Calibration with A,B, &C Springs using MKMOD4.exe

Allan Wylie IDWR

2008 Reach Gain and Spring Discharge Targets

- Evaluate Monthly Stress Periods
  - Using
    - MKMOD4.exe
      - Using On-Farm algorithm
    - P100608A
      - Assumes that the On-Farm algorithm would be used
      - Place holder for non-irrigated recharge
      - Null SW irrigation entity in IAR file
    - No steady state targets
    - Aquifer head
      - 1985-2002
        - » Same
    - Snake reach gain and loss targets
      - Updated through 2008 to match recharge data
      - 1985-2008
    - Spring discharge
      - Updated through 2008 to match recharge data
      - 1985-2008

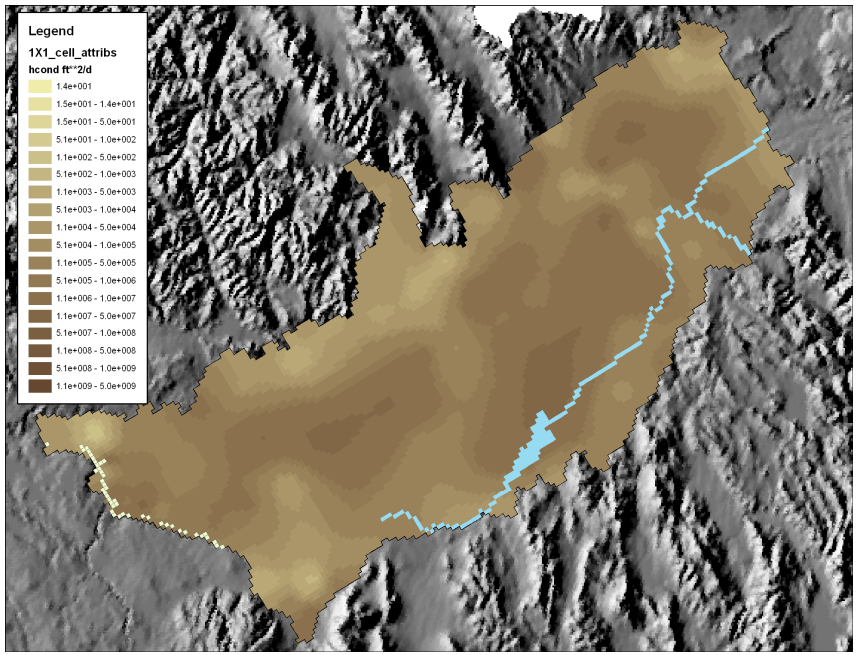
2008 Reach Gain and Spring Discharge Targets

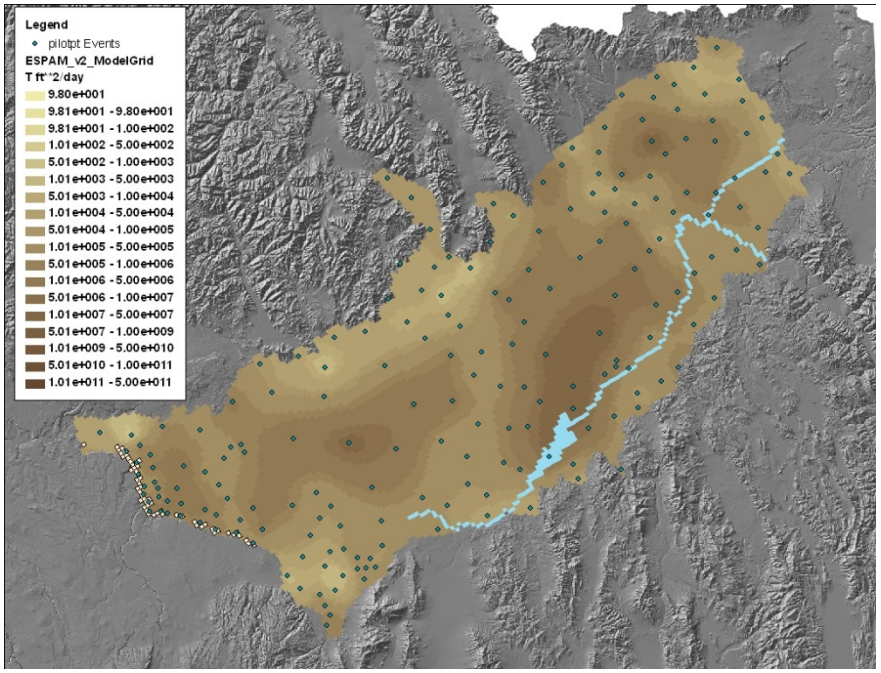
- Adjustable Parameters
  - Transmissivity
    - Pilot Points
      - 1e-10 – 1e+10
  - Specific Yield
    - Pilot Points
      - 0.001 – 0.30
  - Riverbed Conductance
    - By reach
      - 1.0 – 1e+10
  - Drain Conductance
    - By drain cell
      - Up to 3 drain cells per model cell
      - 1e-10 - 3e+8
  - Canal seepage
    - Uniform by entity
      - 1e-6 – 1.2
  - Non-irrigated recharge
    - Thin Thick and Lava
    - 1e-6 - 20
  - ET
    - Surface Water Entity
      - Sprinkler and Gravity
      - +/-5%
    - Groundwater Entity
      - Sprinkler and Gravity
      - +/-5%
  - Perched River Seepage
    - River reach
    - +/-20%
  - Tributary Underflow
    - Tributary Basin
    - 0.5 - 2

2008 Reach Gain and Spring Discharge Targets

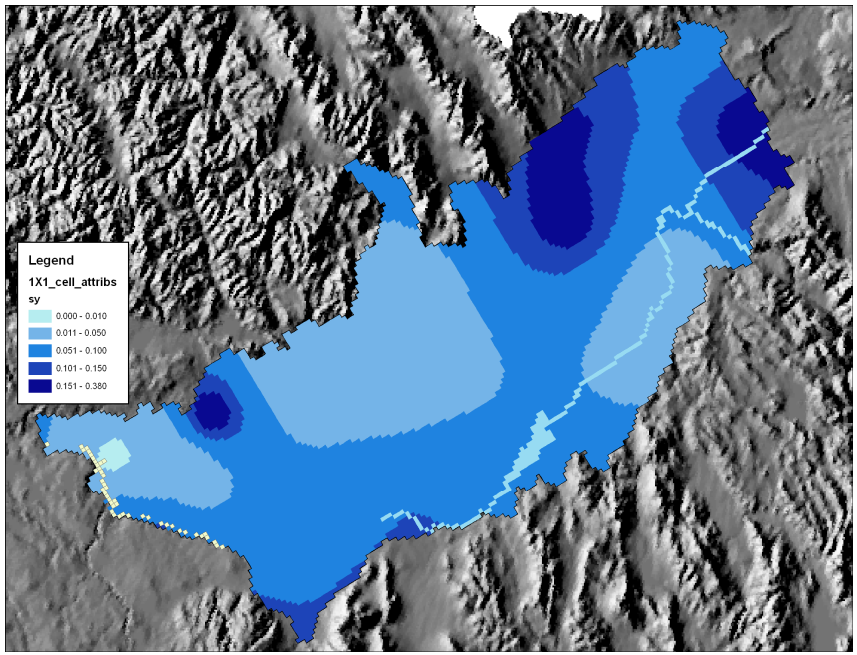
- Adjustable Parameters (cont)
  - On Farm Parameters
    - EffSp
      - 0.10-0.90
    - EffGr
      - 0.10-0.90
    - DPin
      - 1e-4-1.0
    - DPex
      - 1e-4-1.0
      - Entities with no returns DPex fixed at 1.0

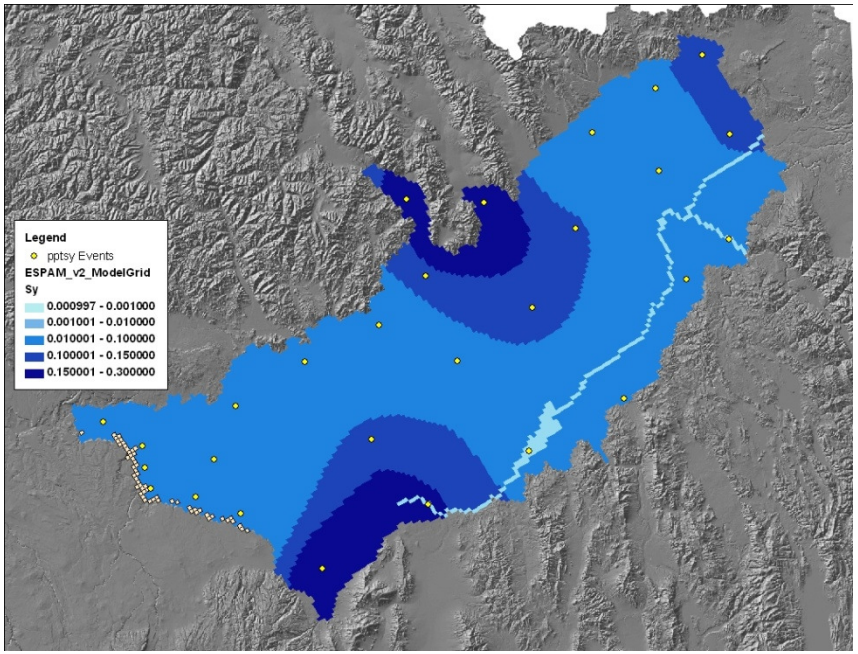
V 1.1


Legend
1X1_cell_attribs
hcond ft**2/d
1.4e+001
1.5e+001 - 1.4e+001
1.5e+001 - 5.0e+001
5.1e+001 - 1.0e+002
1.1e+002 - 5.0e+002
5.1e+002 - 1.0e+003
1.1e+003 - 5.0e+003
5.1e+003 - 1.0e+004
1.1e+004 - 5.0e+004
5.1e+004 - 1.0e+005
1.1e+005 - 5.0e+005
5.1e+005 - 1.0e+006
1.1e+006 - 1.0e+007
1.1e+007 - 5.0e+007
5.1e+007 - 1.0e+008
1.1e+008 - 5.0e+008
5.1e+008 - 1.0e+009
1.1e+009 - 5.0e+009

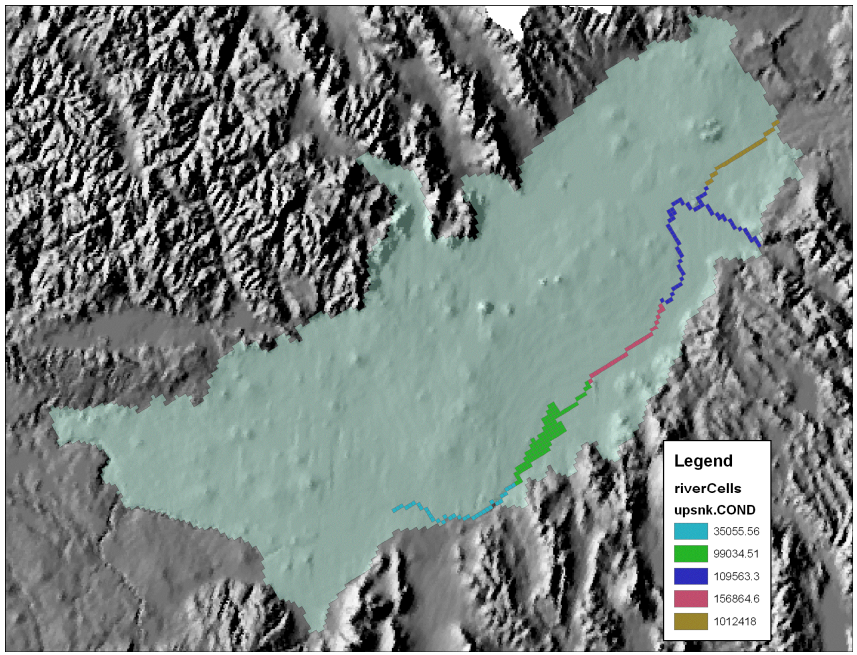

Legend
pilotpt Events
ESPAM_v2_ModelGrid
T ft**2/day
9.80e+001
9.81e+001 - 9.80e+001
9.81e+001 - 1.00e+002
1.01e+002 - 5.00e+002
5.01e+002 - 1.00e+003
1.01e+003 - 5.00e+003
5.01e+003 - 1.00e+004
1.01e+004 - 5.00e+004
5.01e+004 - 1.00e+005
1.01e+005 - 5.00e+005
5.01e+005 - 1.00e+006
1.01e+006 - 5.00e+006
5.01e+006 - 1.00e+007
1.01e+007 - 5.00e+007
5.01e+007 - 1.00e+009
1.01e+009 - 5.00e+010
5.01e+010 - 1.00e+011
1.01e+011 - 5.00e+011

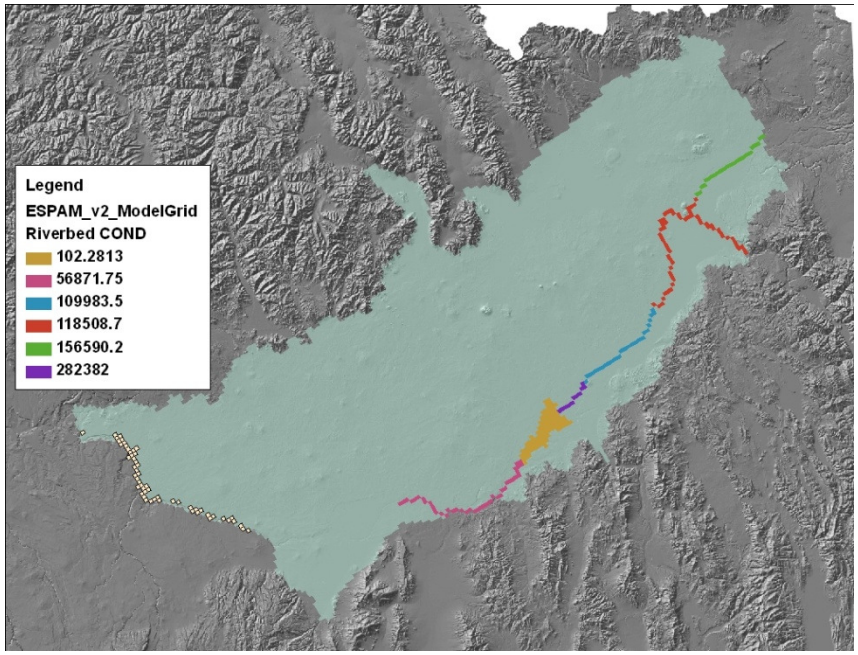
V 1.1


Legend
1X1_cell_attribs
sy
0.000 - 0.010
0.011 - 0.050
0.051 - 0.100
0.101 - 0.150
0.151 - 0.380

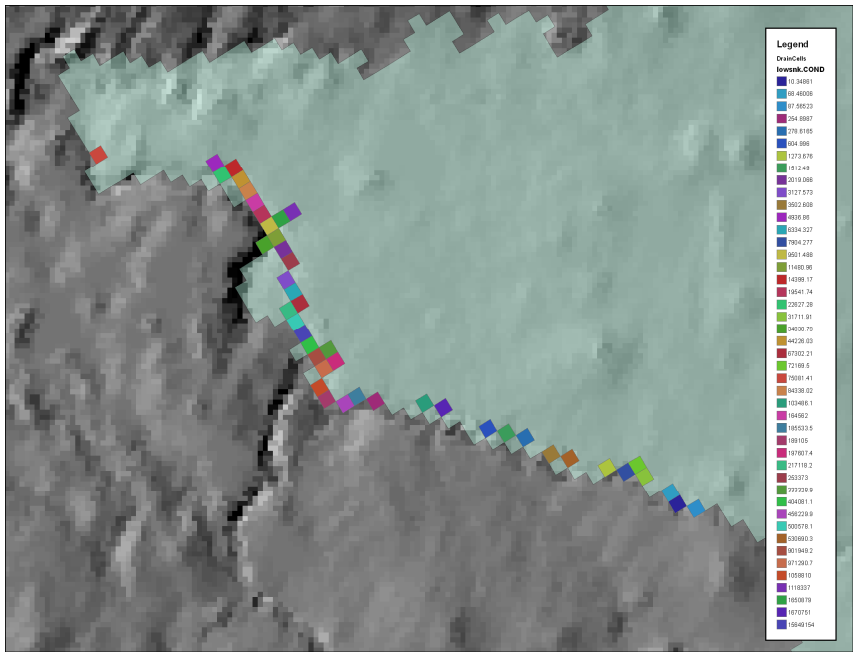

Legend
pptsy Events
ESPAM_v2_ModelGrid
Sy
0.000997 - 0.001000
0.001001 - 0.010000
0.010001 - 0.100000
0.100001 - 0.150000
0.150001 - 0.300000

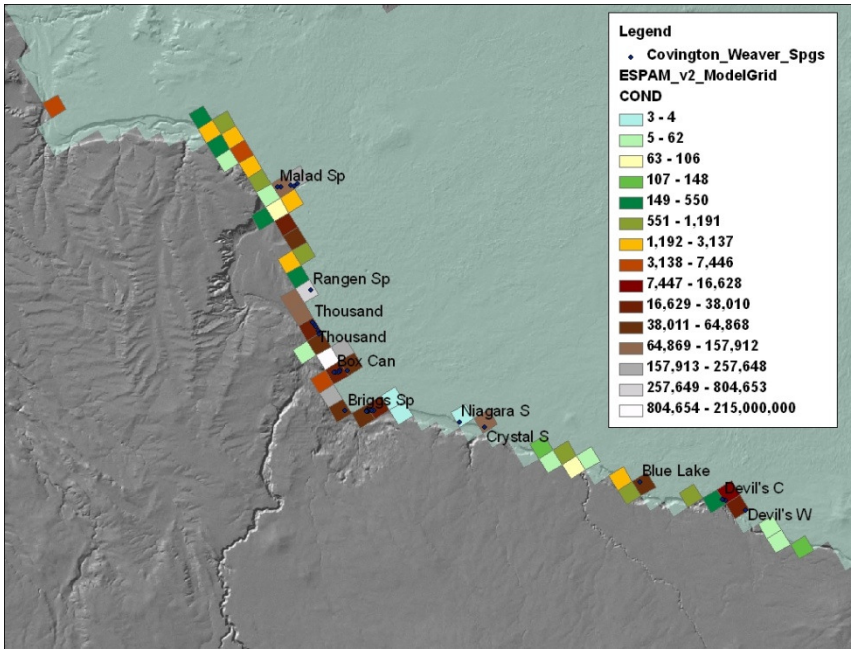
V 1.1


Legend
riverCells
upsnk.COND
35055.56
99034.51
109563.3
156864.6
1012418

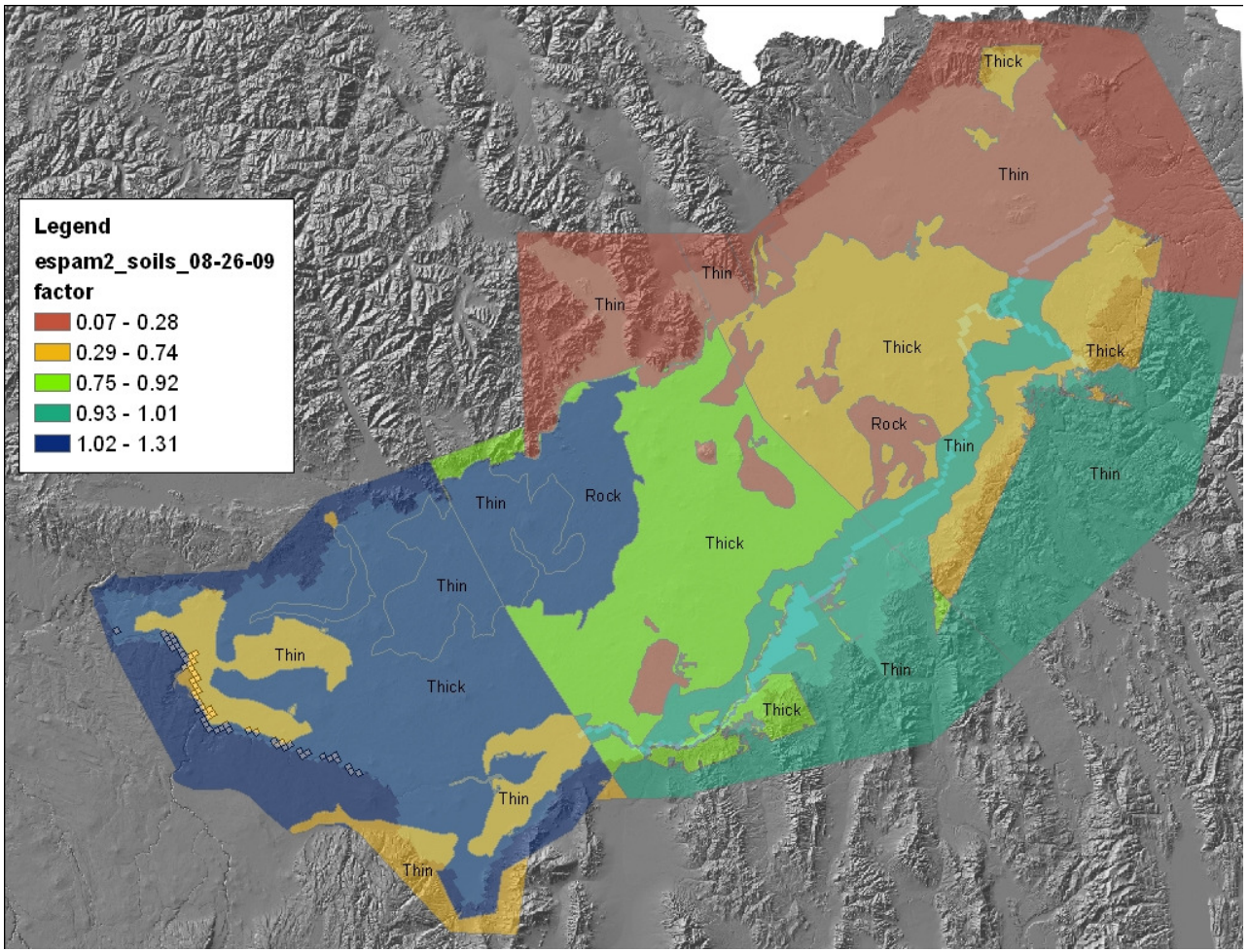

Legend
ESPAM_v2_ModelGrid
Riverbed COND
102.2813
56871.75
109983.5
118508.7
156590.2
282382

V 1.1

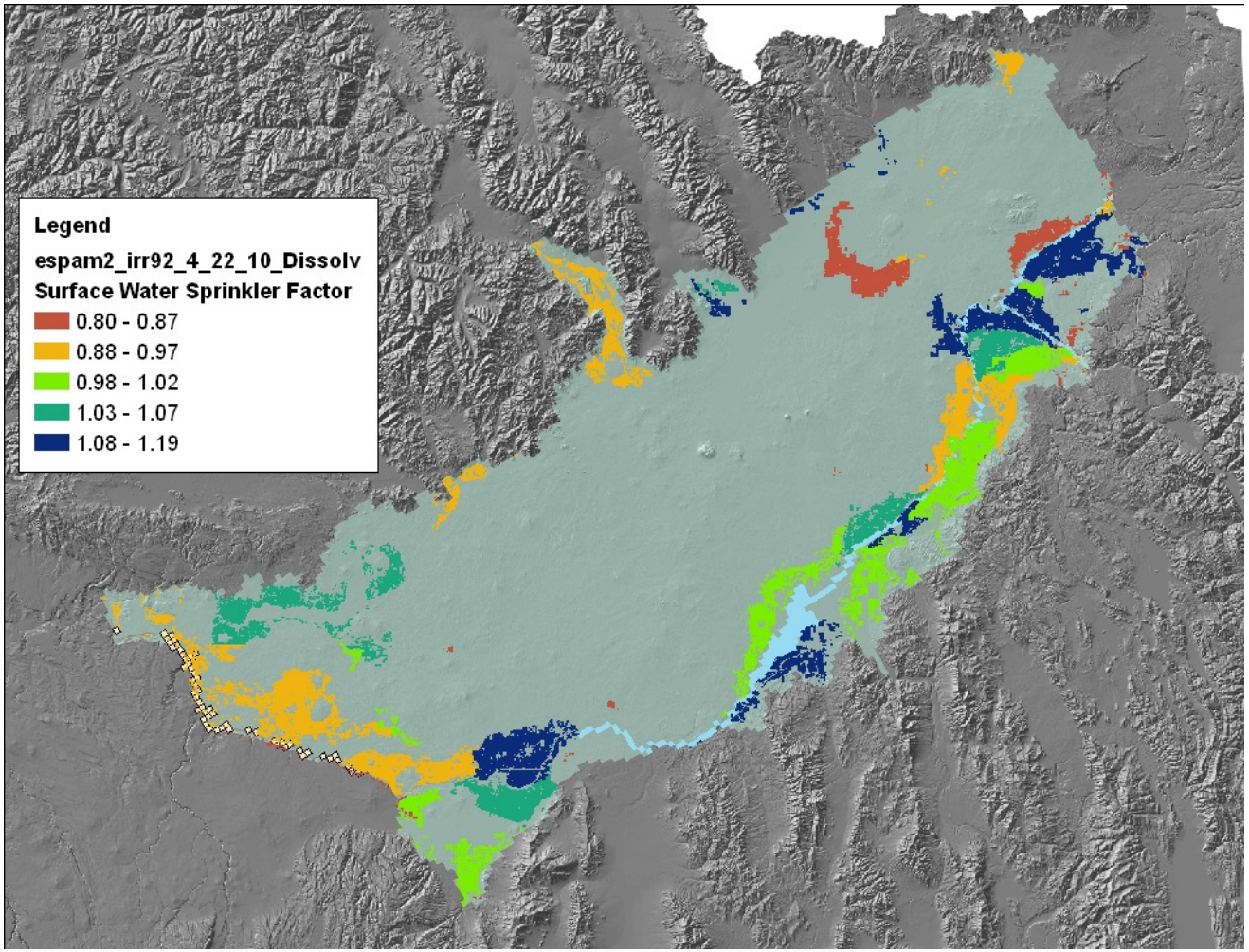

Legend
DrainCells
lowsnk.COND


Legend
Covington_Weaver_Spgs
ESPAM_v2_ModelGrid
COND
3 - 4
5 - 62
63 - 106
107 - 148
149 - 550
551 - 1,191
1,192 - 3,137
3,138 - 7,446
7,447 - 16,628
16,629 - 38,010
38,011 - 64,868
64,869 - 157,912
157,913 - 257,648
257,649 - 804,653
804,654 - 215,000,000
Malad Sp
Rangen Sp
Thousand
Thousand
Box Can
Briggs Sp
Niagara S
Crystal S
Blue Lake
Devil's C
Devil's W

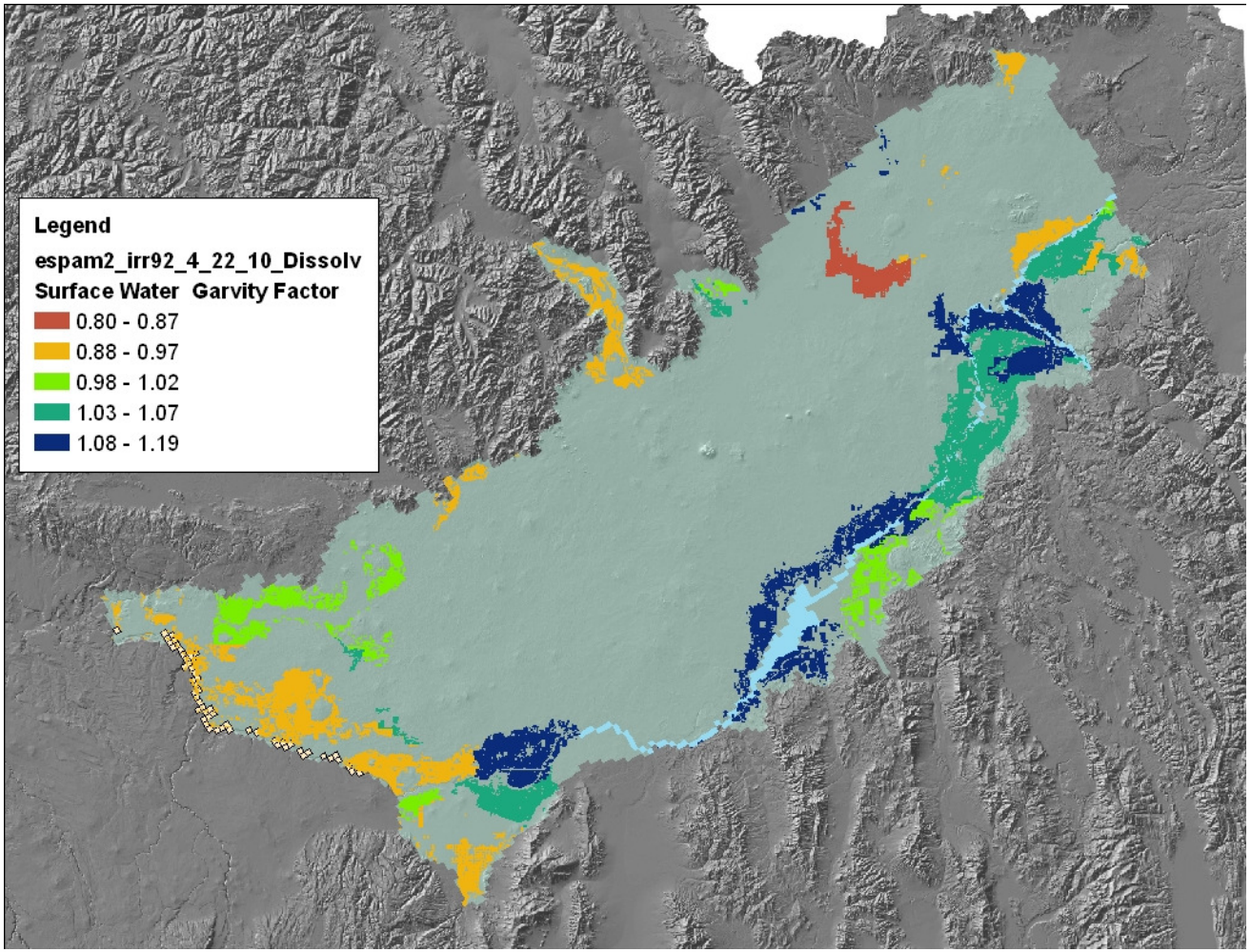
Non-irrigated Recharge



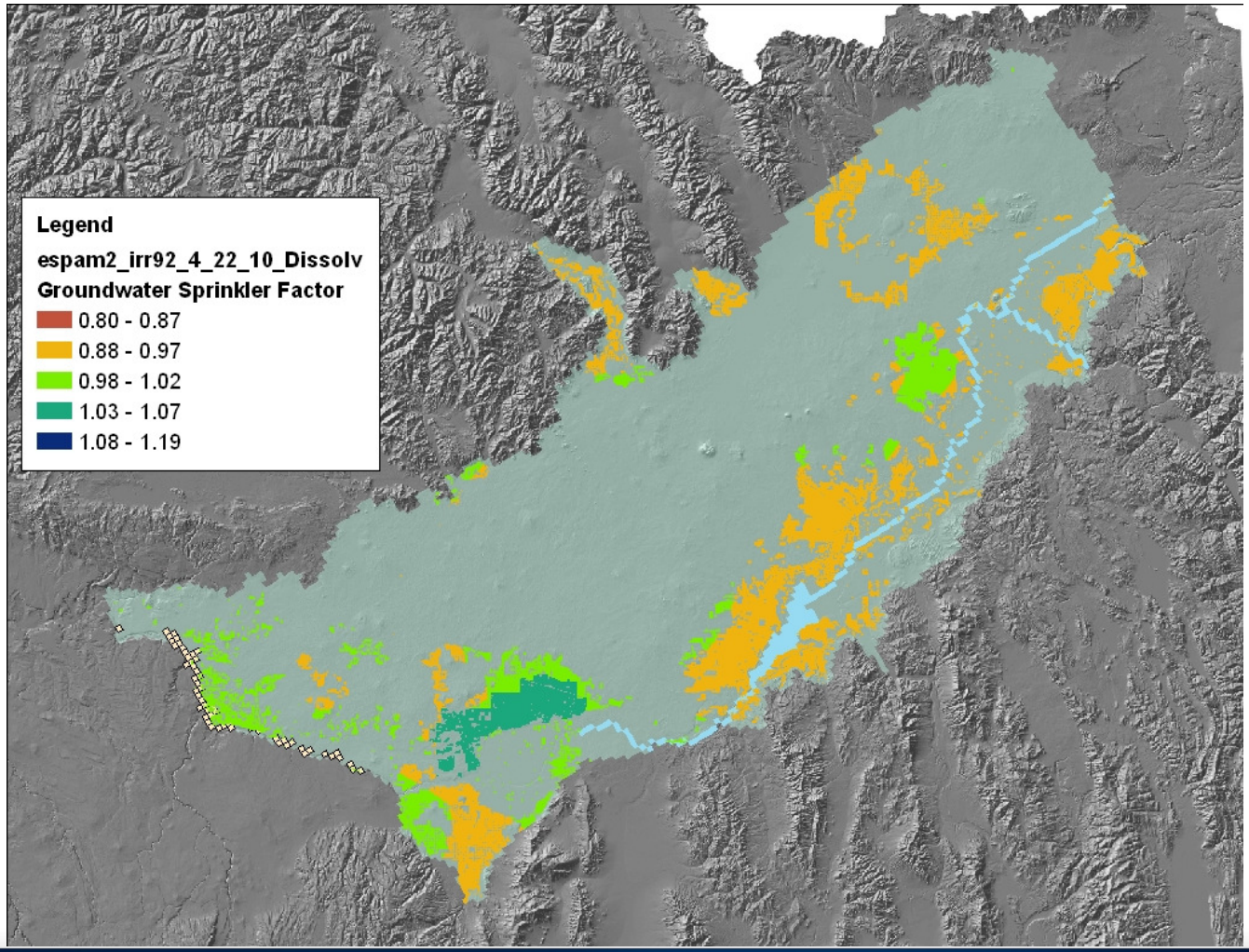
ET Surface Water Sprinkler



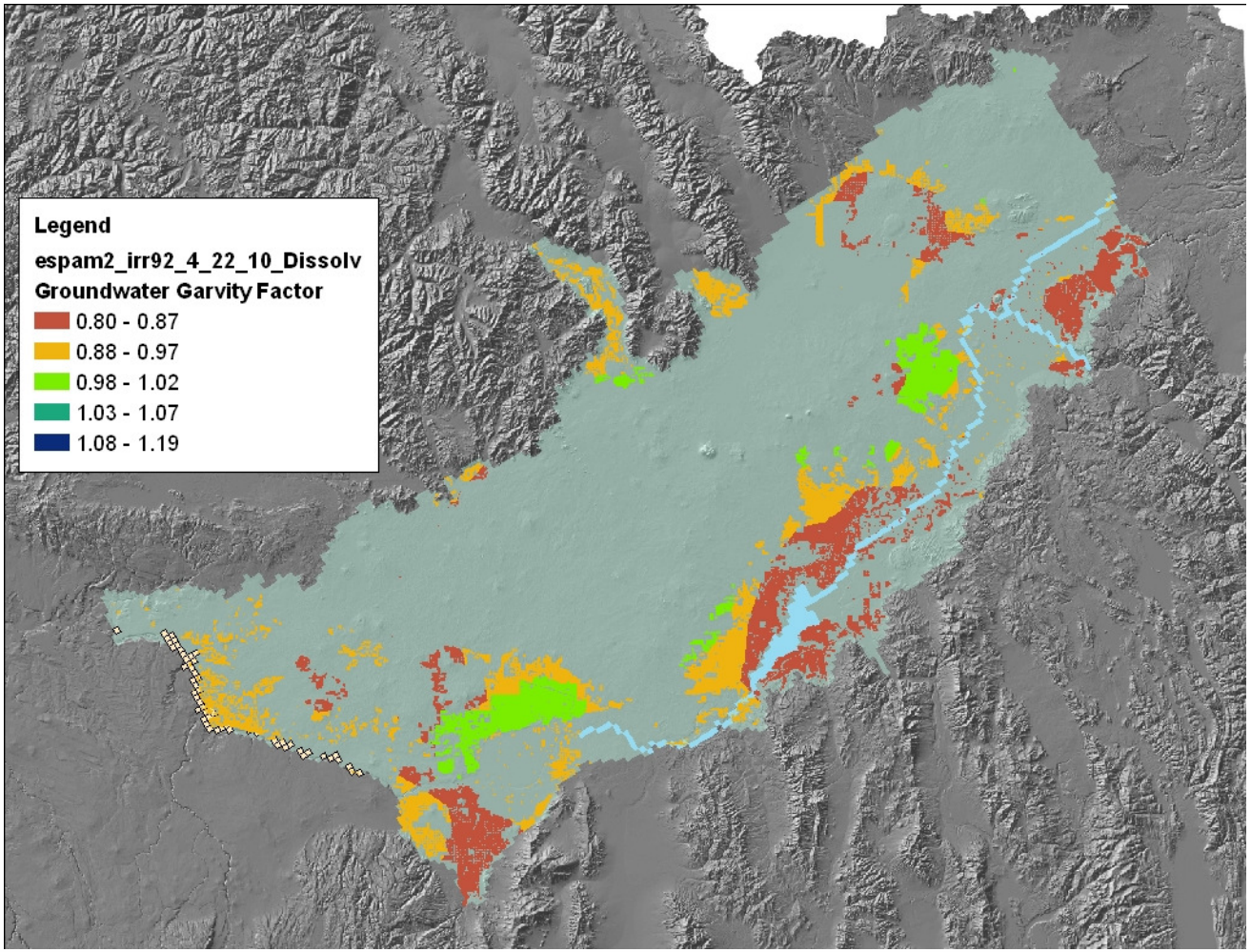
ET Surface Water Gravity



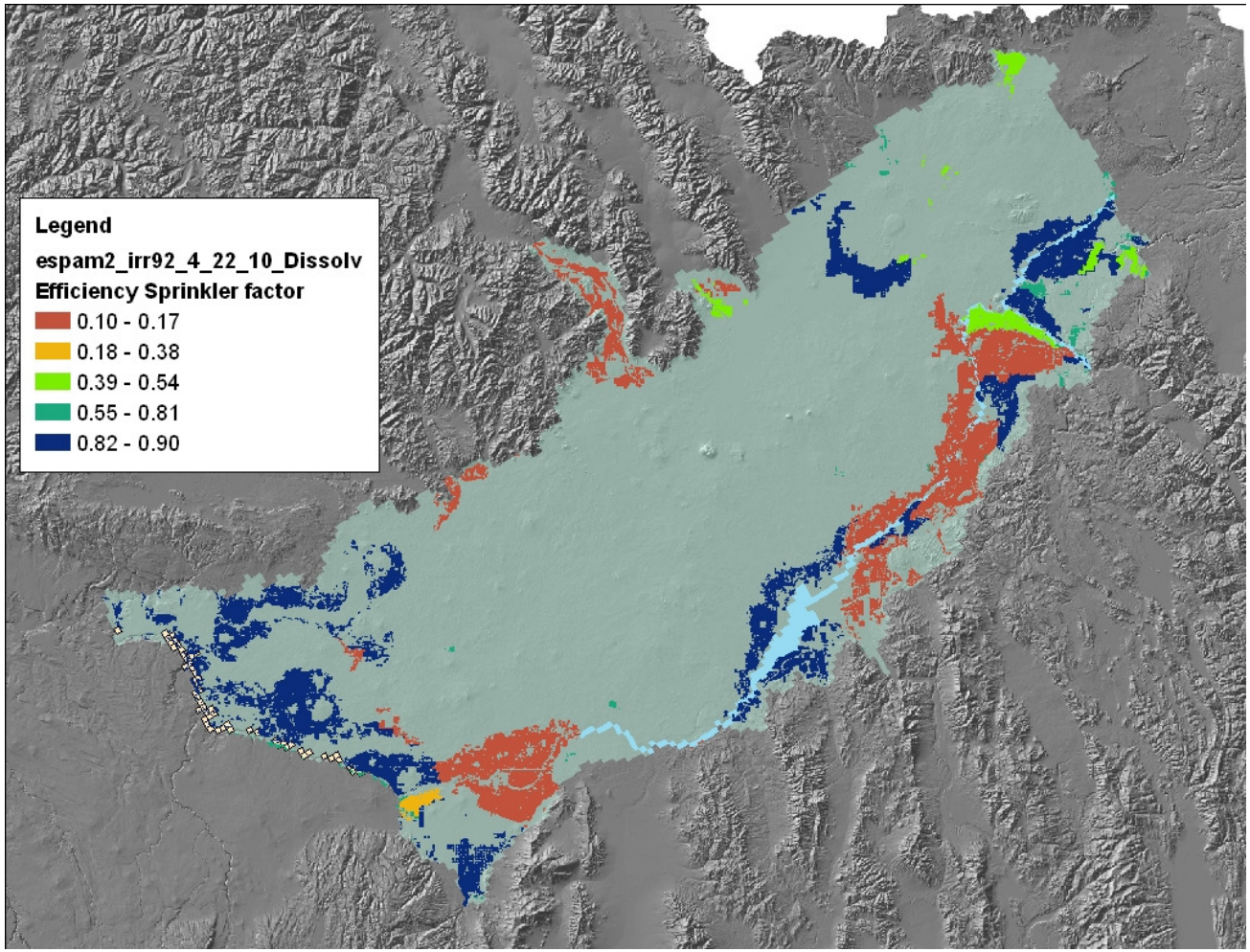
ET Groundwater Sprinkler



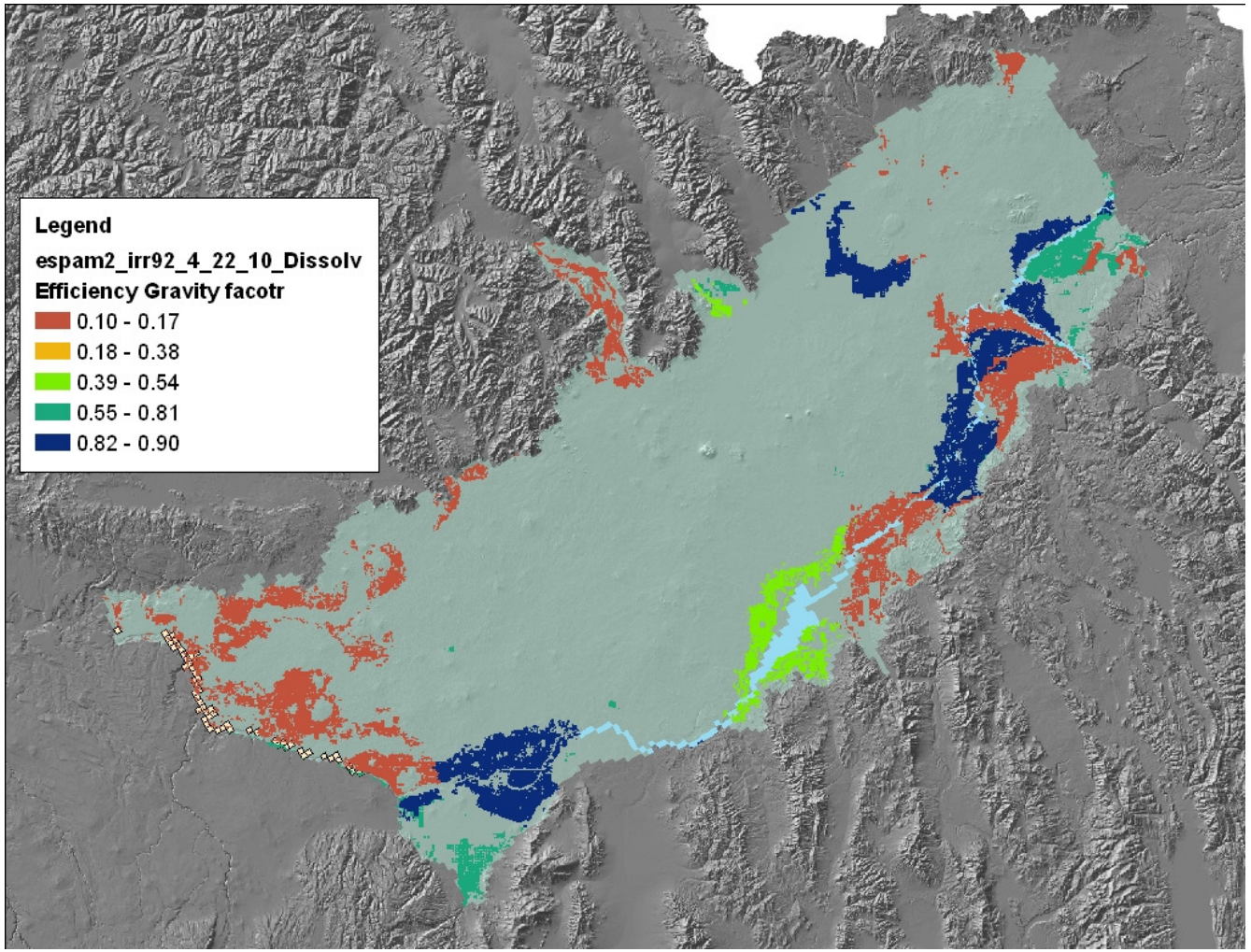
ET Groundwater Gravity



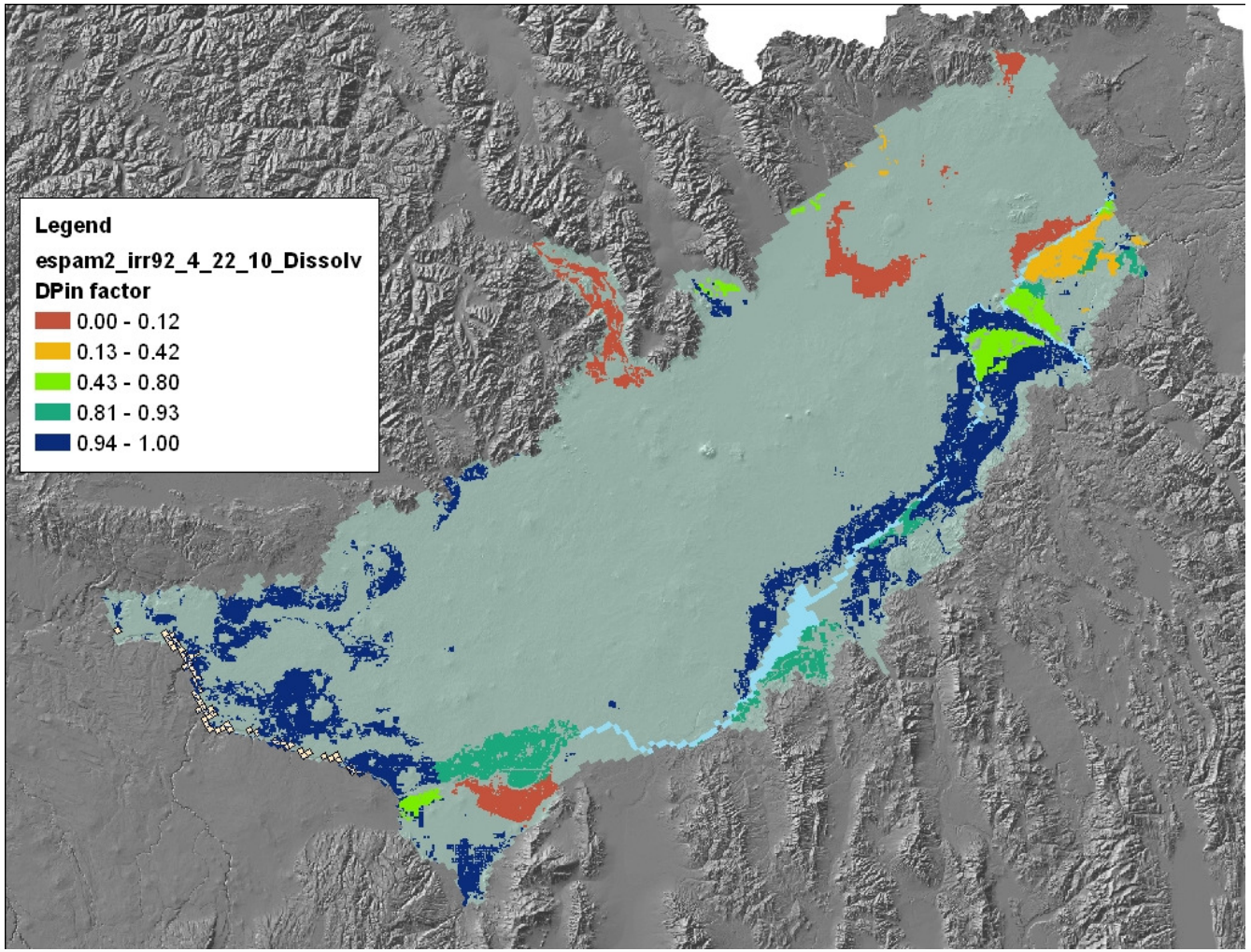
EffSp


Legend
espam2_irr92_4_22_10_Dissolv
Efficiency Sprinkler factor
0.10 - 0.17
0.18 - 0.38
0.39 - 0.54
0.55 - 0.81
0.82 - 0.90

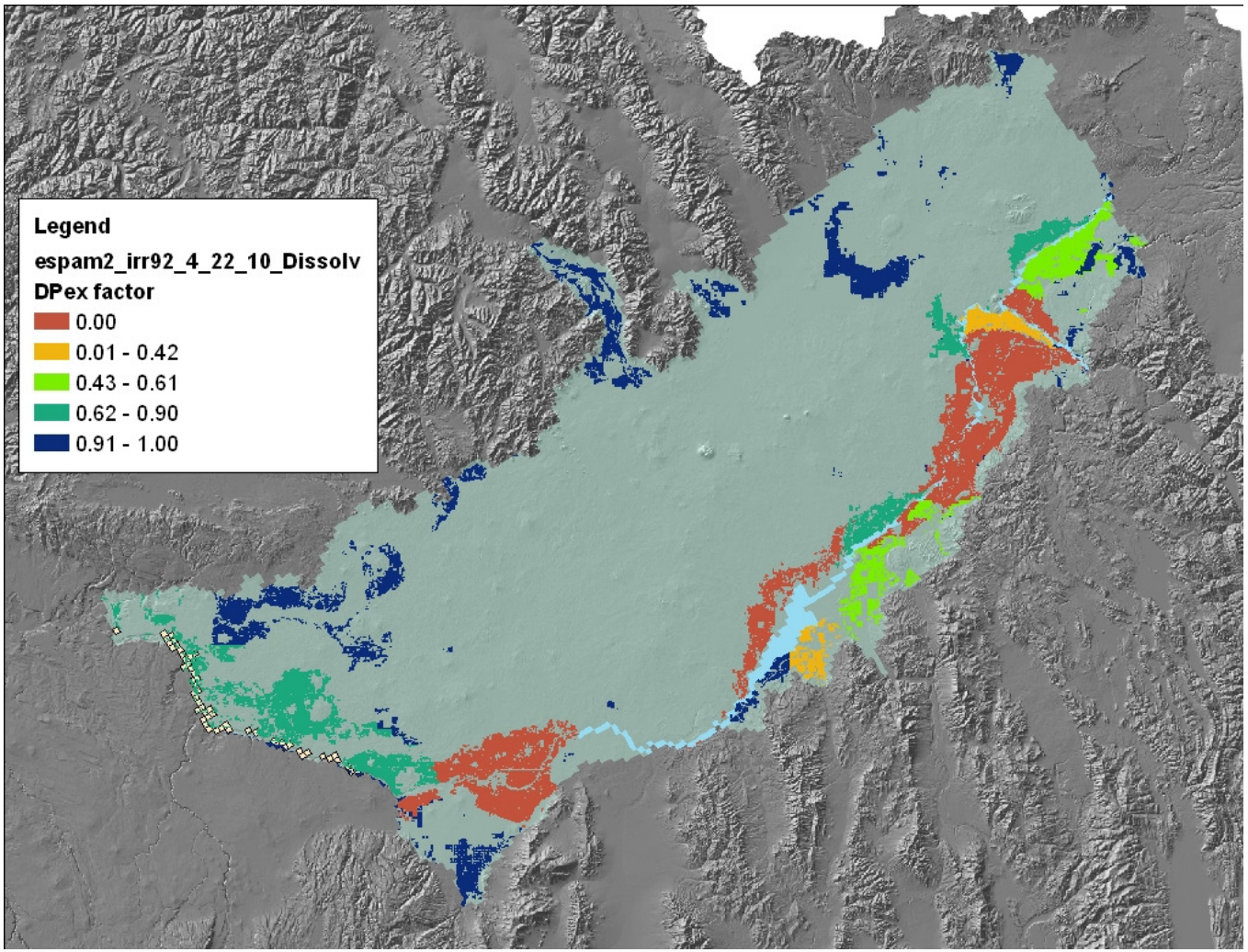
EffGr

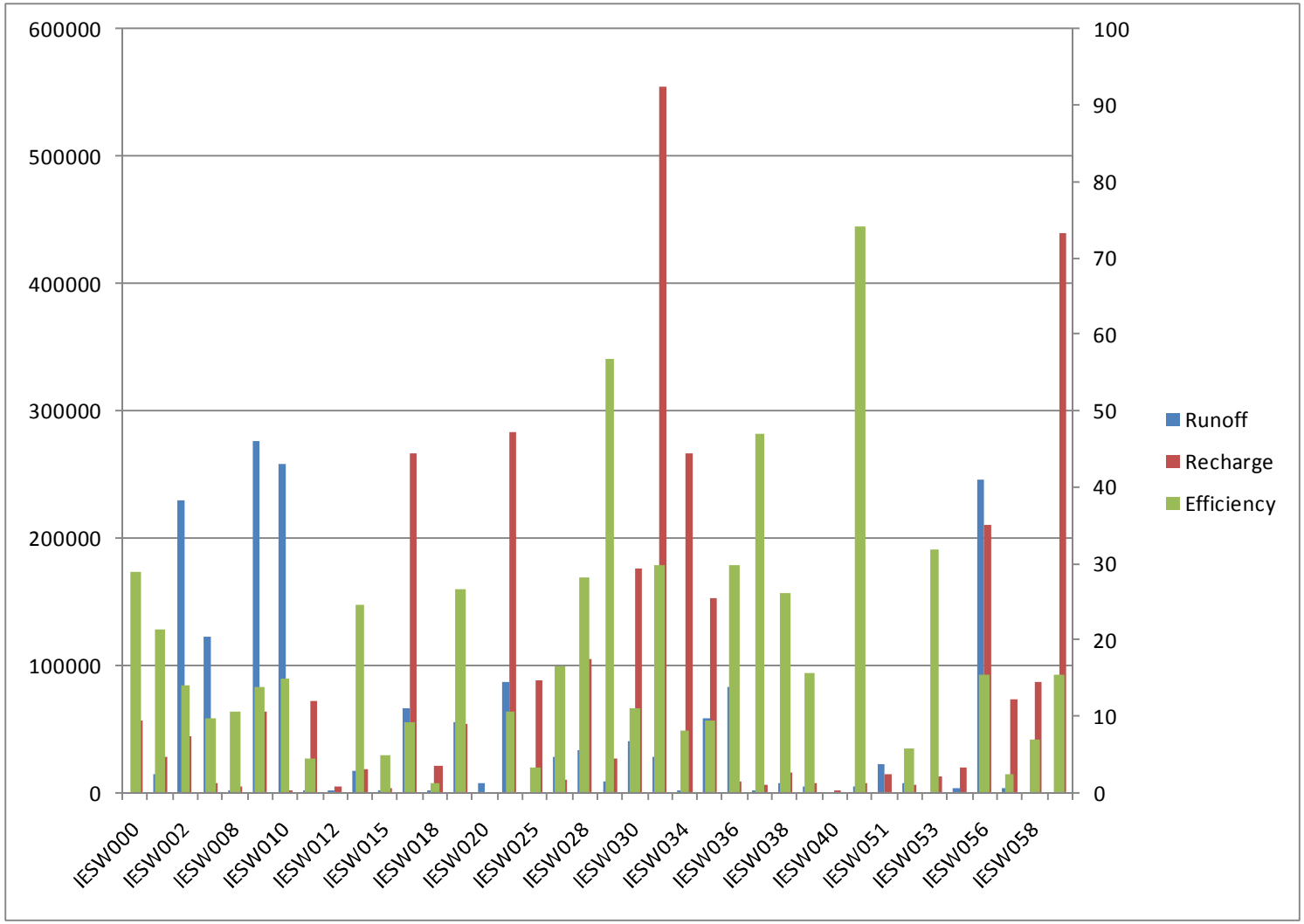

Legend
espam2_irr92_4_22_10_Dissolv
Efficiency Gravity facotr
0.10 - 0.17
0.18 - 0.38
0.39 - 0.54
0.55 - 0.81
0.82 - 0.90

DPin

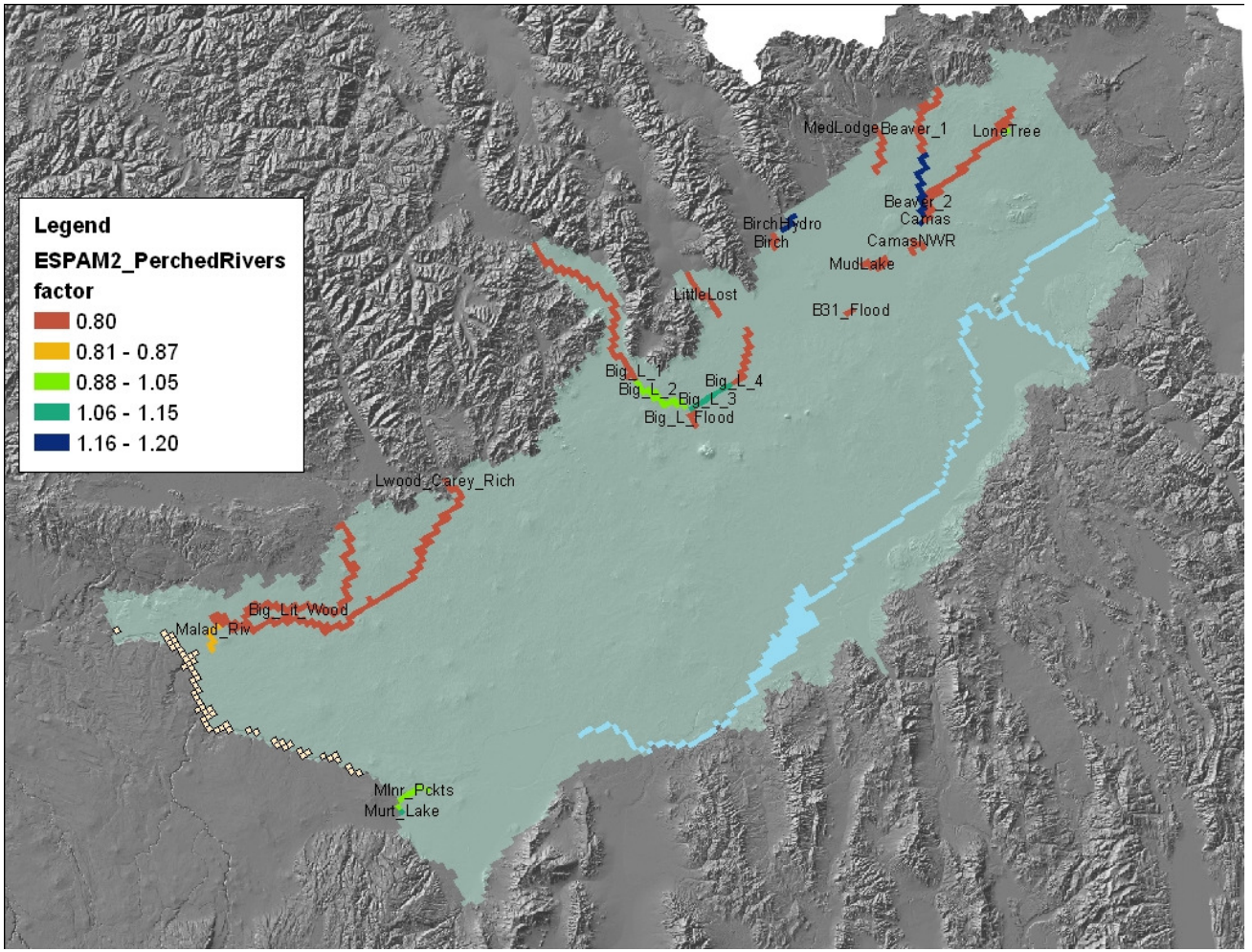

Legend
espam2_irr92_4_22_10_Dissolv
DPin factor
0.00 - 0.12
0.13 - 0.42
0.43 - 0.80
0.81 - 0.93
0.94 - 1.00

DPex

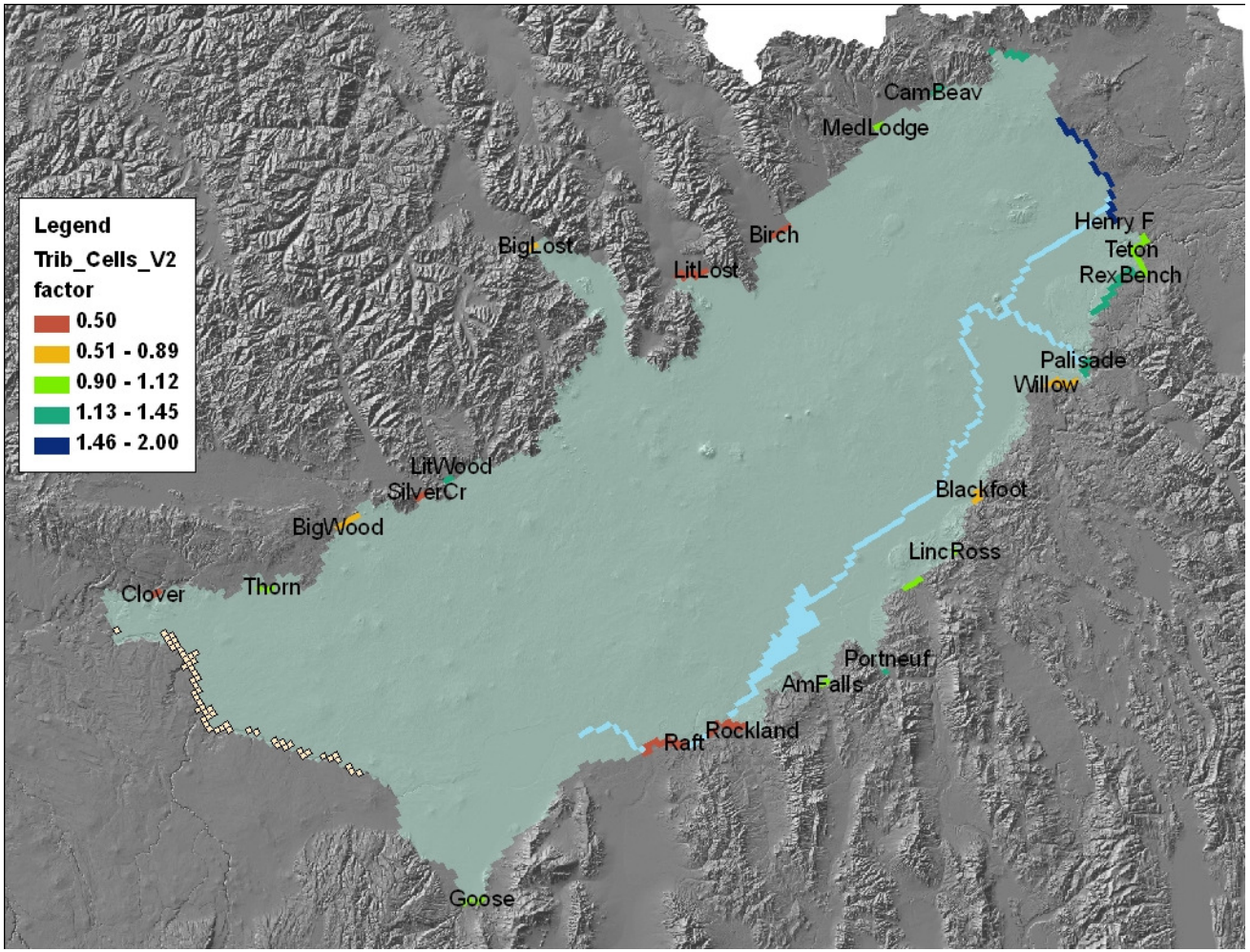

Legend
espam2_irr92_4_22_10_Dissolv
DPex factor
0.00
0.01 - 0.42
0.43 - 0.61
0.62 - 0.90
0.91 - 1.00


600000
500000
400000
300000
200000
100000
0
100
90
80
70
60
50
40
30
20
10
0
Runoff
Recharge
Efficiency
IESW000
IESW002
IESW008
IESW010
IESW012
IESW015
IESW018
IESW020
IESW025
IESW028
IESW030
IESW034
IESW036
IESW038
IESW040
IESW051
IESW053
IESW056
IESW058

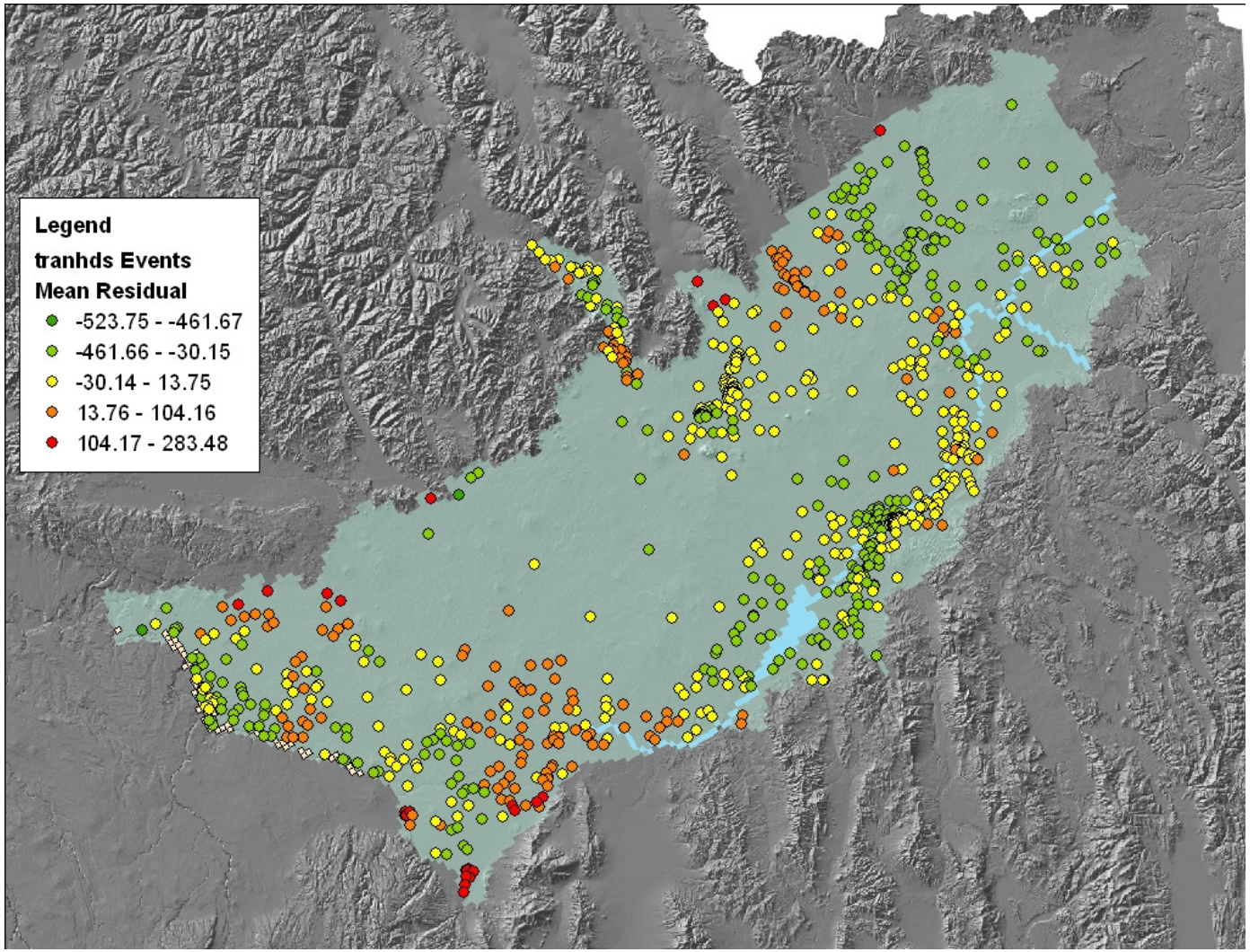
Perched River Seepage

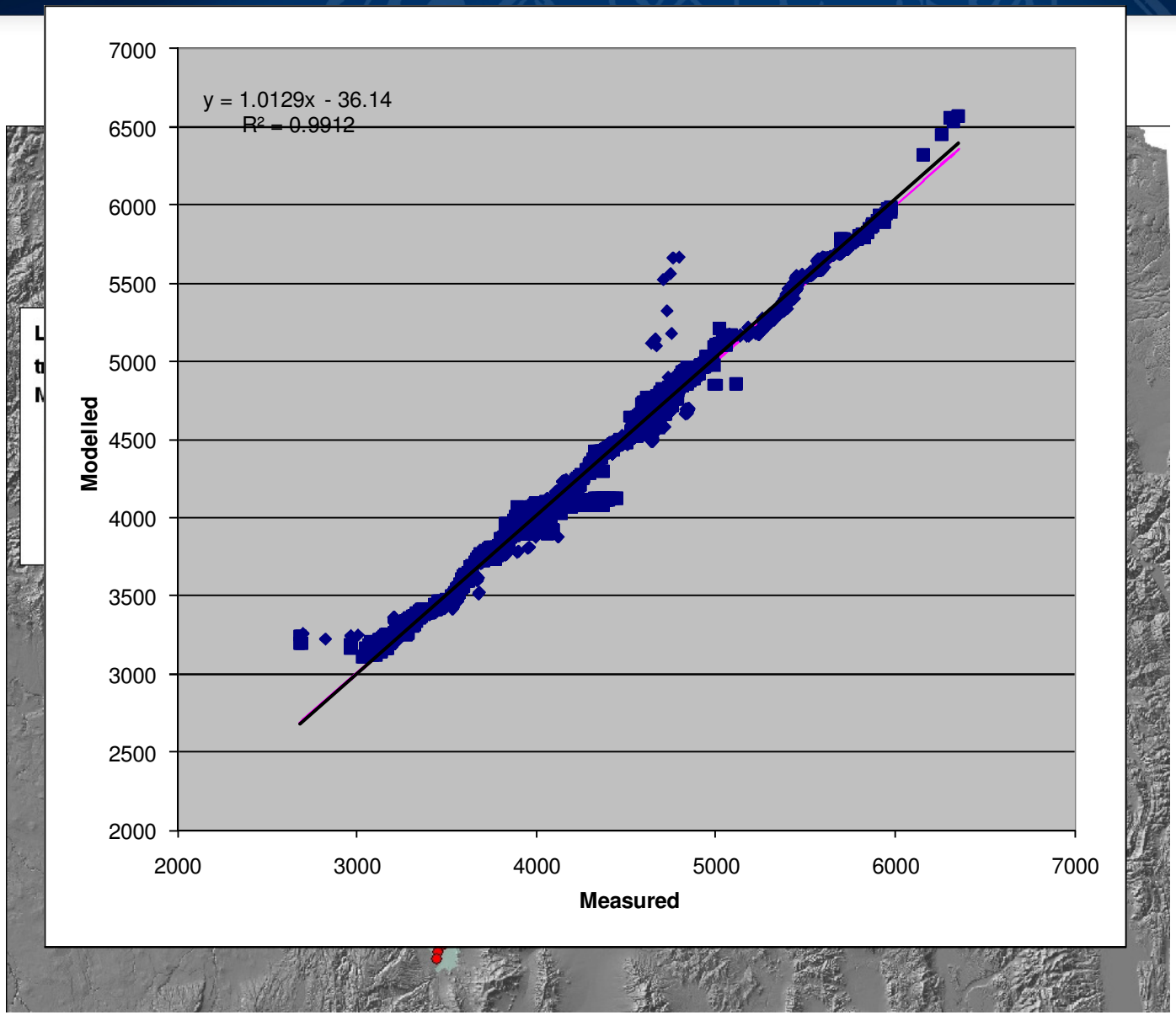


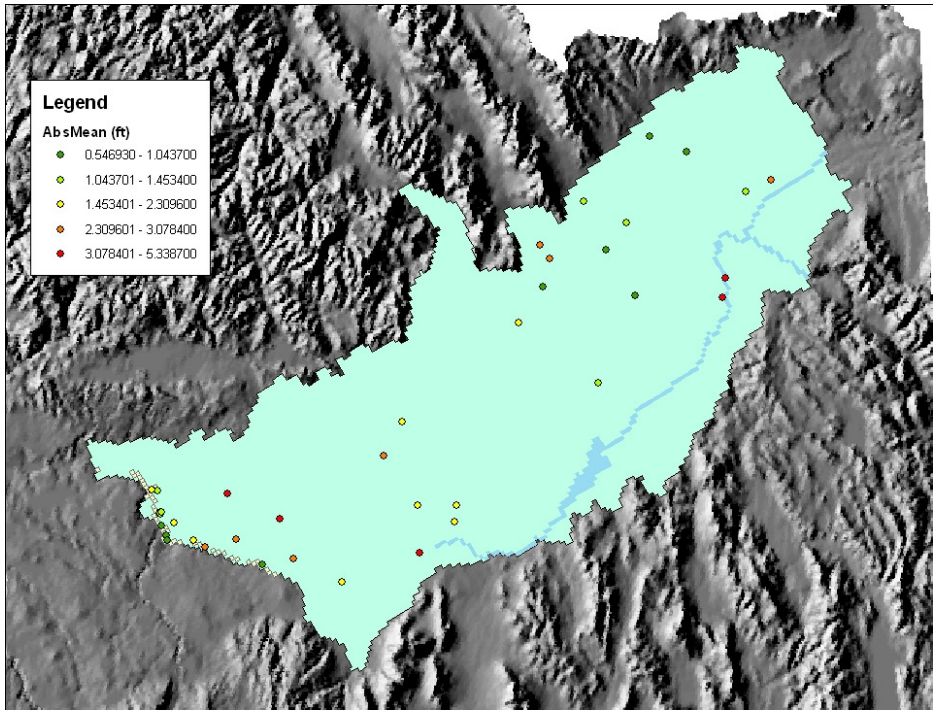
Tributary Underflow



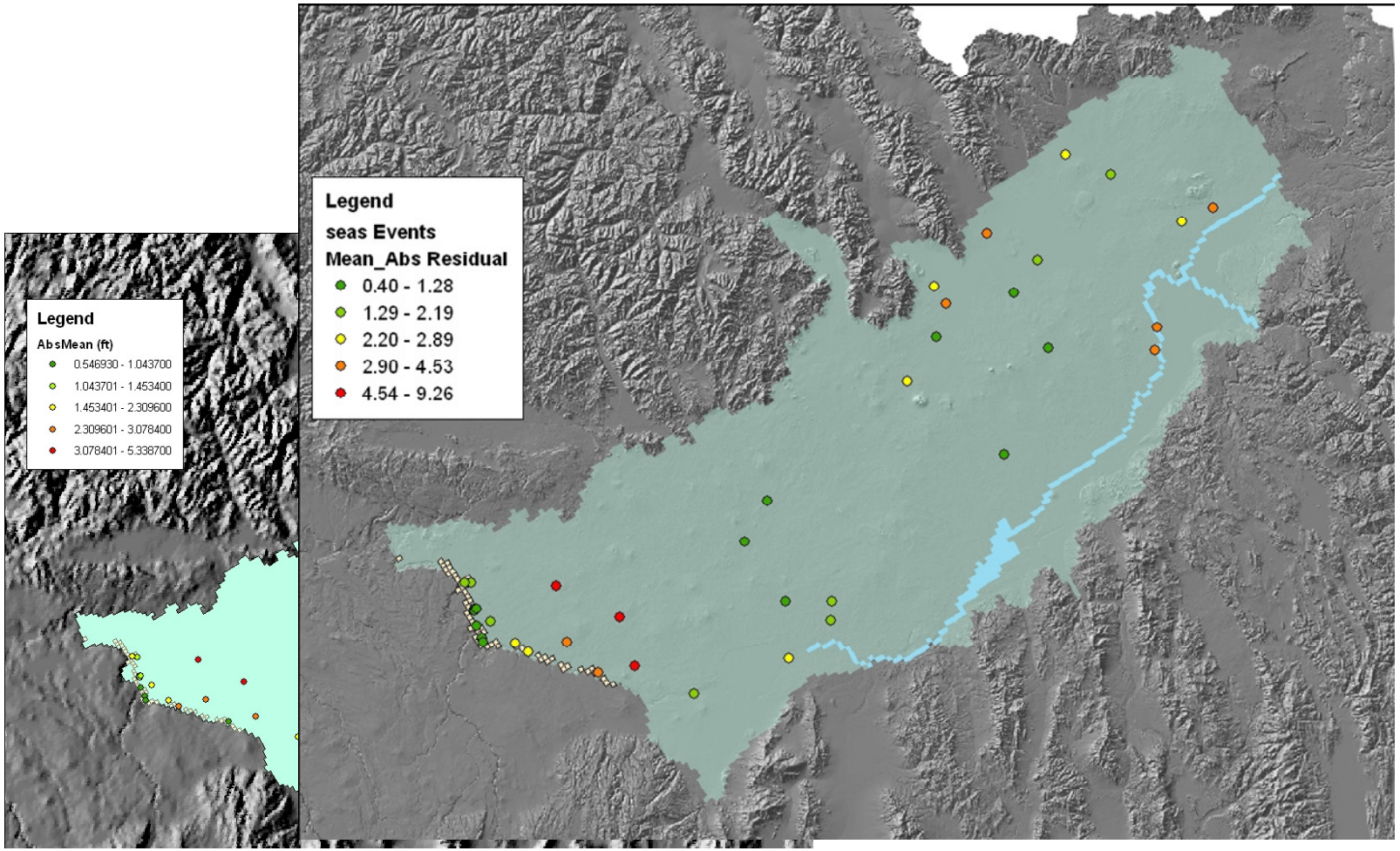
Transient Heads

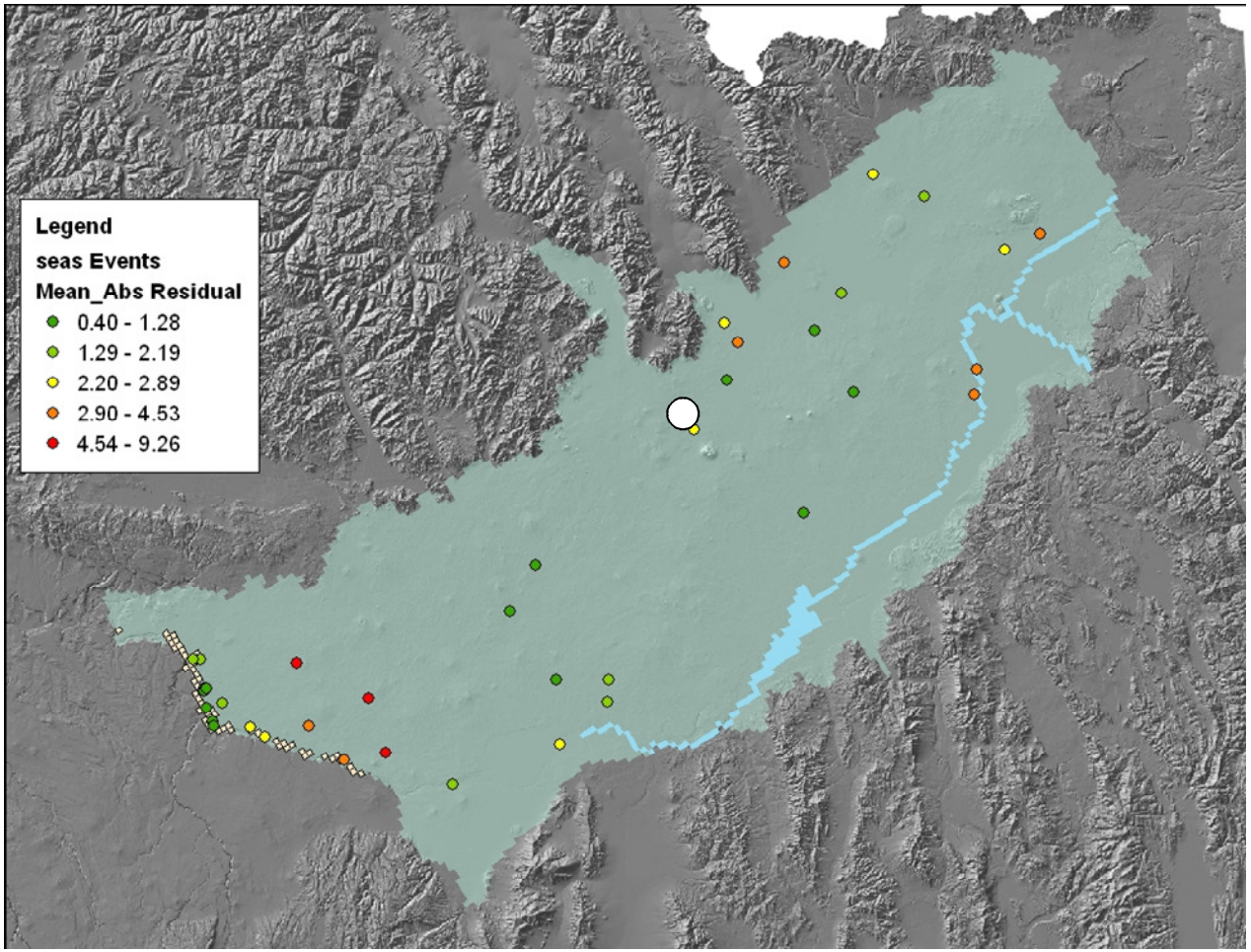


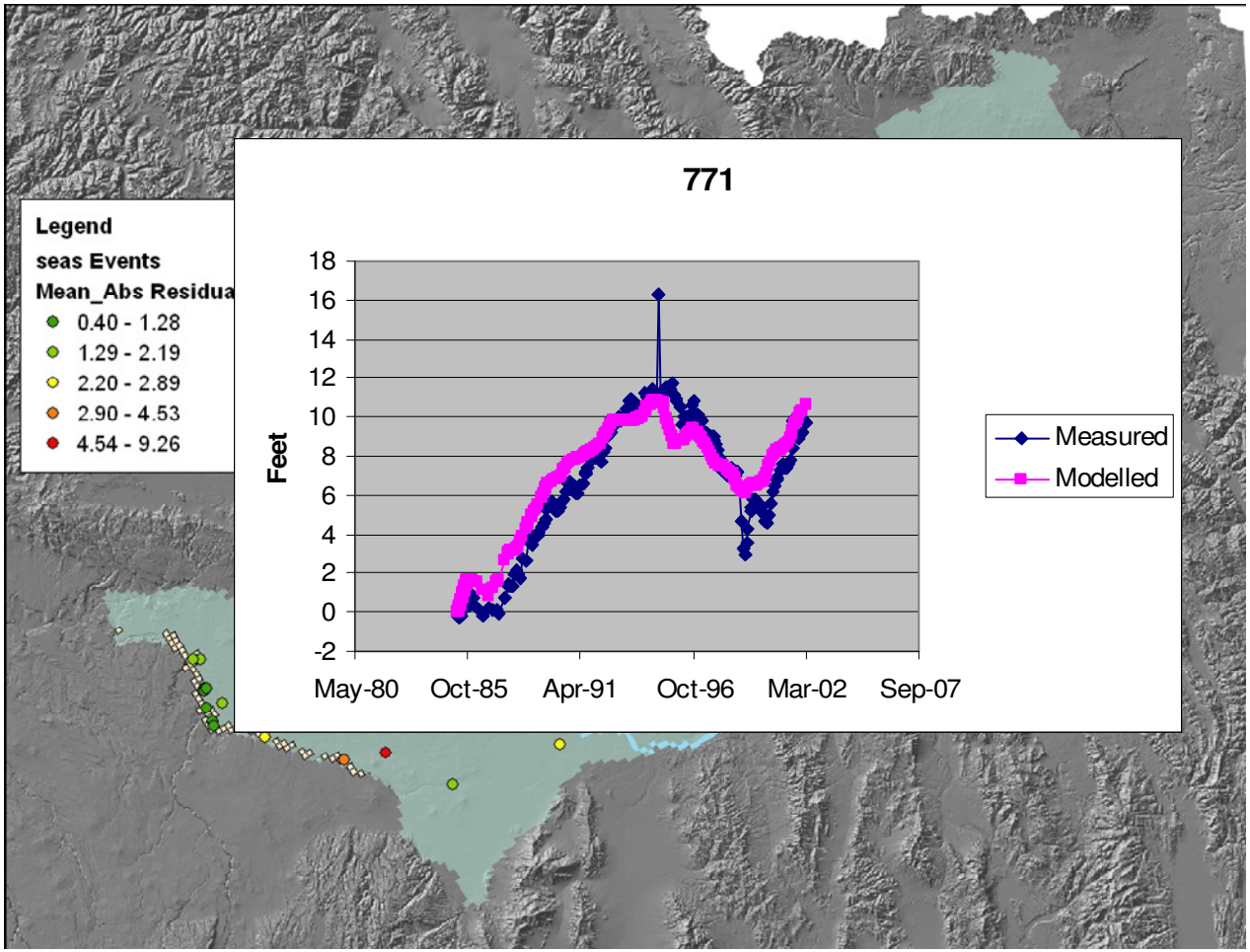

y = 1.0129x - 36.14
R² = 0.9912
Modelled
Measured
7000
6500
6000
5500
5000
4500
4000
3500
3000
2500
2000
2000
3000
4000
5000
6000
7000

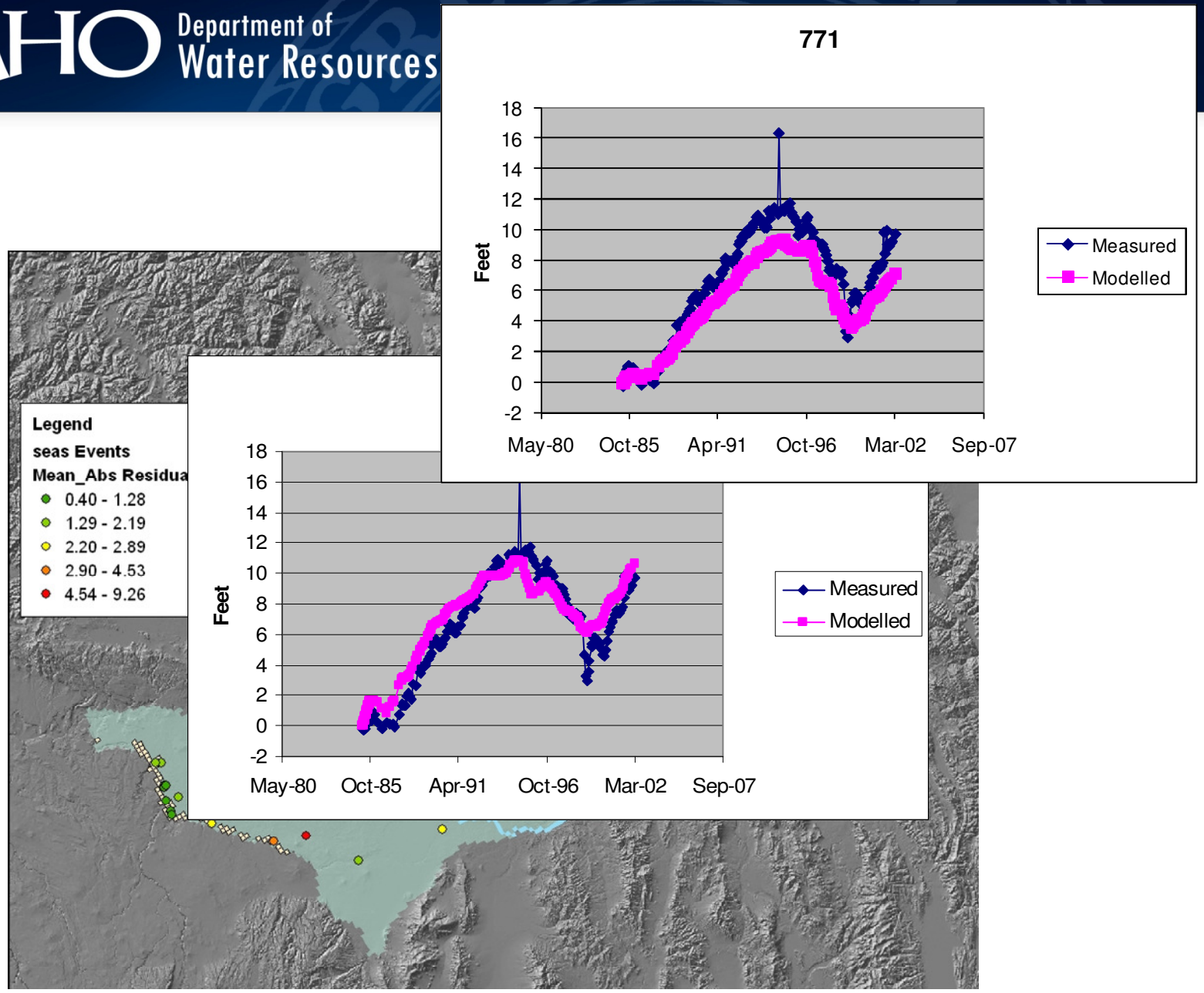


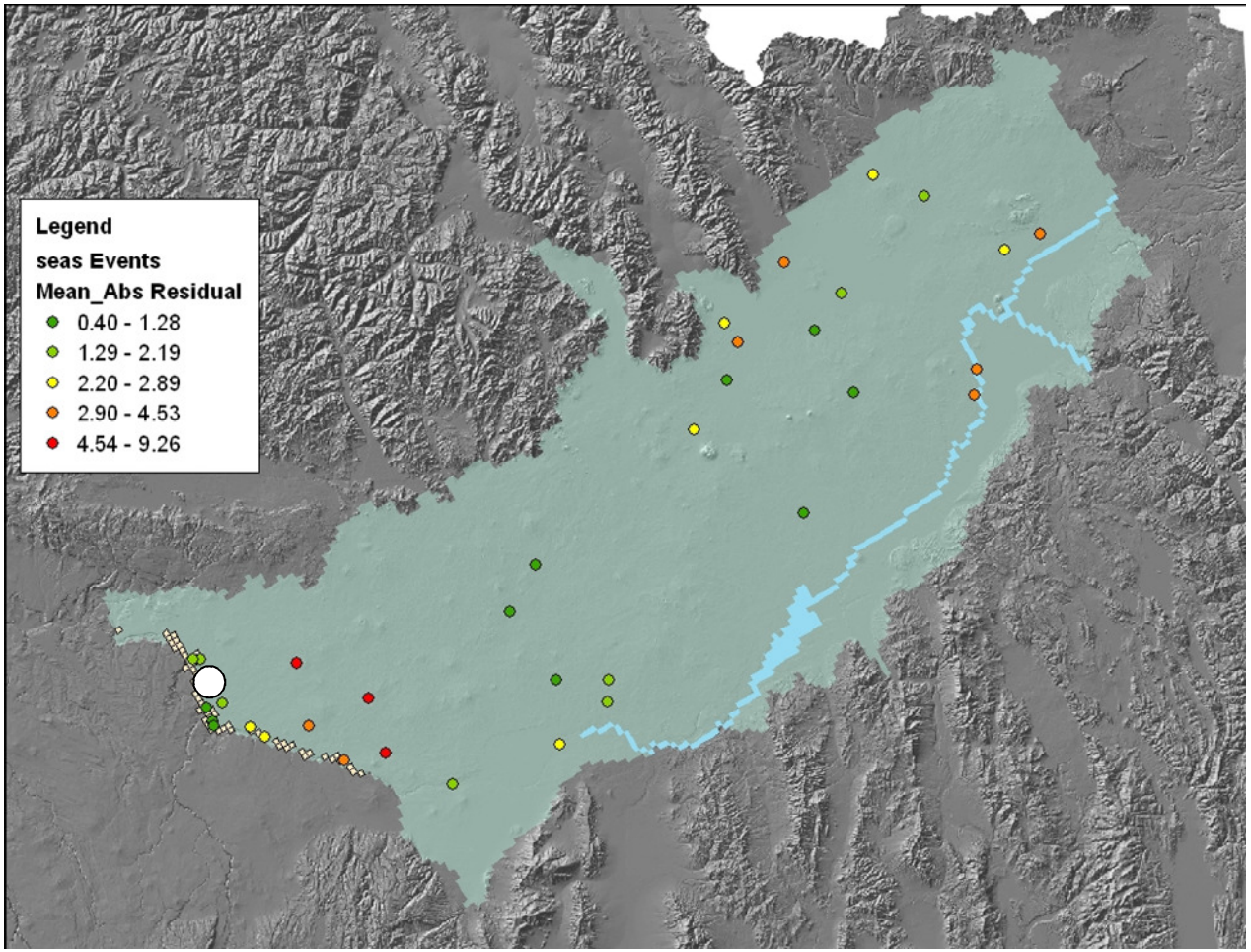
- Hundreds to thousands of observations
  - Lots of data
  - Limited spatial coverage

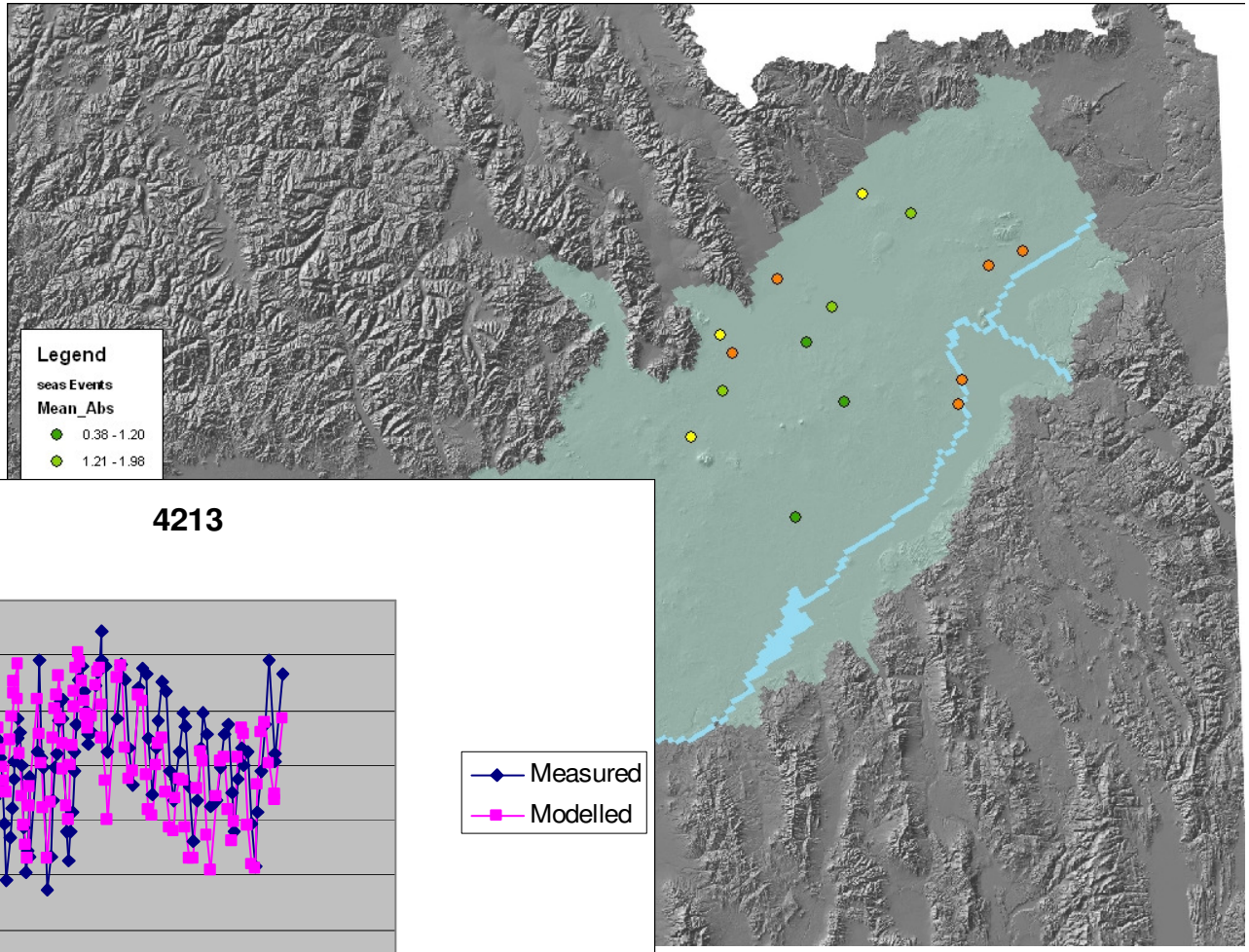

Legend
AbsMean (ft)
0.546930 - 1.043700
1.043701 - 1.453400
1.453401 - 2.309600
2.309601 - 3.078400
3.078401 - 5.338700
Legend
seas Events
Mean_Abs Residual
0.40 - 1.28
1.29 - 2.19
2.20 - 2.89
2.90 - 4.53
4.54 - 9.26

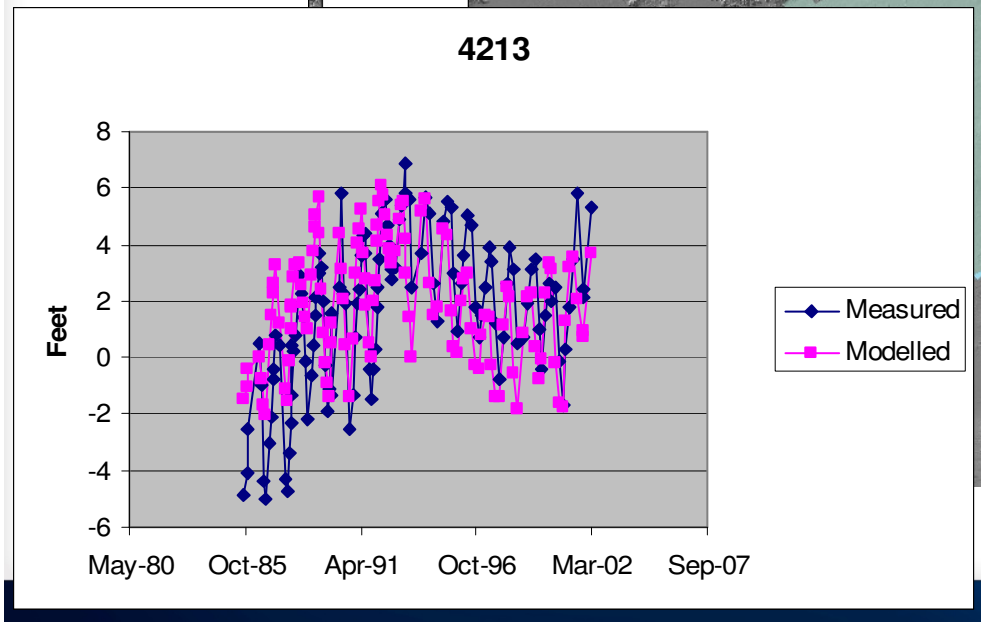

Legend
seas Events
Mean_Abs Residual
0.40 - 1.28
1.29 - 2.19
2.20 - 2.89
2.90 - 4.53
4.54 - 9.26

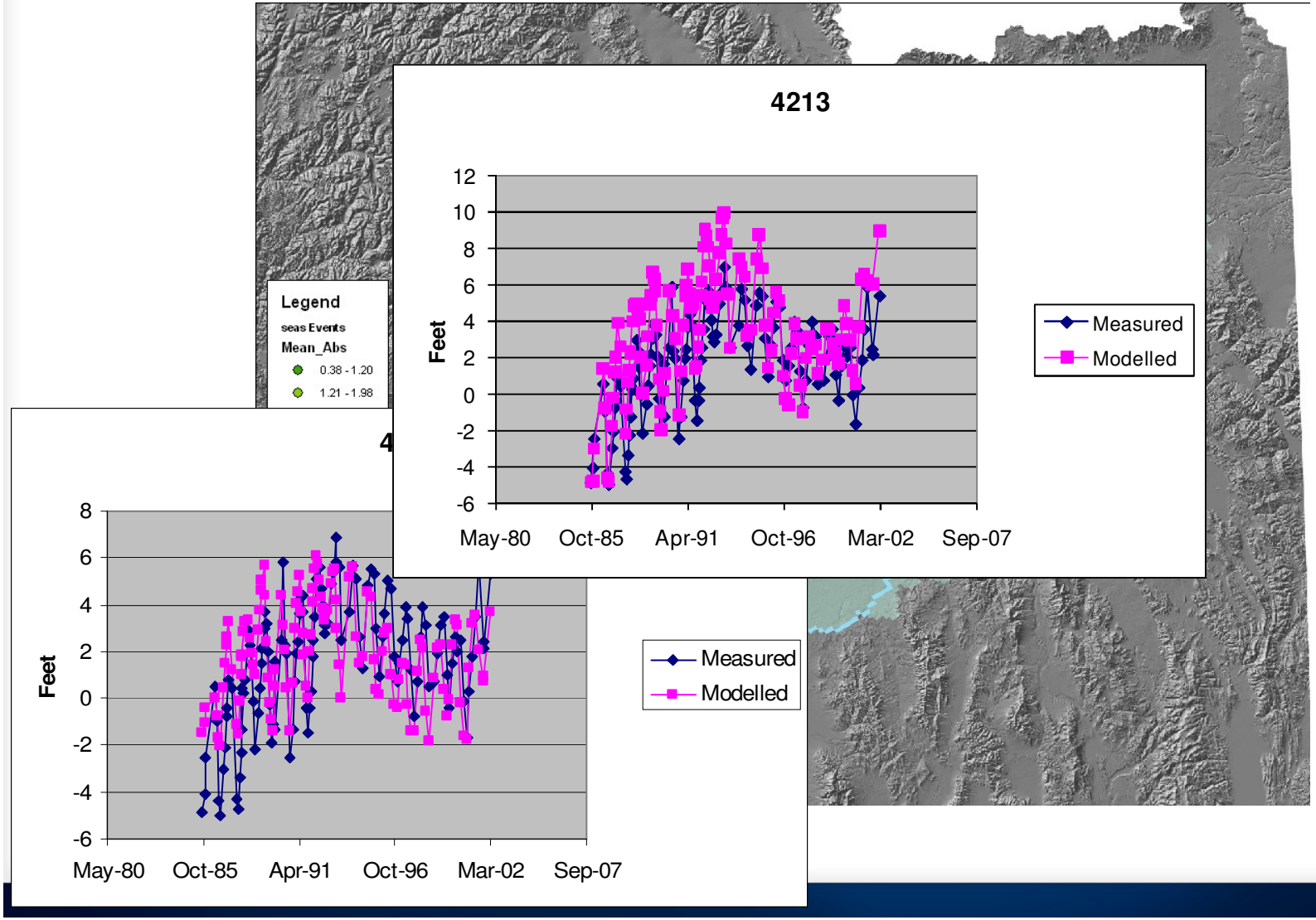

Legend
seas Events
Mean_Abs Residua
0.40 - 1.28
1.29 - 2.19
2.20 - 2.89
2.90 - 4.53
4.54 - 9.26
771
Feet
18
16
14
12
10
8
6
4
2
0
-2
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Measured
Modelled

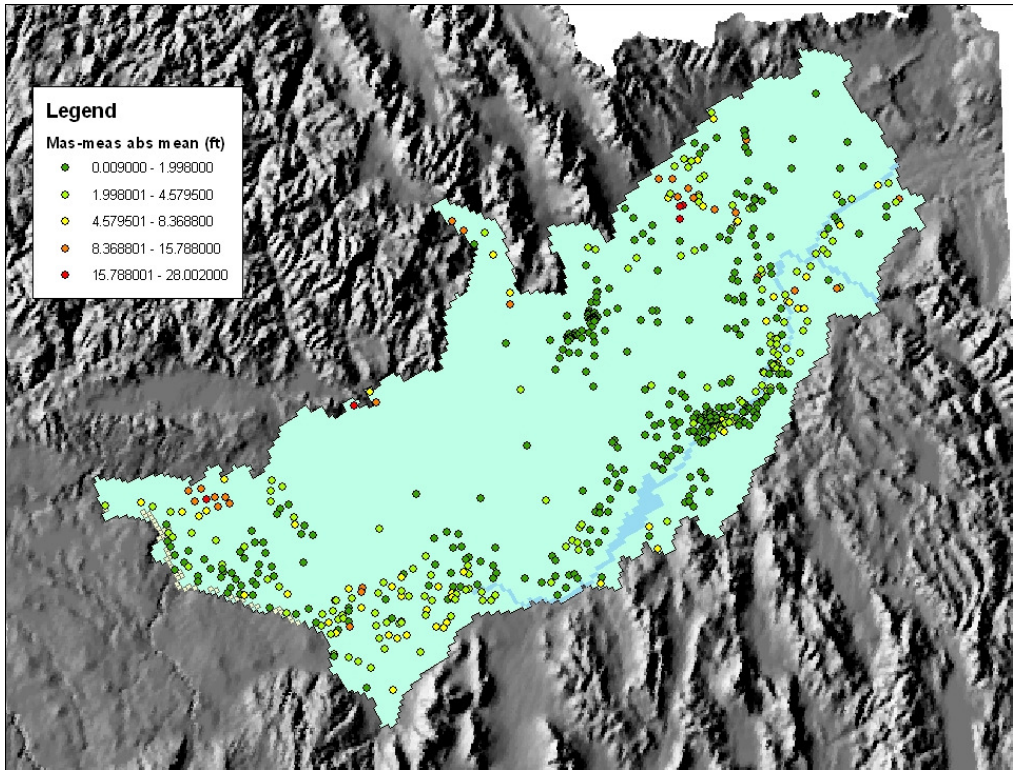

771
Feet
18
16
14
12
10
8
6
4
2
0
-2
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Measured
Modelled
Legend
seas Events
Mean_Abs Residua
0.40 - 1.28
1.29 - 2.19
2.20 - 2.89
2.90 - 4.53
4.54 - 9.26


Legend
seas Events
Mean_Abs Residual
0.40 - 1.28
1.29 - 2.19
2.20 - 2.89
2.90 - 4.53
4.54 - 9.26

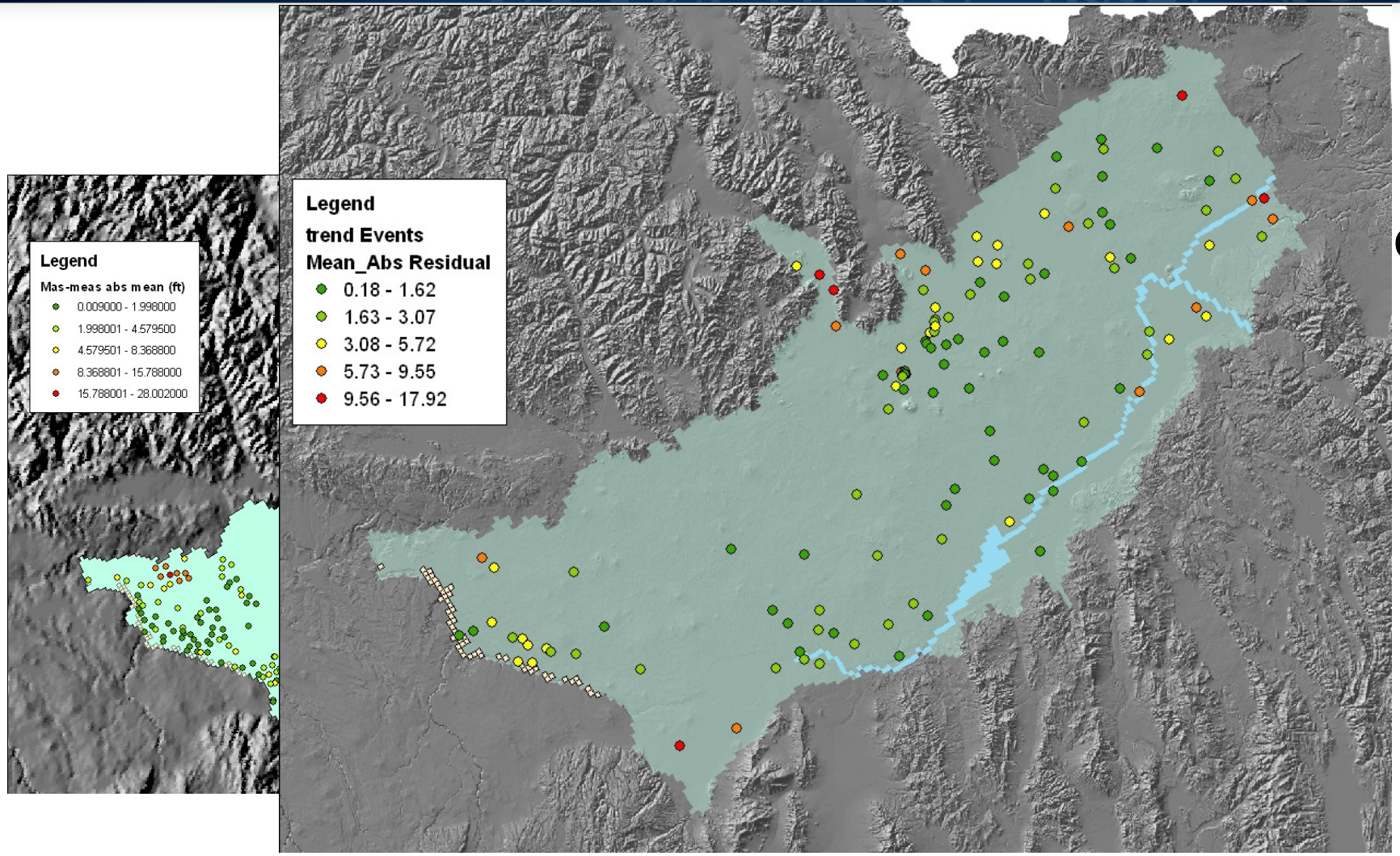

Legend
seas Events
Mean_Abs
0.38 - 1.20
1.21 - 1.98


4213
Feet
8
6
4
2
0
-2
-4
-6
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Measured
Modelled

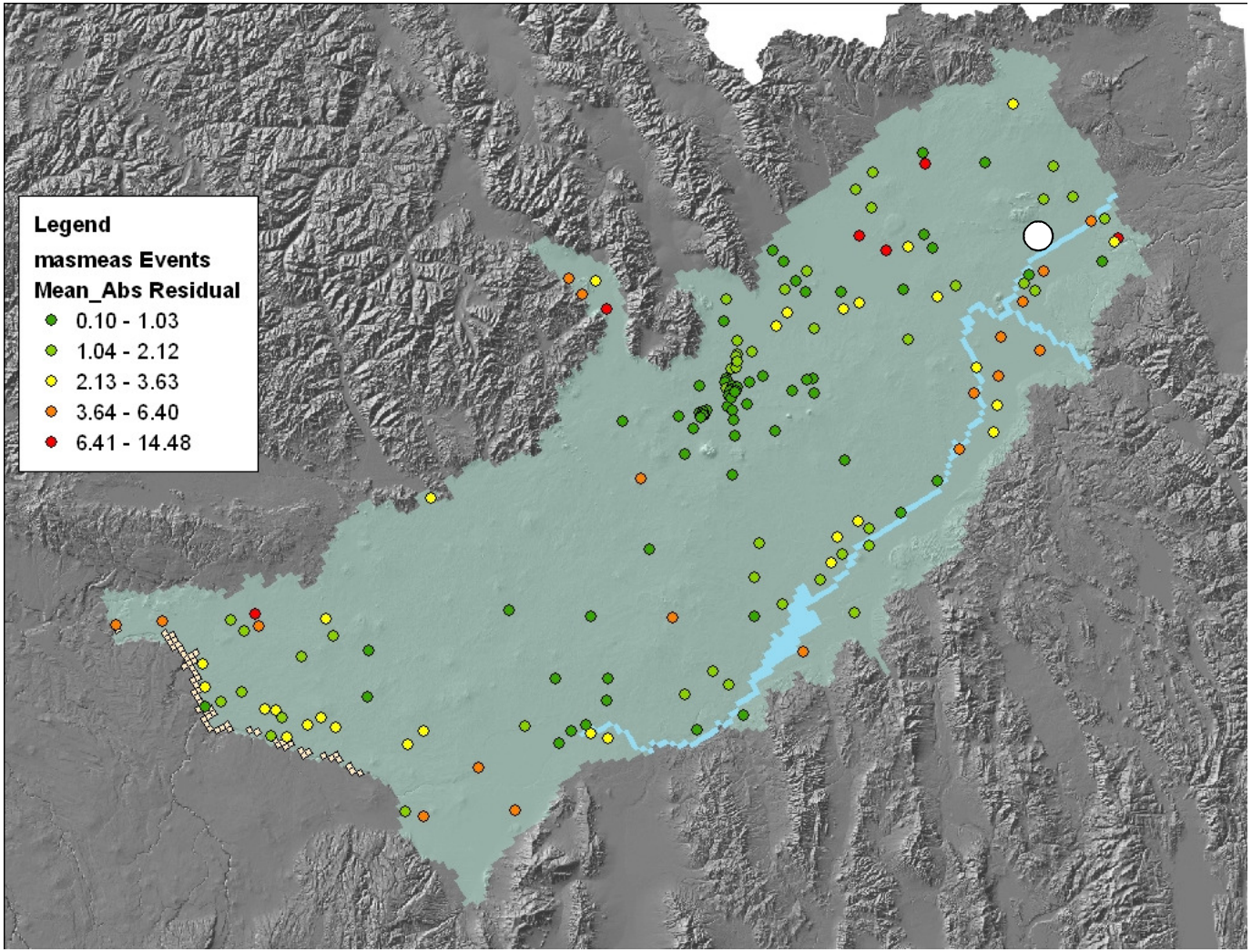

Legend
seas Events
Mean_Abs
0.38 - 1.20
1.21 - 1.98
4213
Feet
12
10
8
6
4
2
0
-2
-4
-6
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Measured
Modelled
Feet
8
6
4
2
0
-2
-4
-6
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Measured
Modelled

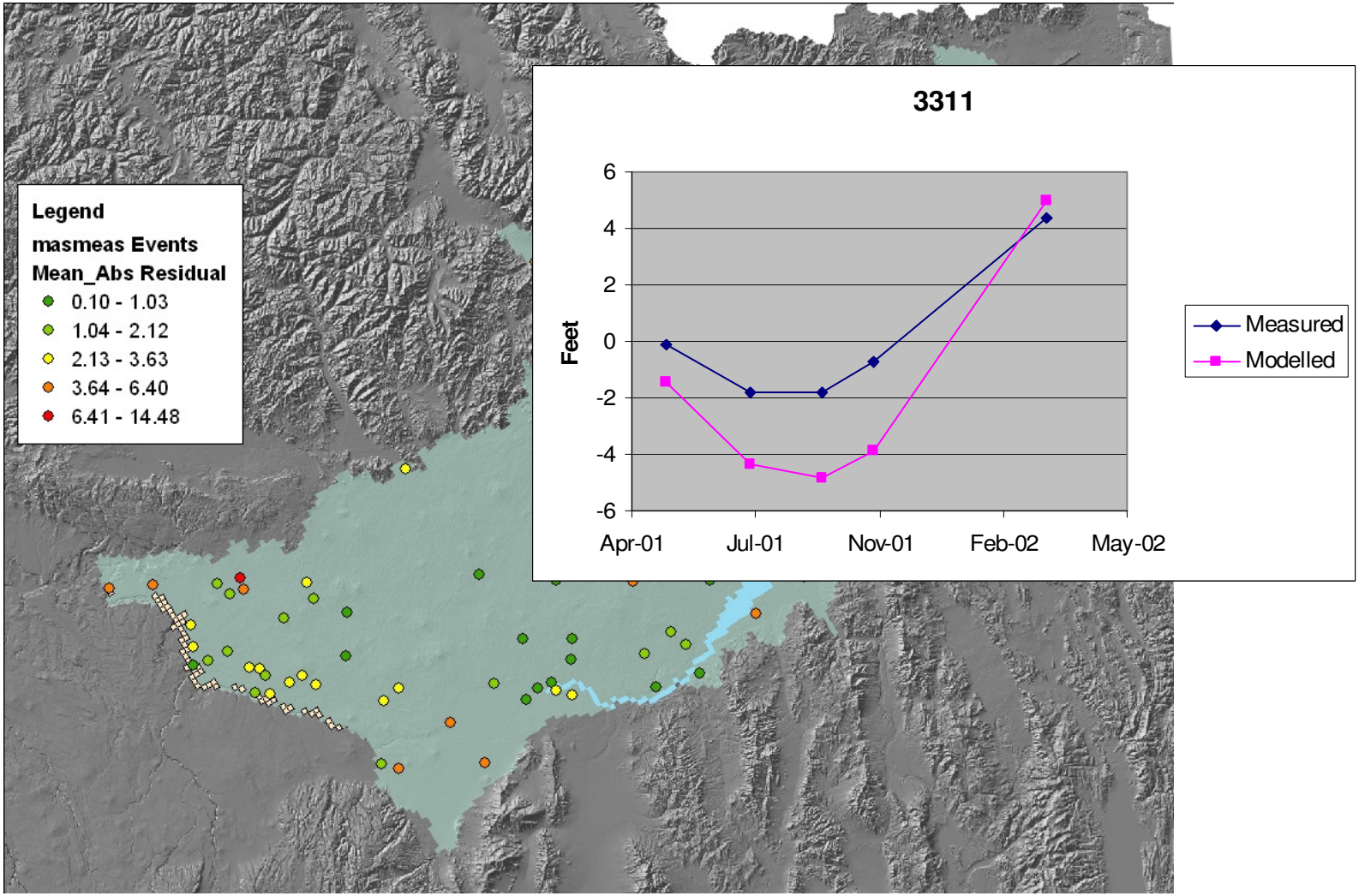


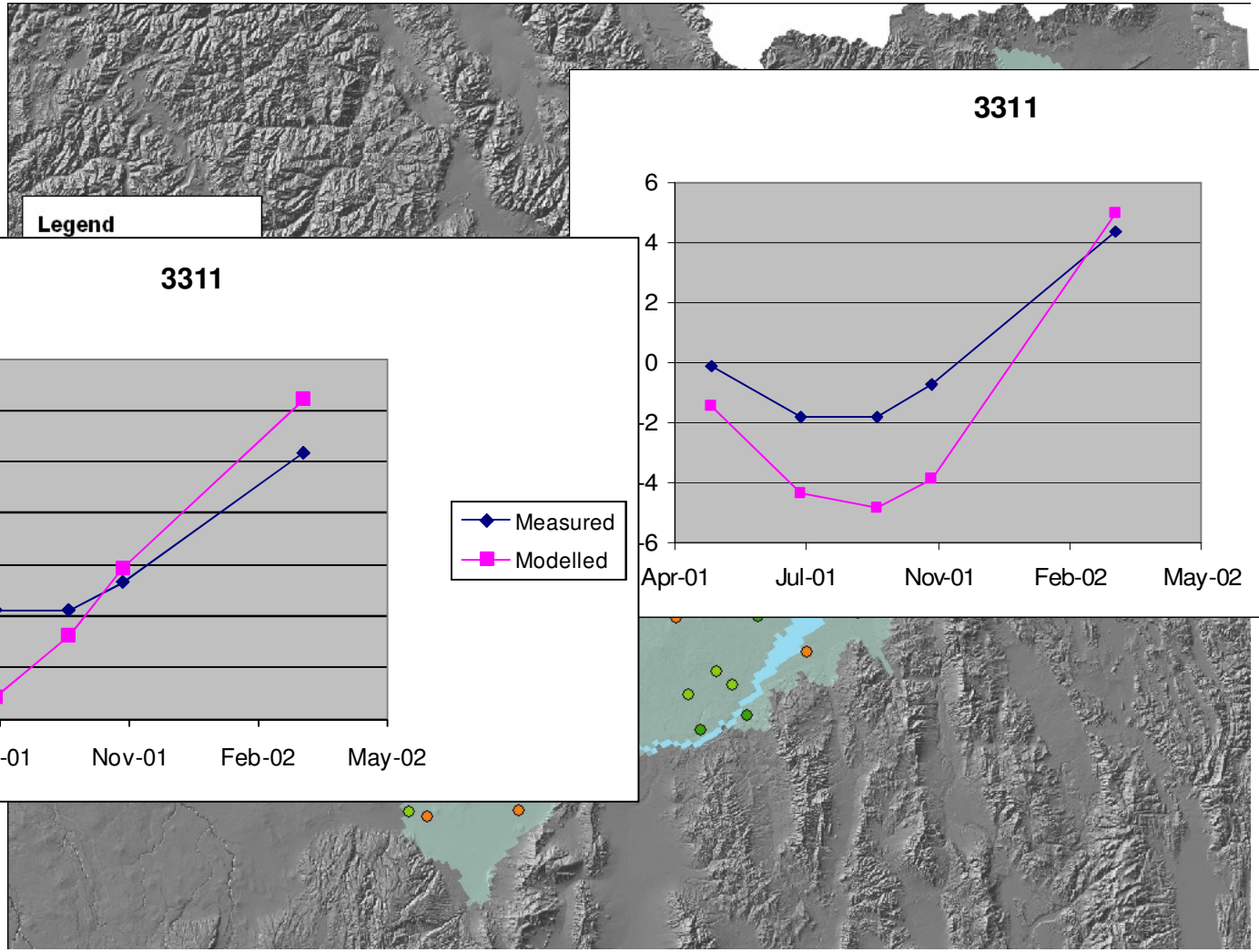
- Observations collected on behalf of this modeling effort
  - 3/1/2001 –5/8/2002

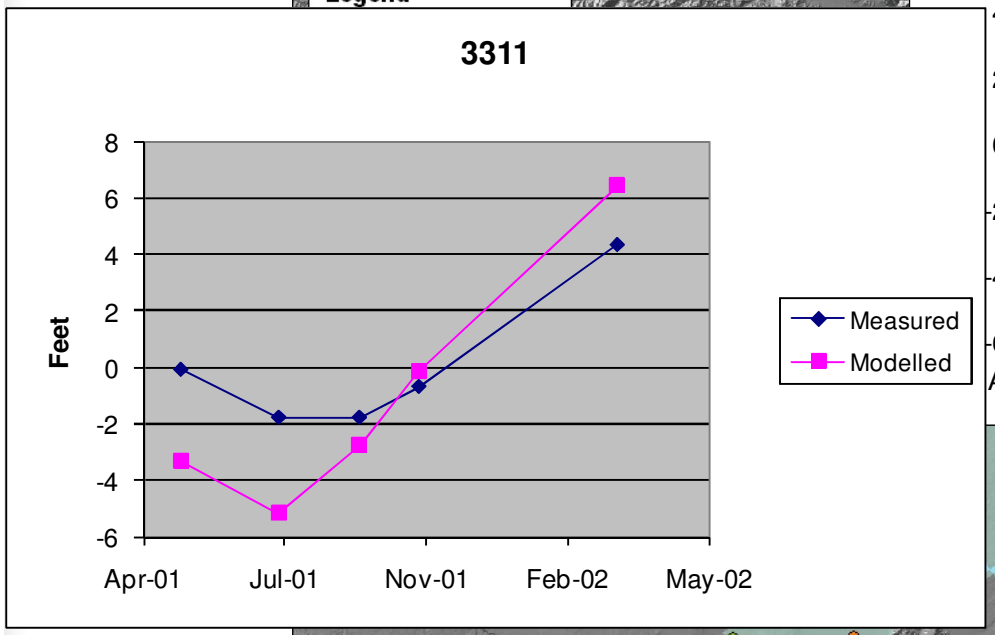

Legend
Mas-meas abs mean (ft)
0.009000 - 1.998000
1.998001 - 4.579500
4.579501 - 8.368800
8.368801 - 15.788000
15.788001 - 28.002000
Legend
trend Events
Mean_Abs Residual
0.18 - 1.62
1.63 - 3.07
3.08 - 5.72
5.73 - 9.55
9.56 - 17.92

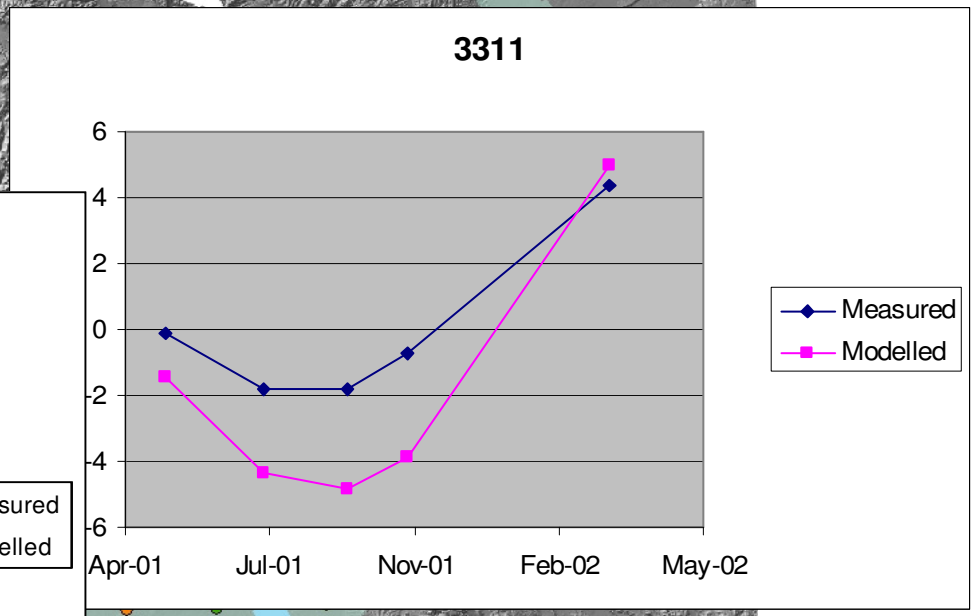
d

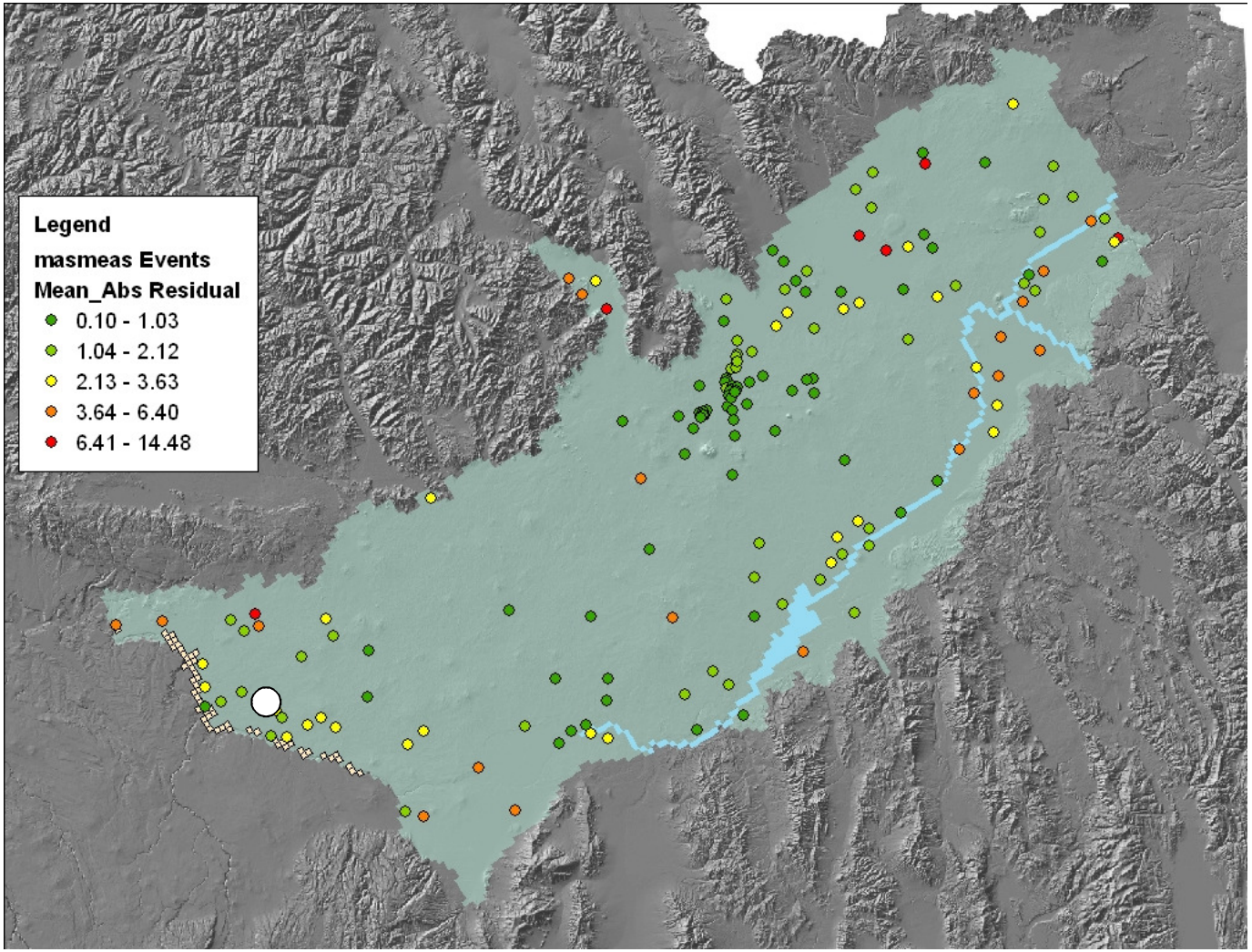

Legend
masmeas Events
Mean_Abs Residual
0.10 - 1.03
1.04 - 2.12
2.13 - 3.63
3.64 - 6.40
6.41 - 14.48

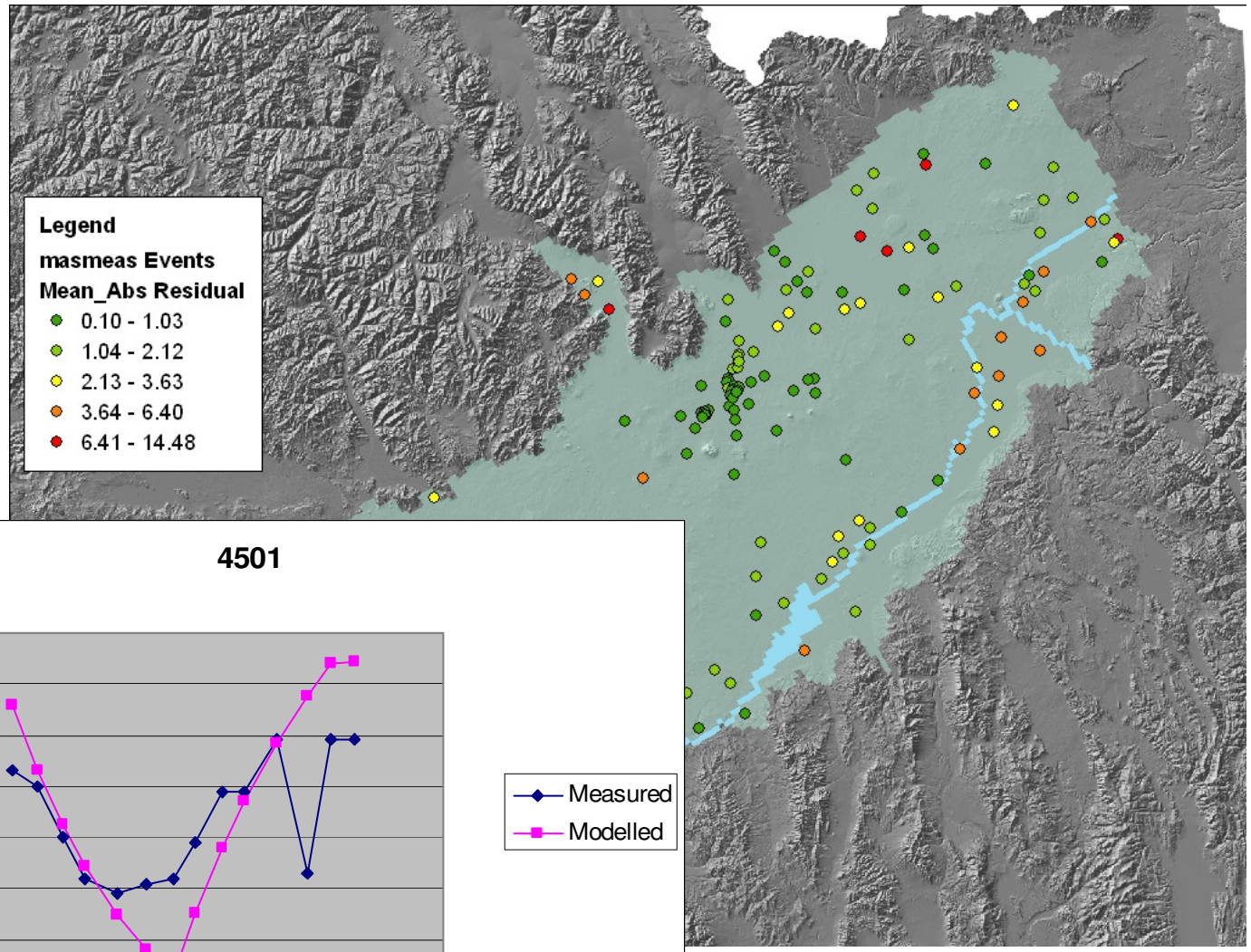

Legend
masmeas Events
Mean_Abs Residual
0.10 - 1.03
1.04 - 2.12
2.13 - 3.63
3.64 - 6.40
6.41 - 14.48
3311
Feet
6
4
2
0
-2
-4
-6
Apr-01
Jul-01
Nov-01
Feb-02
May-02
Measured
Modelled

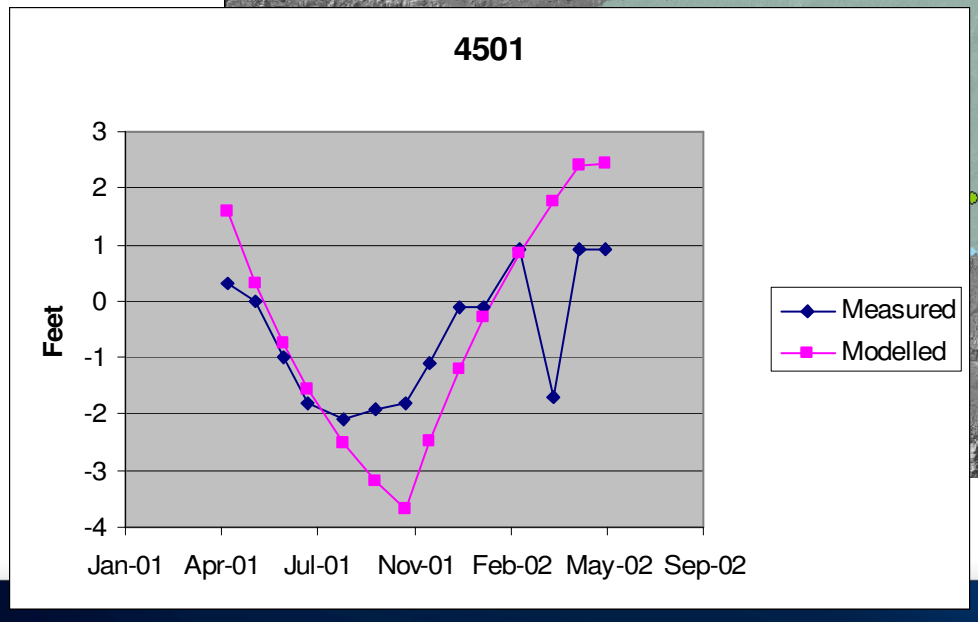

Legend

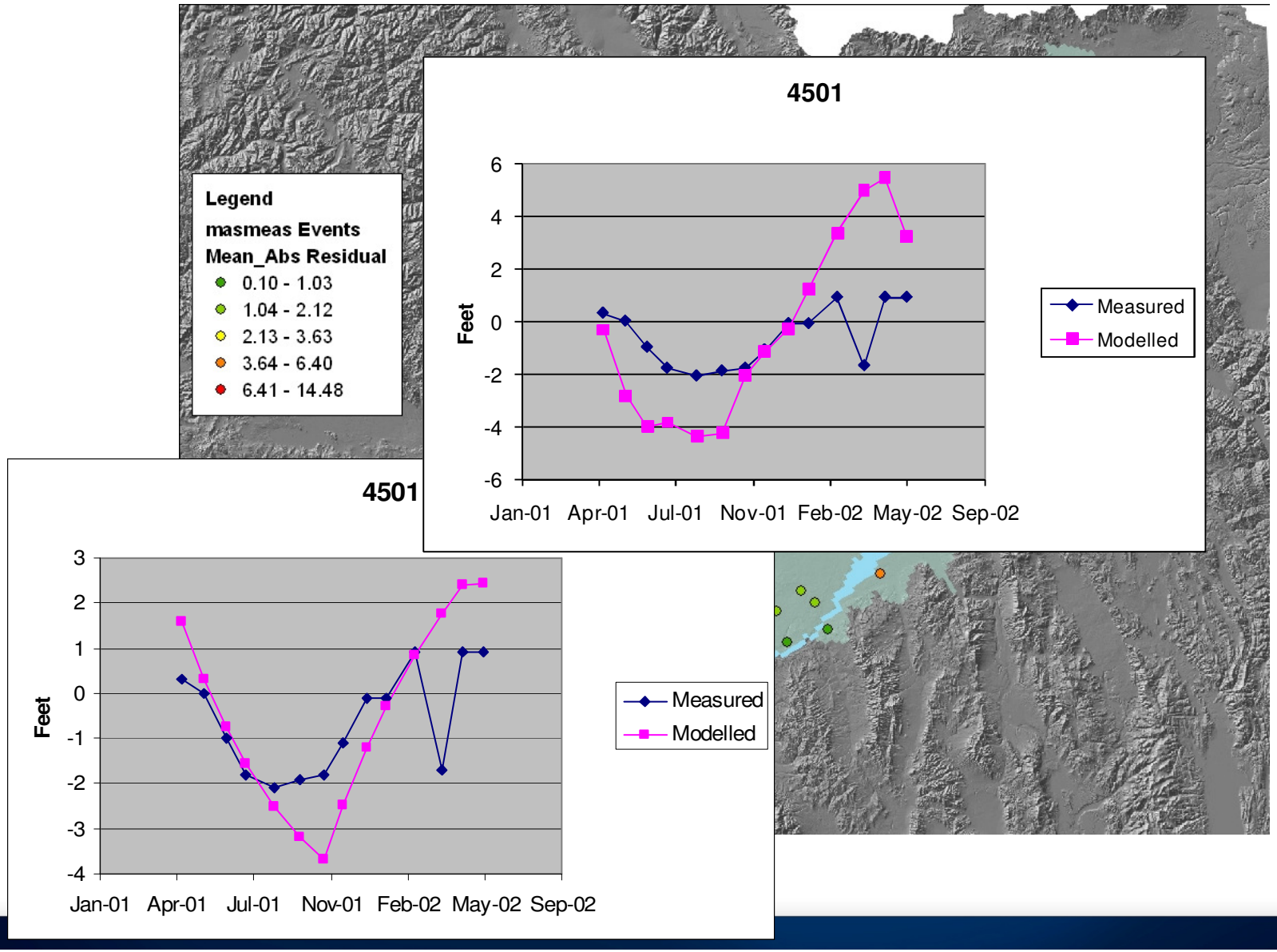

3311
Feet
8
6
4
2
0
-2
-4
-6
Apr-01
Jul-01
Nov-01
Feb-02
May-02
Measured
Modelled

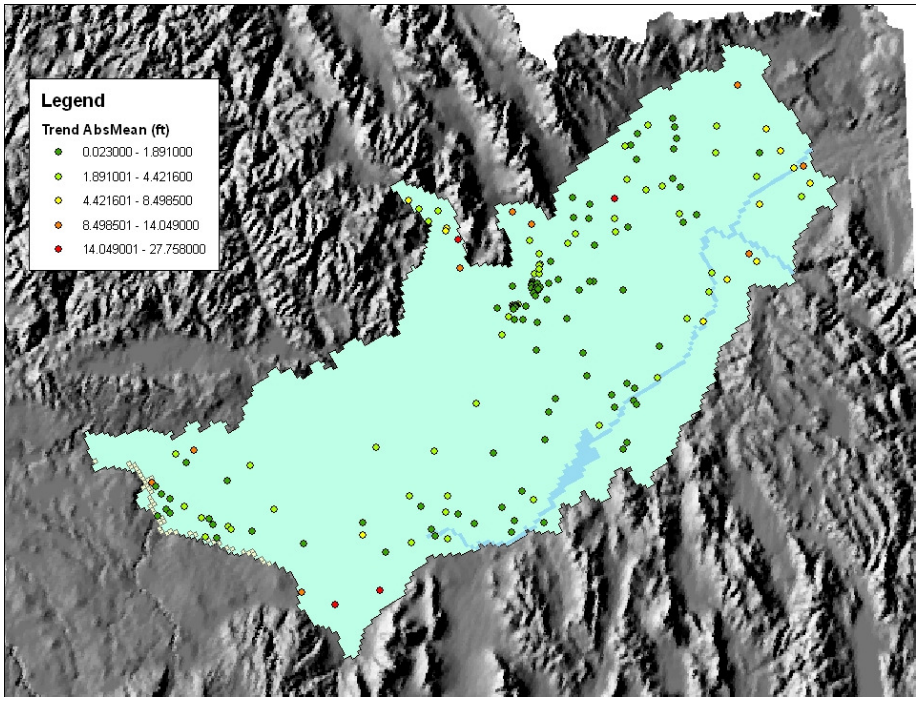

3311
6
4
2
0
-2
-4
-6
Apr-01
Jul-01
Nov-01
Feb-02
May-02
Measured
Modelled


Legend
masmeas Events
Mean_Abs Residual
0.10 - 1.03
1.04 - 2.12
2.13 - 3.63
3.64 - 6.40
6.41 - 14.48


Legend
masmeas Events
Mean_Abs Residual
0.10 - 1.03
1.04 - 2.12
2.13 - 3.63
3.64 - 6.40
6.41 - 14.48

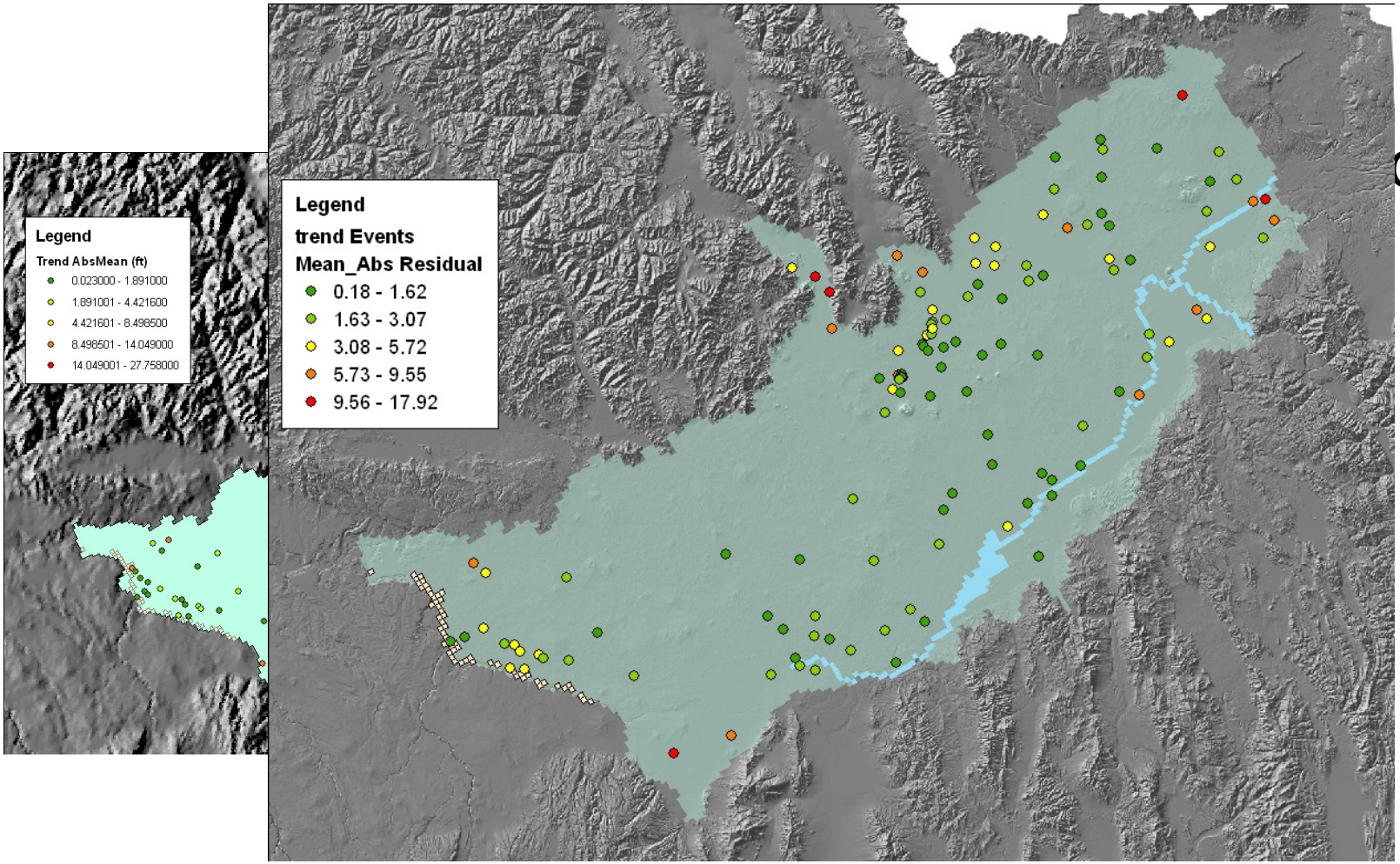

4501
Feet
3
2
1
0
-1
-2
-3
-4
Jan-01
Apr-01
Jul-01
Nov-01
Feb-02
May-02
Sep-02
Measured
Modelled

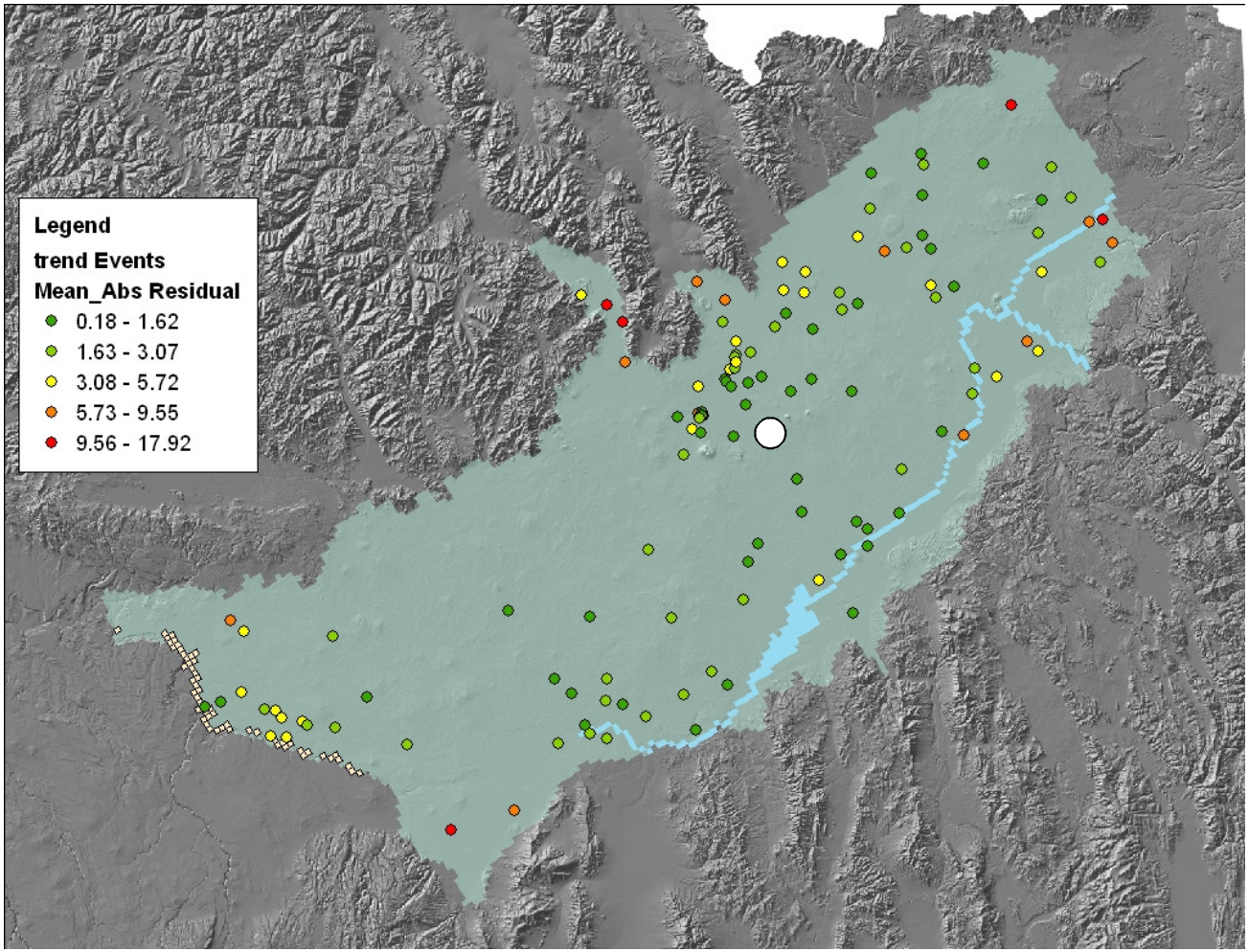

Legend
masmeas Events
Mean_Abs Residual
0.10 - 1.03
1.04 - 2.12
2.13 - 3.63
3.64 - 6.40
6.41 - 14.48
4501
Feet
6
4
2
0
-2
-4
-6
Jan-01
Apr-01
Jul-01
Nov-01
Feb-02
May-02
Sep-02
Measured
Modelled
4501
Feet
3
2
1
0
-1
-2
-3
-4
Jan-01
Apr-01
Jul-01
Nov-01
Feb-02
May-02
Sep-02
Measured
Modelled

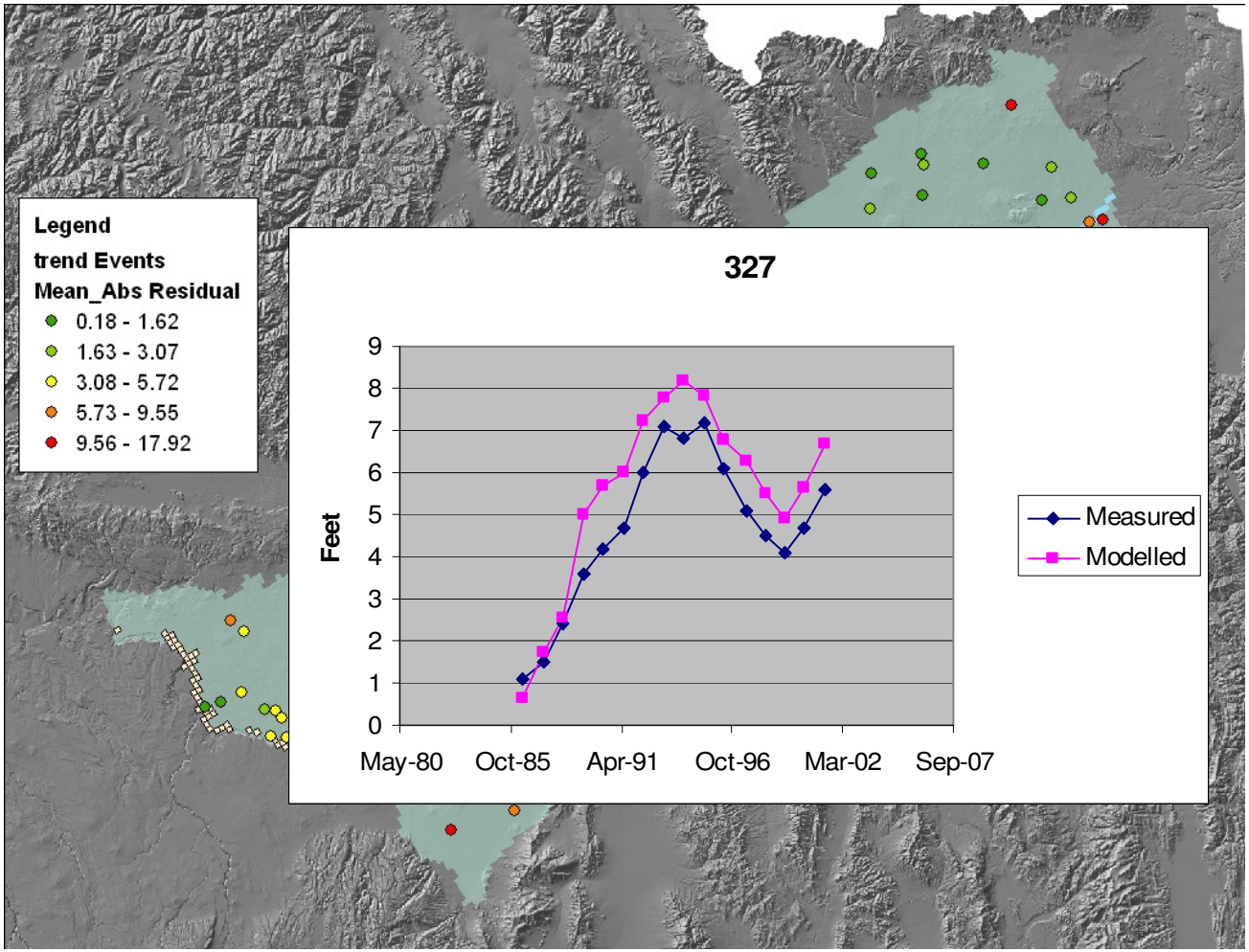


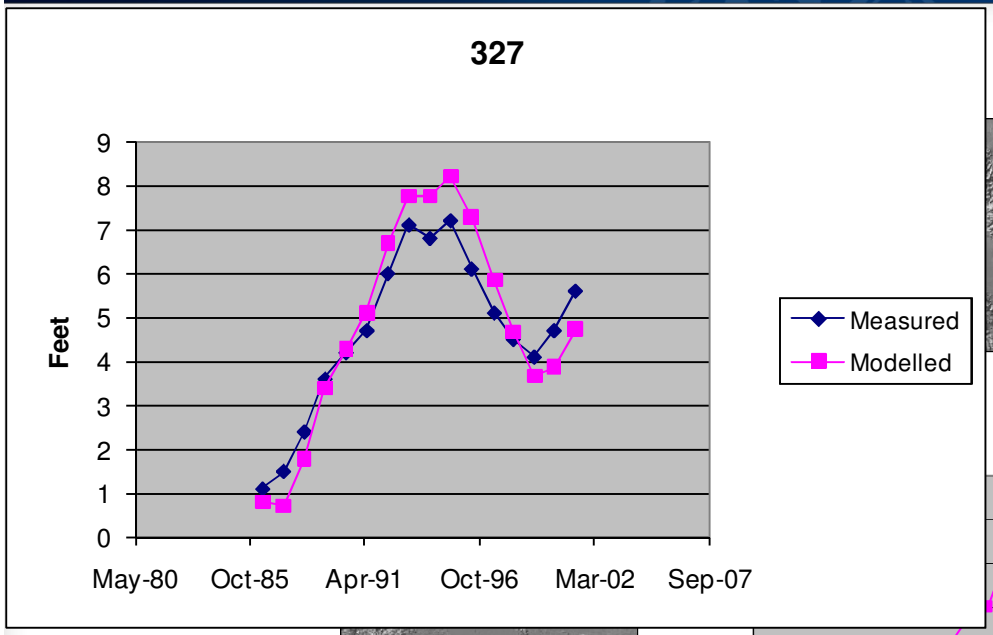
- Annual observations in wells

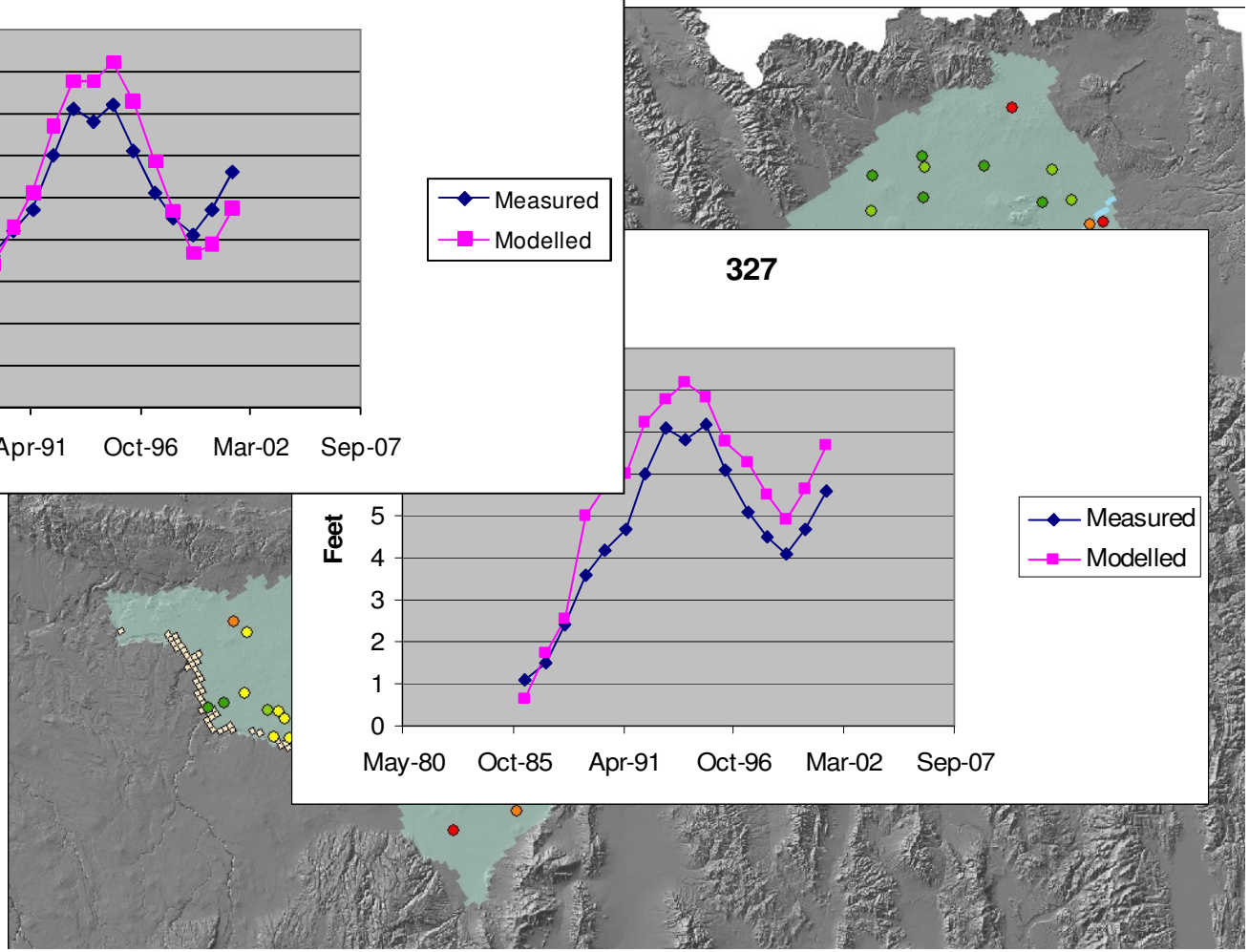
ons

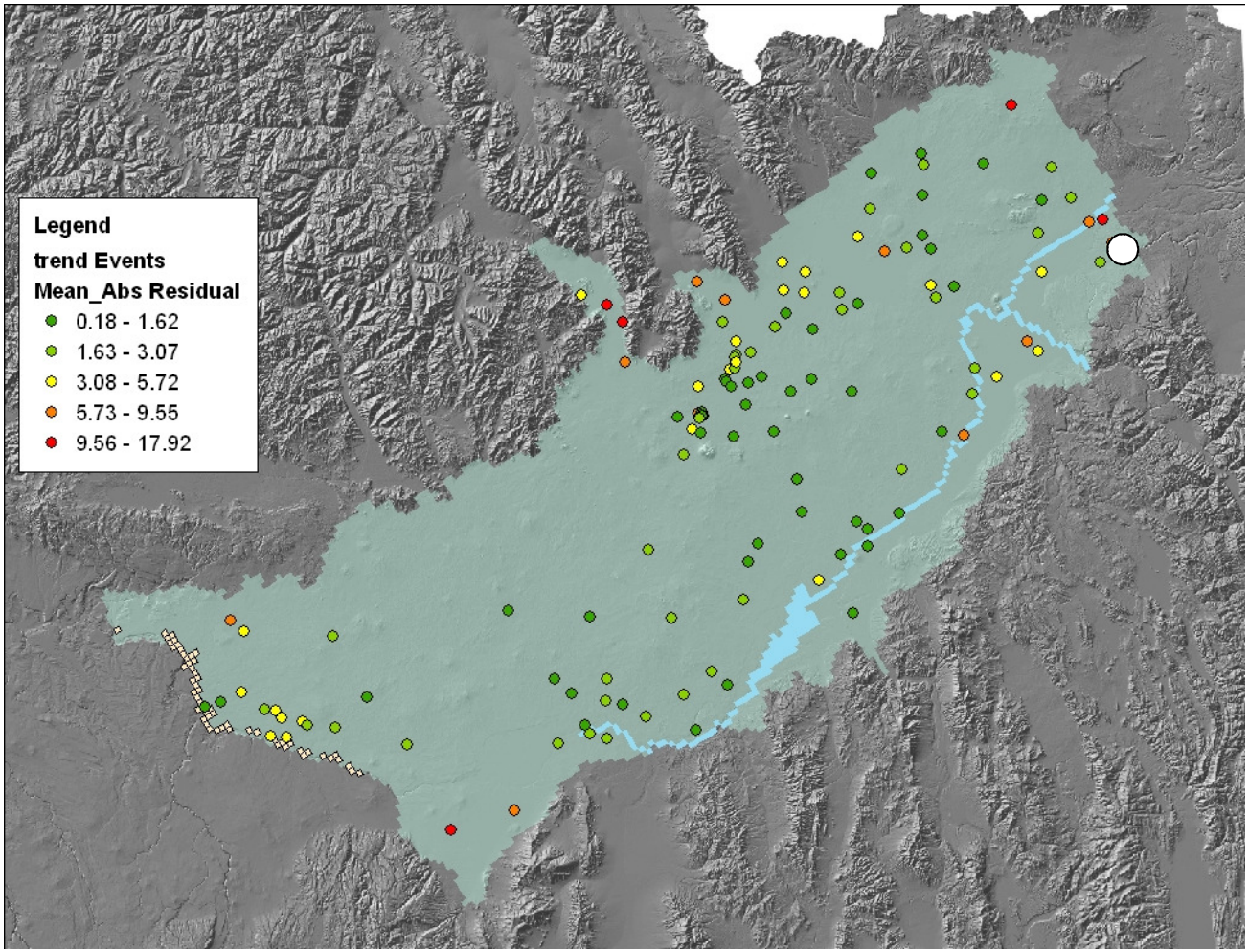

Legend
Trend AbsMean (ft)
0.023000 - 1.891000
1.891001 - 4.421600
4.421601 - 8.498500
8.498501 - 14.049000
14.049001 - 27.758000
Legend
trend Events
Mean_Abs Residual
0.18 - 1.62
1.63 - 3.07
3.08 - 5.72
5.73 - 9.55
9.56 - 17.92

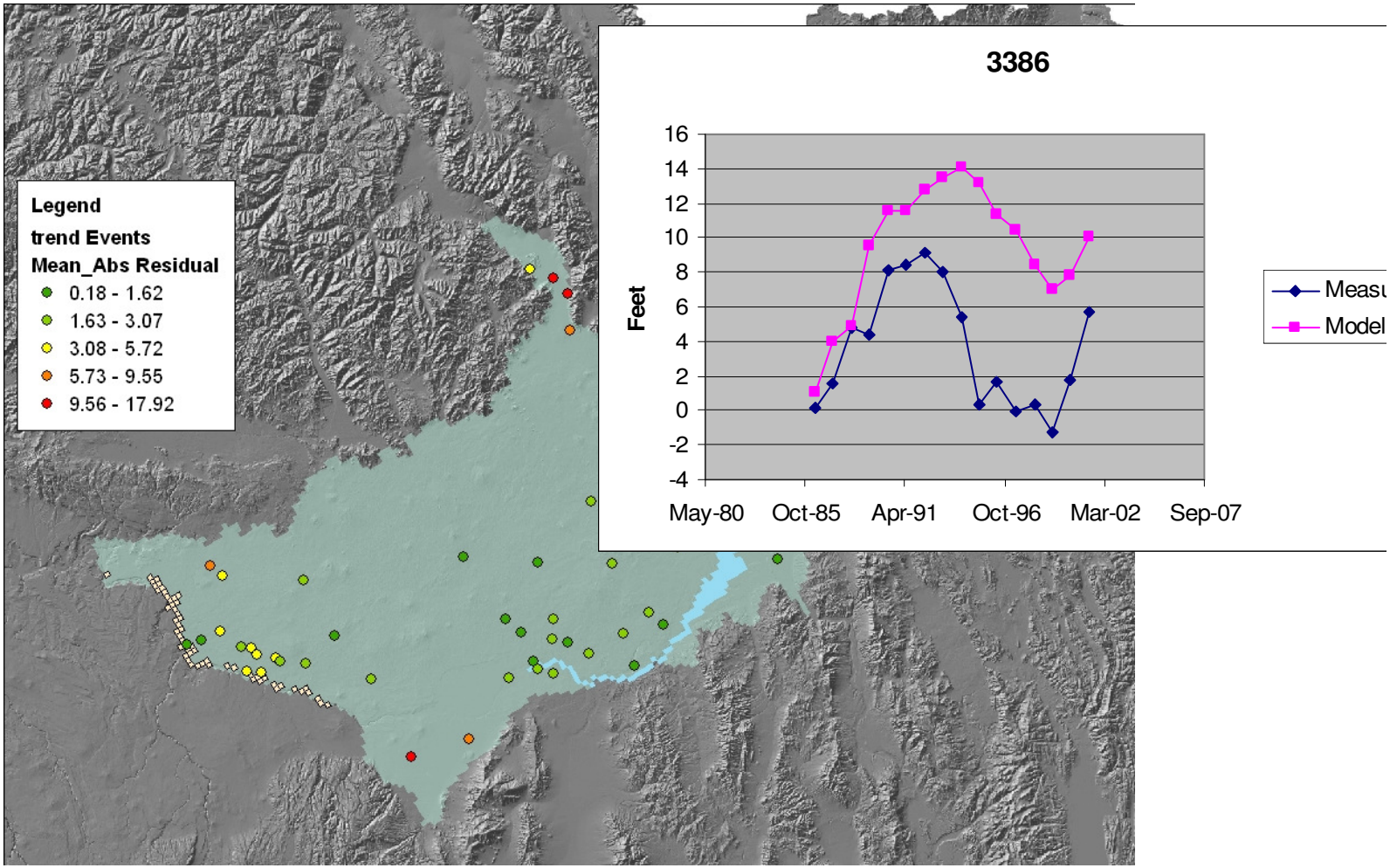

Legend
trend Events
Mean_Abs Residual
0.18 - 1.62
1.63 - 3.07
3.08 - 5.72
5.73 - 9.55
9.56 - 17.92

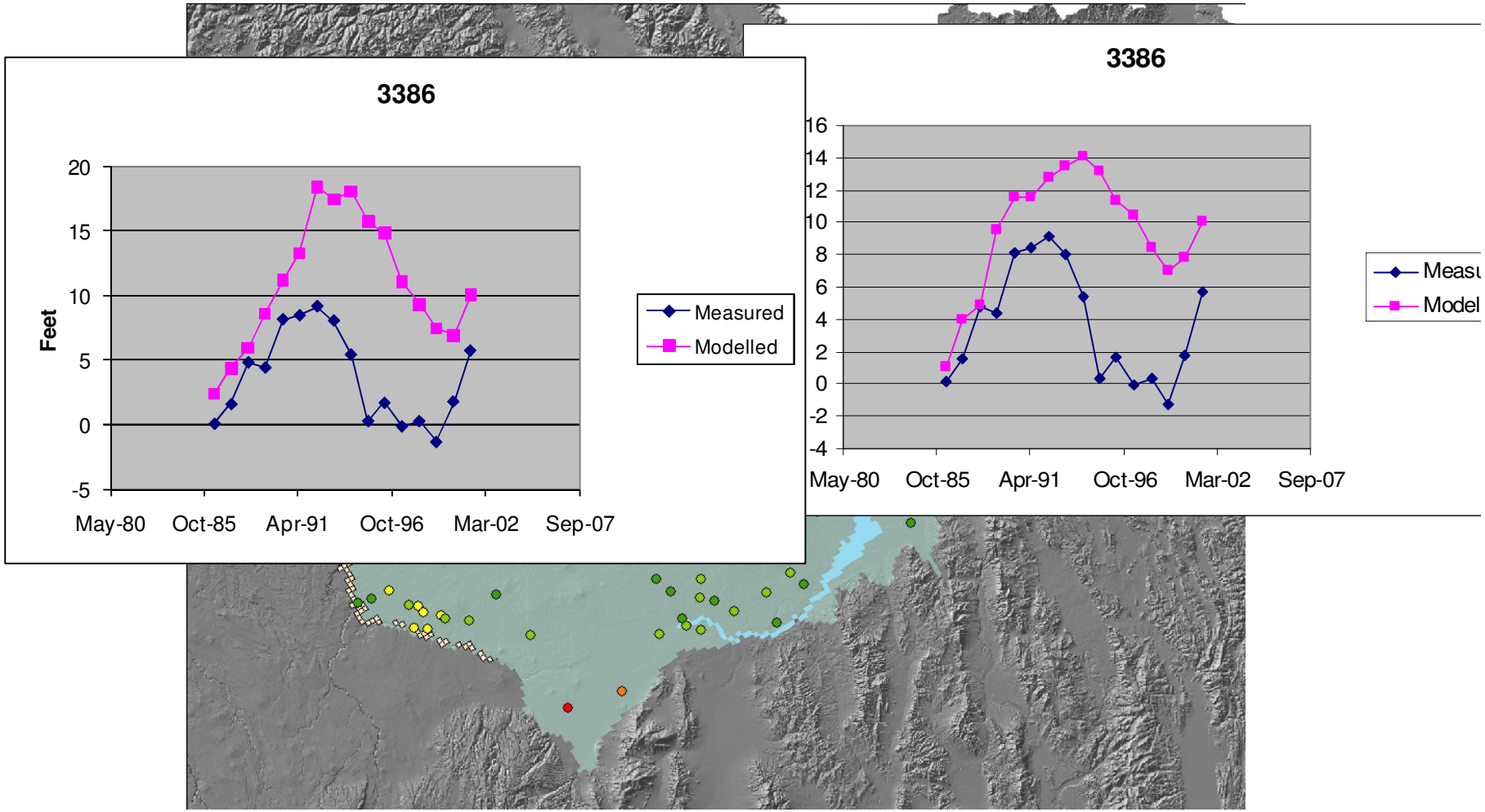

Legend
trend Events
Mean_Abs Residual
0.18 - 1.62
1.63 - 3.07
3.08 - 5.72
5.73 - 9.55
9.56 - 17.92
327
Feet
0
1
2
3
4
5
6
7
8
9
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Measured
Modelled

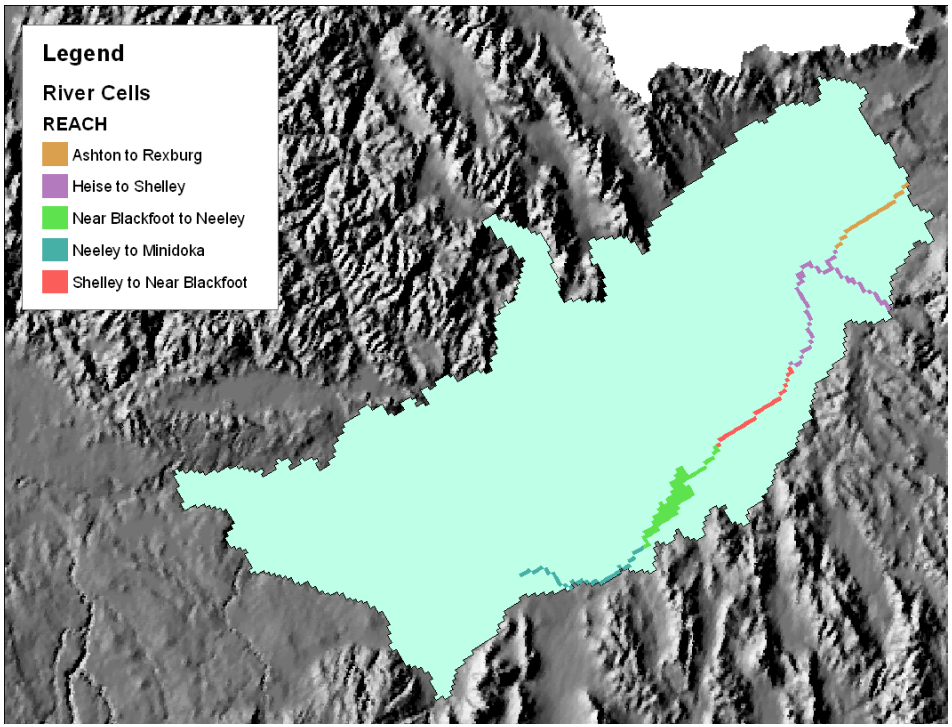

327
Feet
9
8
7
6
5
4
3
2
1
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Measured
Modelled


327
Feet
5
4
3
2
1
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Measured
Modelled

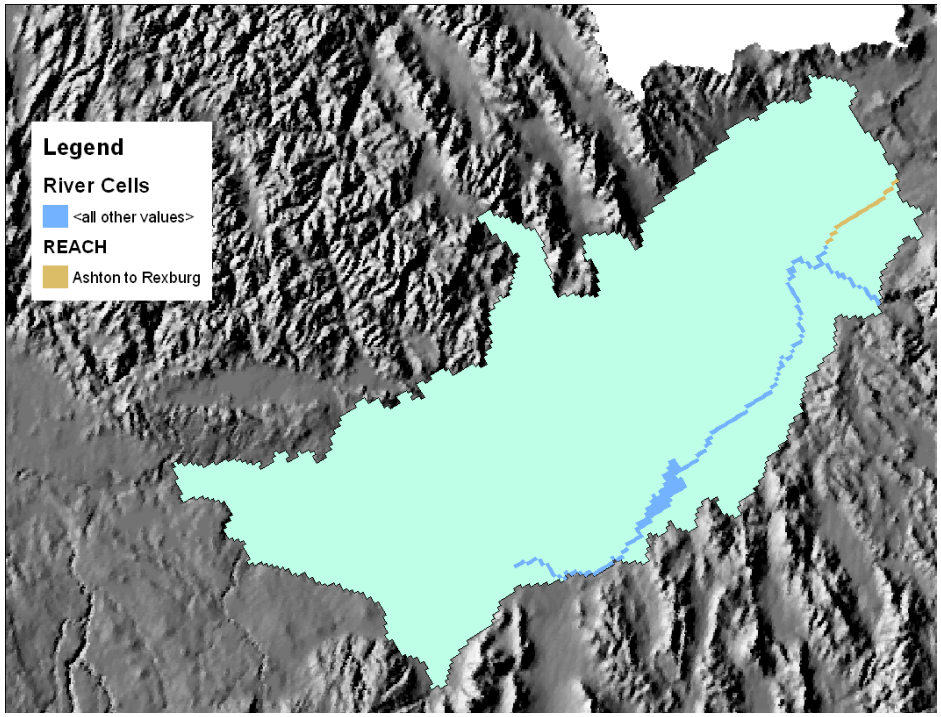

Legend
trend Events
Mean_Abs Residual
0.18 - 1.62
1.63 - 3.07
3.08 - 5.72
5.73 - 9.55
9.56 - 17.92


Legend
trend Events
Mean_Abs Residual
0.18 - 1.62
1.63 - 3.07
3.08 - 5.72
5.73 - 9.55
9.56 - 17.92
3386
Feet
16
14
12
10
8
6
4
2
0
-2
-4
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Measu
Model

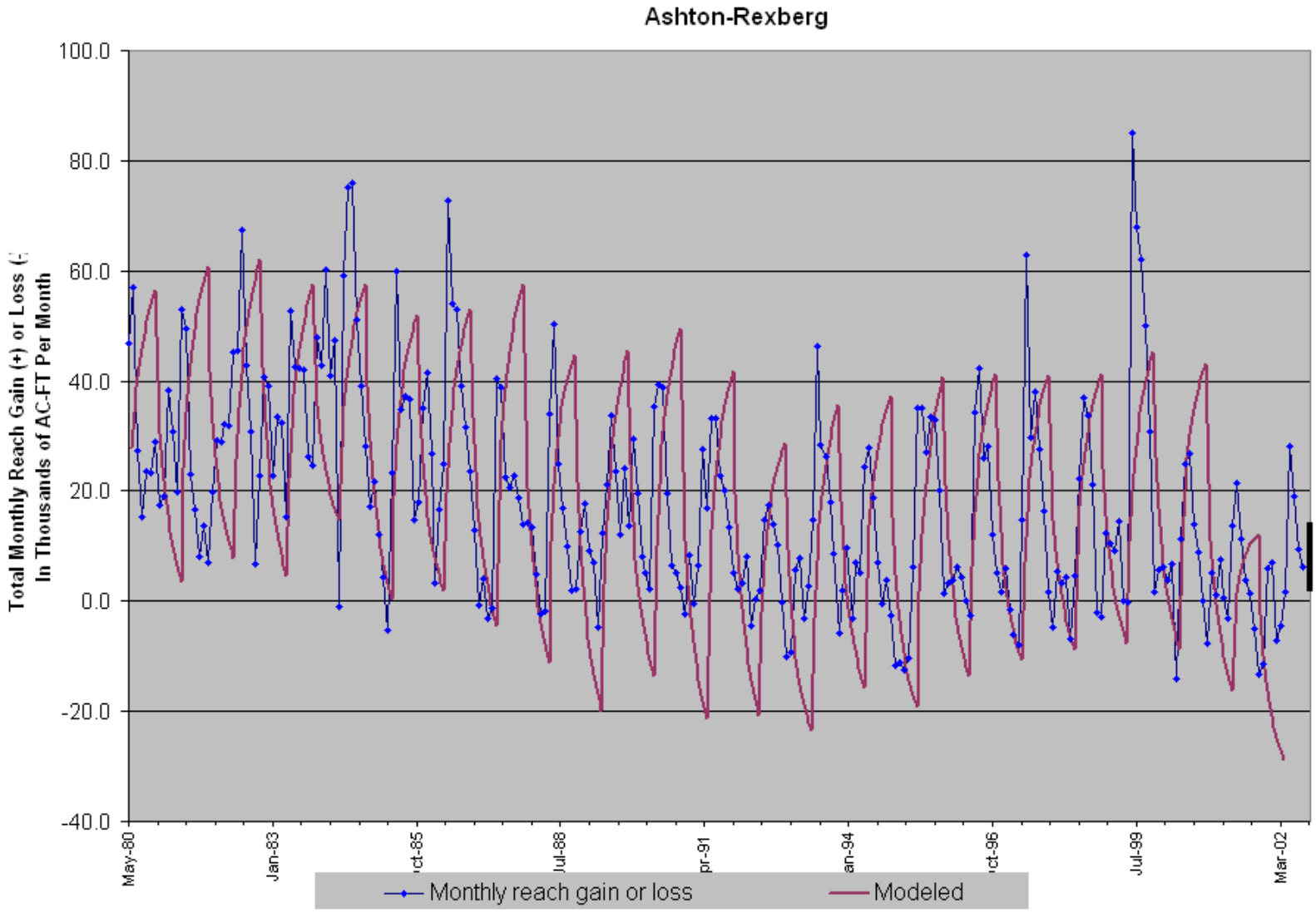

3386
Feet
20
15
10
5
0
-5
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Measured
Modelled
3386
16
14
12
10
8
6
4
2
0
-2
-4
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Measu
Model

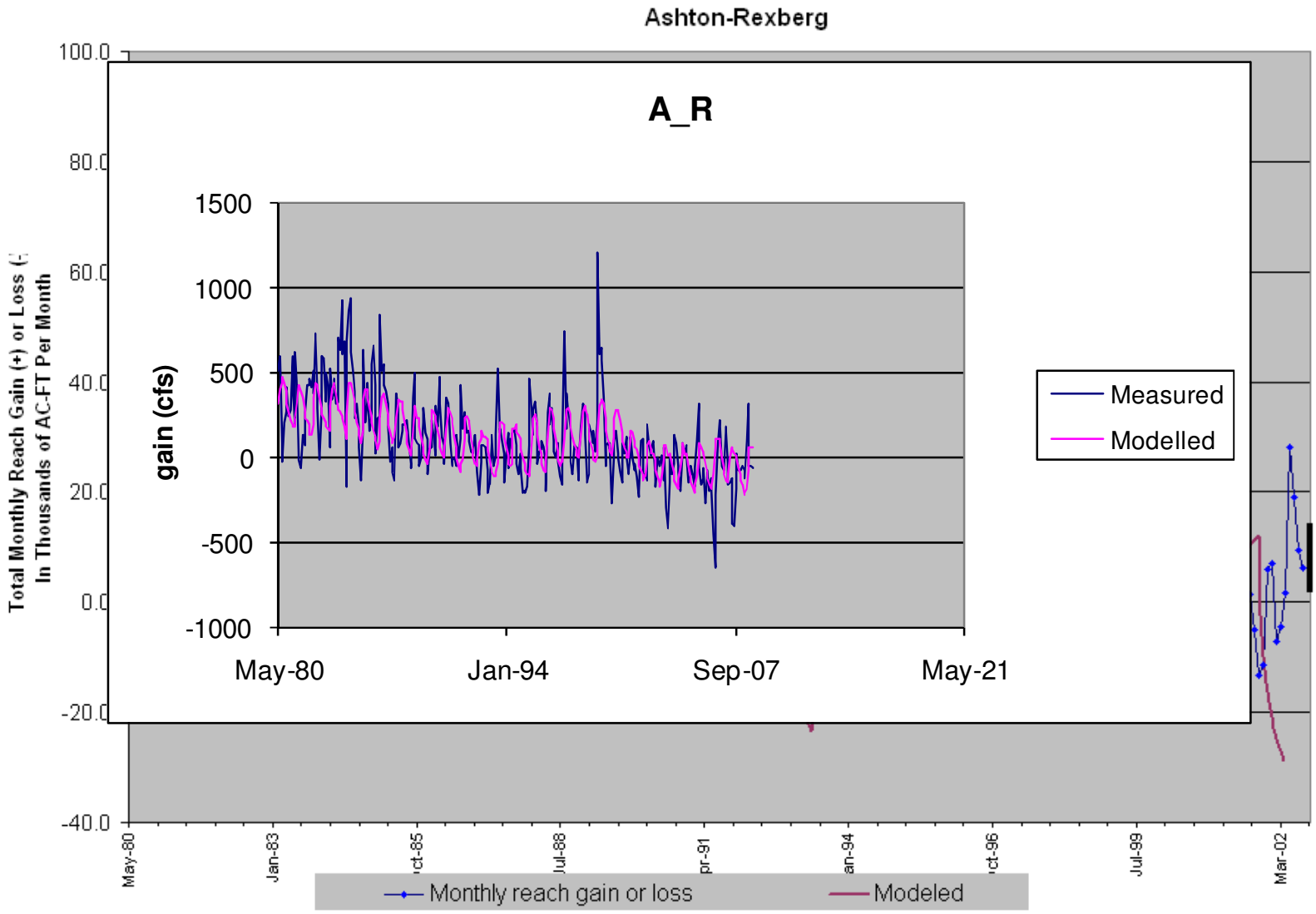


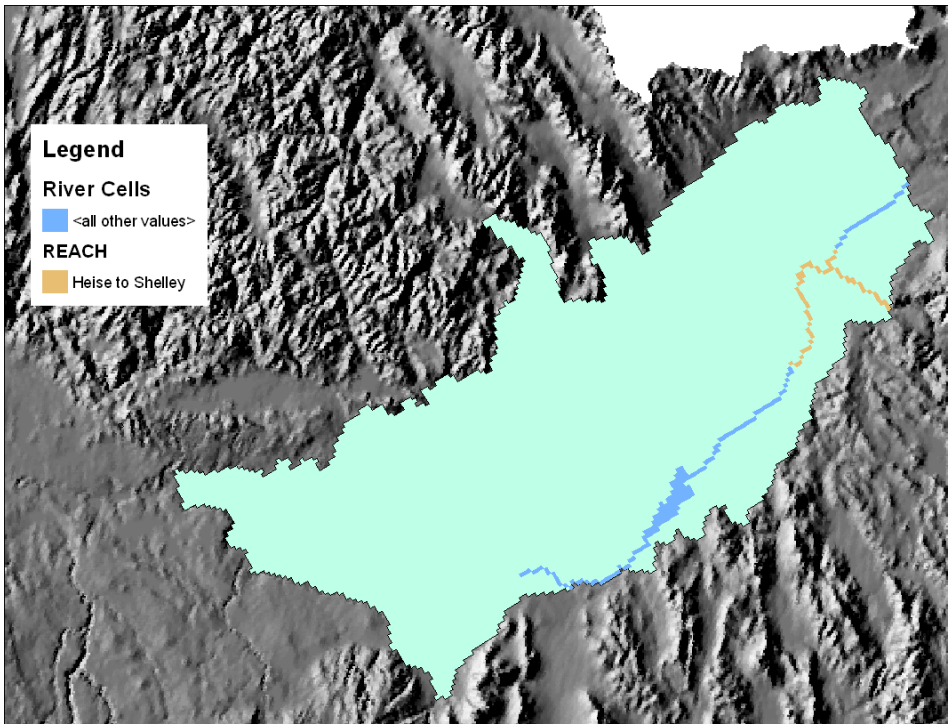
- Snake River reaches



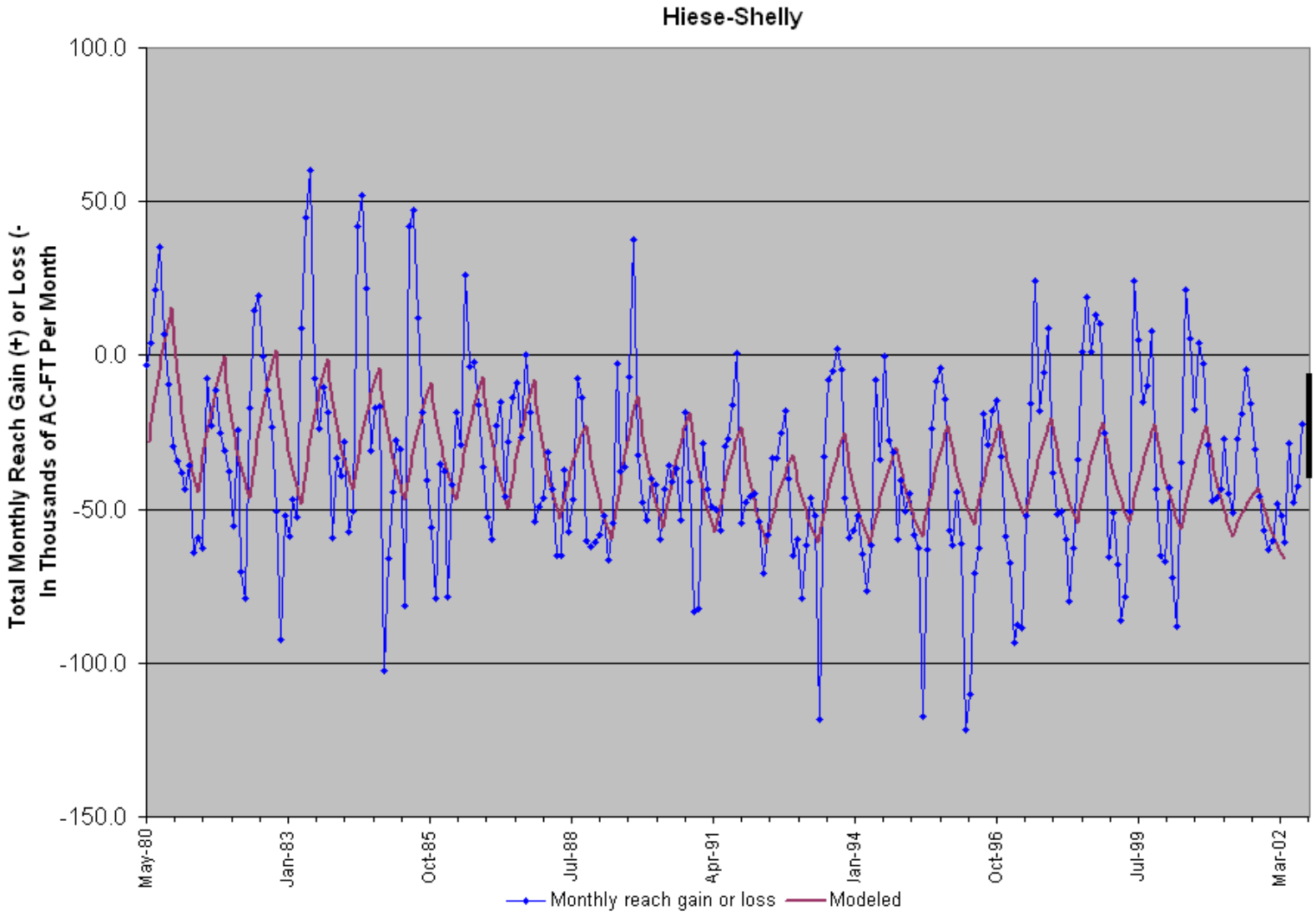
- Ashton to Rexburg

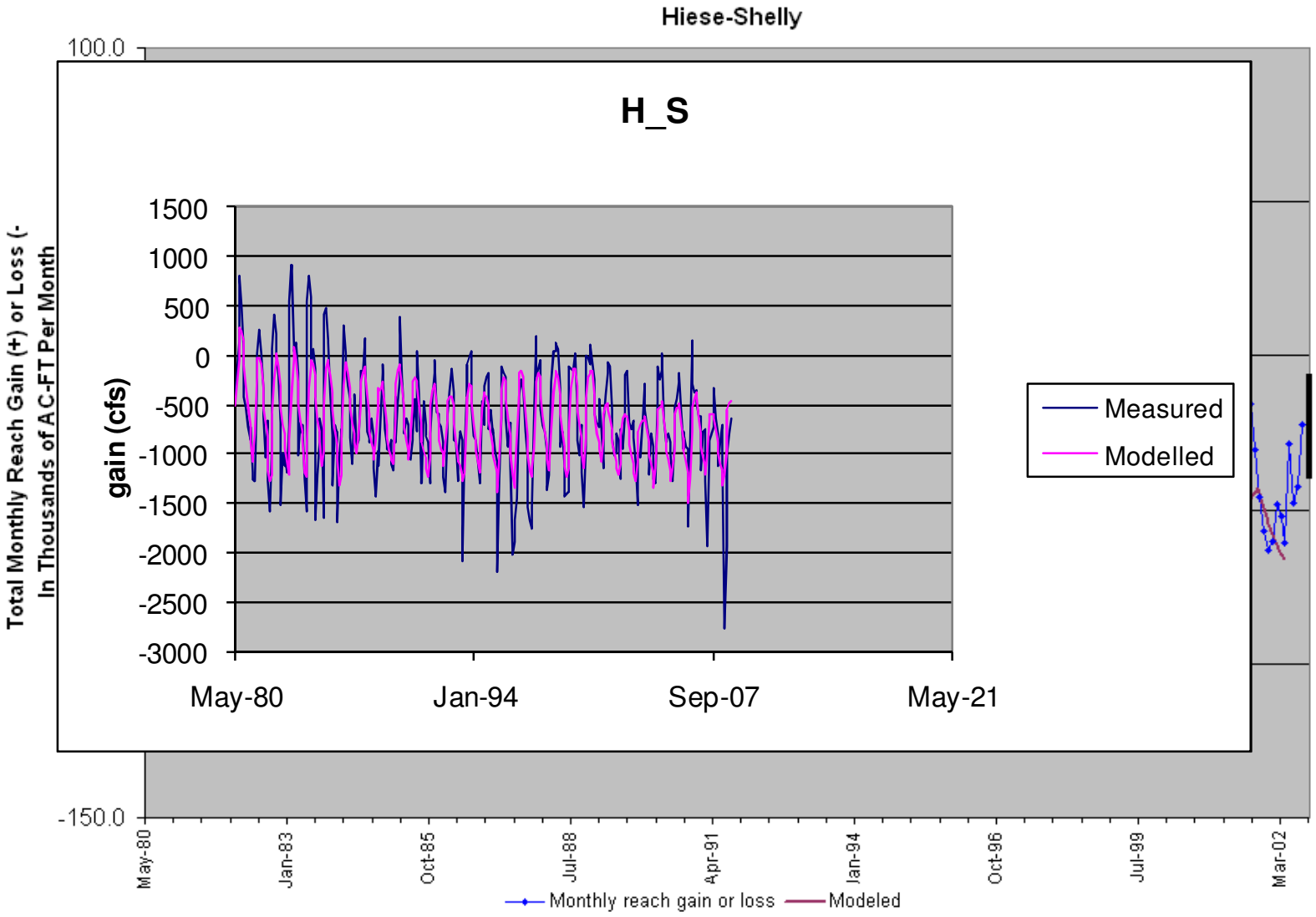

Ashton-Rexberg
Total Monthly Reach Gain (+) or Loss (-)
In Thousands of AC-FT Per Month
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
May-80
Jan-83
Jul-88
Jul-99
Mar-02
Monthly reach gain or loss
Modeled

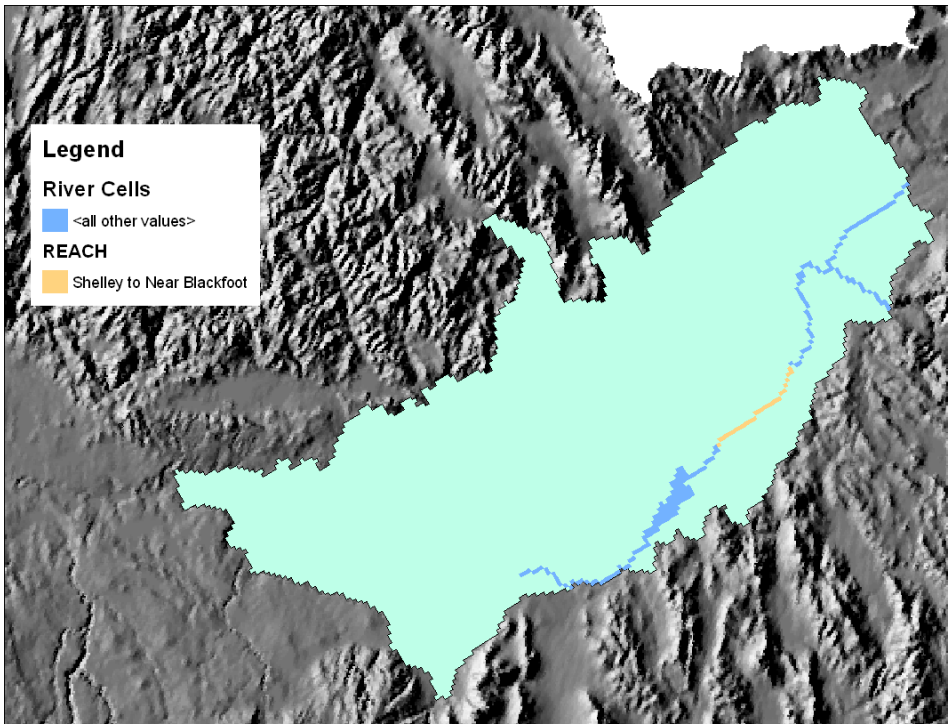

Ashton-Rexberg
Total Monthly Reach Gain (+) or Loss (-) In Thousands of AC-FT Per Month
100.0
80.0
60.0
40.0
20.0
0.0
-20.0
-40.0
May-80
Jan-83
Jul-88
Jan-94
Jul-99
Mar-02
Monthly reach gain or loss
Modeled
A_R
gain (cfs)
1500
1000
500
0
-500
-1000
May-80
Jan-94
Sep-07
May-21
Measured
Modelled



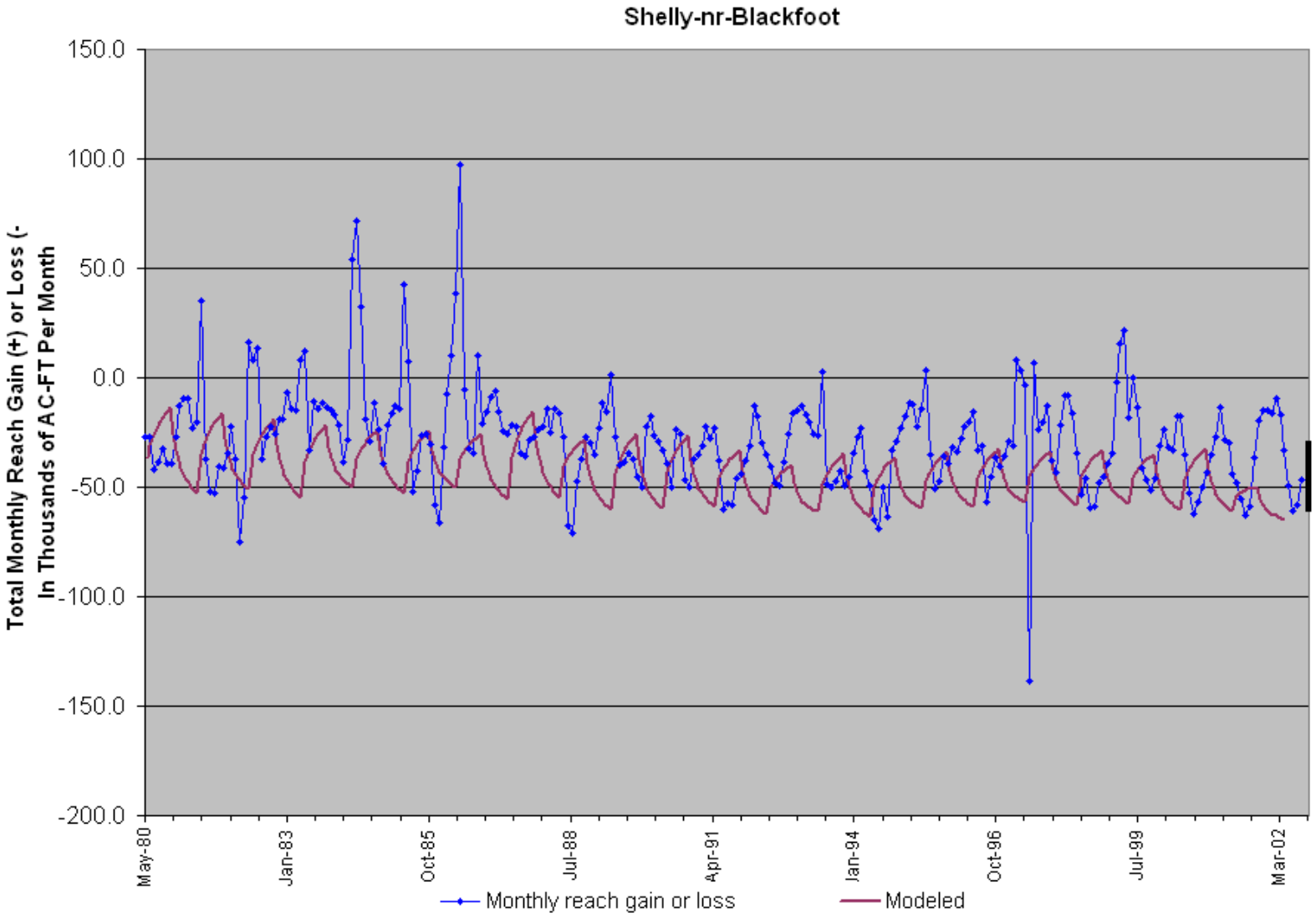
- Heise to Shelly

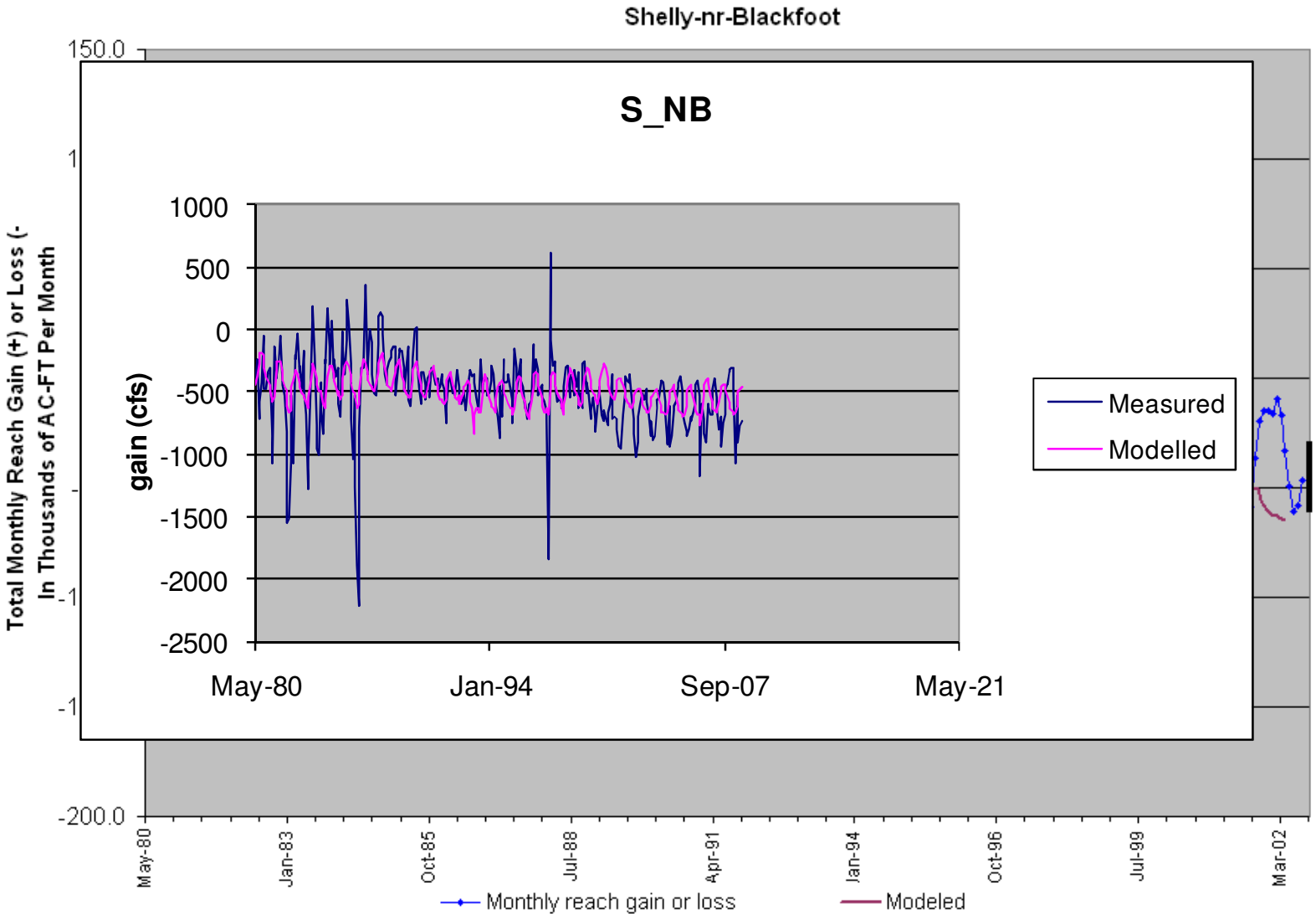

Hiese-Shelly
Total Monthly Reach Gain (+) or Loss (-
In Thousands of AC-FT Per Month
100.0
50.0
0.0
-50.0
-100.0
-150.0
May-80
Jan-83
Oct-85
Jul-88
Apr-91
Jan-94
Oct-96
Jul-99
Mar-02
Monthly reach gain or loss
Modeled

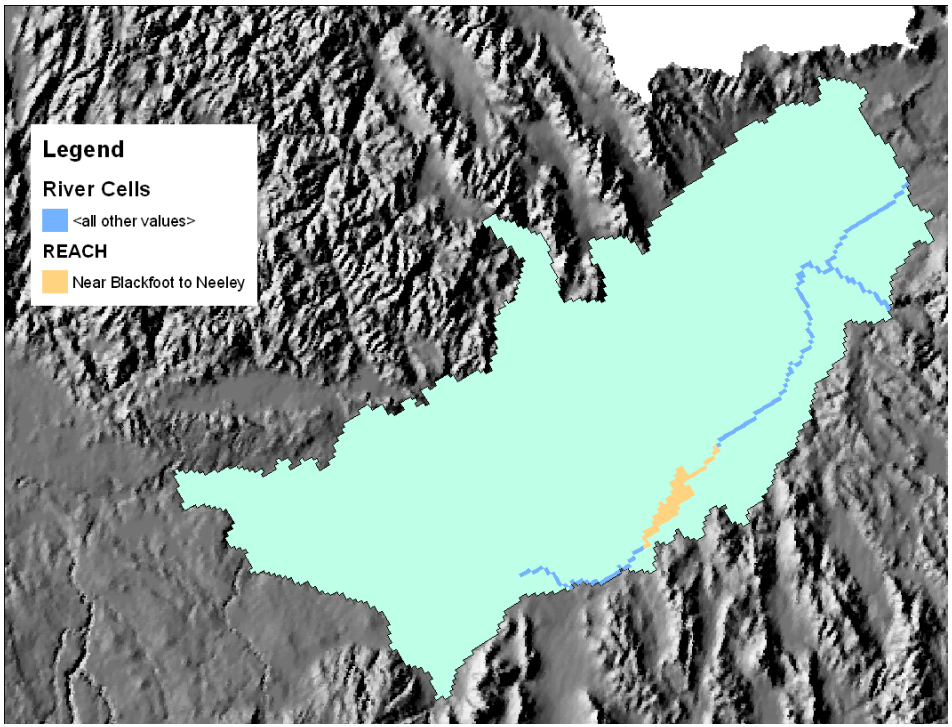

Hiese-Shelly
H_S
gain (cfs)
1500
1000
500
0
-500
-1000
-1500
-2000
-2500
-3000
May-80
Jan-94
Sep-07
May-21
Measured
Modelled
Total Monthly Reach Gain (+) or Loss (-
In Thousands of AC-FT Per Month
100.0
-150.0
May-80
Jan-83
Oct-85
Jul-88
Apr-91
Jan-94
Oct-96
Jul-99
Mar-02
Monthly reach gain or loss
Modeled



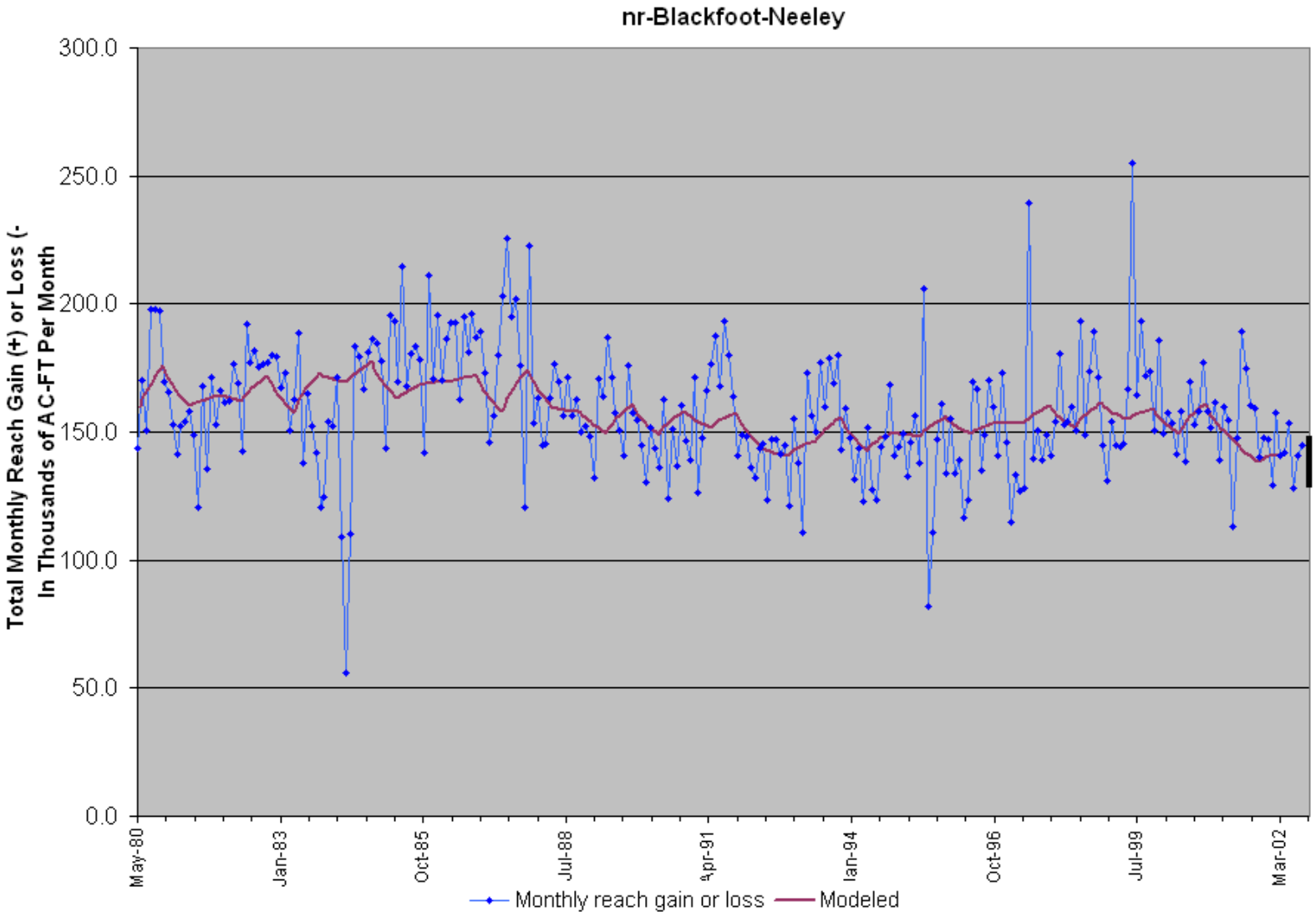
- Shelly - Blackfoot

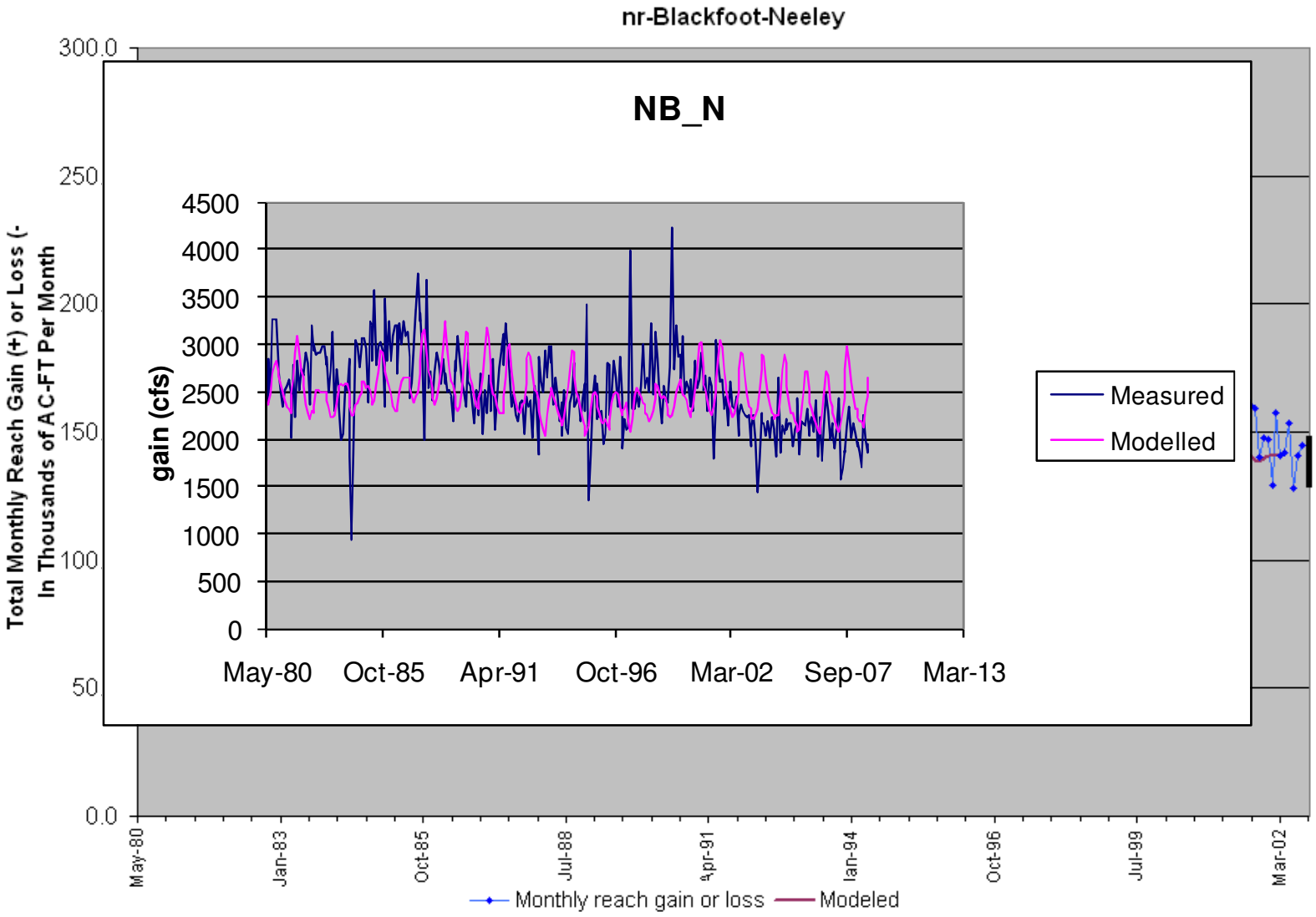

Shelly-nr-Blackfoot
Total Monthly Reach Gain (+) or Loss (-
In Thousands of AC-FT Per Month
150.0
100.0
50.0
0.0
-50.0
-100.0
-150.0
-200.0
May-80
Jan-83
Oct-85
Jul-88
Apr-91
Jan-94
Oct-96
Jul-99
Mar-02
Monthly reach gain or loss
Modeled

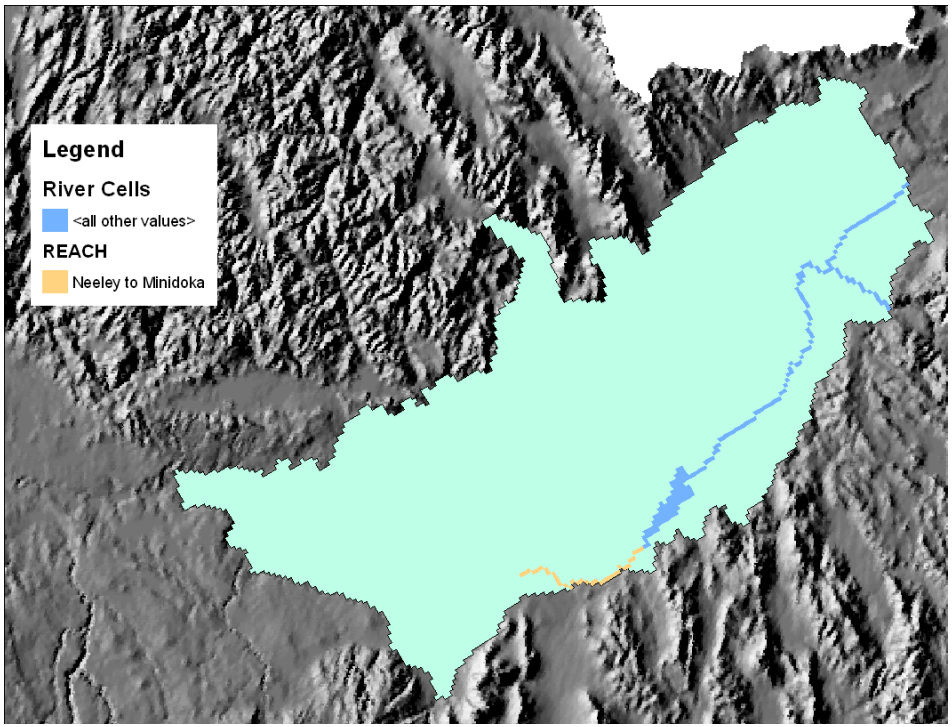

Shelly-nr-Blackfoot
S_NB
gain (cfs)
1000
500
0
-500
-1000
-1500
-2000
-2500
May-80
Jan-94
Sep-07
May-21
Measured
Modelled
Total Monthly Reach Gain (+) or Loss (-
In Thousands of AC-FT Per Month
150.0
1
-1
-1
-200.0
May-80
Jan-83
Oct-85
Jul-88
Apr-91
Jan-94
Oct-96
Jul-99
Mar-02
Monthly reach gain or loss
Modeled



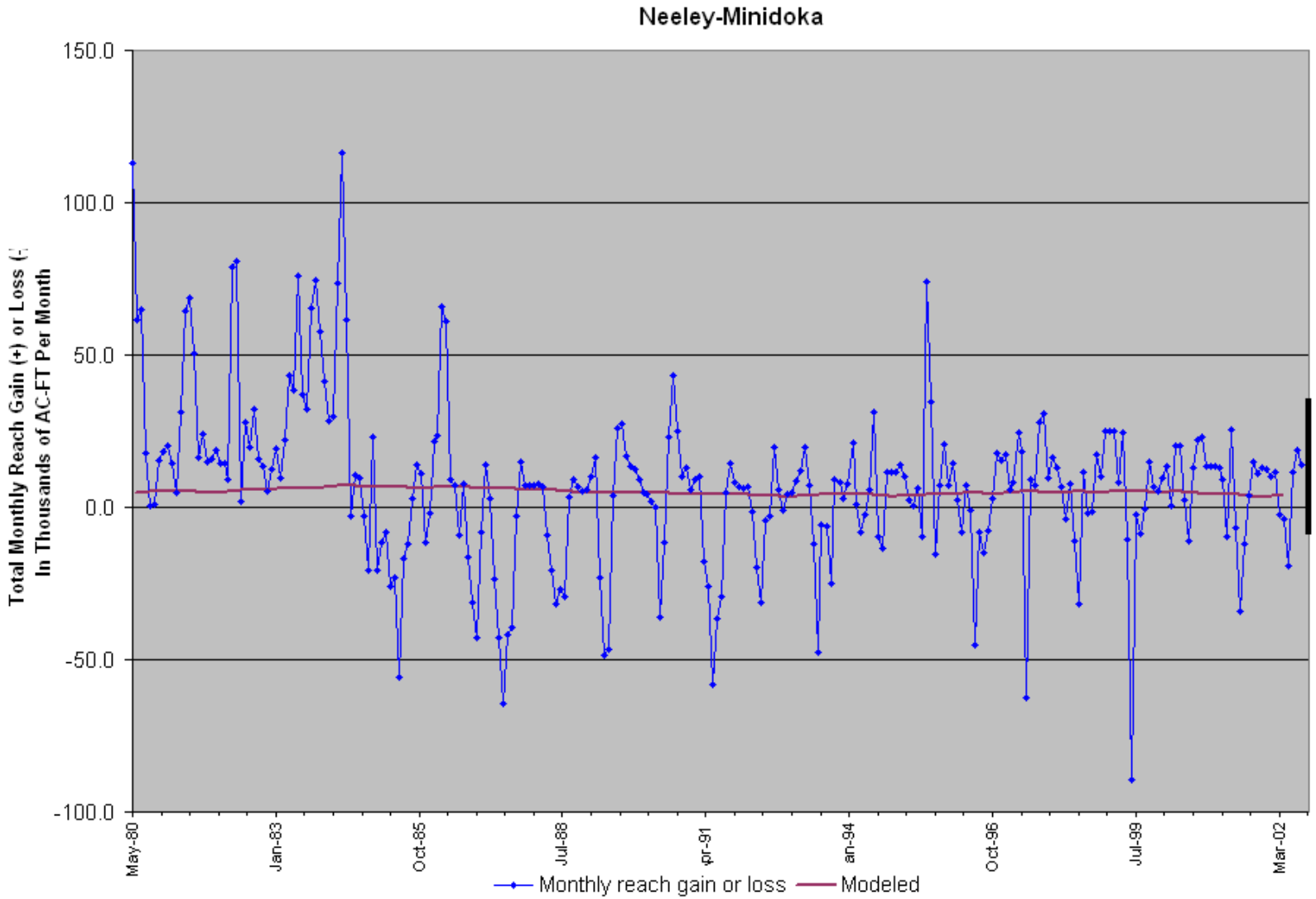
- Blackfoot – Neeley

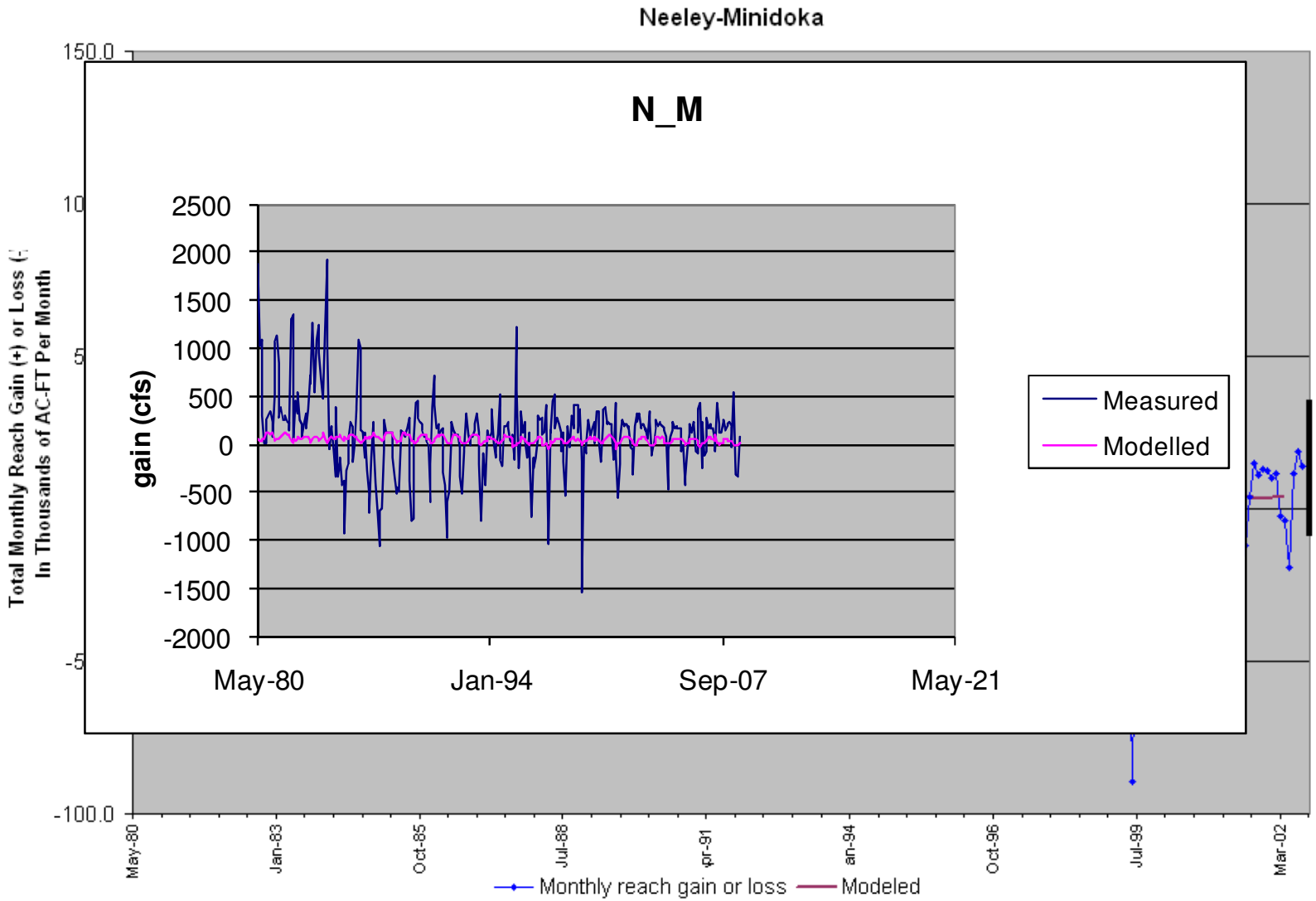

nr-Blackfoot-Neeley
Total Monthly Reach Gain (+) or Loss (-
In Thousands of AC-FT Per Month
300.0
250.0
200.0
150.0
100.0
50.0
0.0
May-80
Jan-83
Oct-85
Jul-88
Apr-91
Jan-94
Oct-96
Jul-99
Mar-02
Monthly reach gain or loss
Modeled

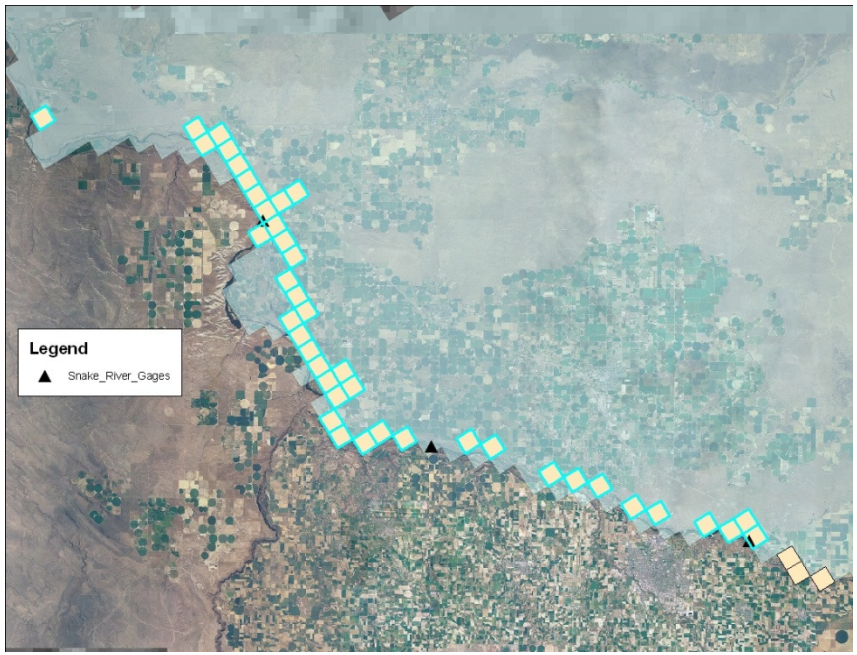

nr-Blackfoot-Neeley
Total Monthly Reach Gain (+) or Loss (-
In Thousands of AC-FT Per Month
300.0
250
200
150
100
50
0.0
May-80
Jan-83
Oct-85
Jul-88
Apr-91
Jan-94
Oct-96
Jul-99
Mar-02
Monthly reach gain or loss
Modeled
NB_N
gain (cfs)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled



- Neeley – Minidoka

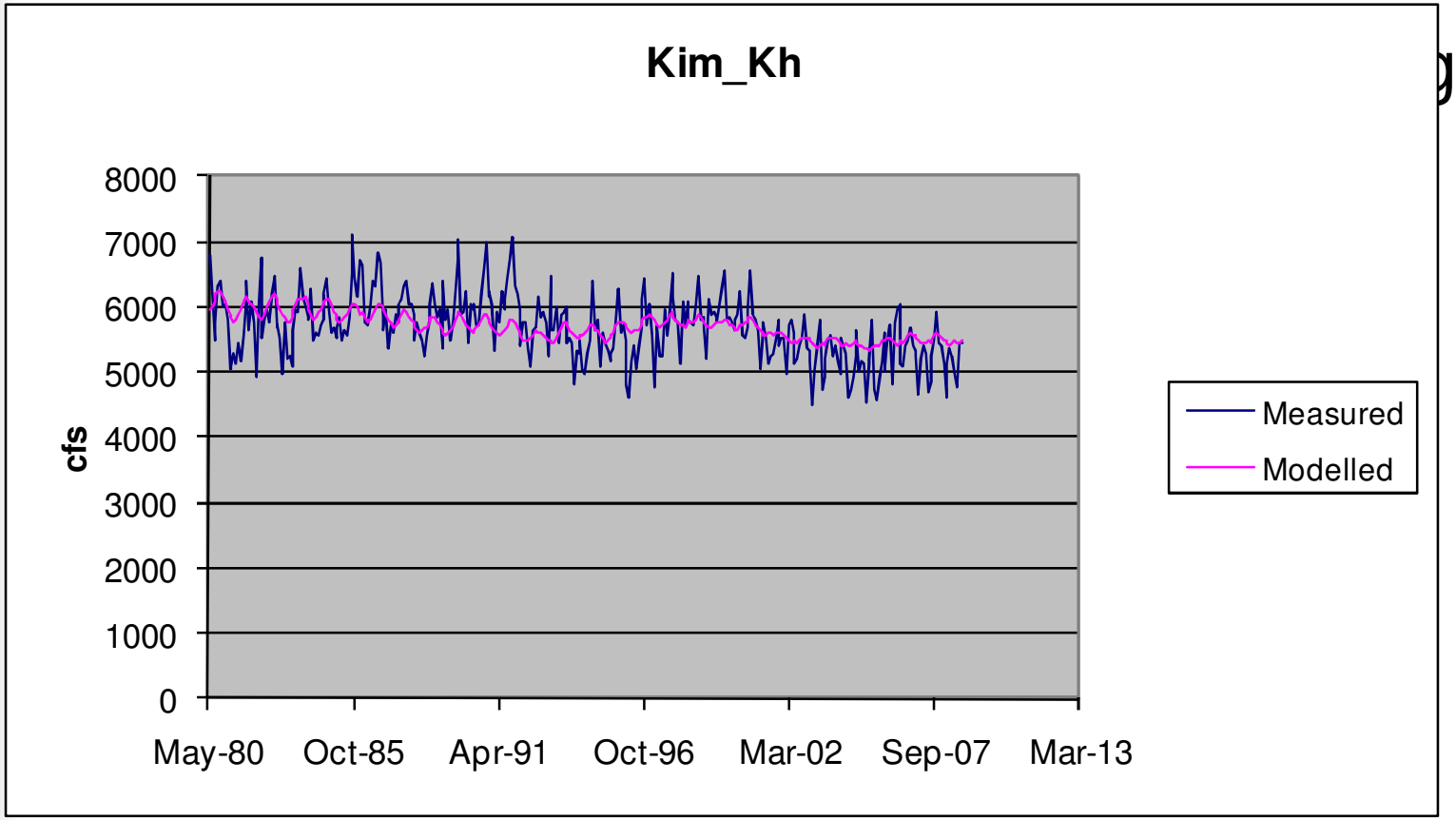

Neeley-Minidoka
150.0
100.0
50.0
0.0
-50.0
-100.0
Total Monthly Reach Gain (+) or Loss (-)
In Thousands of AC-FT Per Month
May-80
Jan-83
Oct-85
Jul-88
Apr-91
Jan-94
Oct-96
Jul-99
Mar-02
Monthly reach gain or loss
Modeled

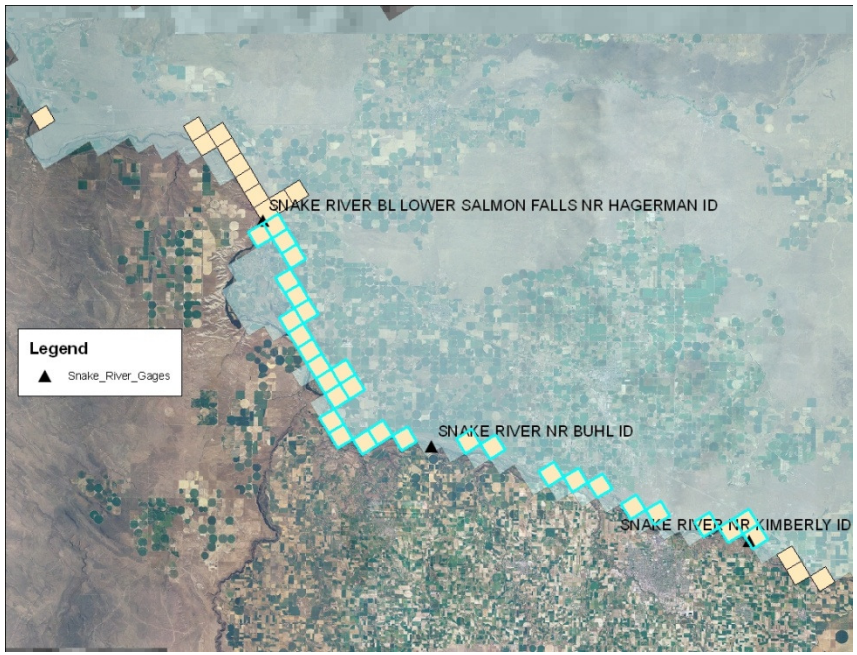

Neeley-Minidoka
150.0
100.0
-100.0
Total Monthly Reach Gain (+) or Loss (-)
In Thousands of AC-FT Per Month
May-80
Jan-83
Oct-85
Jul-88
Apr-91
Jan-94
Oct-96
Jul-99
Mar-02
Monthly reach gain or loss
Modeled
N_M
gain (cfs)
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
May-80
Jan-94
Sep-07
May-21
Measured
Modelled



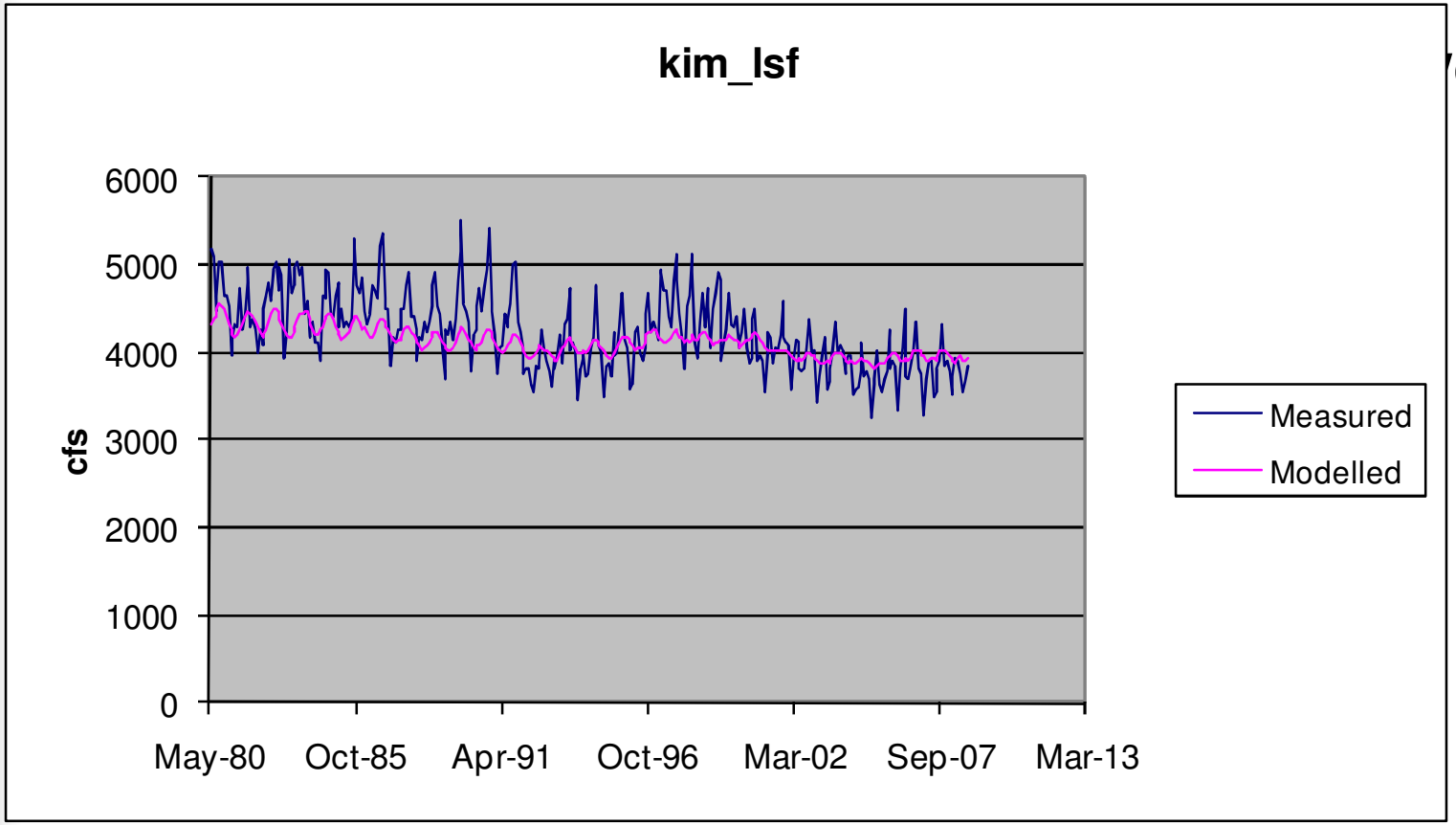
- Kimberly-King Hill

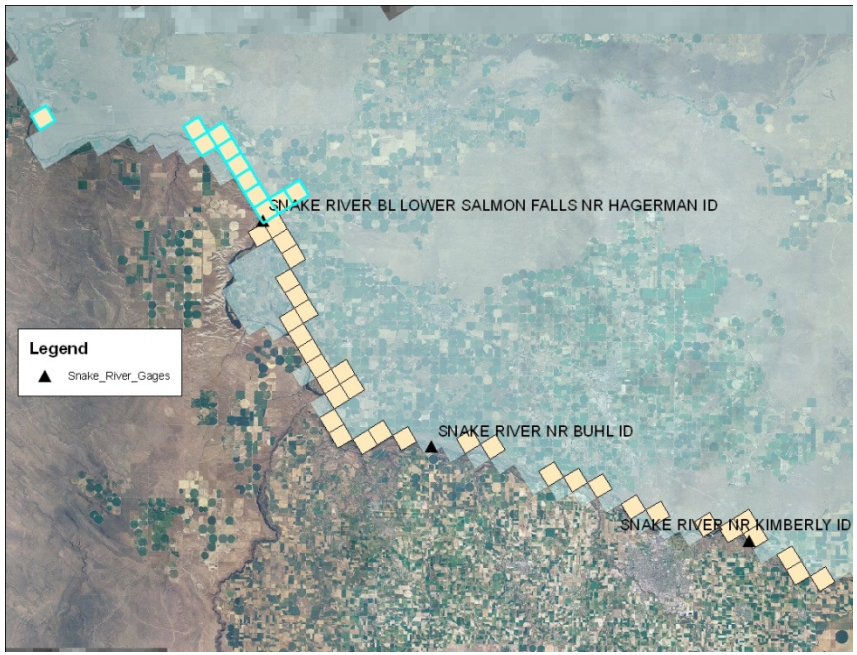
g Hill


Kim_Kh
8000
7000
6000
5000
4000
3000
2000
1000
0
cfs
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled



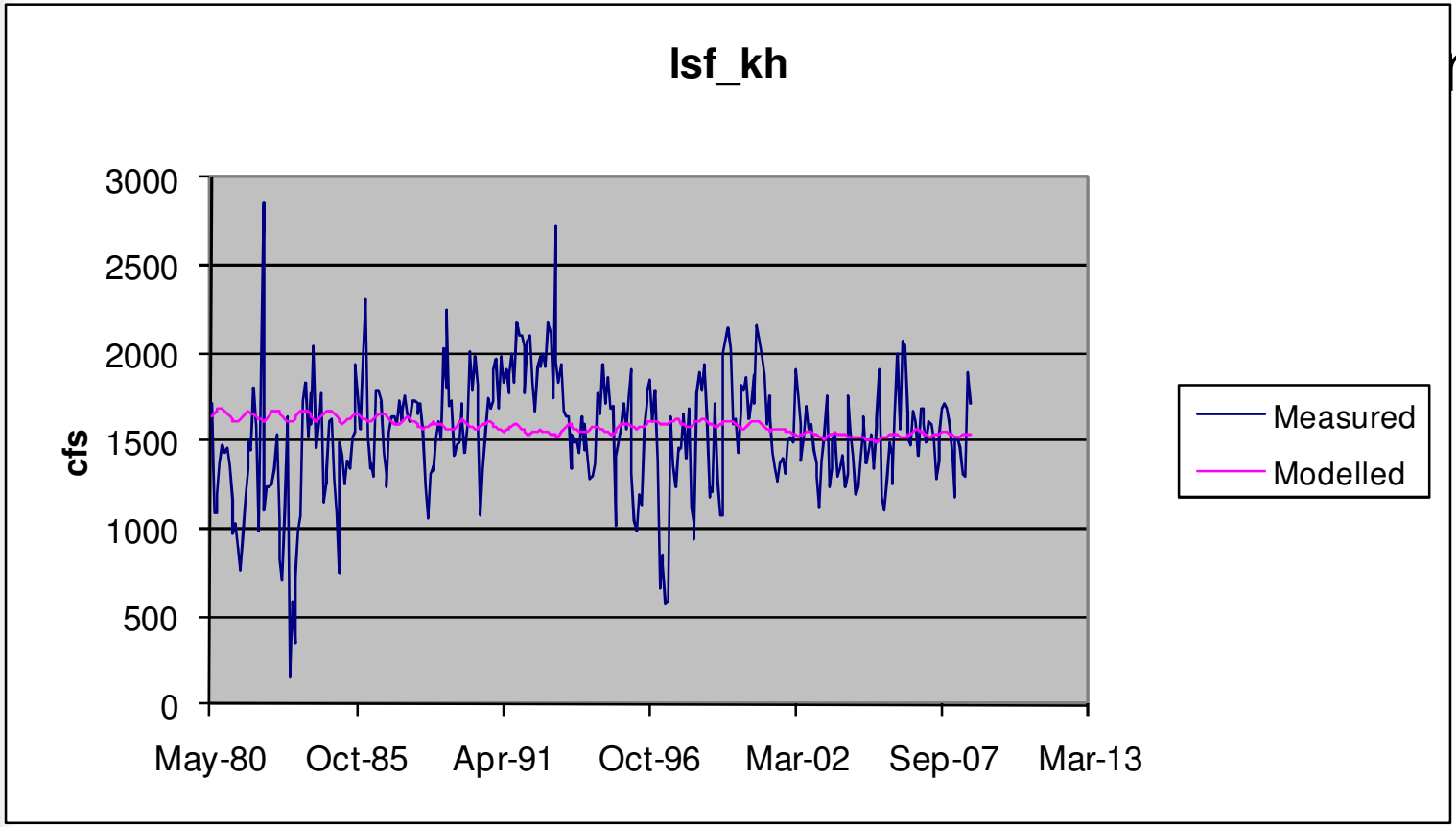
- Kimberly-Lower Salmon Falls

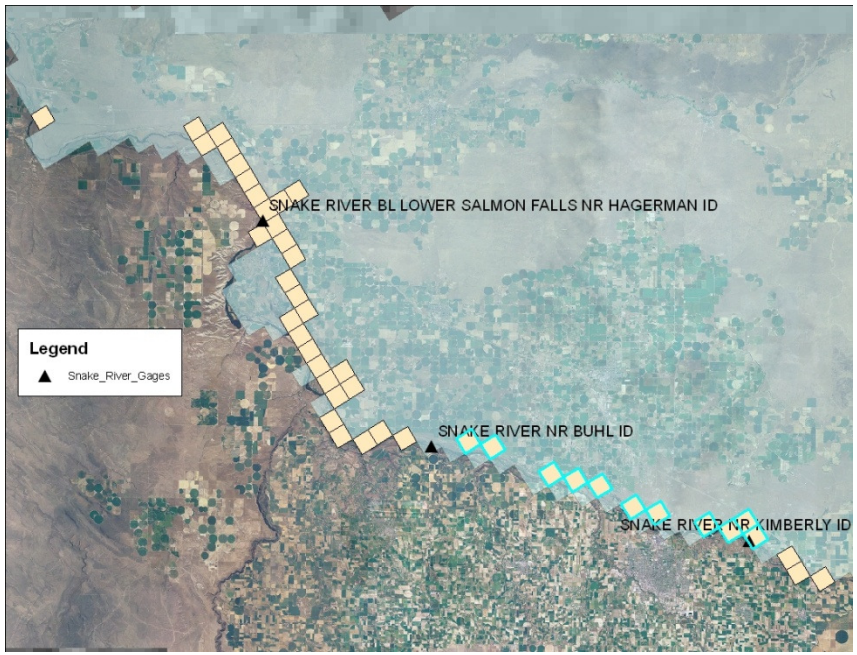

kim_lsf
6000
5000
4000
3000
2000
1000
0
cfs
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled



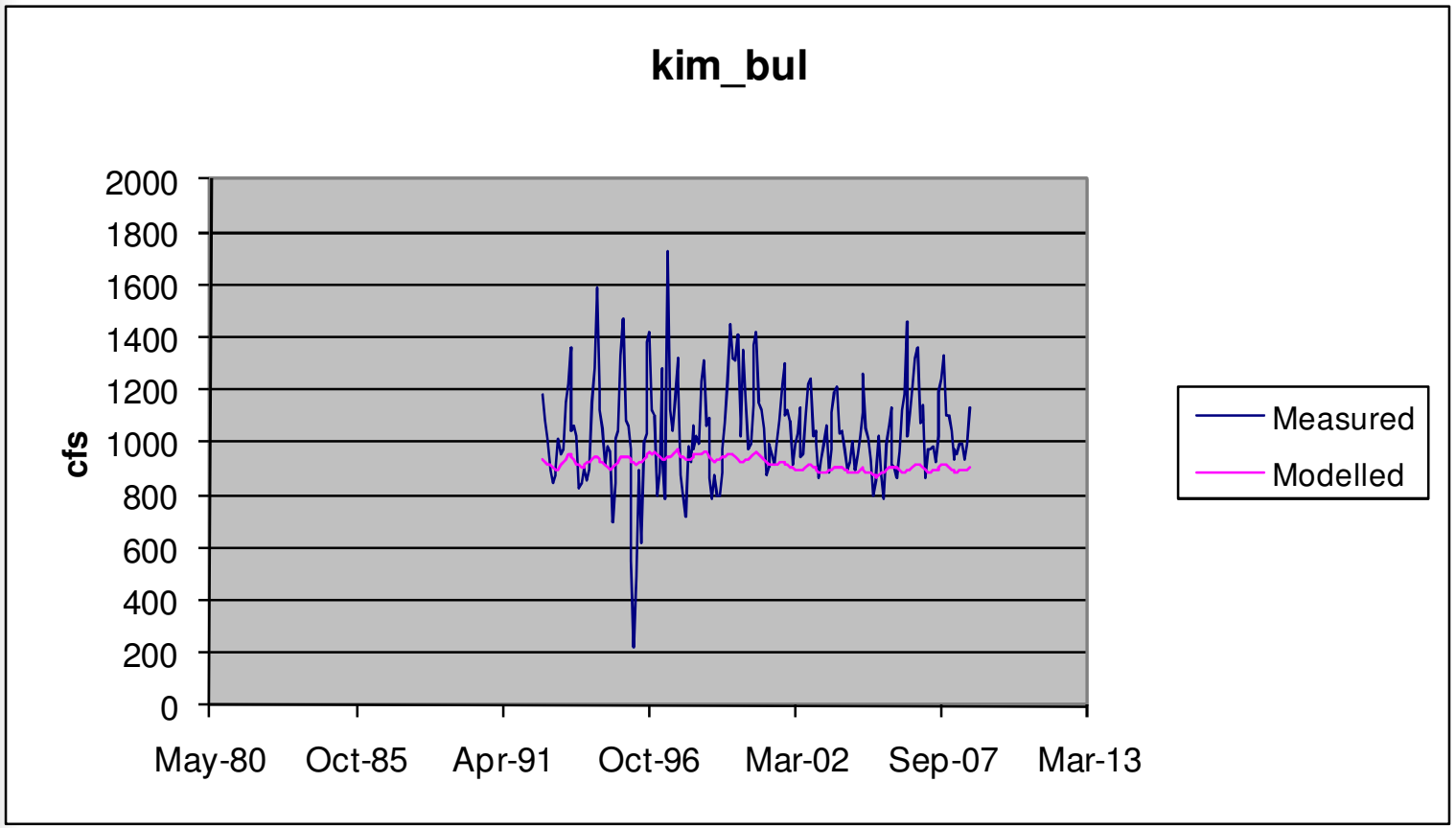
- Lower Salmon Falls – King Hill

n Falls –


lsf_kh
cfs
3000
2500
2000
1500
1000
500
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled



- Kimberly-Buhl


kim_bul
cfs
2000
1800
1600
1400
1200
1000
800
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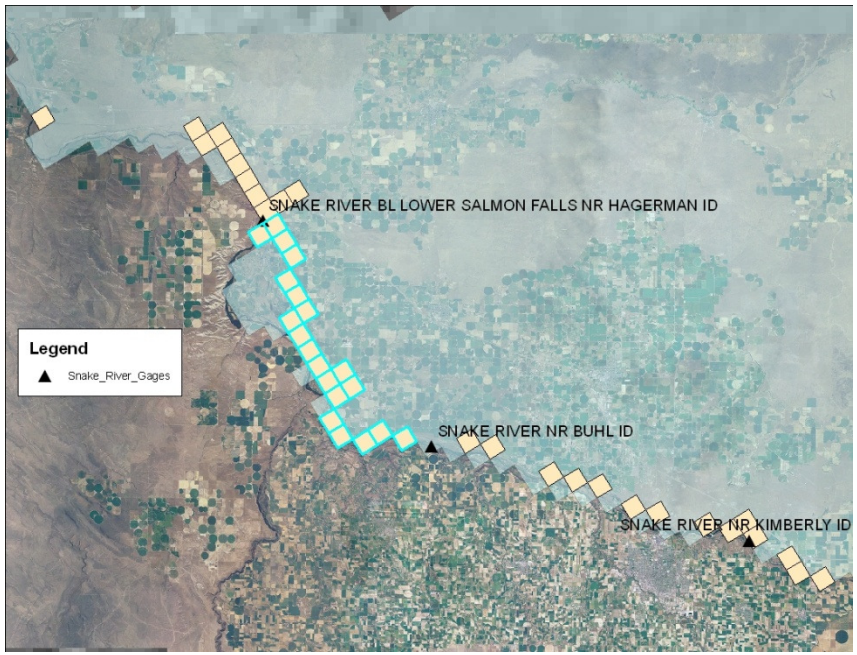
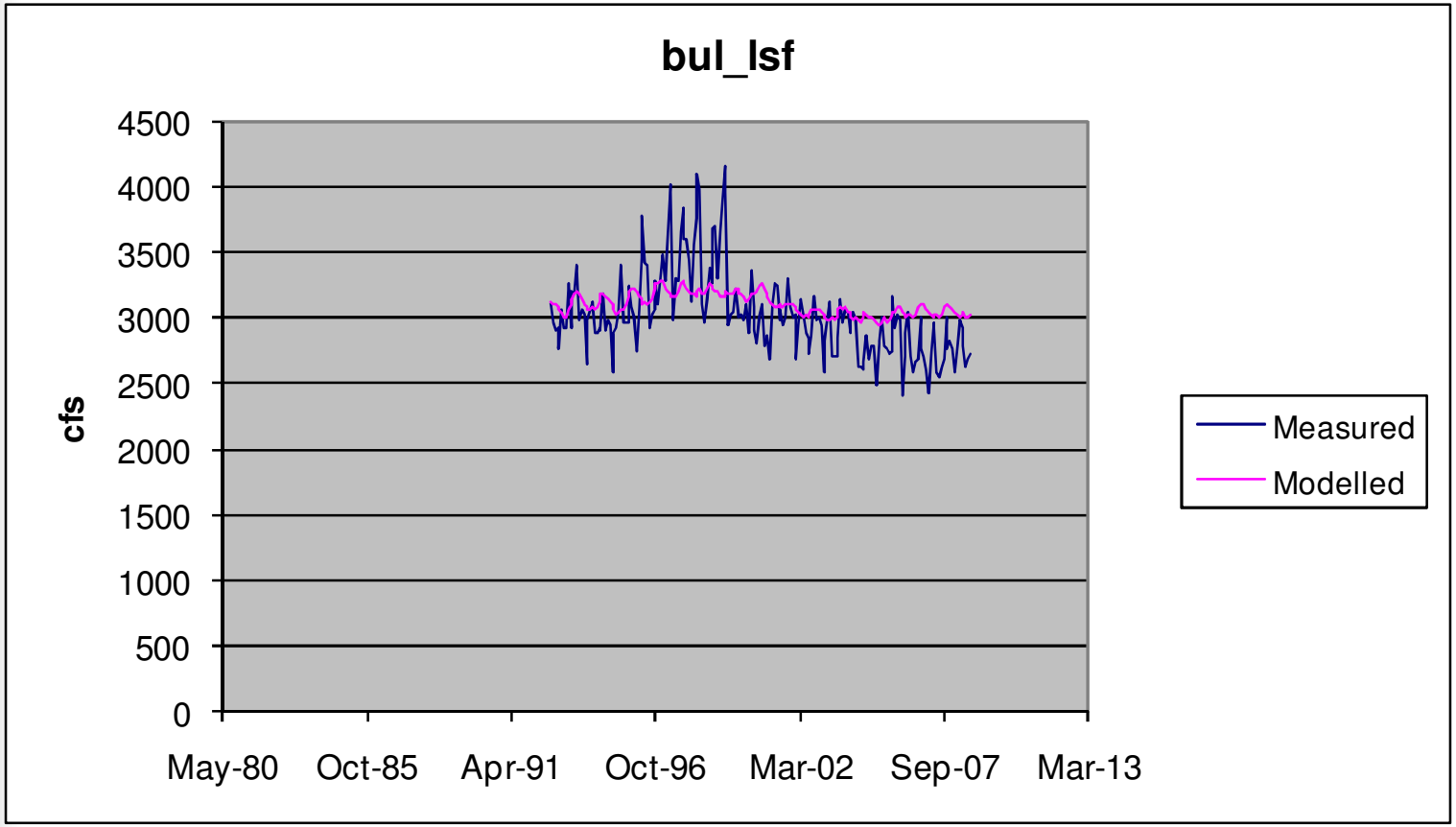
400
200
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled



- Buhl-Lower Salmon Falls


bul_lsf
cfs
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2500
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1000
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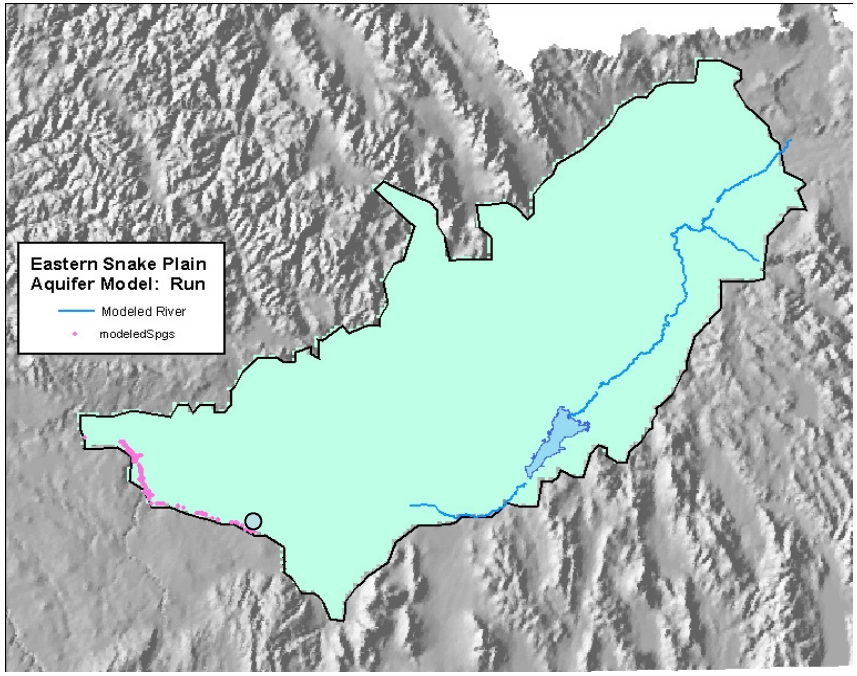
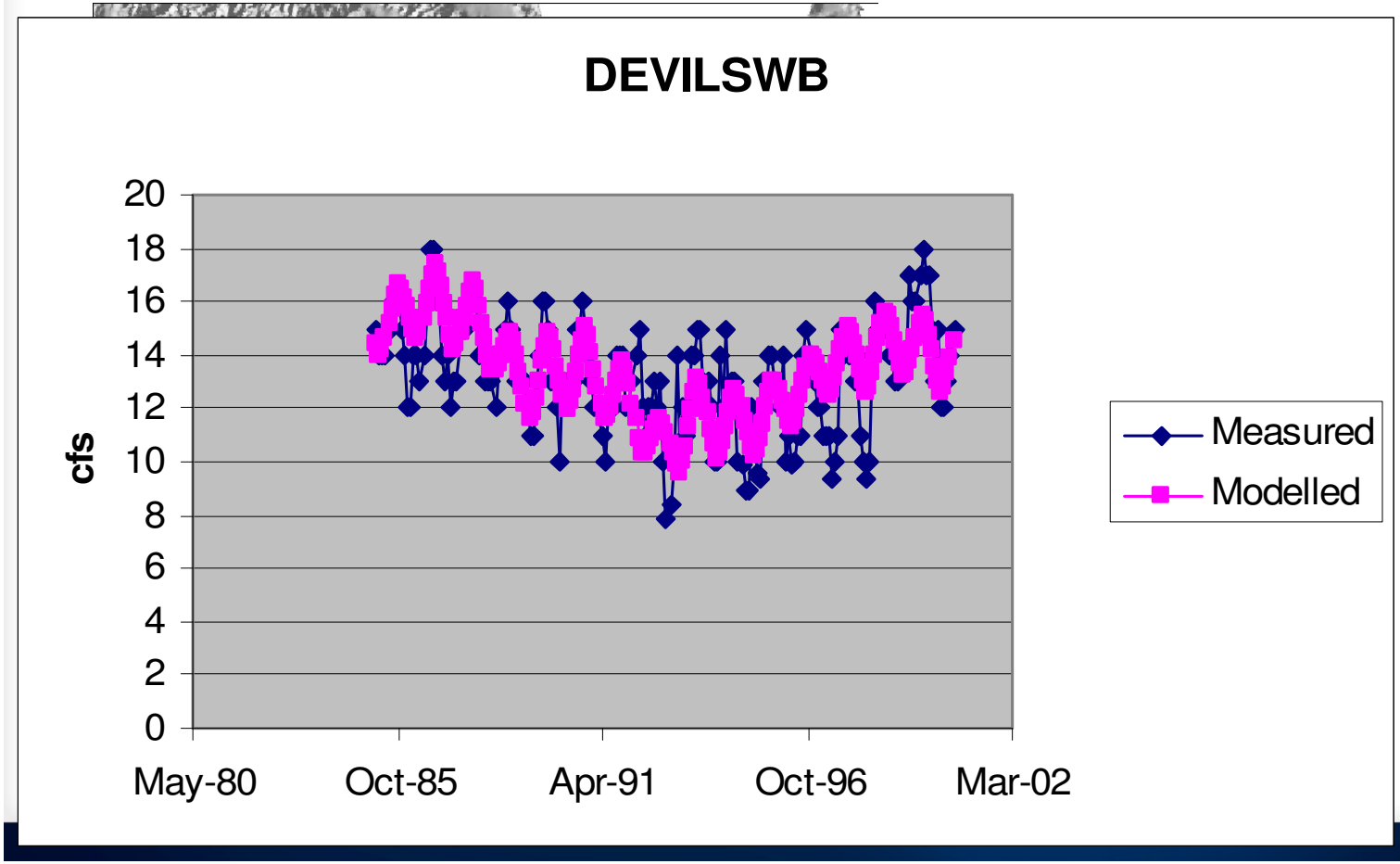
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled

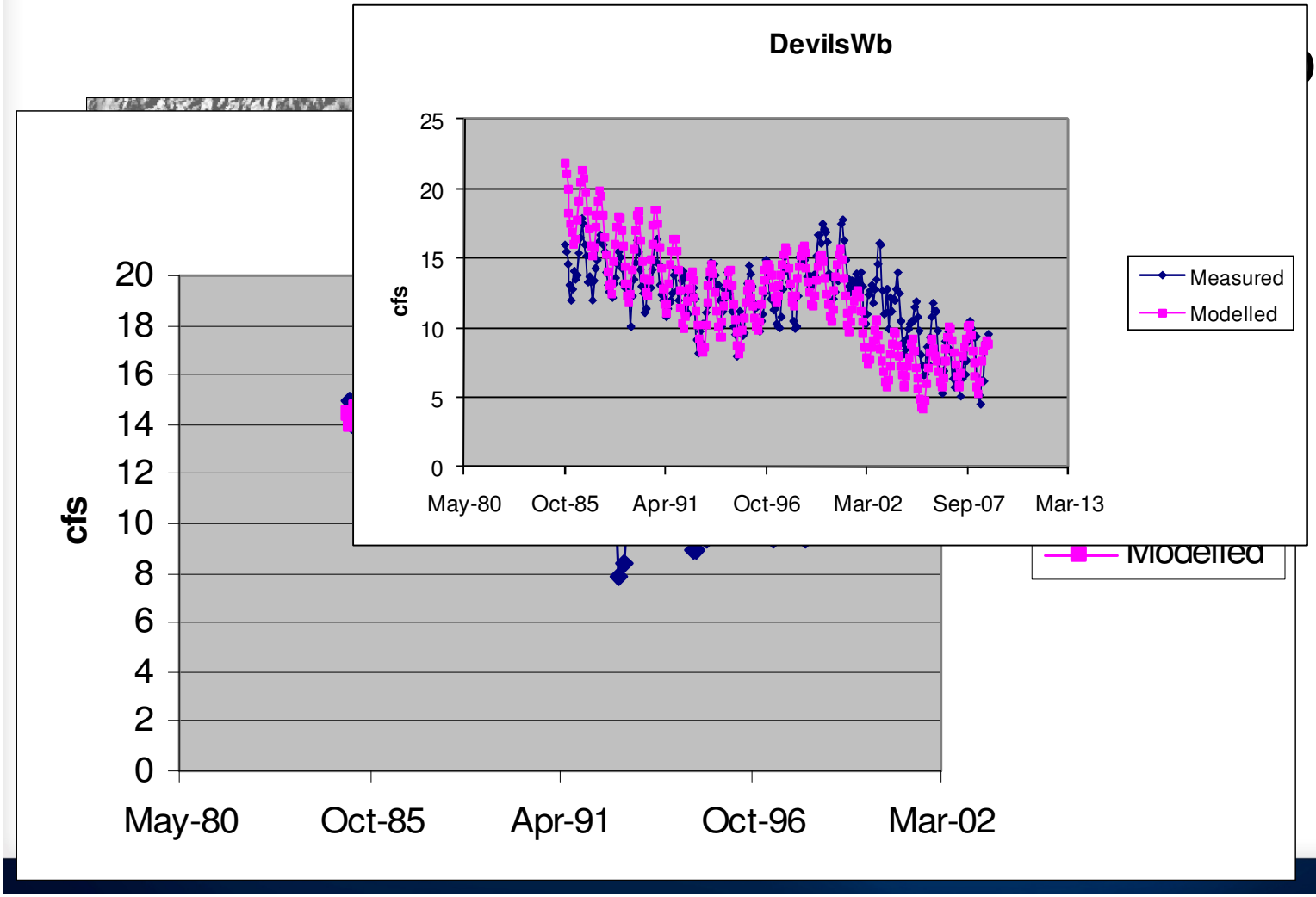
almon

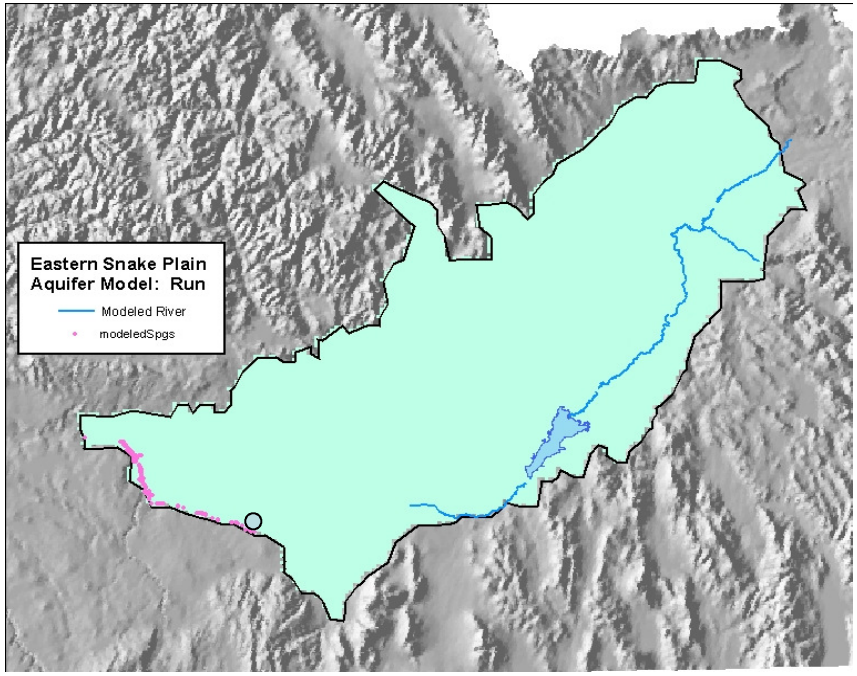


- Devils Washbowl

- Devils Washbowl

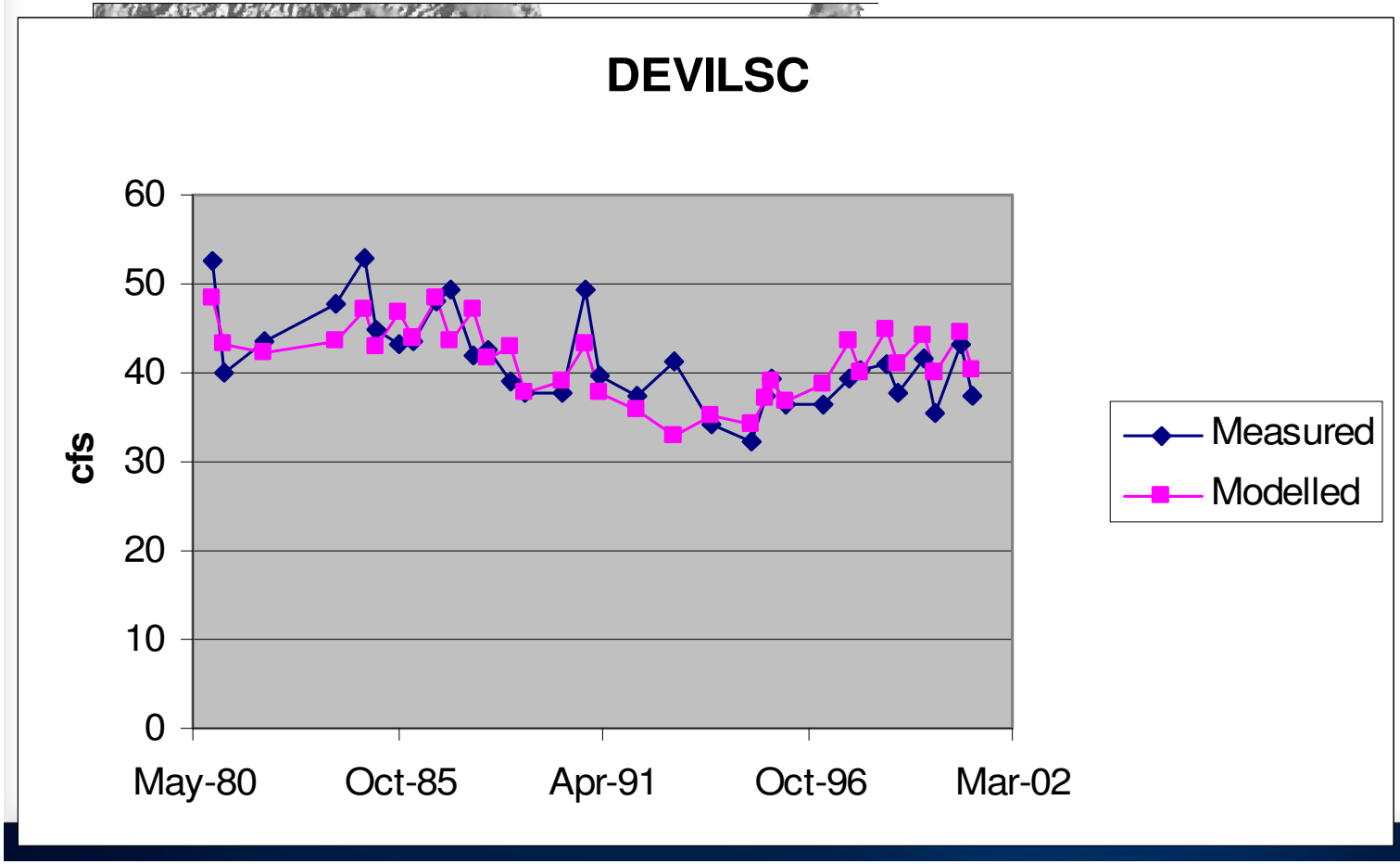


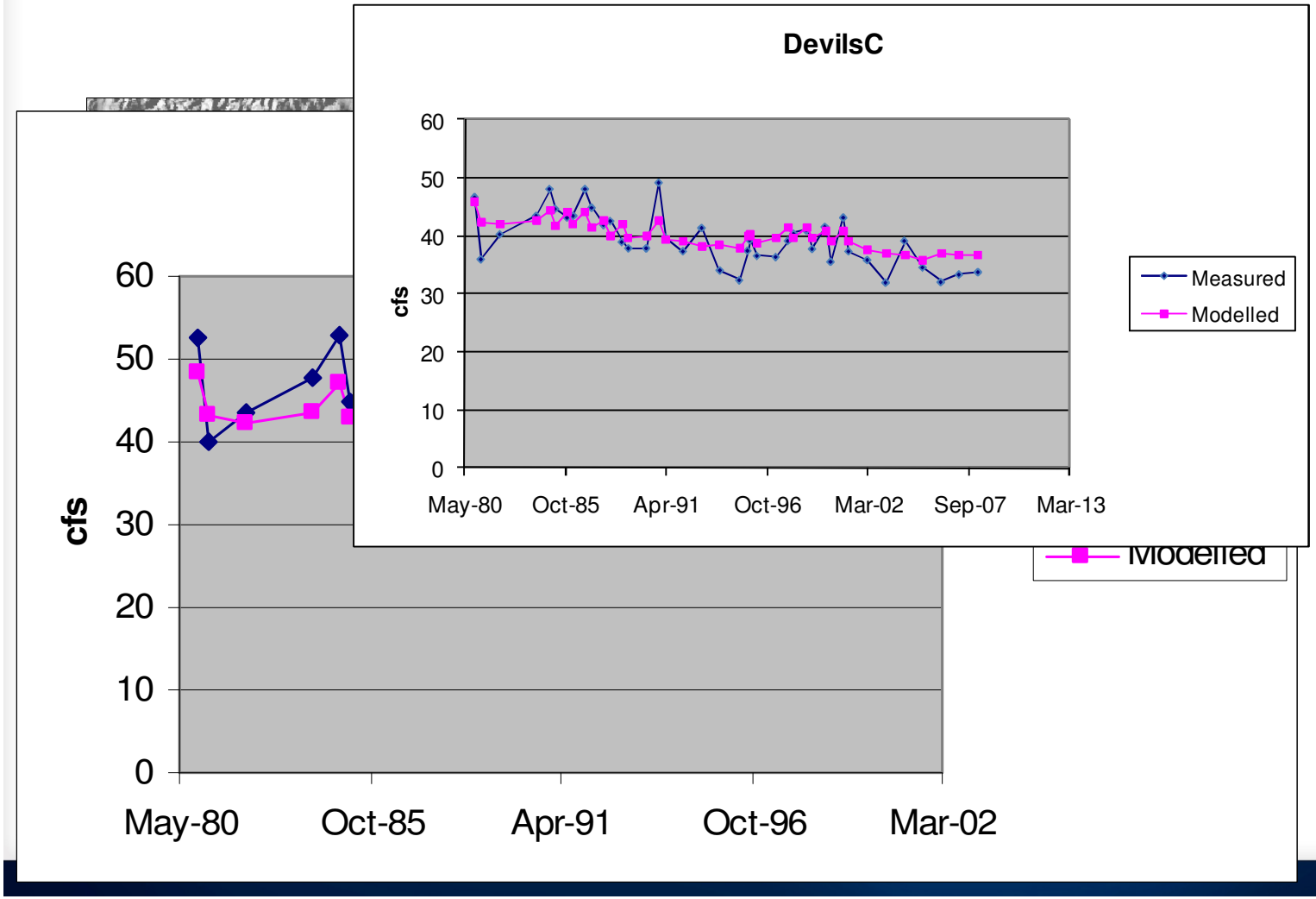

DevilsWb
cfs
25
20
15
10
5
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled
cfs
20
18
16
14
12
10
8
6
4
2
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Modelled

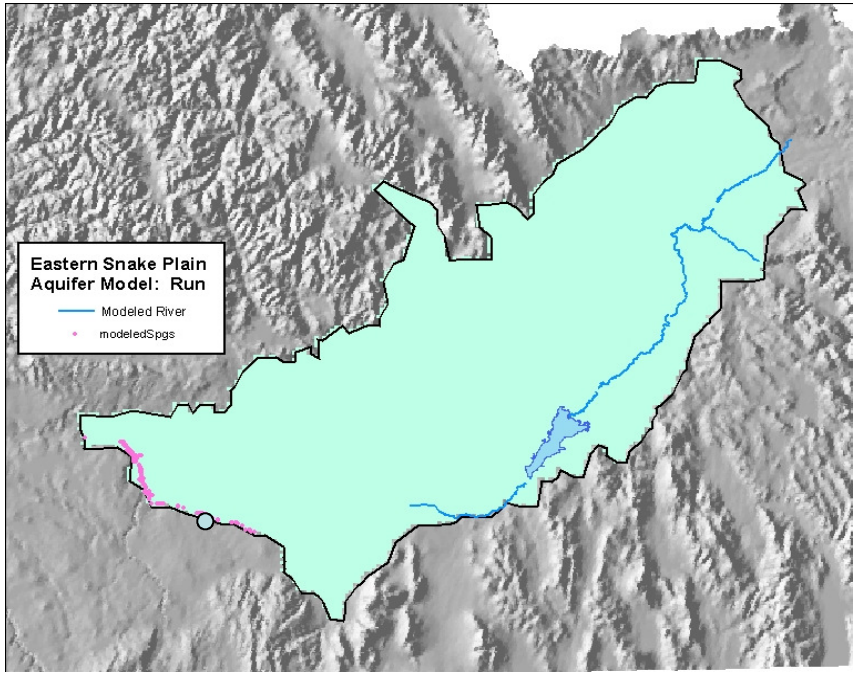


- Devils Corral

- Devils Corral

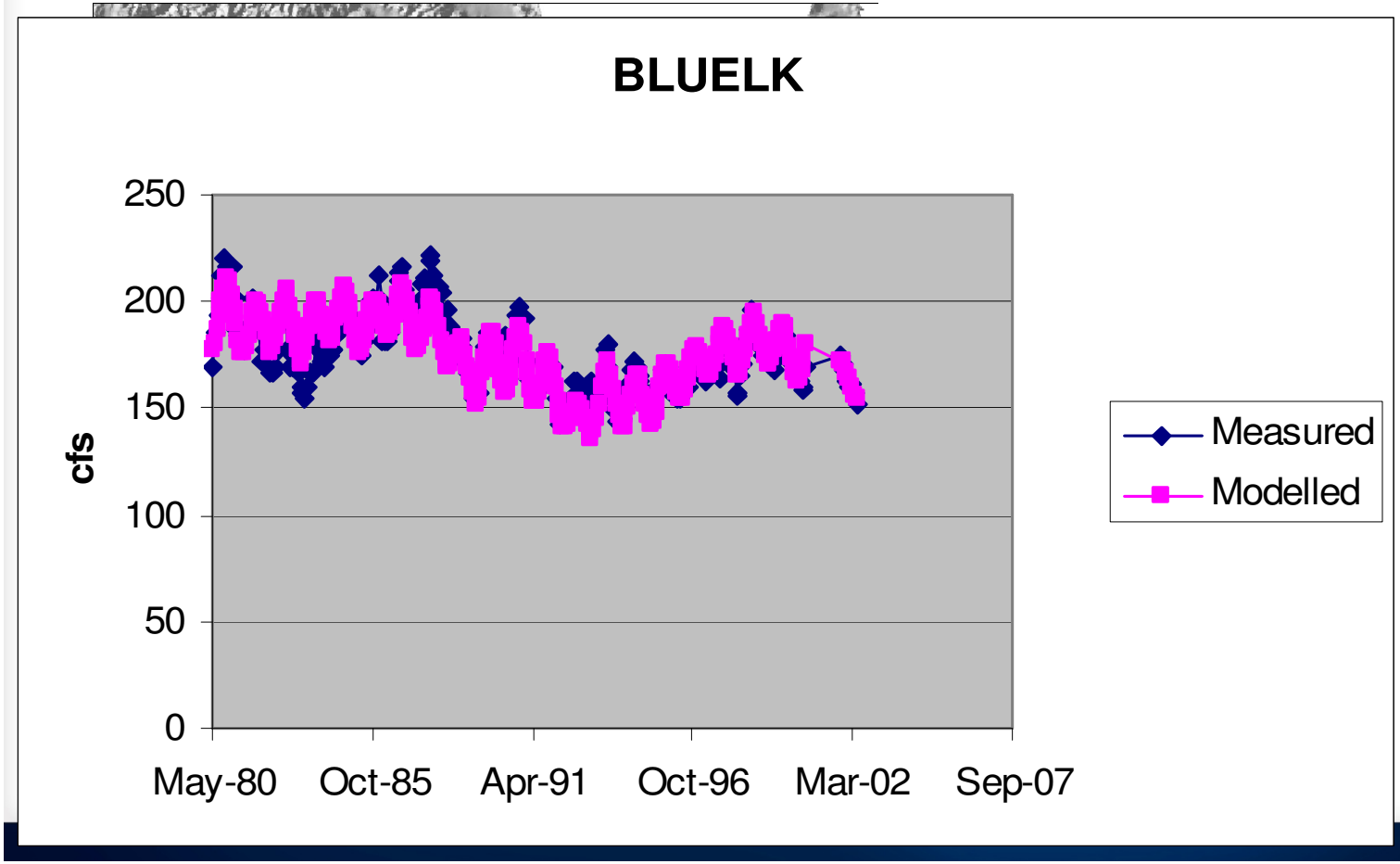


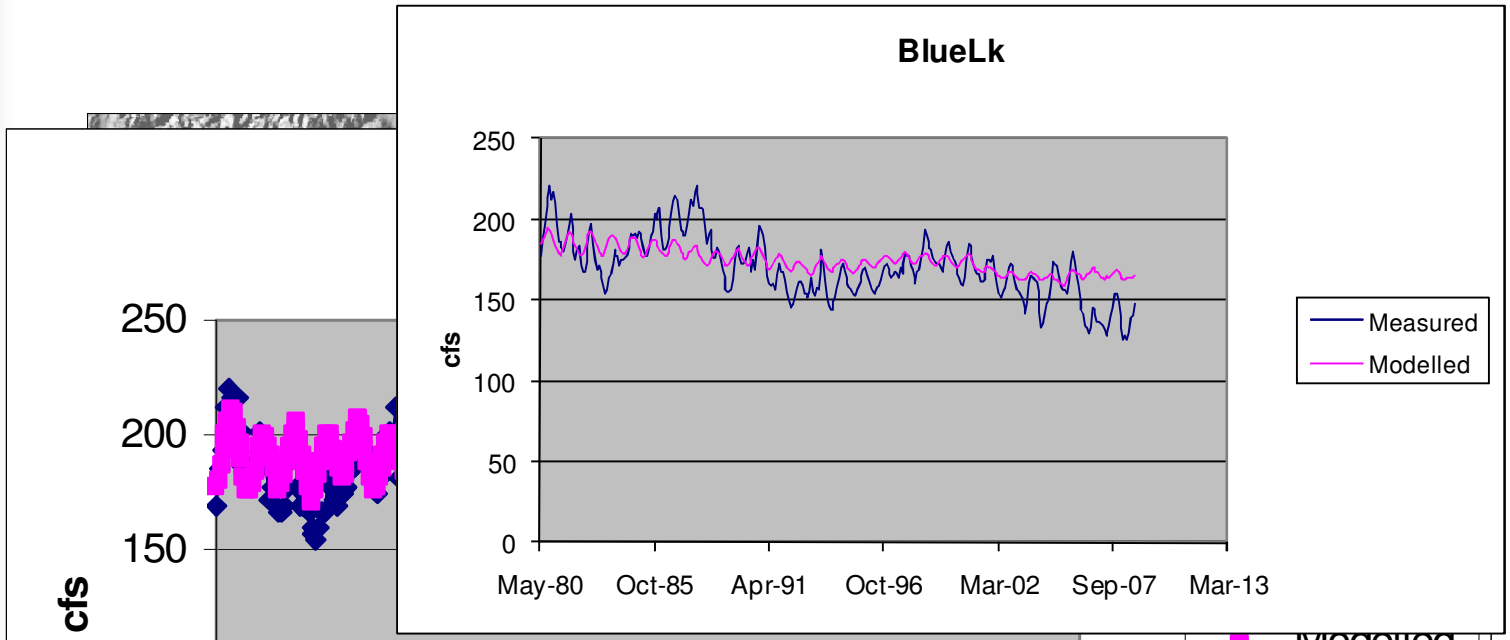

DevilsC
cfs
60
50
40
30
20
10
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled
cfs
60
50
40
30
20
10
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Modelled


Eastern Snake Plain
Aquifer Model: Run
Modeled River
modeledSpgs

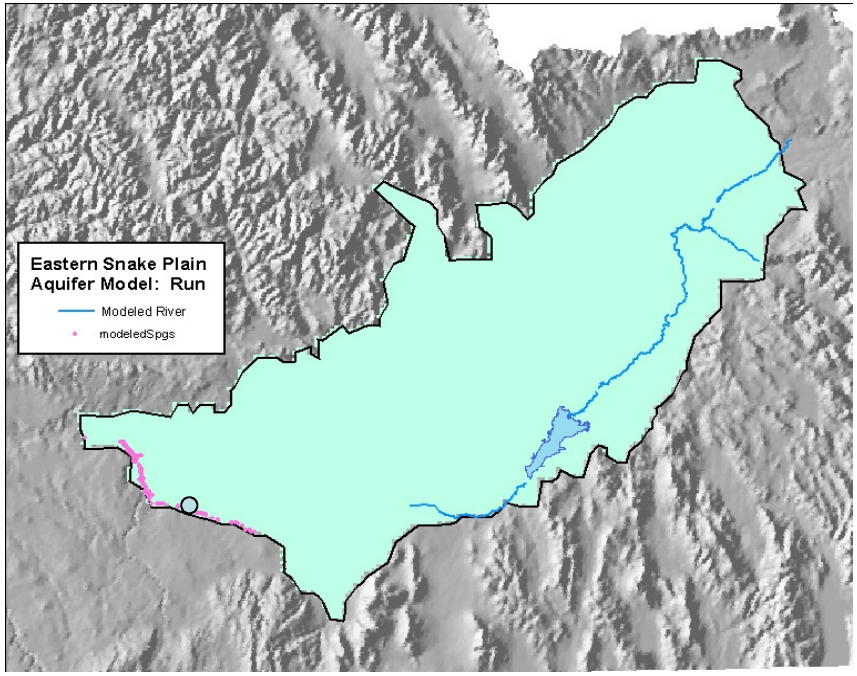
- Blue Lakes

- Blue Lakes


BLUELK
250
200
150
100
50
0
cfs
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Measured
Modelled

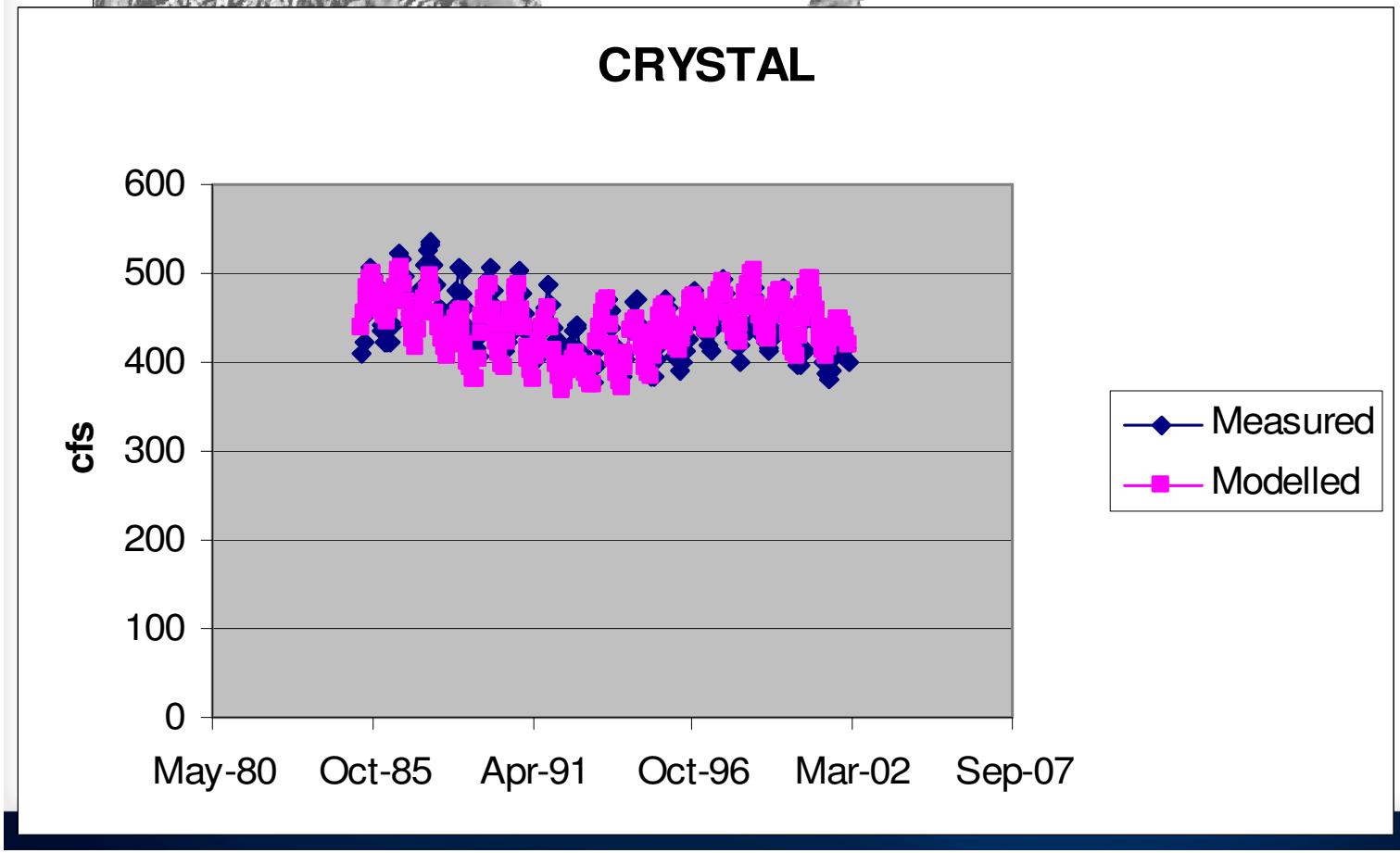

BlueLk
250
200
150
100
50
0
cfs
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled

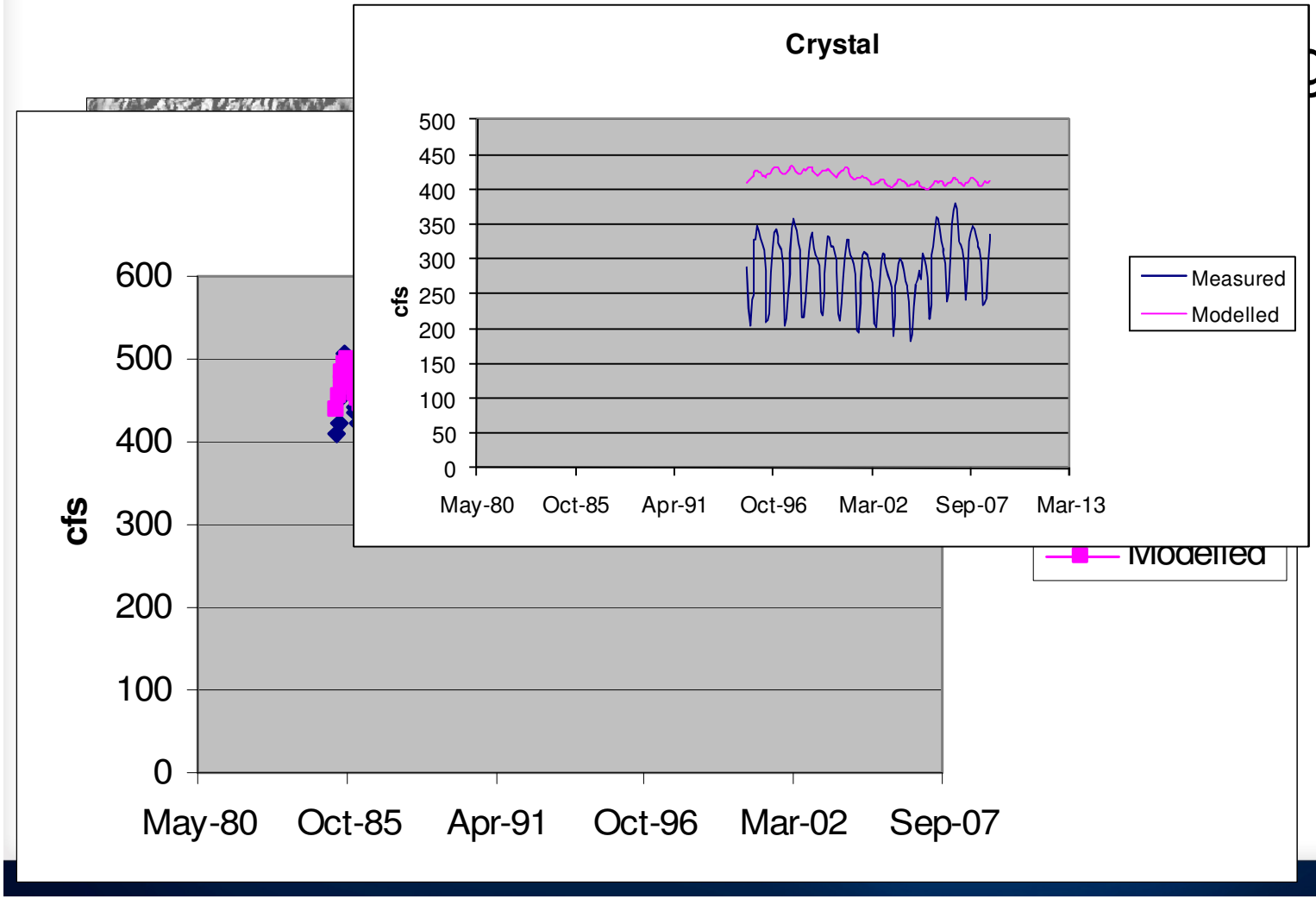
250
200
150
100
50
0
cfs
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Modelled

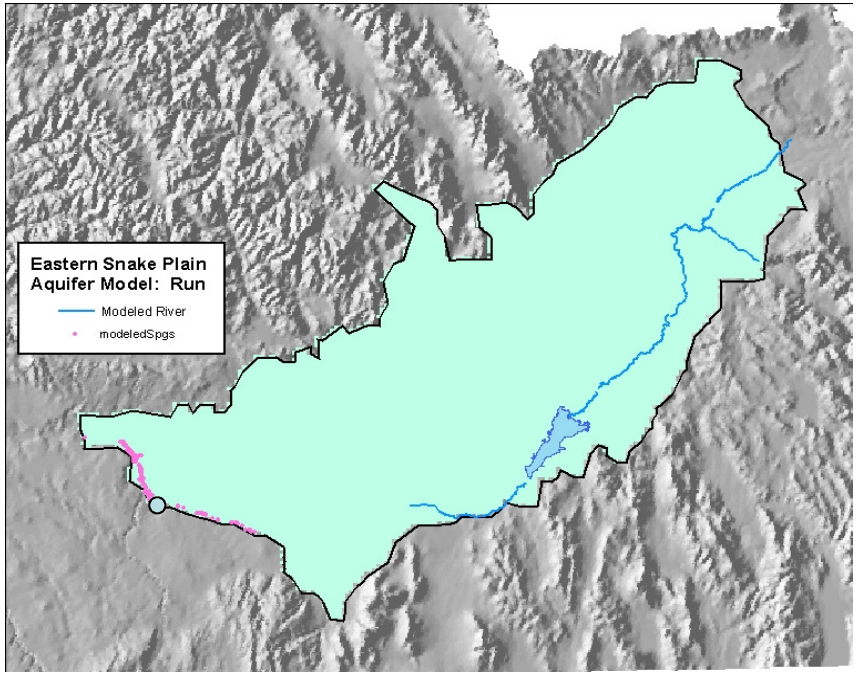


- Crystal Springs

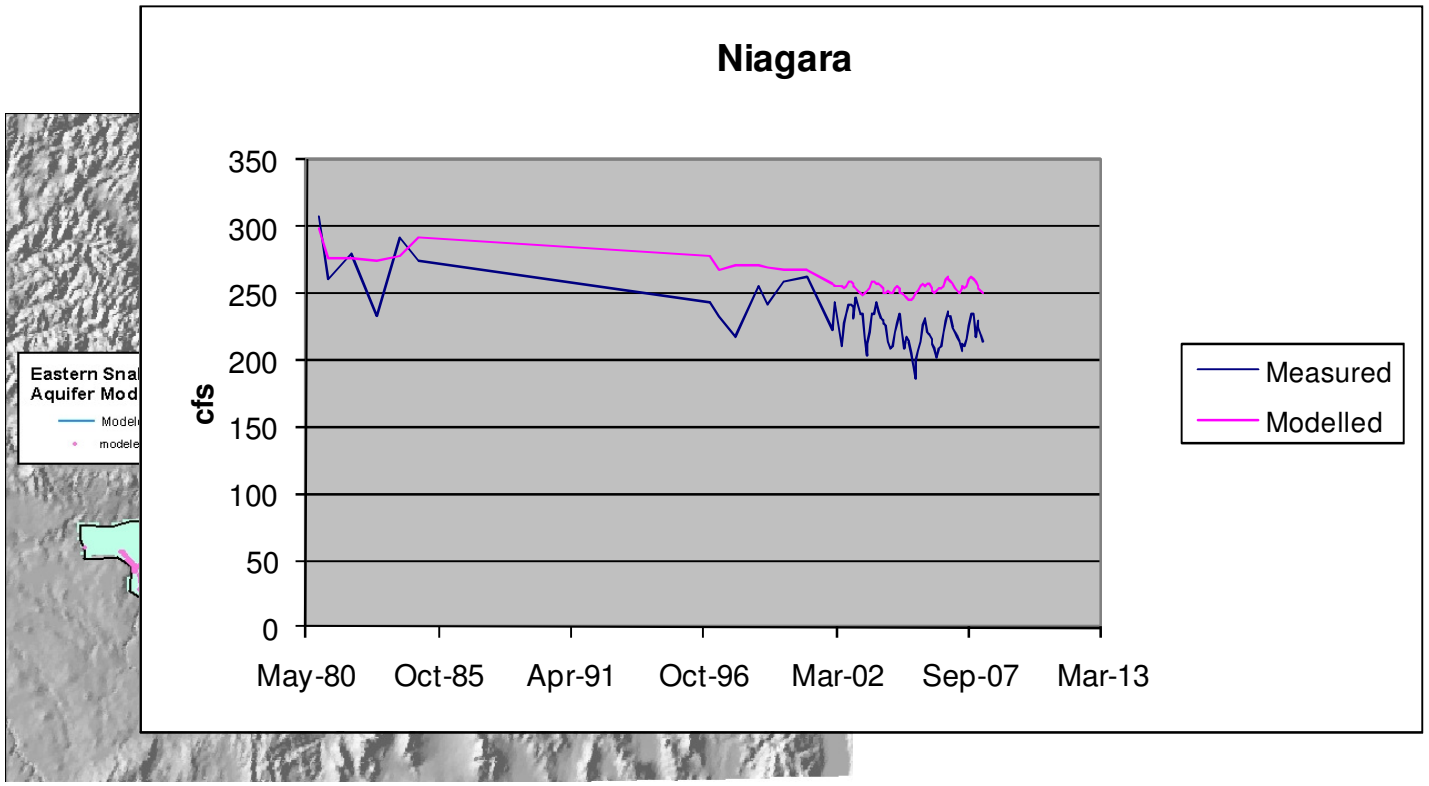
- Crystal Springs

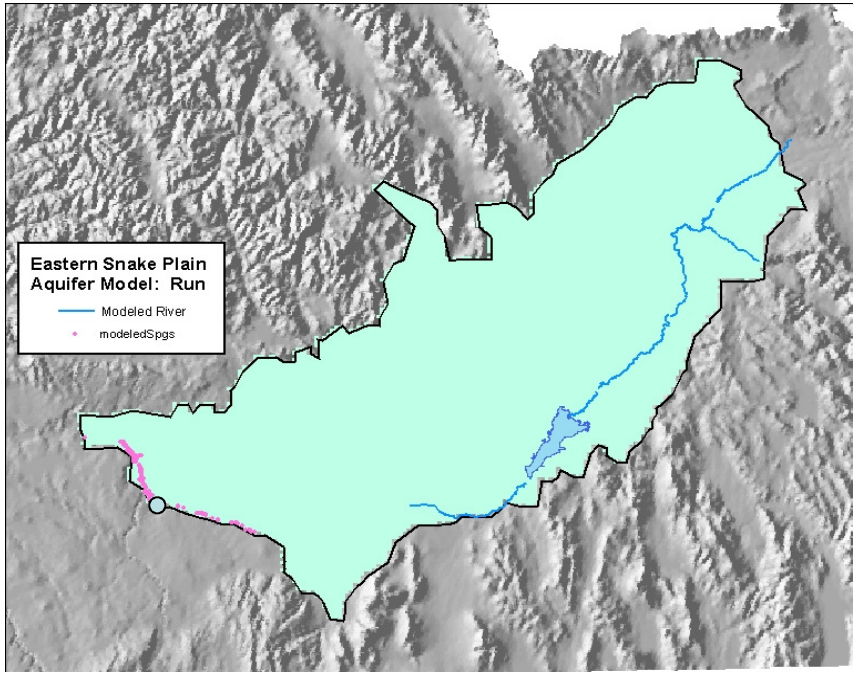



Crystal
500
450
400
350
300
250
200
150
100
50
0
cfs
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled
600
500
400
300
200
100
0
cfs
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Modelled


Eastern Snake Plain
Aquifer Model: Run
Modeled River
modeledSpgs

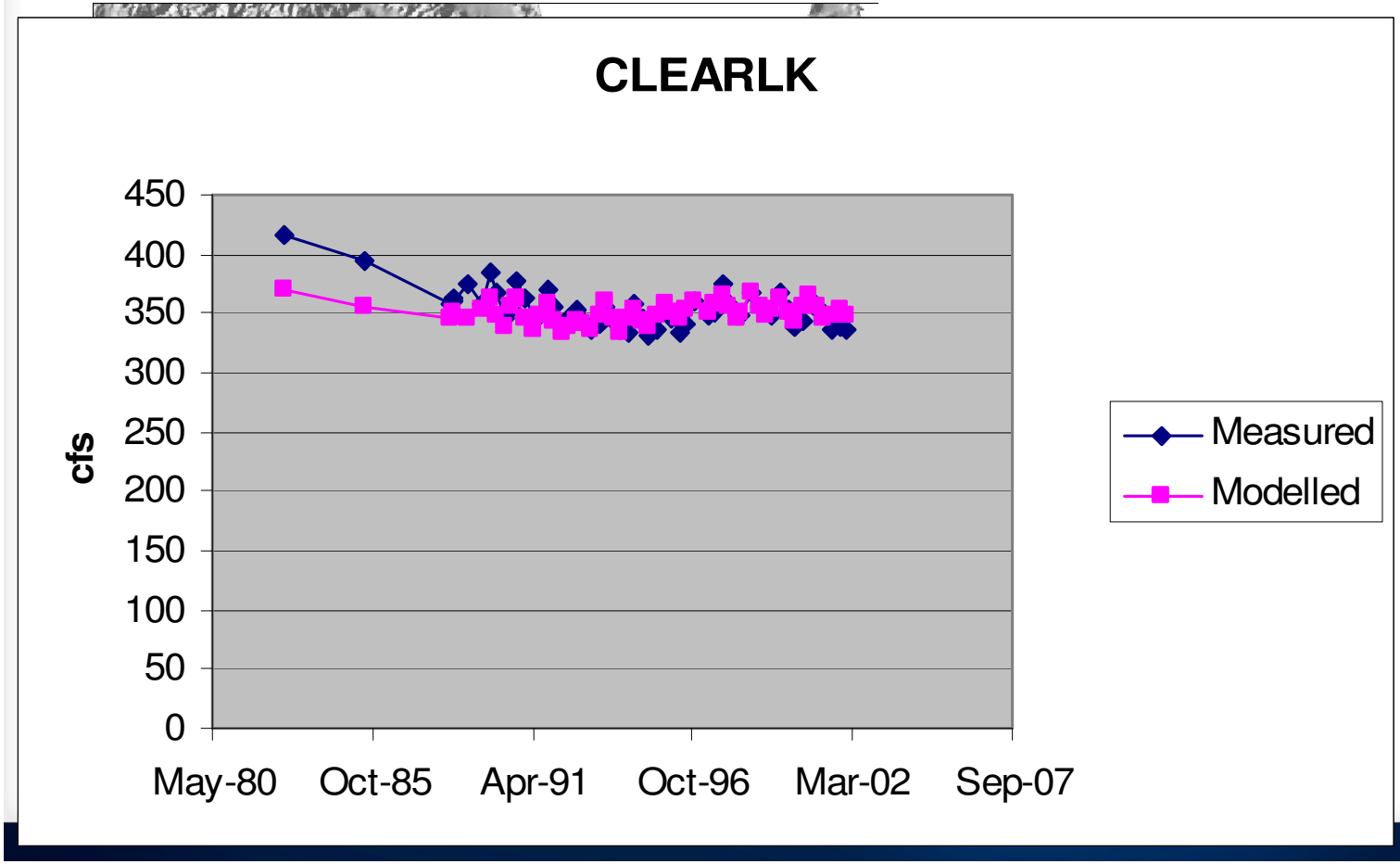
- Niagara

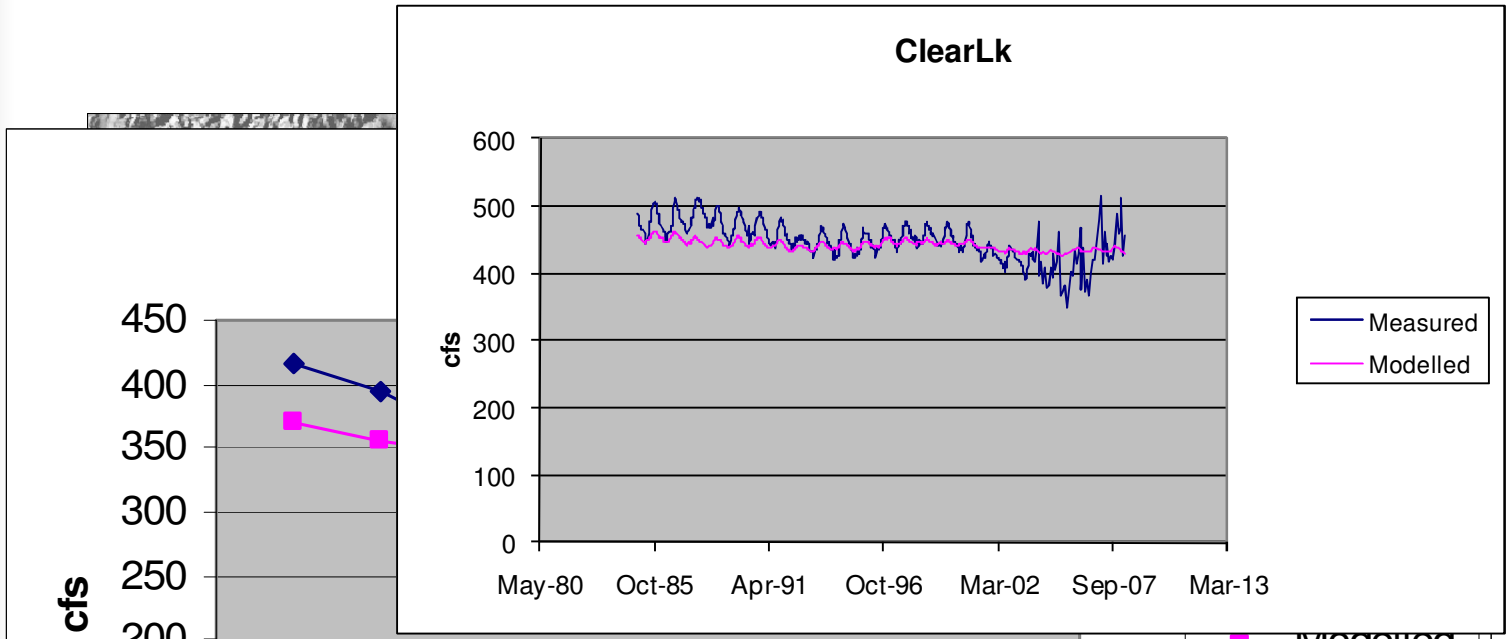

Eastern Snak
Aquifer Mod
Model
modele
Niagara
cfs
350
300
250
200
150
100
50
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled


Eastern Snake Plain
Aquifer Model: Run
Modeled River
modeledSpgs

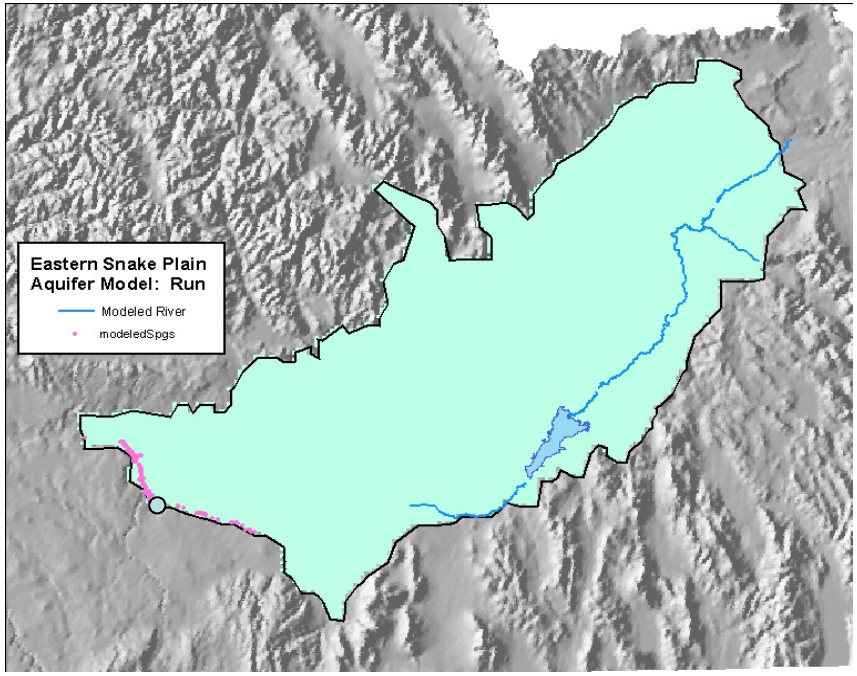
- Clear Lakes

- Clear Lakes


CLEARLK
cfs
450
400
350
300
250
200
150
100
50
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Measured
Modelled

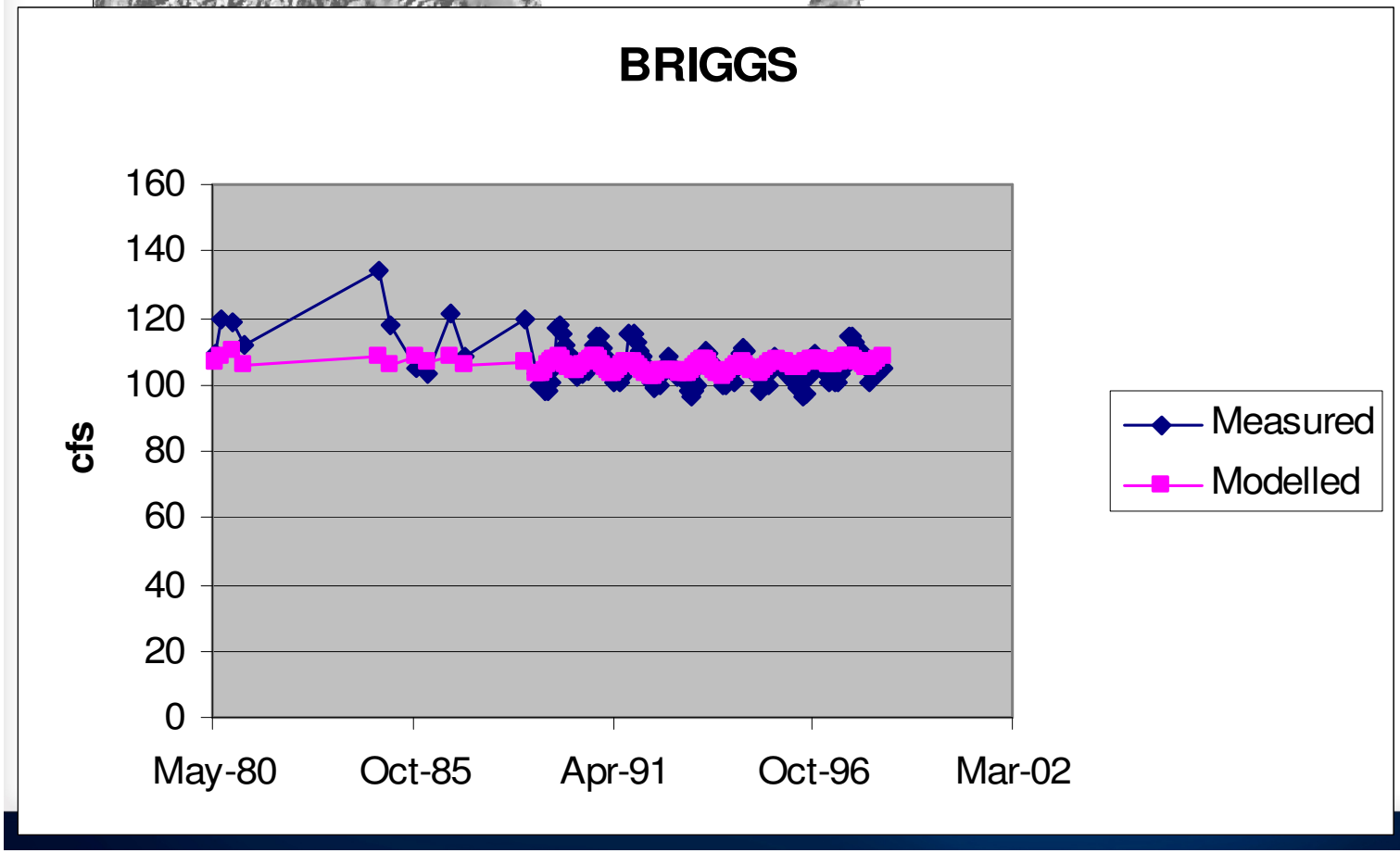

ClearLk
600
500
400
300
200
100
0
cfs
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled

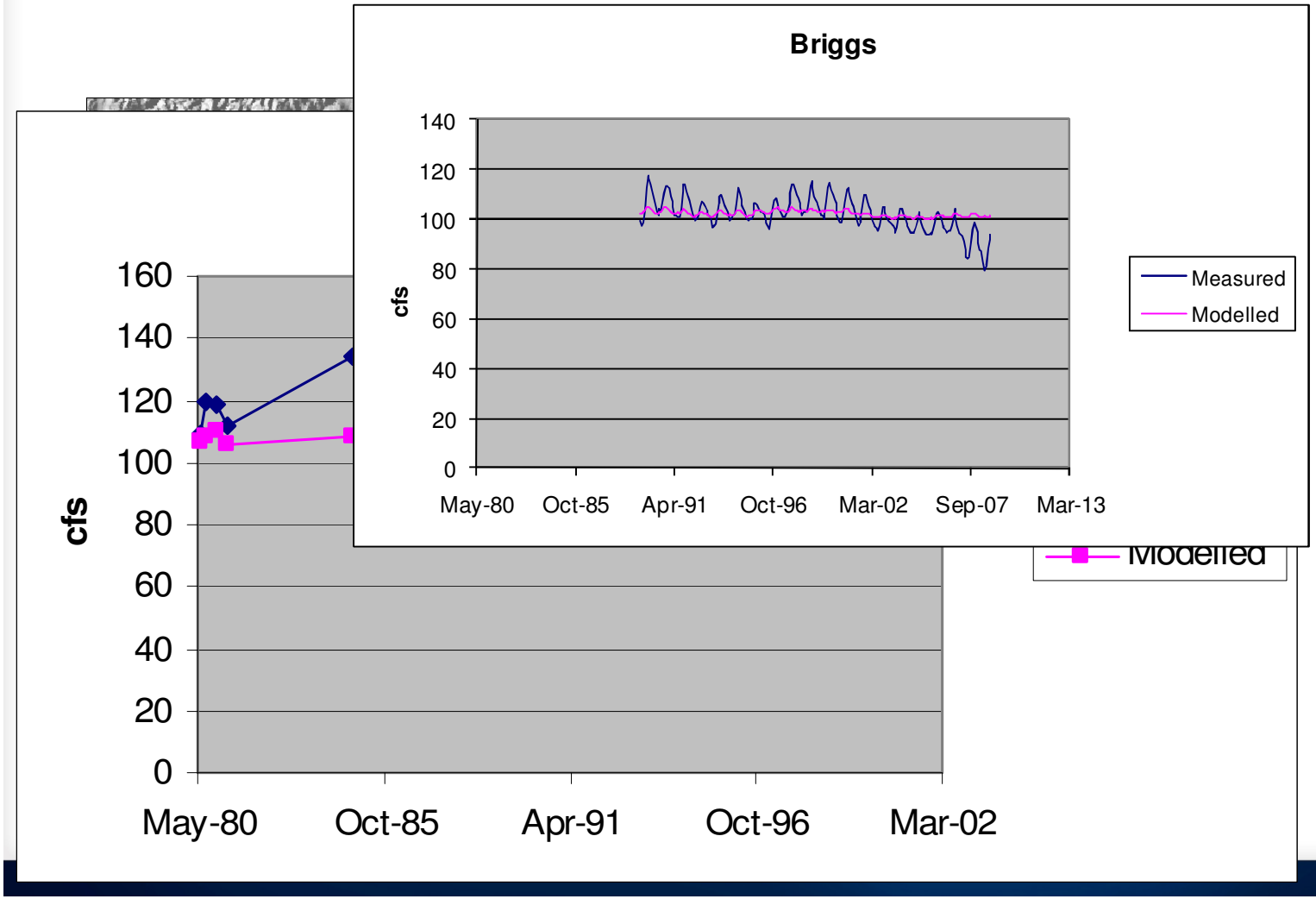
450
400
350
300
250
200
150
100
50
0
cfs
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Modelled

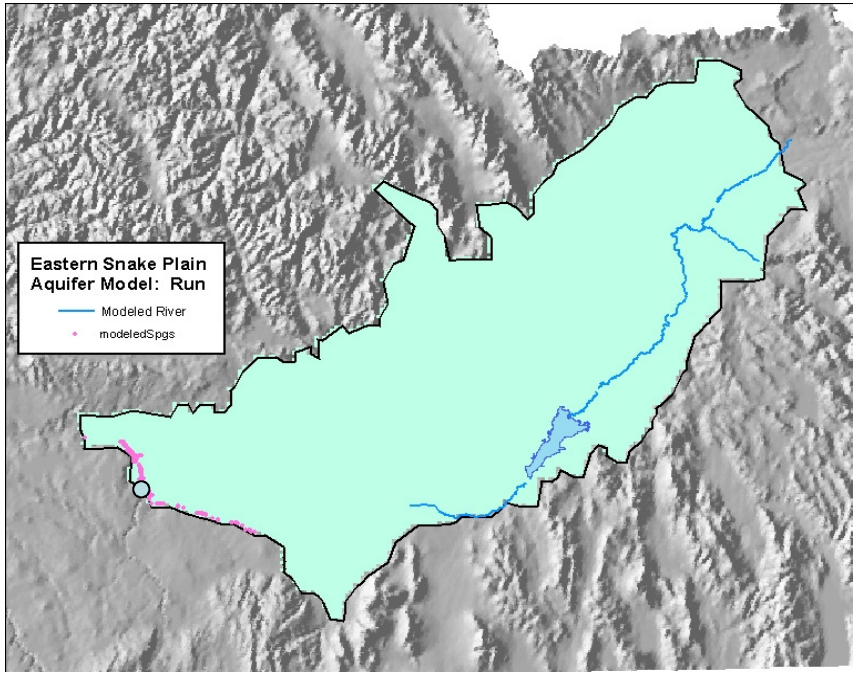


- Briggs Spring

- Briggs Spring

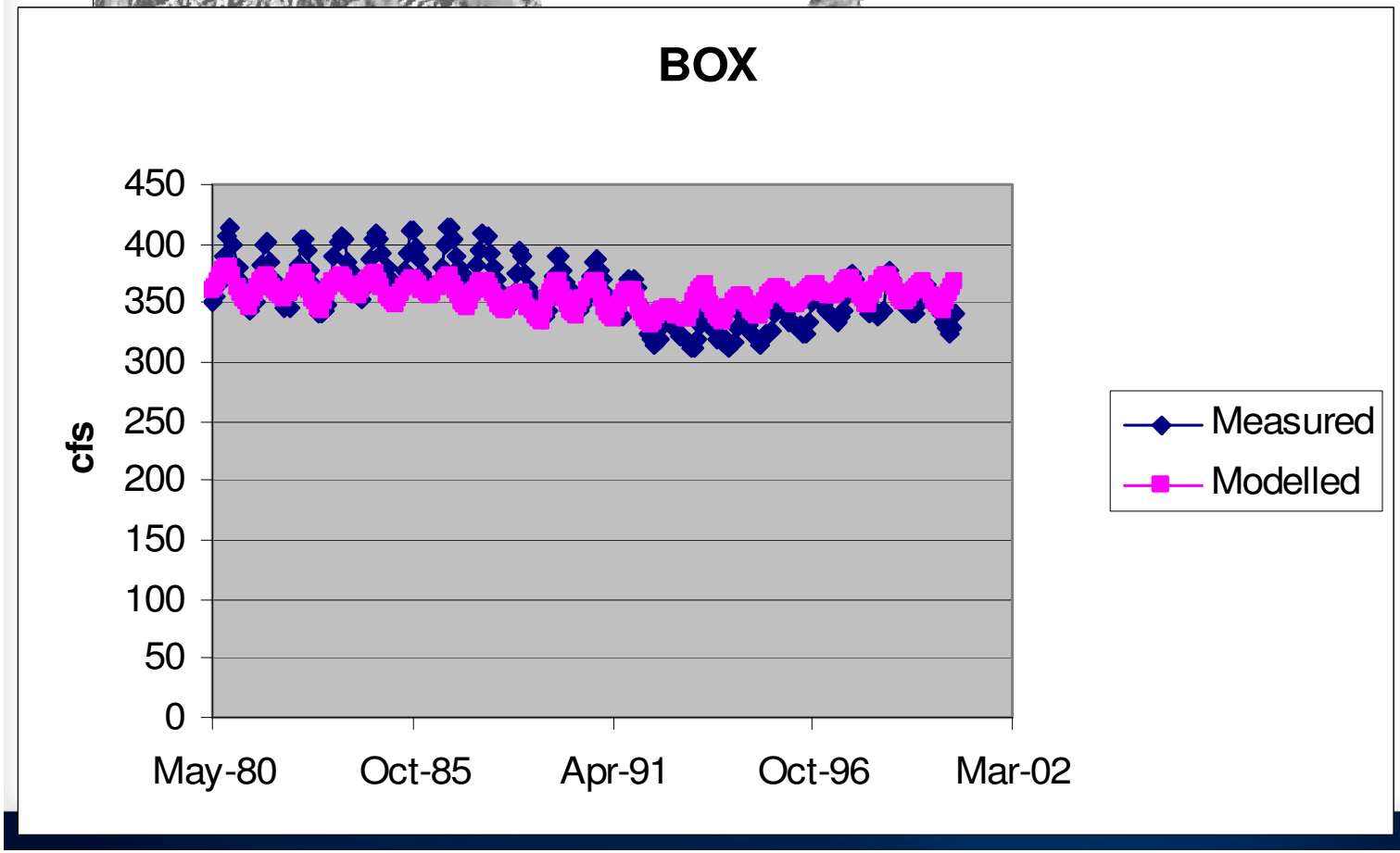



Briggs
140
120
100
80
60
40
20
0
cfs
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled
160
140
120
100
80
60
40
20
0
cfs
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Modelled

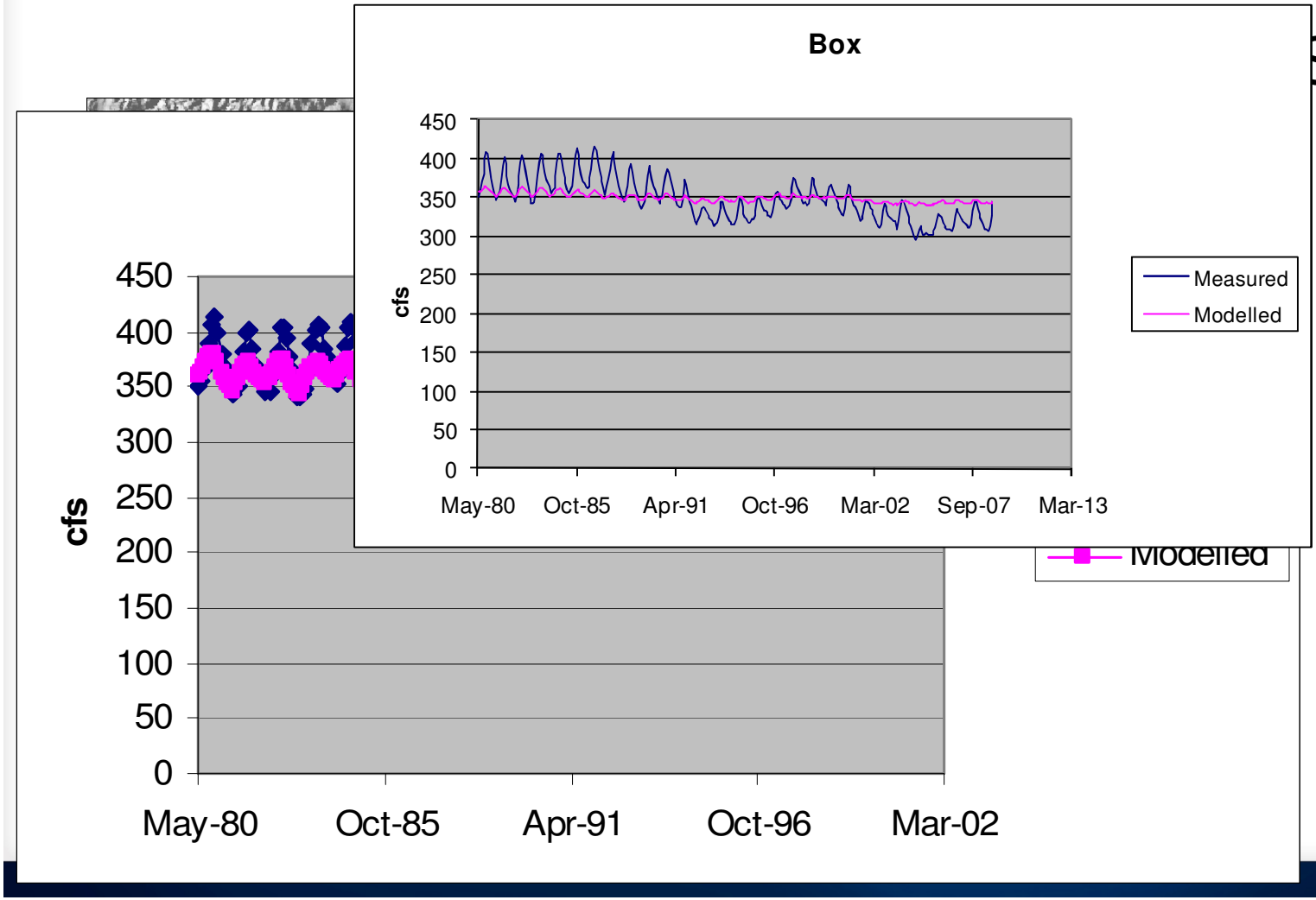


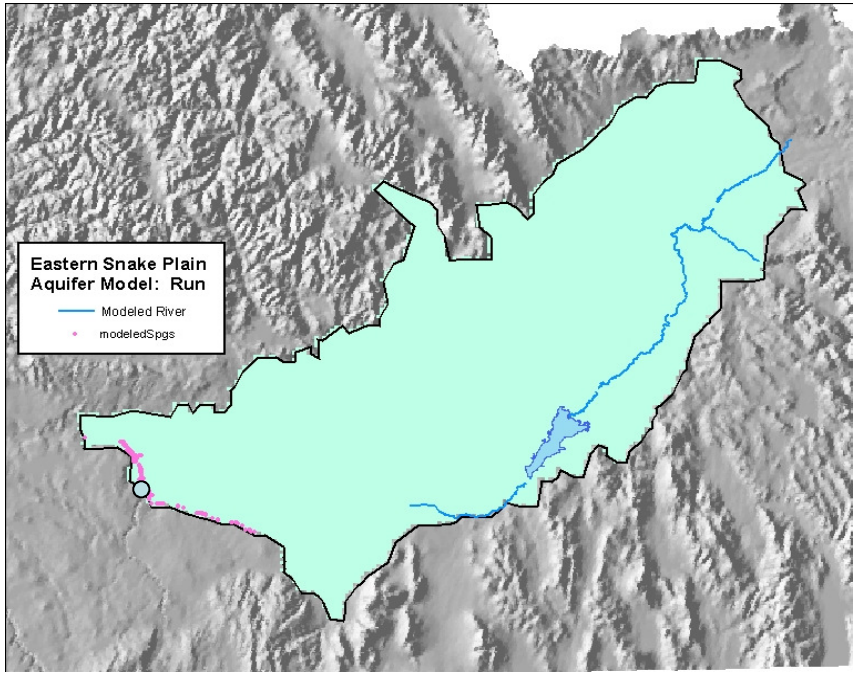
- Box Canyon Spring

- Box Canyon Spring



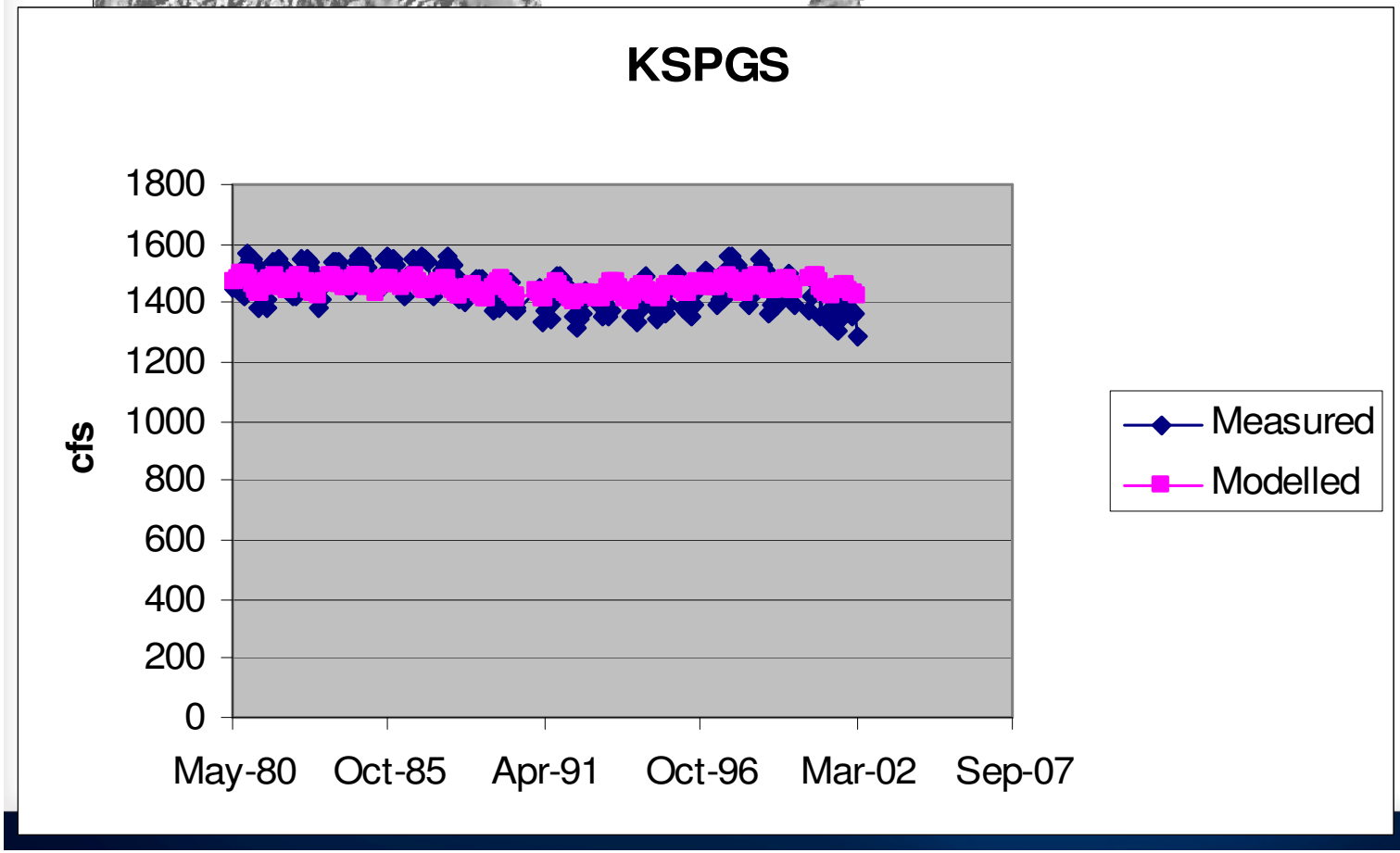
Spring


Box
450
400
350
300
250
200
150
100
50
0
cfs
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled
cfs
450
400
350
300
250
200
150
100
50
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Modelled

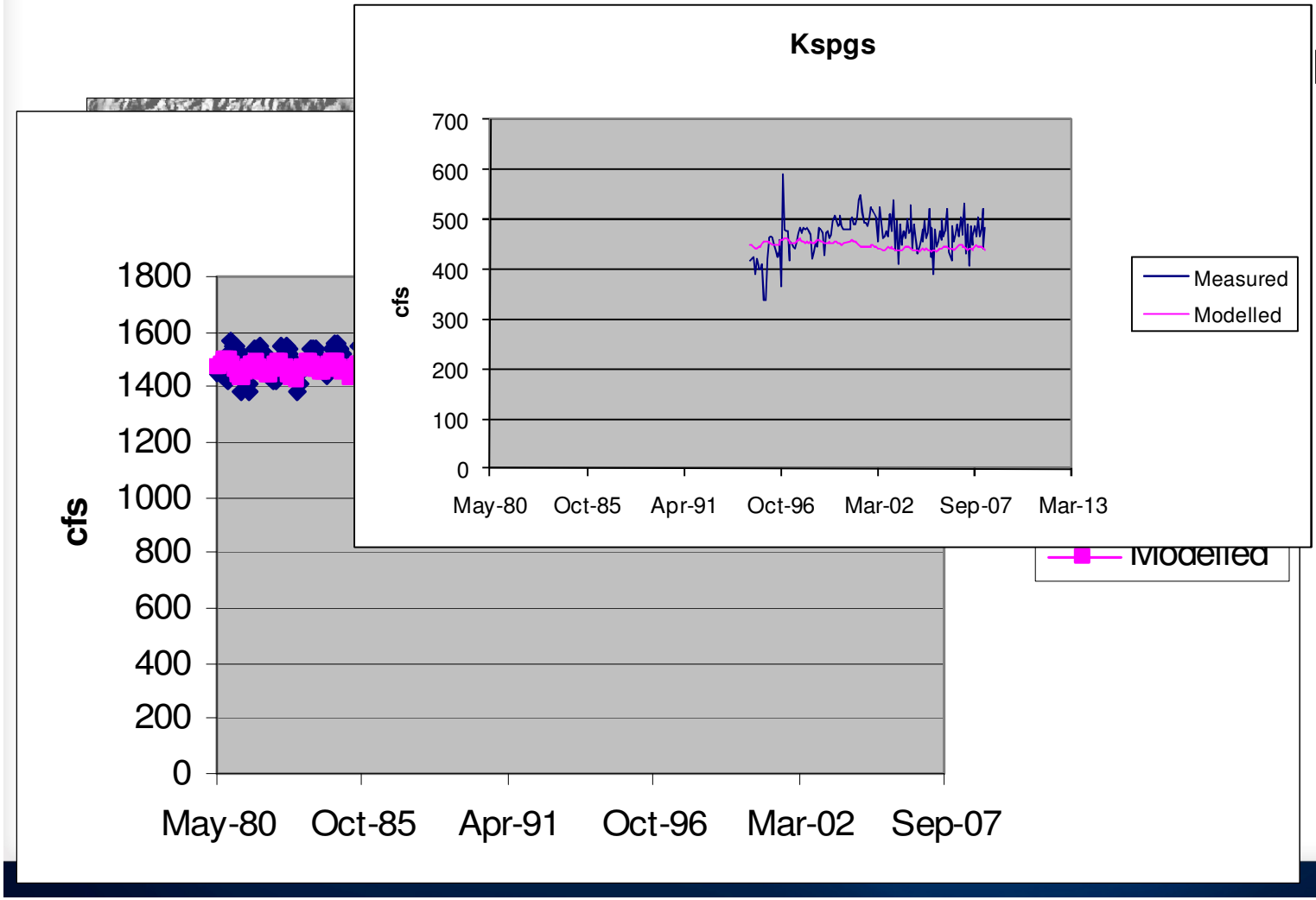


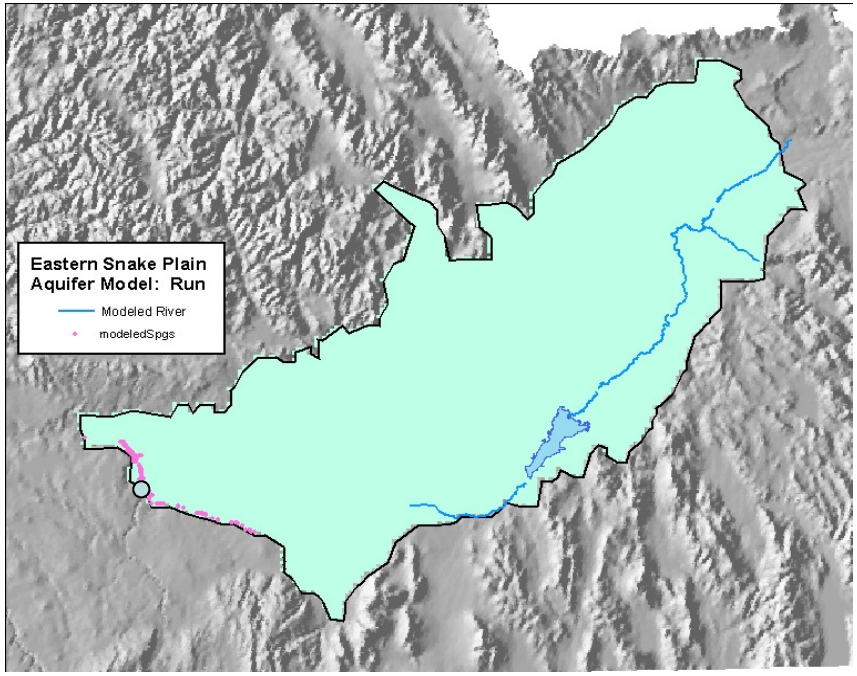
- Thousand Springs

- Thousand Springs

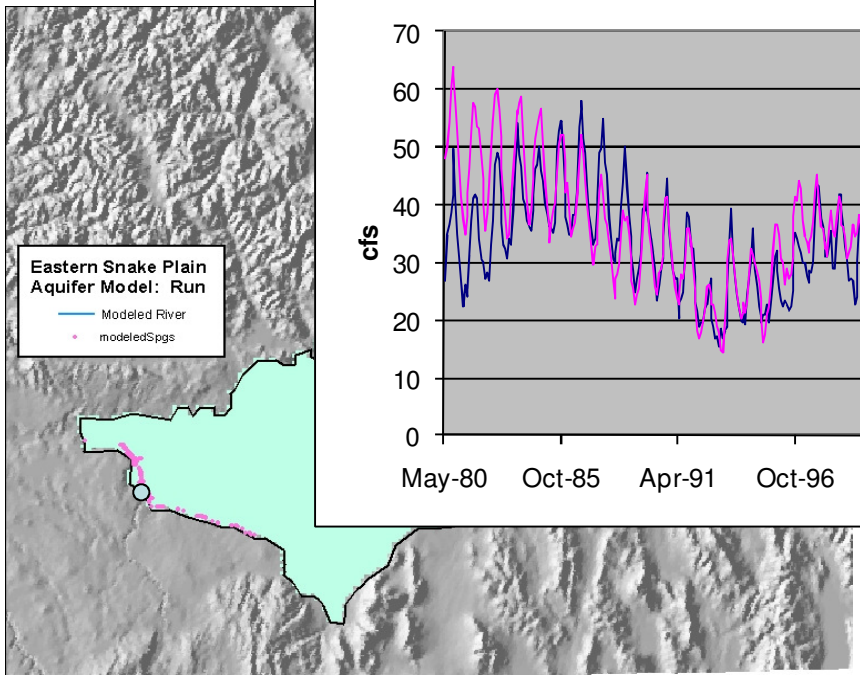


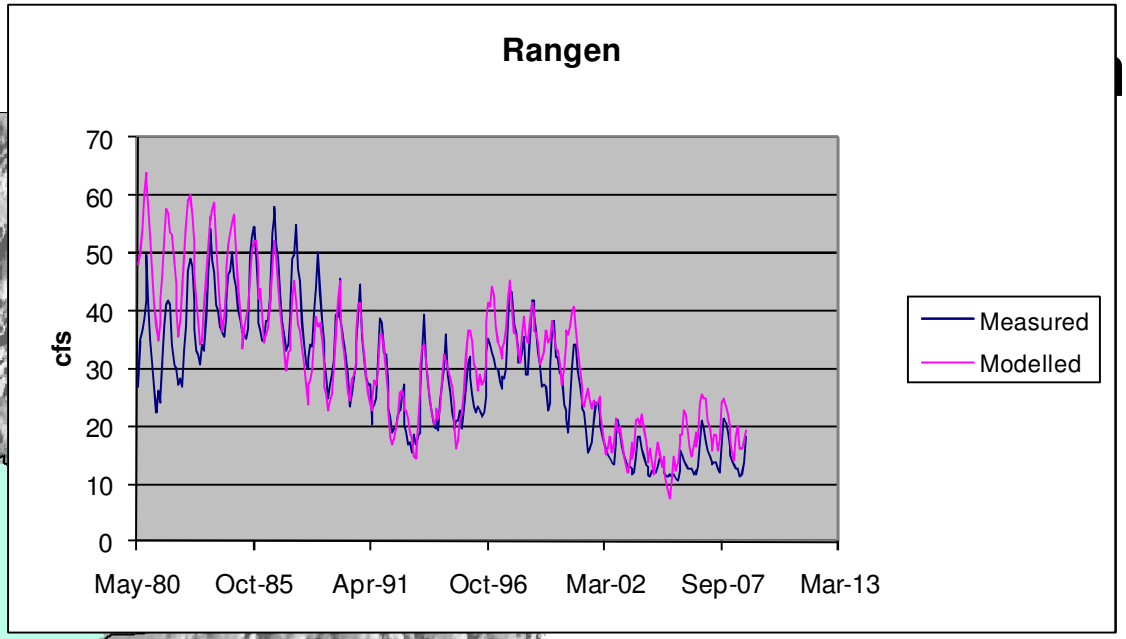
rings

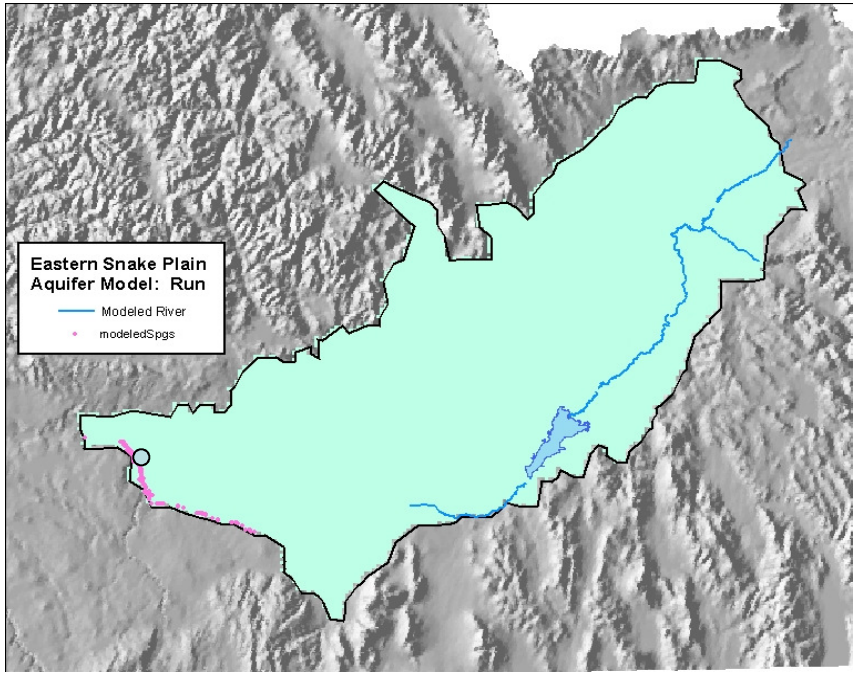

Kspgs
cfs
700
600
500
400
300
200
100
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled
cfs
1800
1600
1400
1200
1000
800
600
400
200
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Modelled



- Rangen Spring

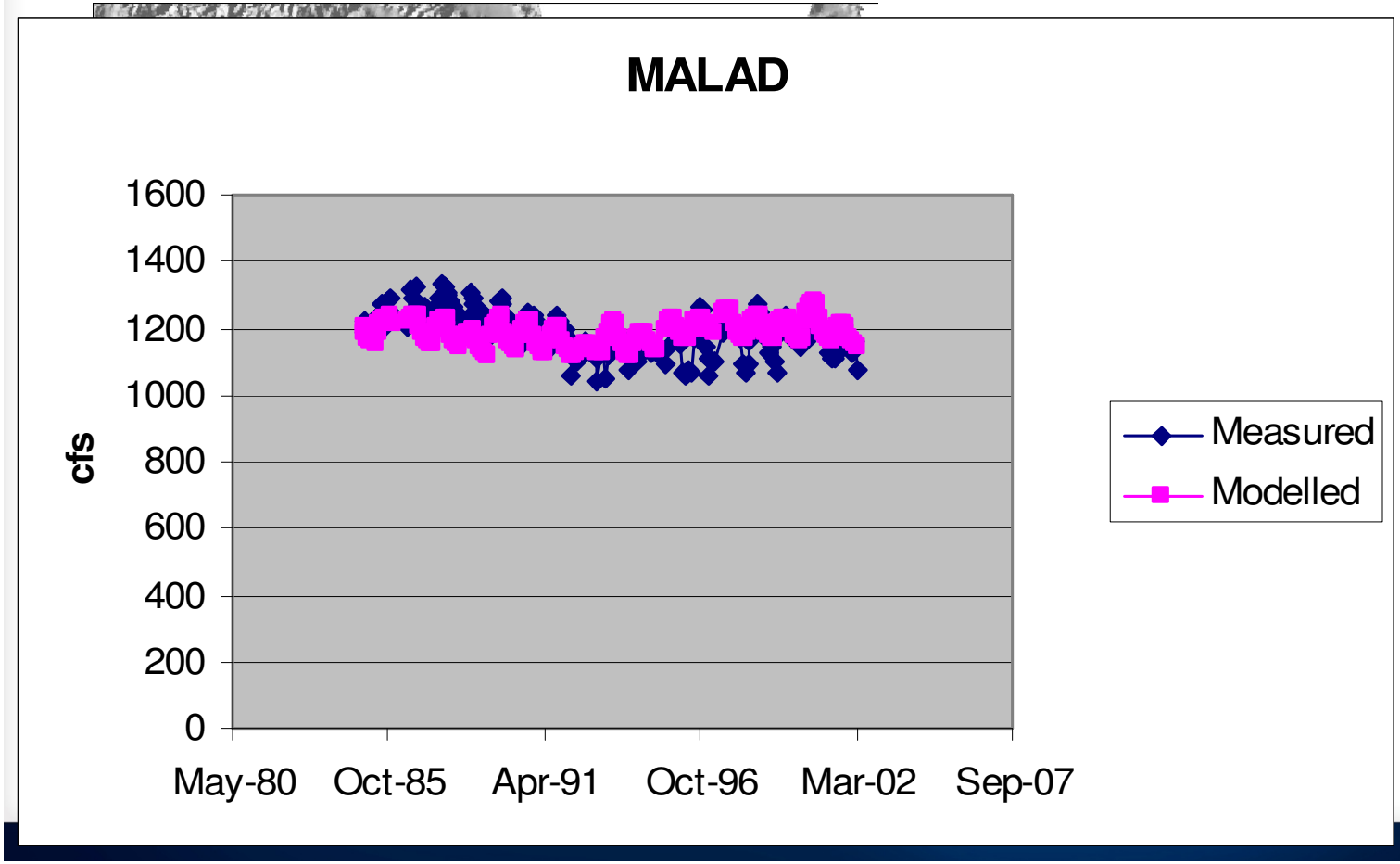

Eastern Snake Plain
Aquifer Model: Run
Modeled River
modeledSpgs

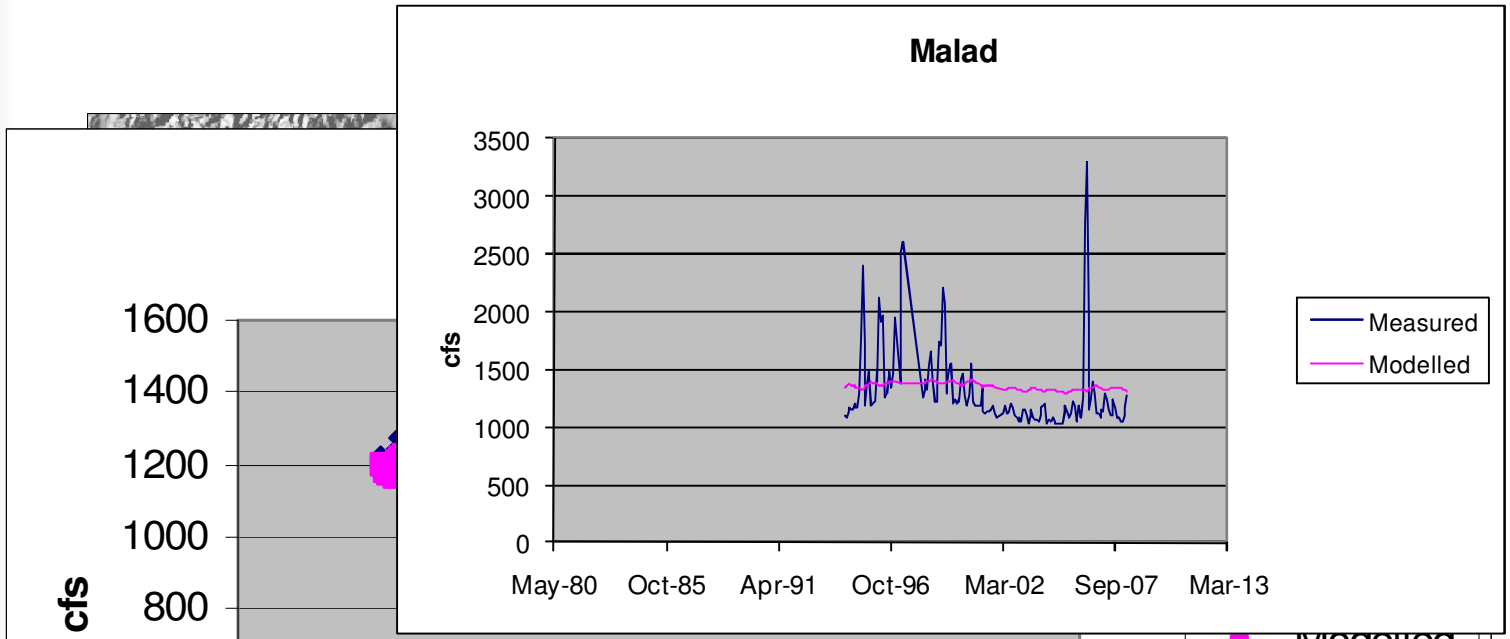

Rangen
cfs
70
60
50
40
30
20
10
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled


Eastern Snake Plain
Aquifer Model: Run
Modeled River
modeledSpgs

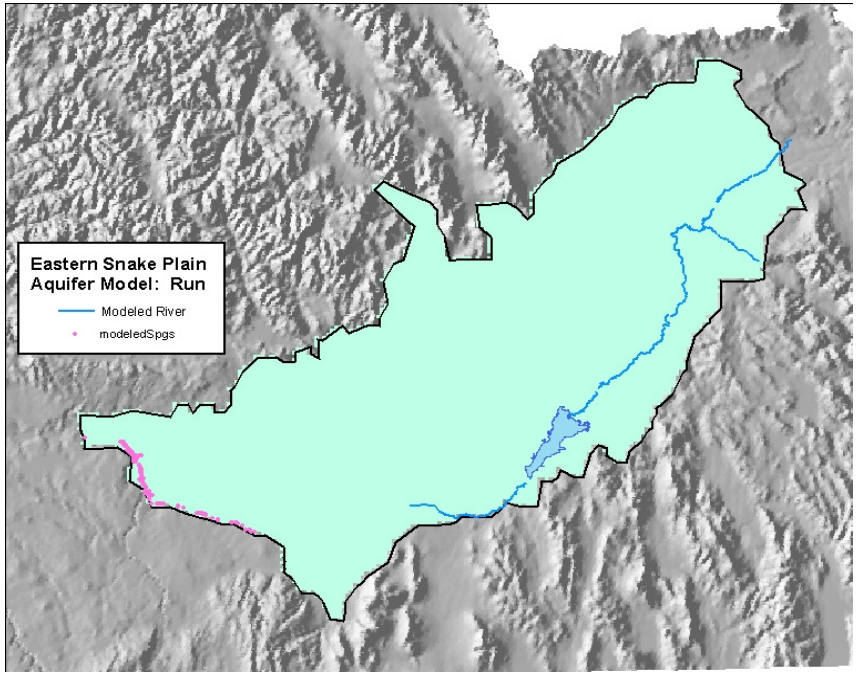
- Malad

- Malad


MALAD
cfs
1600
1400
1200
1000
800
600
400
200
0
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Measured
Modelled

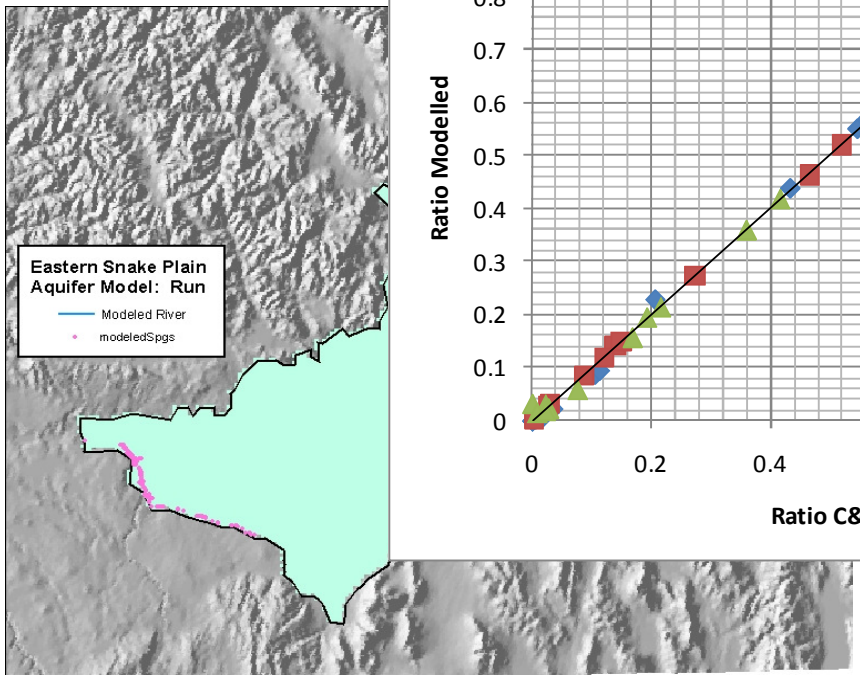

Malad
3500
3000
2500
2000
1500
1000
500
0
cfs
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Mar-13
Measured
Modelled

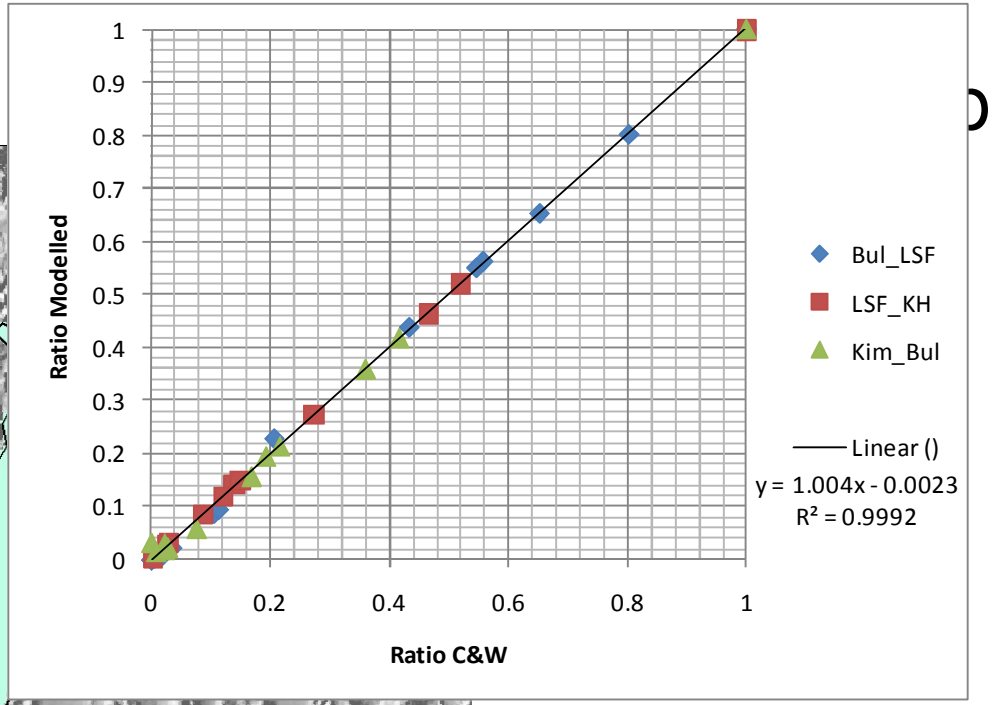
1600
1400
1200
1000
800
600
400
200
0
cfs
May-80
Oct-85
Apr-91
Oct-96
Mar-02
Sep-07
Modelled



- Group C Springs

...prings


Eastern Snake Plain
Aquifer Model: Run
Modeled River
modeledSpgs


Ratio Modelled
Ratio C&W
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
0.2
0.4
0.6
0.8
Bul_LSF
LSF_KH
Kim_Bul
Linear ()
y = 1.004x - 0.0023
R² = 0.9992

END