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Agent Based Modeling

12/4/21

Final Model Results and Analysis

Results

The mean of the means for egg survival during drought years was 107,874 eggs (s.d. 8,373, 95% CI +/- 1,641) (Table 1). The mean of means for egg survival during flood years was 128,084 eggs (s.d. 7,832, 95% CI +/- 1,535) (Table 1). During flood years for every 1 degree celsius increase in temperature there were 1,120.7 more eggs that survived (p.value: 0.0157, 95% CI +/- 865.4, R^2 0.0631) (Figure 1), and during drought years for every 1 degree celsius increase in temperature there were 3,800.7 more eggs that survived (p.value: $7.32*10^{-10}$, 95% CI +/- 1104.9, R^2 0.3223) (Figure 2). During flood years for every 1 cfs increase in discharge there were 3.47 more eggs that survived (p.value: $2.0*10^{-16}$;95% CI +/- 0.68;R^2: 0.5081) (Figure 3), and during drought years for every 1 cfs increase in discharge there were 7.36 more eggs that survived (p.value: $3.2*10^{-13}$;95% CI +/- 1.84;R^2: 0.3921) (Figure 4).

Discussion

Bighead Carp and Silver Carp spawning, and survival were related to temperature and discharge. However, stark differences were observed between drought and flood years. The relationship between survival and habitat variables were more profound during drought years

than flood years. Temperature had little explanatory power during flood years (R^2: 0.0631; Figure 1) but was significant during drought years (R^2: 0.323; Figure 2). Increases in the same increment of discharge during drought years as flood years resulted in twice as many eggs surviving. All of these results illustrate that not only does Carp survival in the Red River rely on flood years, but slight variations in both temperature and discharge during a drought year can produce wide fluctuations in recruitment.

Model Discussion

Overall, I think this model is a rudimentary foundation for building a future model from. Things that I would change would be to have linked each individual female throughout the sixteen time-steps, because how the model runs now each week there are 1000 new females. The model does predict survival for eggs based off discharge and temperature for drought and flood years; however, I would like to add more stochasticity to the model rather than a few probabilities that could occur to make it more realistic of a real system.

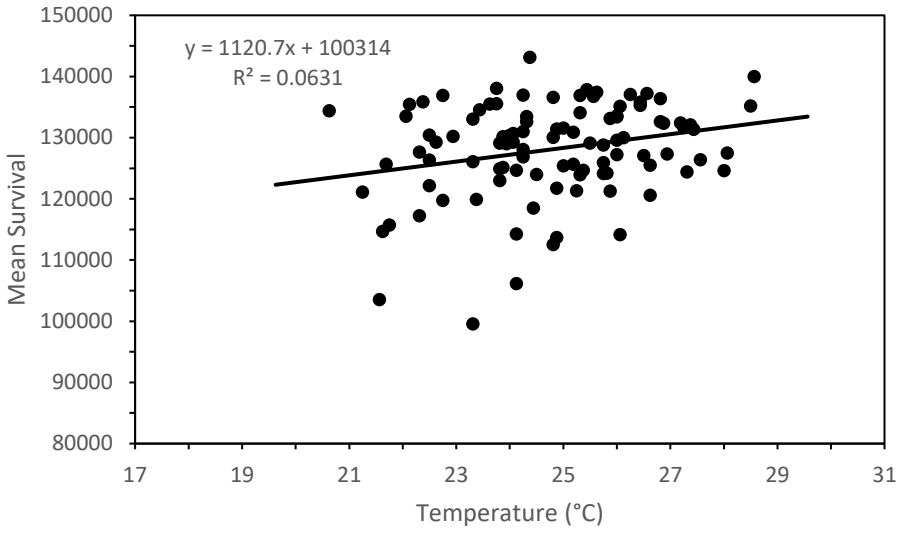

Figure 1. The mean weakly survival for the spawning season by temperature over 100 iterations for Bighead and Silver Carp in the lower Red River during a flood year.

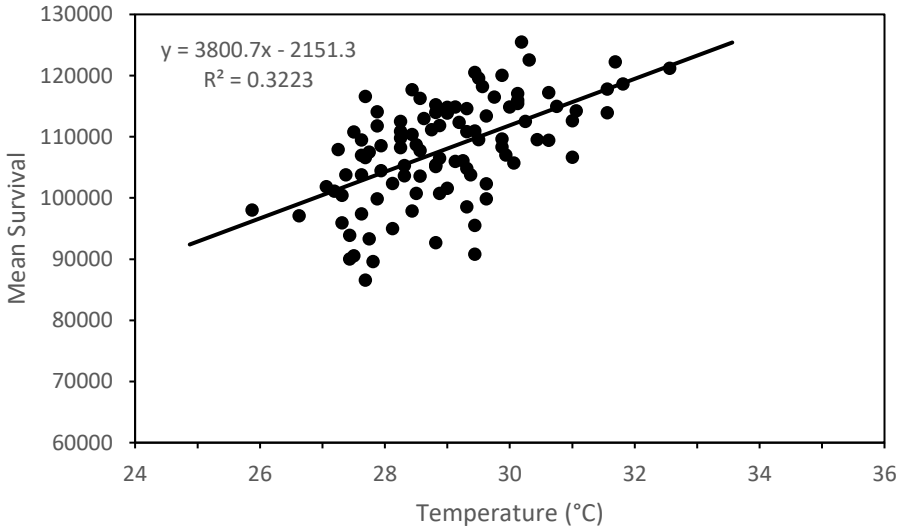

Figure 2. The mean weakly survival for the spawning season by temperature over 100 iterations for Bighead and Silver Carp in the lower Red River during a drought year.

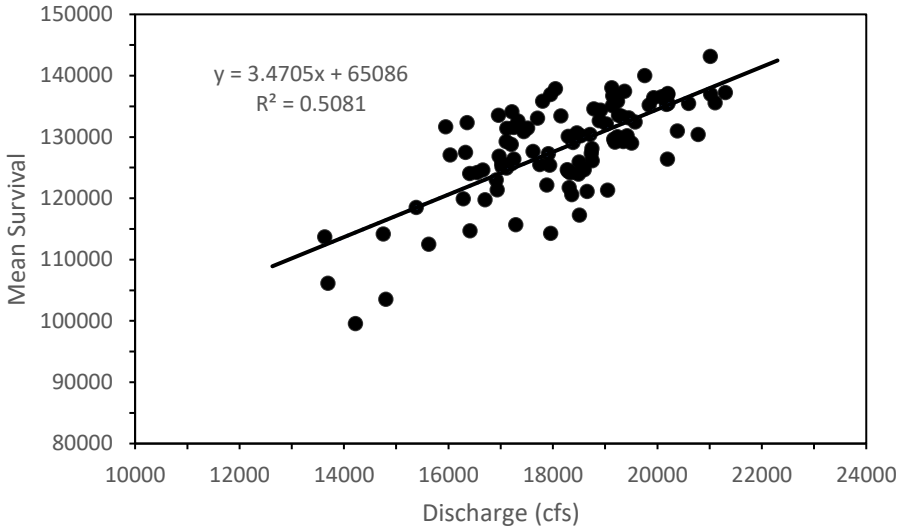

Figure 3. The mean weakly survival for the spawning season by discharge over 100 iterations for Bighead and Silver Carp in the lower Red River during a flood year.

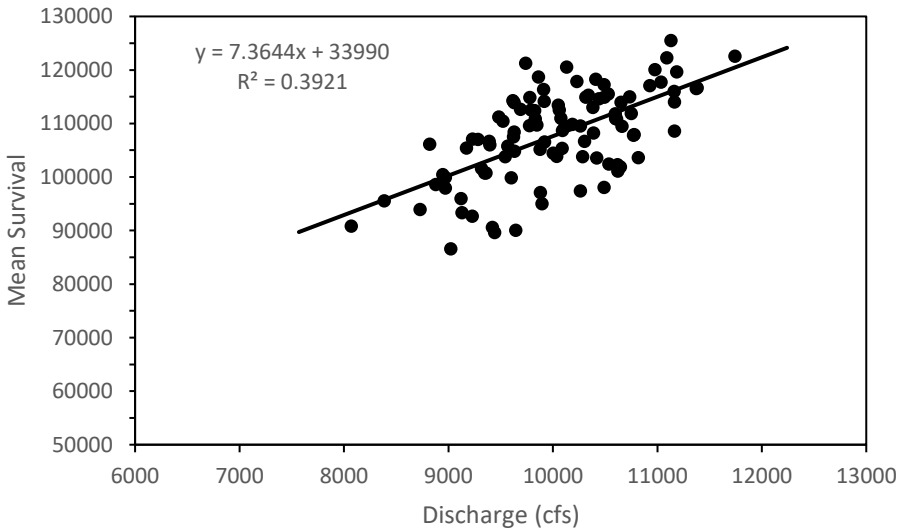

Figure 3. The mean weakly survival for the spawning season by discharge over 100 iterations for Bighead and Silver Carp in the lower Red River during a drought year.

Table 1. Mean egg survival for all 100 iterations with corresponding standard deviation (SD) and 95% confidence intervals for both drought and flood years.

Year Type	Mean of means	SD	95% CI Upper Limit	95% CI lower limit
Flood	128084	7832	126549	129619
Drought	107874	8373	106233	109515