McPhee Discharge and Downstream Temperature Modeling

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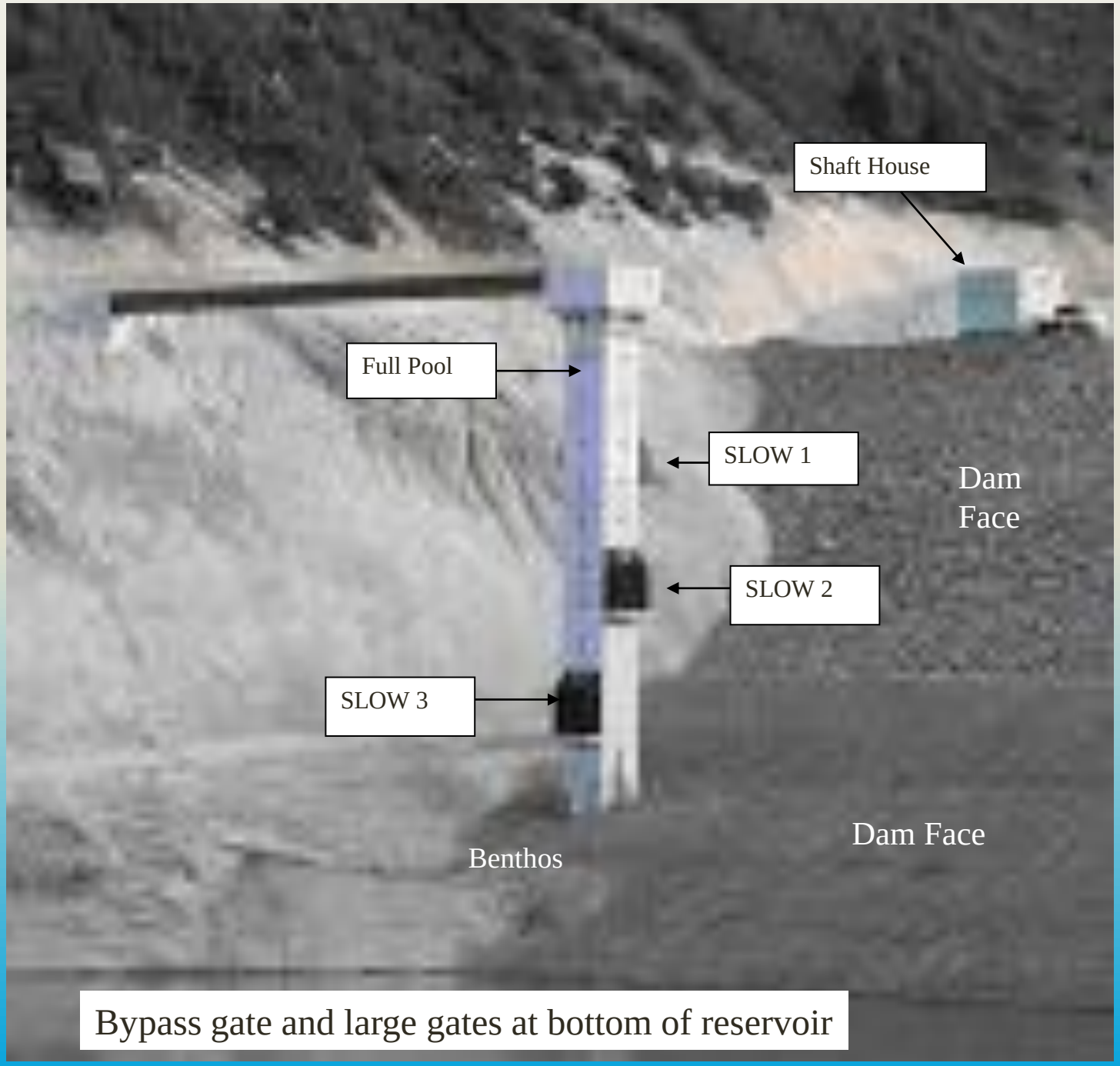
3/24/11

As biologists and dam operators:
What next?

- Is model useful?
- Want it developed further?
- If so, what changes/additions etc.?
- How do you want it packaged?

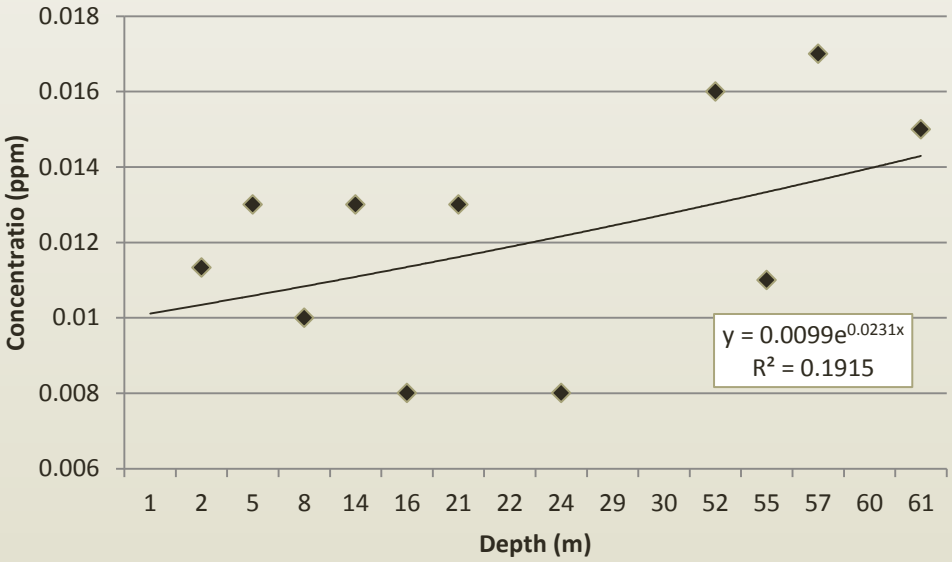


Bypass gate and large gates at bottom of reservoir

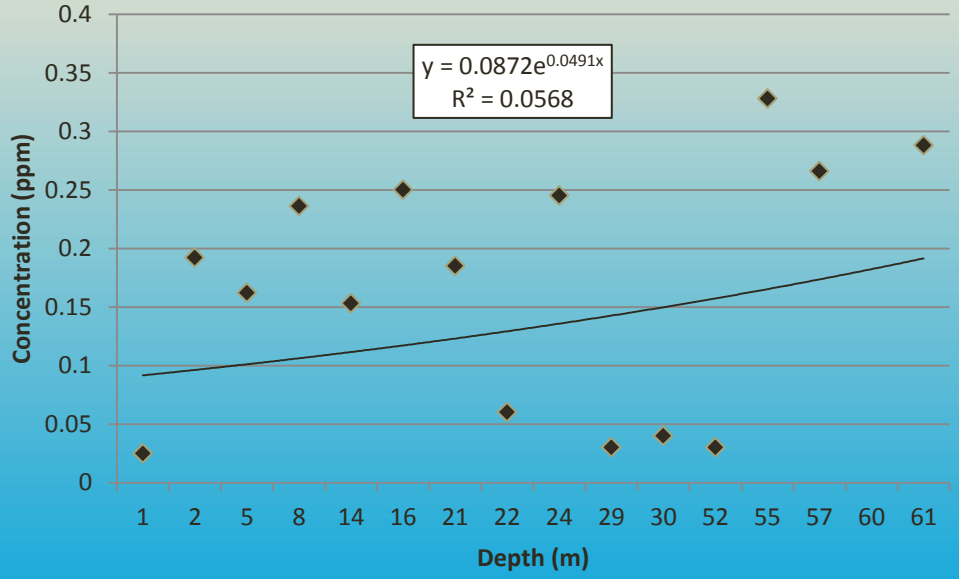
Operational Constraints

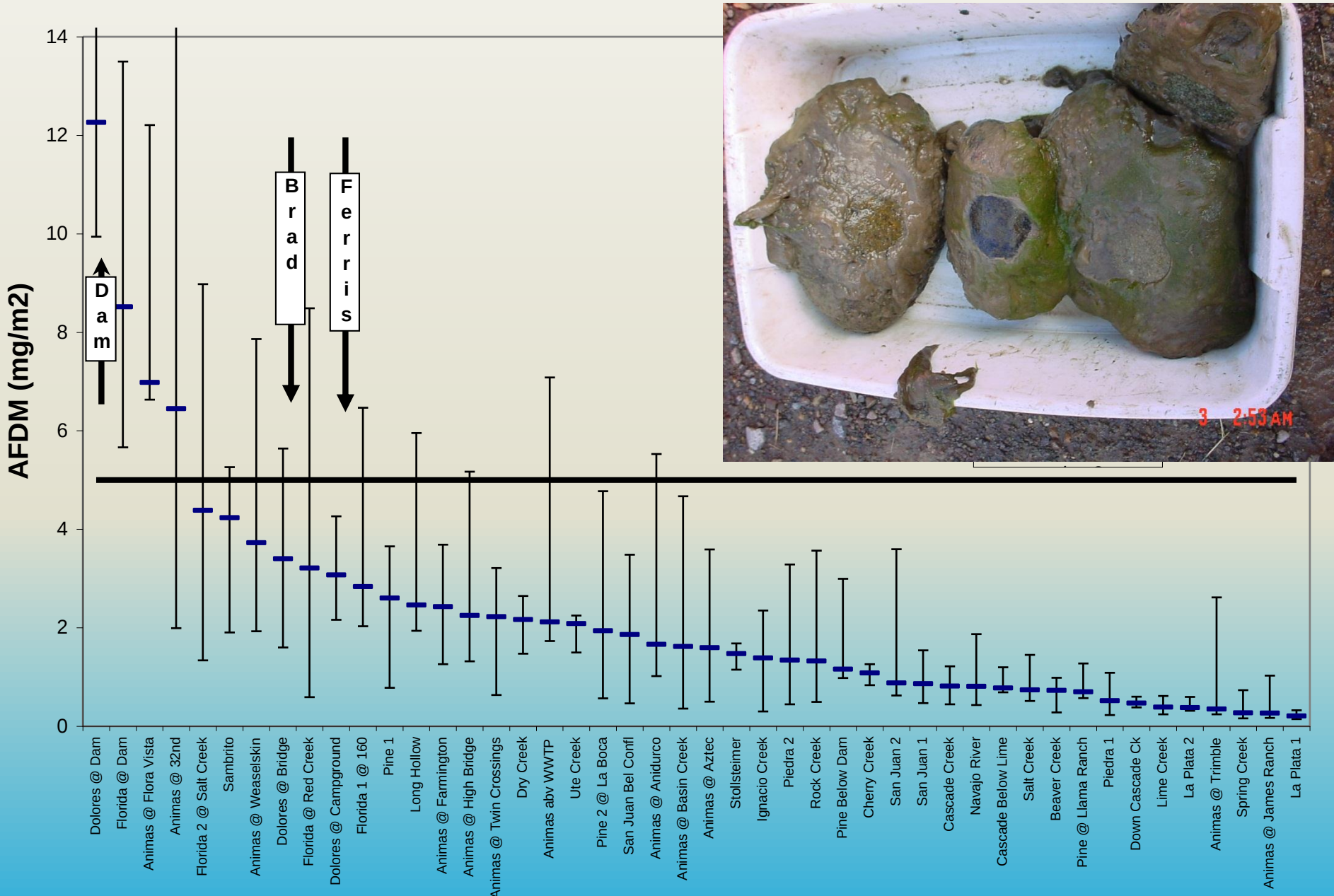
- No water over spillway
- Original design of SLOWs, max release = 205 cfs
- With powerplant added, max release = 144cfs
- Operating powerplant only release 25, 50 or 75 cfs through SLOWs
- Bypass gate @ bottom of reservoir max release = 55cfs
- Large gates at bottom of reservoir, max release of 4,500cfs in increments of 125cfs?

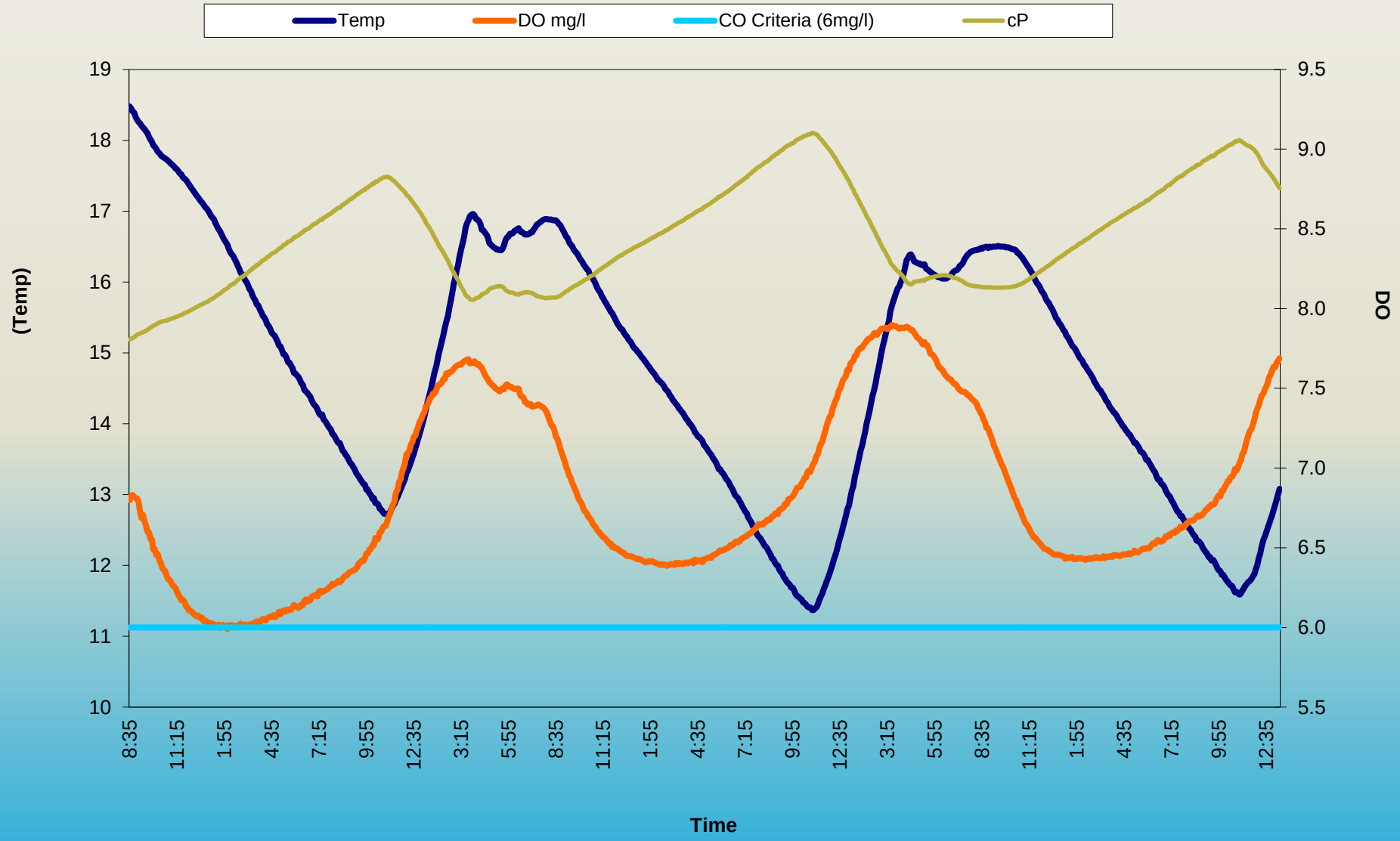
Average of Total Phosphorus

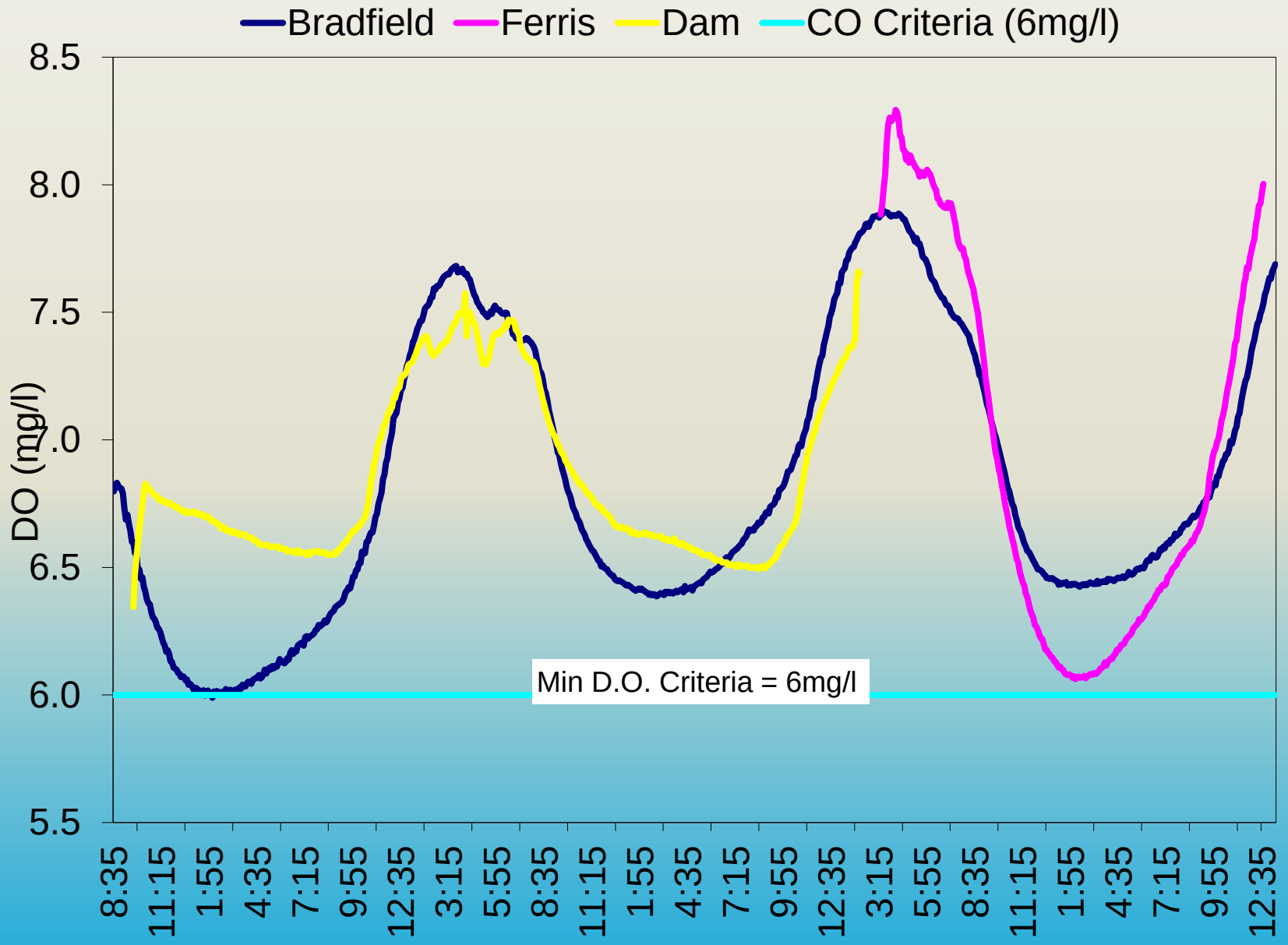


Average of Total Nitrogen




AFDM (mg/m2)
14
12
10
8
6
4
2
0
Dam
Brad
Ferris
Dolores @ Dam
Florida @ Dam
Animas @ Flora Vista
Animas @ 32nd
Florida 2 @ Salt Creek
Sambrito
Animas @ Weaselskin
Dolores @ Bridge
Florida @ Red Creek
Dolores @ Campground
Florida 1 @ 160
Pine 1
Long Hollow
Animas @ Farmington
Animas @ High Bridge
Animas @ Twin Crossings
Dry Creek
Animas abv WWTP
Ute Creek
Pine 2 @ La Boca
San Juan Bel Confl
Animas @ Aniduro
Animas @ Basin Creek
Animas @ Aztec
Stollsteimer
Ignacio Creek
Piedra 2
Rock Creek
Pine Below Dam
Cherry Creek
San Juan 2
San Juan 1
Cascade Creek
Navajo River
Cascade Below Lime
Salt Creek
Beaver Creek
Pine @ Llama Ranch
Piedra 1
Down Cascade Ck
Lime Creek
La Plata 2
Animas @ Trimble
Spring Creek
Animas @ James Ranch
La Plata 1


Temp
DO mg/l
CO Criteria (6mg/l)
cP
(Temp)
DO
Time
19
18
17
16
15
14
13
12
11
10
9.5
9.0
8.5
8.0
7.5
7.0
6.5
6.0
5.5
8:35
11:15
1:55
4:35
7:15
9:55
12:35
3:15
5:55
8:35
11:15
1:55
4:35
7:15
9:55
12:35
3:15
5:55
8:35
11:15
1:55
4:35
7:15
9:55
12:35


Bradfield
Ferris
Dam
CO Criteria (6mg/l)
8.5
8.0
7.5
7.0
6.5
6.0
5.5
DO (mg/l)
Min D.O. Criteria = 6mg/l
8:35
11:15
1:55
4:35
7:15
9:55
12:35
3:15
5:55
8:35
11:15
1:55
4:35
7:15
9:55
12:35
3:15
5:55
8:35
11:15
1:55
4:35
7:15
9:55
12:35

2010 Sonde Sampling

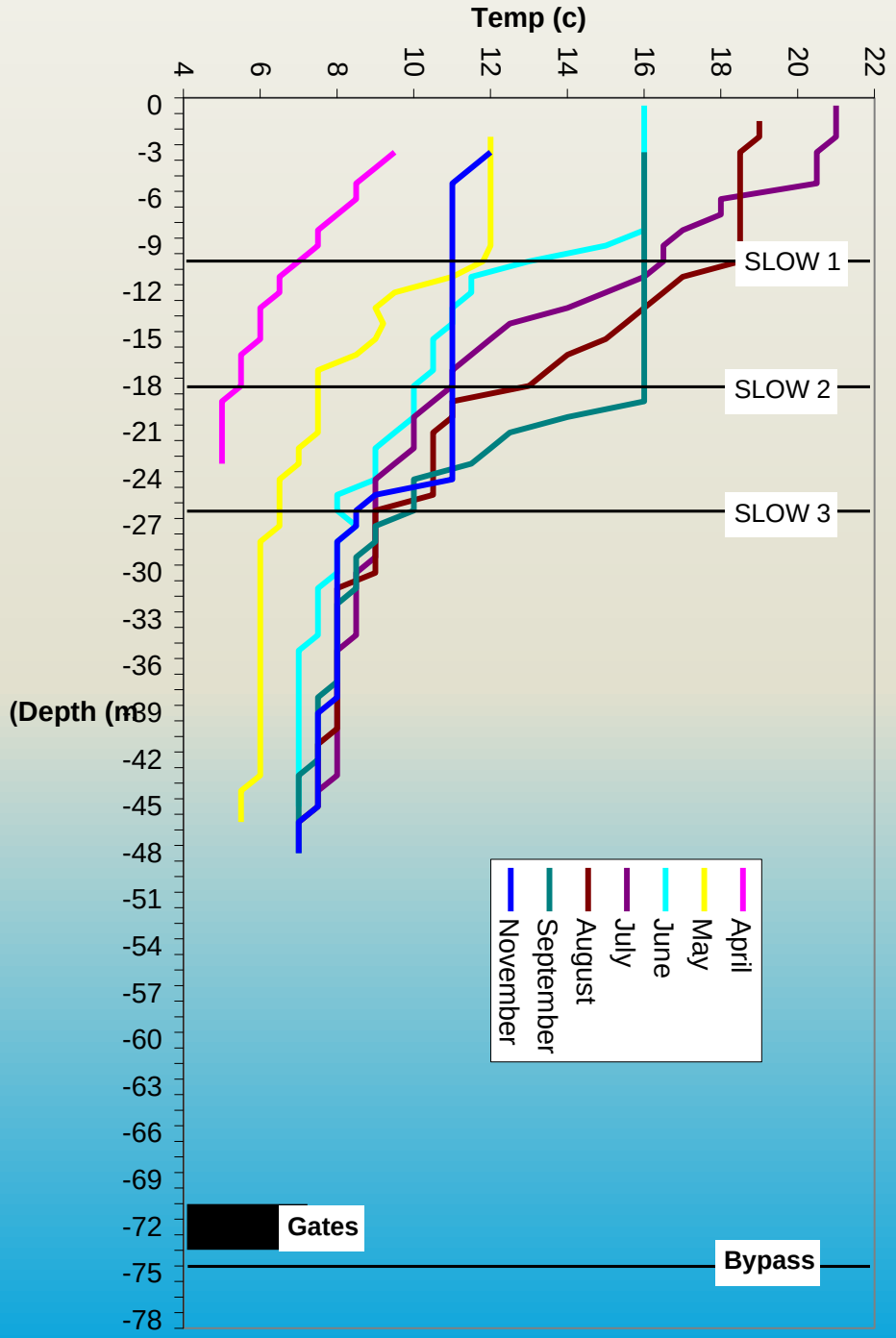
Minimum of Dissolved Oxygen (mg/l)

	June	July	August
Ferris Creek	7.7	7.7	7.6
Bradfield Bridge	7.2	6.5	6.9
Dove Creek Pumps	6.5	6.3	6.8
Disappointment Creek	6.1	0.2	6.6
Big Gypsum Valley Bridge	6.8	n.d.	n.d.
Bedrock	n.d.	0.0	n.d.
San Miguel	6.9	n.d.	7.3

SELECT

Reservoir discharge temperature model

"SELECT is a numerical, one-dimensional model of selective withdrawal developed at the U.S. Army Engineer Research and Development Center to compute withdrawal characteristics and release water quality for various operational alternatives of selective withdrawal structures."


Temp (c)
4
6
8
10
12
14
16
18
20
22
0
-3
-6
-9
-12
-15
-18
-21
-24
-27
-30
-33
-36
-39
-42
-45
-48
-51
-54
-57
-60
-63
-66
-69
-72
-75
-78
(Depth (m
SLOW 1
SLOW 2
SLOW 3
November
September
August
July
June
May
April
Gates
Bypass

Historical Discharge Temperatures

	April	May	June 1rst Half	June 2nd Half	July 1rst Half	July 2nd Half	August 1rst Half	August 2nd Half	Sept 1rst Half	Sept 2nd Half
Median	40.3	41.9	43.5	44.8	44.6	45.3	45.9	45.8	46.6	47.0
Average	40.8	42.2	43.8	45.0	44.9	45.5	45.7	46.0	46.7	47.0
Maximum	50	49	47.0	48.0	47.0	48.7	48.0	48.2	49.0	51.4
Minimum	38	40.8	42.8	43.0	43.0	43.0	43.6	44.1	44.8	44.4
Standard Deviation	2.33	1.49	1.08	1.37	1.62	1.87	1.40	1.36	1.09	1.61
@ Median Discharge	45	220	231	72	78	77.3	64.9	76.2	58.4	40.3

Predicted Discharge Temperatures

	April	May	June 1rst Half	June 2nd Half	July 1rst Half	July 2nd Half	August 1rst Half	August 2nd Half	Sept 1rst Half	Sept 2nd Half
1rst SLOW (75cfs)	44.5	49.5	63.1	58.2	59.7	65.5	67.0	65.5	64.2	58.0
2nd SLOW (75cfs)	41.6	47.5	51.3	49.8	51.4	51.9	53.3	59.9	55.7	55.5
3rd SLOW (75cfs)	40.9	44.4	46.5	47.4	49.6	48.2	48.2	50.4	46.1	46.0
Bypass Gate (55cfs)	39.1	41.4	39.3	38.6	43.2	43.2	43.2	44.6	43.5	42.8

SSTEMP Stream

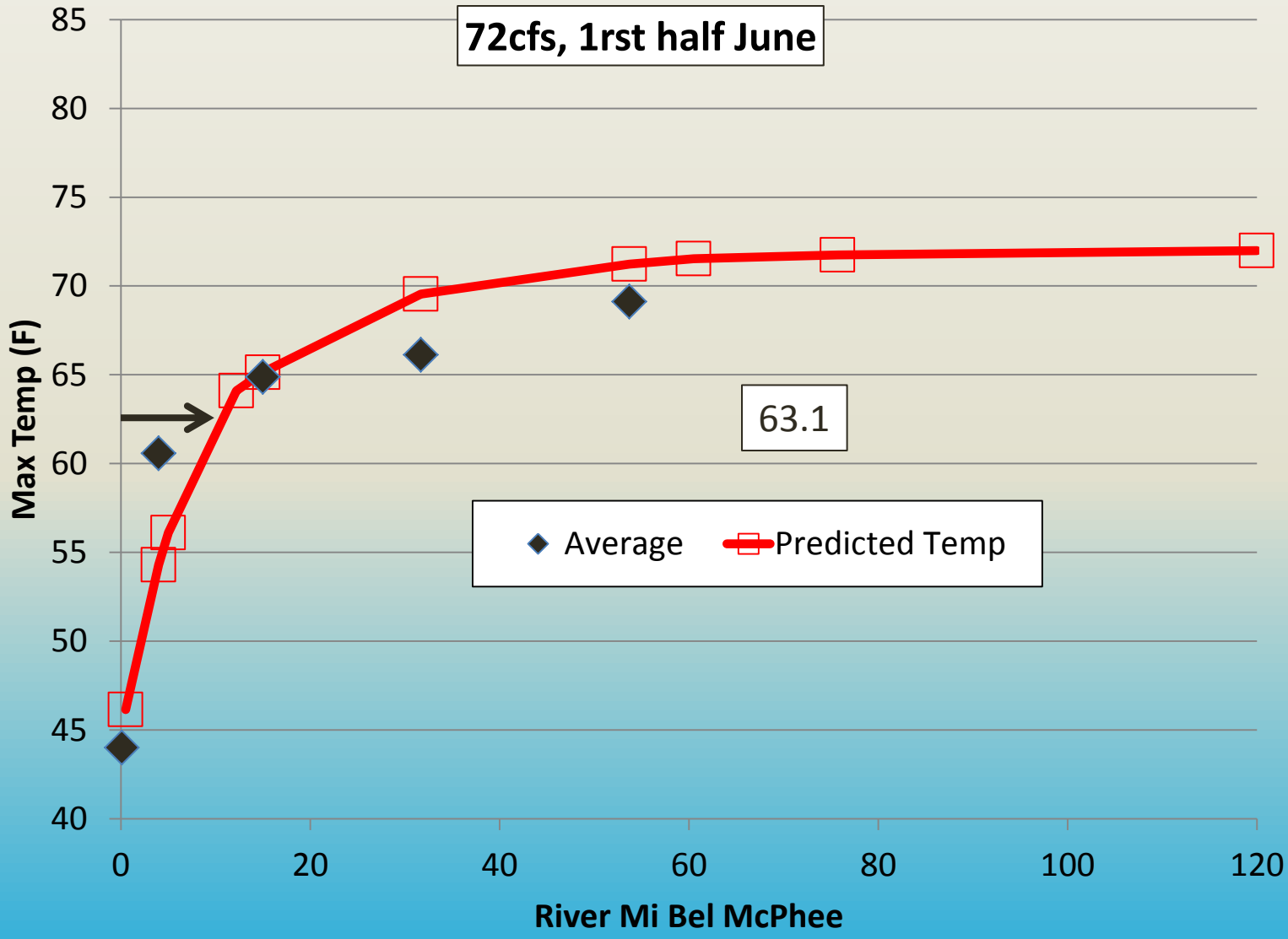
Segment Temperature Model

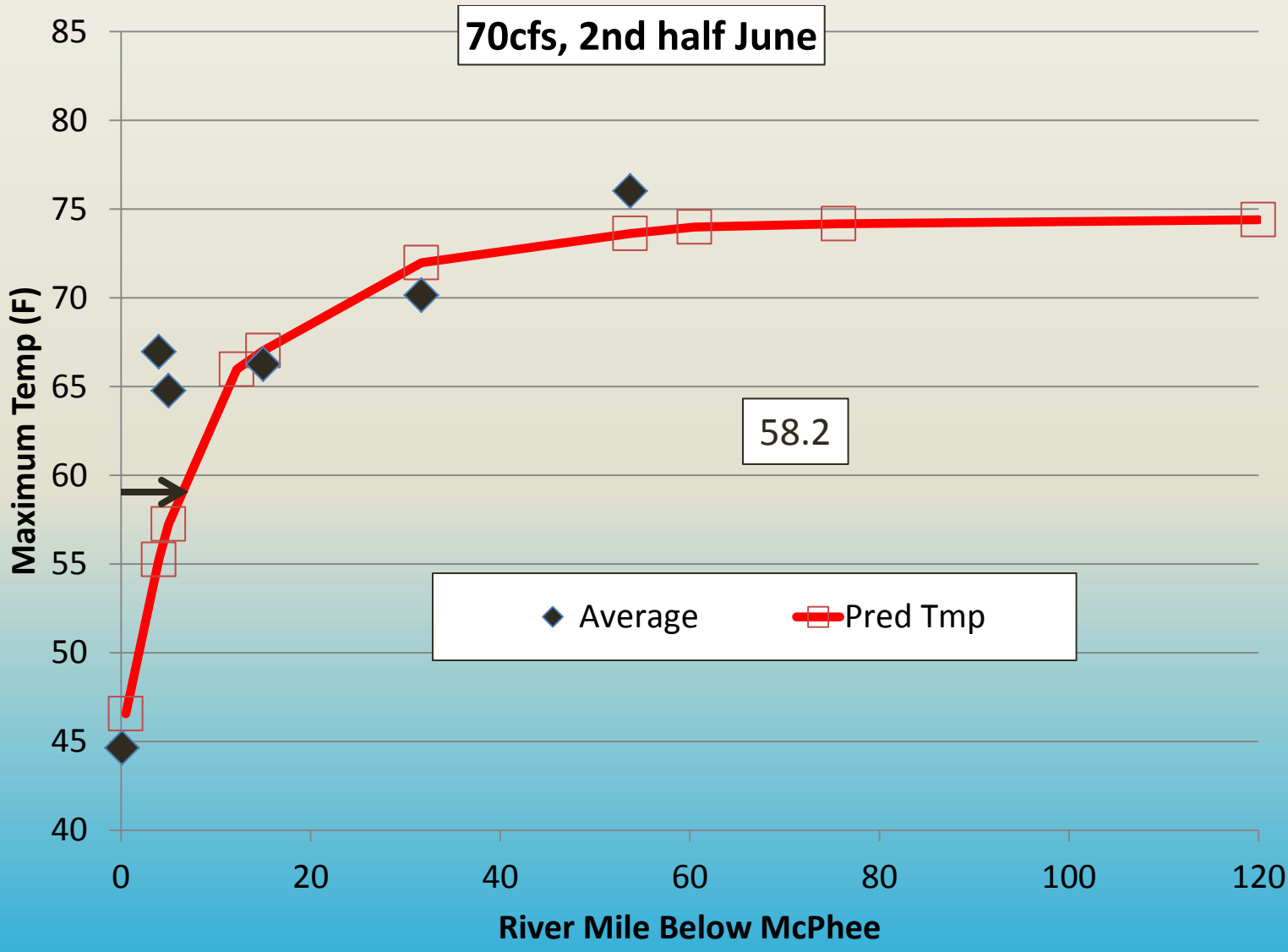
"SSTEMP may be used to evaluate alternative reservoir release proposals, analyze the effects of changing riparian shade or the physical features of a stream, and examine the effects of different stream withdrawals and returns on in-stream temperature."

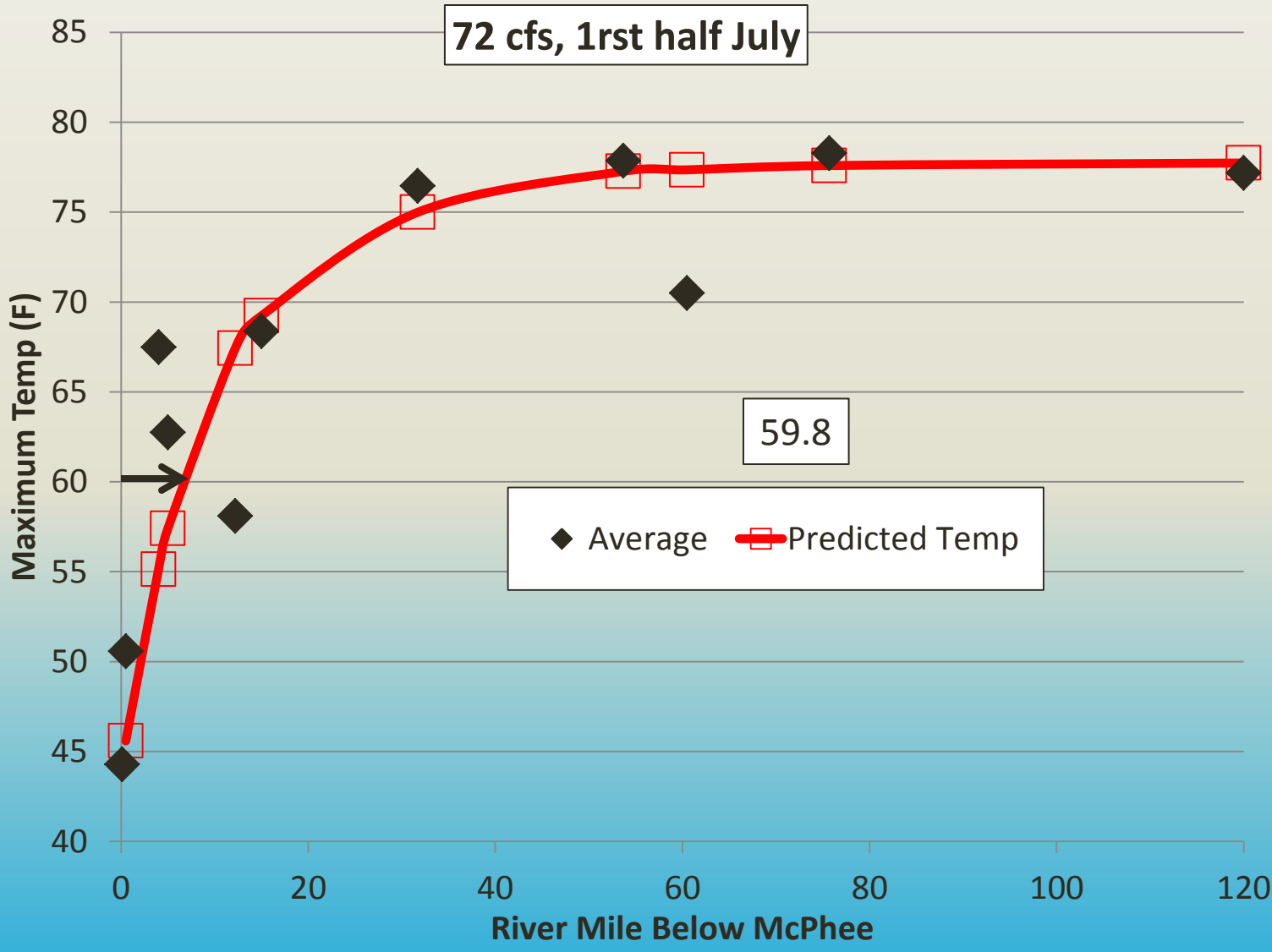
Segment Inflow (cfs)	75
Inflow Temperature (°F)	45.1
Segment Outflow (cfs)	60
Accretion Temp. (°F)	55
Latitude (degrees)	38
Segment Length (mi)	120
Upstream Elevation (ft)	6,674
Downstream Elevation (ft)	4,843
Width's A Term (s/ft^2)	35
B Term where W = A*Q**B	0.1
Manning's n	0.035
Air Temperature (°F)	60
Relative Humidity (%)	31.04
Wind Speed (mph)	2.96
Ground Temperature (°F)	55
Thermal gradient ($j/m^2/s/C$)	1.65
Possible Sun (%)	100
Dust Coefficient	5
Ground Reflectivity (%)	20
Segment Azimuth (degrees)	20
Topographic Altitude (degrees)	35
Vegetation Height (ft)	100
Vegetation Crown (ft)	25
Vegetation Offset (ft)	20
Vegetation Density (%)	40

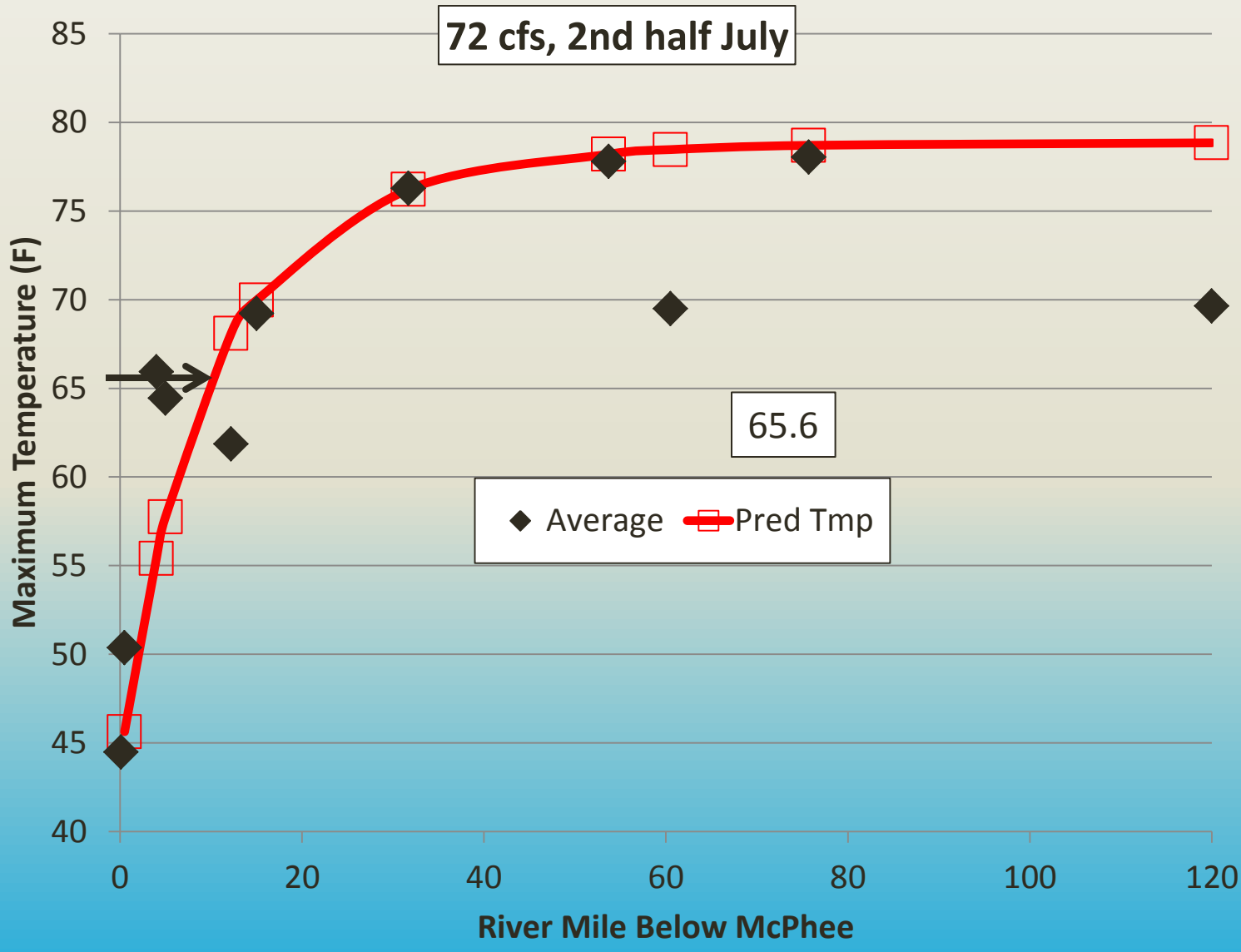
Input Variables

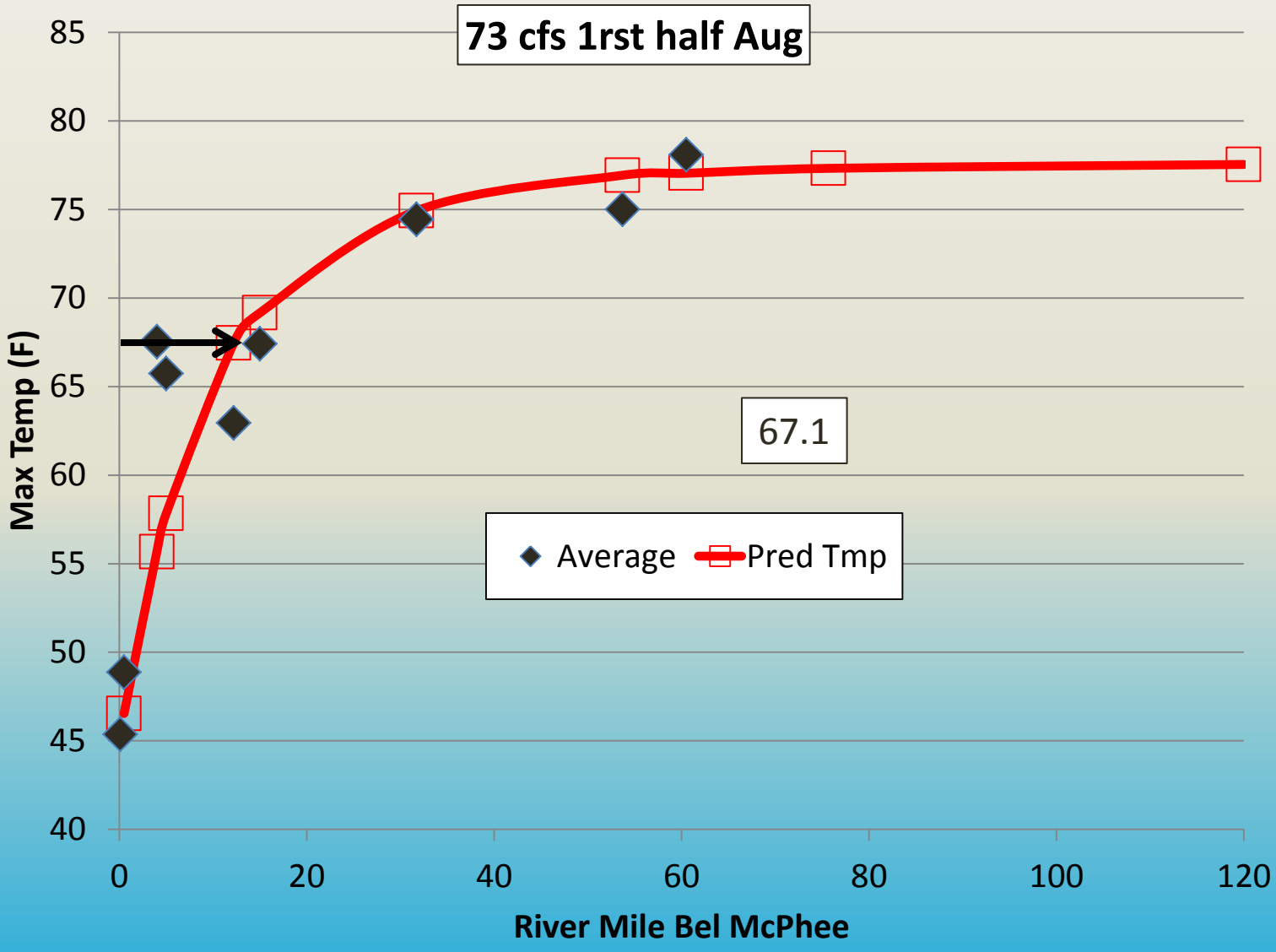
	April	May	June 1rst Half	June 2nd Half	July 1rst Half	July 2nd Half	August 1rst Half	August 2nd Half	Sept 1rst Half	Sept 2nd Half
Ave Temp Brad Brdge	46.0	53.7	60.0	65.5	69.1	69.2	67.1	64.5	59.9	54.9
Rel. Humidity Cahone	38.44	37.02	31.0	26.38	33.1	38.69	36.58	39.9	36.4	36.6
Wind speed Cahone	3.8	3.39	2.96	2.82	2.22	2.0	2.05	2.12	2.60	2.64

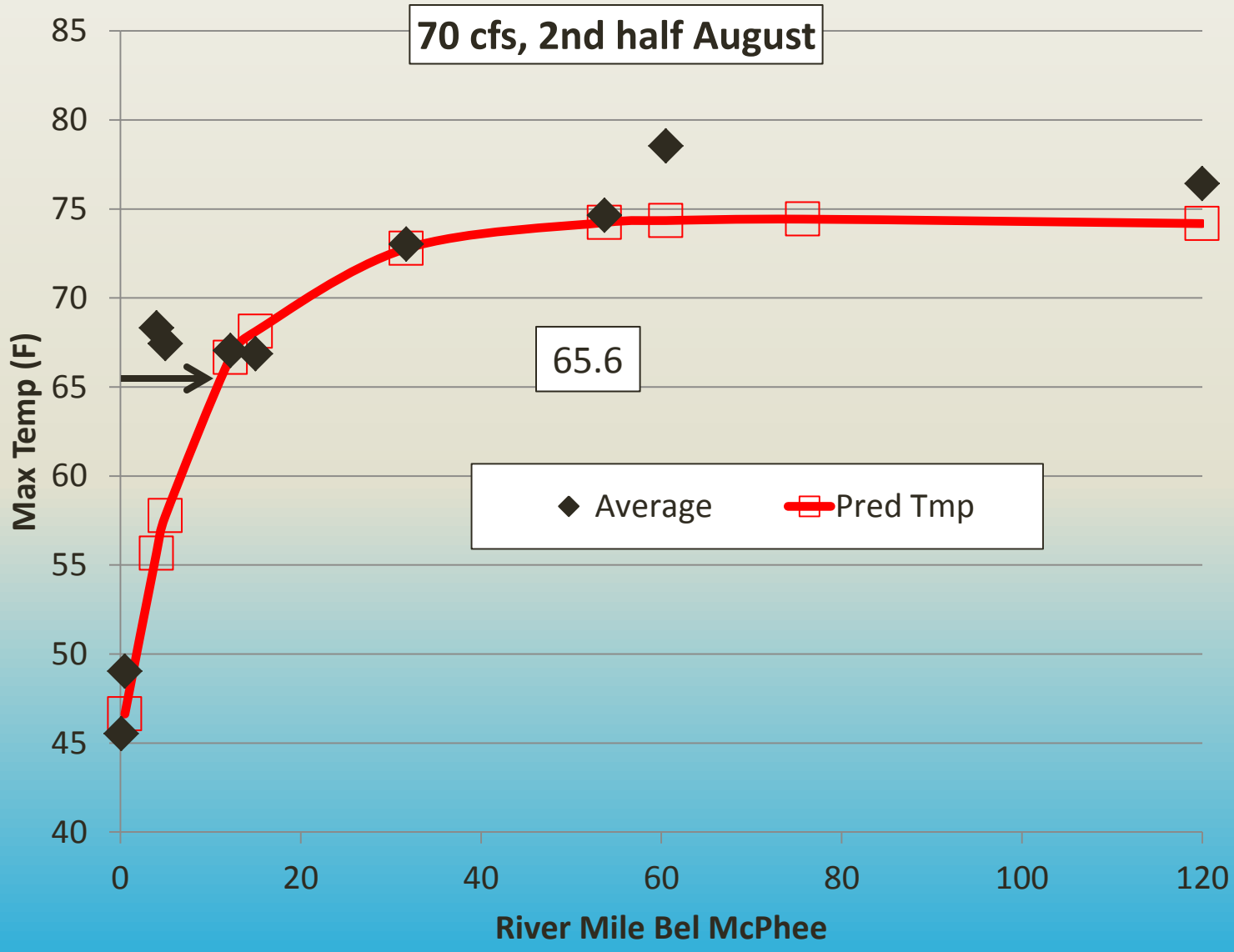

72cfs, 1rst half June
Max Temp (F)
85
80
75
70
65
60
55
50
45
40
0
20
40
60
80
100
120
River Mi Bel McPhee
63.1
Average
Predicted Temp


70cfs, 2nd half June
Maximum Temp (F)
85
80
75
70
65
60
55
50
45
40
0
20
40
60
80
100
120
River Mile Below McPhee
58.2
Average
Pred Tmp


72 cfs, 1rst half July
Maximum Temp (F)
85
80
75
70
65
60
55
50
45
40
0
20
40
60
80
100
120
River Mile Below McPhee
59.8
Average
Predicted Temp


72 cfs, 2nd half July
Maximum Temperature (F)
85
80
75
70
65
60
55
50
45
40
0
20
40
60
80
100
120
River Mile Below McPhee
65.6
Average
Pred Tmp


73 cfs 1rst half Aug
Max Temp (F)
85
80
75
70
65
60
55
50
45
40
0
20
40
60
80
100
120
River Mile Bel McPhee
67.1
Average
Pred Tmp


70 cfs, 2nd half August
65.6
Average
Pred Tmp
Max Temp (F)
River Mile Bel McPhee
85
80
75
70
65
60
55
50
45
40
0
20
40
60
80
100
120

Conclusions

- Increase higher temp habitat 6 to 12 miles upstream using SLOW 1
- River model accurate for Bradfield Bridge to Disappointment
- More accurate modeling may come from using SNTEMP that includes tributaries inflows and gaining/losing reaches
- More accuracy gained with field measurements of input variables

What next?

- Is model useful?
- Want it developed further?
- If so, what changes/additions etc.?
- How do you want it packaged?