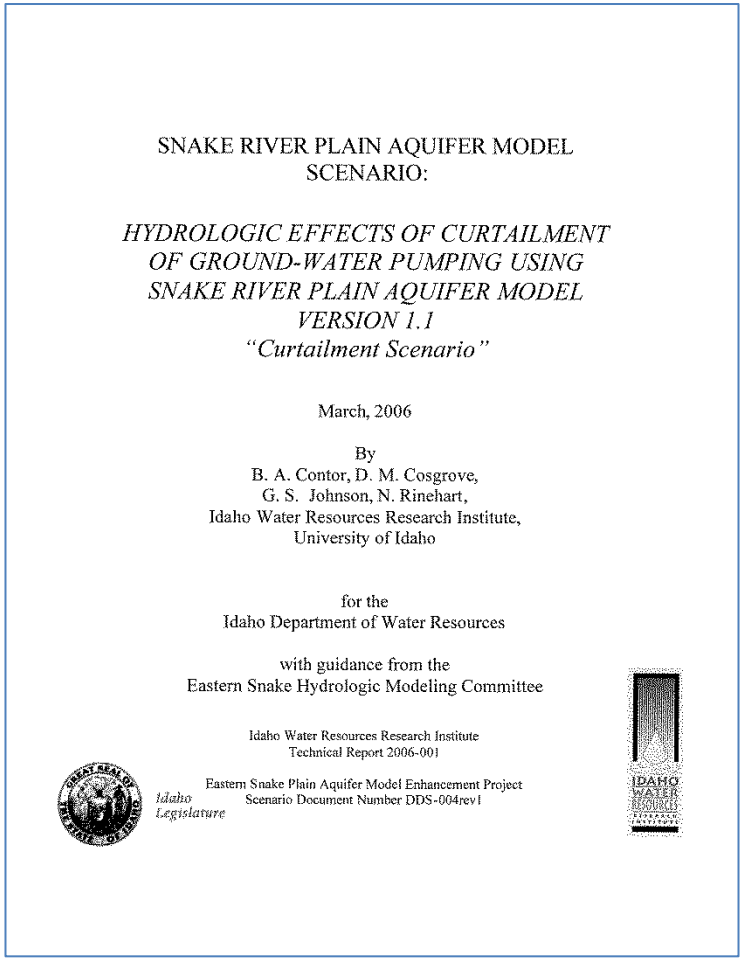
Comparison of ESPAM2.0 with ESPAM1.1 via the Curtailment Scenario

Presented by Jennifer Sukow, P.E., P.G.

June 22, 2012

ESPAM1.1 Curtailment Scenario

- Contor, et al. (2006) available at http://www.if.uidaho.edu/~johnson/ifiwrri/projects.html#prj rpt
- Modeled curtailment of groundwater irrigation within model boundary junior to five selected priority dates
- No administrative boundaries were applied (no trim line, no area of common groundwater)



SNAKE RIVER PLAIN AQUIFER MODEL
SCENARIO:

HYDROLOGIC EFFECTS OF CURTAILMENT OF GROUND-WATER PUMPING USING SNAKE RIVER PLAIN AQUIFER MODEL VERSION 1.1
"Curtailment Scenario"

March, 2006

By
B. A. Contor, D. M. Cosgrove,
G. S. Johnson, N. Rinehart,
Idaho Water Resources Research Institute,
University of Idaho

for the
Idaho Department of Water Resources

with guidance from the
Eastern Snake Hydrologic Modeling Committee

Idaho Water Resources Research Institute
Technical Report 2006-001

Idaho Legislature

Eastern Snake Plain Aquifer Model Enhancement Project
Scenario Document Number DDS-004rev1

IDAHO WATER RESOURCES RESEARCH INSTITUTE

ESPAM1.1 Curtailment Scenario

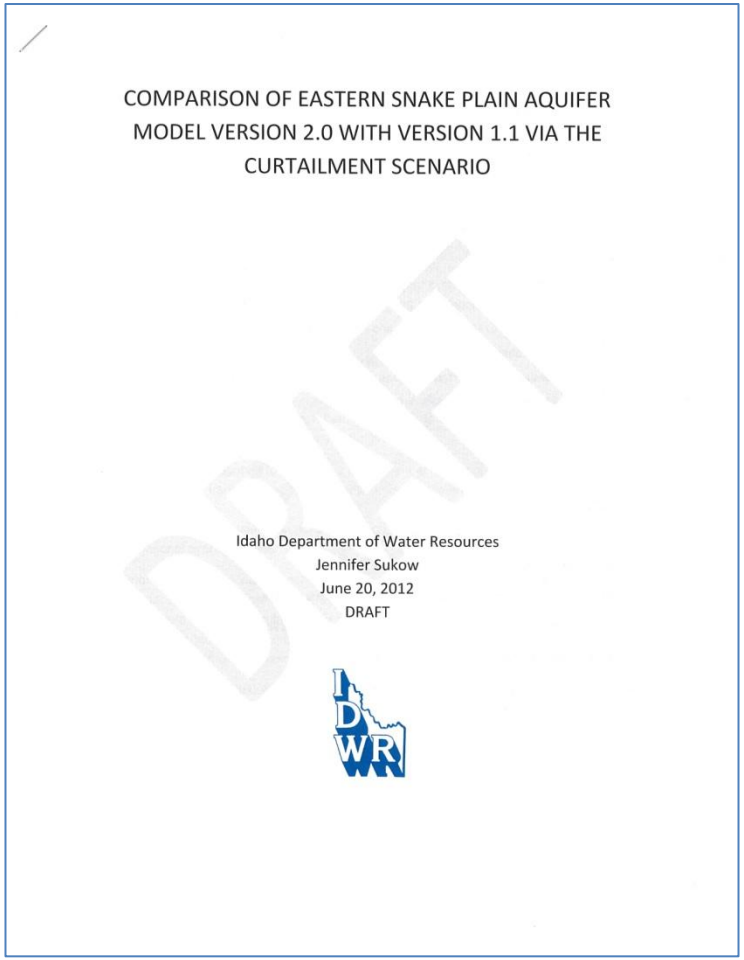
- Numerical superposition version of EPSAM1.1
- Average precipitation from 1961-1990
- Average ET from 1980-2001

- Predictions
  - Steady state response to continuous curtailment
  - Transient response to continuous curtailment for 150 years
  - Transient response to a one-year curtailment

ESPAM2.0 Curtailment Scenario

- Draft report available for ESHMC review and comment at http://www.idwr.idaho.gov/Browse/WaterInfo/ESPAM/model_files/Version_2.0_Development/Current_Documentation/ESPAM2_curtailment_scenario/

- Modeled same scenarios as Contor et al. (2006)



COMPARISON OF EASTERN SNAKE PLAIN AQUIFER MODEL VERSION 2.0 WITH VERSION 1.1 VIA THE CURTAILMENT SCENARIO

DRAFT

Idaho Department of Water Resources
Jennifer Sukow
June 20, 2012
DRAFT

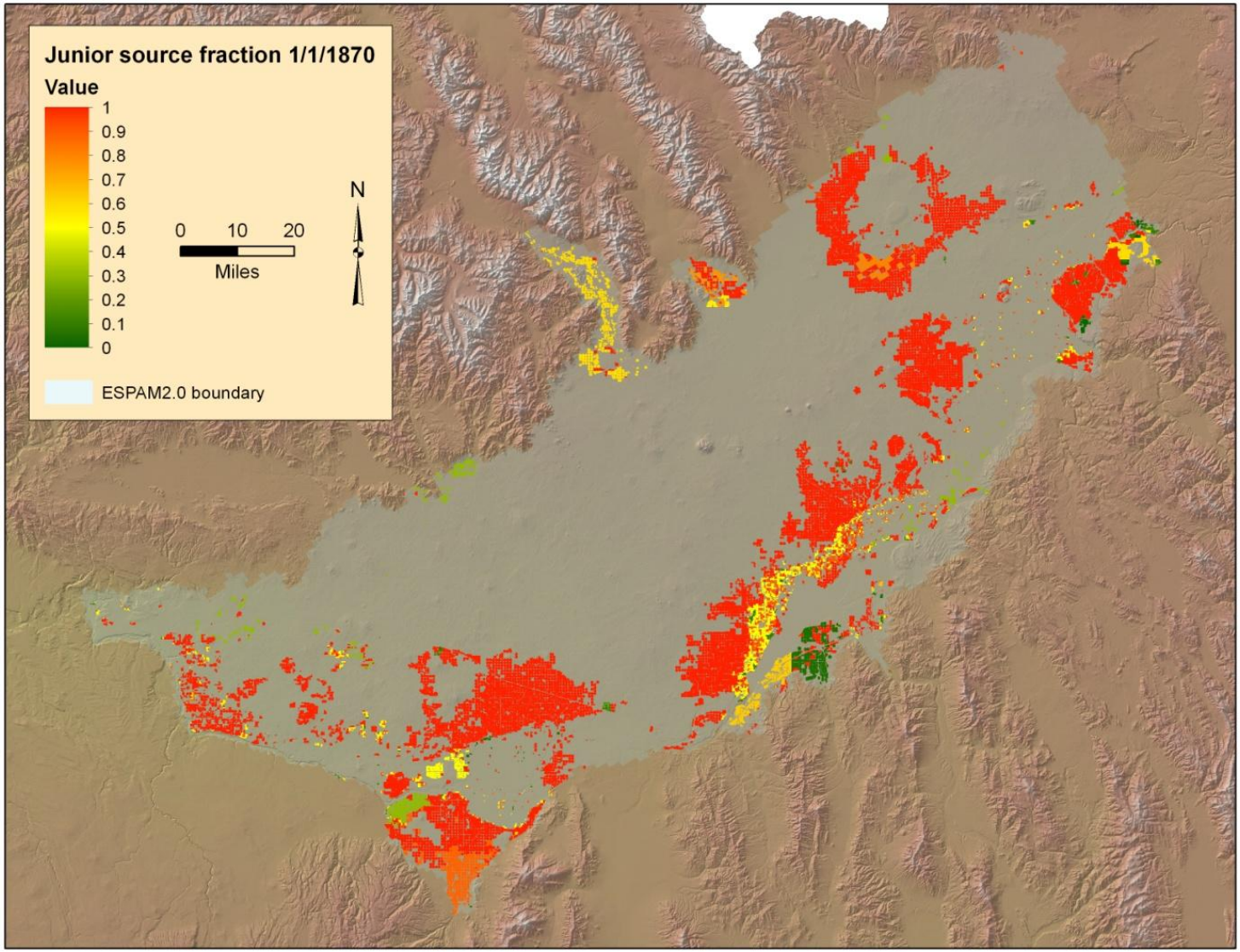
ESPAM2.0 Curtailment Scenario

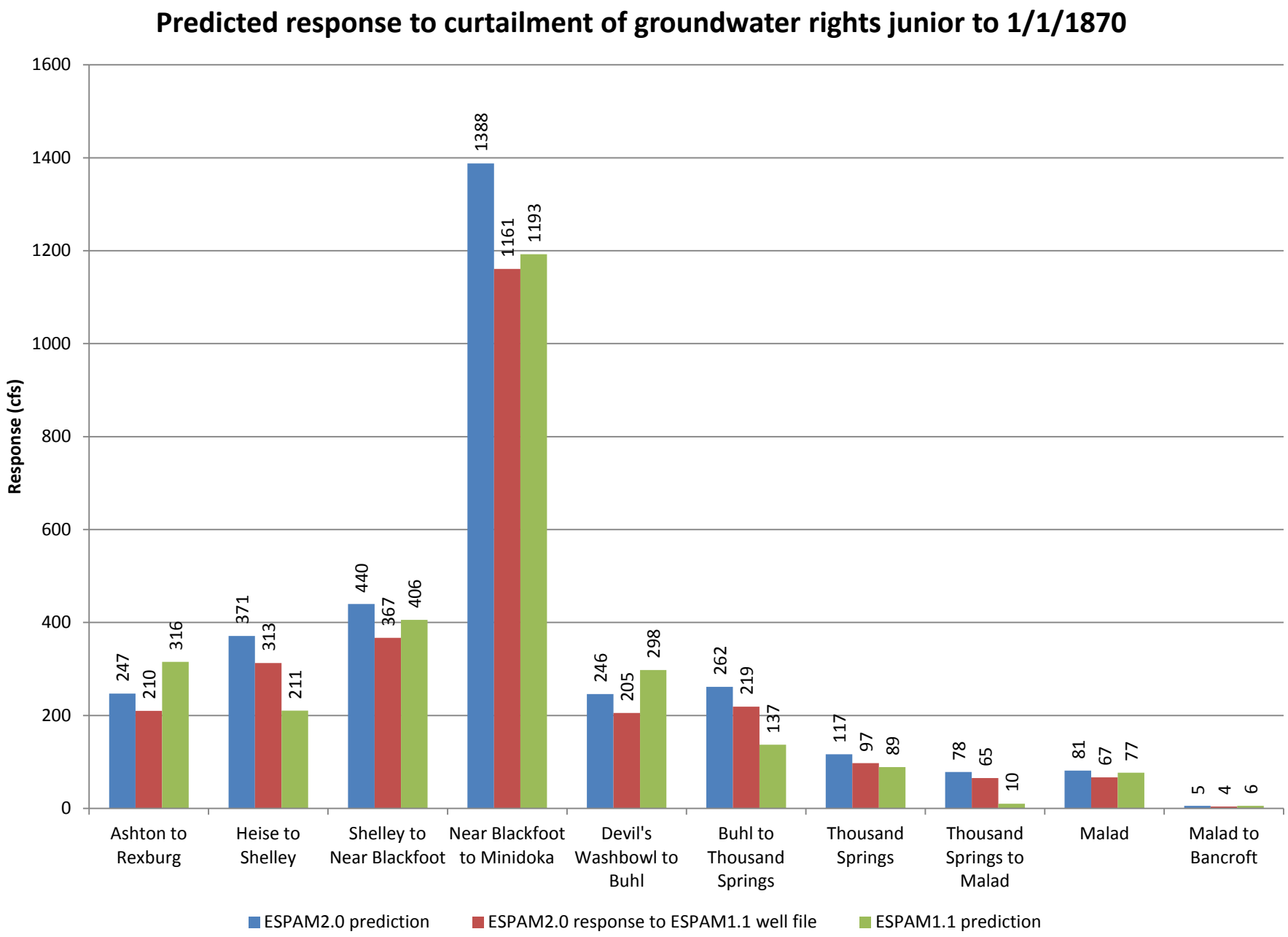
- Numerical superposition version of EPSAM2.0
- Run with well files from ESPAM1.1 scenarios
- Run again with well files created using ESPAM2.0 input data
  - 2012 POD file
  - 2008 irrigated lands
  - Average groundwater fraction raster
  - Average precipitation from Nov 1998 – Oct 2008
  - Average ET from Nov 1998 – Oct 2008

Comparison of Steady State Results

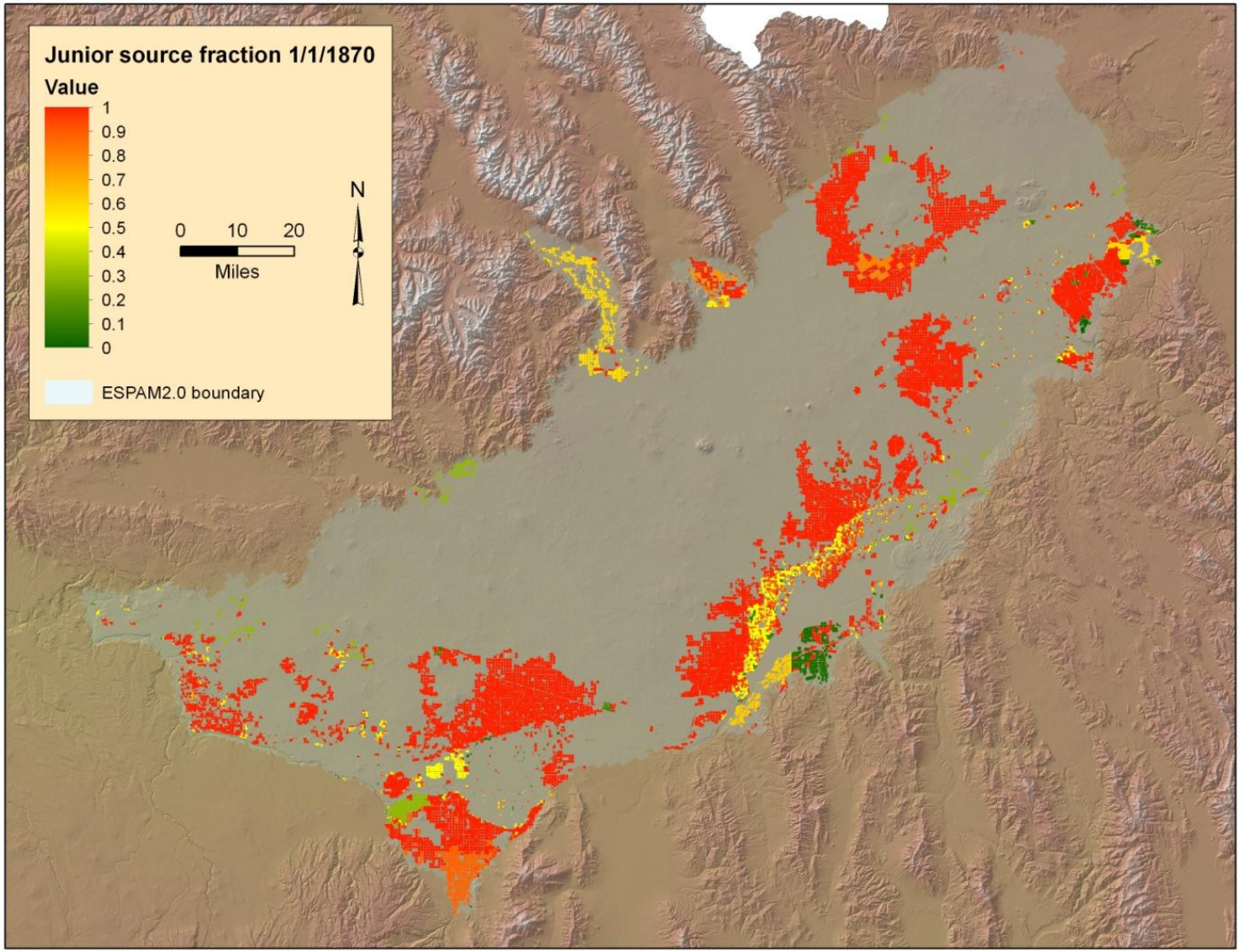
- Compare ESPAM2.0 prediction (with ESPAM2.0 input data) to ESPAM1.1 prediction for net difference
- Comparison of ESPAM2.0 predicted response to ESPAM1.1 well file with ESPAM1.1 prediction illustrates differences in model structure and model parameters
- Comparison of EPSAM2.0 prediction with ESPAM2.0 predicted response to ESPAM1.1 well file illustrates differences in input data

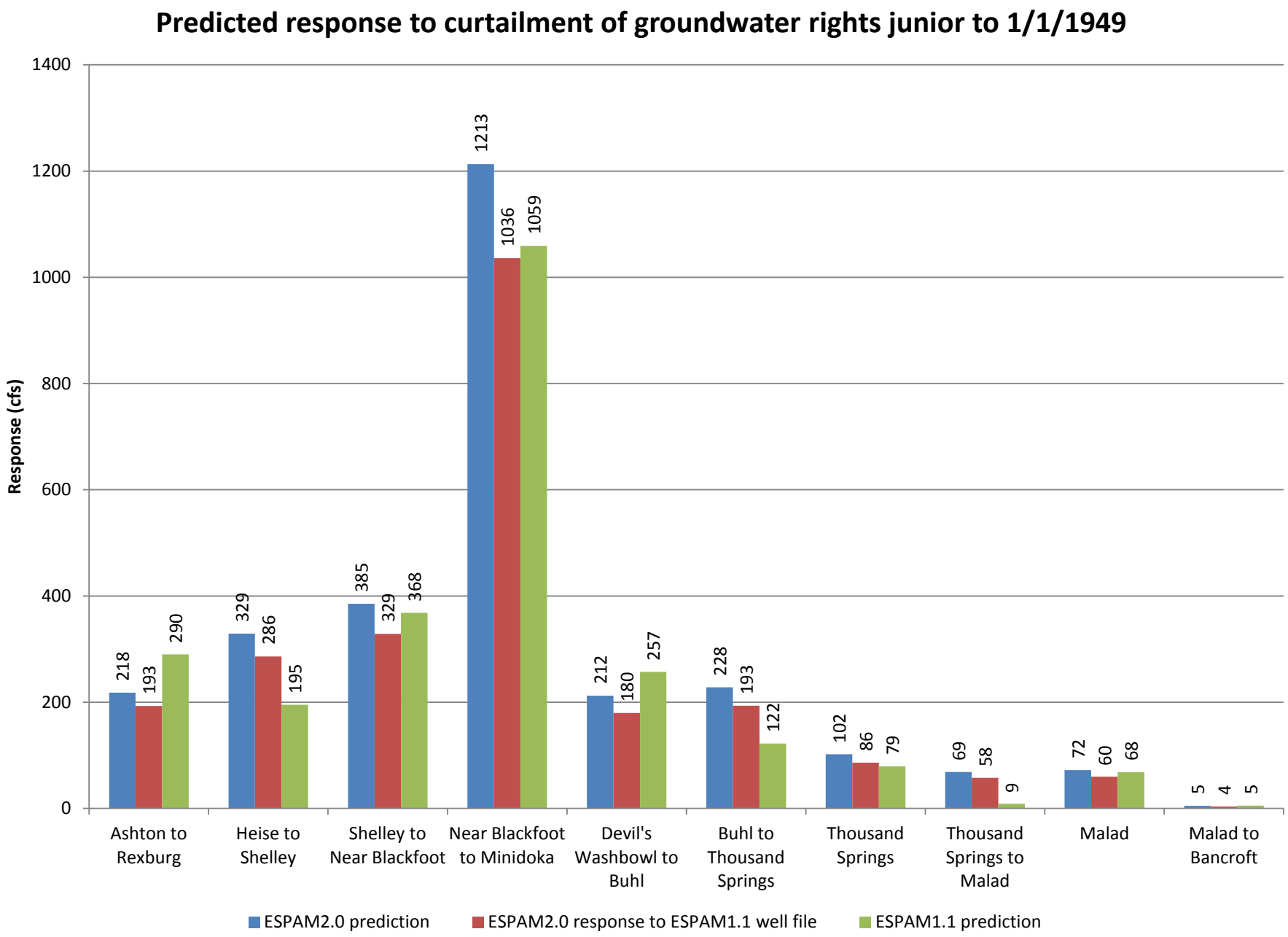
SIMULATED CURTAILMENT, 1/1/1870



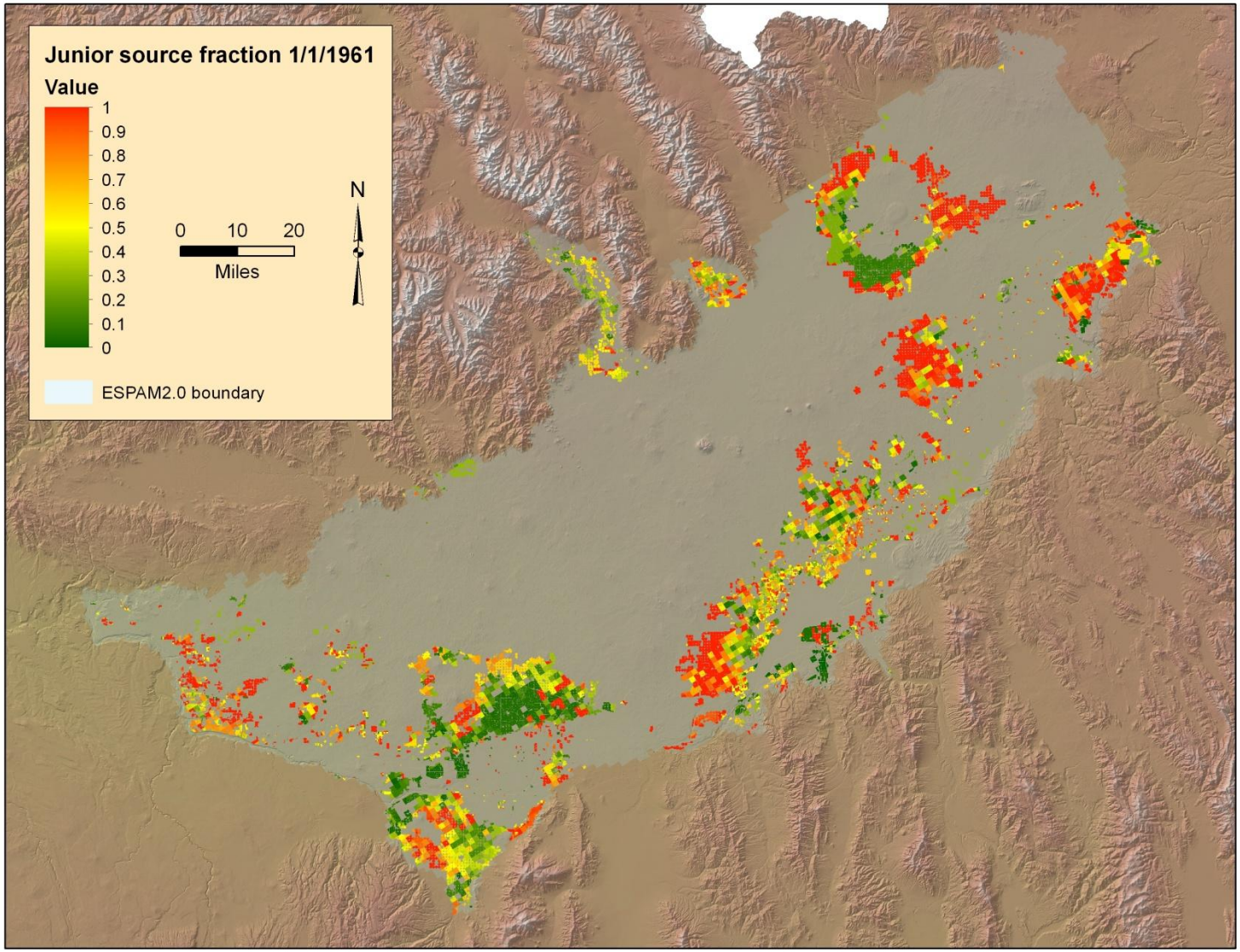

Predicted response to curtailment of groundwater rights junior to 1/1/1870
Response (cfs)
1600
1400
1200
1000
800
600
400
200
0
247
210
316
371
313
211
440
367
406
1388
1161
1193
246
205
298
262
219
137
117
97
89
78
65
10
81
67
77
5
4
6
Ashton to Rexburg
Heise to Shelley
Shelley to Near Blackfoot
Near Blackfoot to Minidoka
Devil's Washbowl to Buhl
Buhl to Thousand Springs
Thousand Springs
Thousand Springs to Malad
Malad
Malad to Bancroft
ESPAM2.0 prediction
ESPAM2.0 response to ESPAM1.1 well file
ESPAM1.1 prediction

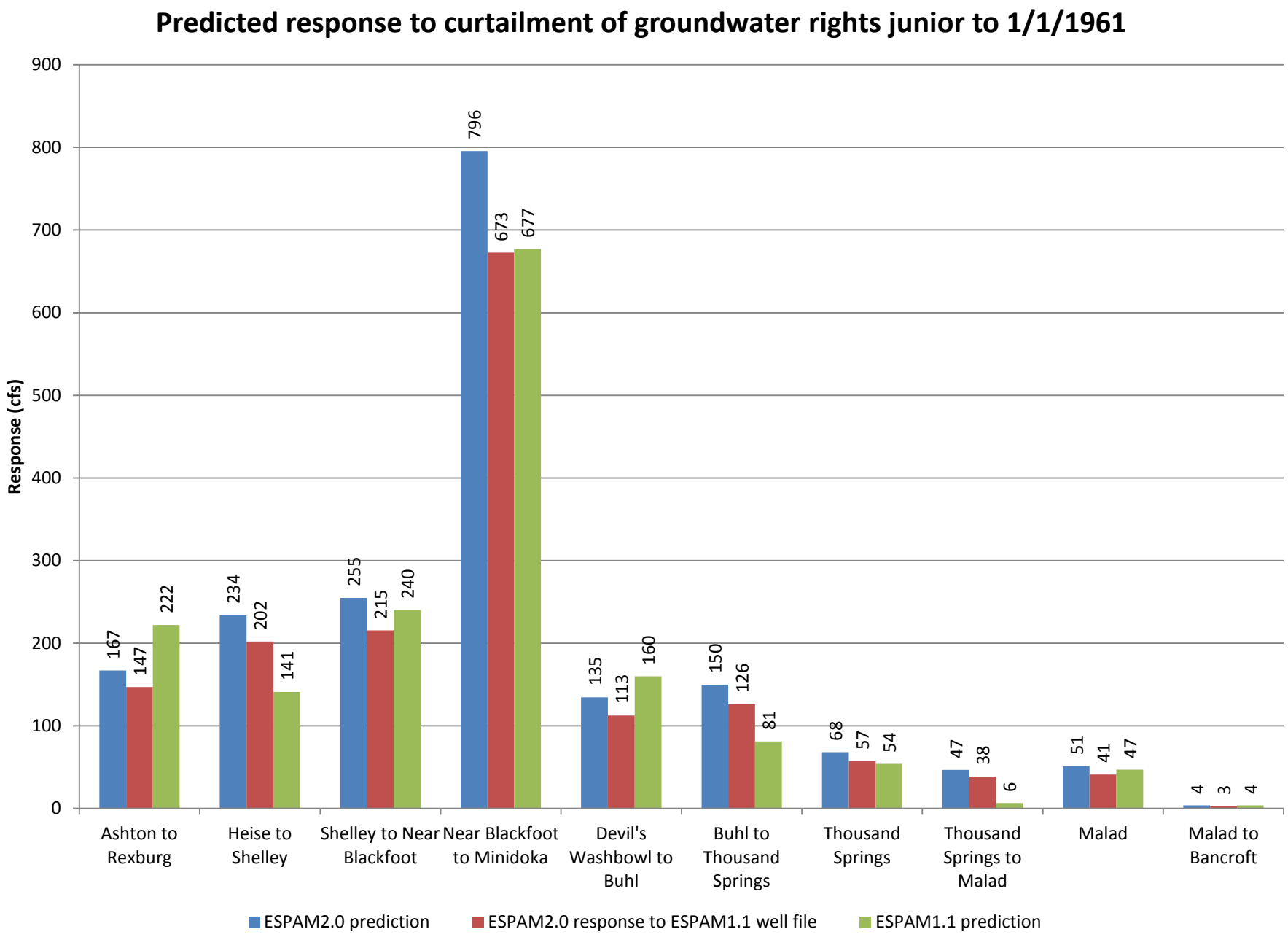
SIMULATED CURTAILMENT, 1/1/1949



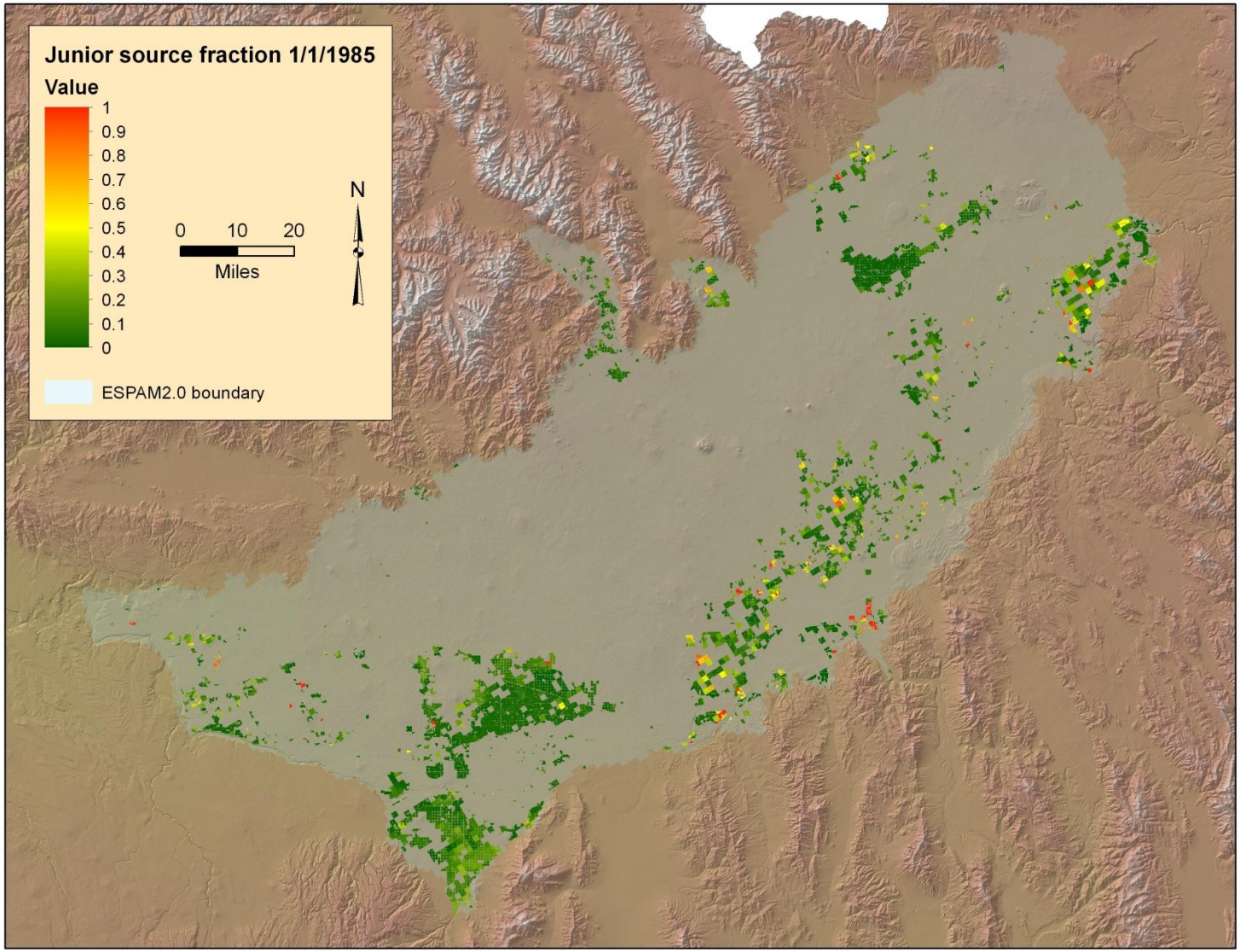

Predicted response to curtailment of groundwater rights junior to 1/1/1949
Response (cfs)
1400
1200
1000
800
600
400
200
0
218
193
290
329
286
195
385
329
368
1213
1036
1059
212
180
257
228
193
122
102
86
79
69
58
9
72
60
68
5
4
5
Ashton to Rexburg
Heise to Shelley
Shelley to Near Blackfoot
Near Blackfoot to Minidoka
Devil's Washbowl to Buhl
Buhl to Thousand Springs
Thousand Springs
Thousand Springs to Malad
Malad
Malad to Bancroft
ESPAM2.0 prediction
ESPAM2.0 response to ESPAM1.1 well file
ESPAM1.1 prediction

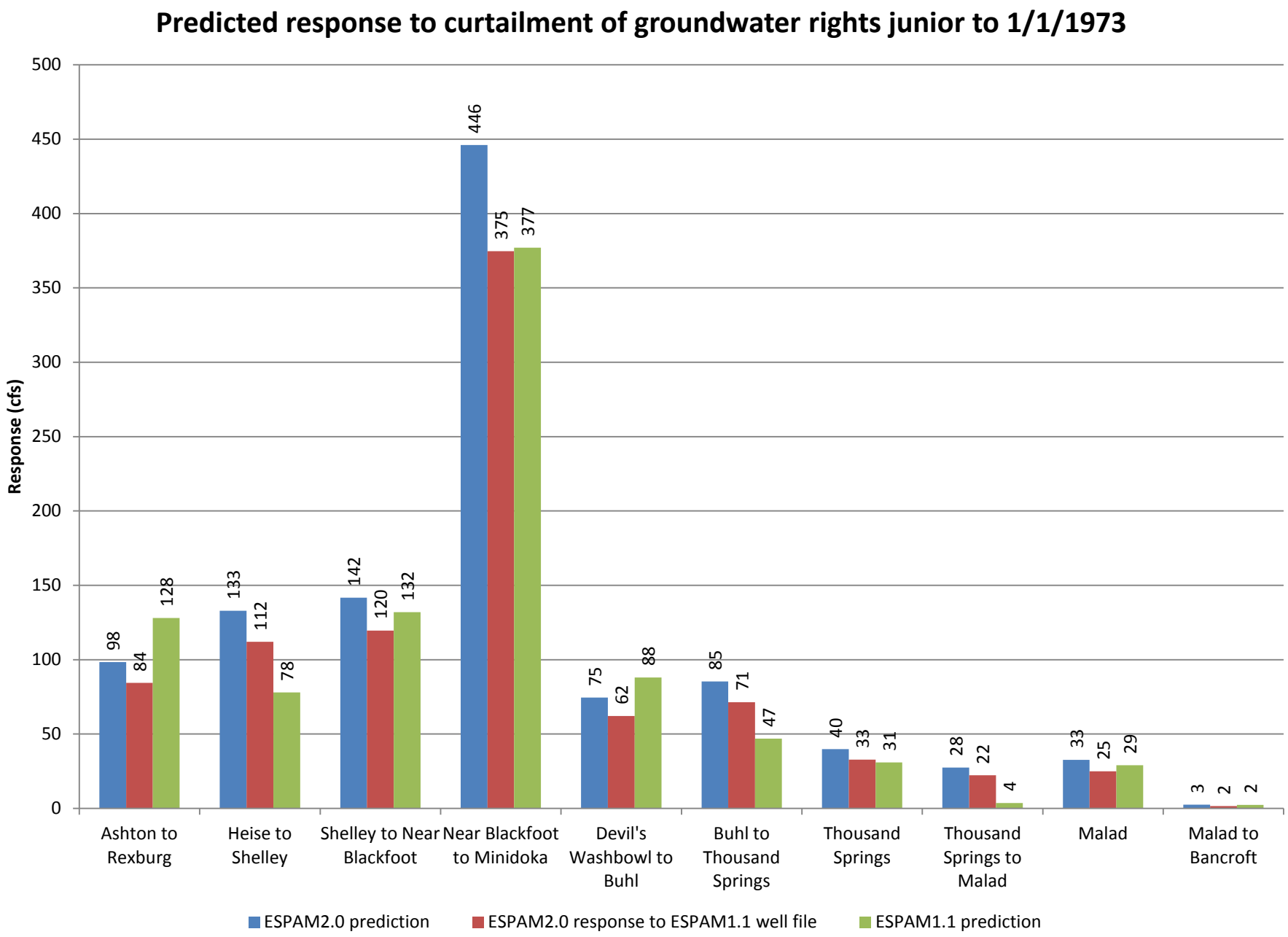
SIMULATED CURTAILMENT, 1/1/1961



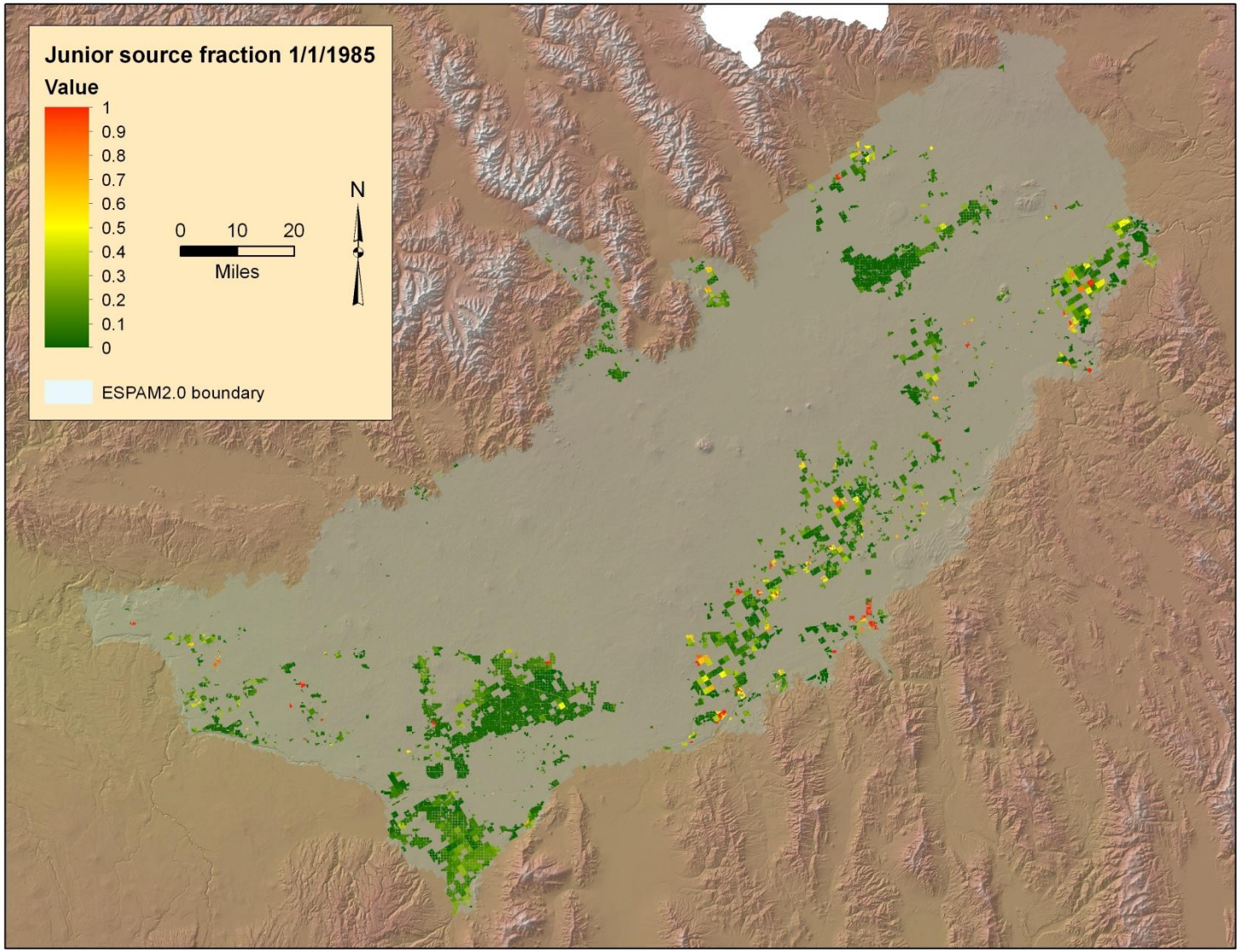

Predicted response to curtailment of groundwater rights junior to 1/1/1961
Response (cfs)
900
800
700
600
500
400
300
200
100
0
167
147
222
234
202
141
255
215
240
796
673
677
135
113
160
150
126
81
68
57
54
47
38
6
51
41
47
4
3
4
Ashton to Rexburg
Heise to Shelley
Shelley to Near Blackfoot
Near Blackfoot to Minidoka
Devil's Washbowl to Buhl
Buhl to Thousand Springs
Thousand Springs
Thousand Springs to Malad
Malad
Malad to Bancroft
ESPAM2.0 prediction
ESPAM2.0 response to ESPAM1.1 well file
ESPAM1.1 prediction

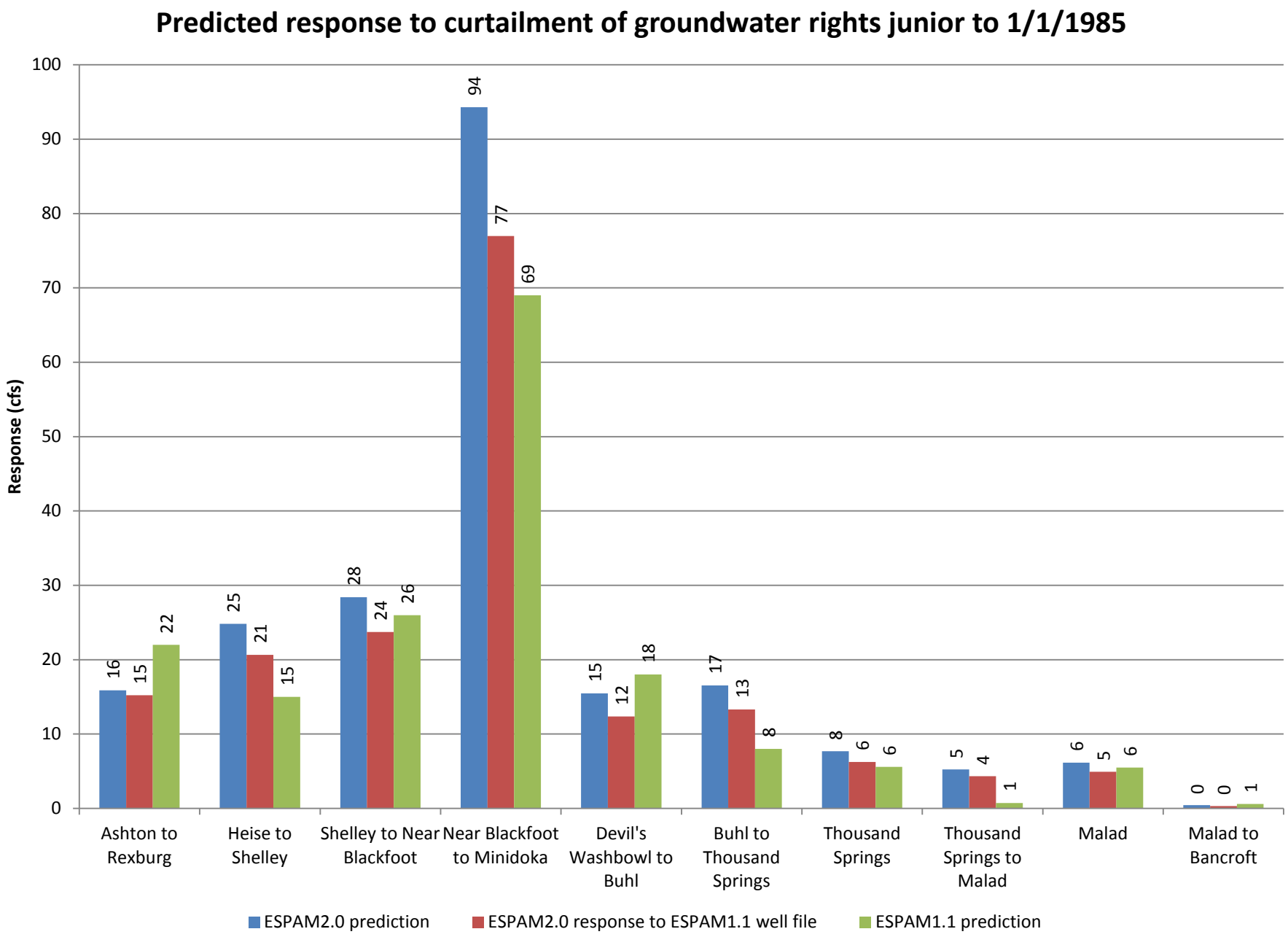
SIMULATED CURTAILMENT, 1/1/1973




Predicted response to curtailment of groundwater rights junior to 1/1/1973
Response (cfs)
500
450
400
350
300
250
200
150
100
50
0
98
84
128
133
112
78
142
120
132
446
375
377
75
62
88
85
71
47
40
33
31
28
22
4
33
25
29
3
2
2
Ashton to Rexburg
Heise to Shelley
Shelley to Near Blackfoot
Near Blackfoot to Minidoka
Devil's Washbowl to Buhl
Buhl to Thousand Springs
Thousand Springs
Thousand Springs to Malad
Malad
Malad to Bancroft
ESPAM2.0 prediction
ESPAM2.0 response to ESPAM1.1 well file
ESPAM1.1 prediction

SIMULATED CURTAILMENT, 1/1/1985




Predicted response to curtailment of groundwater rights junior to 1/1/1985
Response (cfs)
100
90
80
70
60
50
40
30
20
10
0
16
15
22
25
21
15
28
24
26
94
77
69
15
12
18
17
13
8
8
6
6
5
4
1
6
5
6
0
0
1
Ashton to Rexburg
Heise to Shelley
Shelley to Near Blackfoot
Near Blackfoot to Minidoka
Devil's Washbowl to Buhl
Buhl to Thousand Springs
Thousand Springs
Thousand Springs to Malad
Malad
Malad to Bancroft
ESPAM2.0 prediction
ESPAM2.0 response to ESPAM1.1 well file
ESPAM1.1 prediction

Comparison of Steady State Results

- Volume of curtailed consumptive use for a given priority date is 17% to 21% higher using ESPAM2.0 input data
  - Improved representation of irrigated lands
  - Updated ET data
  - Improved representation of ET adjustment factors
  - Updated precipitation data
  - Updated water rights data
- Changes in relative responses of some spring and river reaches
  - Improved and updated calibration targets
  - Improved and updated water budget input data
  - Addition of general head boundaries

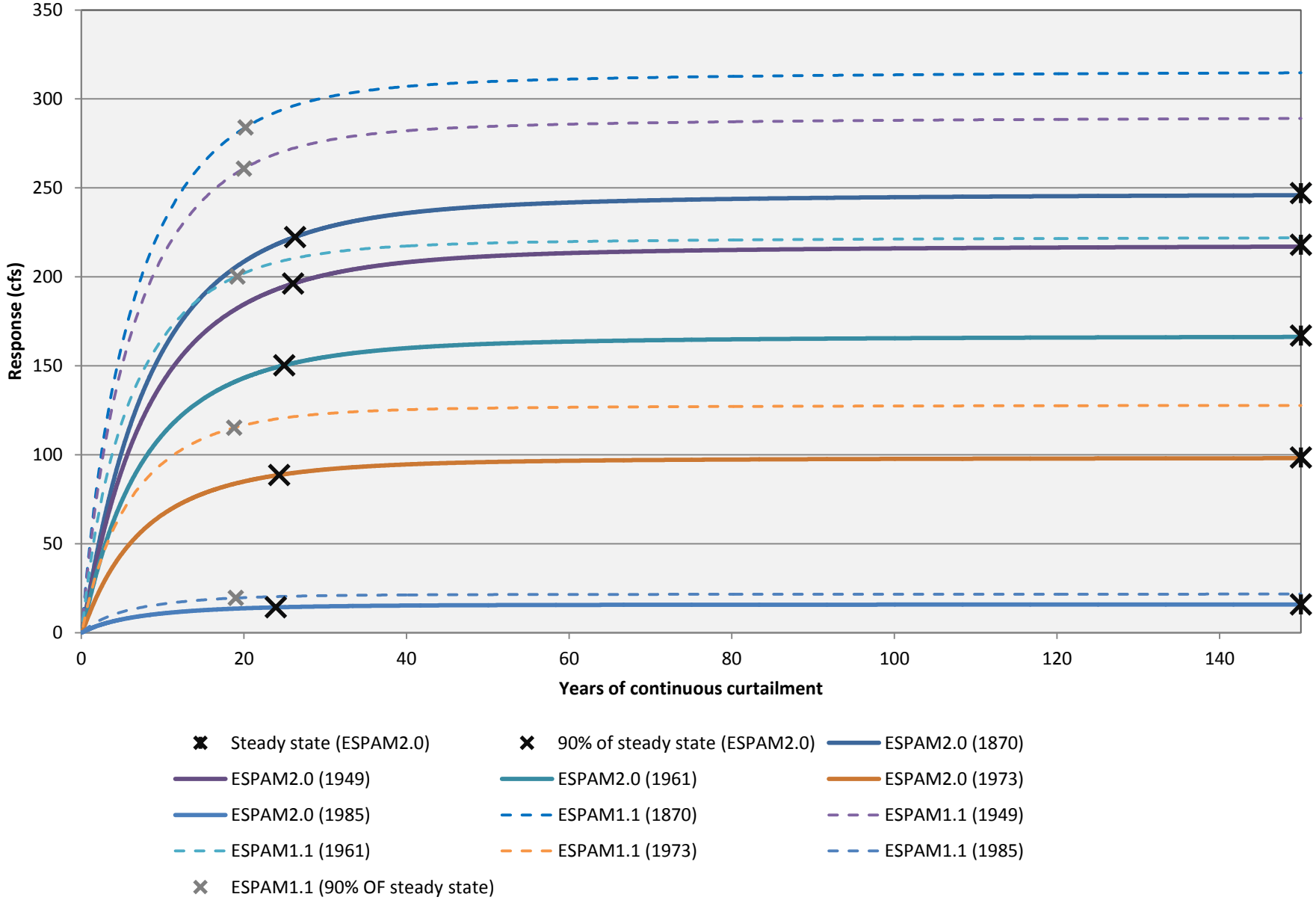
Comparison of Long Term Transient Results

- Long term transient simulation of 150 years of continuous curtailment modeled using average annual rate

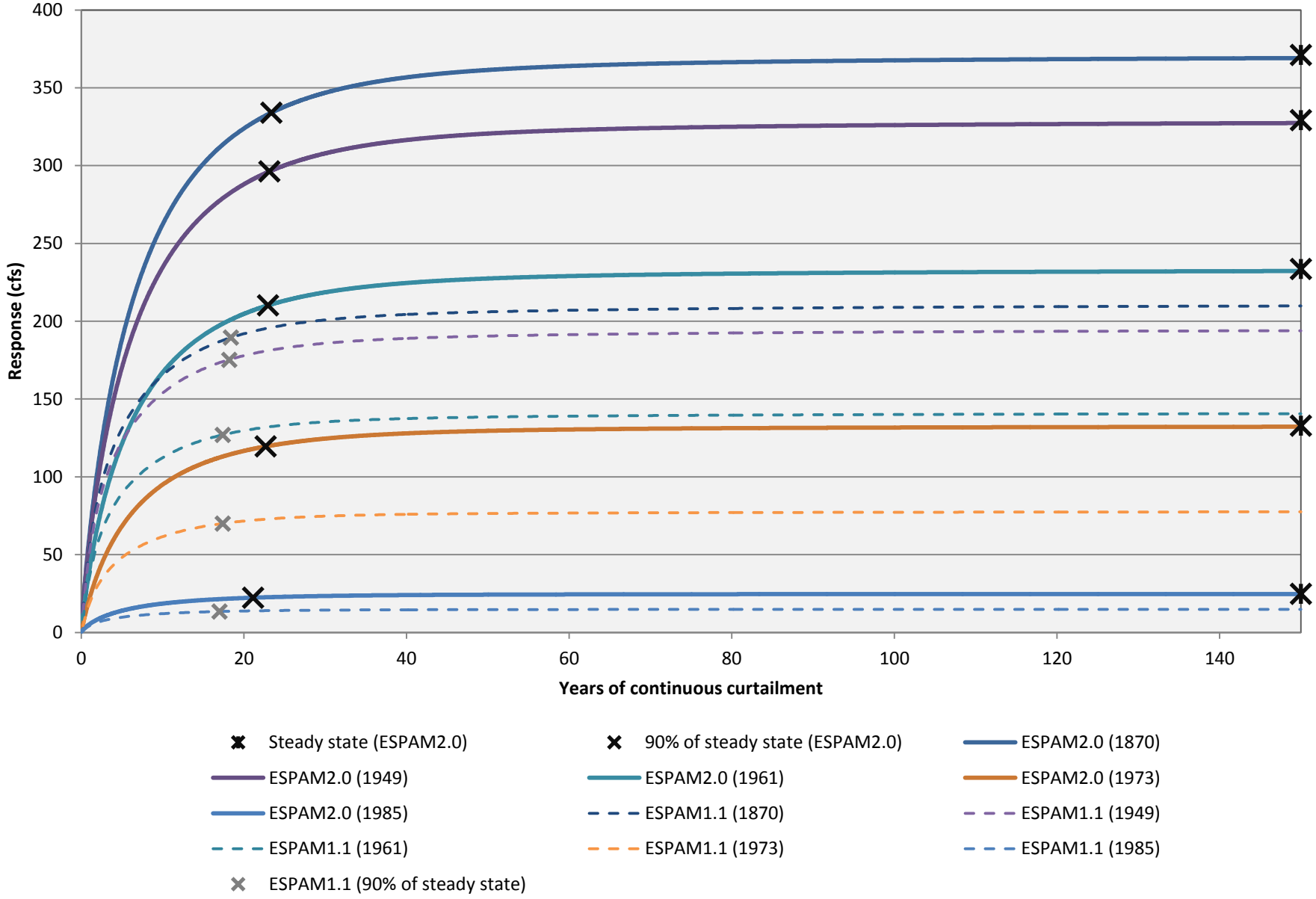
- Compare ESPAM2.0 prediction (with ESPAM2.0 input data) to ESPAM1.1 prediction for net difference

- Comparison of ESPAM2.0 predicted response to ESPAM1.1 well file with ESPAM1.1 prediction illustrates differences in model structure and model parameters

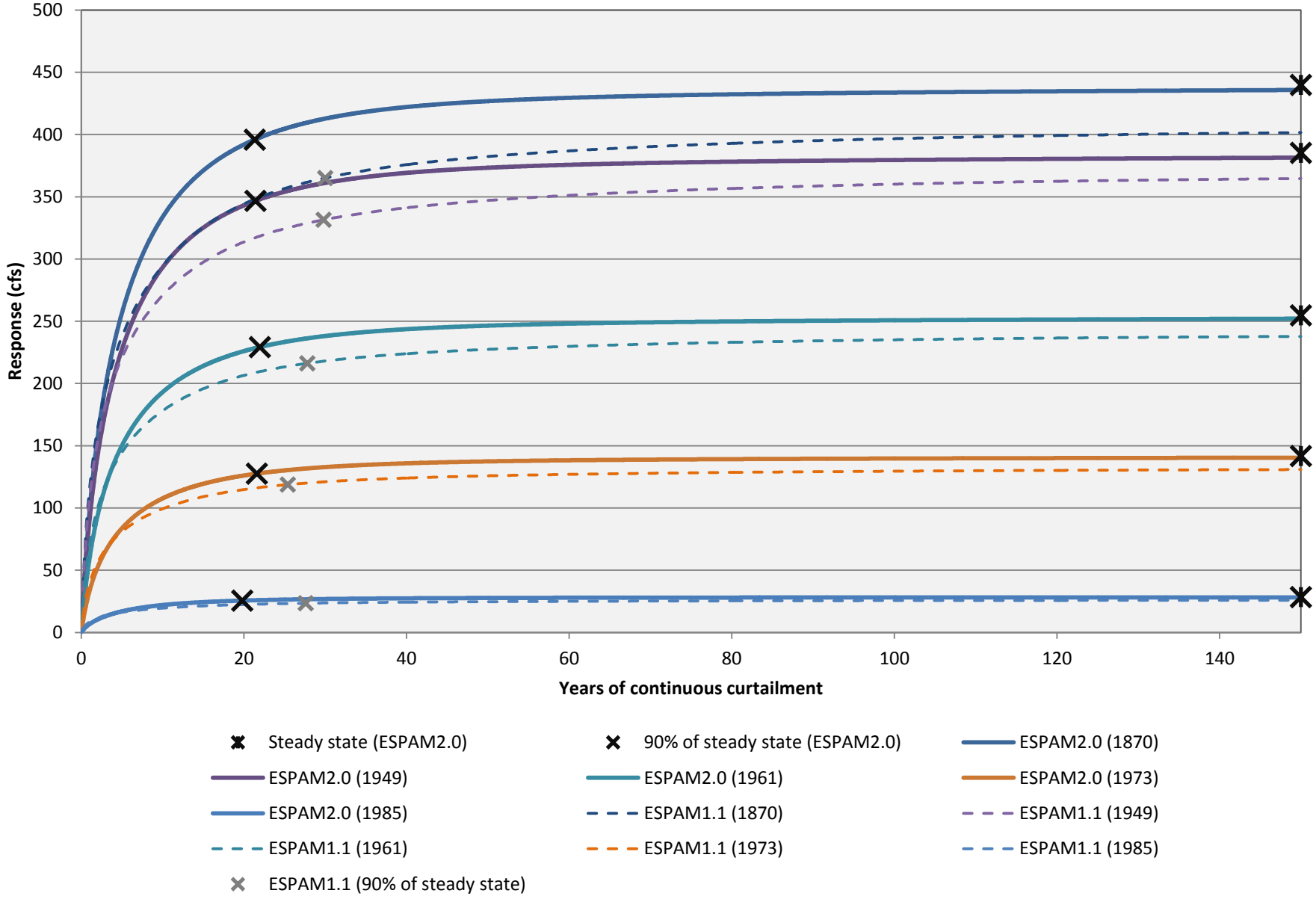
Predicted response to curtailment, Ashton to Rexburg reach



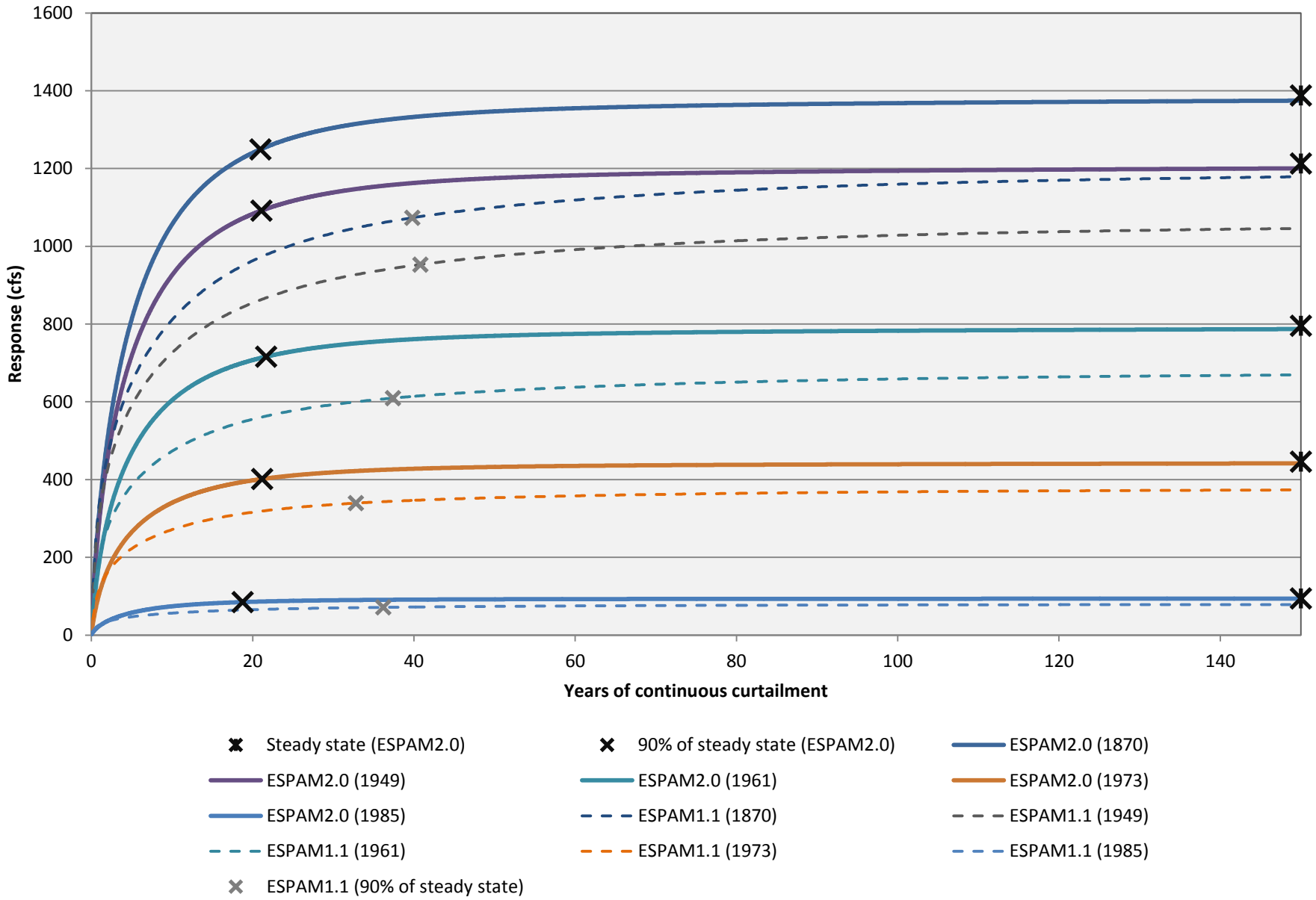
Predicted response to curtailment, Heise to Shelley reach



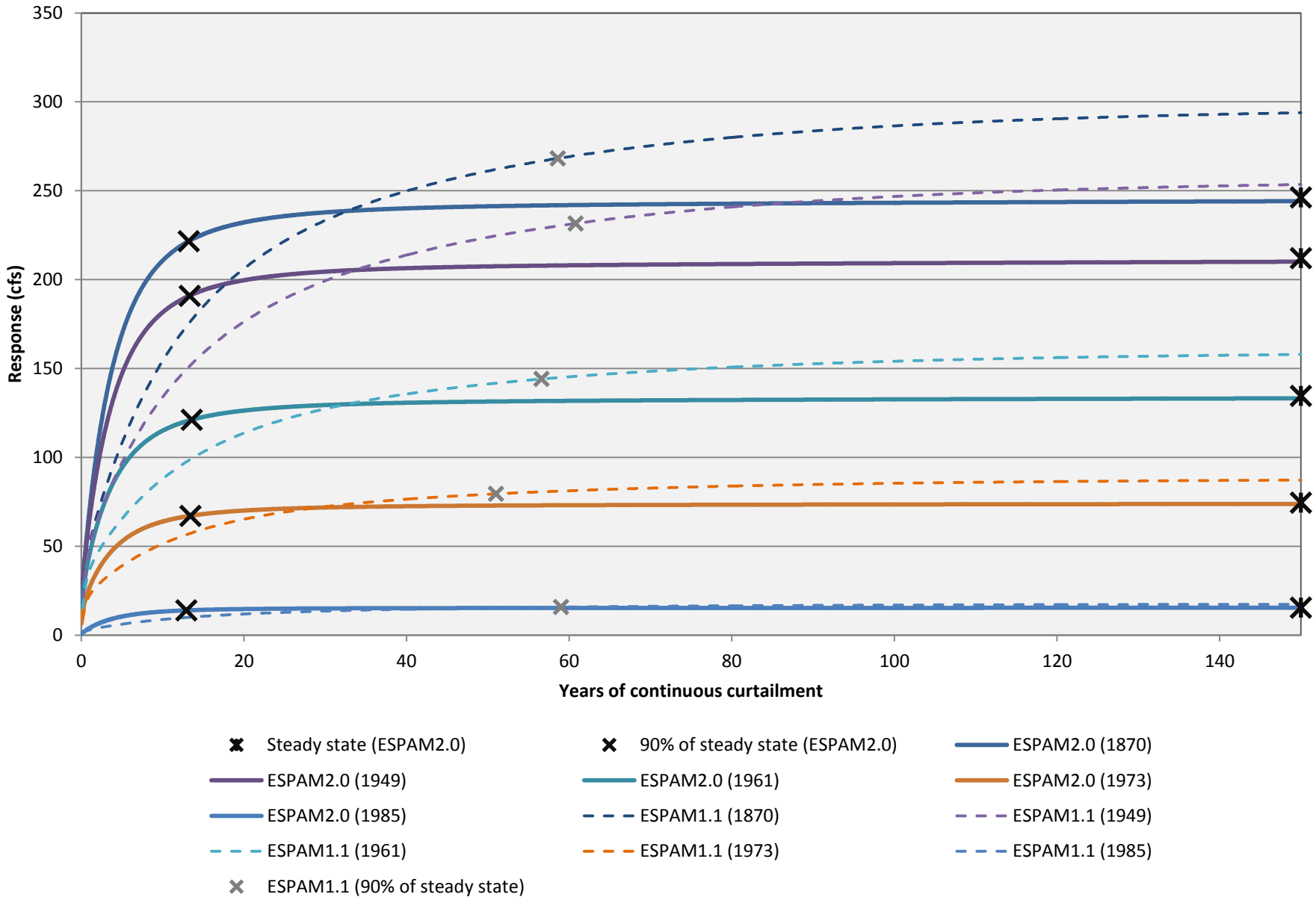
Predicted response to curtailment, Shelley to near Blackfoot reach



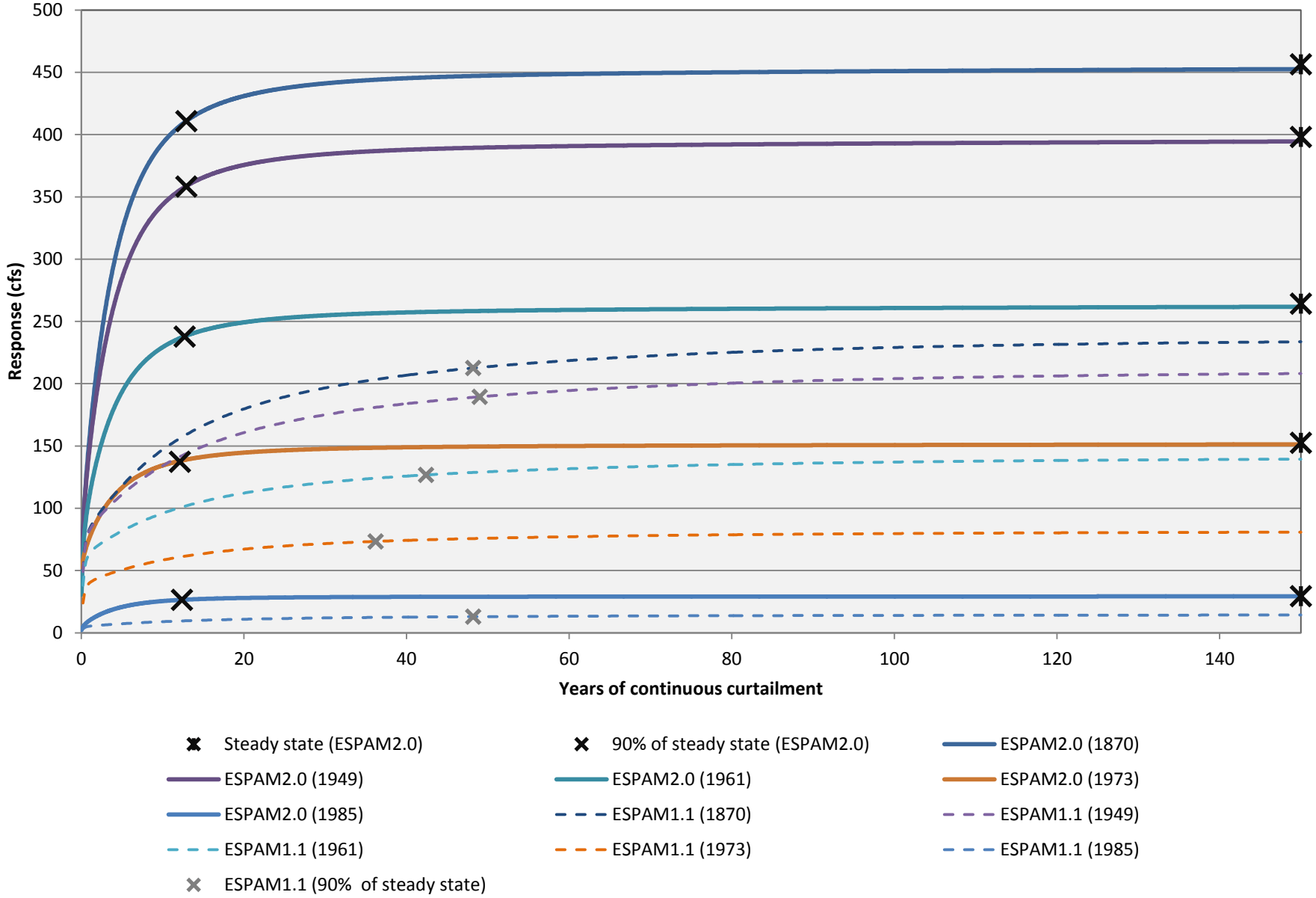
Predicted response to curtailment, near Blackfoot to Minidoka reach



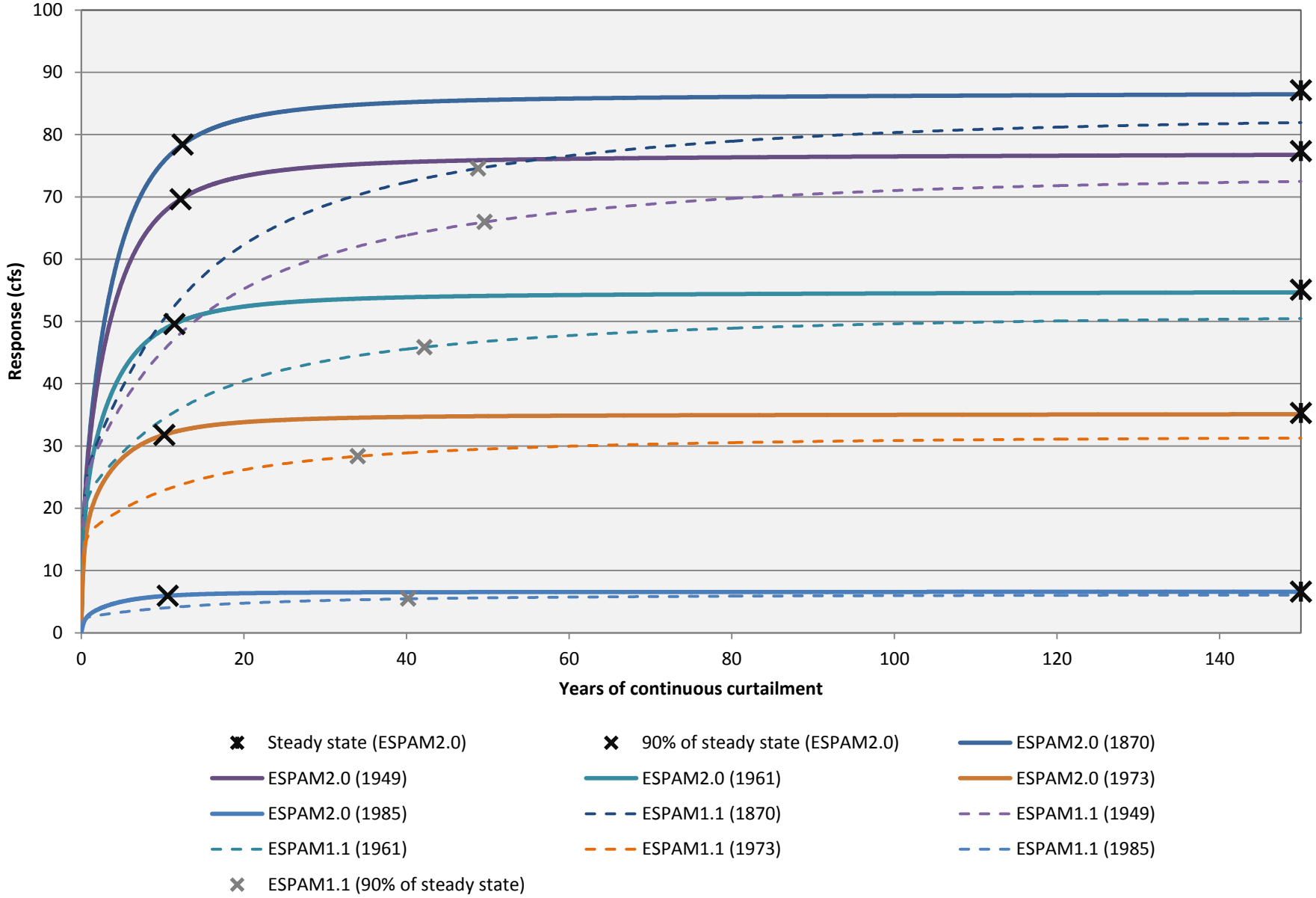
Predicted response to curtailment, Kimberly to Buhl springs



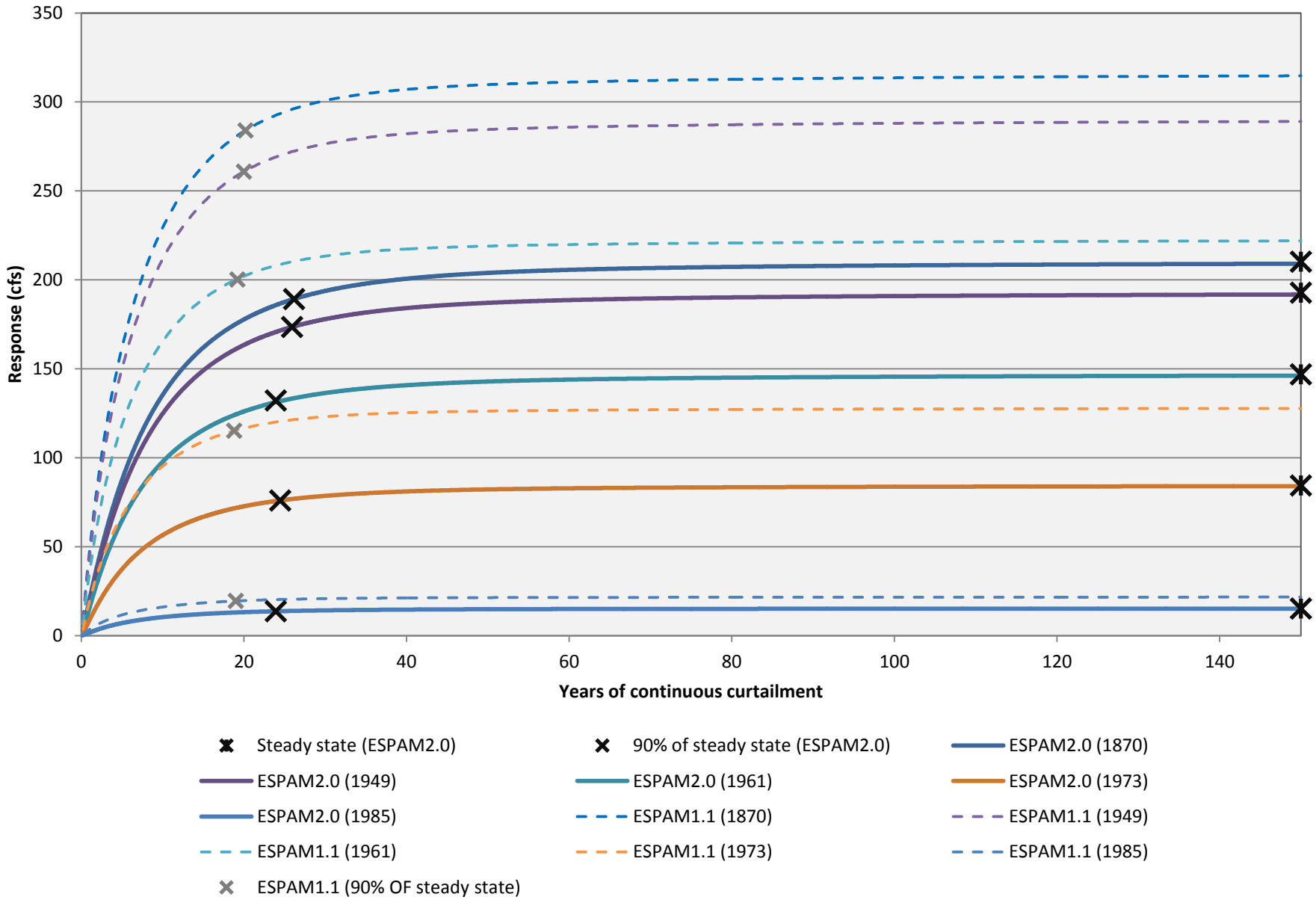
Predicted response to curtailment, Buhl to Lower Salmon Falls springs



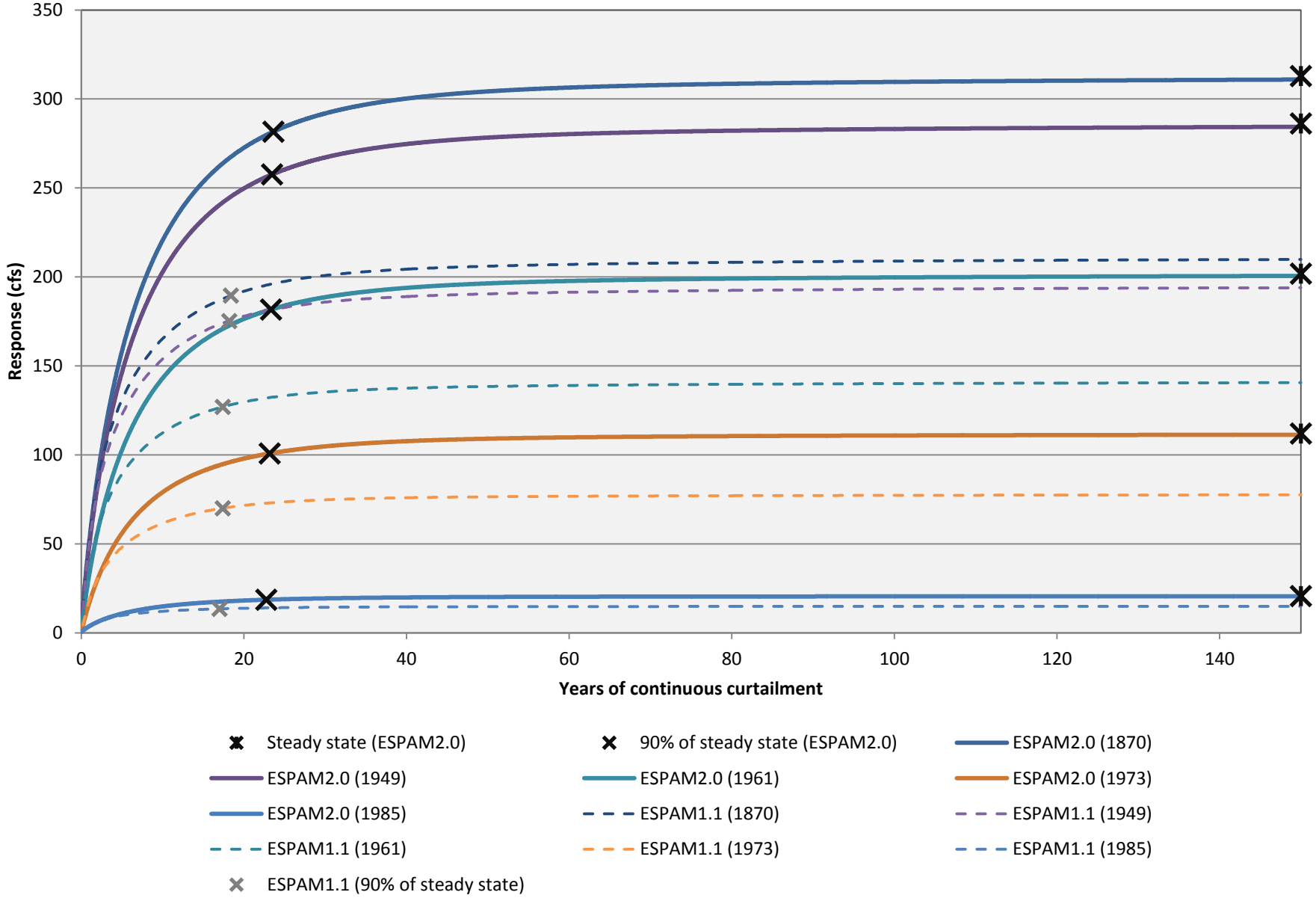
Predicted response to curtailment, LSF to King Hill springs

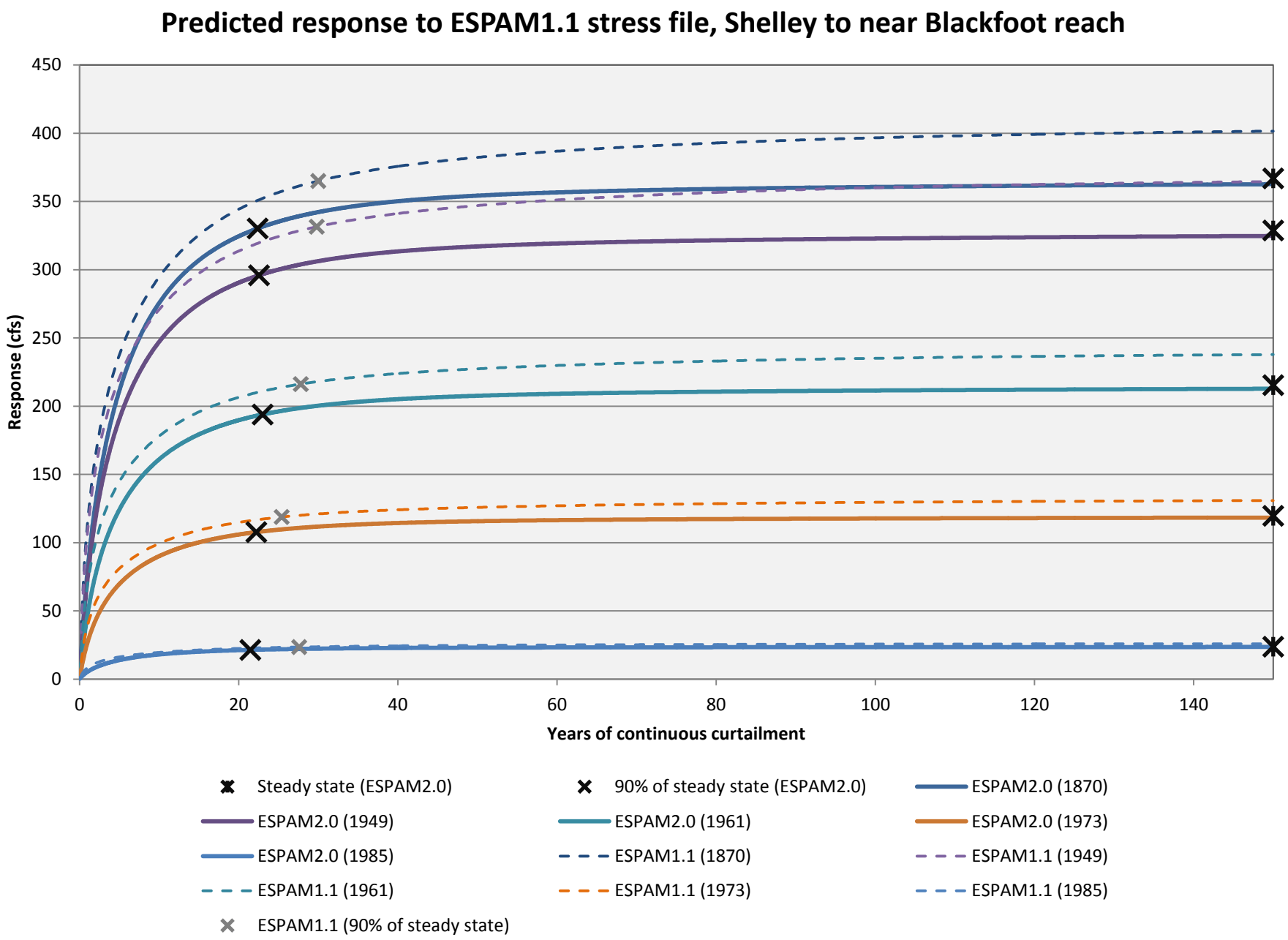


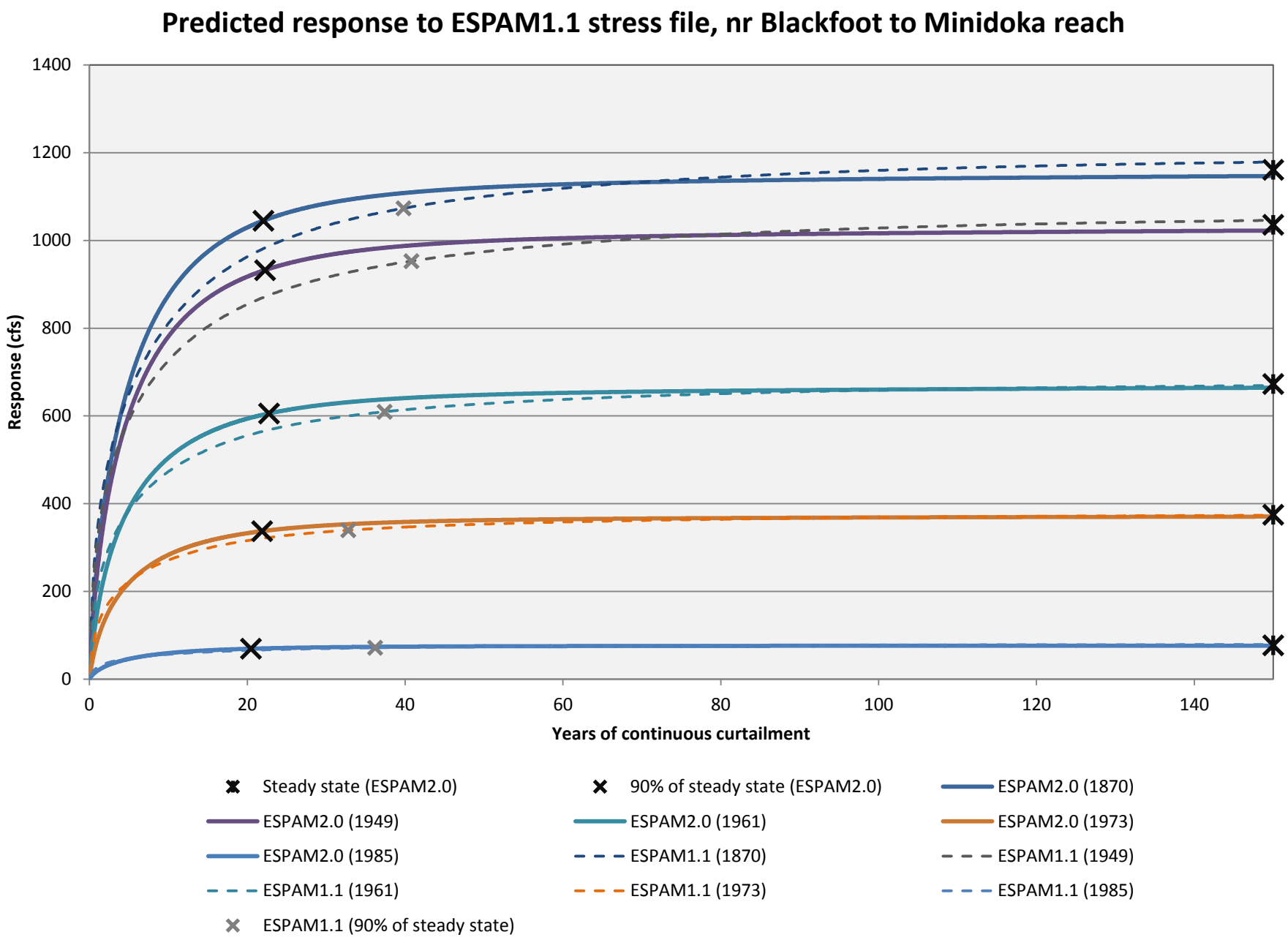
Predicted response to ESPAM1.1 stress file, Ashton to Rexburg reach



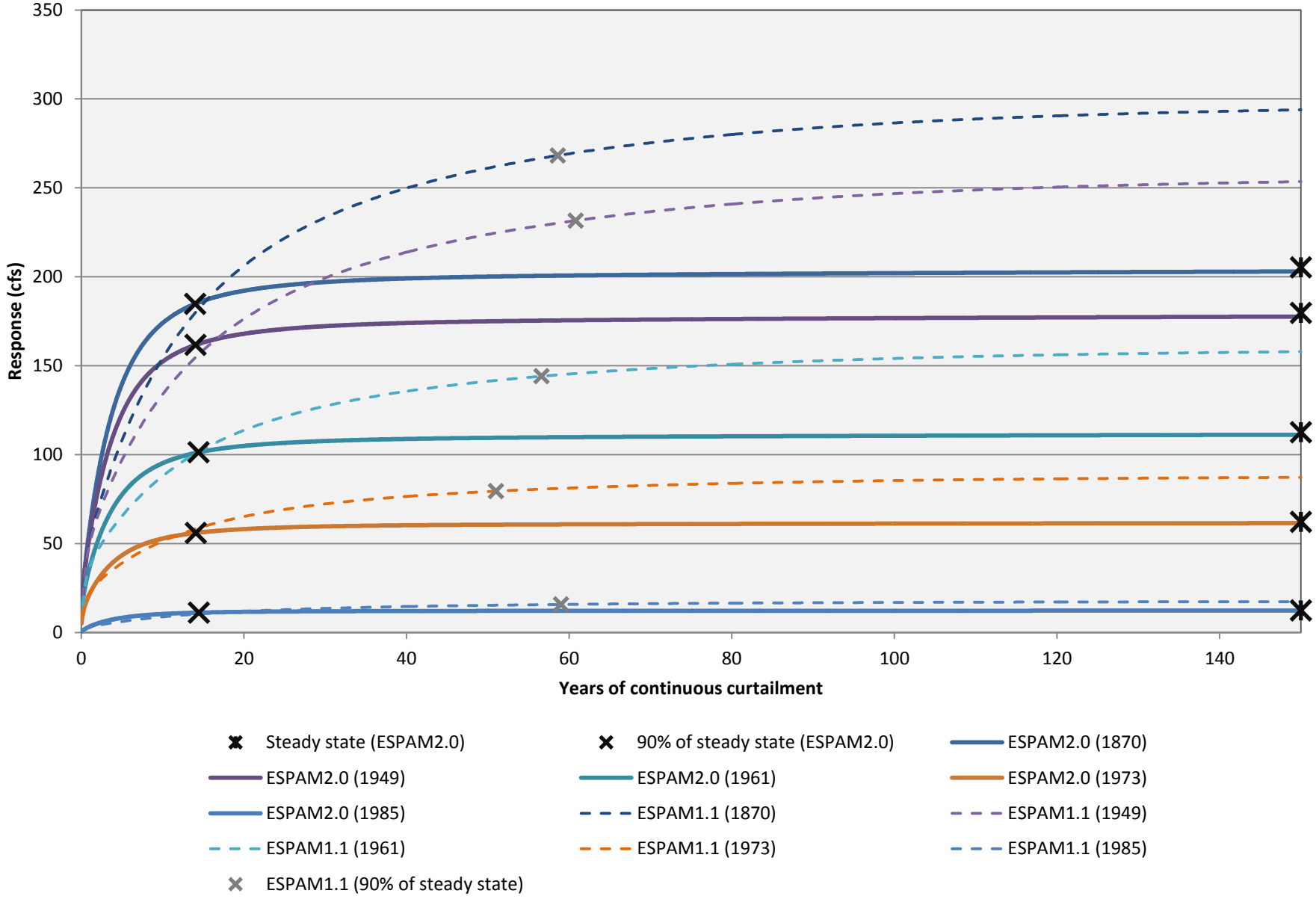
Predicted response to ESPAM1.1 stress file, Heise to Shelley reach

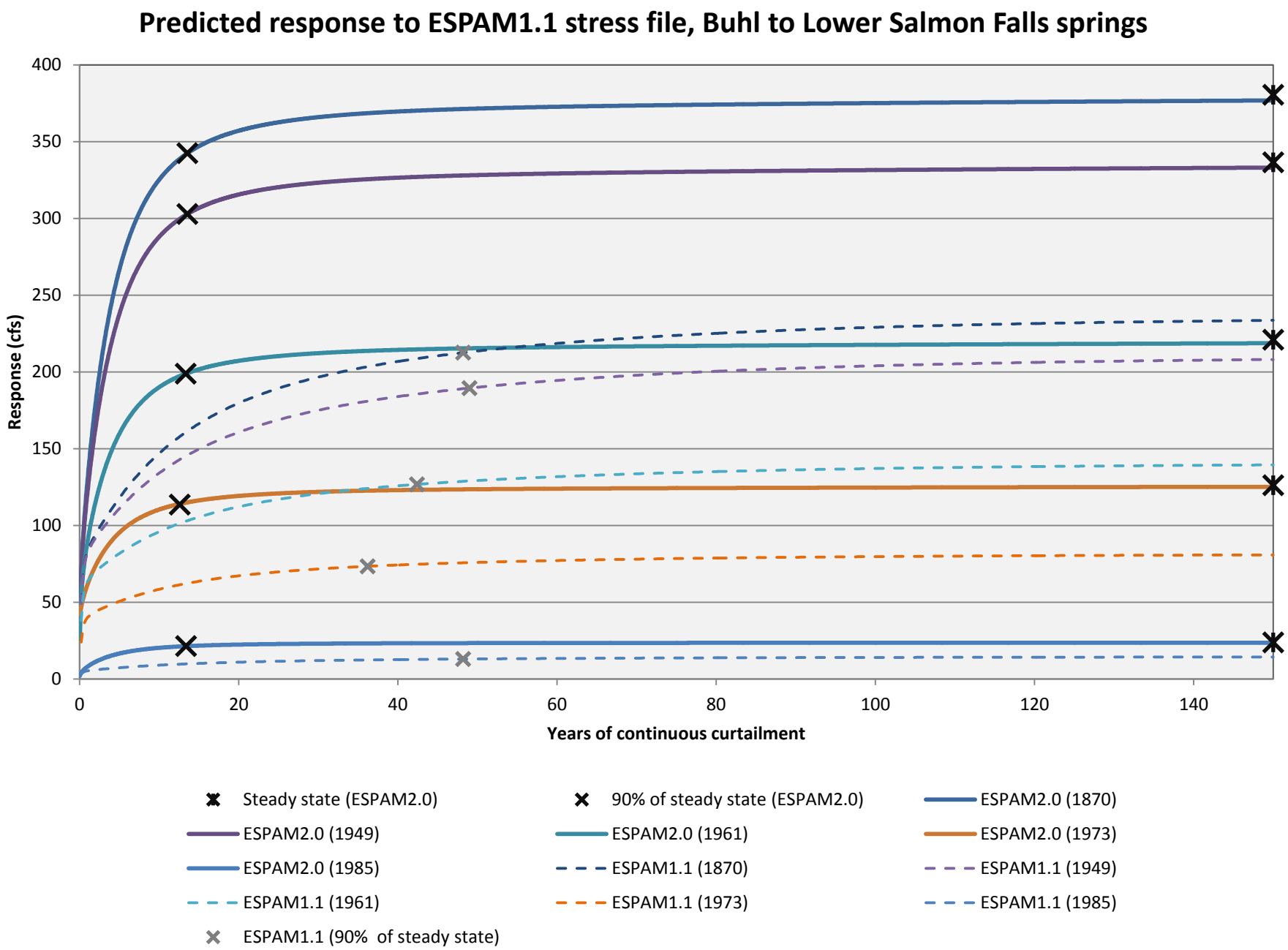


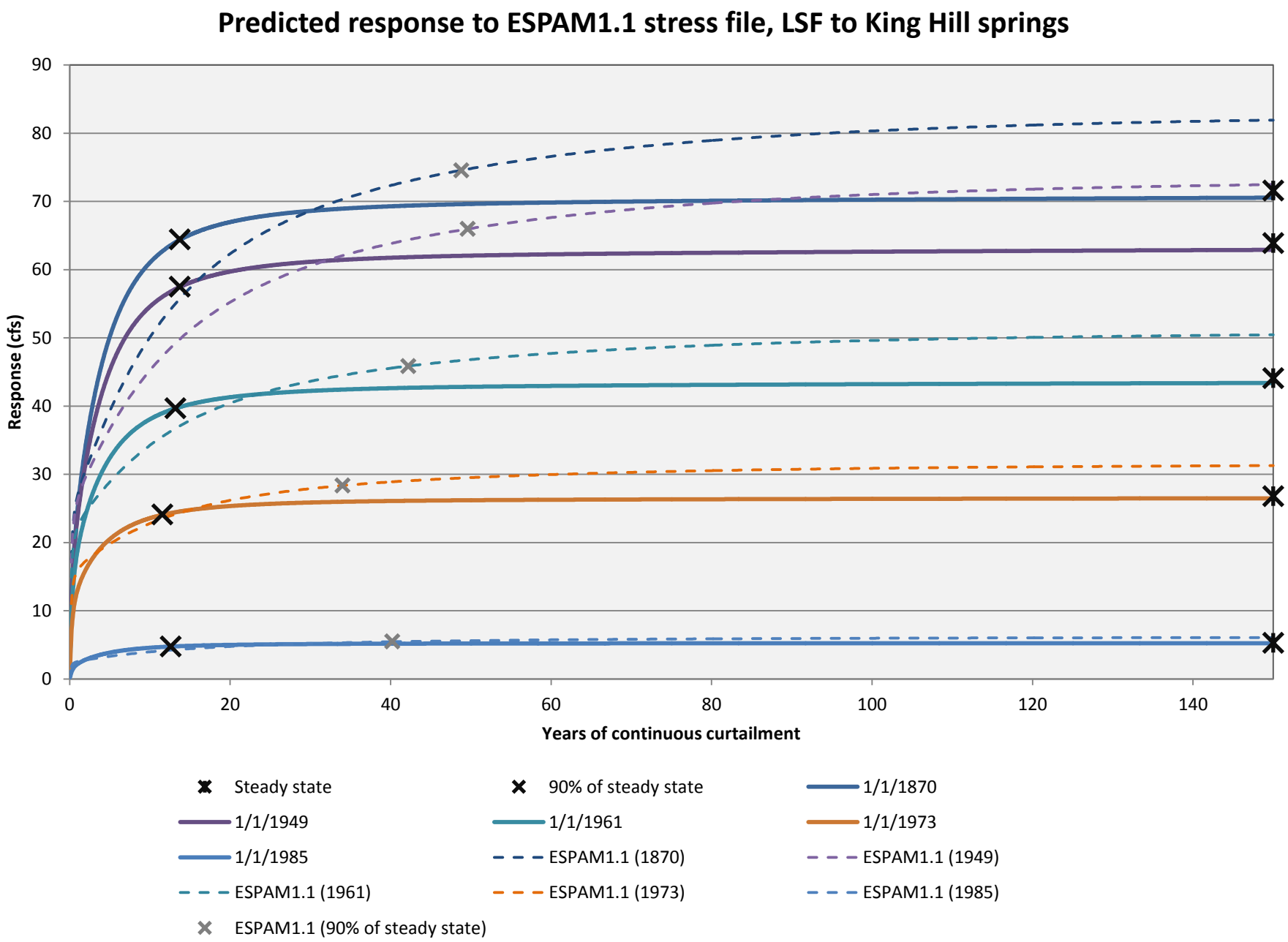

Predicted response to ESPAM1.1 stress file, Shelley to near Blackfoot reach
Response (cfs)
450
400
350
300
250
200
150
100
50
0
0
20
40
60
80
100
120
140
Years of continuous curtailment
Steady state (ESPAM2.0)
90% of steady state (ESPAM2.0)
ESPAM2.0 (1870)
ESPAM2.0 (1949)
ESPAM2.0 (1961)
ESPAM2.0 (1973)
ESPAM2.0 (1985)
ESPAM1.1 (1870)
ESPAM1.1 (1949)
ESPAM1.1 (1961)
ESPAM1.1 (1973)
ESPAM1.1 (1985)
ESPAM1.1 (90% of steady state)


Predicted response to ESPAM1.1 stress file, nr Blackfoot to Minidoka reach
Response (cfs)
1400
1200
1000
800
600
400
200
0
0
20
40
60
80
100
120
140
Years of continuous curtailment
Steady state (ESPAM2.0)
90% of steady state (ESPAM2.0)
ESPAM2.0 (1870)
ESPAM2.0 (1949)
ESPAM2.0 (1961)
ESPAM2.0 (1973)
ESPAM2.0 (1985)
ESPAM1.1 (1870)
ESPAM1.1 (1949)
ESPAM1.1 (1961)
ESPAM1.1 (1973)
ESPAM1.1 (1985)
ESPAM1.1 (90% of steady state)

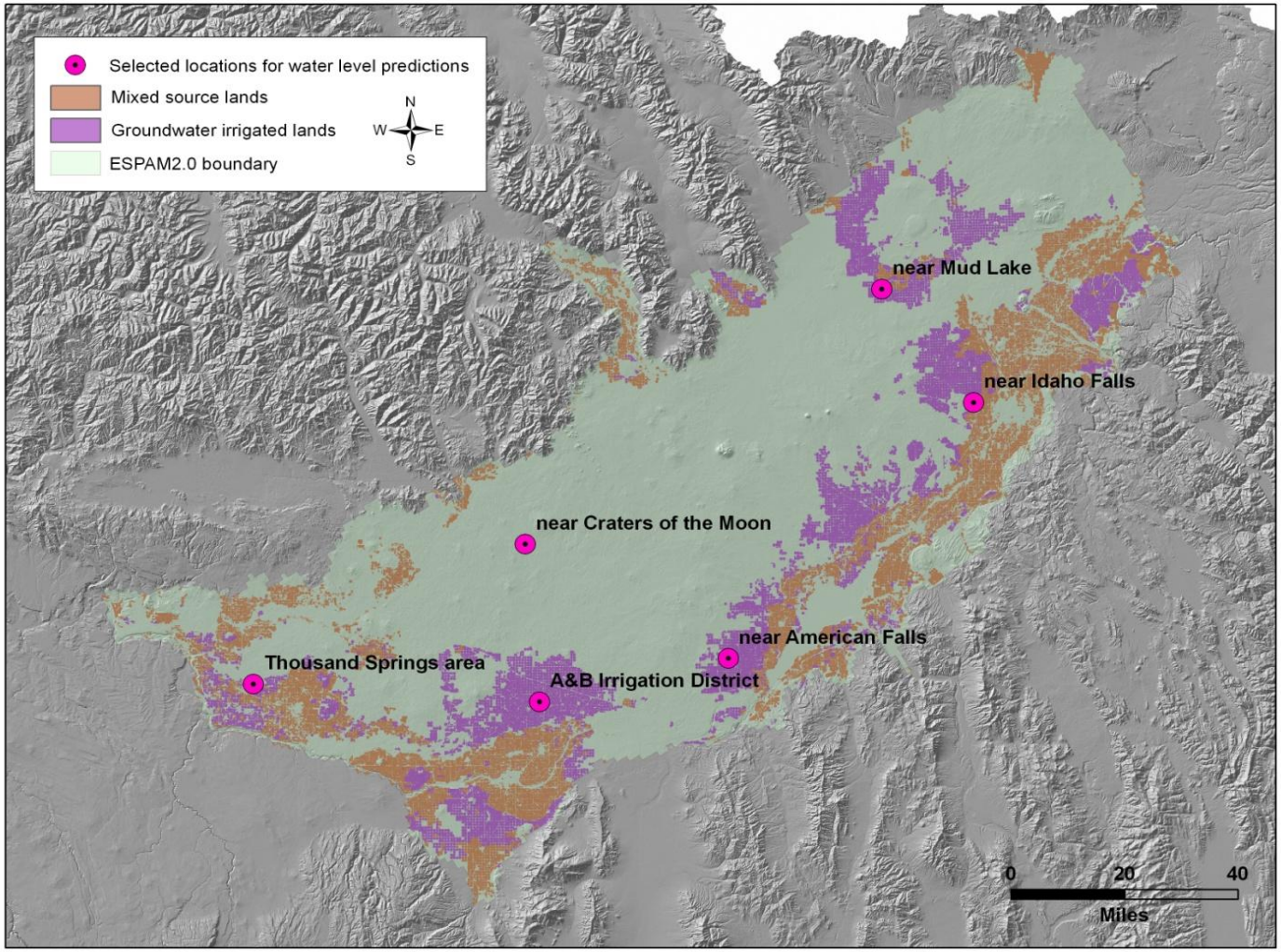
Predicted response to ESPAM1.1 stress file, Kimberly to Buhl springs

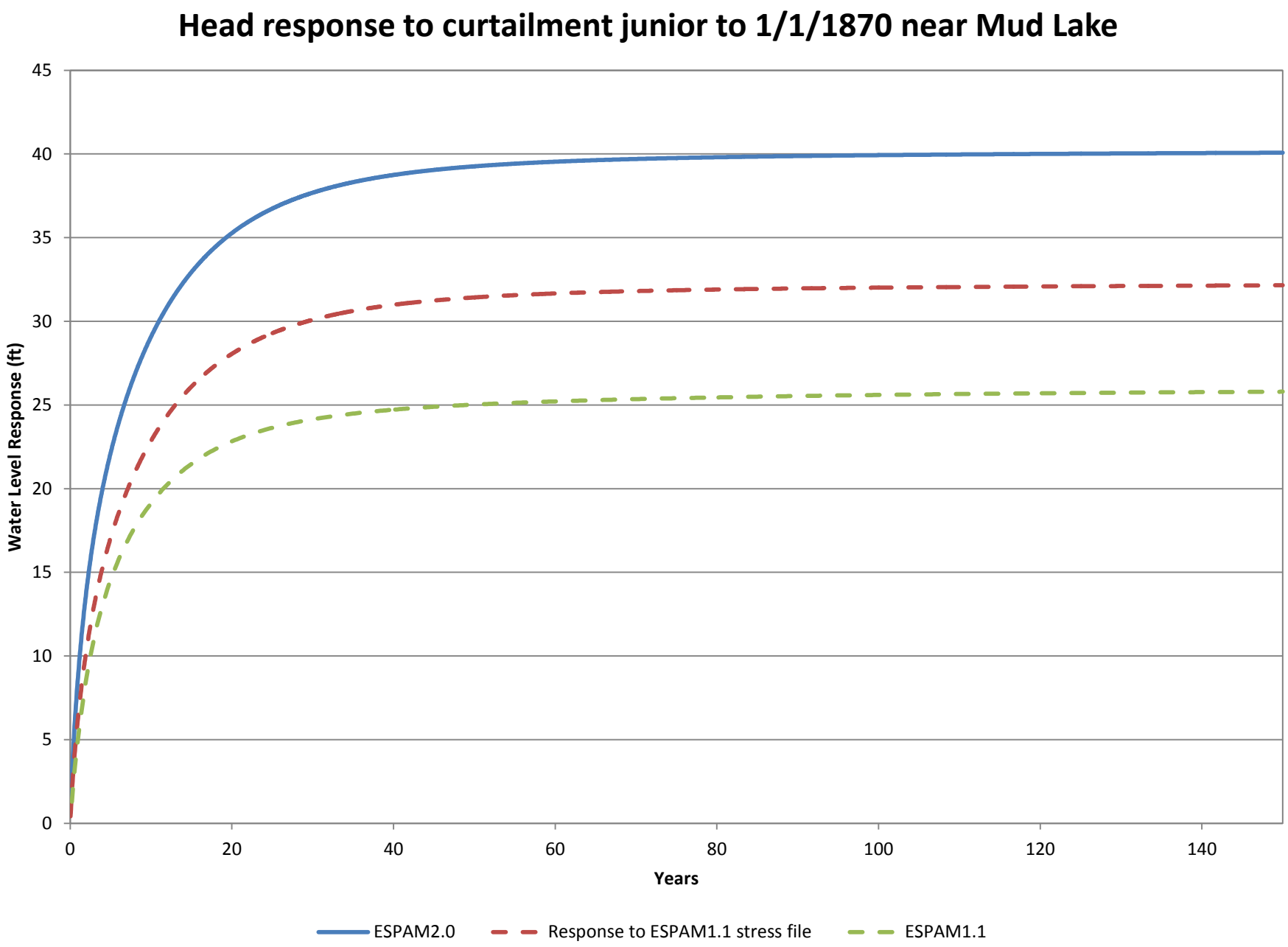


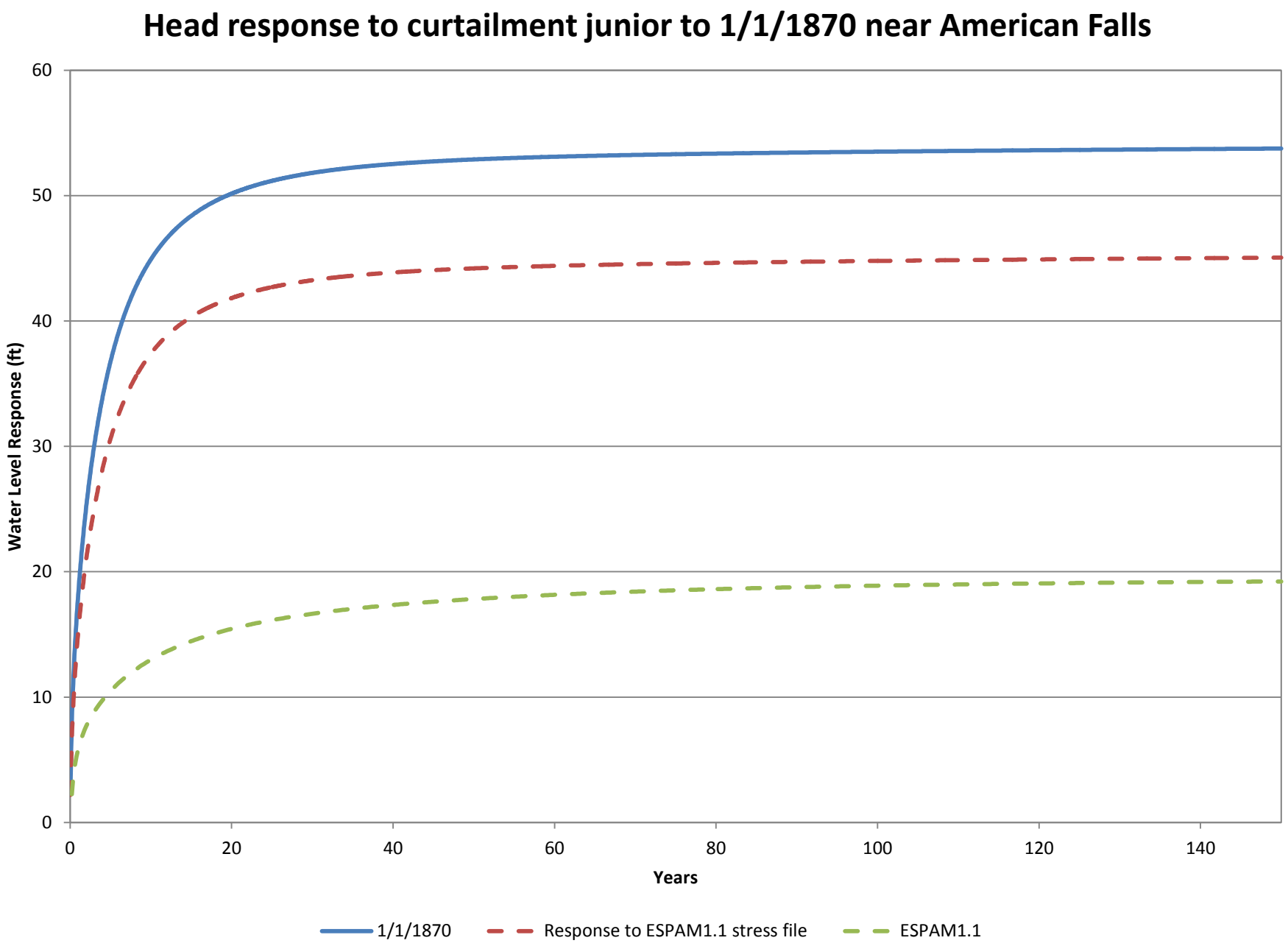

Predicted response to ESPAM1.1 stress file, Buhl to Lower Salmon Falls springs
Response (cfs)
400
350
300
250
200
150
100
50
0
0
20
40
60
80
100
120
140
Years of continuous curtailment
Steady state (ESPAM2.0)
90% of steady state (ESPAM2.0)
ESPAM2.0 (1870)
ESPAM2.0 (1949)
ESPAM2.0 (1961)
ESPAM2.0 (1973)
ESPAM2.0 (1985)
ESPAM1.1 (1870)
ESPAM1.1 (1949)
ESPAM1.1 (1961)
ESPAM1.1 (1973)
ESPAM1.1 (1985)
ESPAM1.1 (90% of steady state)

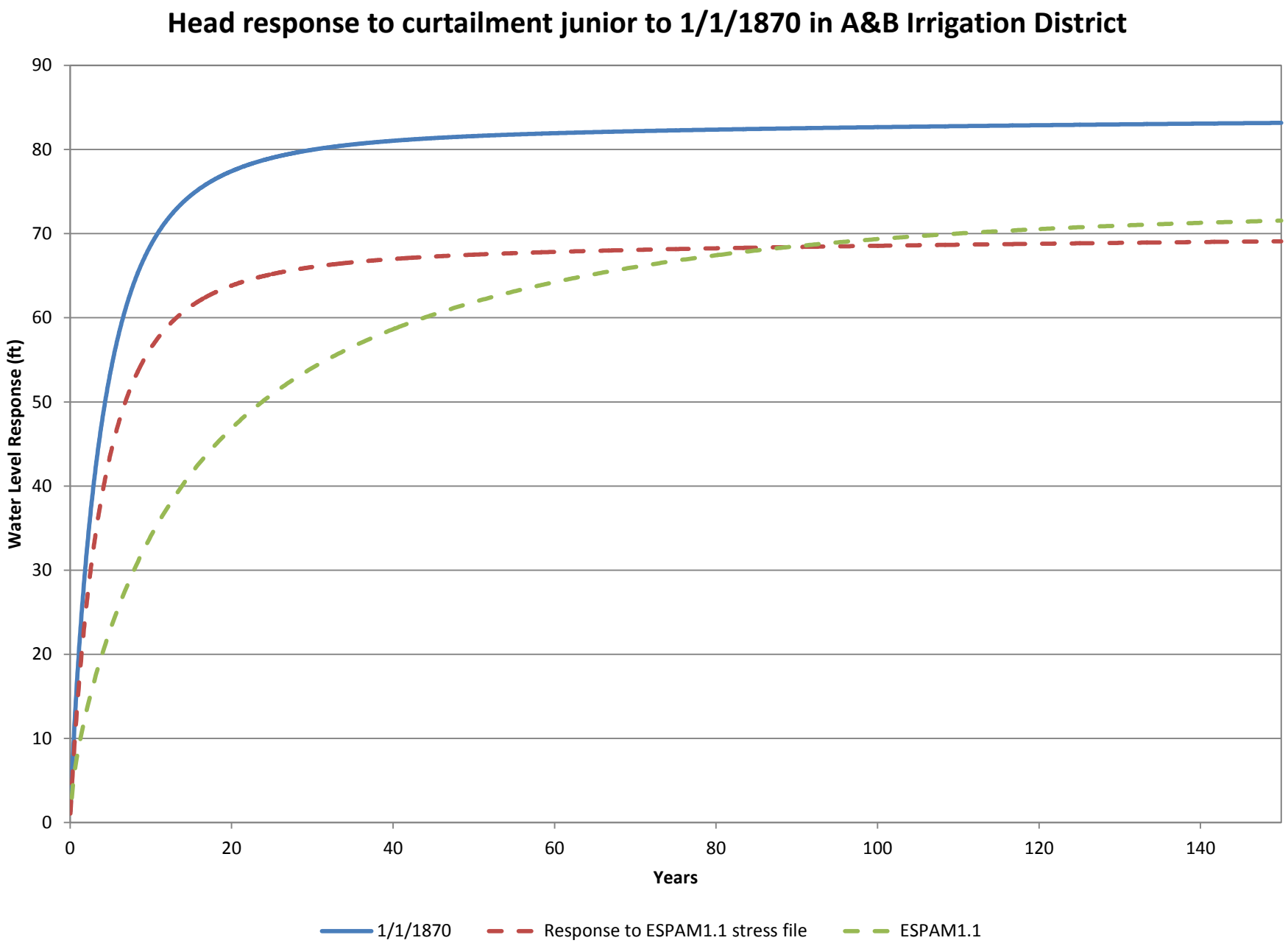

Predicted response to ESPAM1.1 stress file, LSF to King Hill springs
Response (cfs)
0
10
20
30
40
50
60
70
80
90
0
20
40
60
80
100
120
140
Years of continuous curtailment
Steady state
90% of steady state
1/1/1870
1/1/1949
1/1/1961
1/1/1973
1/1/1985
ESPAM1.1 (1870)
ESPAM1.1 (1949)
ESPAM1.1 (1961)
ESPAM1.1 (1973)
ESPAM1.1 (1985)
ESPAM1.1 (90% of steady state)

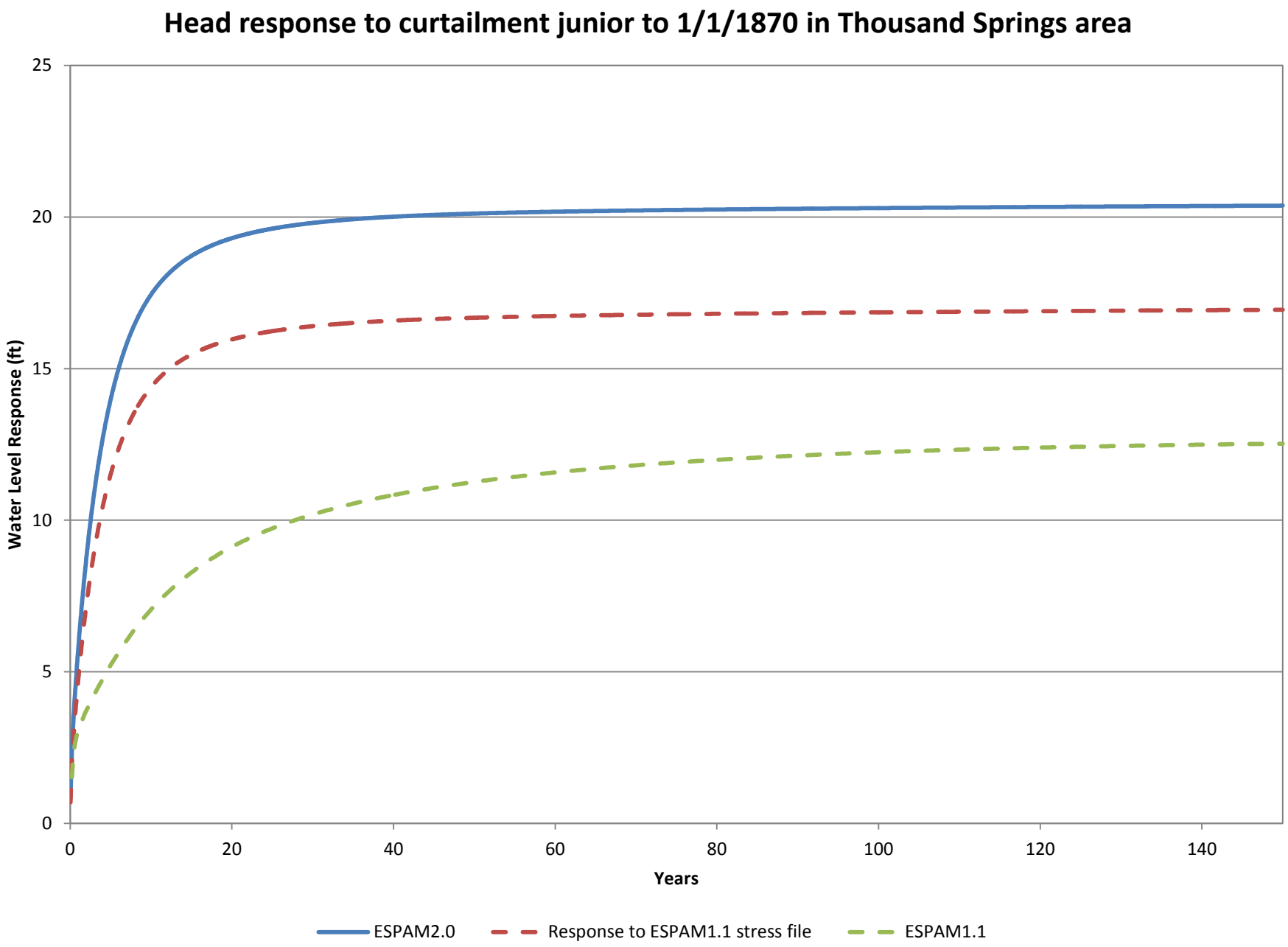
Head response at selected locations

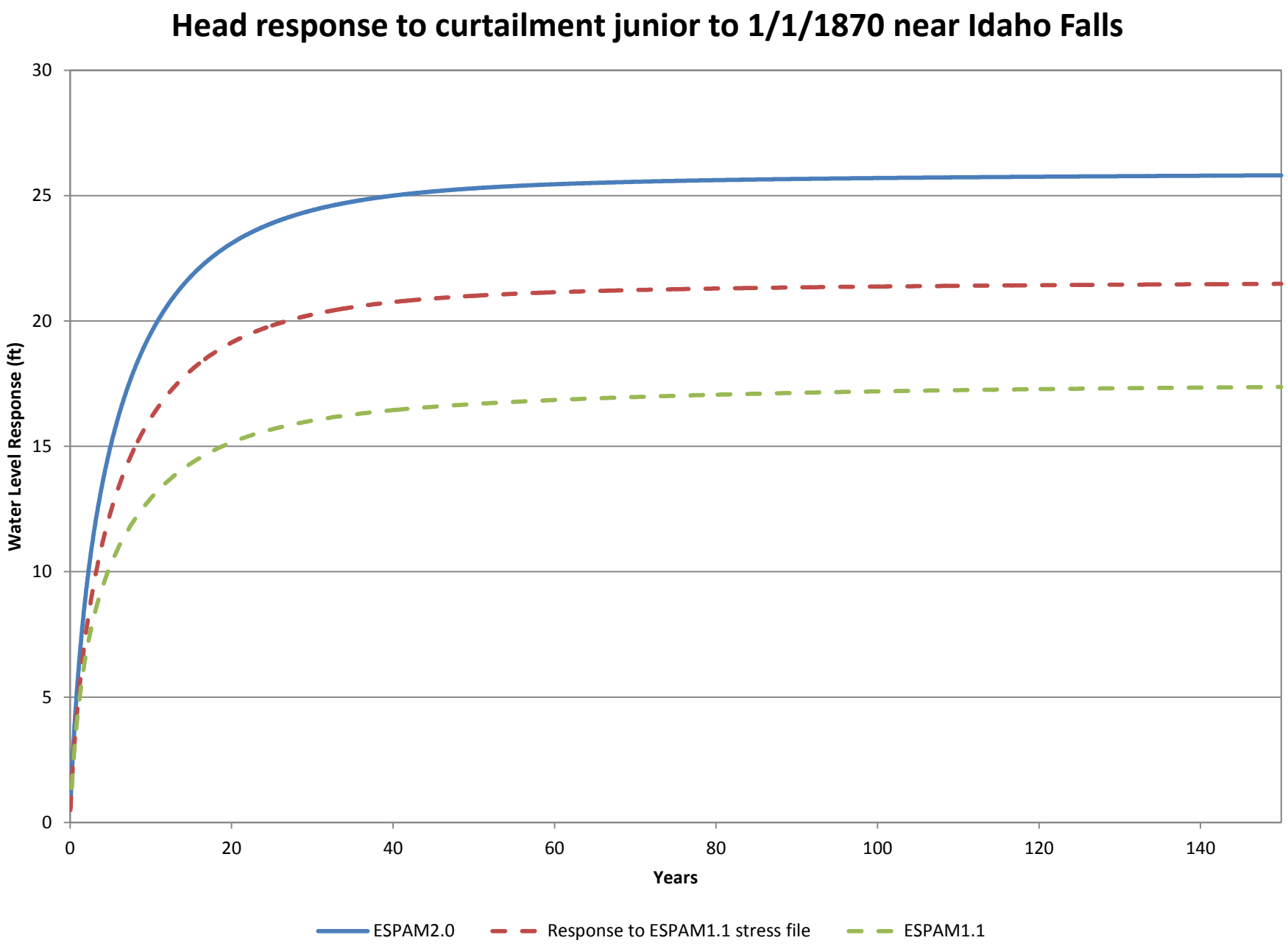


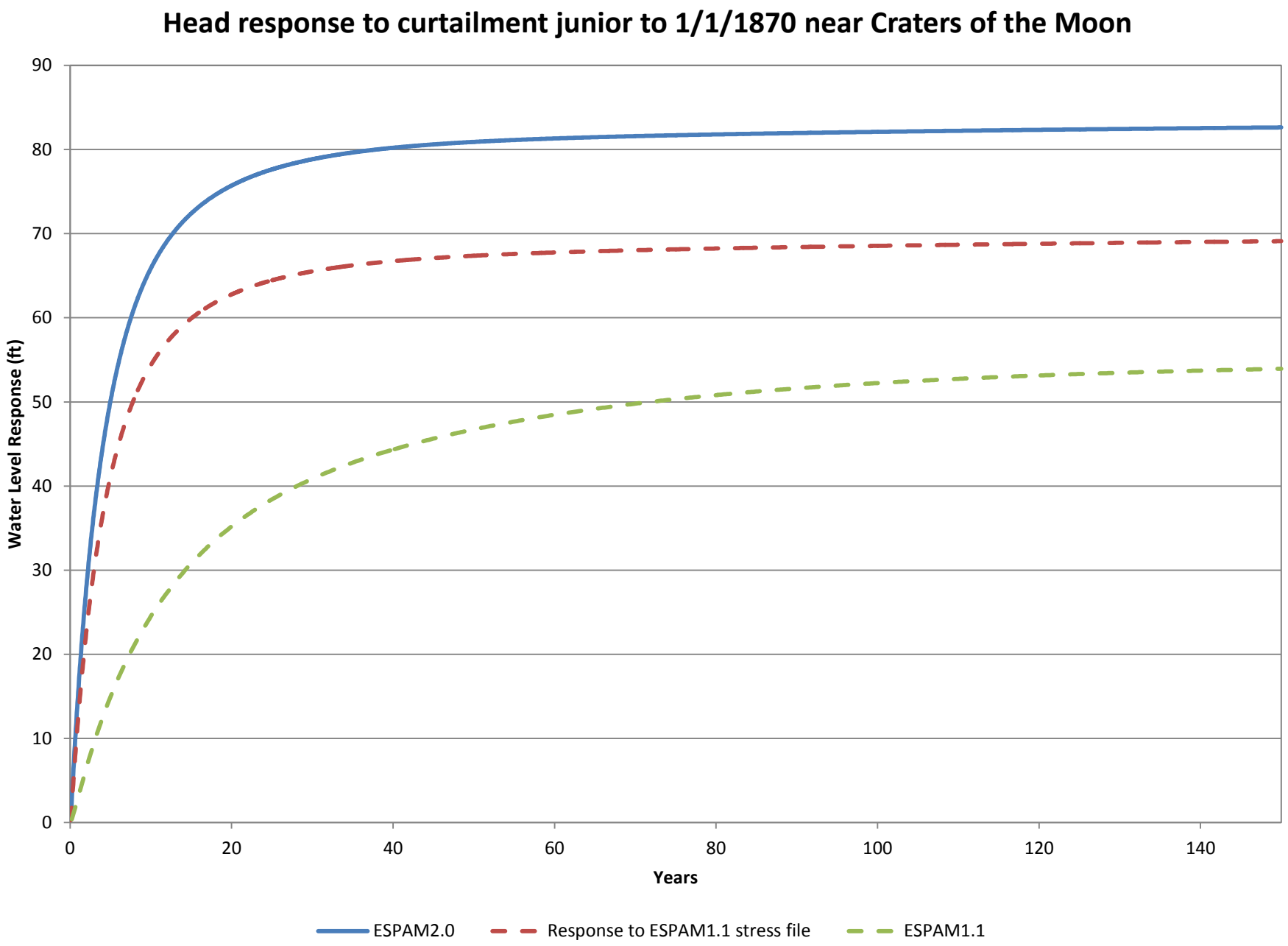

Head response to curtailment junior to 1/1/1870 near Mud Lake
Water Level Response (ft)
45
40
35
30
25
20
15
10
5
0
0
20
40
60
80
100
120
140
Years
ESPAM2.0
Response to ESPAM1.1 stress file
ESPAM1.1


Head response to curtailment junior to 1/1/1870 near American Falls
Water Level Response (ft)
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
Years
1/1/1870
Response to ESPAM1.1 stress file
ESPAM1.1


Head response to curtailment junior to 1/1/1870 in A&B Irrigation District
Water Level Response (ft)
90
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
Years
1/1/1870
Response to ESPAM1.1 stress file
ESPAM1.1


Head response to curtailment junior to 1/1/1870 in Thousand Springs area
Water Level Response (ft)
25
20
15
10
5
0
0
20
40
60
80
100
120
140
Years
ESPAM2.0
Response to ESPAM1.1 stress file
ESPAM1.1


Head response to curtailment junior to 1/1/1870 near Idaho Falls
Water Level Response (ft)
30
25
20
15
10
5
0
0
20
40
60
80
100
120
140
Years
ESPAM2.0
Response to ESPAM1.1 stress file
ESPAM1.1


Head response to curtailment junior to 1/1/1870 near Craters of the Moon
Water Level Response (ft)
90
80
70
60
50
40
30
20
10
0
0
20
40
60
80
100
120
140
Years
ESPAM2.0
Response to ESPAM1.1 stress file
ESPAM1.1

Comparison of Long Term Transient Results

- Response at nr Blackfoot to Minidoka reach and at springs downstream of Milner reaches 90% of steady state more quickly than in ESPAM1.1

- Head response at selected locations near American Falls, in A&B Irrigation District, near Craters of the Moon, and in Thousand Springs area also approach steady state more quickly than in ESPAM1.1

- Reflects changes in calibration of aquifer transmissivity and storativity

Short Term Transient Results

- Illustrate seasonal response patterns resulting from change in discretization of model stress periods

- ESPAM1.1 applied consumptive use from groundwater irrigation as a constant stress at an average seasonal rate from May 1 to October 31

- ESPAM2.0 applies consumptive use from groundwater irrigation at average monthly rate

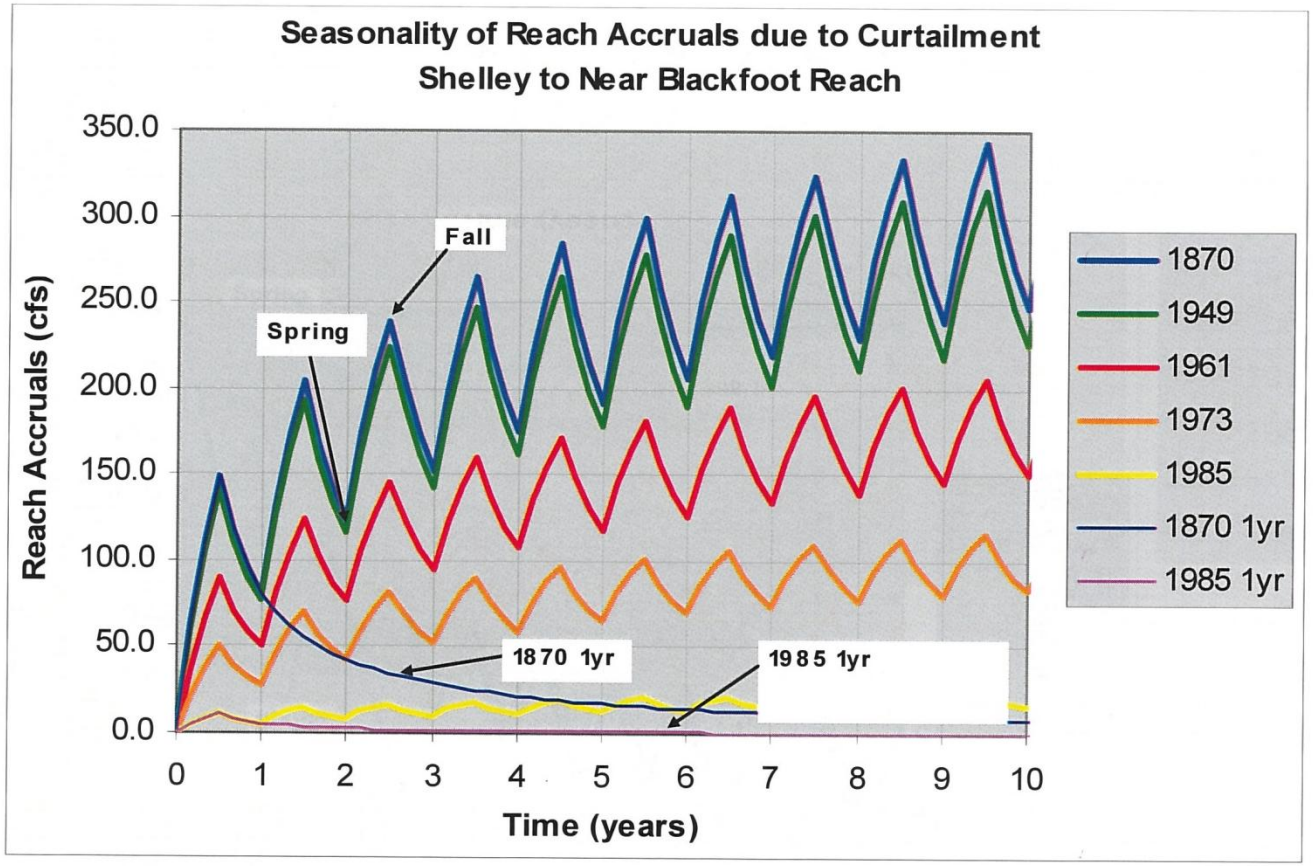
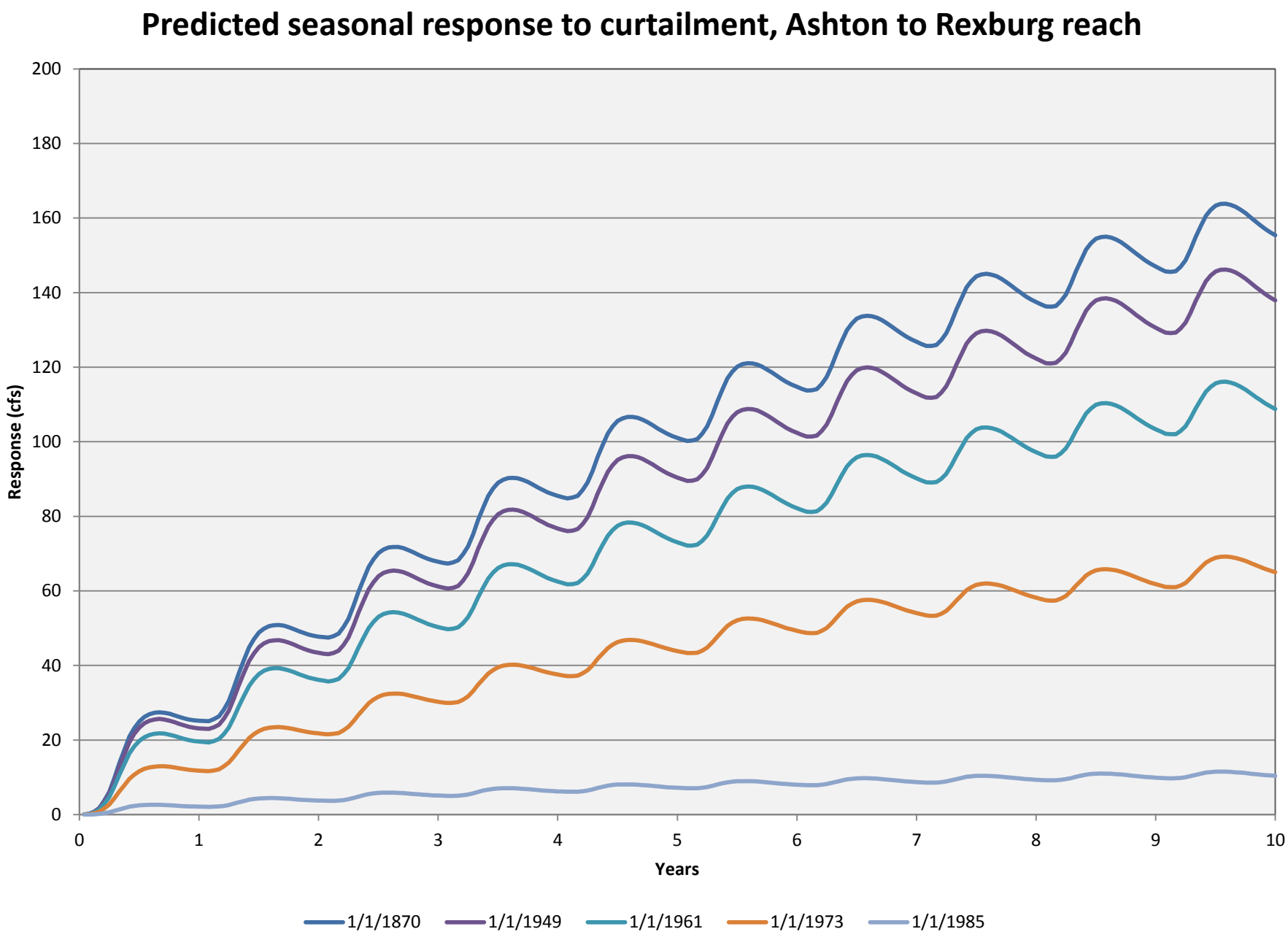
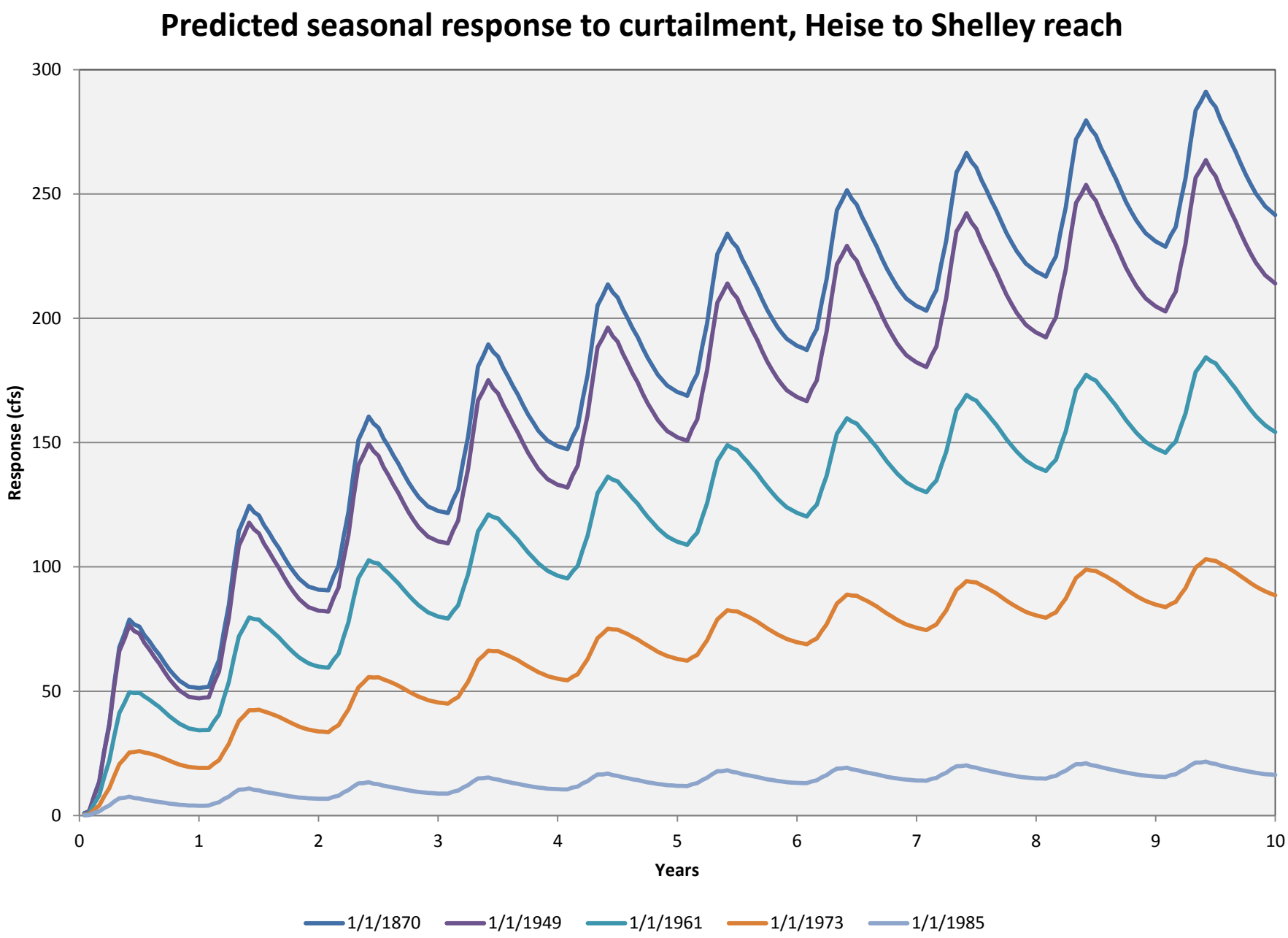
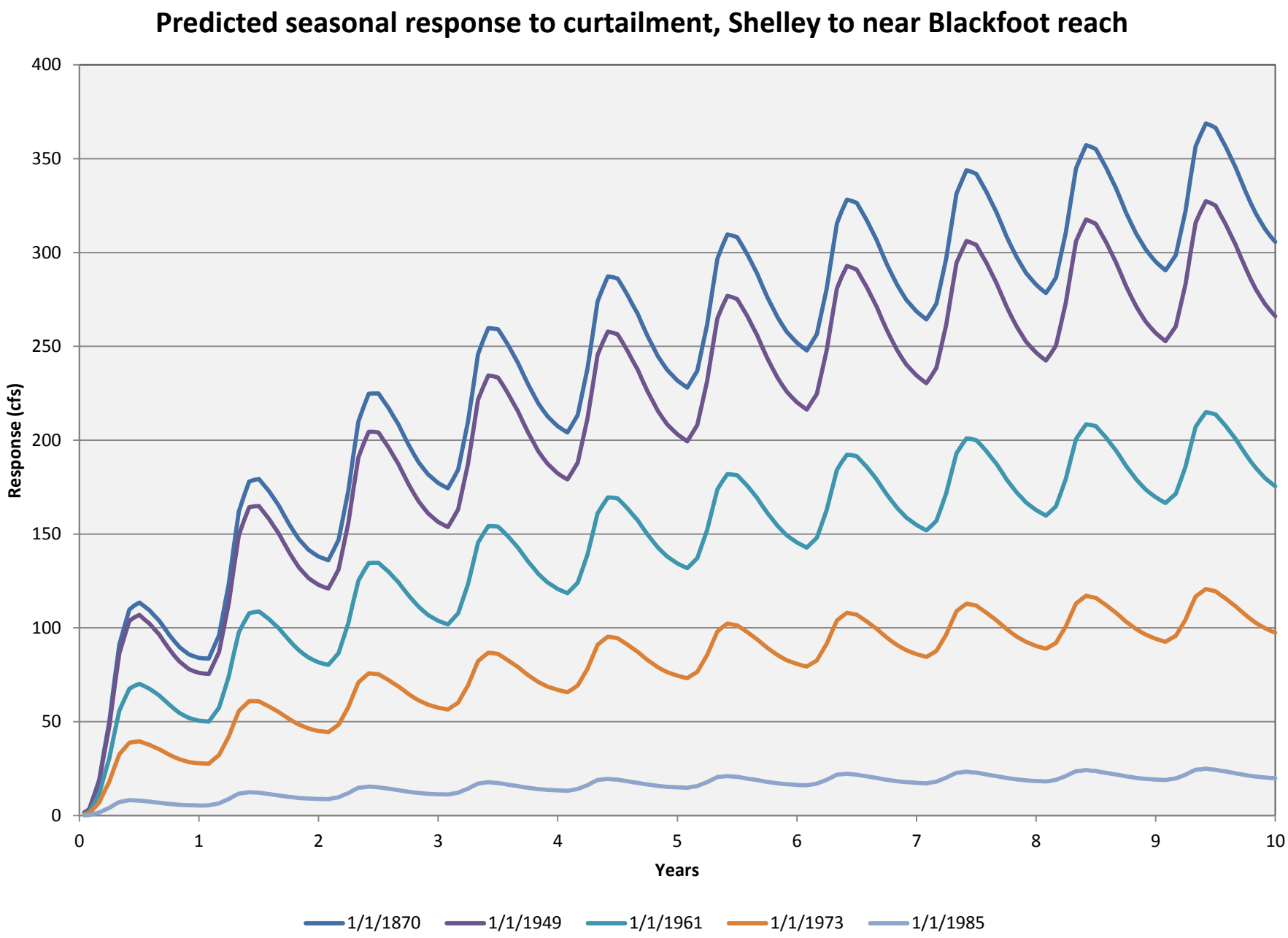
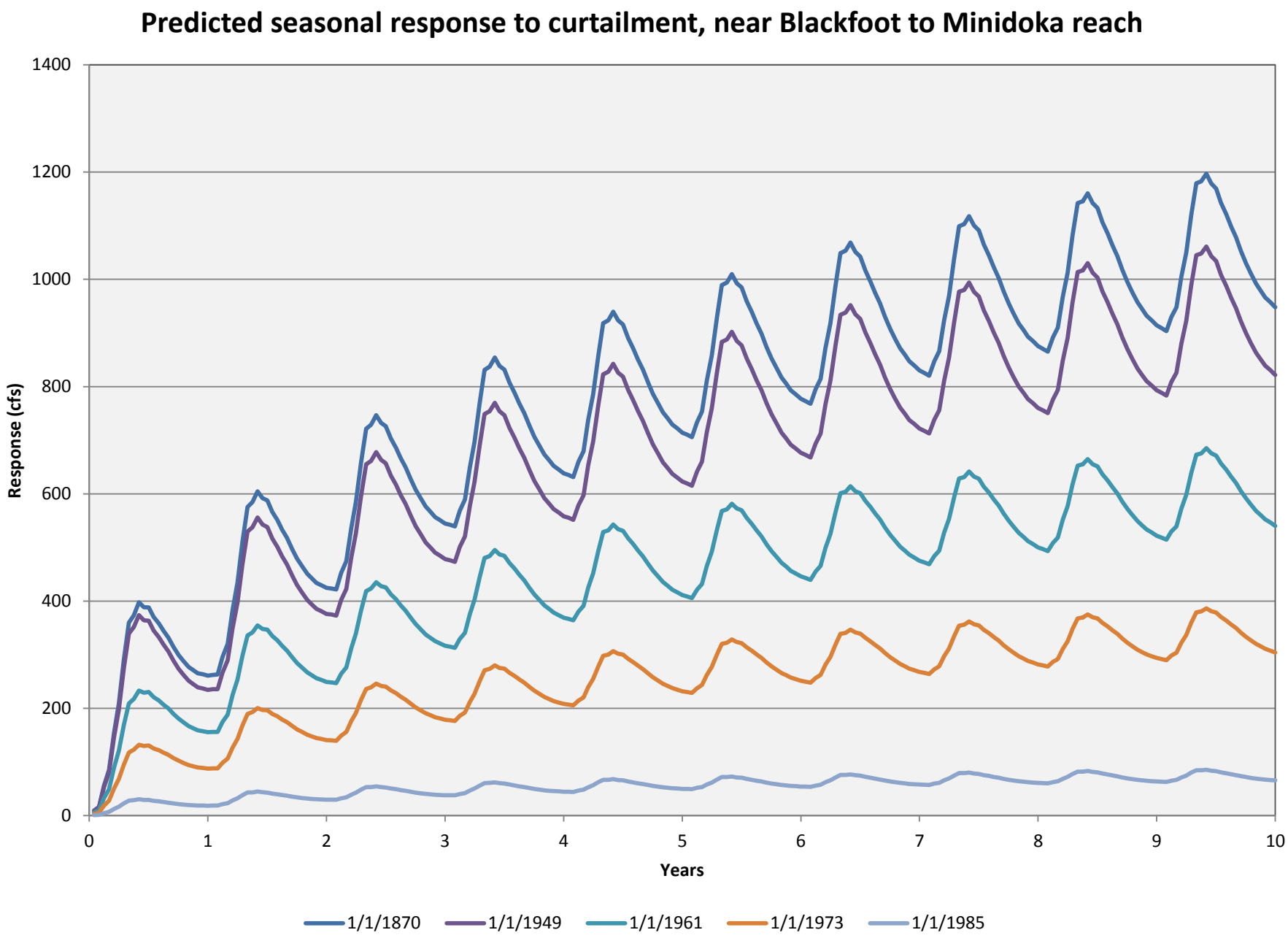


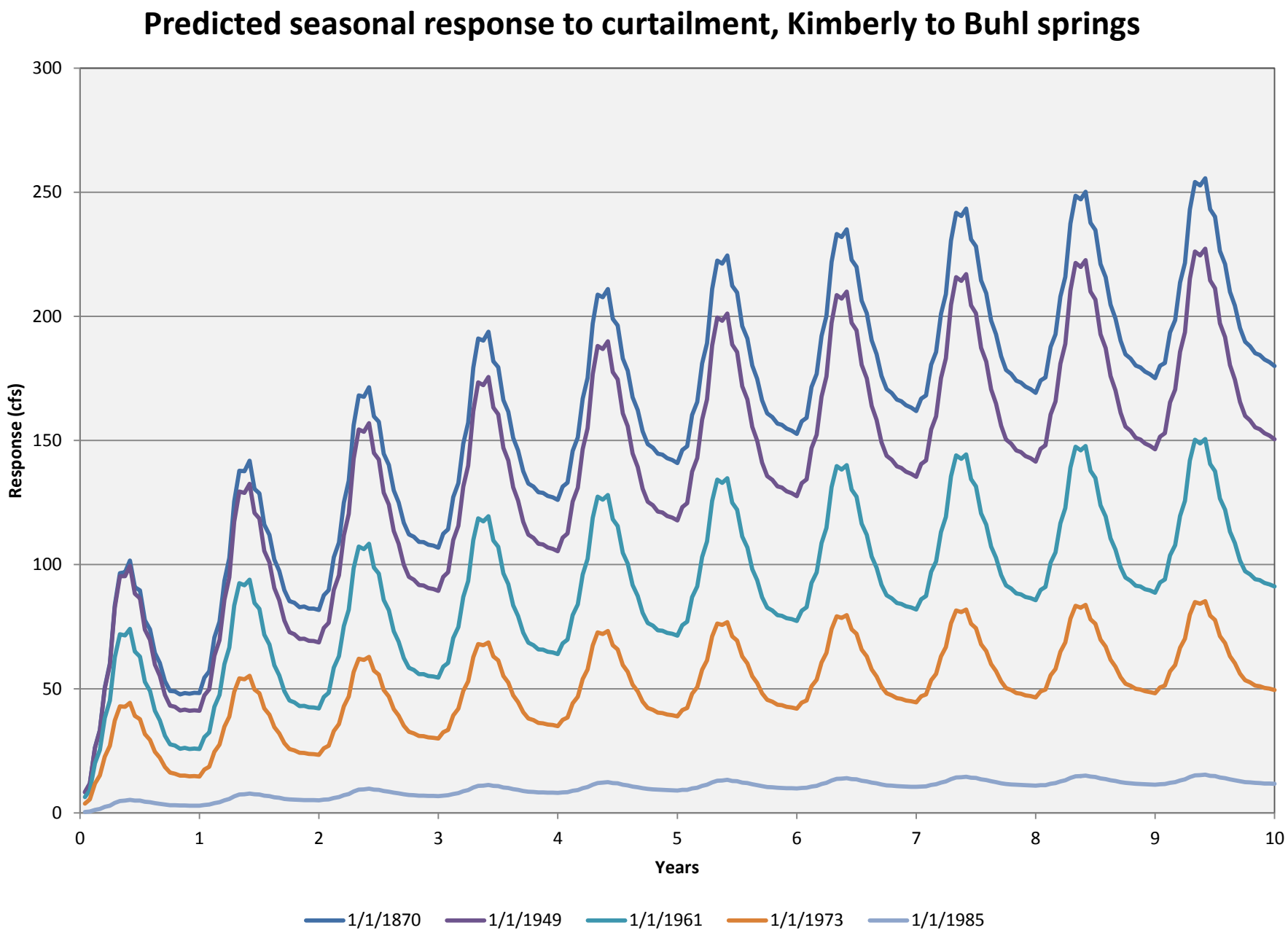
Figure 20. Seasonality of Reach Accruals due to Curtailment of Ground-Water Pumping for Shelley-Near Blackfoot Reach (generated using ESPAM v1.1).

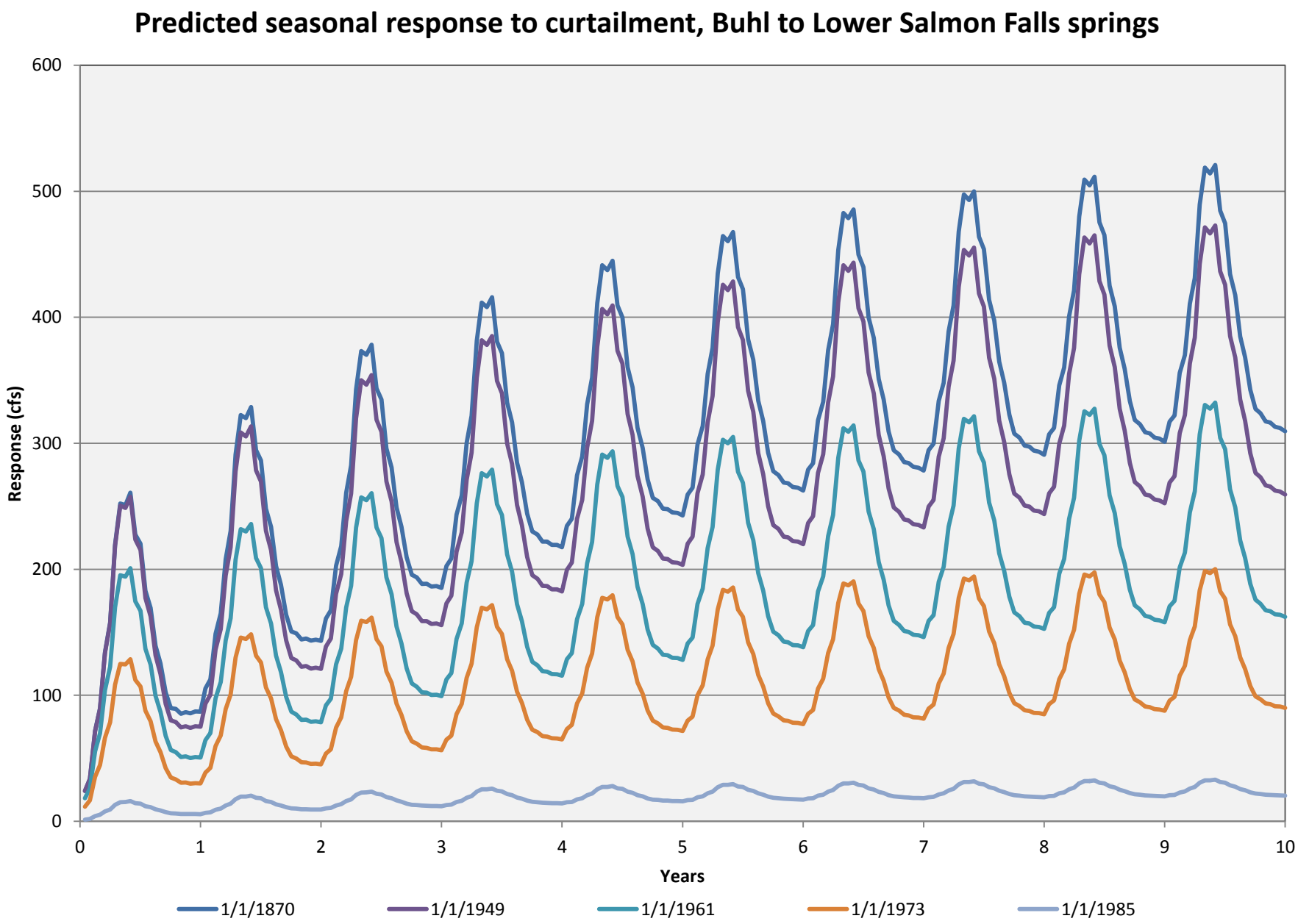

Predicted seasonal response to curtailment, Ashton to Rexburg reach
Response (cfs)
200
180
160
140
120
100
80
60
40
20
0
0
1
2
3
4
5
6
7
8
9
10
Years
1/1/1870
1/1/1949
1/1/1961
1/1/1973
1/1/1985

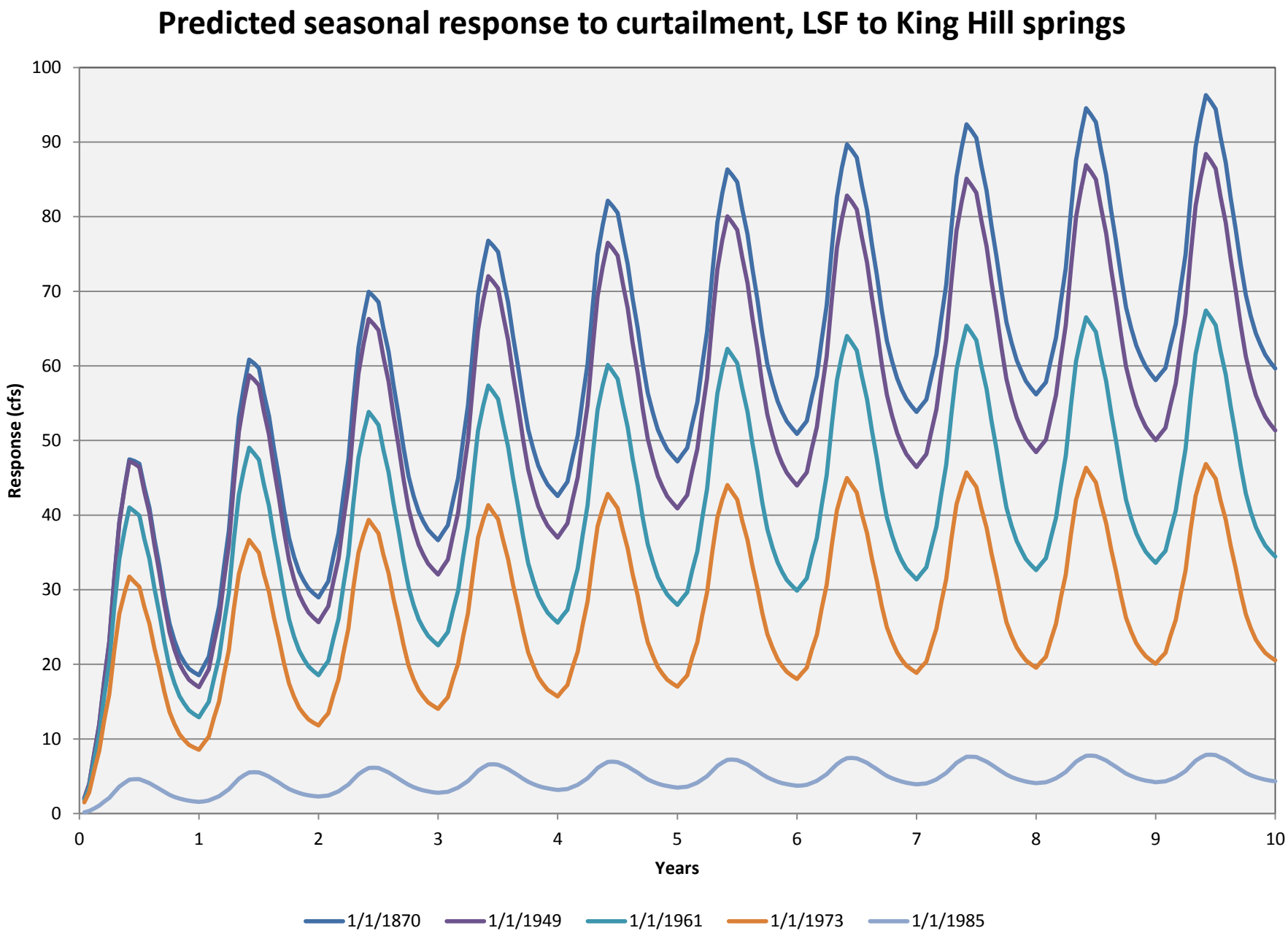

Predicted seasonal response to curtailment, Heise to Shelley reach
Response (cfs)
300
250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
9
10
Years
1/1/1870
1/1/1949
1/1/1961
1/1/1973
1/1/1985


Predicted seasonal response to curtailment, Shelley to near Blackfoot reach
Response (cfs)
400
350
300
250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
9
10
Years
1/1/1870
1/1/1949
1/1/1961
1/1/1973
1/1/1985


Predicted seasonal response to curtailment, near Blackfoot to Minidoka reach
Response (cfs)
1400
1200
1000
800
600
400
200
0
0
1
2
3
4
5
6
7
8
9
10
Years
1/1/1870
1/1/1949
1/1/1961
1/1/1973
1/1/1985


Predicted seasonal response to curtailment, Kimberly to Buhl springs
Response (cfs)
300
250
200
150
100
50
0
0
1
2
3
4
5
6
7
8
9
10
Years
1/1/1870
1/1/1949
1/1/1961
1/1/1973
1/1/1985


Predicted seasonal response to curtailment, Buhl to Lower Salmon Falls springs
Response (cfs)
600
500
400
300
200
100
0
0
1
2
3
4
5
6
7
8
9
10
Years
1/1/1870
1/1/1949
1/1/1961
1/1/1973
1/1/1985

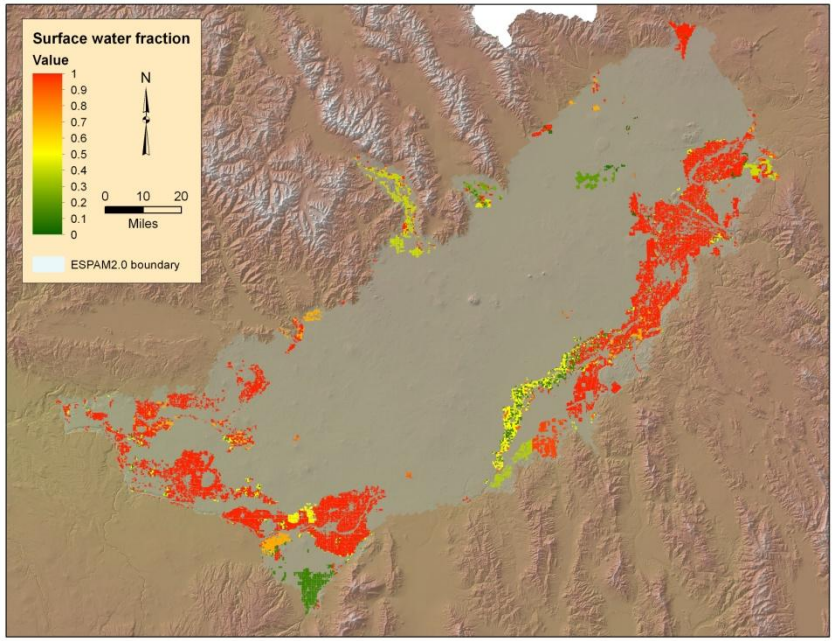
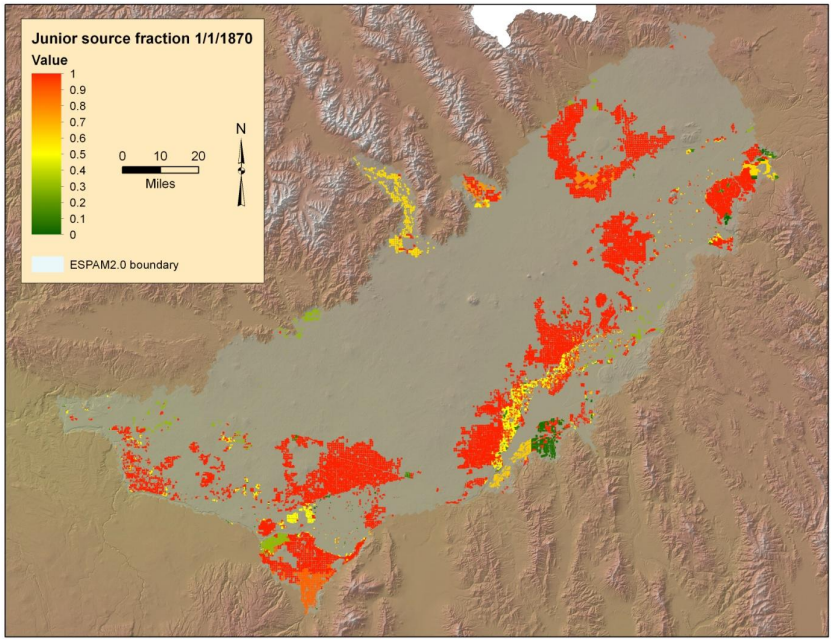

Predicted seasonal response to curtailment, LSF to King Hill springs
Response (cfs)
100
90
80
70
60
50
40
30
20
10
0
0
1
2
3
4
5
6
7
8
9
10
Years
1/1/1870
1/1/1949
1/1/1961
1/1/1973
1/1/1985

Summary

- ESPAM2.0 data indicate groundwater irrigated acreage and consumptive use are higher than calculated with ESPAM1.1 data
- Changes in calibrated model parameters result in changes in the relative responses of some spring and river reaches
- Changes in calibrated model parameters generally result in quicker transient responses in the western portion of the model
- Seasonal response pattern reflects change to monthly stress periods

Questions?

Surface Water Irrigated Lands



Groundwater Irrigated Lands