Population Monitoring Work Group Meeting

December 1, 2020

Meeting Materials:

Agenda

Minutes

RGSM Expert Elicitation Form [read-ahead, spreadsheet]

Process-Based Recruitment Prediction [read-ahead]

Expert Elicitation Responses [presentation]

Draft PMWG Report Findings and Recommendations [follow-up, spreadsheet, draft]

Middle Rio Grande Endangered Species Collaborative Program

Est. 2000

Population Monitoring Work Group (PMWG)
December 1, 2020
9:00 AM – 12:00 PM

Zoom Information:
https://west-inc.zoom.us/j/8983593120?pwd=bU54V3NGeG93bXVlSlJFcEIzcE9wZz09
Code: 1251; Call-In: +1-669-900-6833; Meeting ID: 898-359-3120

Meeting Agenda

9:00 – 9:15	**Welcome, Intros, Agenda, Meeting Notes** ➢ **Decision:** Approval of Oct 22, 2020 meeting minutes ➢ **Decision:** Approval of Nov 18, 2020 meeting agenda Read aheads: ☐ October 22, 2020 PMWG meeting minutes	*PMWG Chair*
9:15 – 9:30	**Update—Report to EC on Fish Monitoring Program**	*Rich Valdez*
9:30 – 10:30	**Expert Elicitation—Integrated Model** • Review and Discussion of Forms Completed by PMWG • Role of Expert Elicitation in Model Development Read aheads: ☐ Expert Elicitation Forms (sent 11/5/2020)	*Charles Yackulic*
10:30 – 10:45	**Break**	
10:45 – 11:45	**Expert Elicitation—Integrated Model (continued)** • Review and Discussion of Forms Completed by PMWG • Role of Expert Elicitation in Model Development Read aheads: ☐ Expert Elicitation Forms (sent 11/5/2020)	*Charles Yackulic*
11:45 – 12:00	**Wrap-Up** • Announcements • Action Items • Next Meeting	*PMWG Chair*
12:00	**Adjourn**	

Middle Rio Grande Endangered Species Collaborative Program
Est. 2000

Population Monitoring Work Group (PMWG)
Meeting Minutes

December 1, 2020; 2:00 PM–5:00 PM
Location: Zoom Meeting

Decisions:

- ✓ Approval of December 1, 2020 PMWG meeting agenda
- ✓ Approval of October 22, 2020 PMWG meeting minutes

Action Items:

Who	What	By When
Catherine Murphy and Rich Valdez	Discuss the best option for summarizing the status report to the Executive Committee (EC)	12/2/2020
Rich V.	Send the summary of findings and list of recommendations from the draft status report to PMWG members for feedback	12/3/2020
PMWG members	Provide comments on the summary of findings and list of recommendations from the draft status report	12/8/2020
Rich V.	Send the draft status report to PMWG members for review	12/15/2020
Rich V.	Present progress on the draft status report to the EC	12/17/2020
PMWG members who submitted expert elicitation forms	Review previous expert elicitation responses and send final versions to Charles Yackulic	12/18/2020
Program Support Team (PST)	*Schedule a meeting in January to discuss results of the expert elicitation	Before January
Charles Y.	Synthesize the expert elicitation responses and incorporate them into the population model	January meeting

*The January meeting will be scheduled by the PST, with guidance from the Science and Adaptive Management Committee (SAMC). The small group of PMWG members working on the population model will request to continue their work as a Science & Technical Ad Hoc Group under the SAMC.

Meeting Summary

Welcome, Intros, Agenda, Meeting Notes

Rich V., SWCA Environmental Consultants and PMWG chair, opened the meeting and Michelle Tuineau, PST, introduced the meeting attendees. Rich V. reviewed the December 1, 2020 meeting agenda and October 22, 2020 meeting minutes.

- ✓ **Decision**: Approval of December 1, 2020 PMWG meeting agenda
- ✓ **Decision**: Approval of October 22, 2020 PMWG minutes

Update—Report to EC on Fish Monitoring Program:

Rich V. updated the group on the progress of the PMWG report to the EC:

- Rich V. put together an executive summary that provides an overview of the PMWG findings and list of recommendations.
  - Rich V. will send out the draft findings and list of recommendations to the PMWG before the EC meeting on December 17th. The findings and recommendations, once finalized, will be presented to the EC at a later meeting.
- Rich V. will send the draft PMWG report to the PMWG for feedback.
- The PMWG report will be 30–35 pages long.
  - Catherine Murphy and Rich V. will discuss summarizing the PWMG report further for the EC.

- ➢ **Action Item**: Rich Valdez will send the findings and list of recommendations from the draft PMWG report to PMWG members for feedback
- ➢ **Action Item**: PMWG members will provide comments on the findings and list of recommendations from the draft PMWG report
- ➢ **Action Item**: Rich Valdez will send the draft PMWG report to PMWG members for review
- ➢ **Action Item**: Rich Valdez will present progress on the draft PMWG report to the EC
- ➢ **Action Item**: Catherine Murphy and Rich Valdez will discuss the best option for presenting the PMWG report to the EC

Expert Elicitation—Integrated Model

Review and Discussion of Forms Completed by PMWG

Role of Expert Elicitation in Model Development

Charles Y., U.S. Geological Survey, discussed the responses to the expert elicitation form (see expert elicitation form for questions and slideshow for responses). He presented anonymized and summarized responses, which the PWMG reviewed and discussed in detail. Rather than coming to agreement, PMWG members were asked to explain their thinking processes. PMWG members who filled out expert elicitation forms were asked to review and adjust their responses (where appropriate) post-discussion, and send them to Charles Y. by December 18, 2020. Charles Y. will analyze the final responses and use them to inform the Rio Grande silvery minnow (RGSM) population model before the next RGSM Population Modeling Ad Hoc Group meeting (pending SAMC approval).

- ➢ **Action Item**: PMWG members who submitted expert elicitation forms will review their previous responses and send final versions to Charles Yackulic
- ➢ **Action Item**: Charles Yackulic will synthesize the expert elicitation responses and incorporate them into the RGSM population model

- ➢ **Action Item**: The PST will schedule a meeting in January to discuss results of the expert elicitation

Announcements

- The final PMWG report to the EC will likely take until next year to finalize.
- Rich V. will solicit feedback on what to present to the EC at the December 17th meeting next week.
- Catherine M. discussed the future of the PMWG and its role in the Collaborative Program:
    - The EC will sunset all standing science and technical work groups as of the December 17th meeting, with the purpose of transitioning the Collaborative Program to a new structure that includes the SAMC.
    - Under the new structure, the SAMC will form and provide oversight for Science & Technical (S&T) Ad Hoc Groups. The new structure is more efficient for addressing problems because smaller groups will work on smaller problems/questions in a shorter time frame.
    - Products developed under the new structure will be in the correct format to enter into the Adaptive Management (AM) Database, with the appropriate linkages between objectives, hypotheses, and scientific activities.
        - This ensures all the work being done is incorporated into Program tools, so the Program can inform decision making.
    - The RGSM Population Modeling Ad Hoc Group is an example of how one of these smaller ad hoc groups will work. The work of the population modeling group will continue in that format.
    - The PMWG report to the EC will summarize the work done, findings from the work, and how those findings should be applied in the future.
    - How do we continue meetings for the population model and PMWG report next year?
        - The groups can continue to meet, but will not receive PST support unless they are S&T Ad Hoc Groups created by the SAMC with formal charges.

Meeting Participants

Participant	Organization
Ashlee Rudolph	U.S. Bureau of Reclamation
Catherine Murphy	Program Support Team
Charles Yackulic	U.S. Geological Survey
Grace Haggerty	New Mexico Interstate Stream Commission
Joel Lusk	U.S. Bureau of Reclamation
Michelle Tuineau	Program Support Team
Mickey Porter	U.S. Army Corps of Engineers
Mo Hobbs	Albuquerque Bernalillo County Water Utility Authority
Rich Valdez	SWCA Environmental Consultants
Thomas Archdeacon	U.S. Fish and Wildlife Service

Thank you for agreeing to participate in this exercise!

The results of this exercise will be incorporated into the population model allowing us to evaluate questions related to both monitoring and management. Specifically, the information derived from your participation in this exercise will help: 1) constrain the population model where direct monitoring data does not provide enough information, 2) to develop a covariate to predict recruitment that integrates knowledge from various ongoing studies and is semi-mechanistic or process based (i.e., that attempts to link flow to recruitment based on our understanding of the various processes required to produce juveniles from adults), which will be used for the model, but also may provide clues on how flows should be designed to maximize Rio Grande silvery minnow production for a given seasonal flow amount, and 3) Inform our understanding of the degree to which monitoring data are reducing uncertainty in key parameters.

You will be asked to estimate, to the best of your ability, parameter values (e.g., survival rates) and relationships (e.g., the relative amount of larval habitat at different discharges). I understand that you may have more refined understanding of some parameters or relationships and less of an understanding of other parameters or relationships - that's okay! We are going through this exercise as a group and you don't have to get everything "right" the first time. The exercise may take over an hour to complete, but should not be overly onerous. This exercise is being carried out because there is does not appear to be sufficient data to determine the quantities. If there are data to support your responses, please use them. But if you are not aware of data, please use your best professional judgment based on your understanding of the system and the species.

The keys to this process are that you: 1) Complete all parts of this worksheet and return to me by the evening of Nov. 13 (a completed worksheet on time is more helpful than a "correct" worksheet that is never returned!), 2) Meet with the rest of the group on Nov. 18 to discuss our answers to questions, and 3) modify your initial worksheet based on the group discussion and return to me a second time.

What will make this exercise a success is if you: 1) Complete the exercise a first time before our group meeting. Treat this as an openbook exercise and keep track of keep figures/graphs/references that you use in formulating your answers - be prepared to share these with the group, 2) Share your reasoning (and figures) with others and listen to their reasoning, and 3) Update/change your answers based on our interactions as a group.

The various sheets in this workbook are numbered in the order they should be addressed. The next sheet (0_EX1) provides a worked example, afterwhich your input begins. At the end of the exercise, there is a progress tab that identifies whether you provided all the necessary information and whether there are any logical errors. Please try to address these errors before sending in to me.

A NOTE ON DISCHARGE

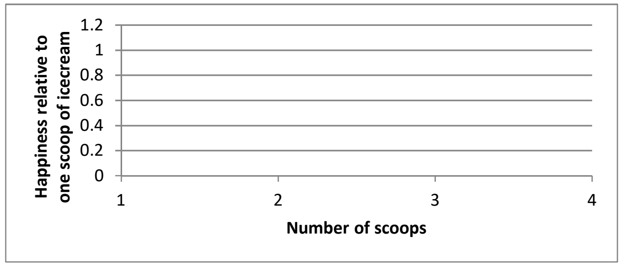
When determining relationships between discharge and various quantities, assume discharge is measured at the Angostura gage for the Angostura river segment, and San Acacia gage for the Isleta and San Acacia river segments.

Email me at cyackulic@usgs if you have any questions and also return workbooks to this email address.

PART A: In the following, worksheets you will encounter something that looks like this. Read through the comments 1 - 10 (click on the purple corners) and then scroll down to PART B.

Description: Can you have too much ice cream? Estimate how much more (or less happy) each additional ice cream scoop makes you. Assume the ice cream is free, your favorite flavor, and the size of a tennis ball, but you must eat all of it.

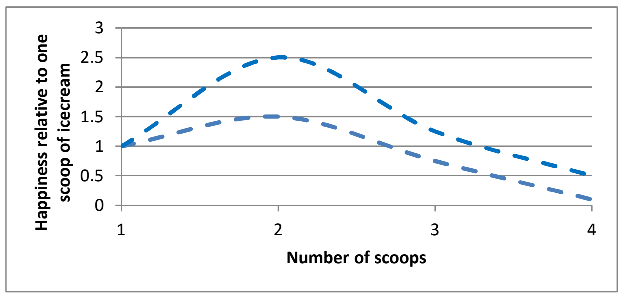
Scoops of Ice cream	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
1	1	1	NA	1
2				
3				
4				



upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
0	0	1
0	0	1
0	0	1

PART B: To begin with you will fill in values for column B, column C and column D. Note that the first two flags have turned green. Read through the comments on rows 17 - 19 to understand the logic behind the entries, then proceed to Part C.

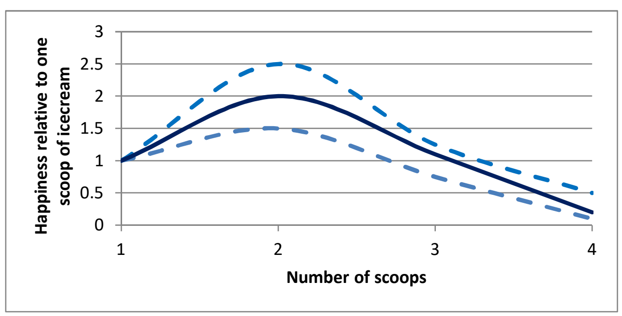
Scoops of Ice cream	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
1	1	1	NA	1
2	1.5	2.5	90	
3	0.75	1.25	90	
4	0.1	0.5	90	



upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
1	1	0
1	1	0
1	1	0

PART C: We're done with this worksheet! A new line has been added and all flags are green!

Scoops of Ice cream	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
1	1	1	NA	1
2	1.5	2.5	90	2
3	0.75	1.25	90	1.1
4	0.1	0.5	90	0.2



upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
1	1	1
1	1	1
1	1	1

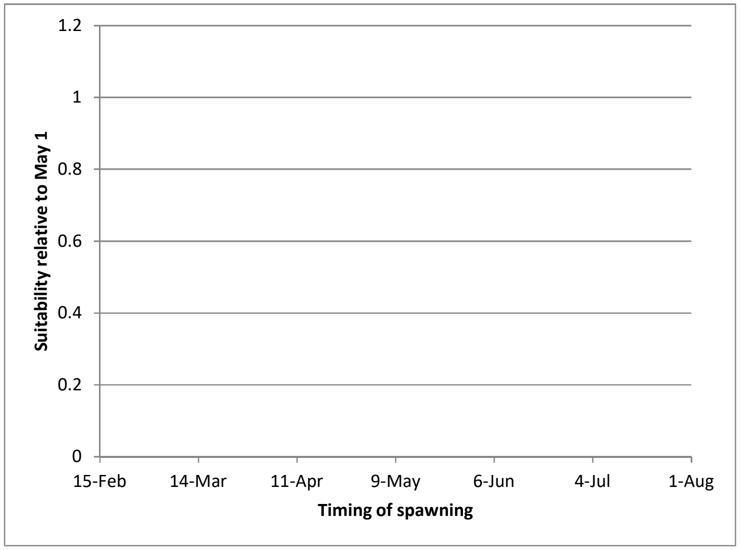
Description: It appears to be well agreed that RGSM are not strictly synchronous in their spawning, particularly in years when water (and thus larval habitat) are readily available. We are interested in quantifying the proportion of individuals that might be expected to lay eggs at different times throughout the spring and early summer when water (and any cue for spawning are not limiting). We choose as a reference, May 1st, and fix its values to 1 and then ask experts to quantify how much more, or less likely, an individual RGSM is to produce eggs on other days relative to May 1st. For example, a value of 1.5 indicates and individual would be 50% more likely to produce eggs relative to May 1st, whereas a value of 0.1 indicates an individual would only be 10% change as likely to produce eggs as on May 1st.

It is important for experts to keep in mind:

1)The function being estimated is based on when eggs are produced and may differ from back-calculated hatch dates if larval habitat availability (and thus survival) differs substantially.

2)We are focusing on the timing of egg-laying when cues are not limiting (i.e., in wet years).

Date	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
2-Mar				
12-Mar				
22-Mar				
1-Apr				
11-Apr				
21-Apr				
1-May	1	1	NA	1
11-May				
21-May				
31-May				
10-Jun				
20-Jun				
30-Jun				



upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1

Description: Evidence from low-flow years suggests that many individuals delay egg-laying (even though they are sufficiently mature) until there is a cue to lay eggs. If this cue occurs early in the reproductive season, we expect that egg-laying will be largely unaffected, however, if this cue does not occur until later in the season, we expect there may be large numbers of egg laid shortly after the cue. Based on evidence from recent “jiggles” we assume that raising flow by 100 cfs for a single day is a sufficient cue, however there is less clarity over the minimum flow at which such a cue is required to induce egg-laying (e.g., clearly in years when flow is 150 cfs a cue is needed and in years when flows are greater than 2000 cfs no cue is needed, but where is the breakpoint in baseflows when a cue would be required).

Questions	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)		upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
What is the maximum base flow (in units of cfs) for which a cue of a 1-day increase of 100 cfs or more is required to induce spawning? (Same question reworded - what is the minumum flow for which a 1-day increase of 100 cfs or more is NOT necessary to cue reproduction?)						0	0	1

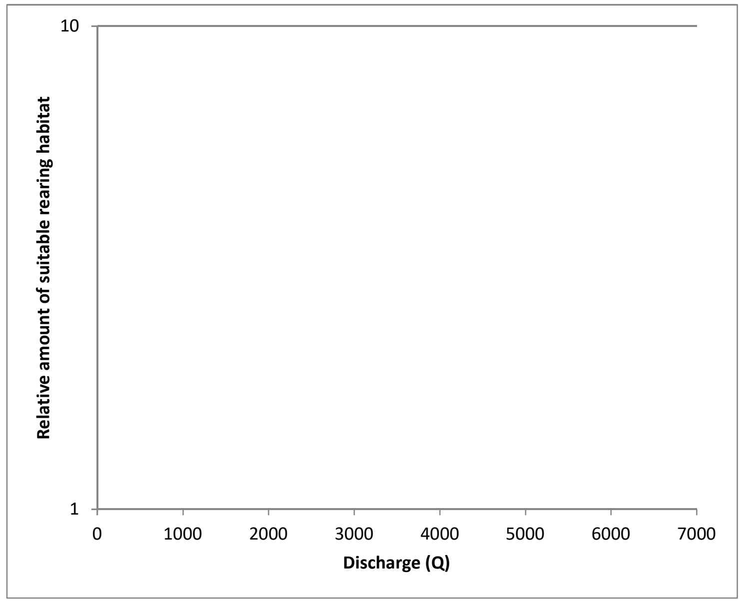
Relationship between discharge and larval habitat in the Angostura reach - present day

Description: It is well established that the flows required to overbank the channel vary in each of the three major river segments (and have changed over time) and that overbanking should generally lead to substantial increases in larval habitat, however there is some debate about how reach-wide (as opposed to in smaller segments of river) larval habitat availability varies with discharge.

The goal of this exercise is to estimate how much larval habitat is available at a given flow relative to the amount of habitat available at 500 cfs in that same reach. 500 cfs was chosen as a reference point as the channel is generally full at this discharge, but has not overbanked. Importantly, experts are asked only to focus on larval habitat availability without consideration of duration.

Discharge - Q (cfs)	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
5				
50				
100				
150				
200				
250				
500	1	1	NA	1
1000				
1500				
2000				
2500				
3000				
4000				
5000				
6000				
7000				

(or more)



upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1

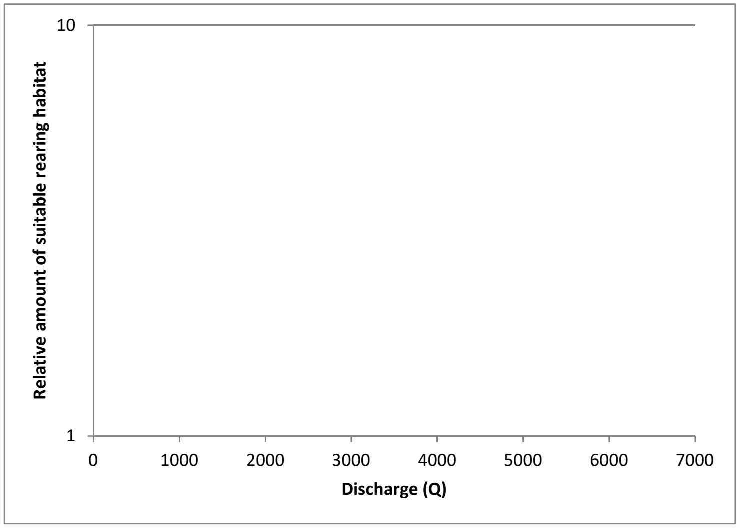
Relationship between discharge and larval habitat in the Angostura reach - Two decades ago (2000)

Description: It is well established that the flows required to overbank the channel vary in each of the three major river segments (and have changed over time) and that overbanking should generally lead to substantial increases in larval habitat, however there is some debate about how reach-wide (as opposed to in smaller segments of river) larval habitat availability varies with discharge.

The goal of this exercise is to estimate how much larval habitat was available 20 years ago at a given flow relative to the amount of habitat available at 500 cfs in that same reach. 500 cfs was chosen as a reference point as the channel is generally full at this discharge, but has not overbanked. For this analysis, we assume that larval habitat availability has not changed significantly at a discharge of 500 cfs, but may have changed at other discharges.

Discharge - Q (cfs)	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
5				
50				
100				
150				
200				
250				
500	1	1	NA	1
1000				
1500				
2000				
2500				
3000				
4000				
5000				
6000				
7000				

(or more)



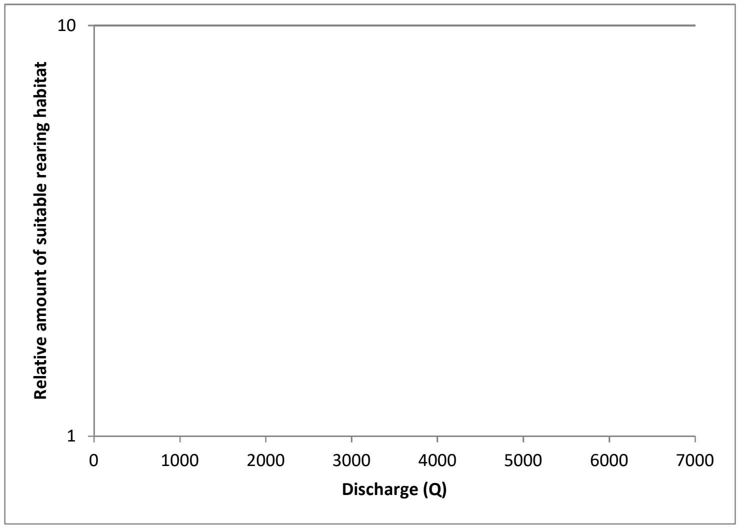
upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1

Relationship between discharge and larval habitat in the Isleta reach - present day

Description: It is well established that the flows required to overbank the channel vary in each of the three major river segments (and have changed over time) and that overbanking should generally lead to substantial increases in larval habitat, however there is some debate about how reach-wide (as opposed to in smaller segments of river) larval habitat availability varies with discharge.

The goal of this exercise is to estimate how much larval habitat is available at a given flow relative to the amount of habitat available at 500 cfs in that same reach. 500 cfs was chosen as a reference point as the channel is generally full at this discharge, but has not overbanked. Importantly, experts are asked only to focus on larval habitat availability without consideration of duration.

Discharge - Q (cfs)	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
5				
50				
100				
150				
200				
250				
500	1	1	NA	1
1000				
1500				
2000				
2500				
3000				
4000				
5000				
6000				
7000 (or more)				



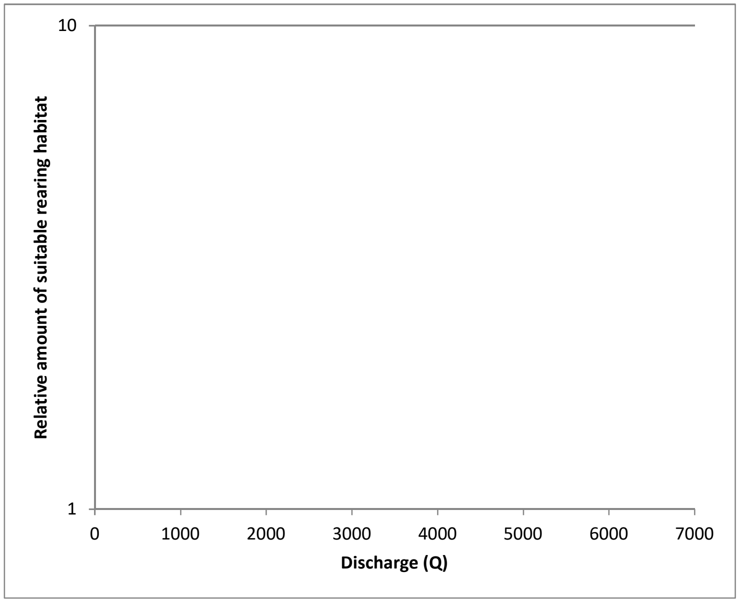
upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1

Relationship between discharge and larval habitat in the Isleta reach - Two decades ago (2000)

Description: It is well established that the flows required to overbank the channel vary in each of the three major river segments (and have changed over time) and that overbanking should generally lead to substantial increases in larval habitat, however there is some debate about how reach-wide (as opposed to in smaller segments of river) larval habitat availability varies with discharge.

The goal of this exercise is to estimate how much larval habitat was available 20 years ago at a given flow relative to the amount of habitat available at 500 cfs in that same reach. 500 cfs was chosen as a reference point as the channel is generally full at this discharge, but has not overbanked. For this analysis, we assume that larval habitat availability has not changed significantly at a discharge of 500 cfs, but may have changed at other discharges.

Discharge - Q (cfs)	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
5				
50				
100				
150				
200				
250				
500	1	1	NA	1
1000				
1500				
2000				
2500				
3000				
4000				
5000				
6000				
7000				
(or more)				



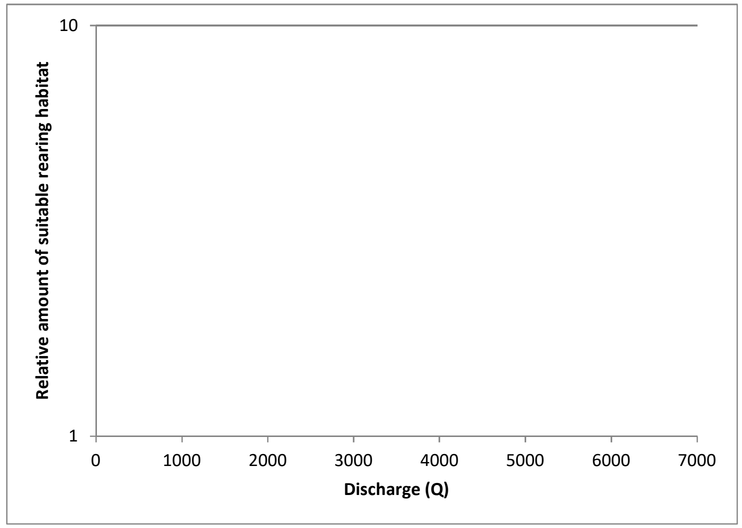
upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1

Relationship between discharge and larval habitat in the San Acacia reach - present day

Description: It is well established that the flows required to overbank the channel vary in each of the three major river segments (and have changed over time) and that overbanking should generally lead to substantial increases in larval habitat, however there is some debate about how reach-wide (as opposed to in smaller segments of river) larval habitat availability varies with discharge.

The goal of this exercise is to estimate how much larval habitat is available at a given flow relative to the amount of habitat available at 500 cfs in that same reach. 500 cfs was chosen as a reference point as the channel is generally full at this discharge, but has not overbanked. Importantly, experts are asked only to focus on larval habitat availability without consideration of duration.

Discharge - Q (cfs)	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
5				
50				
100				
150				
200				
250				
500	1	1	NA	1
1000				
1500				
2000				
2500				
3000				
4000				
5000				
6000				
7000 (or more)				



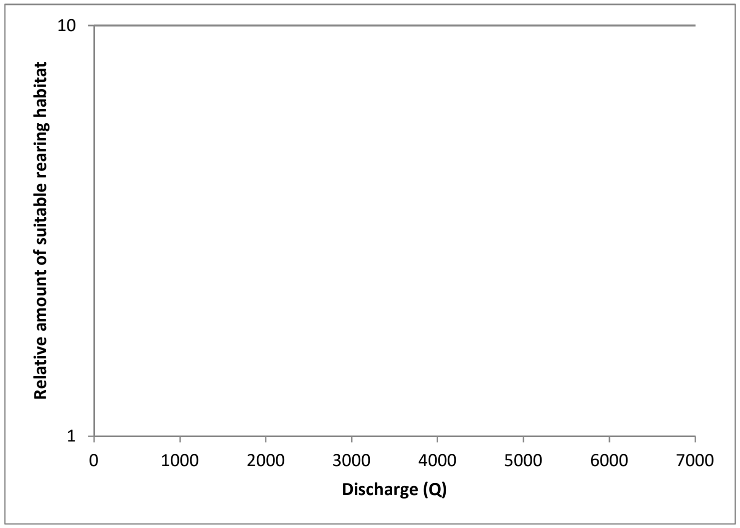
upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1

Relationship between discharge and larval habitat in the San Acacia reach - Two decades ago (2000)

Description: It is well established that the flows required to overbank the channel vary in each of the three major river segments (and have changed over time) and that overbanking should generally lead to substantial increases in larval habitat, however there is some debate about how reach-wide (as opposed to in smaller segments of river) larval habitat availability varies with discharge.

The goal of this exercise is to estimate how much larval habitat was available 20 years ago at a given flow relative to the amount of habitat available at 500 cfs in that same reach. 500 cfs was chosen as a reference point as the channel is generally full at this discharge, but has not overbanked. For this analysis, we assume that larval habitat availability has not changed significantly at a discharge of 500 cfs, but may have changed at other discharges.

Discharge - Q (cfs)	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
5				
50				
100				
150				
200				
250				
500	1	1	NA	1
1000				
1500				
2000				
2500				
3000				
4000				
5000				
6000				
7000 (or more)				



upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1

Description: We assume that larvae derived from eggs laid on a given day require larval habitat for a particular amount of time until they are capable of persisting in less specialized habitat. We ask experts to estimate this quantity keeping in mind that we are focused only on the duration required for individuals derived from eggs laid on a single day.

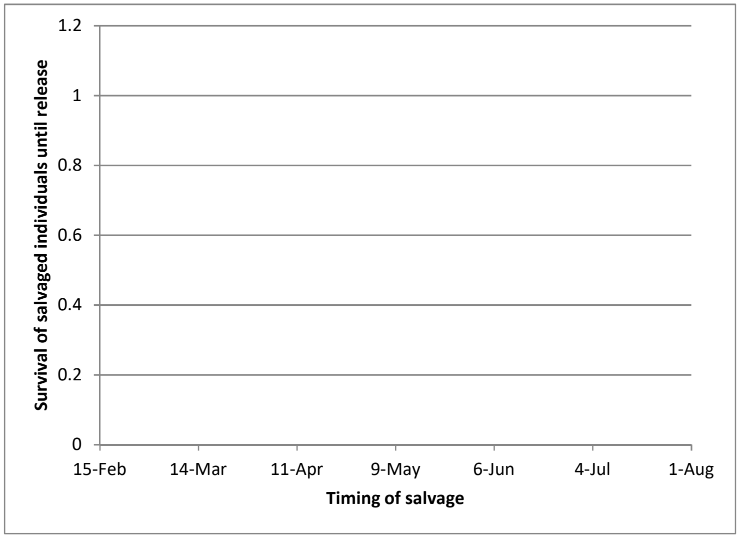
Questions	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)		upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
For how many days after egg-laying is larval habitat required before individuals can survive reasonably in less specialized habitat?						0	0	1

Description: Some proportion of Rio Grande Silvery Minnow move out as drying occurs, but this quantity is hard to estimate from existing data. Values for the upper CI, lower CI and best guess should be between 0 and 1.

Questions	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)	upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
What proportion of individuals are expected to successfully move out of a drying area in the absence of salvage, under typical drying rates (i.e., less than 6 km a day)? (answers should be between 0 and 1)					0	0	1

Description: It has been hypothesized that survival of salvaged individuals may depend on the timing of when they are salvaged. (Keep in mind that we are **not** concerned here about individuals that are not caught by the seines used during salvage, but rather the survival of individuals removed from drying pools and released in wetted areas.) Upper CI, lower CI and means should be between 0 and 1.

Date	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
15-Mar				
1-Apr				
15-Apr				
1-May				
15-May				
1-Jun				
15-Jun				
1-Jul				

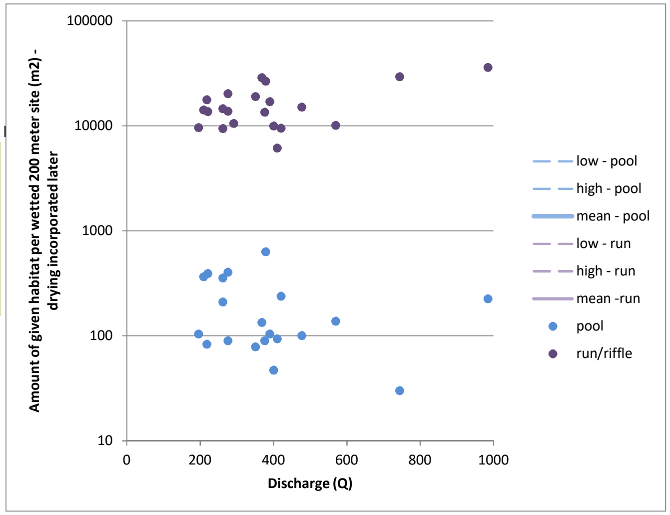


upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1

Angostura - Run/Riffle and pool habitat vs. discharge

Description: Interpreting catch and effort data in terms of reach abundances requires estimating the availability of run/riffle and pool habitat at different discharges. For this sheet, we include available data in the graph and as raw data. Experts should be aware that these data are from a few 200 m sites and may not represent an average 200 m site. Rather than asking experts to estimate the amount of habitat per 200 m site, we are asking them to estimate river width at various discharges and the proportion of pools at different discharges. These quantities can be combined to determine areas of the two major habitat types (if you are interested in these calculations, move the figure and look at the columns underneath). Also, note that the y-axis is on a log scale, that river width is in meters, and that proportion of pool habitat should be between 0 and 1.

	River width (m)				Proportion pool habitat (0 to 1)			
Discharge - Q (cfs)	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
5								
50								
100								
150								
200								
250								
500								
1000								



River width flags			% pool flags		
upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI	upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1

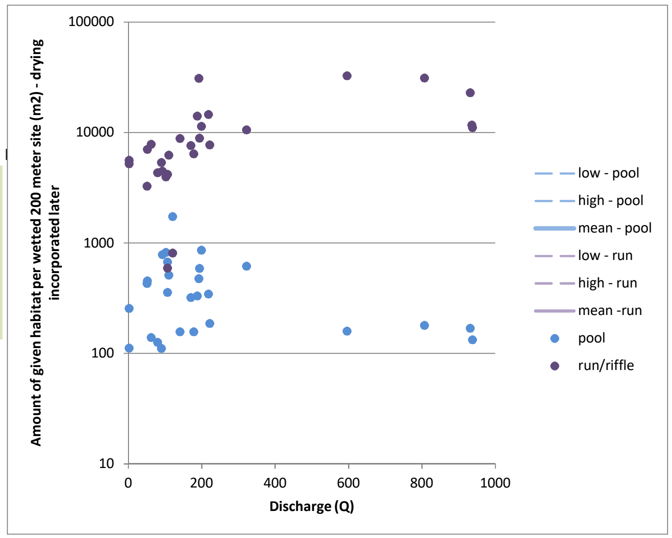
Available data

Q	pool	run/riffle
196	104.2	9593
210	366.3	14171
218	83.43	17781
221	391.1	13648
262	356	14602
262	210.6	9425
276	404.4	13811
276	89.71	20230
292	0	10533
351	78.56	19073
368	133.6	28748
376	89.79	13438
379	631.2	26582
390	104.3	16960
401	47.07	9983
410	93.97	6153
421	238.9	9478
477	100.4	15037
570	138	10112
744	30.15	29338
985	224.9	36081
1020	316.3	38039

Isleta - Run/Riffle and pool habitat vs. discharge

Description: Interpreting catch and effort data in terms of reach abundances requires estimating the availability of run/riffle and pool habitat at different discharges. For this sheet, we include available data in the graph and as raw data. Experts should be aware that these data are from a few 200 m sites and may not represent an average 200 m site. Rather than asking experts to estimate the amount of habitat per 200 m site, we are asking them to estimate river width at various discharges and the proportion of pools at different discharges. These quantities can be combined to determine areas of the two major habitat types (if you are interested in these calculations, move the figure and look at the columns underneath). Also, note that the y-axis is on a log scale, that river width is in meters, and that proportion of pool habitat should be between 0 and 1.

	River width (m)				Proportion pool habitat (0 to 1)			
Discharge - Q (cfs)	lowe r CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
5								
50								
100								
150								
200								
250								
500								
1000								



River width flags			% pool flags		
upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI	upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1

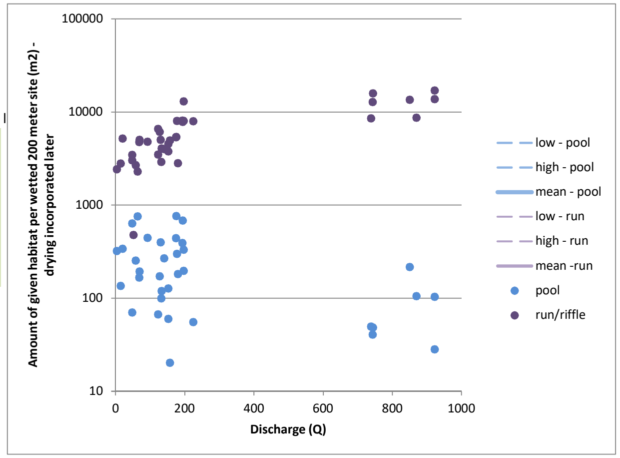
Available data

Q	pool	run/riffle
2	256	5201.2
2	112	5617.3
51	430	3278
52	454	7025.6
62	139	7820.8
80	126	4343.2
90	111	5369.4
93	784	4489.2
102	821	3973.2
107	671	592.18
107	358	4192.5
110	513	6246.5
121	1740	809.57
141	157	8814.6
170	322	7635.6
178	157	6432.2
188	331	14062
192	474	30996
194	588	8899.2
199	864	11363
218	346	14611
222	187	7756.8
322	618	10611
596	159	32590
807	180	31295
932	169	22946
936	0	11683
938	133	11086

San Acacia - Run/Riffle and pool habitat vs. discharge

Description: Interpreting catch and effort data in terms of reach abundances requires estimating the availability of run/riffle and pool habitat at different discharges. For this sheet, we include available data in the graph and as raw data. Experts should be aware that these data are from a few 200 m sites and may not represent an average 200 m site. Rather than asking experts to estimate the amount of habitat per 200 m site, we are asking them to estimate river width at various discharges and the proportion of pools at different discharges. These quantities can be combined to determine areas of the two major habitat types (if you are interested in these calculations, move the figure and look at the columns underneath). Also, note that the y-axis is on a log scale, that river width is in meters, and that proportion of pool habitat should be between 0 and 1.

	River width (m)				Proportion pool habitat (0 to 1)			
Discharge - Q (cfs)	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
5								
50								
100								
150								
200								
250								
500								
1000								



River width flags			% pool flags		
upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI	upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1
0	0	1	0	0	1

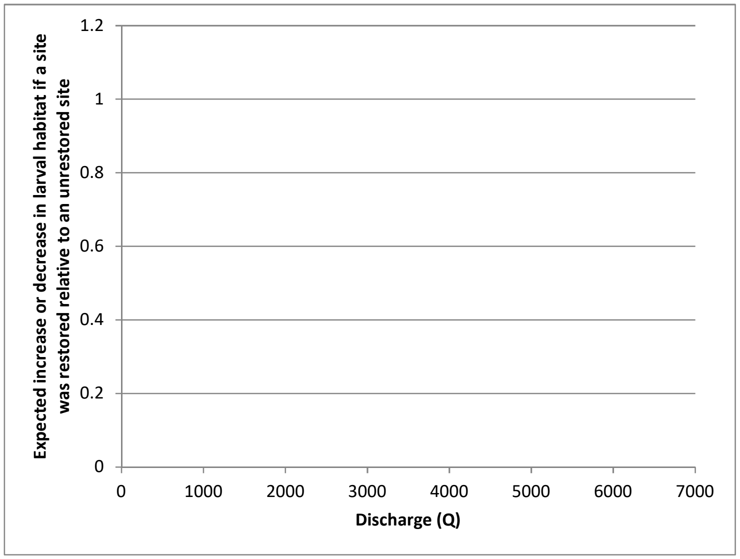
Available data

Q	pool	run/riffle
3	322.2	2431
15	135.7	2815
20	341.3	5204
47	639.2	3470
48	70.23	3047
51	0	480.8
58	255.4	2696
64	758.8	2306
69	167.6	4778
70	194.2	5058
92	447.6	4822
123	67.43	3494
123	0	6590
127	173.2	6167
130	400.4	5040
132	100	2928
133	120	4078
140	268.4	4028
152	60.18	4561
152	128.2	3783
157	20.33	4969
174	445	5365
175	768.8	5432
177	300.4	8059
180	182.1	2829
193	395.1	8096
194	685.2	7899
197	333.6	13043
197	197.5	8087
224	55.51	7978
738	49.89	8574
743	40.97	12900
744	48.62	15987
850	216.7	13646
869	105.9	8704
922	103.8	17153
922	28.37	13758

Angostura - restoration

Description: In an average 200 m site within this river reach, how much does restoration increase or decrease larval habitat availability at each discharge relative to an unrestored site. (So if you think restoration does not affect larval habitat availability at a particular discharge you would choose a value of 1, whereas a value of 0.9 would mean you had decreased larval habitat availability by 10% and a value of 1.1 would mean you had increased larval habitat availability at that discharge by 10%). Focus on a site for these calculations as we can easily scale to the reach later - in other words, there may be a large effect within sites, but if only a few sites are restored the overall effect may still be modest.

Discharge - Q (cfs)	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
5				
50				
100				
150				
200				
250				
500				
1000				
1500				
2000				
2500				
3000				
4000				
5000				
6000				
7000 (or more)				



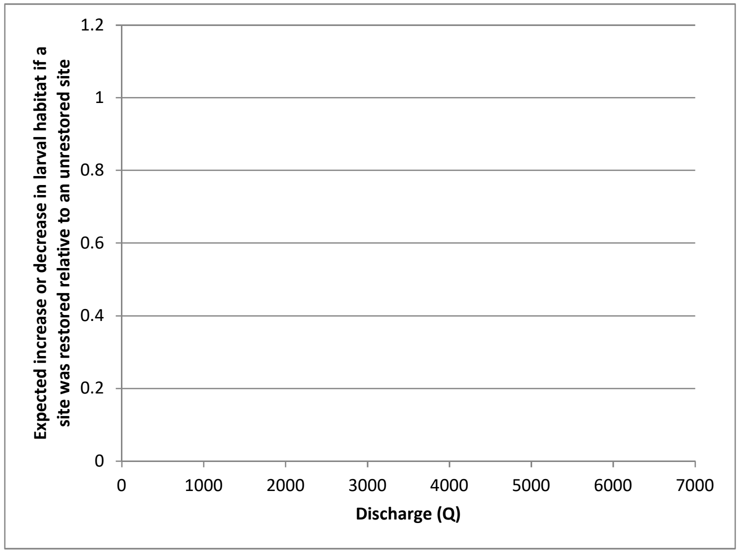
upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1

Isleta -restoration

Description: In an average 200 m site within this river reach, how much does restoration increase or decrease larval habitat availability at each discharge relative to an unrestored site. (So if you think restoration does not affect larval habitat availability at a particular discharge you would choose a value of 1, whereas a value of 0.9 would mean you had decreased larval habitat availability by 10% and a value of 1.1 would mean you had increased larval habitat availability at that discharge by 10%). Focus on a site for these calculations as we can easily scale to the reach later - in other words, there may be a large effect within sites, but if only a few sites are restored the overall effect may still be modest.

Discharge - Q (cfs)	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
5				
50				
100				
150				
200				
250				
500				
1000				
1500				
2000				
2500				
3000				
4000				
5000				
6000				
7000				

(or more)

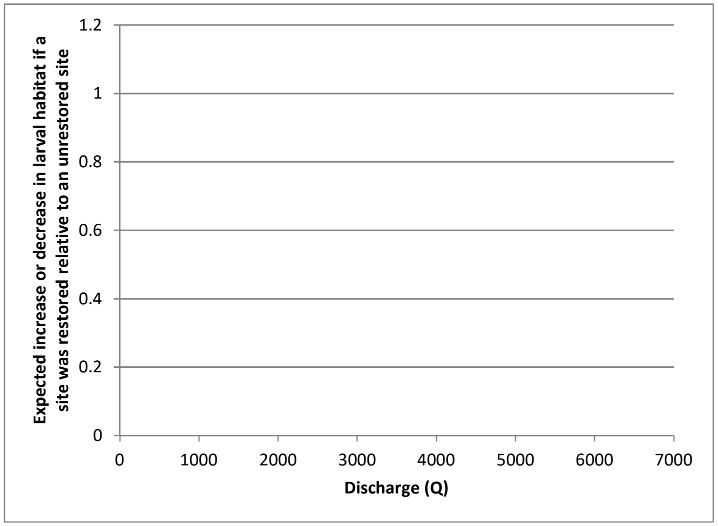


upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1

San Acacia - restoration

Description: In an average 200 m site within this river reach, how much does restoration increase or decrease larval habitat availability at each discharge relative to an unrestored site. (So if you think restoration does not affect larval habitat availability at a particular discharge you would choose a value of 1, whereas a value of 0.9 would mean you had decreased larval habitat availability by 10% and a value of 1.1 would mean you had increased larval habitat availability at that discharge by 10%). Focus on a site for these calculations as we can easily scale to the reach later - in other words, there may be a large effect within sites, but if only a few sites are restored the overall effect may still be modest.

Discharge - Q (cfs)	lower CI	upper CI	probability truth is within your lower and upper CI (not graphed)	best guess (mean)
5				
50				
100				
150				
200				
250				
500				
1000				
1500				
2000				
2500				
3000				
4000				
5000				
6000				
7000				
(or more)				



upper CI > lower CI	95 >= CI >= 50	upper CI >= mean >=lower CI
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1
0	0	1

Sheet	% filled out	Flags
1	0%	24
2	0%	2
3a	0%	30
3b	0%	30
3c	0%	30
3d	0%	30
3e	0%	30
3f	0%	30
4	0%	2
5a	0%	2
5b	0%	16
6a	0%	32
6b	0%	32
6c	0%	32
7a	0%	32
7b	0%	32
7c	0%	32

PROCESS-BASED RECRUITMENT PREDICTION

While not the sole purpose of this exercise, many worksheets are focused on quantities related to understanding and predicting recruitment. The goal of this exercise is to build a covariate that incorporates insights arising from a variety of ongoing research projects focused on various aspects of early life history in Rio Grande silvery minnow. As these projects are ongoing, we expect that our understanding of these quantities may change over time and that this covariate could be updated accordingly. Specifically, we are interested in four aspects of early life history:

1) timing of egg laying,
2) necessary cues for egg laying,
3) availability of larval habitat, and
4) the duration of time after egg-laying when larval habitat is required.

Expert elicitation will yield the following functions:

1) Timing will be characterized by a function, τ_d, which describes the proportion of eggs laid on a particular day (under the assumption that conditions are good enough that a cue was not required). Note that the sum of τ_d over all days in the spring/summer will sum to 1.
2) The cue analysis will yield a single parameter, κ, indicating the discharge under which a cue of a 100 cfs increase in flow is required to cue egg laying.
3) The larval habitat analysis will yield functions, γ, describing how discharge is related to relative larval habitat availability for a given river segment and time period (for now we ignore subscripts).
4) The duration, δ, after egg-laying for which larval habitat is required for a given cohort to have reasonable survival.

Given the functions/parameters described above, a year's hydrograph will be analyzed by:

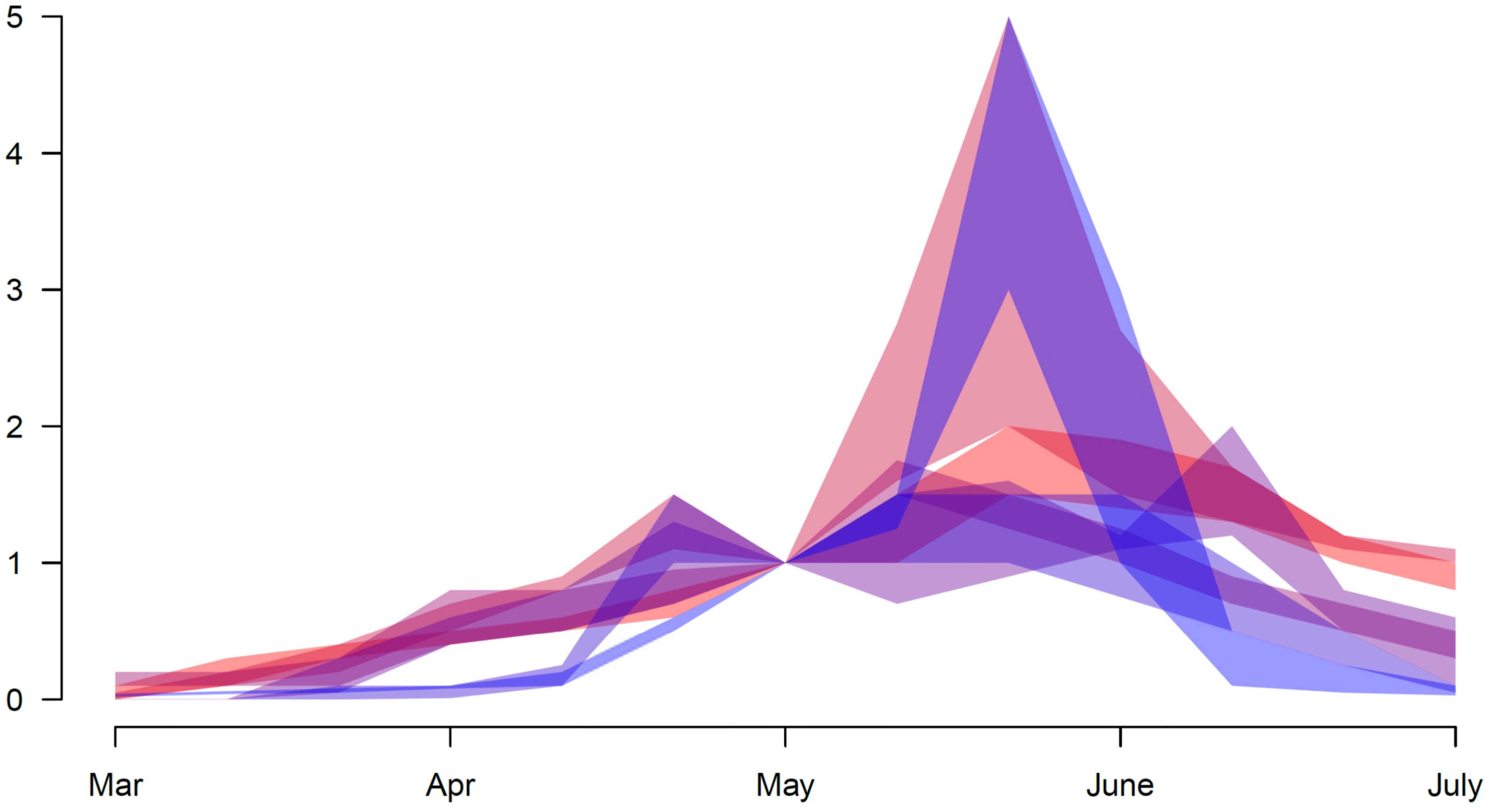
1) Calculating the first day of the reproductive season in that year, *y*, and segment, S, when either discharge was greater than κ, or the change in discharge from the day before was 100 cfs or greater, we refer to this day as $d^*_{S,y}$.
2) Calculating the following quantity meant to represent the cumulative amount of larval habitat, ***L***, for a given river segment, S, and year, y:

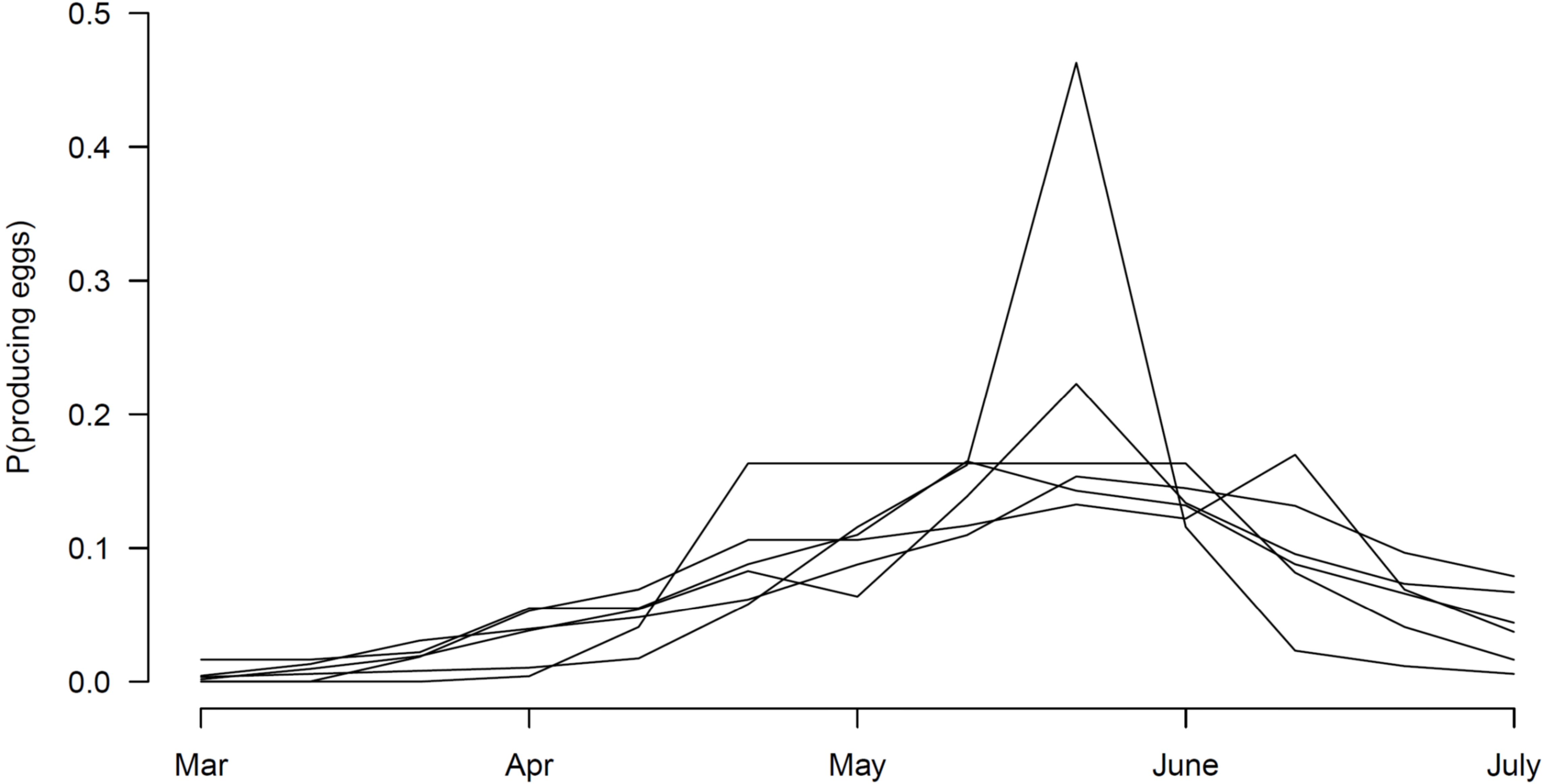
$$L_{S,y} = \min\left\{\gamma\left(Q_{d^*_{S,y}}\right), \gamma\left(Q_{d^*_{S,y}+1}\right), \ldots, \gamma\left(Q_{d^*_{S,y}+\delta}\right)\right\} \sum_{d=1}^{d^*_{S,y}} \tau_d + \sum_{d=d^*_{S,y}}^{D} \tau_d \min\{\gamma(Q_d), \gamma(Q_{d+1}), \ldots, \gamma(Q_{d+\delta})\}$$

Which suggests an underlying model based on a couple key hypotheses:

a) Individual females develop eggs with a schedule described by τ_d. In good years, eggs are laid as soon as females develop eggs.
b) In years when flows are below κ, females wait until a change in flow of 100 cfs or more and will produce eggs once that occurs.
c) Once eggs are laid, there relative success in producing juveniles is determined by the minimum amount of larval habitat over the duration of time when they require this habitat, δ.

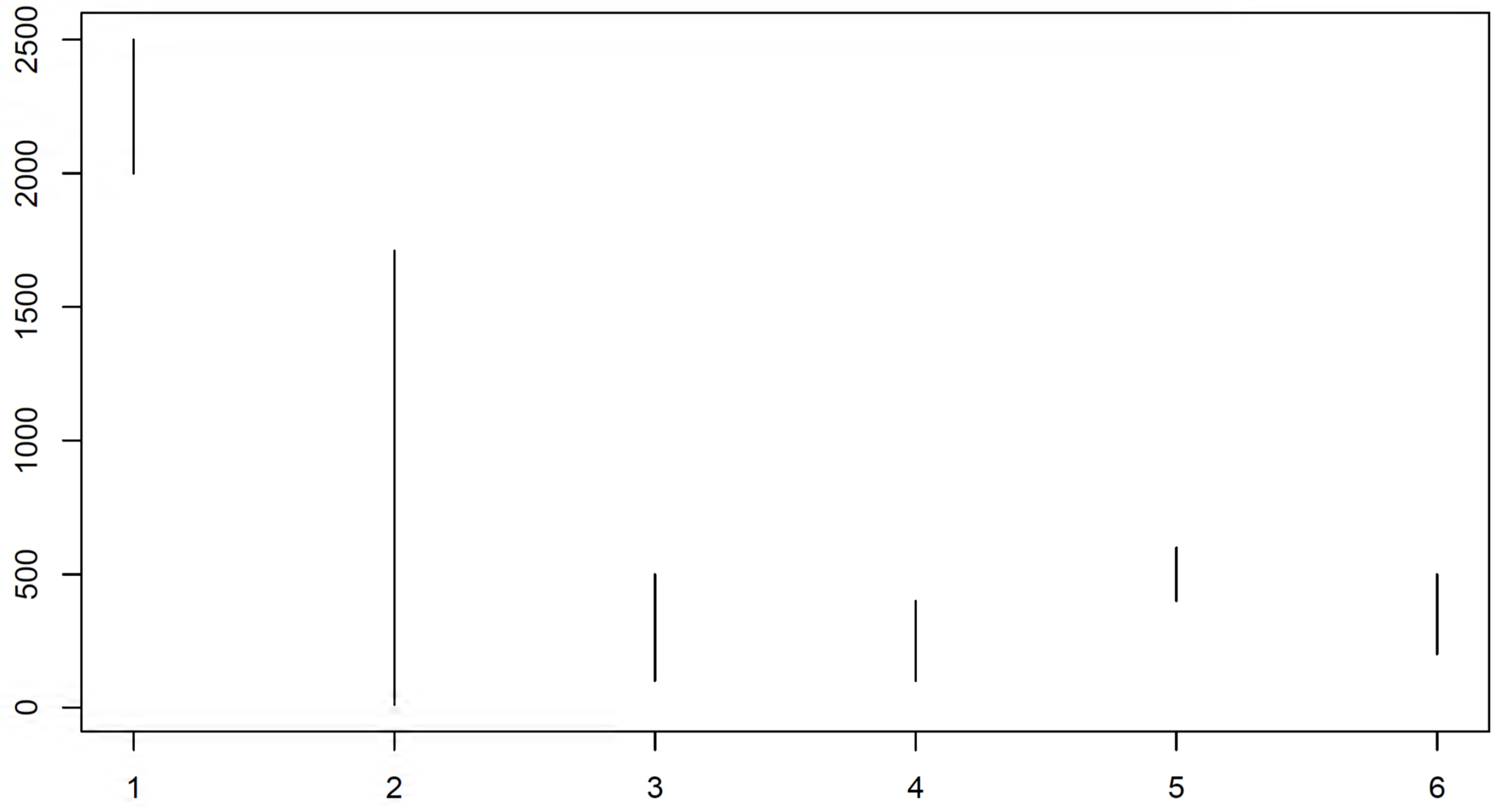
Question 1


5
4
3
2
1
0
Mar
Apr
May
June
July

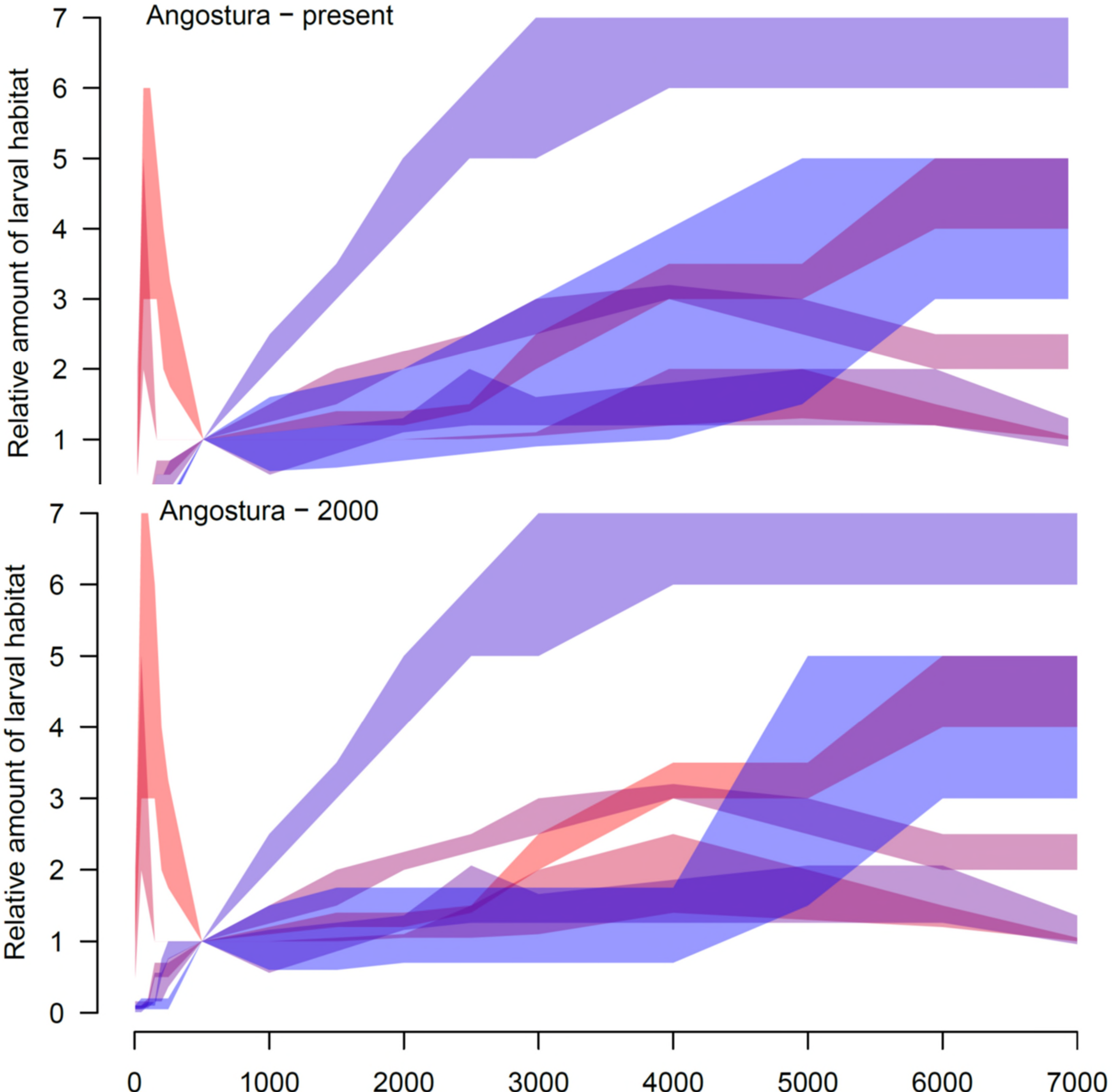


P(producing eggs)
0.5
0.4
0.3
0.2
0.1
0.0
Mar
Apr
May
June
July

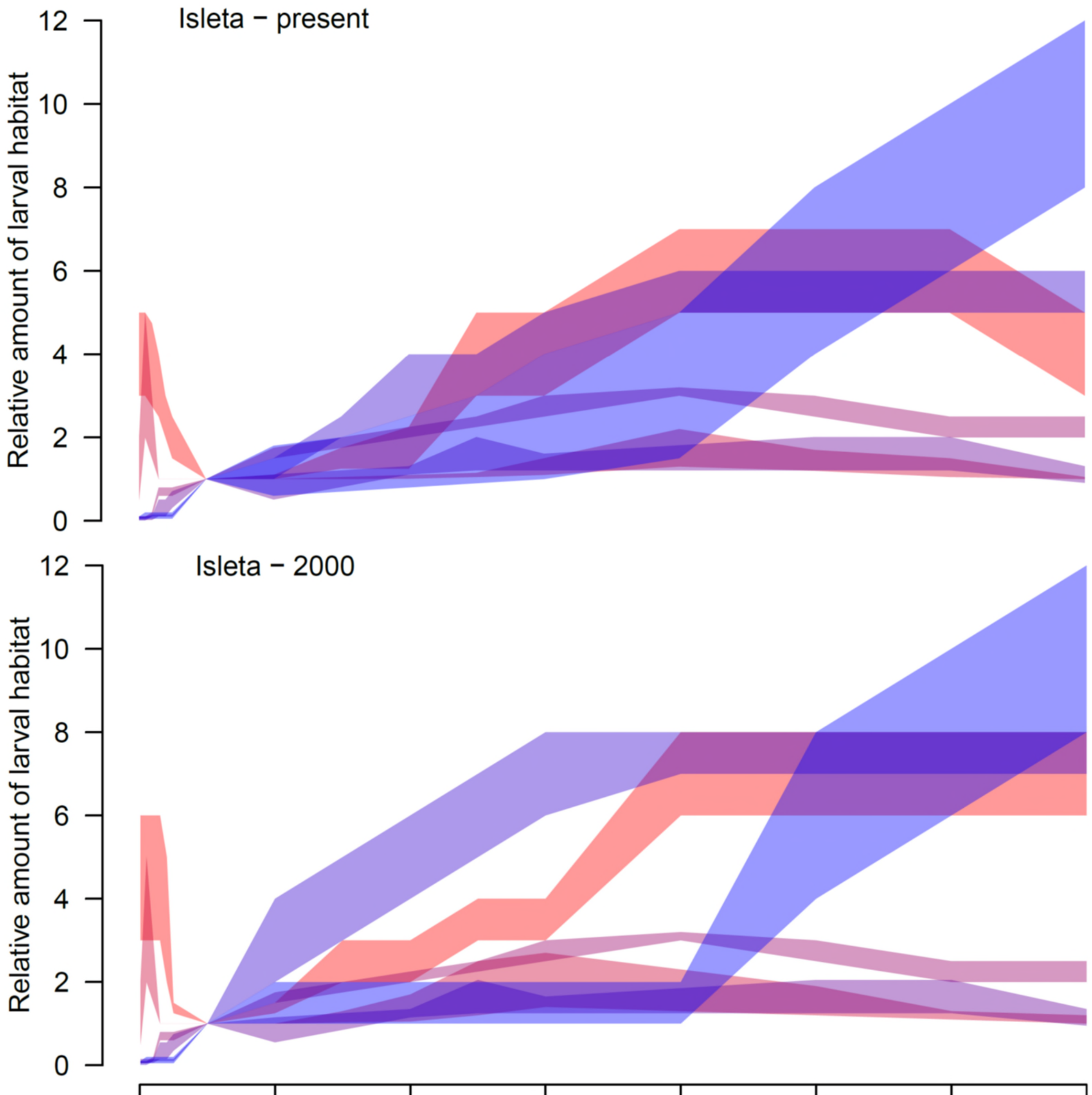
Question 2

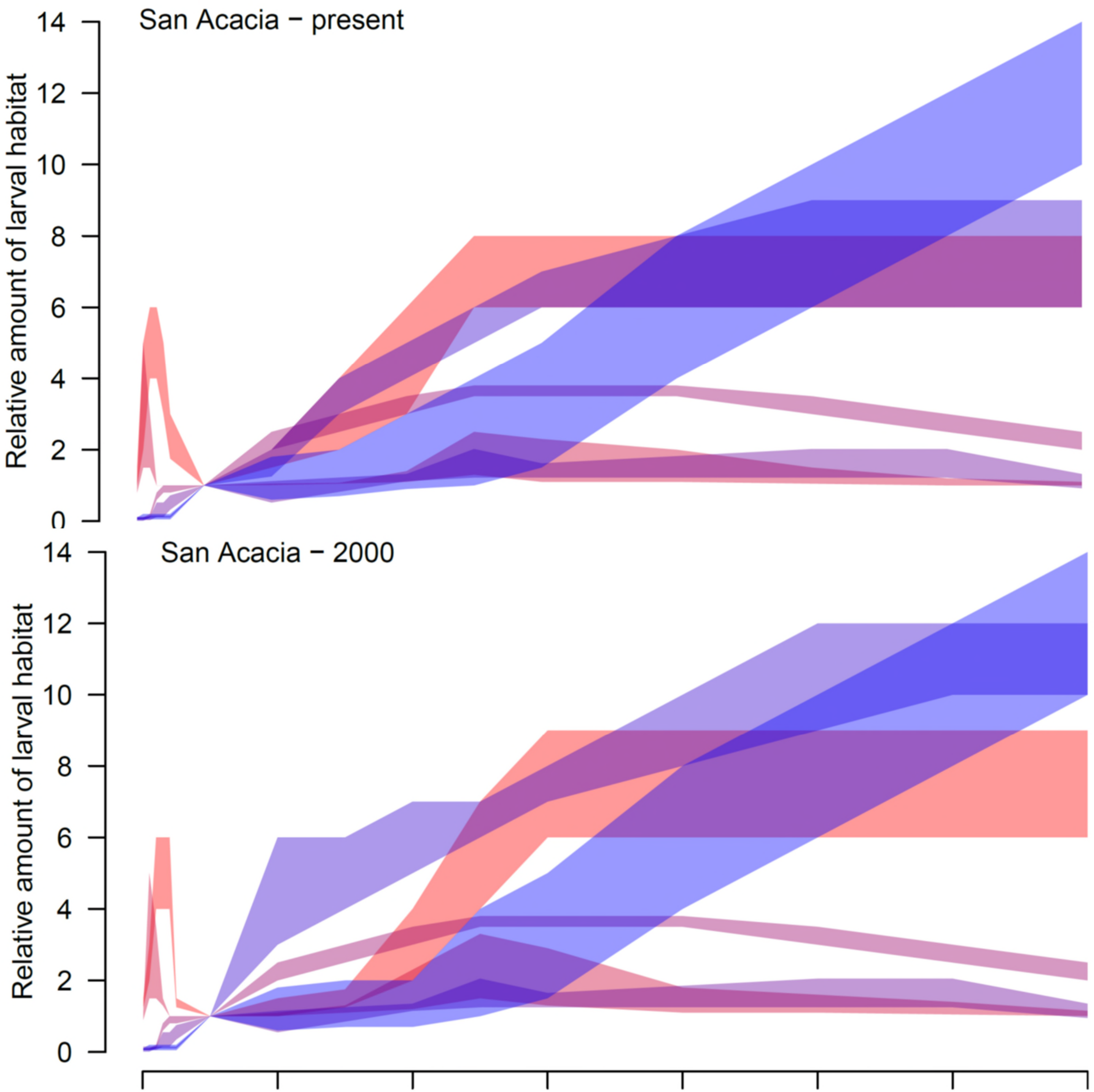

2500
2000
1500
1000
500
0
1
2
3
4
5
6

Question 3



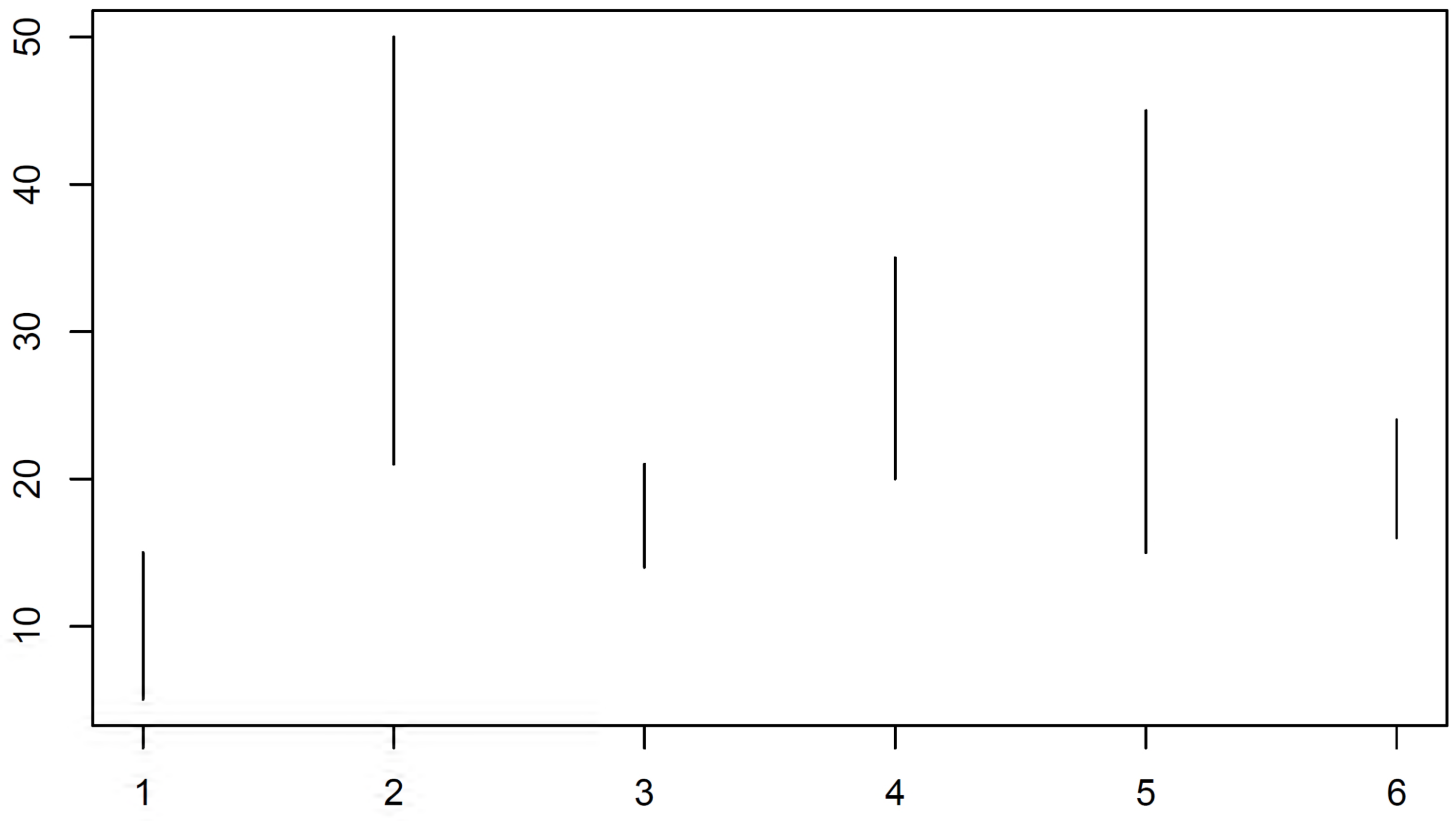
Angostura − present
Relative amount of larval habitat
1
2
3
4
5
6
7
Angostura − 2000
Relative amount of larval habitat
0
1
2
3
4
5
6
7
0
1000
2000
3000
4000
5000
6000
7000


Isleta − present
Relative amount of larval habitat
0
2
4
6
8
10
12
Isleta − 2000
Relative amount of larval habitat
0
2
4
6
8
10
12

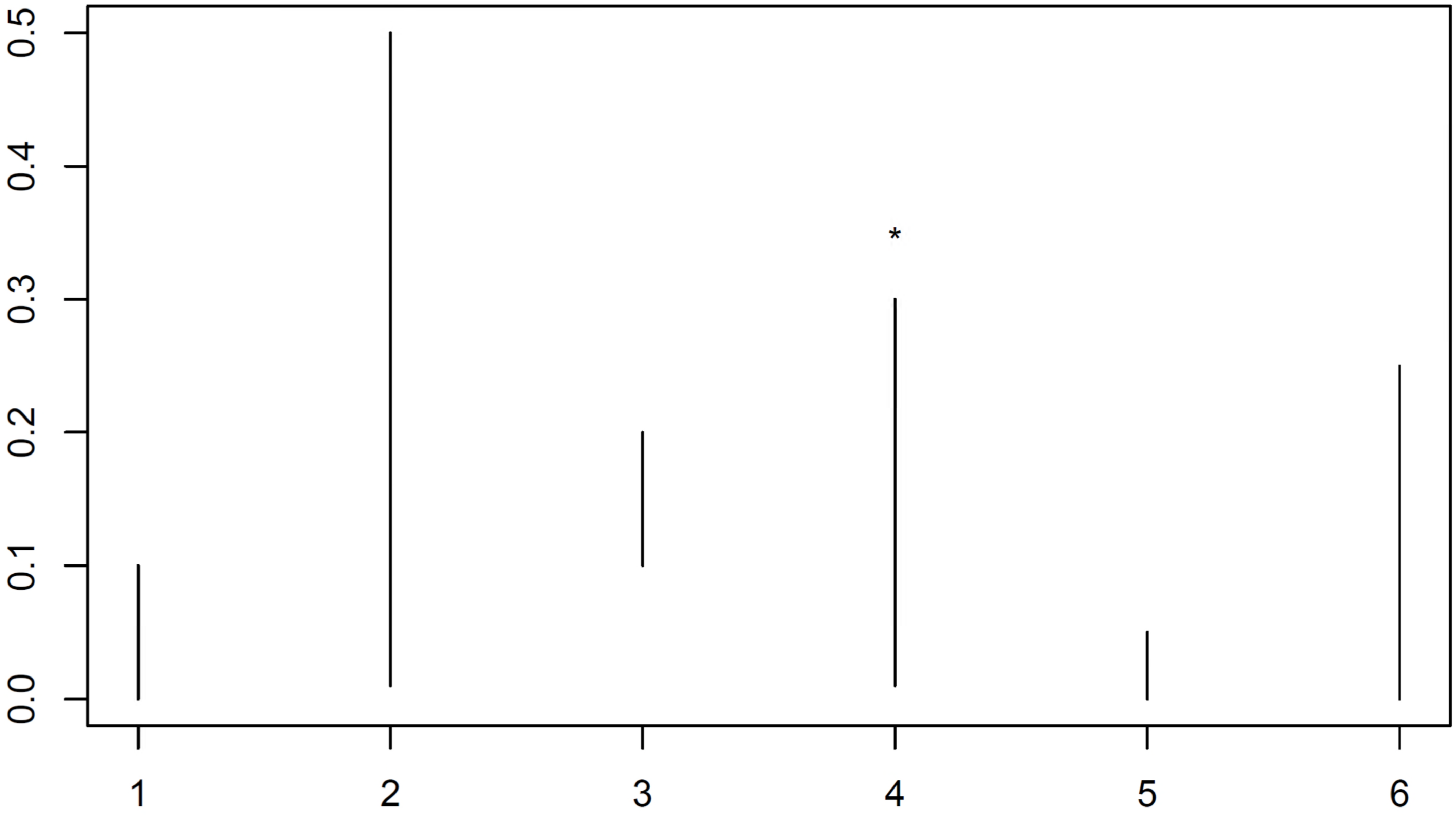


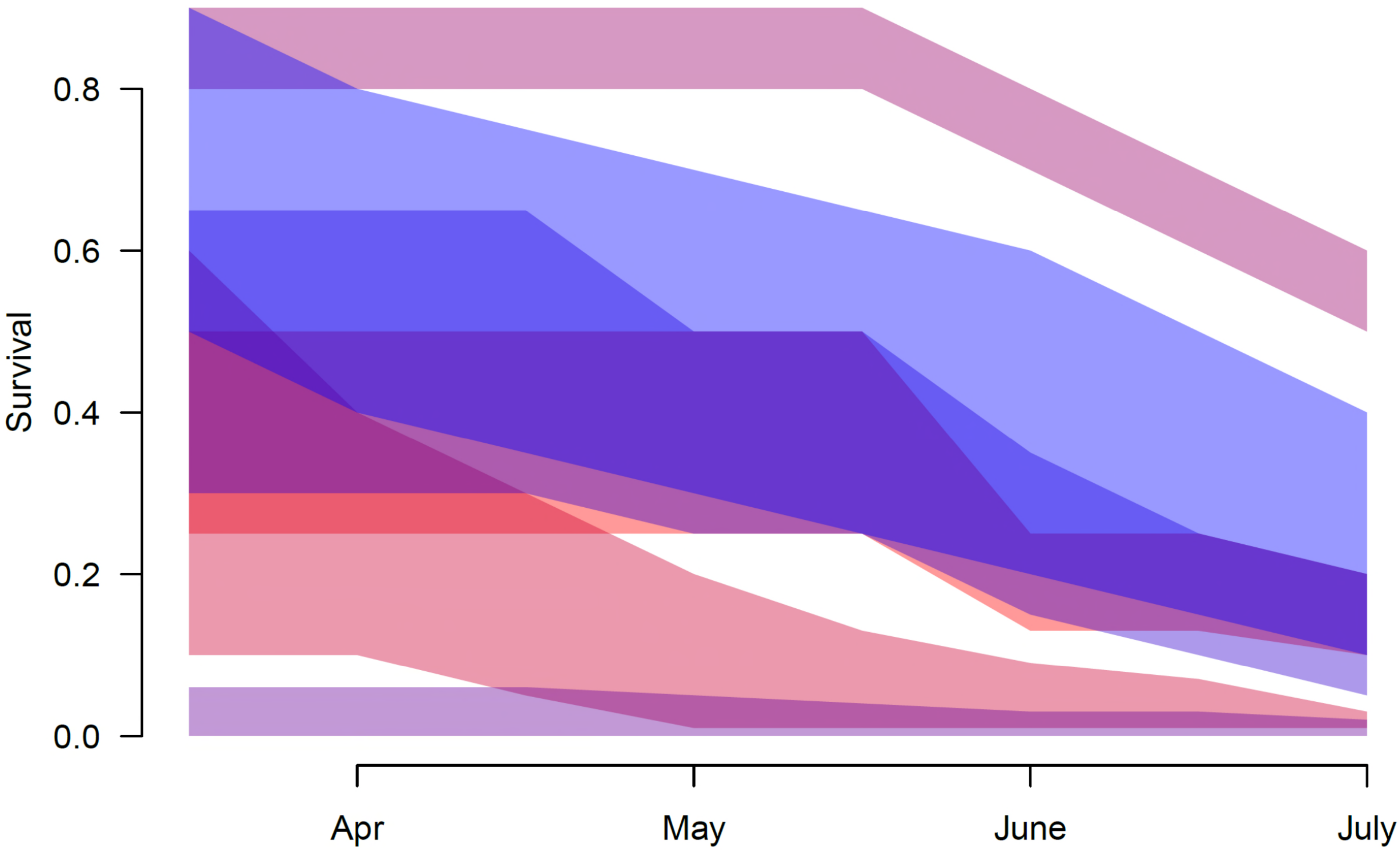
San Acacia − present
San Acacia − 2000
Relative amount of larval habitat
0
2
4
6
8
10
12
14

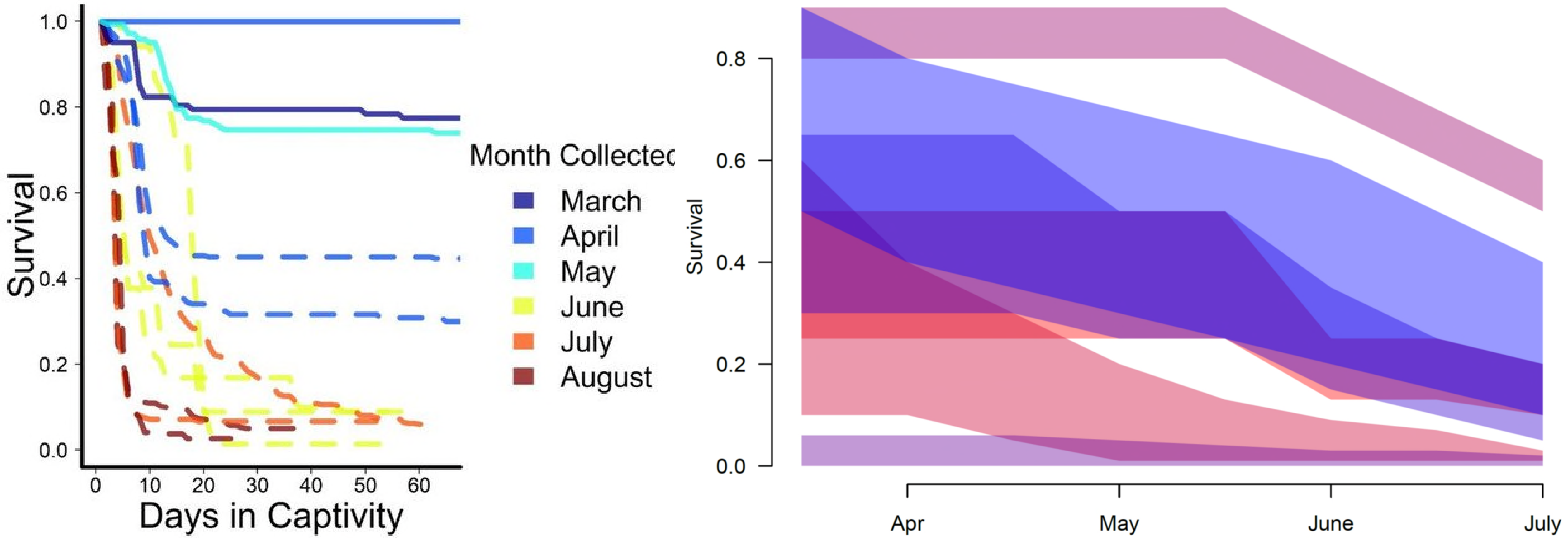
Question 4


10
20
30
40
50
1
2
3
4
5
6

Question 5

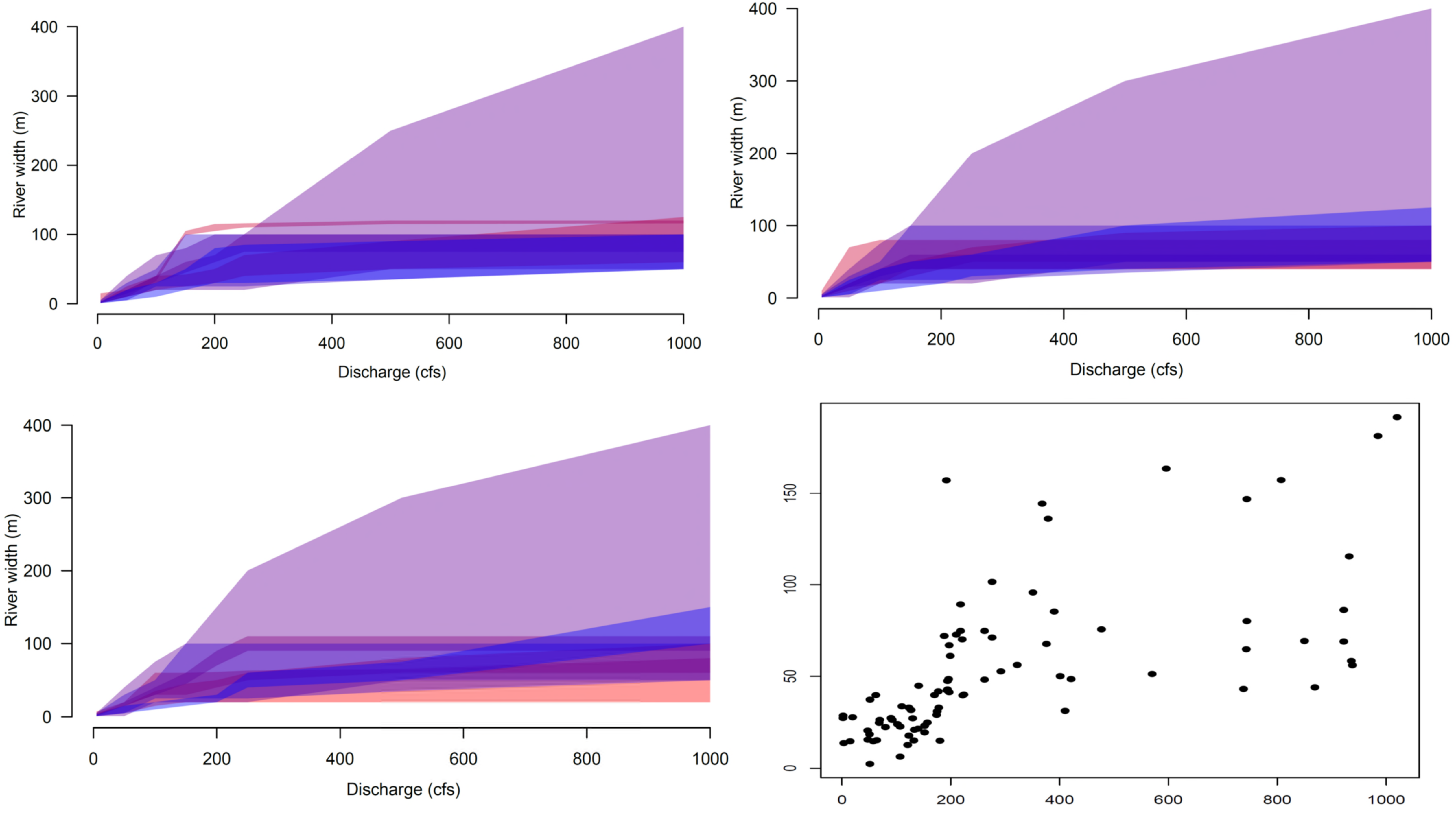

0.0
0.1
0.2
0.3
0.4
0.5
*
1
2
3
4
5
6


Survival
0.0
0.2
0.4
0.6
0.8
Apr
May
June
July

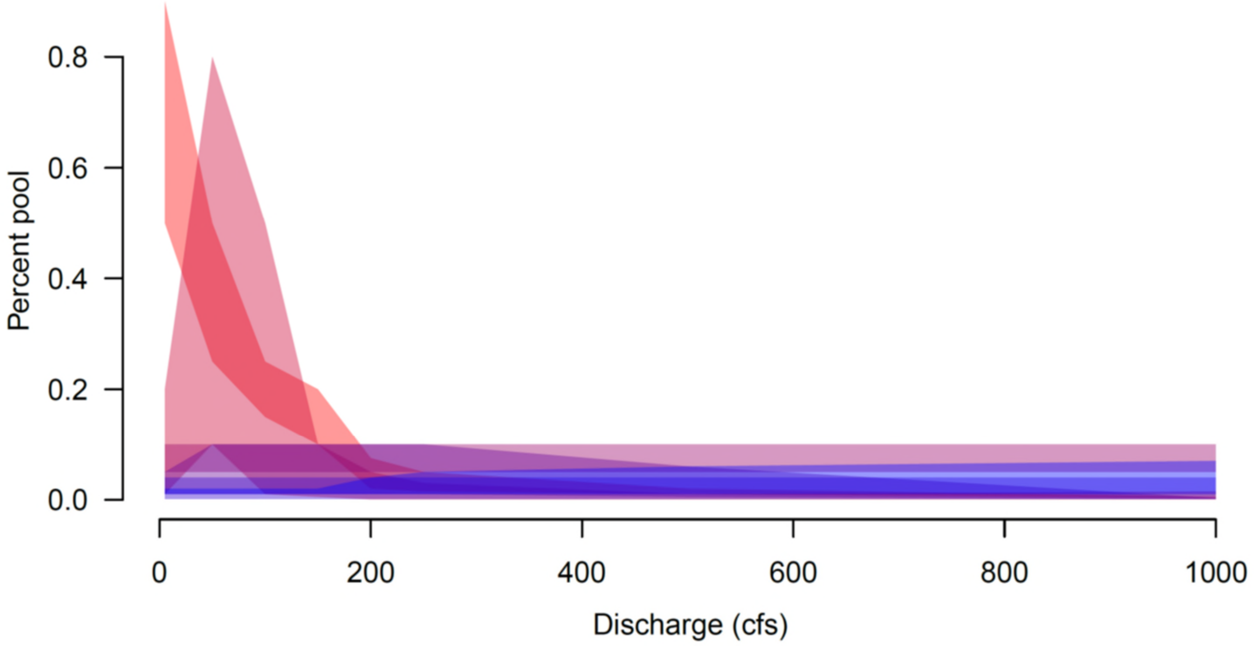


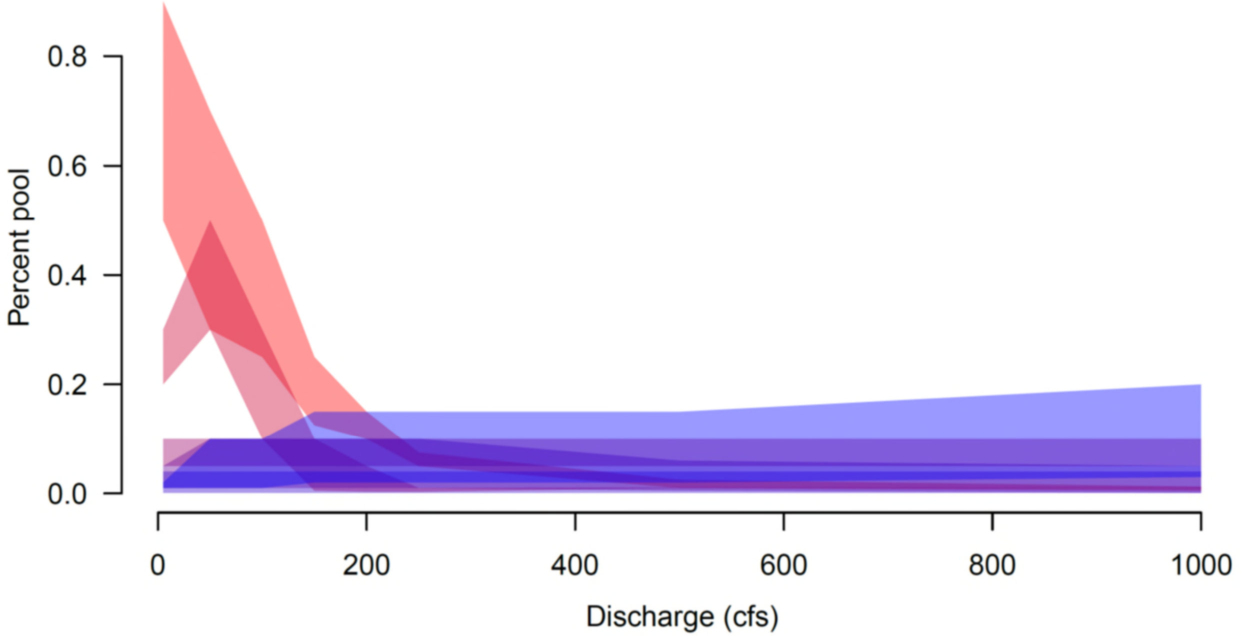
Survival
1.0
0.8
0.6
0.4
0.2
0.0
0
10
20
30
40
50
60
Days in Captivity
Month Collectec
March
April
May
June
July
August
Survival
0.8
0.6
0.4
0.2
0.0
Apr
May
June
July

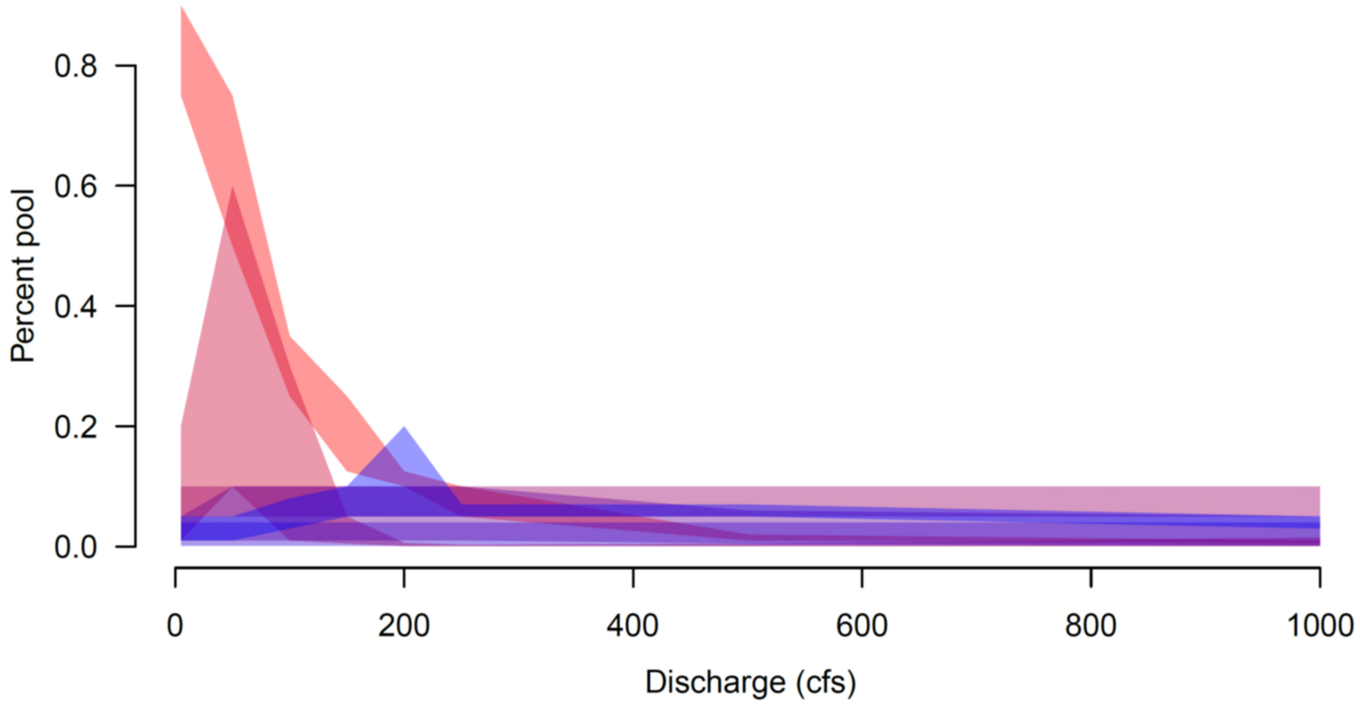
Question 6

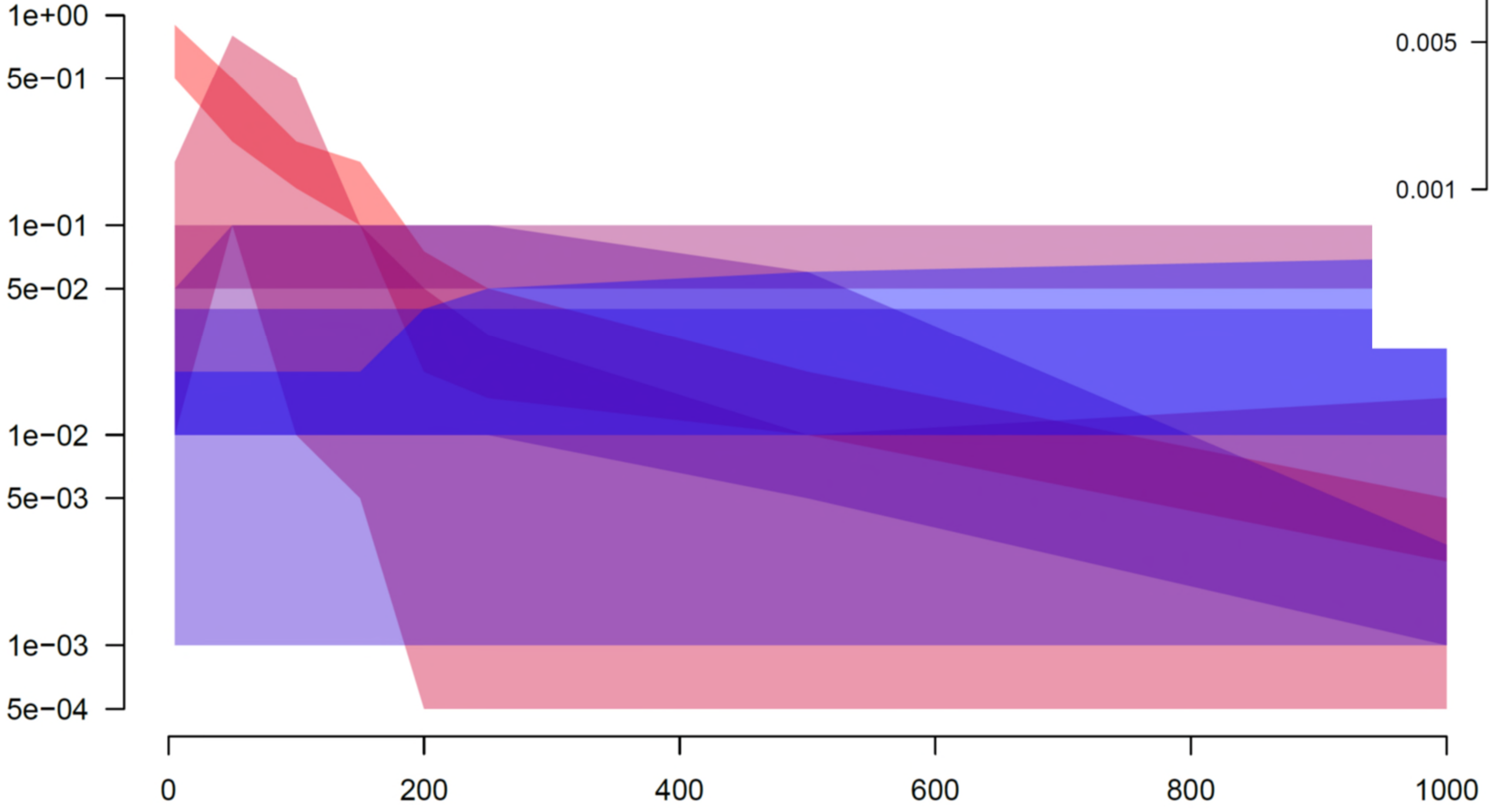


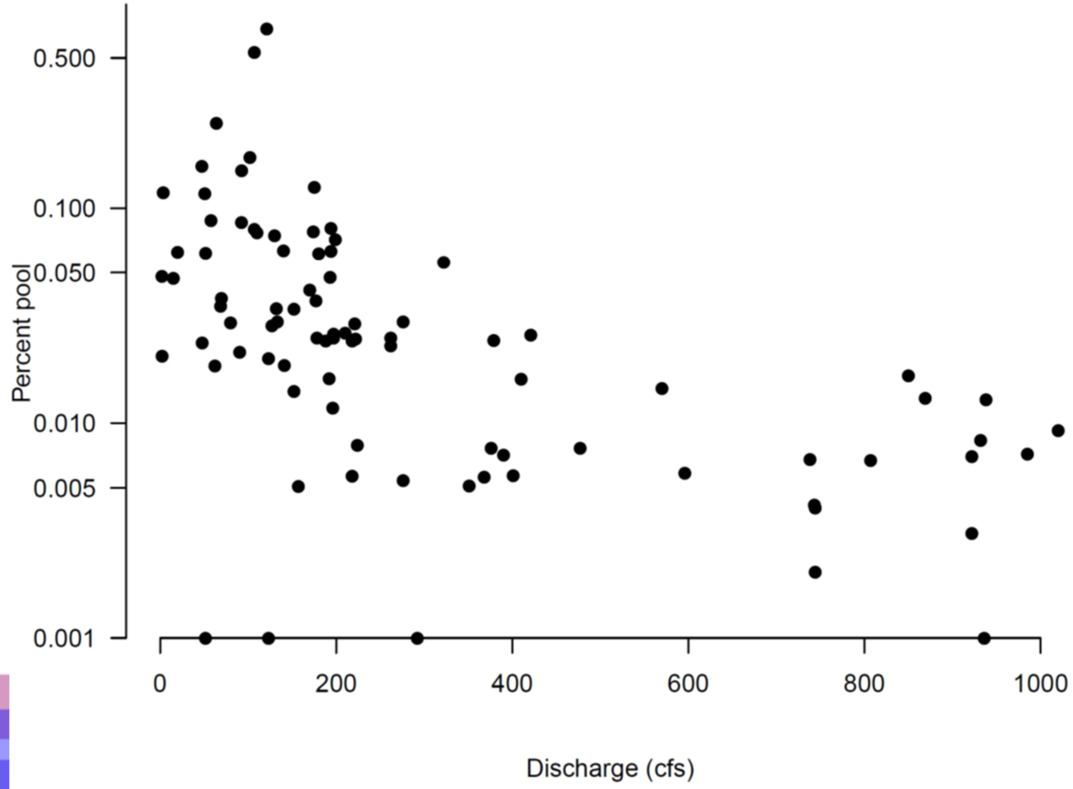
River width (m)
Discharge (cfs)
River width (m)
Discharge (cfs)
River width (m)
Discharge (cfs)


0.8
0.6
0.4
0.2
0.0
Percent pool
0
200
400
600
800
1000
Discharge (cfs)

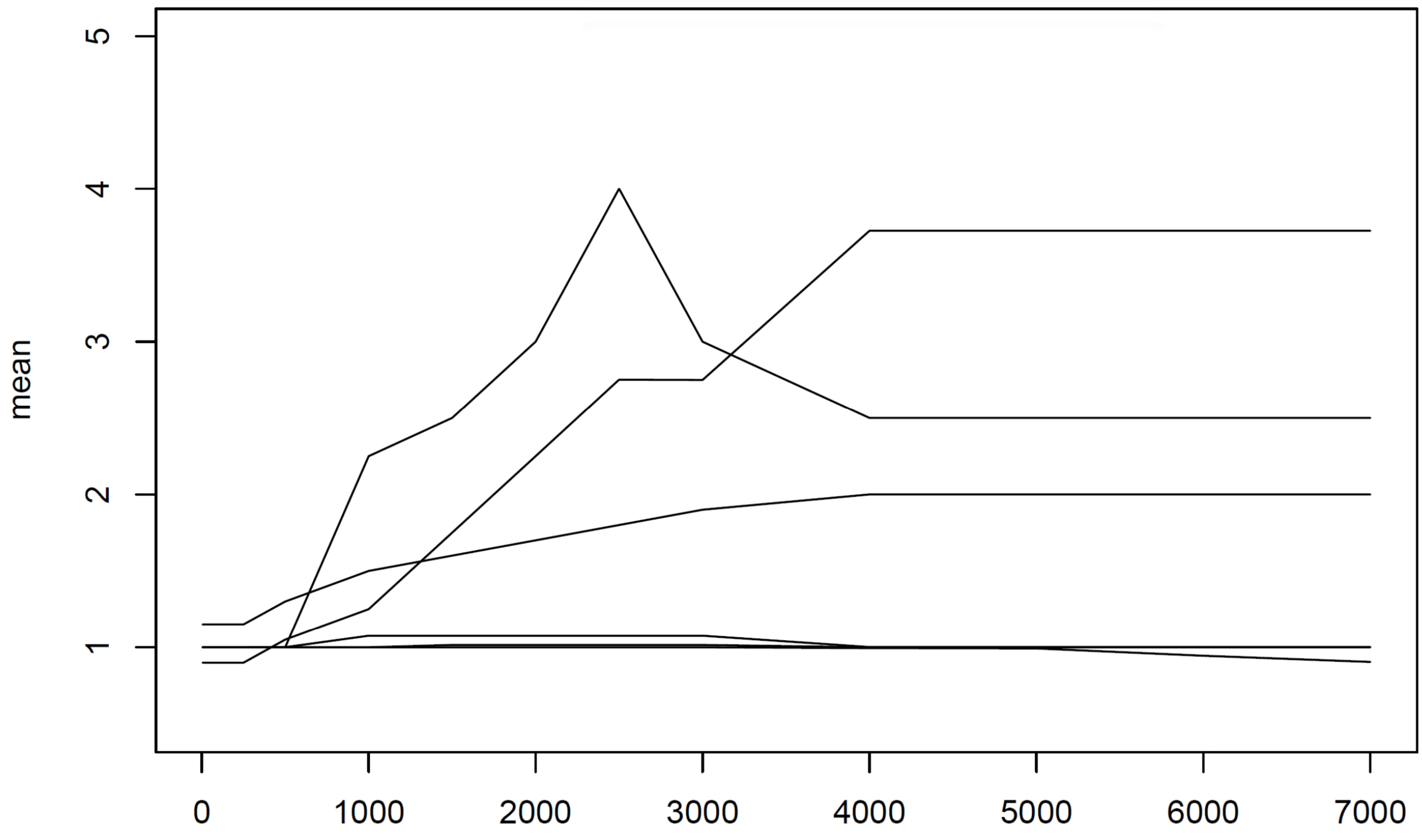

0.8
0.6
0.4
0.2
0.0
Percent pool
0
200
400
600
800
1000
Discharge (cfs)


0.8
0.6
0.4
0.2
0.0
Percent pool
0
200
400
600
800
1000
Discharge (cfs)


1e+00
5e-01
1e-01
5e-02
1e-02
5e-03
1e-03
5e-04
0
200
400
600
800
1000


Percent pool
0.500
0.100
0.050
0.010
0.005
0.001
0
200
400
600
800
1000
Discharge (cfs)

Question 7


mean
1
2
3
4
5
0
1000
2000
3000
4000
5000
6000
7000

To: Population Monitoring Workgroup
From: Rich Valdez, Chair
Subject: Comments on Findings and Recommendations of the PMWG Report to the Executive Committee
Date: December 2, 2020

- The Draft PMWG Report to the EC is near completion, and preliminary Findings and Recommendations have been developed.
- Included in this workbook are two worksheets, one for Findings and one for Recommendations.
- Please review each worksheet and provide comments as requested in the column headings.
    - Column A: contains the written Findings or Recommendations--do not edit or alter these.
    - Column B: if you agree with the statement as written in column A, write "Agree" and provide reason(s).
    - Column C: if you generally agree with the statement in column A, provide comment or recommended rewording.
    - Column D: if you disagree with the statement as written in column A, write "Disagree" and provide reason(s).
    - Column E: if you disagree with the statement in column A, provide alternative language and analysis.
    - **Please provide succinct language.**
- These Findings and Recommendations will be presented to the Executive Committee of the MRG Collaborative Program on December 17, 20
- Please provide comments back to Rich Valdez by COB on Tuesday, December 8, 2020, so that this information can be sent to the EC as a rea
- Thank you.

Findings	If You Agree, Write "Agree" and Provide Reason(s)	If You Generally Agree, Provide Comment or Recommended Rewording	If You Disagree, Write "Disagree" and Provide Reason(s)	If You Disagree, Provide Alternative Language and Analysis
• **Role of Fish Monitoring in the MRG**. Data from the fish monitoring program are used for a variety of program-related functions, including (1) annual October census of RGSM abundance, (2) criteria for the RGSM recovery plan, (3) criteria for the incidental take statement (ITS) of the 2016 Biological Opinion (BiOp), (4) guidance to determine augmentation (stocking) targets for RGSM, (5) criteria for compliance with the 2016 BiOp for river operations and maintenance, (6) environmental flow analyses, and (7) modeling species viability and relationships to hydrology.				
• **Value of Ongoing Long-Term Monitoring Program**. The 26-year program provides a valuable long-term record of the CPUE index from data collected in a systematic and consistent manner since 2002, with fewer samples taken less frequently prior to 2002. Annual monitoring of the RGSM is necessary as the species is short-lived with high inter-annual variability in abundance.				
• **CPUE is a Suitable Index**. CPUE is a suitable index for measuring relative density of the RGSM. Other methods such as mark-recapture or depletion have not been evaluated, but could be difficult, expensive, and possibly ineffective because of the small size and short-lived nature of the RGSM. Further, the relationship of CPUE to abundance of RGSM in the MRG is unresolved.				
• **Sampling Design is Suitable for Trends**. The current sampling design is suitable to characterize the trend of the RGSM population (i.e., increase or decrease, and about by how much) and for estimating important demographic parameters, such as survival, recruitment, and fish growth.				
• **Low CPUE Precision Precludes Measuring Response to Management Actions**. The low precision (i.e., high variability) of CPUE, especially at low RGSM abundances, precludes using this index to measure response to specific management actions.				
• **Diminishing Return of Precision**. Precision of the CPUE may be improved by increasing the number of sites sampled monthly from 20 to 60, but does not improve substantially with more than 60 sites (diminishing return). Increasing the number of sites from 20 to 60 would involve additional cost and may not provide sufficient precision to measure response (significant change in the fish population as measured by CPUE) to specific management actions.				
• **Inherent Variability May Limit Precision**. The inherent variabilities of the RGSM population and flow and habitat of the MRG may limit our ability to obtain precise estimates of CPUE. The RGSM lives in schools of individuals that may or may not be sampled with a particular seine haul, and the river habitat is a shifting sand-bed system with variable flow that produces different conditions with every sampling event.				
• **Strong Empirical Evidence Needed Before Changing Monitoring**. Changes to the monitoring program may improve precision or reduce costs, but no change should be implemented without strong empirical evidence that an alternative sampling design and methodology will provide more accurate and precise estimates of CPUE at improved cost.				

Recommendations	If You Agree, Write "Agree" and Provide Reason(s)	If You Generally Agree, Provide Comment or Recommended Rewording	If You Disagree, Write "Disagree" and Provide Reason(s)	If You Disagree, Provide Alternative Language and Analysis
1. **Continue to implement the current fish monitoring program** annually with consideration for the recommendations listed below.				
2. **Discontinue “additional sites”** requested by the PMWG in 2017, as the three years of data (2017-2019) show no statistically significant difference in CPUE or variance with an increase of ten sites. Use these and other data instead to simulate effect of up to 60 or more sites, as described in recommendation #7 below.				
3. **Continue to use “replacement sites”** when dry sites are encountered, as described in the Replacement Sites Protocol (Reclamation, 2017b).				
4. **Design and implement a sampling protocol to augment the current fish monitoring program in October** when CPUE for RGSM in September is <2.0. Increased sampling is necessary for a more reliable CPUE when apparent abundance of RGSM is low.				
5. **Resolve the relationship of CPUE to total abundance of RGSM in the MRG** by deriving independent population estimates simultaneous to estimates of CPUE. Evaluate other population estimators including small scale, short-term mark-recapture methods.				
6. **Resolve the significance of large-size RGSM not captured during monitoring** to annual CPUE and reproductive potential. Large RGSM are captured in floodplains with fyke nets and in irrigation returns with electrofishing, but few are apparently included in the annual census.				
7. **Determine from simulation with empirical data if measuring response of RGSM to specific management actions in the MRG is feasible** with the current sampling design and existing resource and sample variability. Use various analytical techniques (e.g., bootstrap, power analysis, modeling) to evaluate numbers of seine hauls and sites to determine maximum precision of CPUE as variance, coefficient of variation, and change detection.				
8. **Implement Task 3 by developing and evaluating two or three alternative sampling designs** through simulation with empirical data to help determine if an alternative design would provide more accurate and precise estimates or indices of RGSM abundance at improved program costs. Evaluate increased numbers of sample sites, random vs nonrandom sites, different gear types and methodologies, selected mesohabitat types with highest CPUE, and limiting sampling to October as a necessary census period. Estimate costs for each alternative.				
9. **Continue to evaluate and implement the recommendations of the Hubert et al. (2016) and Noon et al. (2017) science panels**.				
10. **Continue to use integrated population modeling** to better understand complex relationships associated with CPUE and RGSM population dynamics, such as prior year class strength, age-specific survival, individual growth, and the effect of stocked fish and hydrological variables.				