Projected ocean warming creates a conservation challenge for river herring populations

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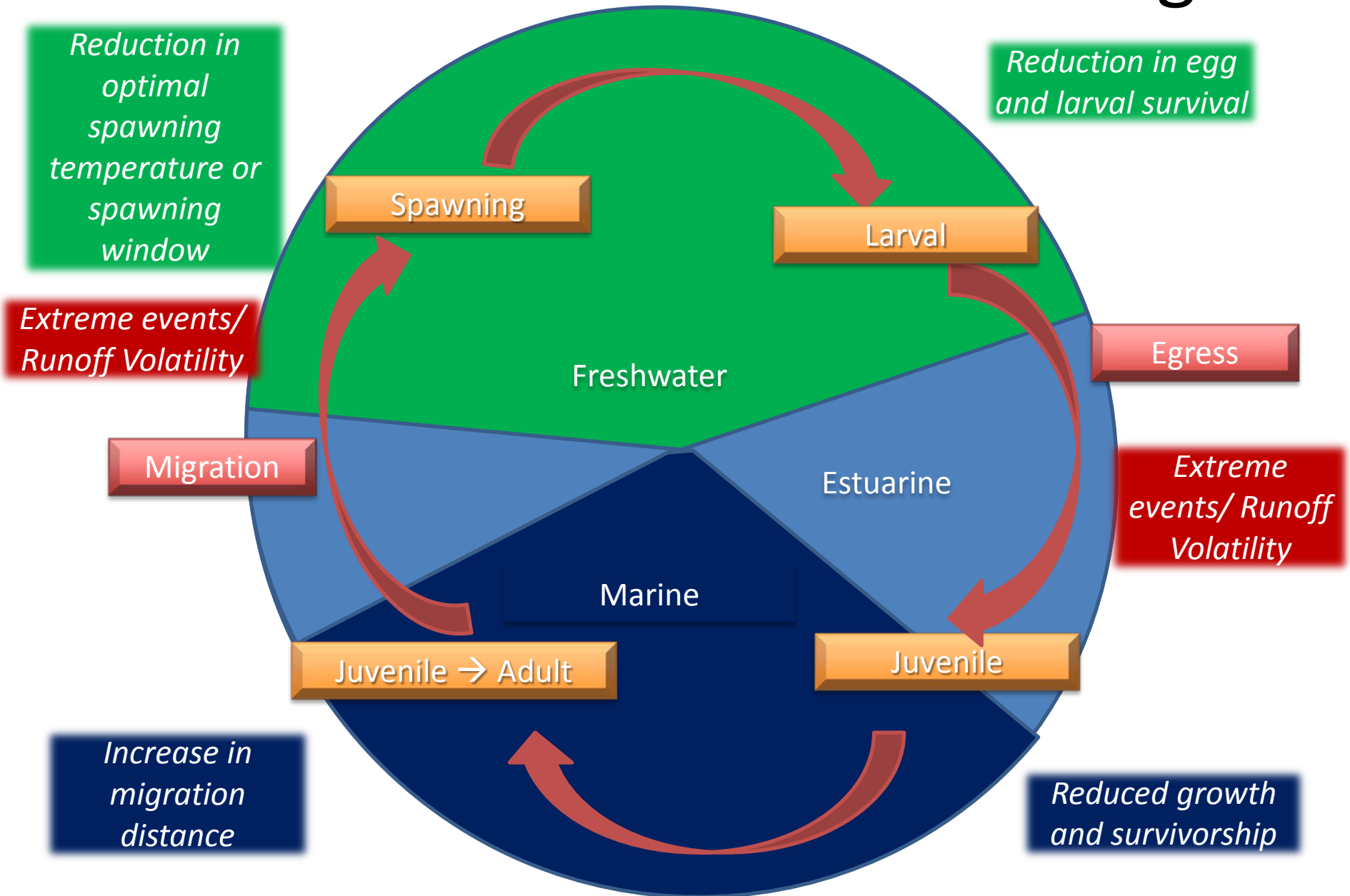
Climate effects on river herring



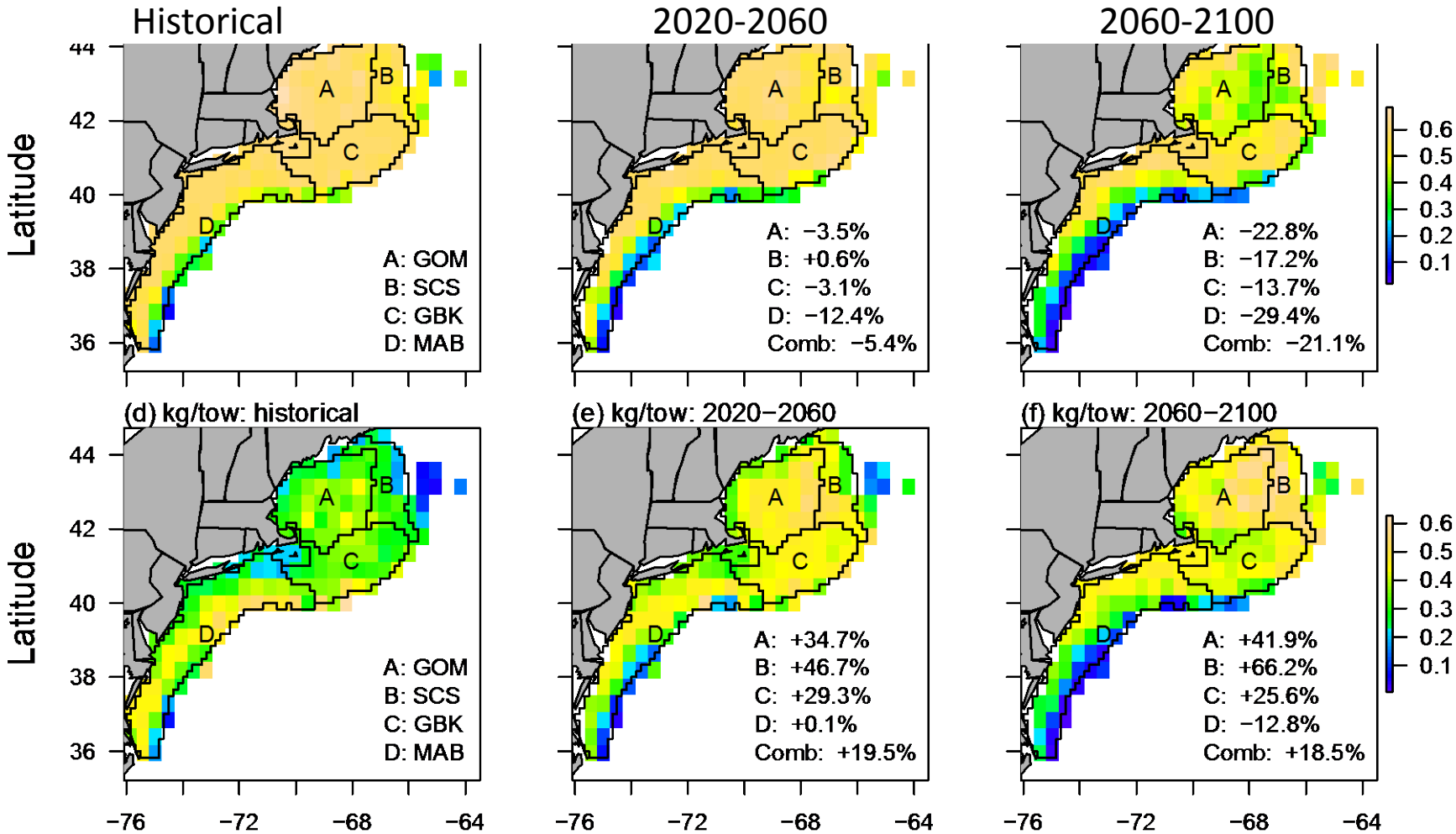
Approach

- Develop a statistical habitat model for marine phase of alewife and blueback herring
- Used NEFSC trawl survey data collected in spring and fall
- 2 stage Generalized Additive Model
  - Presence/Absence
  - Abundance
- SST and BT
- Project abundance and distribution forward with ensemble mean of ~9 statistically “downscaled” Global Climate Models (Hare et al. 2012)
- Three scenarios: B1, A1B, B2

Alewife spring

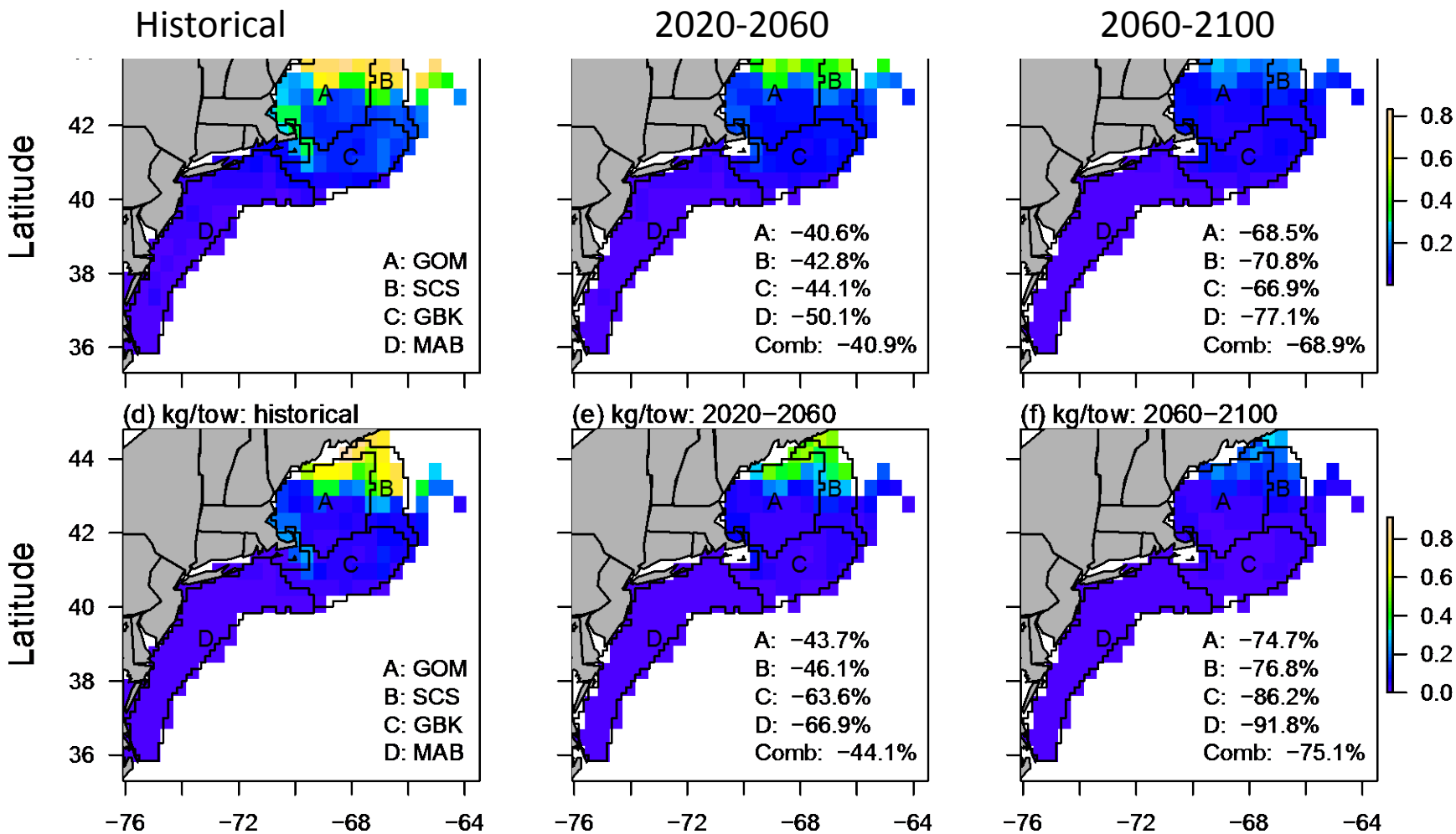
Top panels: Probability of occurrence

Bottom panels: Abundance



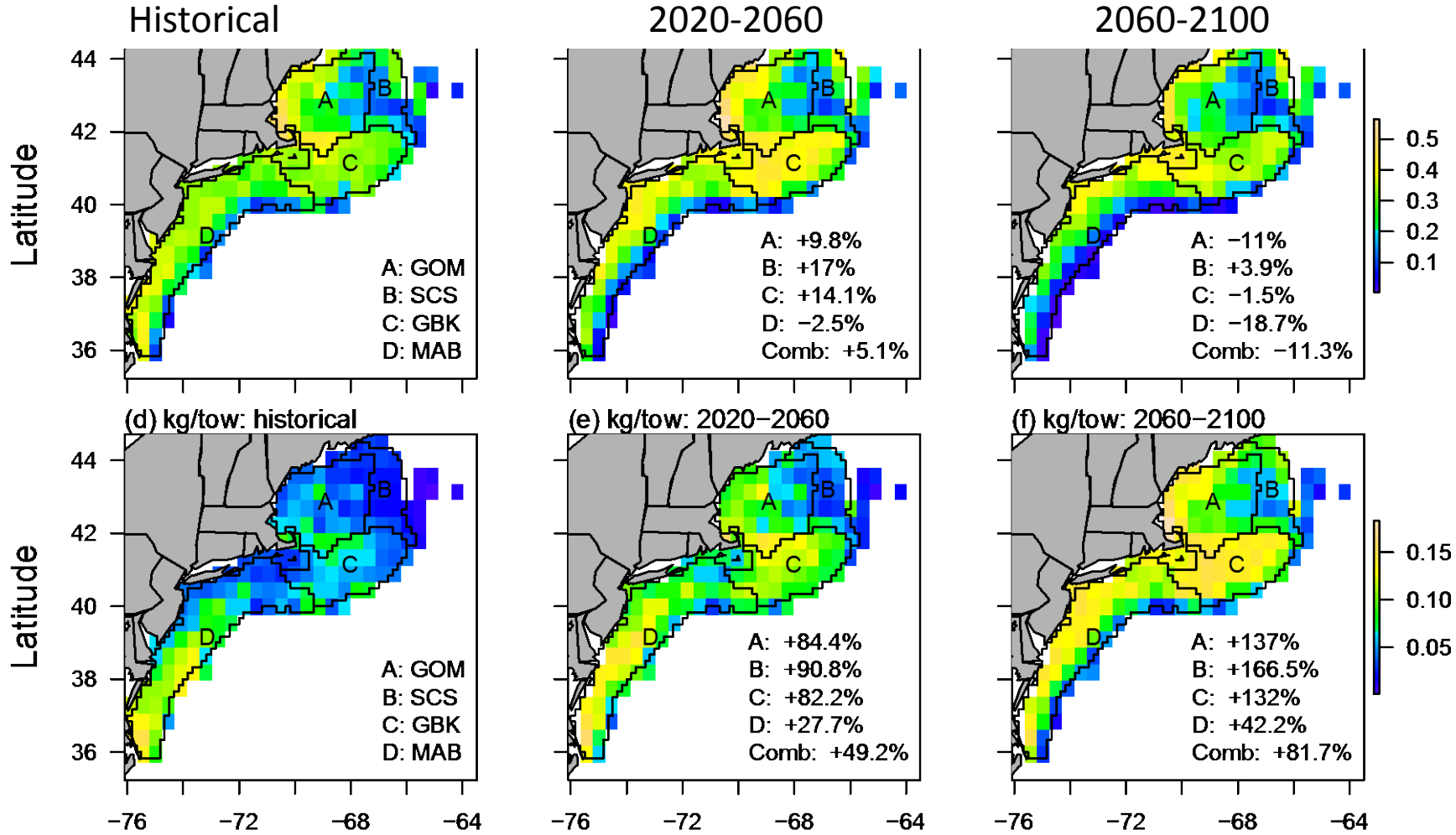
Alewife Fall

Top panels: Probability of occurrence
Bottom panels: Abundance



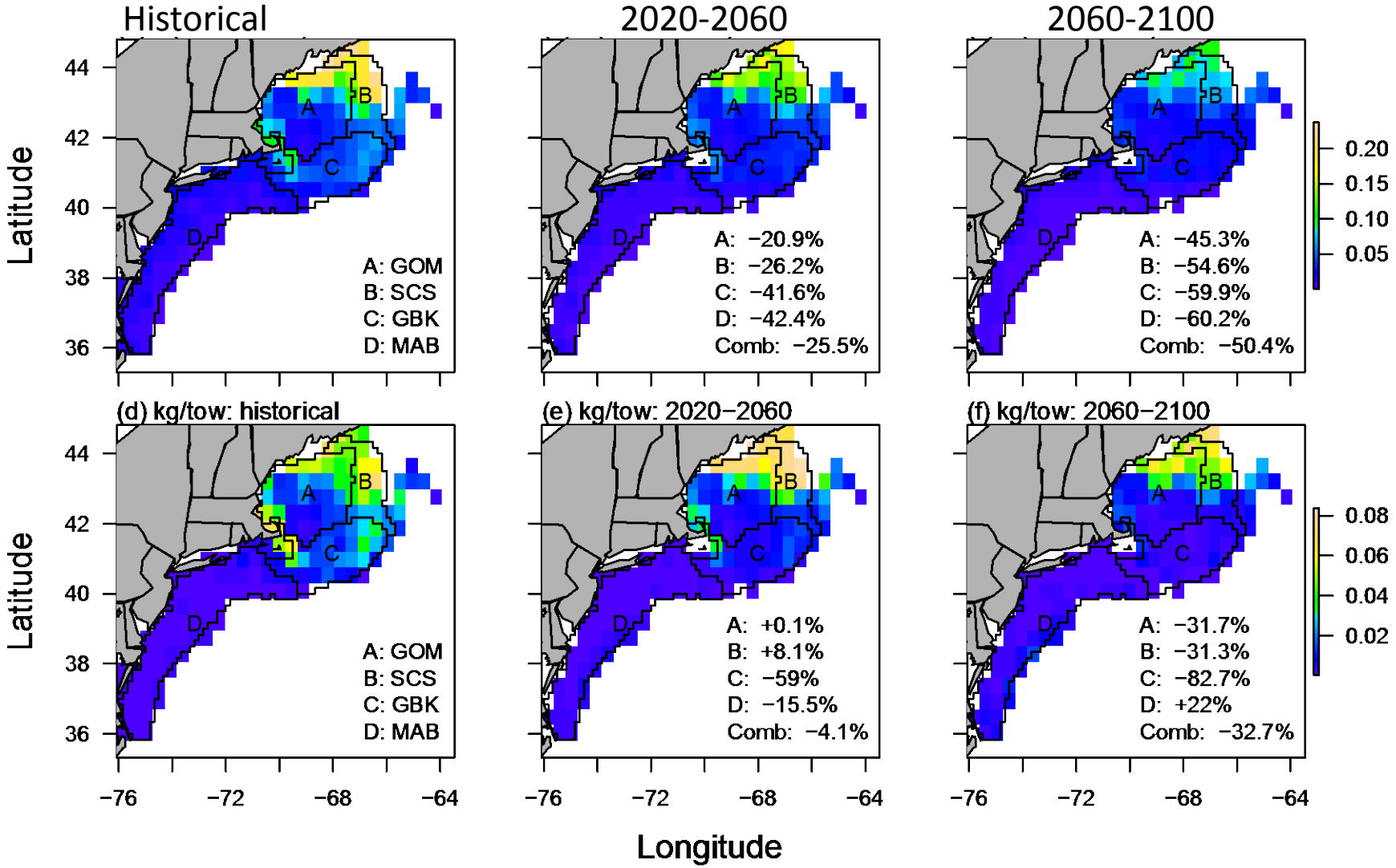
Blueback herring spring

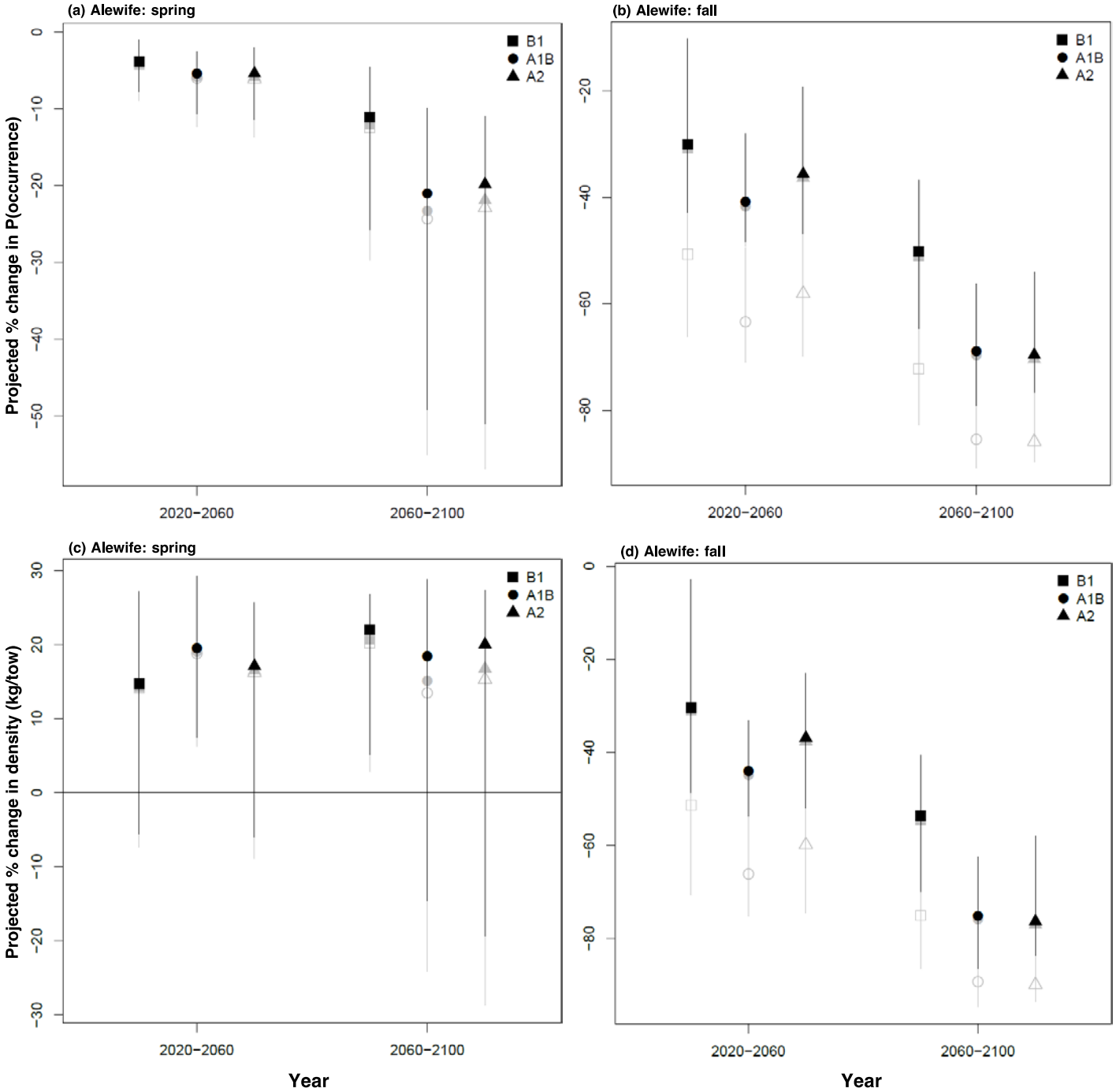
Top panels: Probability of occurrence
Bottom panels: Abundance

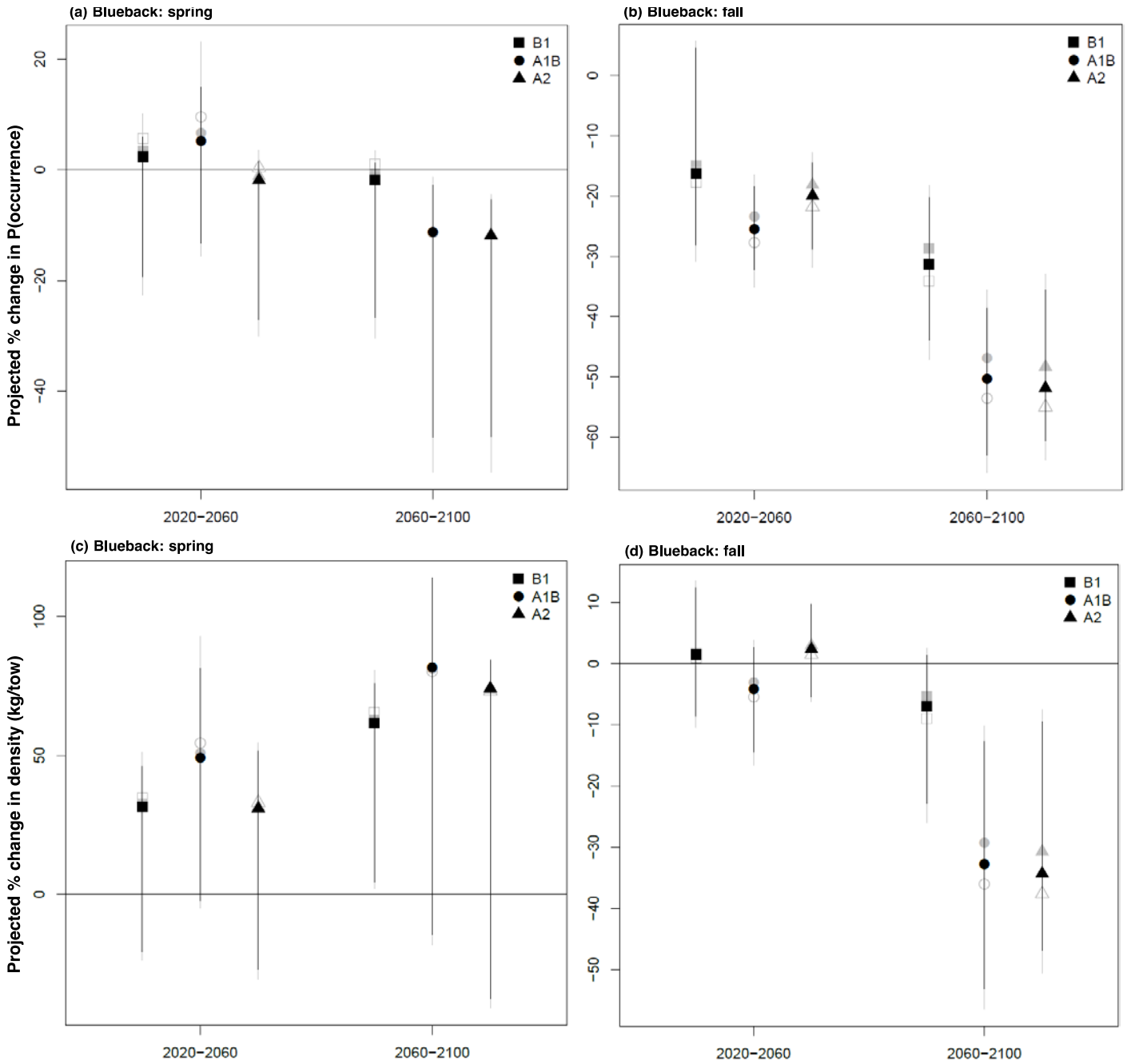


Blueback herring fall

Top panels: Probability of occurrence
Bottom panels: Abundance




(a) Alewife: spring
(b) Alewife: fall
(c) Alewife: spring
(d) Alewife: fall
B1
A1B
A2
Projected % change in P(occurrence)
Projected % change in density (kg/tow)
0
−10
−20
−30
−40
−50
−60
−80
30
10
2020−2060
2060−2100
Year


(a) Blueback: spring
(b) Blueback: fall
(c) Blueback: spring
(d) Blueback: fall
B1
A1B
A2
Projected % change in P(occurrence)
Projected % change in density (kg/tow)
2020–2060
2060–2100

Conclusions

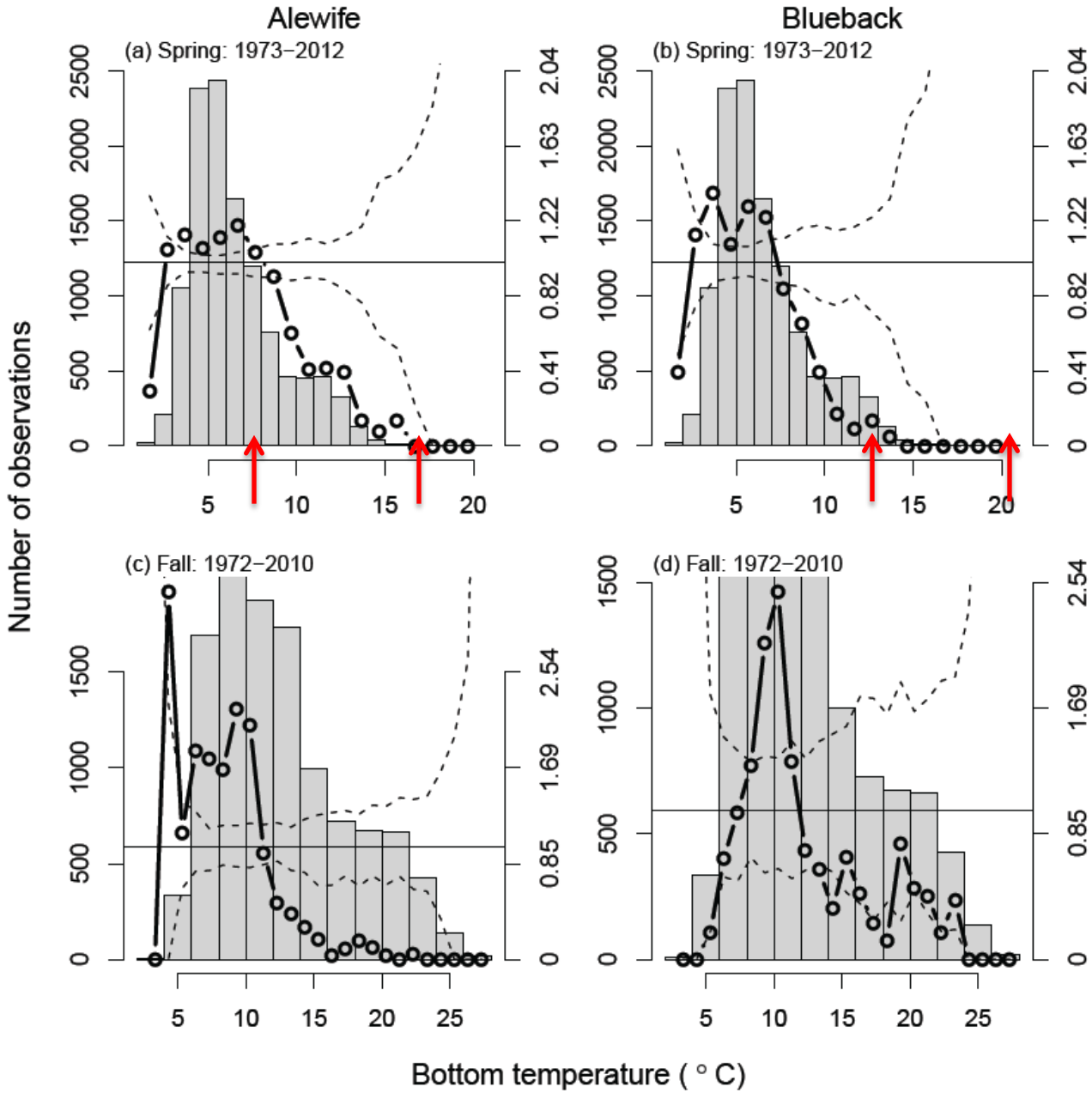
- Predict declines in habitat (occurrence) and abundance under nearly all scenarios by 2060-2100 except an increases in abundance of both species in spring.
- Declines in fall are much greater than spring likely because fall is warmest time of the year.
- Larger declines predicting when population size was assumed to be low

➢ Also saw decline in mean size of fish in survey

➢ Calculated thermal tolerances in marine environment with quotient analysis

	Alewife	Blueback	Source
Spawning migration	Begins ~ 5 - 10 °C [a] Temps < 8 °C and > 18 °C = little adult movement [b] Light & flows also important [b,c]	Begins ~ 10 – 15 °C [a] NS rivers: 13-21 °C [ee] Later than ALE when sympatric.	(a) Loesch 1987 (b) Richkus 1974 (c) Collins 1952 (ee) Crawford et al 1986
Spawning	10 – 20 °C [d,e] Males arrive before females; larger & older spawn first	Optimal 21-25 °C [aa-cc] Min 14 °C, max < 27 °C [dd] NS Rivers : 20-22 °C [ee]	(d) Rounsefell and Stringer 1943 (e) Carlander 1969 (aa) Cianci 1969 (bb) Marcy 1976b (cc) Klauda et al 1991 (dd) Loesch 1968
Egg incubation	Optimal 17-21 °C 2-3 days @ 22 °C 6 days @ 15.6 °C [d,f,g]	3-4 days @ 20-21 °C [g] 55-58 hrs @ 22.2-23.7 °C [aa,cc]	(f) Mansueti 1956 (g) Jones at al 1978
Hatching success	Max at 20.8 °C, ceases at 29.7 °C [h,i,j]		(h) Edsall 1970 (i) Marcy 1971 & 1973 (j) Kellogg 1982
Larval survival	Minimal above 28 °C [h, i]	Minimal above 28 °C [h, i]	

See Collette & Klein-MacPhee, 2002. Fishes of the Gulf of Maine, for review.


Alewife
Blueback
(a) Spring: 1973–2012
(b) Spring: 1973–2012
(c) Fall: 1972–2010
(d) Fall: 1972–2010
Number of observations
Bottom temperature (° C)
0
500
1000
1500
2000
2500
0.41
0.82
1.22
1.63
2.04
0.85
1.69
2.54
5
10
15
20
25