Background & Affiliations

Robert K. Dudley

Educational background:
- University of Pennsylvania (BA–1993)
- University of Arizona (MS–1995)
- University of New Mexico (PhD–2004)

American Southwest Ichthyological Researchers (ASIR):
- Freshwater Fish Ecologist
- Affiliation: 1995–present
- Email: robert_dudley@asirllc.com

Museum of Southwestern Biology, University of New Mexico (UNM):
- Adjunct Assistant Professor
- Affiliation: 1995–present
- Email: dudleyrk@unm.edu

Rio Grande Silvery Minnow Reproductive Monitoring
(2003–2020)

Robert K. Dudley[1,2], Tessia O. Robbins[1], Steven P. Platania[1,2], and Gary C. White[1,3]

[1] American Southwest Ichthyological Researchers (ASIR); 800 Encino Place NE; Albuquerque, NM 87102
[2] Museum of Southwestern Biology (Fishes), UNM; MSC03-2020; Albuquerque, NM 87131
[3] Department of Fish, Wildlife, and Conservation Biology, CSU; 10 Wagar; Fort Collins, CO 80523

Hybognathus amarus (Cyprinidae)

(Rio Grande Silvery Minnow [Girard, 1856])

Photo by
Tom Kennedy

Native Distribution

(*Hybognathus amarus*)

Base map from en.wikipedia.org/wiki/Rio_Grande

Current

Historical

Experimental

Rio Grande PS Reproductive Guild:

Rio Grande Silvery Minnow *Hybognathus amarus*

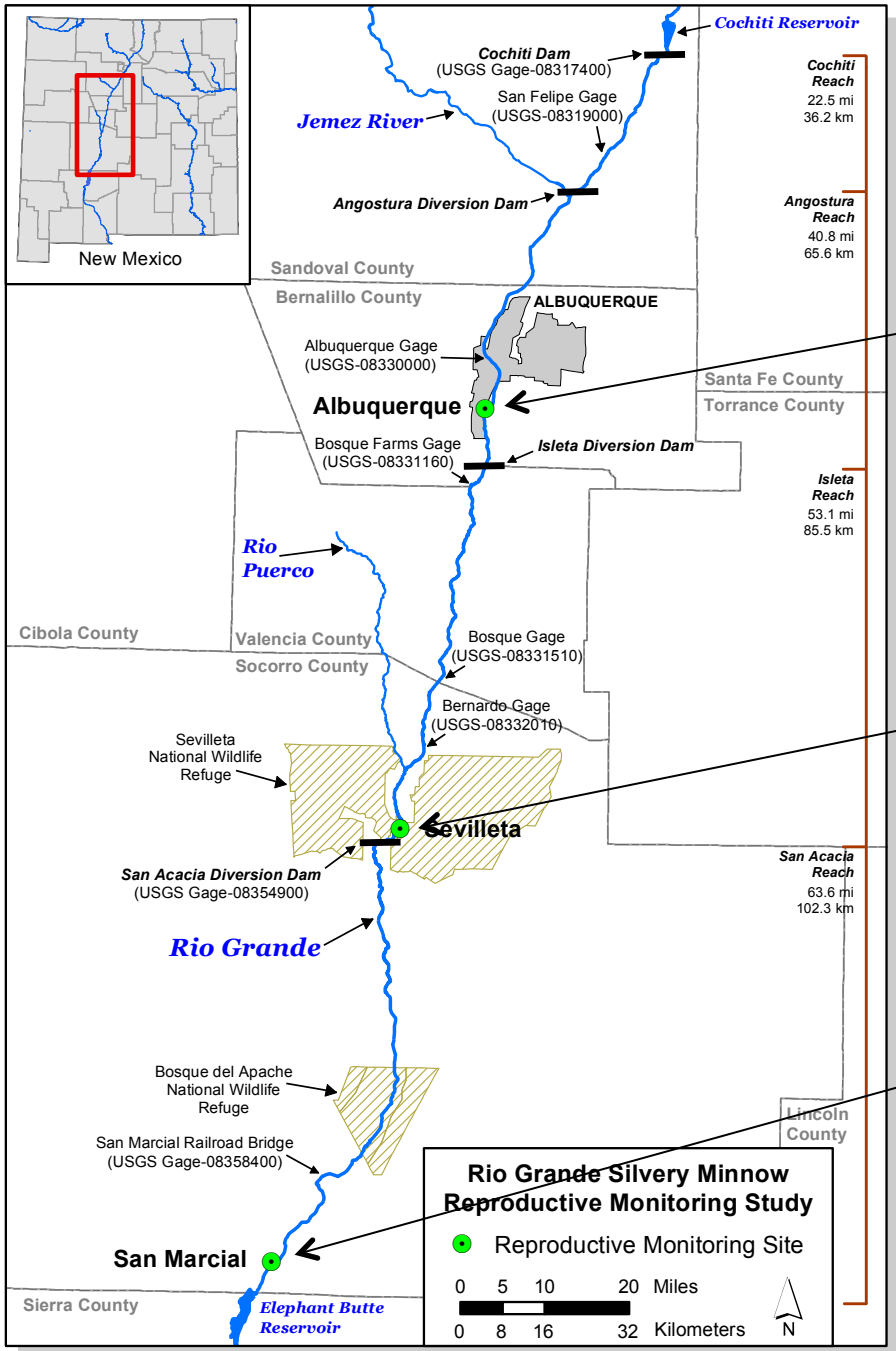
Speckled Chub *Macrhybopsis aestivalis*

Rio Grande Shiner *Notropis jemezanus*

Phantom Shiner *N. orca*

Pecos Bluntnose Shiner *N. simus pecosensis*

Rio Grande Bluntnose Shiner *N. s. simus*



Sampling Sites

Albuquerque (Angostura Reach)

Sevilleta (Isleta Reach)

San Marcial (San Acacia Reach)

Sampling Methods

Sampling equipment:

- Moore Egg Collectors (MECs)
  - Two per site
- Mechanical flow meters
  - Volume sampled
- Temperature data loggers

Sampling intensity:

- Daily: 4 hours per day
- Weekly: 7 days per week
- Annually: 50 days per 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: $P_e = ((D / 100) \cdot Q)$

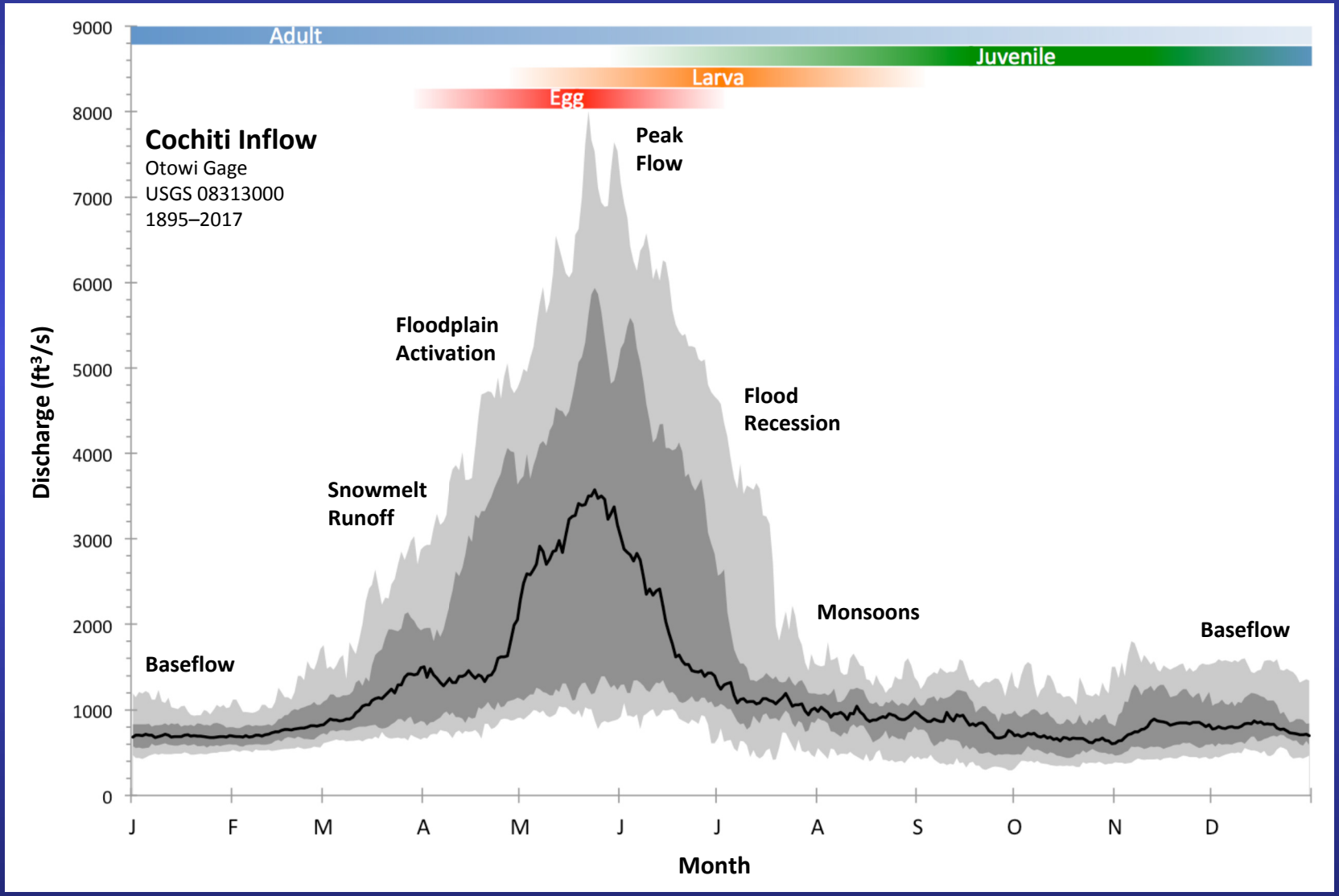
Reproductive Monitoring Program Objectives

1. Characterize and assess the timing, duration, frequency, and magnitude of spawning for Rio Grande Silvery Minnow (RGSM) in the Middle Rio Grande, NM.

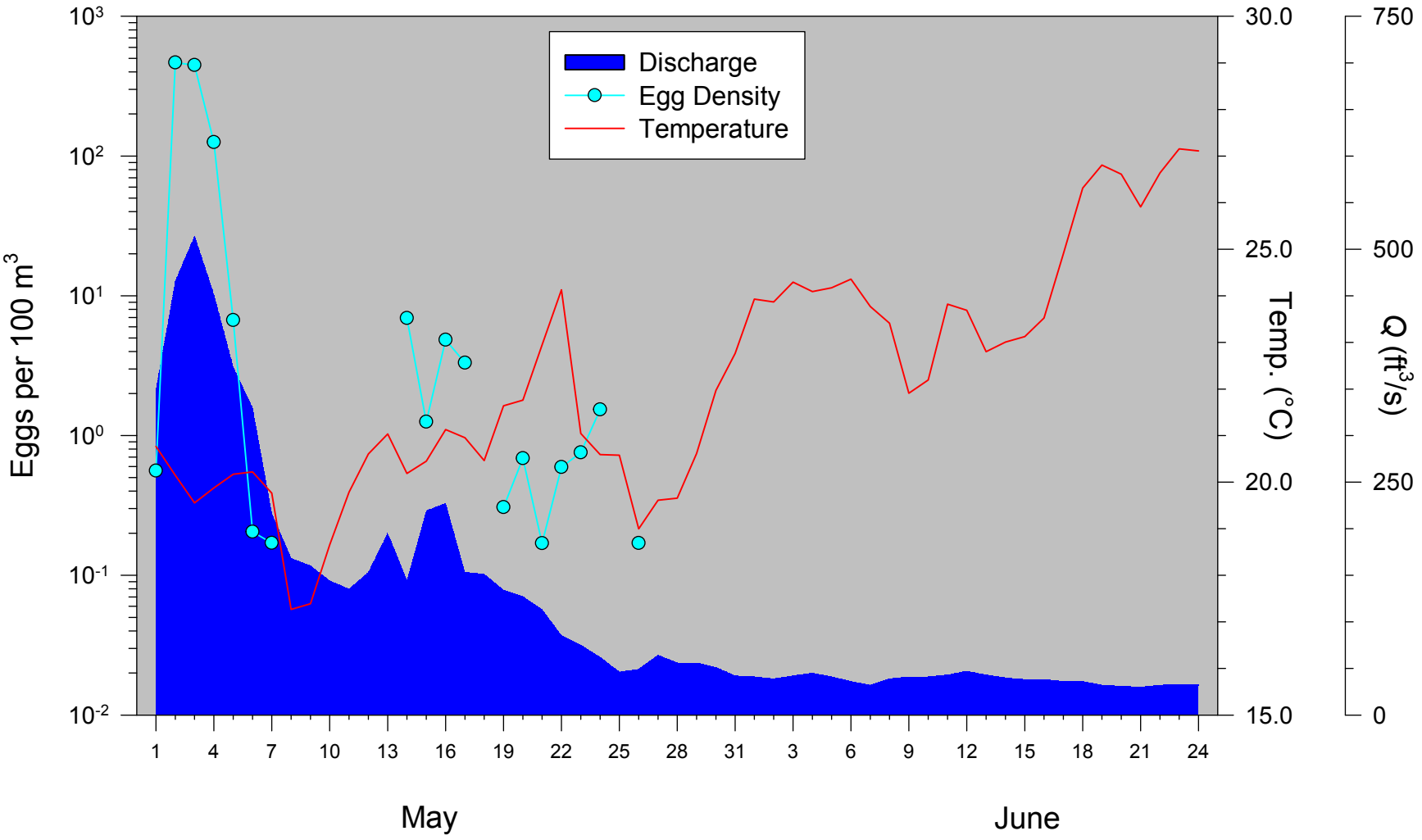
2. Examine the relationships among flow, temperature, and RGSM egg occurrence within years.

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

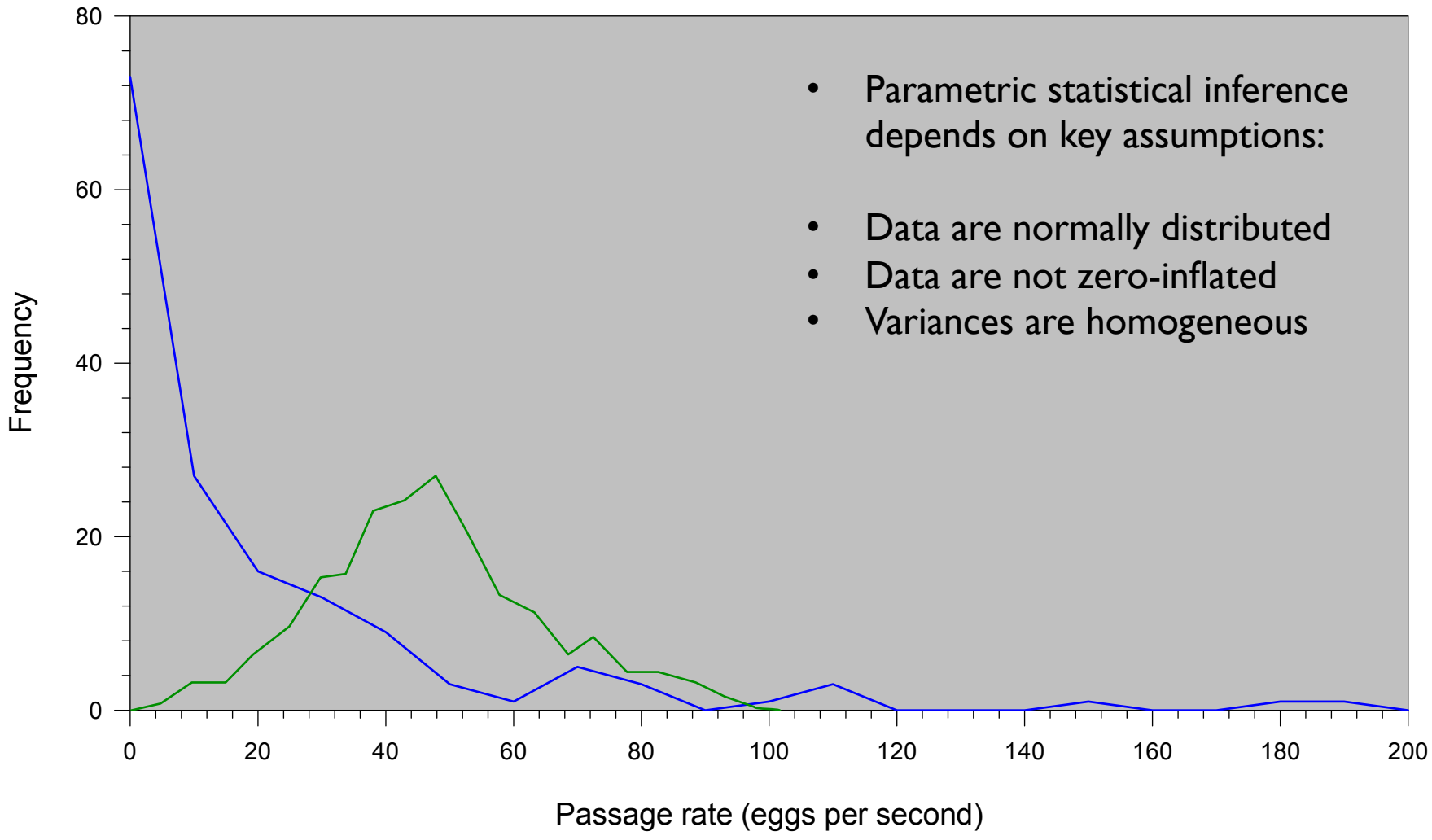
Life History of Rio Grande Silvery Minnow
(Mortensen et al., 2019)



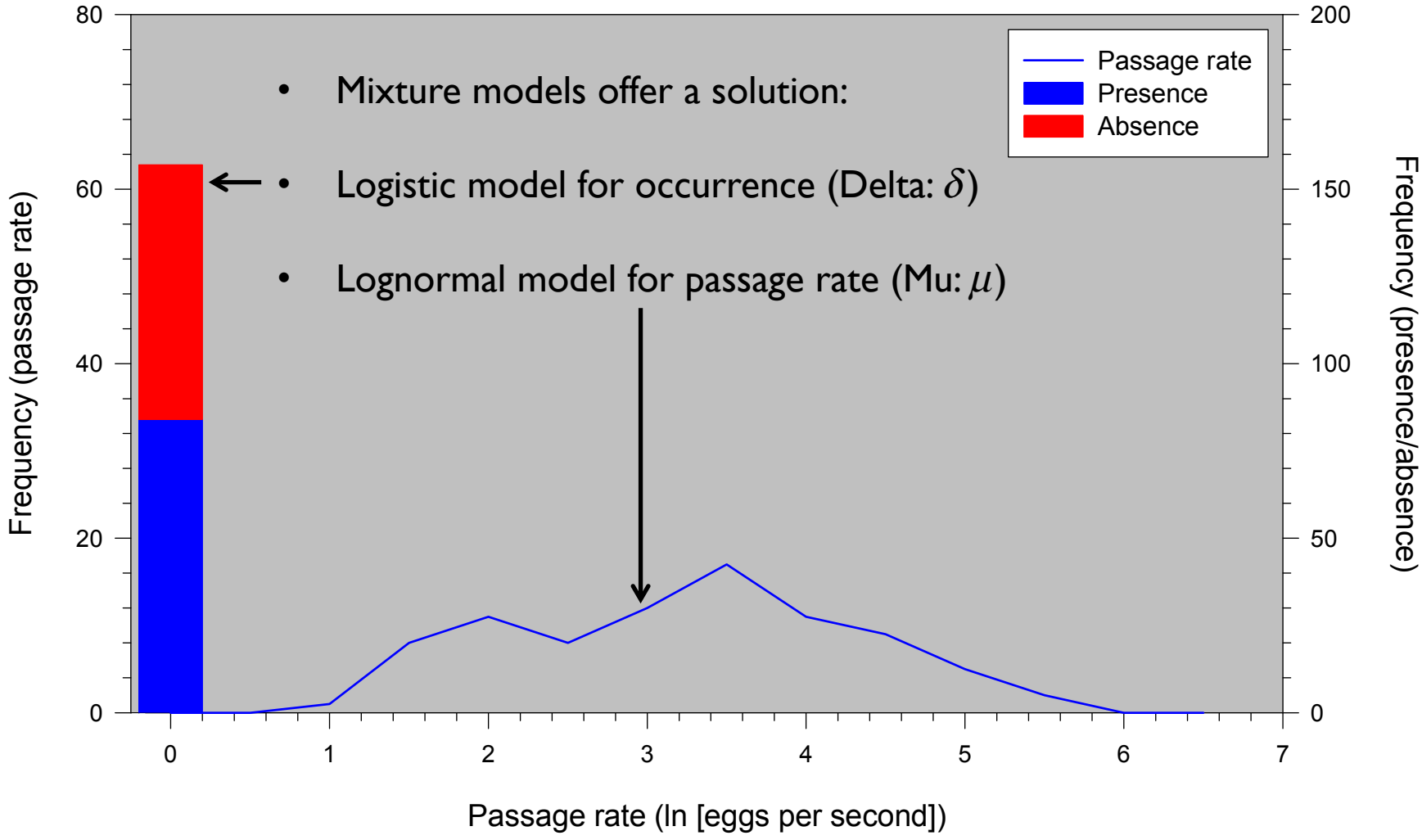
Eggs, Discharge, and Temperature
(San Marcial: 2012)



Frequency Distribution of Raw Data



Occurrence and Passage-Rate Data



Estimated Egg Passage Rate (eggs per second)

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

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

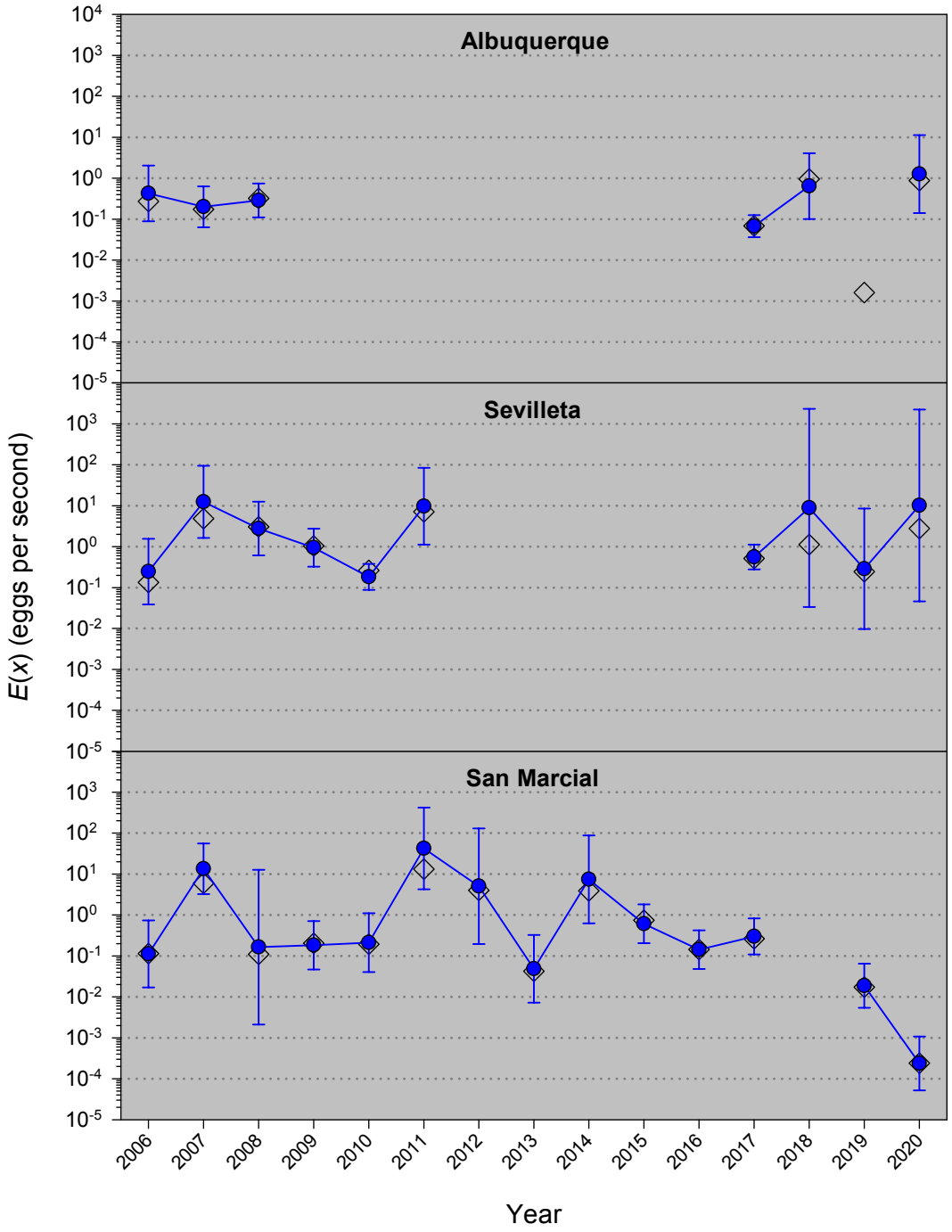
$$\mathrm{UCI} = \exp\left[\log\left(E(x)\right) + 1.96 \cdot \mathrm{SE}\left(E(x)\right) / E(x)\right]$$

Egg Passage Rates
(All Sampling Sites)

- Seasonal timing/duration of spawning (ca. late April to early June) was similar across sampling sites.

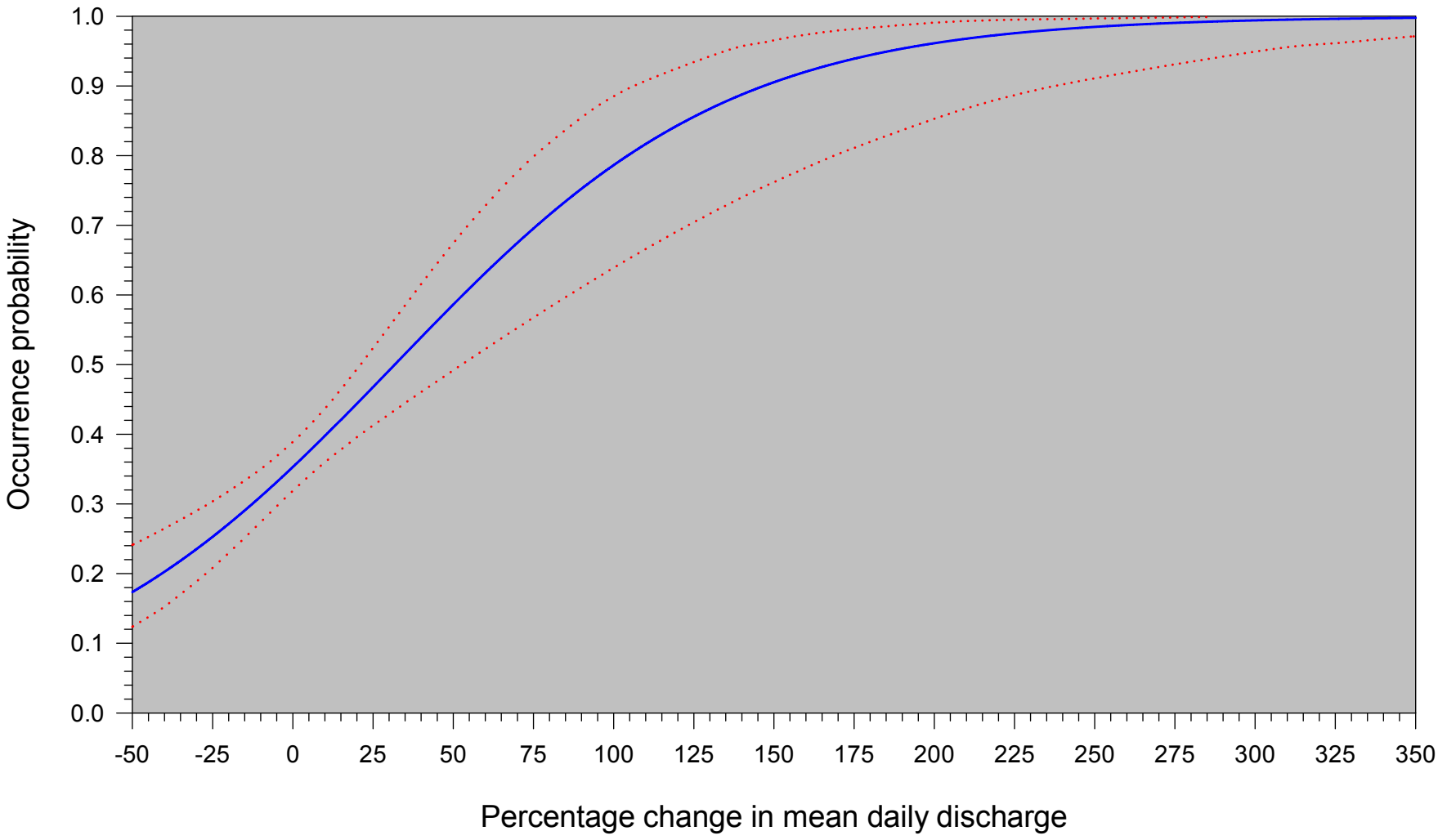
- Egg passage rates at Sevilleta and San Marcial were consistently higher than at Albuquerque.

- Egg passage-rate trends, based on the three sampling sites, were similar across years.



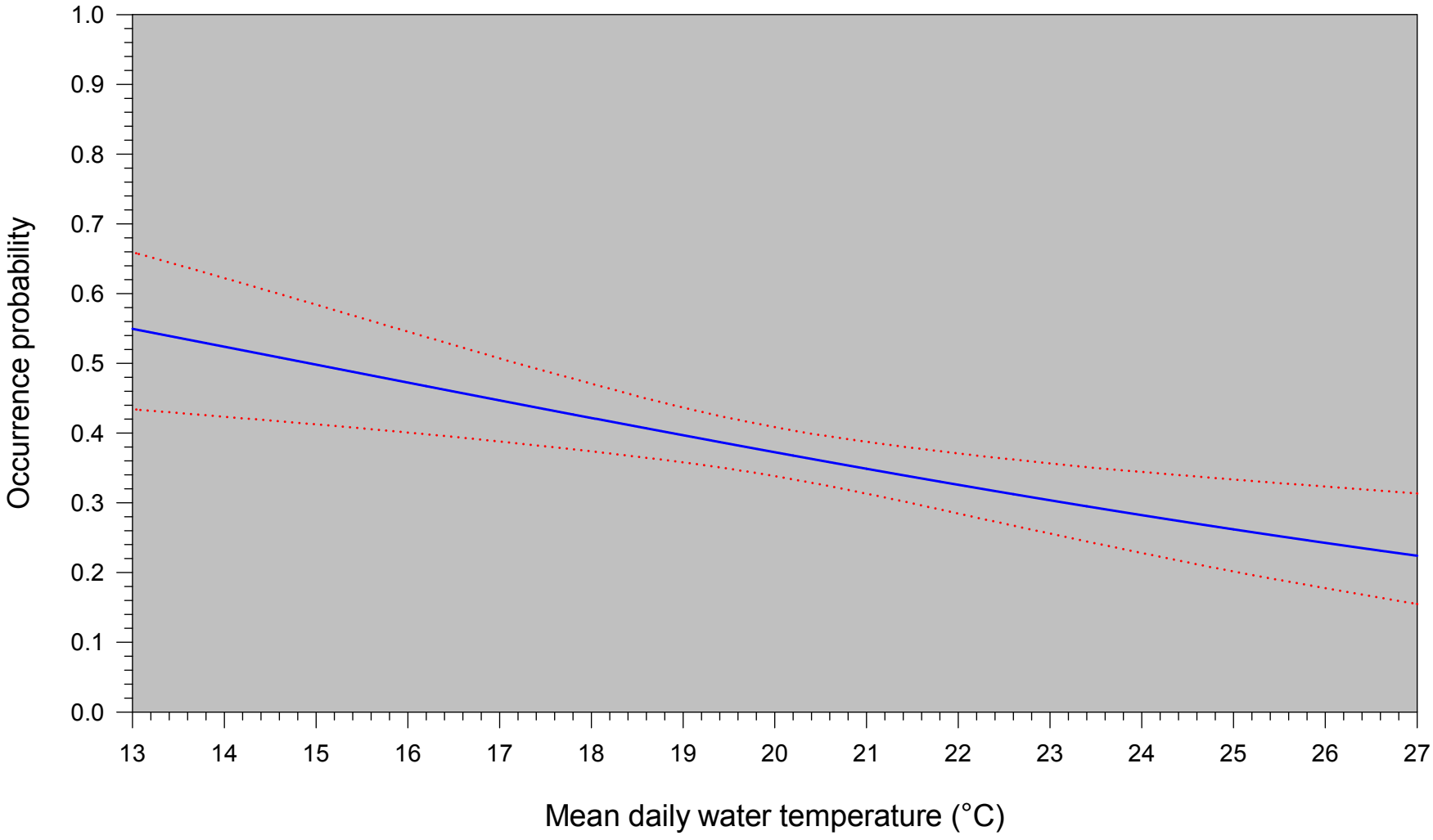
Egg Occurrence Probability and %Δ Discharge

(San Marcial: 2003–2020)



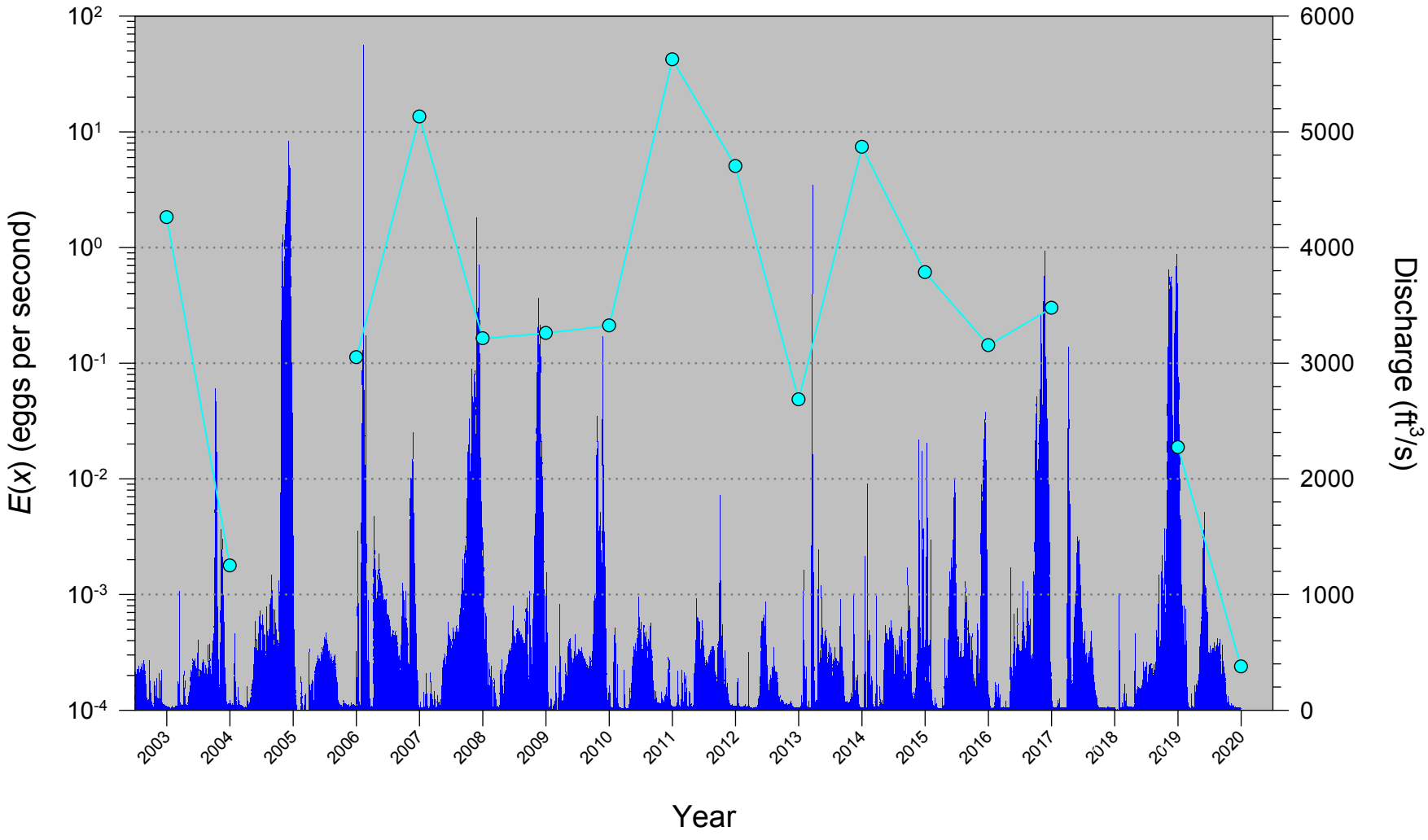
Egg Occurrence Probability and Temperature

(San Marcial: 2003–2020)



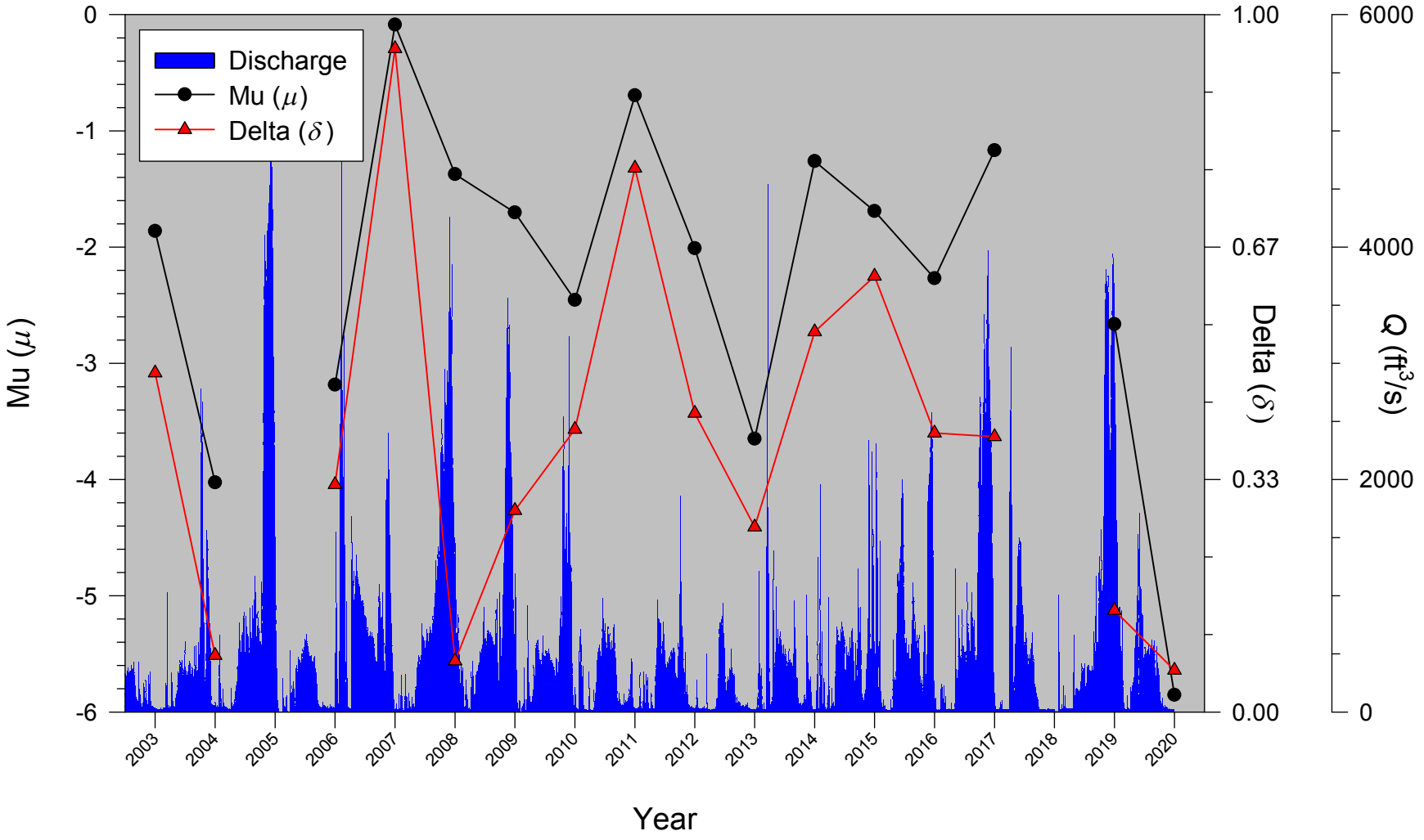
Egg Passage Rates and Discharge

(San Marcial: 2003–2020)



Parameter Estimates and Discharge

(San Marcial: 2003–2020)



Modeling the Spawning Ecology of RGSM
(San Marcial: 2003–2020)

- Generalized linear models (GLMs) included δ (occurrence probability) and μ (lognormal passage rate) with a single environmental covariate for each estimated parameter (e.g., δ[SANmean] μ[SAN>1,500]).

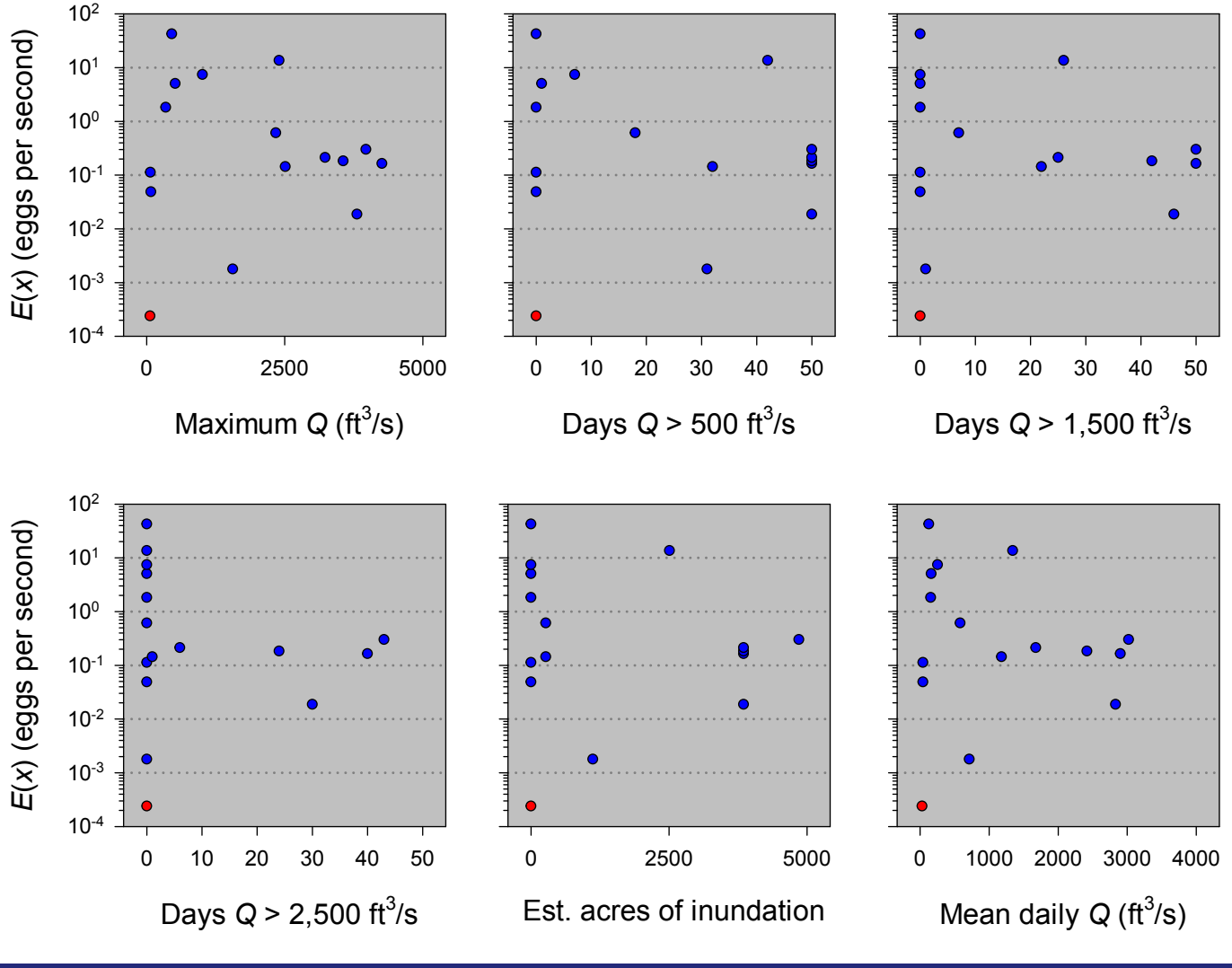
- Covariates (n = 6) representing spring runoff conditions and estimated floodplain inundation were included in the models.

- All covariates included both fixed effects (i.e., covariate explains variation) and random effects (i.e., random error [*R*] around covariate).

- Goodness-of-fit statistics (–2[log-likelihood] and Akaike's information criterion [AIC_c]) were used to assess the fit of data to various models.

Egg Passage Rates vs. Discharge

(San Marcial: 2003–2020)



Ecological Model Results for RGSM

(San Marcial: 2003–2020)

Model	logLike	K	AIC_c	w_i
δ(SAN>2,500+*R*) μ(SANmax+*R*)	1,522.23	9	1,540.49	0.2878
δ(SAN>2,500+*R*) μ(SANmean+*R*)	1,523.51	9	1,541.77	0.1522
δ(SAN>2,500+*R*) μ(SAN>1,500+*R*)	1,524.80	9	1,543.06	0.0798
δ(*R*) μ(SANmean+*R*)	1,527.73	8	1,543.94	0.0514
δ(SAN>2,500+*R*) μ(SAN>500+*R*)	1,525.76	9	1,544.02	0.0494
δ(*R*) μ(SANmax+*R*)	1,528.46	8	1,544.66	0.0358
δ(SANmean+*R*) μ(SANmax+*R*)	1,526.48	9	1,544.74	0.0344
δ(SANmean+*R*) μ(SANmean+*R*)	1,527.04	9	1,545.30	0.0260
δ(SAN>1,500+*R*) μ(SANmax+*R*)	1,527.20	9	1,545.46	0.0241
δ(*R*) μ(SAN>1,500+*R*)	1,529.38	8	1,545.58	0.0226

Conclusions and Implications

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

2. It is likely that the successful upstream retention and recruitment of individuals is positively related to the availability and persistence of floodplain nursery habitats (i.e., shallow, warm, productive areas).

3. Ongoing efforts to restore dynamic river flows, reconnect fragmented reaches, and reestablish a functional floodplain should help to support resilient and self-sustaining populations of Rio Grande Silvery Minnow.

4. Long-term recovery of Rio Grande Silvery Minnow appears strongly dependent on reliably ensuring appropriate seasonal flow and habitat conditions that promote its successful spawning and recruitment.

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- **Report Review:** Jennifer Bachus (USBR) and Michael Porter (U.S. Army Corps of Engineers)

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Questions or Comments?

Robert K. Dudley

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