonal bias by about 0.5 deg F for months of October-December.

Computed and observed temperature (F), bias (model-data) and RMS and mean absolute difference in the San Joaquin River at Lost Lake, Highway 41, Milburn Unit and Donny Bridge

lost lake							Highway 41					
month	# values	Model	Data	Bias	RMS diff	Mean absolute diff	# values	Model	Data	Bias	RMS diff	Mean absolute diff
Jan	495	47.39	49.57	-2.17	2.52	2.22	620	48.16	49.33	-1.17	1.54	1.3
Feb	452	47.86	49.56	-1.7	2.38	1.91	564	50.88	52	-1.12	1.65	1.39
Mar	496	49.12	49.72	-0.6	1.92	1.48	517	52.67	53.5	-0.83	1.53	1.27
Apr	480	49.33	49.66	-0.33	1.4	1.13	563	53.36	54.57	-1.21	1.86	1.44
May	496	50.75	51.16	-0.4	1.22	1.01	501	58.32	59.87	-1.55	2.2	1.74
Jun	386	52.8	53.03	-0.24	1.44	1.13	473	61.05	62.29	-1.24	2.09	1.57
Jul	490	54.48	54.75	-0.27	1.38	1.11	463	65.1	66.44	-1.34	2.26	1.76
Aug	496	54.06	54.69	-0.62	1.4	1.15	522	64.1	65.62	-1.52	2.52	2.05
Sep	480	53.79	54.43	-0.65	1.76	1.27	640	62.72	63.35	-0.63	2.23	1.86
Oct	496	52.66	53.62	-0.96	1.6	1.11	704	58.13	58.49	-0.37	1.77	1.42
Nov	480	52.36	53.47	-1.11	1.68	1.28	712	54.92	54.99	-0.07	1.45	1.19
Dec	493	50.55	51.59	-1.04	1.85	1.54	741	50.59	50.69	-0.1	1.4	1.13
year	5740	51.25	52.1	-0.85	1.76	1.36	7020	56.29	57.15	-0.86	1.88	1.49

Milburn Unit							Donny Bridge					
month	# values	Model	Data	Bias	RMS diff	Mean absolute diff	# values	Model	Data	Bias	RMS diff	Mean absolute diff
Jan	372	48.32	49.21	-0.89	1.15	0.96	744	47.89	48.55	-0.65	1.45	1.21
Feb	340	52.11	52.61	-0.5	0.95	0.76	668	53.28	53.65	-0.37	1.11	0.89
Mar	372	56.78	57.71	-0.93	1.31	1.09	684	58.59	59.44	-0.86	1.43	1.15
Apr	360	58.03	59.52	-1.49	1.89	1.58	720	57.18	58.64	-1.46	1.84	1.53
May	372	62.71	64.74	-2.03	2.31	2.05	665	62.64	64.71	-2.07	2.39	2.1
Jun	453	68.95	71.47	-2.51	2.76	2.54	619	69.22	71.5	-2.29	2.7	2.36
Jul	496	72.83	75.58	-2.75	2.9	2.75	744	76.23	79.31	-3.08	3.34	3.1
Aug	496	71.63	74.24	-2.61	2.8	2.62	855	76.07	77.88	-1.82	2.79	2.51
Sep	478	68.67	70.25	-1.58	1.77	1.59	840	71.92	72.42	-0.49	1.9	1.52
Oct	372	61.74	62.89	-1.16	1.56	1.31	868	63.67	63.52	0.15	1.51	1.19
Nov	360	56.78	56.8	-0.02	0.89	0.69	840	56.49	55.88	0.61	1.37	1.08
Dec	486	49.58	49.74	-0.16	1.01	0.81	865	49.39	49.15	0.24	1.51	1.18
year	4957	61.38	62.83	-1.45	1.98	1.63	9112	61.96	62.9	-0.94	2.04	1.64



Computed and observed temperature (F), bias (model-data) and RMS and mean absolute difference in the San Joaquin River at Skaggs Bridge, Gravelly Ford, Below Bifurcation and at Mendota Dam

Skaggs Bridge							Gravelly Ford-CDEC/CDFG 2008					
month	# values	Model	Data	Bias	RMS diff	Mean absolute diff	# values	Model	Data	Bias	RMS diff	Mean absolute diff
Jan	124	47.73	47.65	0.08	1.5	1.23	740	47.87	47.84	0.03	1.72	1.4
Feb	120	54.54	53.75	0.79	1.48	1.19	676	54.05	53.82	0.23	1.49	1.21
Mar	248	61.69	61.31	0.38	1.68	1.33	744	59.74	59.84	-0.1	1.58	1.25
Apr	205	64.35	64.75	-0.41	1.49	1.18	720	59.49	60.18	-0.69	1.75	1.48
May	124	69.47	70.11	-0.64	1.43	1.09	744	64.51	65.55	-1.04	1.78	1.53
Jun	120	74.74	76.29	-1.56	2.01	1.7	720	70.63	72	-1.37	2.26	1.8
Jul	124	78.97	80.88	-1.91	2.3	1.99	859	79.64	81.32	-1.68	2.63	2.06
Aug	124	79.26	80.97	-1.71	2.17	1.85	868	80.27	80.43	-0.16	1.87	1.55
Sep	120	78	76.57	1.43	1.89	1.6	840	75.98	74.69	1.3	2.25	1.84
Oct	124	68.05	65.38	2.67	3.31	2.8	868	66.62	64.7	1.92	2.78	2.2
Nov	120	60.09	57.67	2.42	2.7	2.44	840	57.75	55.7	2.05	2.75	2.2
Dec	124	49.13	47.77	1.36	1.79	1.52	852	49.46	47.91	1.54	2.69	2.15
year	1677	65.15	64.93	0.22	2	1.61	9471	64.25	64.03	0.22	2.21	1.74

DS Bifurcation							Mendota Dam					
month	# values	Model	Data	Bias	RMS diff	Mean absolute diff	# values	Model	Data	Bias	RMS diff	Mean absolute diff
Jan	0	-901	-901	0	-901	-901	124	49.01	47.16	1.86	4.35	3.38
Feb	0	-901	-901	0	-901	-901	112	55.53	53.58	1.95	3.61	2.43
Mar	75	58.34	58.23	0.11	1.45	1.26	124	59.22	58.49	0.74	2.03	1.08
Apr	120	56.73	57	-0.27	1.21	0.96	121	60.42	59.82	0.61	1.49	1.27
May	124	59.65	60.2	-0.55	1.93	1.46	218	66.86	65.51	1.36	2.01	1.6
Jun	120	74.55	73.78	0.77	3.22	2.54	240	72.63	71.33	1.29	1.68	1.41
Jul	116	82.34	81.75	0.59	2.41	1.97	248	78.61	77.11	1.51	1.72	1.54
Aug	124	80.96	79.71	1.26	2.22	1.85	242	77.2	75.62	1.57	2.01	1.64
Sep	120	76.4	74.99	1.41	2.41	2.02	240	75.08	73.8	1.27	1.63	1.28
Oct	124	69.11	66.83	2.28	3.02	2.47	248	67.7	66.52	1.18	1.48	1.24
Nov	176	55.99	54.14	1.85	2.31	1.95	237	57.17	56.94	0.23	0.68	0.55
Dec	53	53.3	53.47	-0.16	2.13	1.75	124	47.82	49.33	-1.5	6.49	5.16
year	1152	67.3	66.44	0.86	2.34	1.86	2278	66.47	65.4	1.07	2.51	1.68

Computed and observed temperature (F), bias (model-data) and RMS and mean absolute difference in the San Joaquin River at Sack Dam and Dos Palos

month	# values	Sack Dam					Mean absolute diff	Dos Palos					Mean absolute diff
		Model	Data	Bias	RMS diff	# values		Model	Data	Bias	RMS diff		
Jan	124	49.42	50.21	-0.79	1.81	1.34	124	49.42	49.42	0	0.7	0.57	
Feb	112	56.36	55.44	0.91	1.25	1.04	112	56.48	55.64	0.84	1.27	1.02	
Mar	234	61.21	59.86	1.34	1.86	1.5	124	60.87	59.21	1.66	2.06	1.67	
Apr	240	64.76	63	1.76	2.27	1.93	120	62.97	61.09	1.88	2.01	1.88	
May	248	70.02	68.51	1.52	2.05	1.8	124	67.26	64.84	2.42	2.51	2.42	
Jun	240	75.31	73.7	1.6	2.08	1.73	120	75.51	73.69	1.82	2.29	1.95	
Jul	248	80.48	78.88	1.6	1.89	1.64	124	80.78	78.25	2.52	2.8	2.54	
Aug	248	79.29	77.15	2.14	2.35	2.16	124	79.18	76.74	2.44	2.63	2.44	
Sep	240	76.82	74.49	2.33	2.58	2.33	120	76.14	73.15	2.99	4.61	3.33	
Oct	248	68.49	65.89	2.6	3.08	2.66	124	69.94	67.24	2.7	3.93	2.77	
Nov	240	57.54	55.41	2.13	2.48	2.15	108	57.81	55.99	1.83	2.11	1.86	
Dec	125	48.65	50.32	-1.67	2.98	2.59	232	49.89	50.51	-0.62	1.78	1.46	
year	2547	67.8	66.25	1.55	2.3	1.95	1556	64.54	62.99	1.55	2.56	1.96	



Modifications to model heat exchange rates to reduce bias (via the *.run file) (the changes are high lighted in shades of red)

- Mendota Pool

```
c. CL Mendota Pool, SJR, San Joaquin River, 207.5, 202.5
L2 720 4 3. .4 1
L2 1 4 1 0. 1.00 1.00 0
LS 32 25 1. 1000 0
```

```
c. CL Mendota Pool, SJR, San Joaquin River, 207.5, 202.5
L2 720 4 3. .4 1
L2 1 4 1 0. 0.88 1.20 0
LS 32 25 1. 1000 0
```

- Stream reached

```
c. CS San Joaquin River, below Mud Slough to above Merced River
S2 605 118.800 602 116.100 0.90
SR 800 790 6 2 0 0 1.0 5.0
SR .0044 .0100 2.5 0 0 0.0 1.00
SR 790 760 6 2 0 0 1.0 5.0
SR .0044 .0050 1.5 0 0 0.0 0.95
SR 760 740 6 2 0 0 1.0 5.0
SR .0044 .0030 1.0 0 0 1.0 0.95
SR 740 700 6&4 2 0 0 1.0 5.0
SR .0044 .0030 1.0 0 0 1.0 0.95
SR 700 671 6&4 2 0 0 1.0 5.0
SR .0044 .0025 0.8 0 0 1.0 0.95
SR 1695 644 6&4 2 0 0 1.0 5.0
SR .0044 .0020 0.25 0 0 1.0 0.95
SR 659 630 4 2 0 0 1.0 5.0
SR .0044 .0020 0.15 0 0 1.0 0.90
SR -630 602 4 2 0 0 1.0 5.0
SR 0.44 .01 1.0 0 0 1.0 .90
S3FILE= ..\s3_4R.dat
S3END
```

```
c. CS San Joaquin River, below Mud Slough to above Merced River
S2 605 118.800 602 116.100 0.90
SR 800 780 6 2 0 0 1.0 5.0
SR .0044 .0100 2.5 0 0 0.0 1.03
SR 780 760 6 2 0 0.5 0.97 5.0
SR .0044 .0050 1.5 0 0 0.0 0.95
SR 760 740 6 2 0 0 1.0 5.0
SR .0044 .0030 1.0 0 0 1.0 0.90
SR 740 700 6&4 2 0 0 1.0 5.0
SR .0044 .0030 1.0 0 0 1.0 0.95
SR 700 671 6&4 2 0 0 1.0 5.0
SR .0044 .0025 0.8 0 0 1.0 0.88
SR 1695 644 6&4 2 0 0 1.0 5.0
SR .0044 .0020 0.25 0 0 1.0 0.88
SR 659 630 4 2 0 0 1.0 5.0
SR .0044 .0020 0.15 0 0 1.0 0.90
SR -630 602 4 2 0 0 1.0 5.0
SR 0.44 .01 1.0 0 0 1.0 .90
S3FILE= ..\s3_4R.dat
S3END
```

lost lake							Highway 41					
month	# values	Model	Data	Bias	RMS diff	Mean absolute diff	# values	Model	Data	Bias	RMS diff	Mean absolute diff
Jan	495	47.47	49.57	-2.1	2.47	2.17	620	48.39	49.33	-0.94	1.37	1.16
Feb	452	47.99	49.56	-1.56	2.32	1.86	564	51.23	52	-0.76	1.44	1.19
Mar	496	49.28	49.72	-0.43	1.91	1.49	517	53.08	53.5	-0.42	1.32	1.1
Apr	480	49.48	49.66	-0.18	1.41	1.12	563	53.74	54.57	-0.83	1.61	1.22
May	496	50.94	51.16	-0.22	1.22	0.98	501	58.85	59.87	-1.02	1.86	1.42
Jun	386	53.03	53.03	0	1.47	1.1	473	61.64	62.29	-0.65	1.78	1.31
Jul	490	54.73	54.75	-0.01	1.39	1.06	463	65.89	66.44	-0.54	1.97	1.51
Aug	496	54.3	54.69	-0.39	1.34	1.09	522	64.84	65.62	-0.78	2.2	1.73
Sep	480	53.98	54.43	-0.45	1.73	1.23	640	63.37	63.35	0.03	2.2	1.81
Oct	496	52.79	53.62	-0.83	1.53	1.05	704	58.57	58.49	0.08	1.76	1.45
Nov	480	52.44	53.47	-1.03	1.63	1.25	712	55.22	54.99	0.23	1.47	1.19
Dec	493	50.63	51.59	-0.96	1.84	1.53	741	50.84	50.69	0.15	1.39	1.13
year	5740	51.41	52.1	-0.69	1.73	1.33	7020	56.75	57.15	-0.4	1.71	1.34

Milburn Unit							Donny Bridge					
month	# values	Model	Data	Bias	RMS diff	Mean absolute diff	# values	Model	Data	Bias	RMS diff	Mean absolute diff
Jan	372	49.02	49.21	-0.18	0.85	0.69	744	48.53	48.55	-0.01	1.33	1.08
Feb	340	52.82	52.61	0.21	0.94	0.74	668	53.81	53.65	0.16	1.16	0.92
Mar	372	57.85	57.71	0.14	1	0.79	684	59.55	59.44	0.11	1.29	1.02
Apr	360	59.19	59.52	-0.33	1.17	0.94	720	58.05	58.64	-0.6	1.43	1.15
May	372	64.17	64.74	-0.57	1.42	1.15	665	63.7	64.71	-1.02	1.61	1.34
Jun	453	70.87	71.47	-0.6	1.52	1.26	619	70.62	71.5	-0.89	1.66	1.34
Jul	496	75.18	75.58	-0.41	1.16	0.95	744	78.12	79.31	-1.18	1.77	1.47
Aug	496	73.9	74.24	-0.34	1.18	0.95	855	78.15	77.88	0.27	2.27	1.61
Sep	478	70.85	70.25	0.6	1.06	0.83	840	73.96	72.42	1.54	2.54	1.82
Oct	372	63.34	62.89	0.44	1.22	0.88	868	65.33	63.52	1.81	2.51	1.96
Nov	360	58.06	56.8	1.26	1.52	1.29	840	57.74	55.88	1.86	2.37	1.97
Dec	486	50.65	49.74	0.91	1.41	1.1	865	50.43	49.15	1.28	2.1	1.67
year	4957	62.92	62.83	0.09	1.23	0.97	9112	63.27	62.9	0.37	1.94	1.48

Revised Model coefficients



Computed and observed temperature (F), bias (model-data) and RMS and mean absolute difference in the San Joaquin River at Skaggs Bridge, Gravelly Ford, Below Bifurcation and at Mendota Dam

Skaggs Bridge							Gravelly Ford-CDEC/CDFG 2008					
month	# values	Model	Data	Bias	RMS diff	Mean absolute diff	# values	Model	Data	Bias	RMS diff	Mean absolute diff
Jan	124	48.03	47.65	0.38	1.53	1.26	740	48.04	47.84	0.2	1.66	1.31
Feb	120	54.76	53.75	1	1.6	1.3	676	54.14	53.82	0.32	1.43	1.16
Mar	248	62.02	61.31	0.71	1.73	1.34	744	59.9	59.84	0.07	1.48	1.17
Apr	205	65.08	64.75	0.33	1.5	1.2	720	59.75	60.18	-0.43	1.65	1.37
May	124	70.47	70.11	0.36	1.47	1.19	744	64.62	65.55	-0.93	1.69	1.42
Jun	120	75.72	76.29	-0.57	1.45	1.2	720	70.81	72	-1.18	2.07	1.64
Jul	124	80.11	80.88	-0.76	1.48	1.28	859	79.67	81.32	-1.65	2.55	2.01
Aug	124	80.1	80.97	-0.87	1.64	1.36	868	80.33	80.43	-0.09	1.69	1.36
Sep	120	78.65	76.57	2.09	2.43	2.16	840	76.12	74.69	1.43	2.2	1.84
Oct	124	68.99	65.38	3.61	4.12	3.66	868	67.03	64.7	2.33	3.02	2.47
Nov	120	60.8	57.67	3.13	3.36	3.13	840	58.19	55.7	2.49	3.07	2.56
Dec	124	49.6	47.77	1.83	2.17	1.89	852	49.68	47.91	1.77	2.82	2.28
year	1677	65.82	64.93	0.89	2.14	1.69	9471	64.44	64.03	0.41	2.23	1.75

DS Bifurcation							Mendota Dam					
month	# values	Model	Data	Bias	RMS diff	Mean absolute diff	# values	Model	Data	Bias	RMS diff	Mean absolute diff
Jan	0	-901	-901	0	-901	-901	124	48.19	47.16	1.03	4.06	3.22
Feb	0	-901	-901	0	-901	-901	112	54.93	53.58	1.35	3.32	2.16
Mar	75	58.17	58.23	-0.07	1.56	1.36	124	58.63	58.49	0.15	1.92	0.92
Apr	120	56.65	57	-0.35	1.34	1.06	121	59.74	59.82	-0.07	1.34	1.11
May	124	59.51	60.2	-0.69	1.96	1.51	218	66.43	65.51	0.92	1.74	1.36
Jun	120	73.41	73.78	-0.37	3.23	2.61	240	72.2	71.33	0.86	1.42	1.17
Jul	116	80.83	81.75	-0.92	2.6	2.14	248	78.17	77.11	1.06	1.34	1.13
Aug	124	79.59	79.71	-0.12	1.88	1.54	242	76.73	75.62	1.11	1.66	1.2
Sep	120	75.49	74.99	0.5	2.08	1.74	240	74.62	73.8	0.82	1.28	0.91
Oct	124	68.61	66.83	1.78	2.7	2.15	248	66.98	66.52	0.46	1.06	0.79
Nov	176	55.91	54.14	1.77	2.25	1.9	237	56.47	56.94	-0.47	0.91	0.66
Dec	53	52.83	53.47	-0.64	2.43	2.04	124	46.79	49.33	-2.54	6.95	5.69
year	163	66.67	66.44	0.23	2.14	1.69	2278	65.89	65.4	0.49	2.39	1.45

March 21, 2013

Preliminary draft, subject to revision

Revised Model coefficients

Computed and observed temperature (F), bias (model-data) and RMS and mean absolute difference in the San Joaquin River at Sack Dam and Dos Palos

month	# values	Sack Dam					Mean absolute diff	Dos Palos					Mean absolute diff
		Model	Data	Bias	RMS diff	# values		Model	Data	Bias	RMS diff		
Jan	124	48.17	50.21	-2.03	2.62	2.09	124	48.16	49.42	-1.25	1.42	1.25	
Feb	112	55.16	55.44	-0.28	0.98	0.76	112	55.2	55.64	-0.44	1.09	0.86	
Mar	234	59.92	59.86	0.06	1.39	1.1	124	59.6	59.21	0.39	1.29	0.88	
Apr	240	63.3	63	0.3	1.61	1.19	120	61.64	61.09	0.55	0.95	0.75	
May	248	68.41	68.51	-0.09	1.66	1.23	124	65.8	64.84	0.97	1.19	1.02	
Jun	240	73.61	73.7	-0.1	1.47	1.16	120	73.61	73.69	-0.08	1.47	1.2	
Jul	248	78.65	78.88	-0.23	1.12	0.91	124	78.69	78.25	0.44	1.27	1.02	
Aug	248	77.49	77.15	0.34	1.12	0.91	124	77.23	76.74	0.49	1.14	0.89	
Sep	240	74.99	74.49	0.5	1.31	1.02	120	74.15	73.15	1	3.7	2.56	
Oct	248	66.93	65.89	1.04	2.03	1.64	124	68.31	67.24	1.07	3.11	2.02	
Nov	240	56.39	55.41	0.98	1.62	1.26	108	56.64	55.99	0.66	1.25	1.01	
Dec	125	47.48	50.32	-2.84	3.78	3.22	232	48.72	50.51	-1.79	2.5	2.15	
year	2547	66.27	66.25	0.02	1.74	1.29	1556	63.02	62.99	0.03	1.96	1.36	