Climate threats to the American Pika

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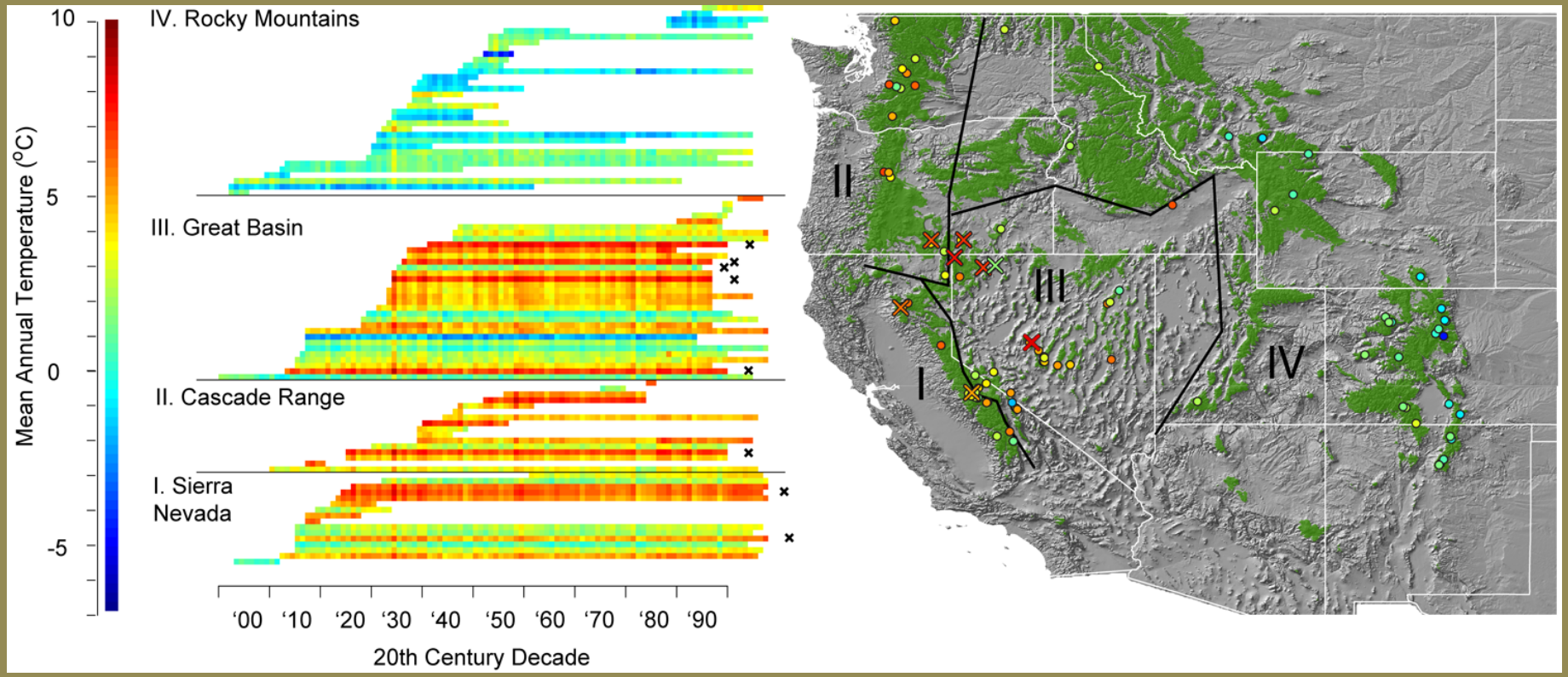
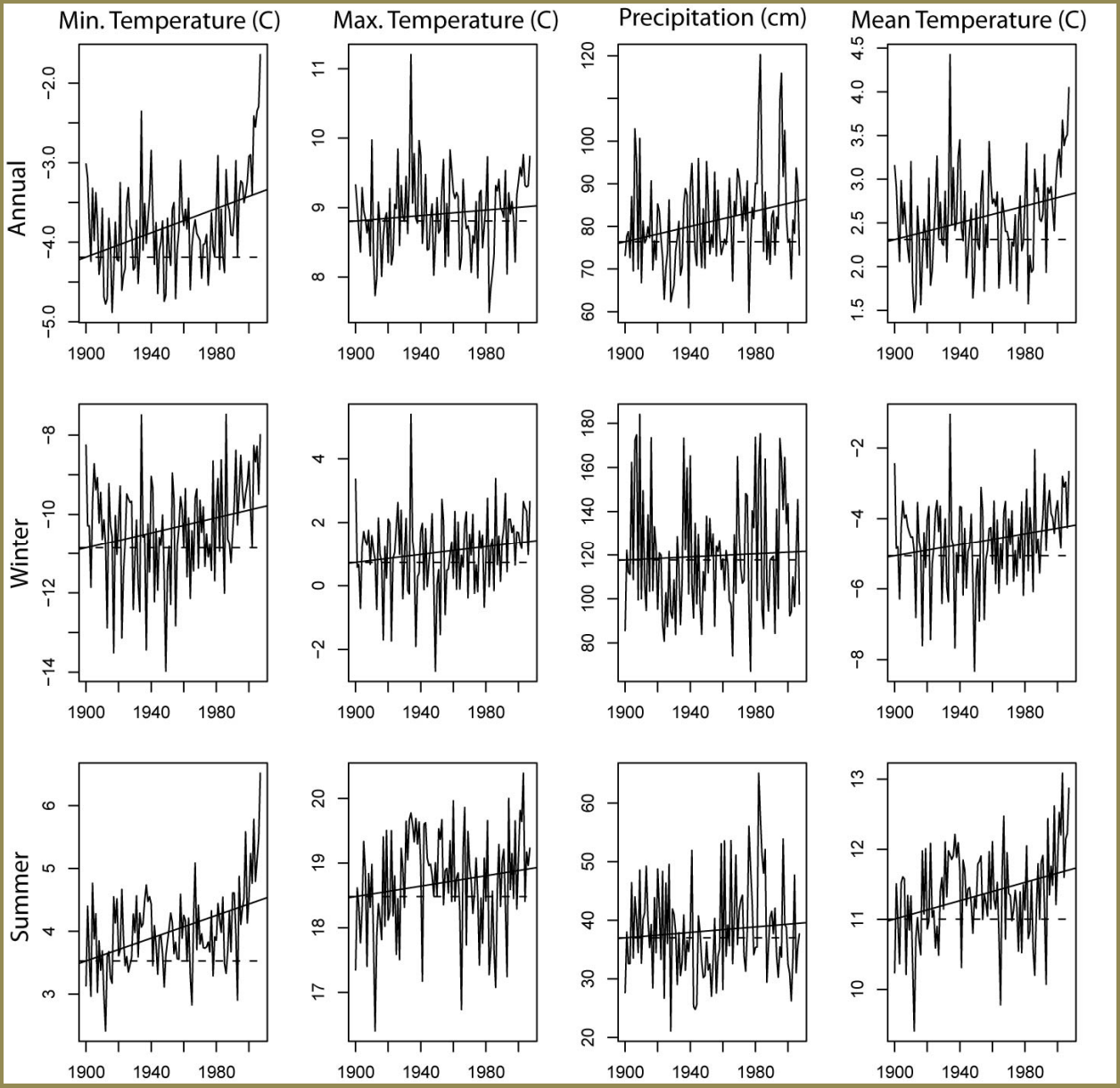
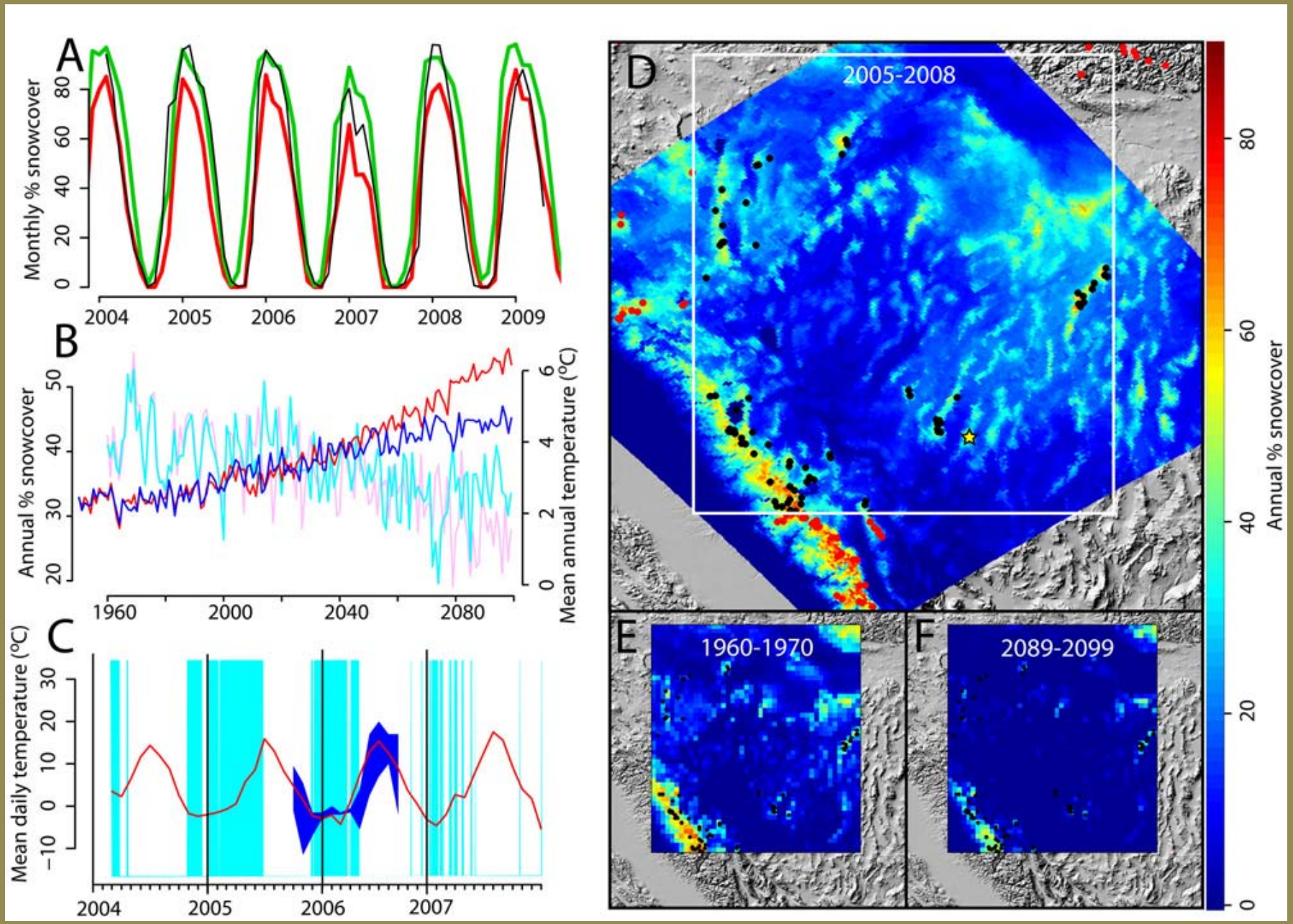
Photo by Scott Loarie

Historic pika persistence data



Climate variables




A
Monthly % snowcover
0
20
40
60
80
2004
2005
2006
2007
2008
2009
B
Annual % snowcover
20
30
40
50
Mean annual temperature (°C)
0
2
4
6
1960
2000
2040
2080
C
Mean daily temperature (°C)
−10
0
10
20
30
2004
2005
2006
2007
D
2005-2008
E
1960-1970
F
2089-2099
Annual % snowcover
0
20
40
60
80

Modeling Persistence

$E_{it} \sim Bernoulli(\theta_{it})$ Probability of extirpation at site i in year t

$\theta_{it} = f(C_{it})$

Photo by Scott Loarie

Modeling Persistence

$$E_{it} \sim Bernoulli(\theta_{it})$$

Probability of extirpation at site i in year t

$$\theta_{it} = f(C_{it})$$

$$P(\psi_i = 1) = \left(\prod_{t=s_i}^{T_i} 1 - \theta_{it} \right)$$

Probability of surviving an interval

Photo by Scott Loarie

Modeling Persistence

$E_{it} \sim Bernoulli(\theta_{it})$ Probability of extirpation at site i in year t

$\theta_{it} = f(C_{it})$

$$P(\psi_i = 1) = \left(\prod_{t=s_i}^{T_i} 1 - \theta_{it} \right)$$ Probability of surviving an interval

Photo by Scott Loarie

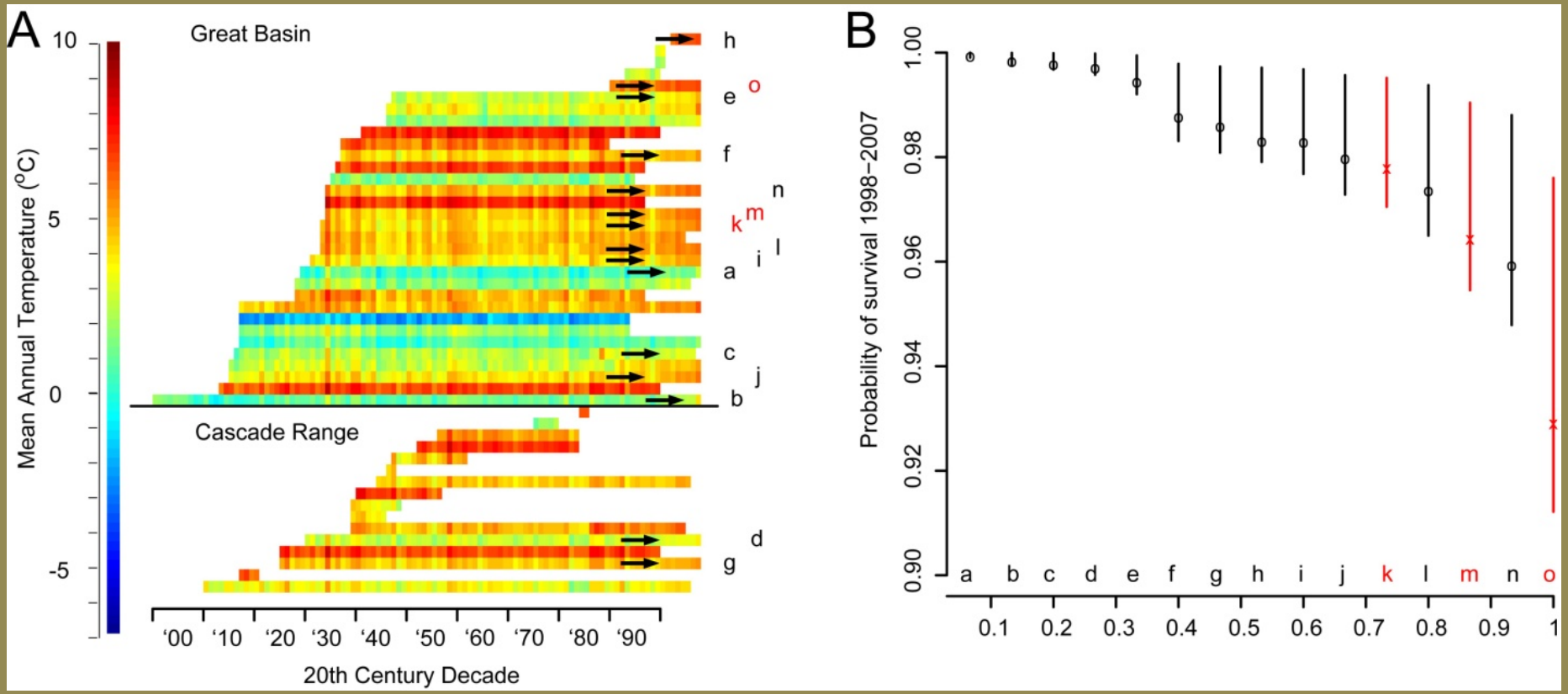
$$logit(\theta_{it}) = \beta_0 + \beta_1 T_{it}^{s,max} + \beta_2 P_{it}^{w,tot}$$

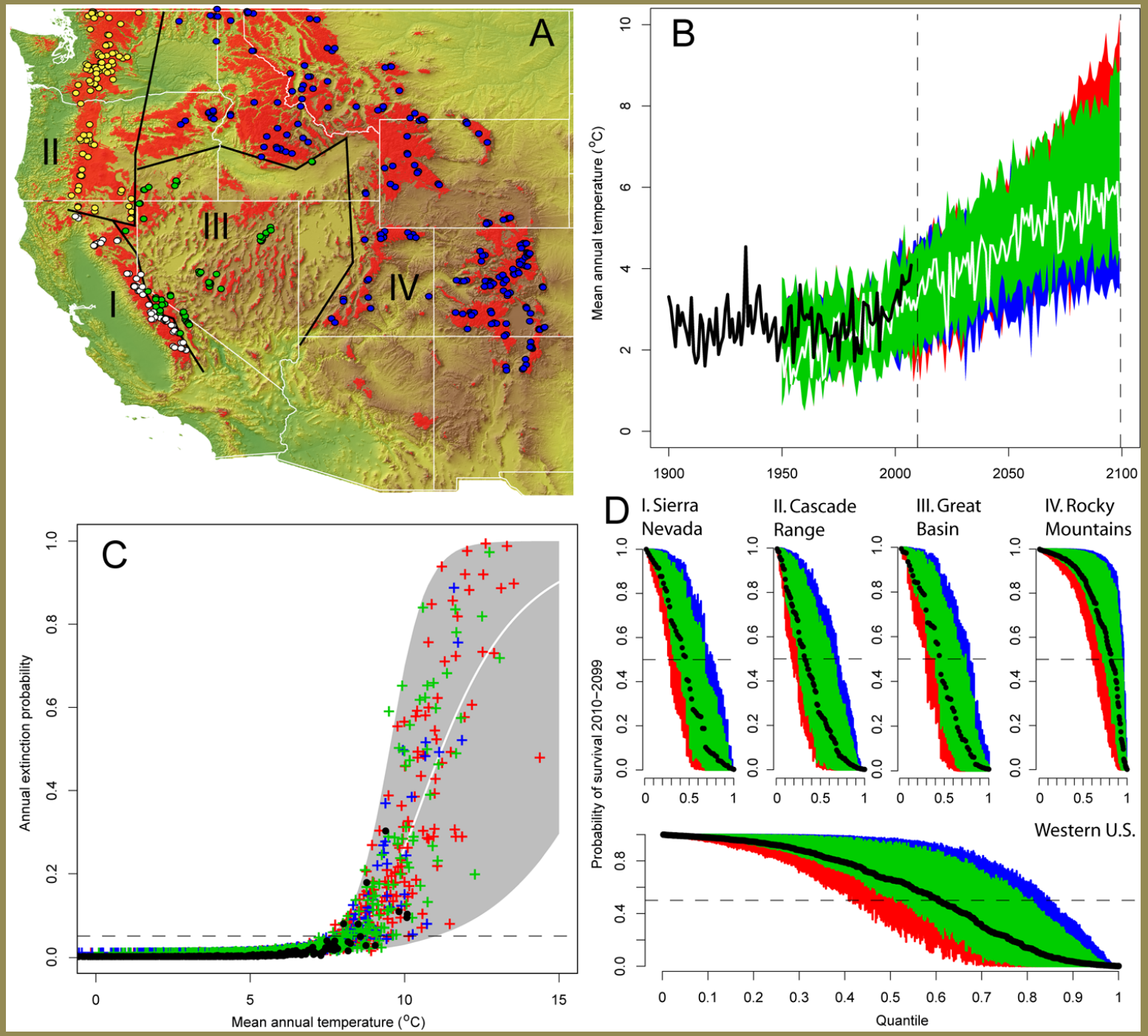
Predictive Loss

$$logit(\theta_{it}) = \beta_0 + \beta_1 T_{it}^{s,max} + \beta_2 P_{it}^{w,tot}$$

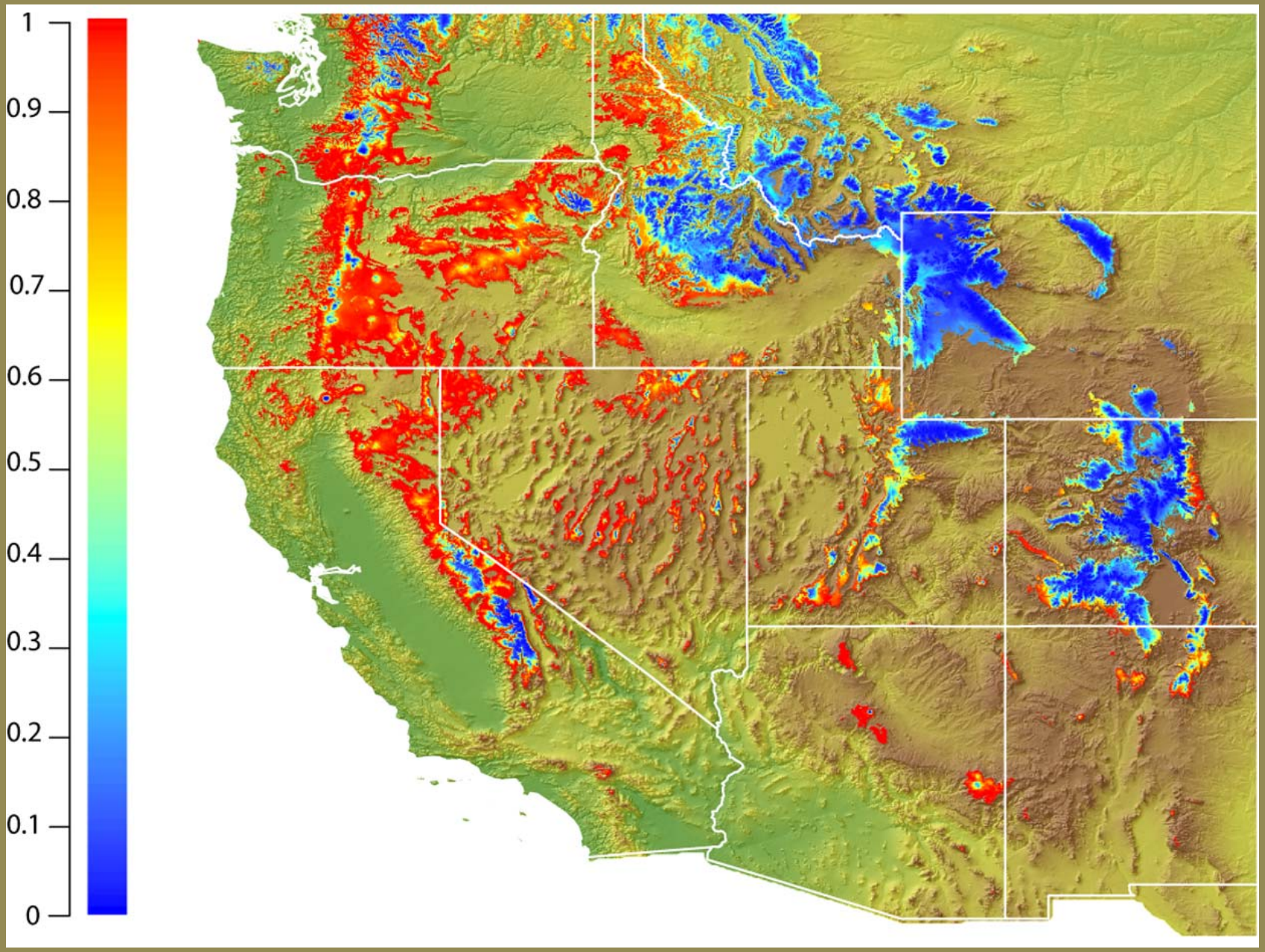
		b0			b1				b2				Gm	Pm	Dev
Tmean	Ann	-12.06	-17.51	-8.26	1.09	0.52	1.81	*					5.16	0.30	3.62
Tmax	Ann	-16.80	-25.63	-10.54	0.88	0.40	1.51	*					3.34	0.28	3.63
Tmean + Ptot	Ann	-11.78	-18.62	-7.57	1.13	0.48	2.04	*	-0.010	-0.050	0.000		6.46	0.26	3.65
Tmean + Ptot	Win	-4.51	-6.05	-3.43	1.05	0.47	1.85	*	-0.010	-0.030	0.000	*	3.28	0.34	3.83
Tmax + Ptot	Ann	-16.47	-26.37	-9.64	0.88	0.36	1.59	*	-0.010	-0.040	0.010		4.27	0.56	3.85
Tmax	Sum	-17.57	-24.88	-11.24	0.52	0.25	0.81	*					3.43	0.43	4.40
Tmean + Ptot	Sum	-16.07	-25.55	-9.46	0.68	0.25	1.21	*	-0.090	-0.190	0.000		3.21	0.44	4.41
Tmax + Ptot	Sum	-18.13	-29.52	-9.90	0.51	0.18	0.94	*	-0.090	-0.210	0.010		5.57	0.27	4.42
Tmean	Win	-5.17	-6.19	-4.42	0.83	0.37	1.39	*					4.48	0.30	4.52
Tmean	Sum	-15.73	-21.93	-10.69	0.68	0.35	1.06	*					6.58	0.25	4.52
Tmin + Ptot	Win	-0.47	-3.16	2.39	0.73	0.30	1.34	*	-0.020	-0.030	0.000	*	4.19	0.33	4.64
Tmax + Ptot	Win	-8.91	-12.61	-6.41	0.71	0.29	1.23	*	-0.010	-0.030	0.000		4.05	0.59	4.73
Tmax	Win	-9.28	-12.61	-7.02	0.70	0.31	1.17	*					4.23	0.50	4.77
Tmin + Ptot	Ann	-4.53	-5.87	-3.56	0.94	0.39	1.74	*	-0.020	-0.050	0.000	*	3.23	0.61	4.83
Tmin	Ann	-5.34	-6.26	-4.59	0.73	0.28	1.28	*					5.99	0.27	5.46
Tmin	Win	-2.70	-4.71	-0.97	0.49	0.18	0.85	*					4.15	0.25	5.84
Tmin + Ptot	Sum	-10.35	-16.48	-6.61	0.60	0.10	1.24	*	-0.100	-0.200	-0.020	*	6.00	0.48	5.89
Tmin	Sum	-9.84	-13.93	-7.06	0.58	0.18	1.08	*					4.28	0.24	6.26
Ptot	Sum	-6.41	-8.57	-5.26	-0.09	-0.17	-0.02	*					4.96	0.82	6.48
Ptot	Ann	-5.58	-6.76	-4.76	-0.02	-0.06	0.00						3.77	0.65	6.72
Ptot	Win	-5.83	-6.85	-5.03	-0.01	-0.03	0.00						3.79	0.62	6.83

Validation

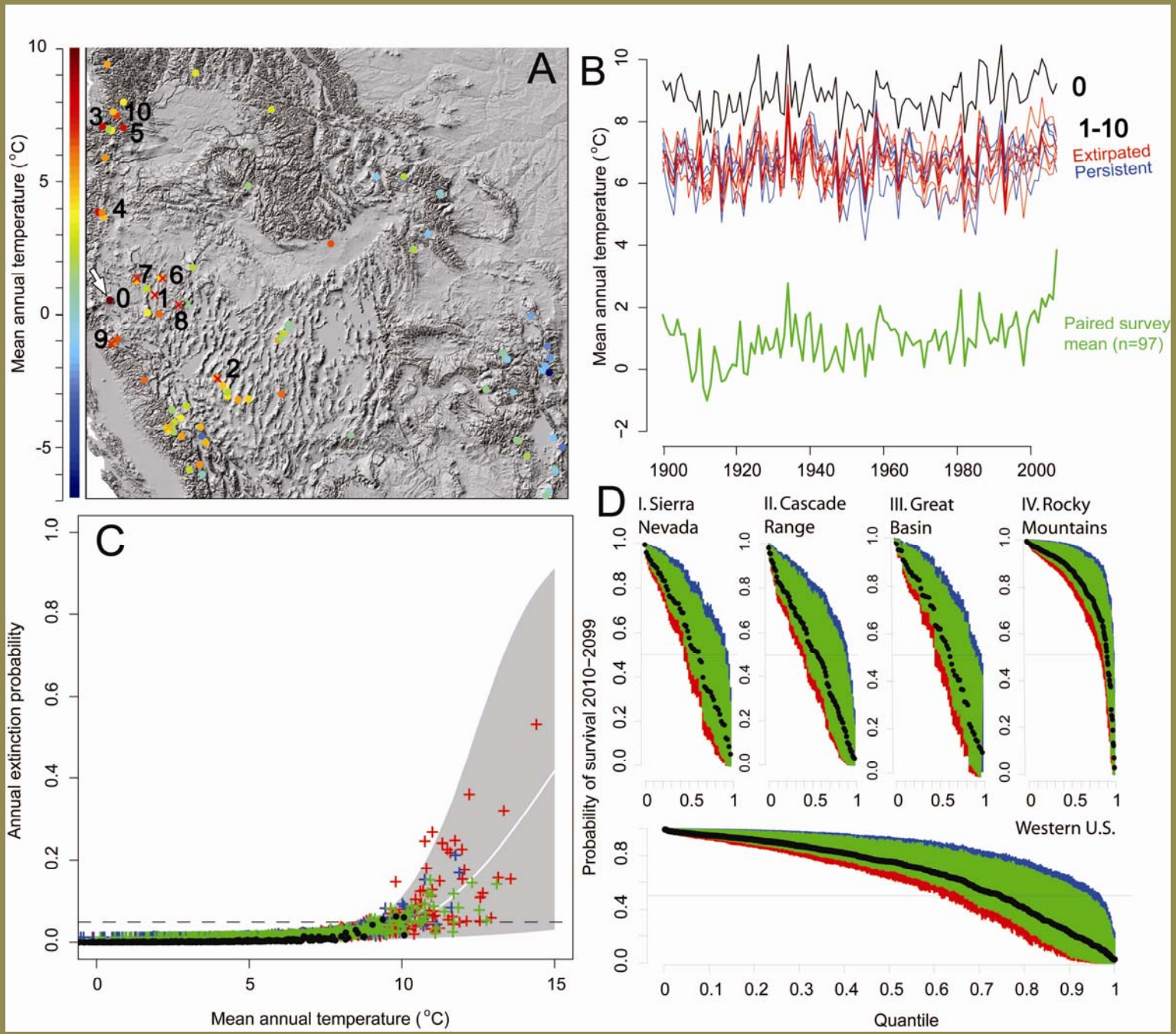

A
Great Basin
Cascade Range
Mean Annual Temperature (°C)
10
5
0
-5
'00
'10
'20
'30
'40
'50
'60
'70
'80
'90
20th Century Decade
h
e
o
f
n
k
m
a
i
l
c
j
b
d
g
B
Probability of survival 1998–2007
1.00
0.98
0.96
0.94
0.92
0.90
a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1


A
II
III
I
IV
B
Mean annual temperature (°C)
0
2
4
6
8
10
1900
1950
2000
2050
2100
C
Annual extinction probability
0.0
0.2
0.4
0.6
0.8
1.0
0
5
10
15
Mean annual temperature (°C)
D
I. Sierra Nevada
II. Cascade Range
III. Great Basin
IV. Rocky Mountains
Probability of survival 2010–2099
0.0
0.2
0.4
0.6
0.8
1.0
0
0.5
1
Western U.S.
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
Quantile

Extirpation 2010-2099



Exclude Lava beds



Exclude Lava beds

Exclude UCB