Rio Grande Silvery Minnow Reproductive Monitoring
(2001–2019)

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Native Distribution

(*Hybognathus amarus*)

Rio Grande PS Reproductive Guild:

Rio Grande Silvery Minnow *Hybognathus amarus*

Speckled Chub *Macrhybopsis aestivalis*

Rio Grande Shiner *Notropis jemezanus*

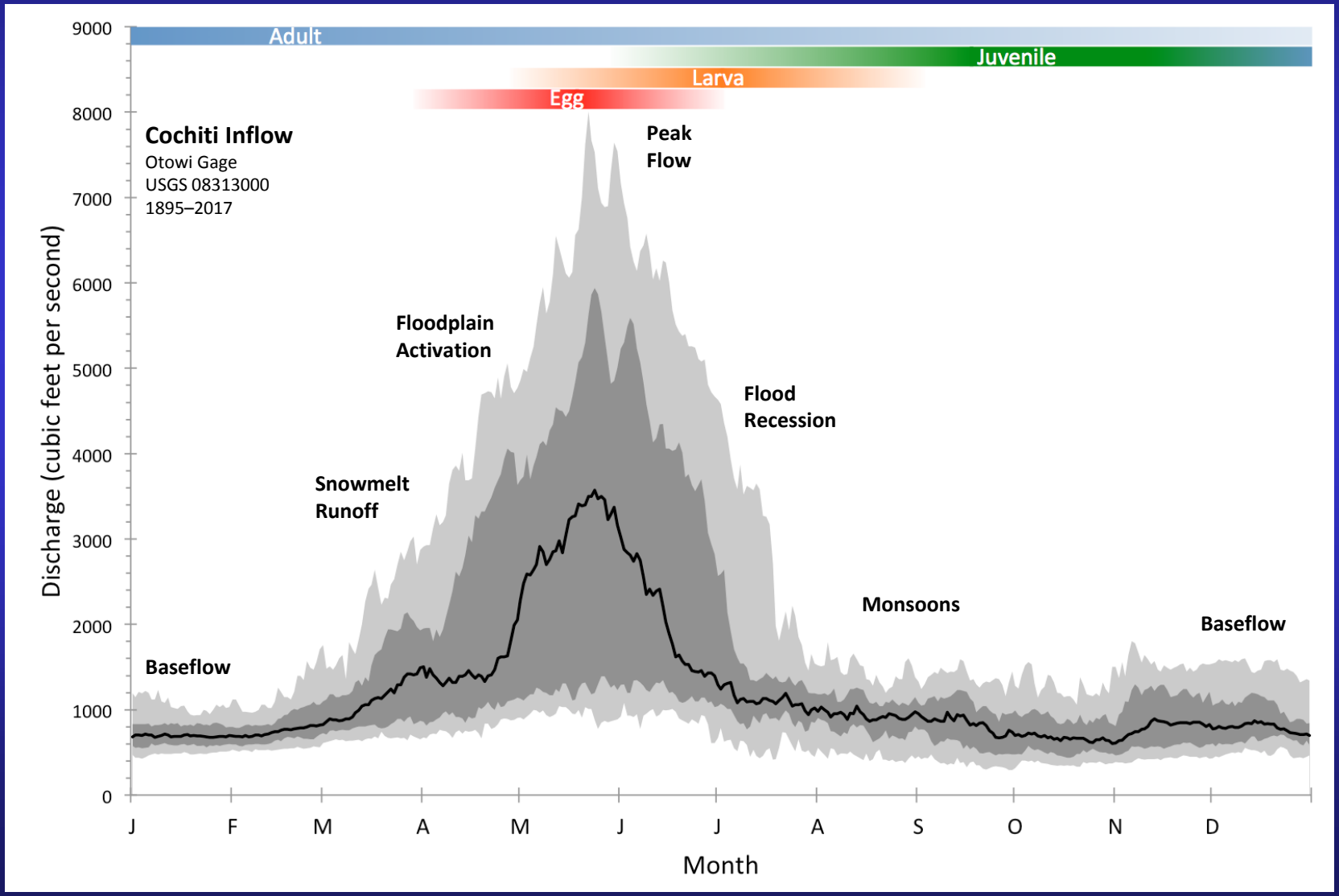
Phantom Shiner *N. orca*

Pecos Bluntnose Shiner *N. simus pecosensis*

Rio Grande Bluntnose Shiner *N. s. simus*

Life History of Rio Grande Silvery Minnow

(Mortensen et al., 2019)



Reproductive Monitoring Program Objectives

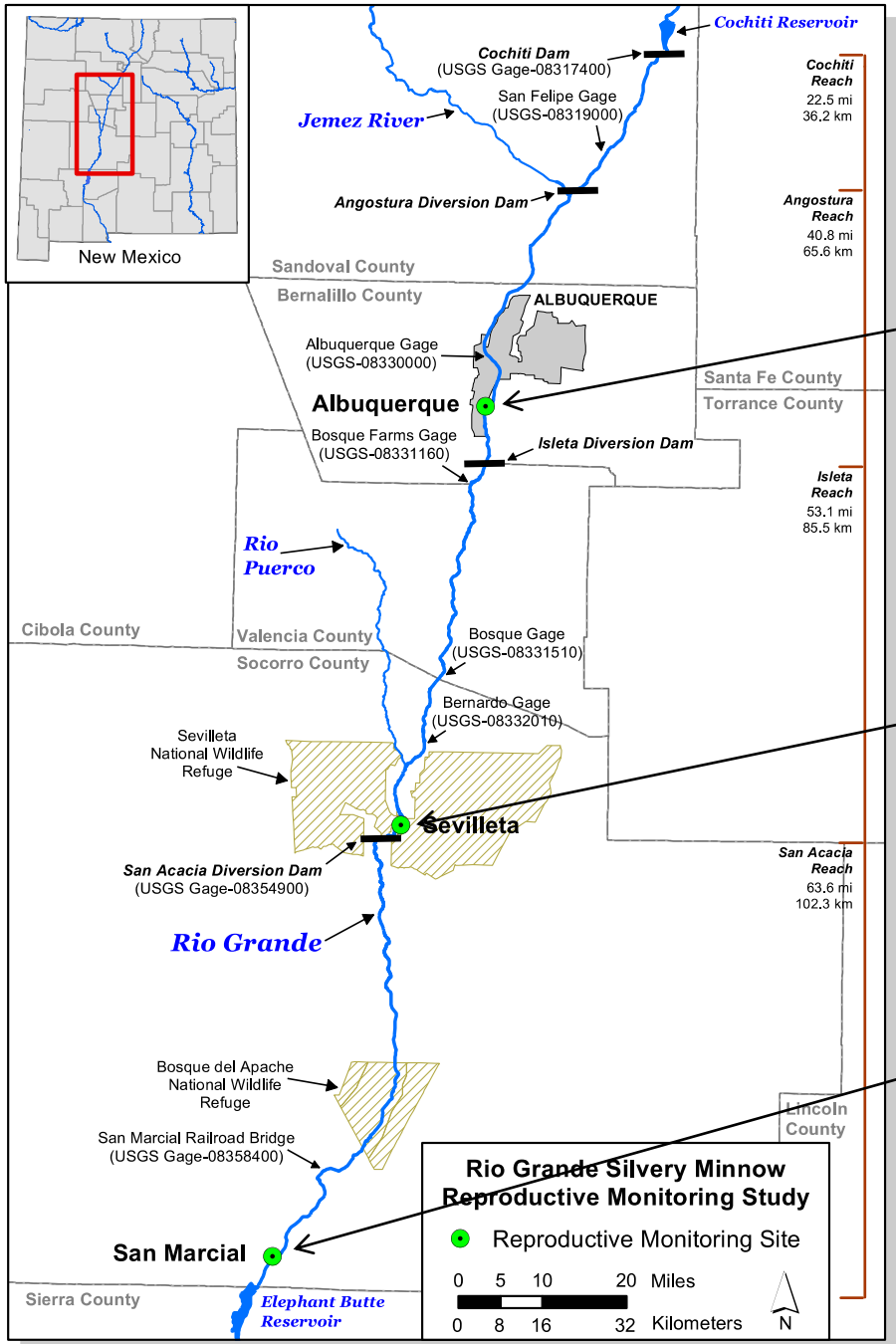
1. Characterize the timing, duration, and magnitude of spawning by Rio Grande Silvery Minnow (RGSM) in the Middle Rio Grande, and assess differences across reaches and years.

2. Examine the relationships between flow, temperature, and RGSM spawning within years.

3. Evaluate the influence of seasonal flows (e.g., magnitude and duration) on RGSM egg passage rates across years.

4. Provide insight into key environmental factors affecting trends in the temporal and spatial spawning patterns of RGSM.

Sampling Sites



Albuquerque (Angostura Reach)

Sevilleta (Isleta Reach)

San Marcial (San Acacia Reach)

Sampling Methods

Sampling equipment:

- Moore Egg Collectors (MEC)
  - Two per site
- Mechanical flow meters
  - Volume sampled

Sampling intensity:

- Daily: 6 hours/day
- Weekly: 7 days/week
- Annually: 50 days/year

Daily samples of drifting eggs:

- Number of eggs (#): n
- Volume sampled (m^3): V
- Density: $D = ((n/V) \cdot 100)$
- Discharge (m^3/s): Q
- Passage Rate: $P_e = ((D/100) \cdot Q)$

Estimated Egg Passage Rate (eggs / s)

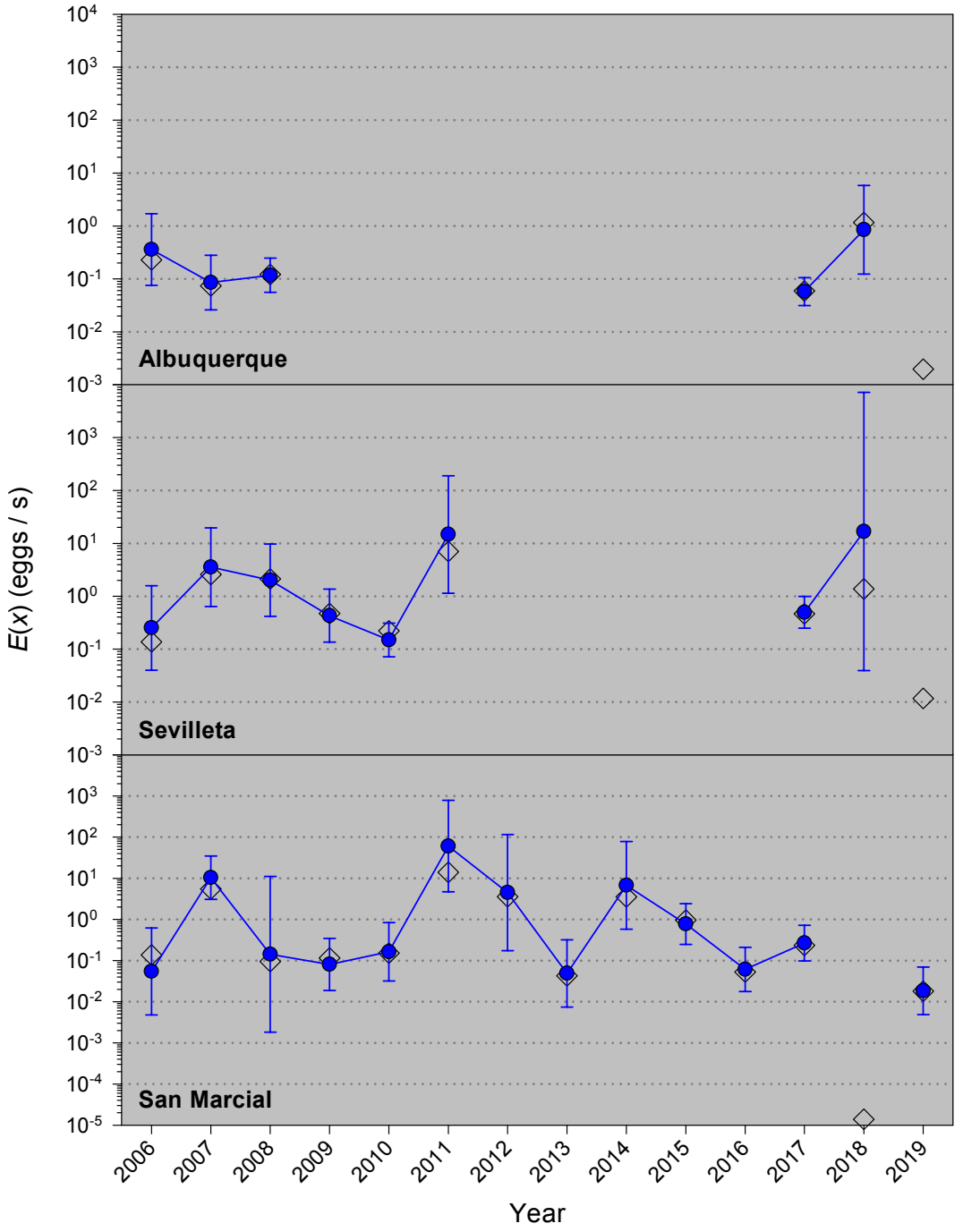
$$E(x) = \delta \exp\left[\mu + \frac{\sigma^2}{2}\right]$$

$$\mathrm{LCI} = \exp\left[\log\left(E(x)\right) - 1.96 \times \mathrm{SE}\left(E(x)\right) / E(x)\right]$$

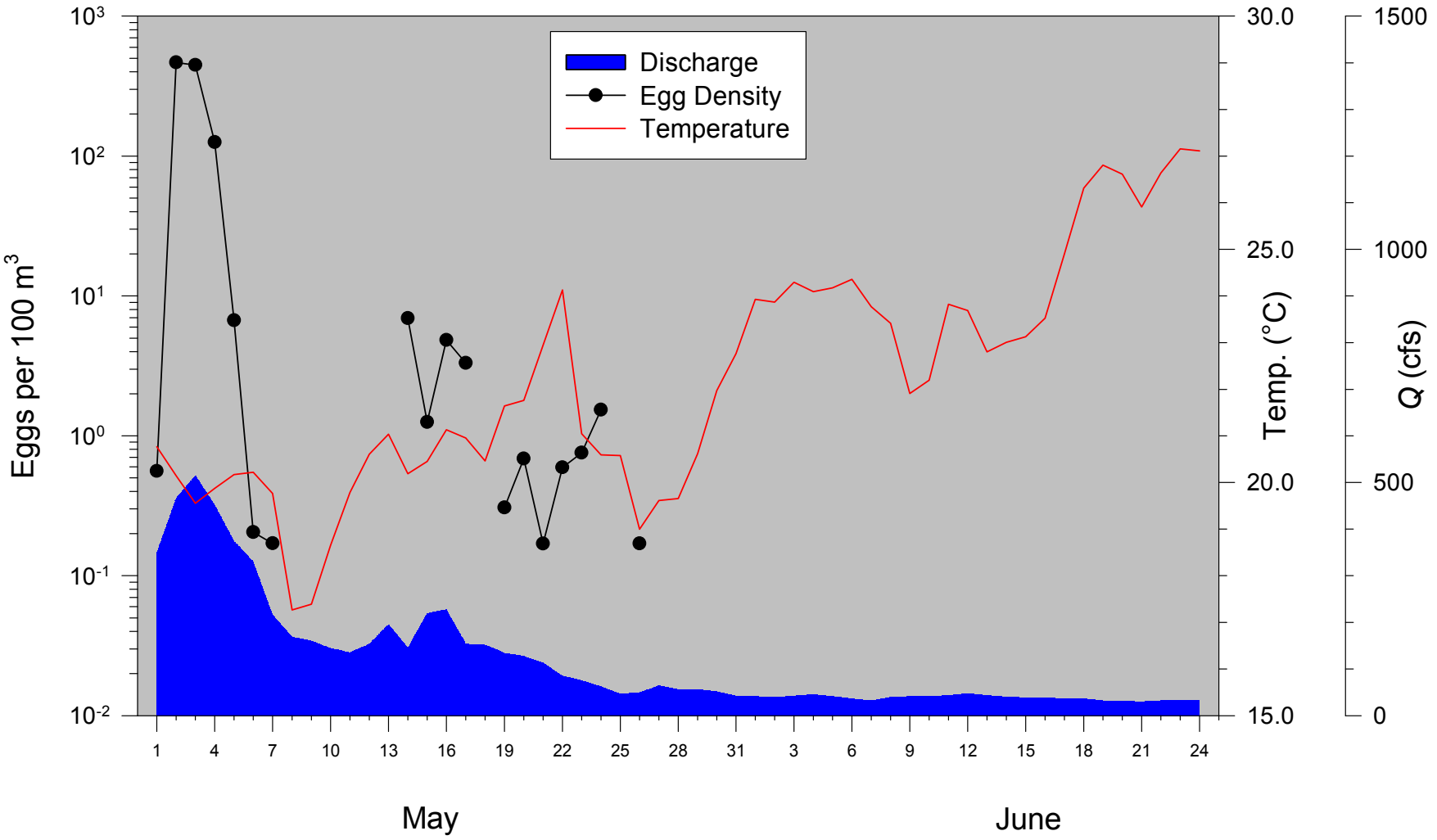
$$\mathrm{UCI} = \exp\left[\log\left(E(x)\right) + 1.96 \times \mathrm{SE}\left(E(x)\right) / E(x)\right]$$

Egg Passage Rates
(All Sampling Sites)

- Seasonal timing/duration of spawning (ca. late April to early June) was similar across sampling sites.
- Egg passage rates at Sevilleta and San Marcial were consistently higher than at Albuquerque.
- Egg passage rate trends, based on the three sampling sites, were very similar across years.

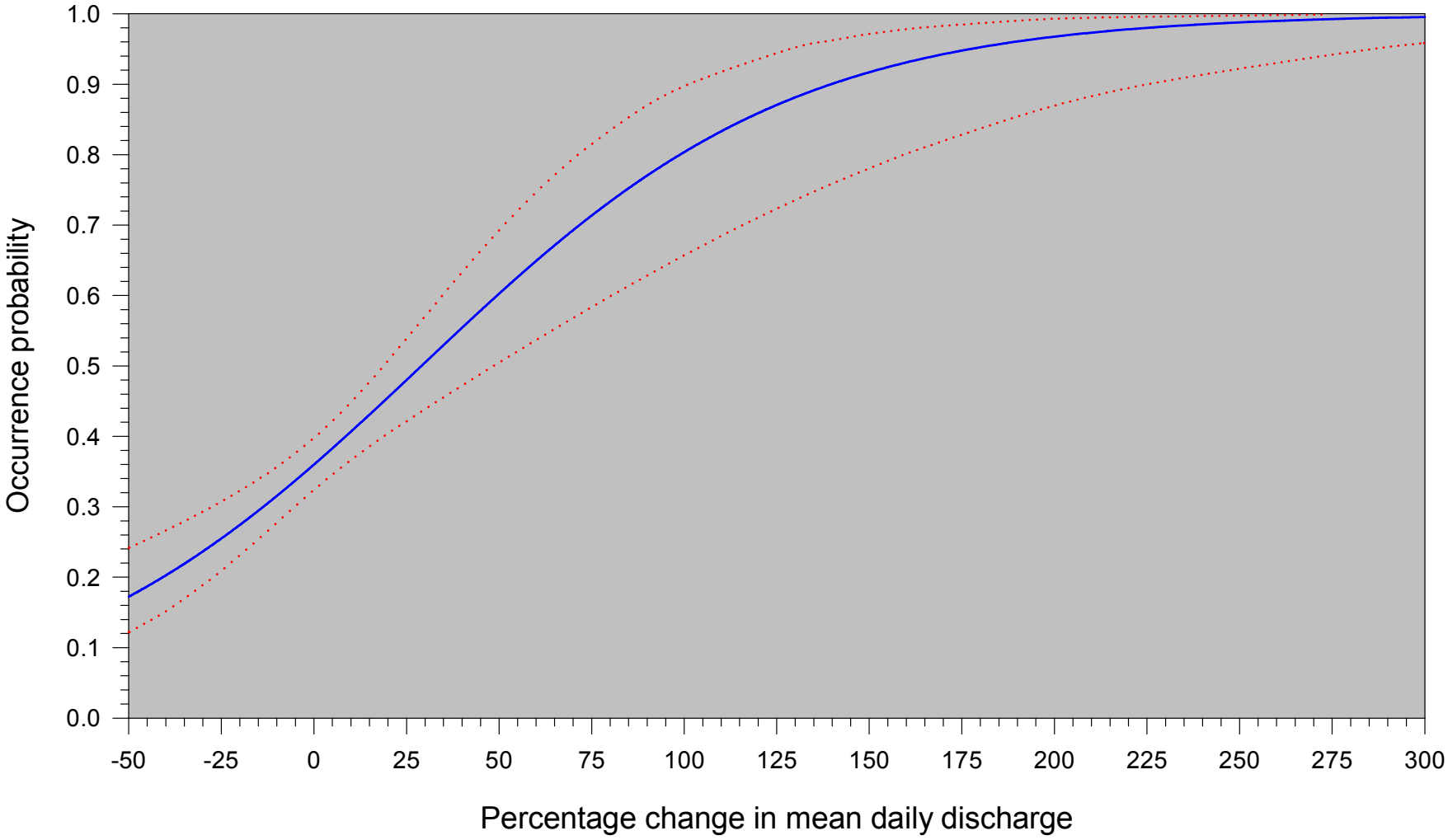


Discharge, Eggs, and Temperature
(San Marcial: 2012)



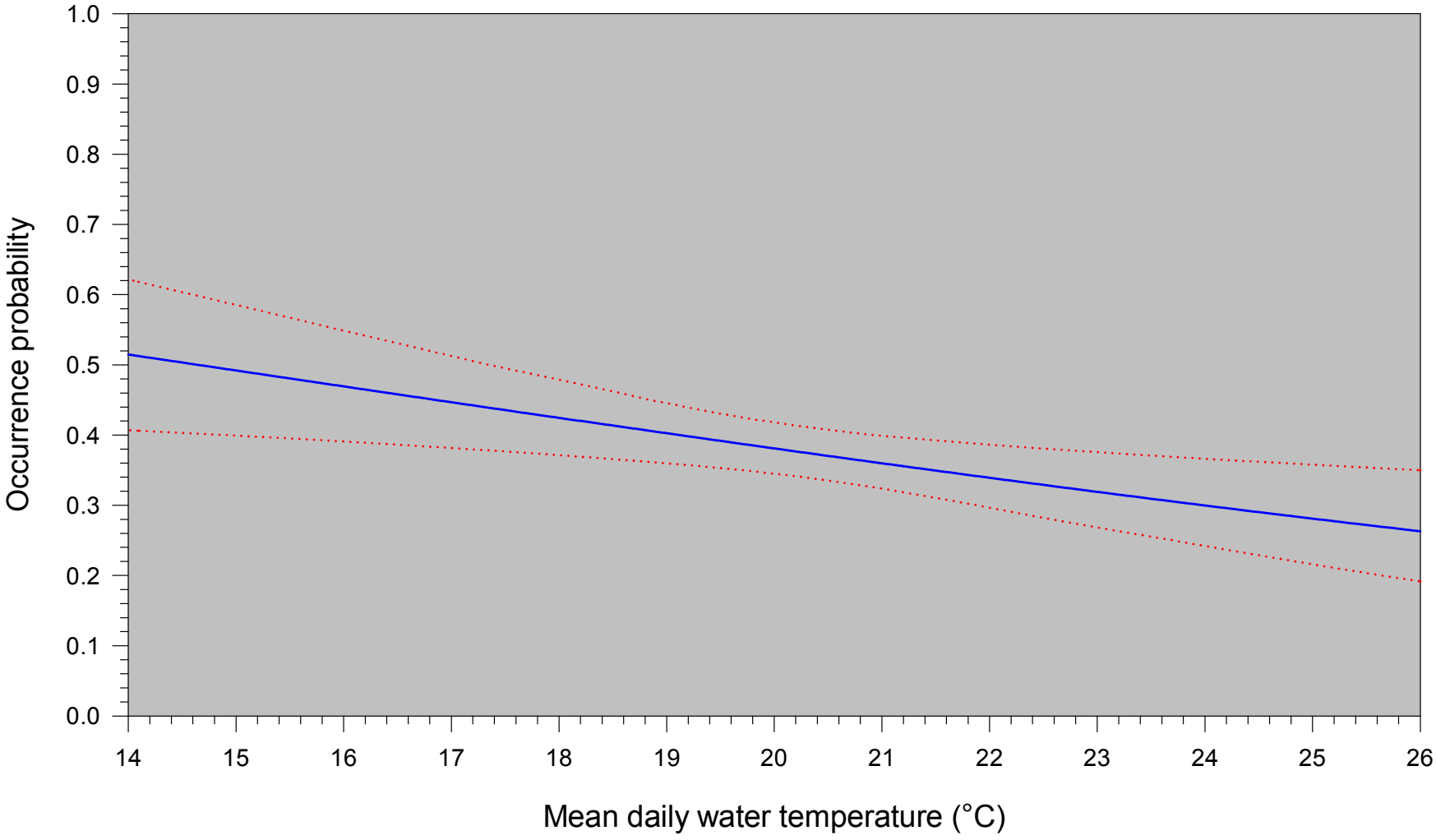
Egg Occurrence Probability and %Δ Discharge

(San Marcial: 2003–2019)

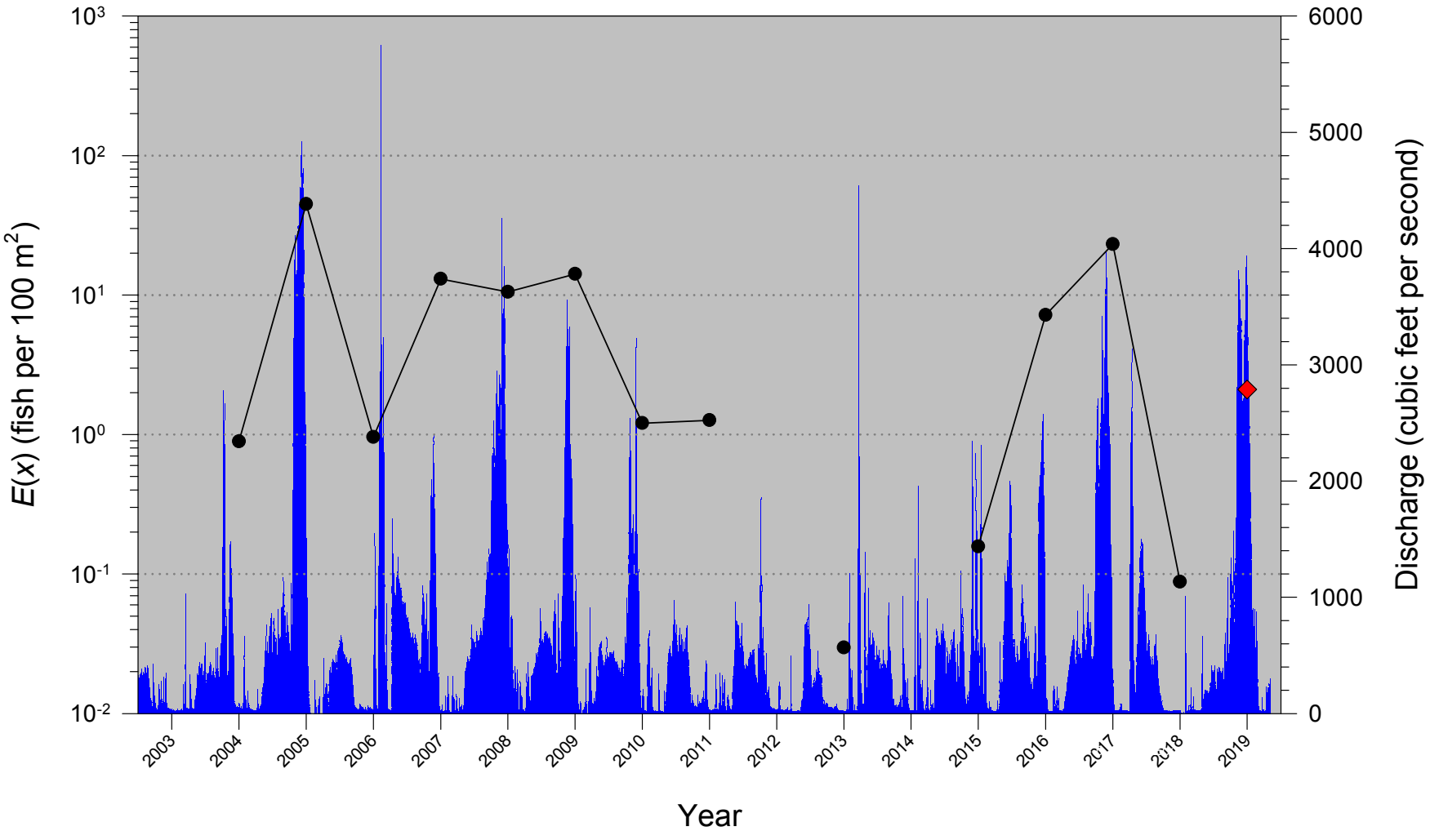


Egg Occurrence Probability and Temperature

(San Marcial: 2003–2019)

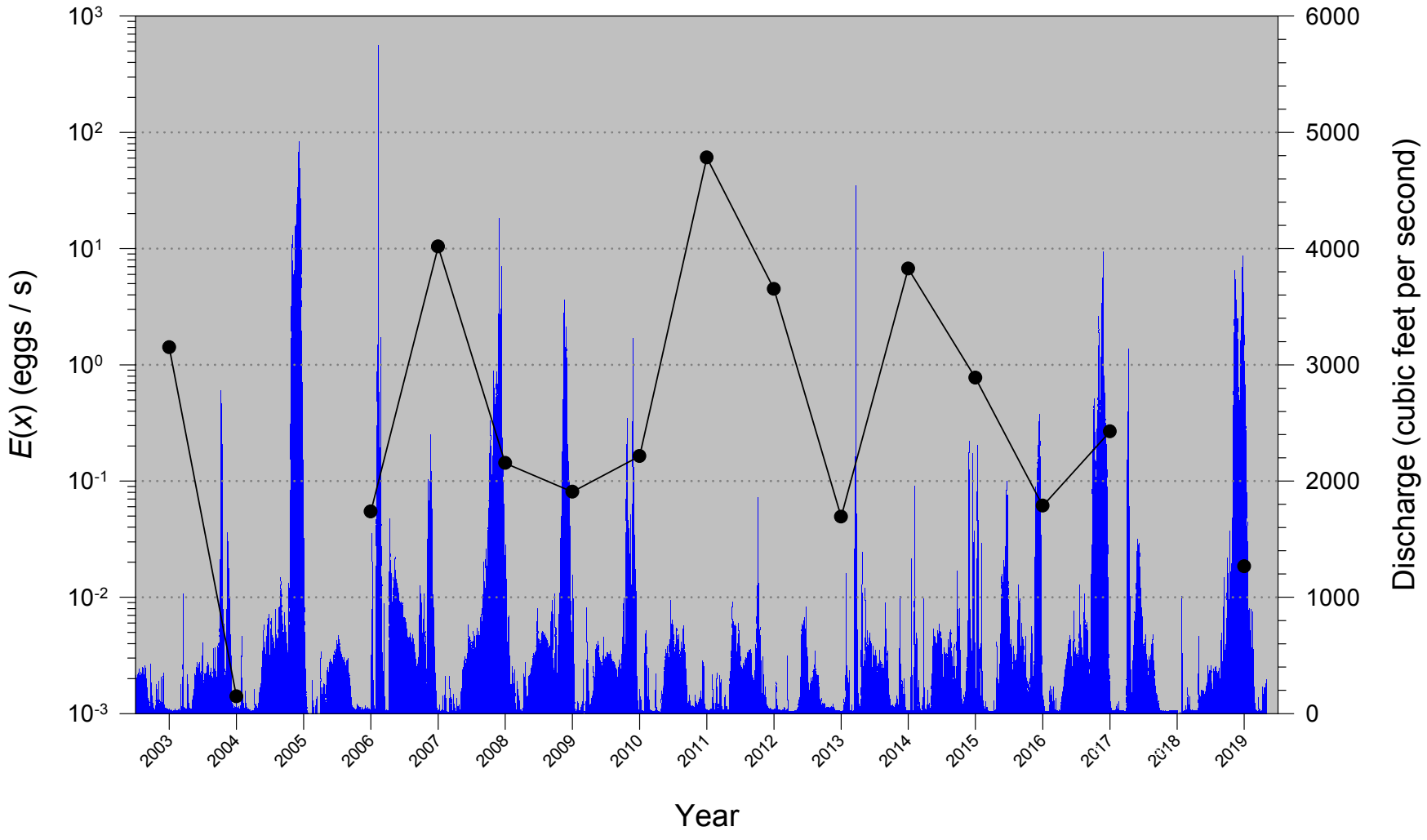


Densities of RGSM and Discharge
(2003–2019)

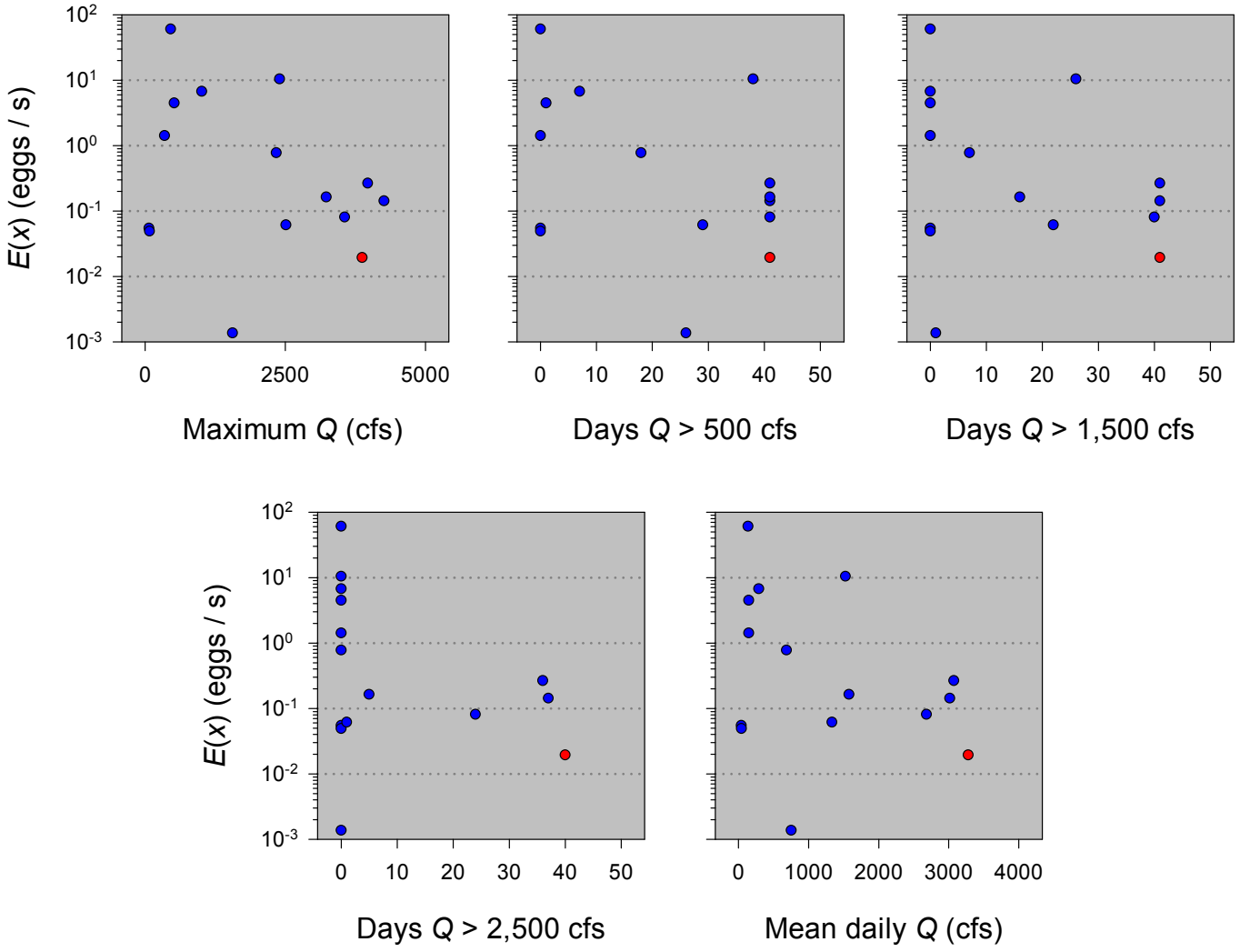


Egg Passage Rates and Discharge

(San Marcial: 2003–2019)



Egg Passage Rate vs. Discharge
(San Marcial: 2003–2019)

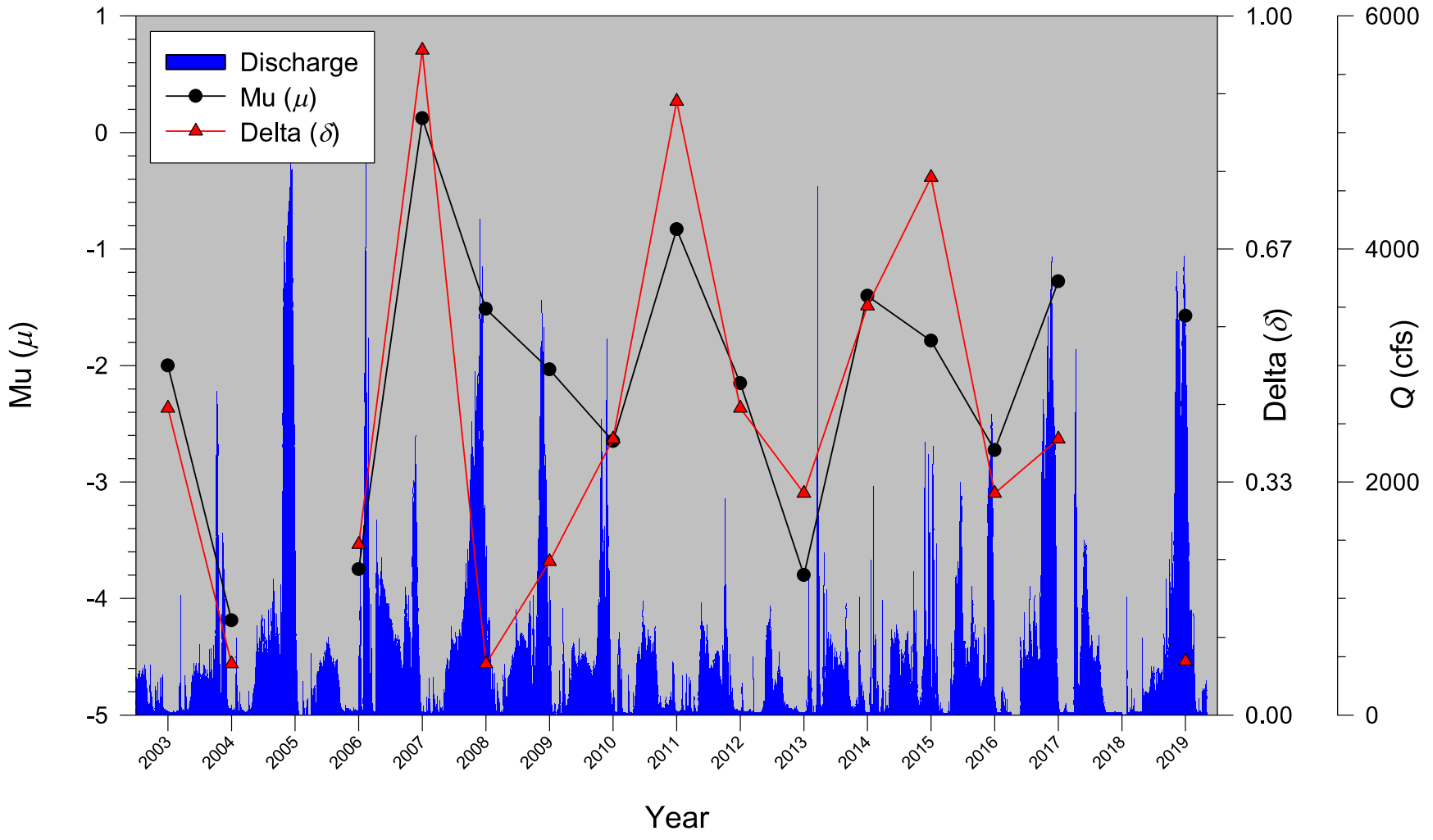


Modeling the Spawning Ecology of RGSM
(San Marcial: 2003–2019)

- Each model included both δ (occurrence probability) and μ (lognormal passage rate) with a single covariate for each estimated parameter (e.g., δ[SANmean] μ[SAN>1,500]).
- Covariates representing various spring runoff conditions were included in models.
- Hydraulic covariates included both fixed effects (i.e., covariate explains variation) and random effects (i.e., random error [*R*] around covariate).
- Goodness-of-fit statistics (log-likelihood and Akaike's information criterion [AIC_c]) were used to assess the fit of data to various models.

Model Estimates and Discharge

(San Marcial: 2003–2019)



Ecological Model Results for RGSM

(San Marcial: 2003–2019)

Model	logLike	K	AIC_c	w_i
δ(SAN>2,500+*R*) μ(SANmax+R)	1,322.69	9	1,341.00	0.3214
δ(SAN>2,500+*R*) μ(SANmean+*R*)	1,323.35	9	1,341.65	0.2315
δ(SAN>2,500+*R*) μ(SAN>1,500+*R*)	1,325.00	9	1,343.30	0.1016
δ(SAN>2,500+*R*) μ(SAN>500+*R*)	1,325.08	9	1,343.38	0.0975
δ(SANmean+*R*) μ(SANmean+*R*)	1,327.01	9	1,345.31	0.0371
δ(SANmean+*R*) μ(SANmax+*R*)	1,327.04	9	1,345.34	0.0367
δ(*R*) μ(SANmean+*R*)	1,329.42	8	1,345.66	0.0312
δ(SAN>1,500+*R*) μ(SANmean+*R*)	1,328.16	9	1,346.46	0.0209
δ(SANmean+*R*) μ(SAN>1,500+*R*)	1,328.62	9	1,346.93	0.0166
δ(SAN>1,500+*R*) μ(SANmax+*R*)	1,328.74	9	1,347.04	0.0157

Conclusions and Implications

1. We found that egg occurrence probabilities were higher during years with reduced and truncated spring flows, and that egg passage rates were lower during years with elevated and extended spring flows.

2. It is likely that the proportion of individuals retained and successfully recruited upstream is related to the complexity of instream habitat conditions and the availability of nursery habitats (i.e., spring runoff).

3. Ongoing efforts to restore dynamic river flows, reconnect fragmented reaches, and reestablish a functional floodplain should help to promote resilient and self-sustaining populations of RGSM.

4. Continued study of the key factors that control this complex aquatic ecosystem will be essential for developing and implementing successful strategies for the long-term recovery of RGSM.

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