FINAL REPORT FY2012
HABITAT ASSESSMENT FUNDED RESEARCH

Project Title: Estimating habitat related variability in natural mortality of juvenile white shrimp for incorporation into stock assessment models

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Goals:

The main goal of our project was to estimate instantaneous natural mortality rates for juvenile white shrimp *Litopenaeus setiferus* within a salt marsh in the Sabine Lake estuary (Louisiana/Texas) using both length-frequency and mark-recapture data. We also examined whether shrimp size and access to emergent marsh vegetation may be related to any differences we observed in natural mortality rates of juvenile white shrimp. We compared our results with those of previous studies where instantaneous natural mortality rates of juvenile white shrimp were estimated using similar methods. A second goal of this project was to incorporate this information on instantaneous natural mortality rates into the new SS-3 assessment model being developed for white shrimp.

Approach:

We used two different methods to estimate mortality rates within our study area. In the first approach, we conducted a mark-recapture experiment July 19-28, 2012 in two small tidal marsh ponds. The intertidal creek leading into each pond was partially blocked in the experiment to maximize the probability of recovering marked shrimp and to retain a minimum pond depth during low-water events. Juvenile (29-50 mm TL) shrimp were marked using visible implant elastomer (VIE) and released into each pond on the first day and every other day of the experiment for a total of 1,800 (900 pond^{-1}) shrimp. Marked shrimp were recaptured using a cast net on the day following each tagging event. Potential predators of juvenile shrimp collected in these samples were identified, measured, and returned to the ponds. The mark-recapture data from this experiment were analyzed using the models developed by Hoenig et al. (1998) to estimate instantaneous mortality rates. For the second method, we estimated instantaneous natural mortality rates by tracking the decline in abundance of individual cohorts of shrimp over time using length-frequency data derived from samples collected with a 1-m^2 drop sampler on July 18, August 1, and August 15, 2012. Length-frequency distributions were constructed separately for each sampling date, and individual cohorts were then separated from these distributions using the MIX program in R. The difference in abundance of a cohort during two sampling dates was then used to calculate the instantaneous mortality rate during that time period. Approximate 95% confidence intervals for these natural mortality rates were estimated using the Delta method.

Work Completed:

We estimated instantaneous natural mortality rates of juvenile white shrimp using length-frequency and mark-recapture methods, compared estimates from the two methods, and attempted to identify factors that may affect these mortality rates. Instantaneous natural mortality estimates (95% CI) obtained from two time periods (July 18-Aug 1 and Aug 1-15) using the length-frequency data were 0.053 d^{-1} (0.040 – 0.067) and 0.027 d^{-1} (0.000 – 0.054), respectively; estimates (95% CI) from the two ponds used in the mark-recapture experiment were 0.129 d^{-1} (0.054 – 0.203) and 0.014 d^{-1} (0.000 – 0.076). These estimates are comparable to the few previously reported values for this species, but we are the first to report a measure of variation with our estimates (Table 1). No relationship was detected between natural mortality rate and shrimp size. In the mark-recapture experiment, mortality rates appeared to be related to predator abundance in ponds and flooding patterns of the surrounding marsh. Shrimp had a lower mean mortality rate in the pond with fewer predators and where the adjacent marsh was continuously flooded for longer during the experiment. No significant difference could be detected in mortality estimates derived from the two methods, but this result should be interpreted with caution because of the uncertainty in our estimates, confounding factors between the methods used, and limited data available from other studies. Despite this caveat, we have provided a reasonable range of natural mortality estimates from our study and the literature that can be incorporated into the new SS-3 stock assessment model or used in other models of white shrimp populations.

Applications:

These newly derived mortality rates and variance estimates are being directly incorporated into white shrimp stock assessment sensitivity model runs. Dependent upon model fits, these rates and variance estimates will be integrated into future stock assessment models (Fall 2013).

Publications/Presentations/Webpages:

- Mace III, MM and LP Rozas (2012) A comparison of two different methods for estimating natural mortality rates of juvenile white shrimp *Litopenaeus setiferus***.** Gulf Estuarine Research Society Meeting, November 8-9, Dauphin Island Sea Lab, Alabama
- Mace III, MM and LP Rozas (2013) A comparison of two different methods for estimating natural mortality rates of juvenile white shrimp *Litopenaeus* setiferus. Coastal and Estuarine Research Federation Conference, November 4-7, San Diego, California
- Mace III, MM and LP Rozas (internal review) Variability in natural mortality rates of juvenile white shrimp *Litopenaeus setiferus* derived from two methods. Anticipate submitting to the journal *Marine Ecology Progress Series*

References:

Baker R, TJ Minello (2010) Growth and mortality of juvenile white shrimp *Litopenaeus setiferus* in a marsh pond. *Marine Ecology Progress Series* 413:95-104

Gracia A, LA Soto (1986) Estimación del tamaño de la población, crecimiento y mortalidad de los juveniles de *Penaeus setiferus* (Linnaeaus, 1767) mediante marcado recaptura en la Laguna Chacahito, Campeche, México. *Anales del Centro de Ciencias del Mar y Limnología 13:*

Hoenig JM, NJ Barrowman, WS Hearn, KH Pollock (1998a) Multiyear tagging studies incorporating fishing effort data. *Canadian Journal of Fisheries and Aquatic Sciences* 55:1466-1476

Knudsen EE, BD Rogers, RF Paille, WH Herke (1996) Juvenile white shrimp growth, mortality, and emigration in weired and unweired Louisana marsh ponds. *North American Journal of Fisheries Management* 16:640-652

Laney RW, BJ Copeland (1981) Population dynamics of penaeid shrimp in two North Carolina tidal creeks. Report 81-1 Carolina Power & Light Co., Raleigh, N.C. 161 pp

Minello TJ, GA Matthews, PA Caldwell, LP Rozas (2008) Population and production estimates for decapod crustaceans in wetlands of Galveston Bay, Texas. *Transactions of the American Fisheries Society* 137:129-146

Table 1. Summary of instantaneous natural mortality estimates for juvenile white shrimp *Litopenaeus setiferus*. The source of the data (reference), method used to compute the mortality rate, mortality estimates (M), 95% confidence intervals for M estimates, location of the study, and the size range of shrimp used in the study are provided. All natural mortality estimates were rounded to the nearest hundredth. Estimates were converted to daily rates when reported in other units.

Reference	Method	M d^{-1}	95% CI	Location	Size (mm TL)
Laney (1981)	Catch-curve	0.01 - 0.09	-	North Carolina, USA	36 - 126
Gracia (1986)	Mark-recapture	0.03	-	Terminos Lagoon, Mexico	75 - 104
Gracia (1986)	Length-frequency	0.03	-	Terminos Lagoon, Mexico	80 - 120
Knudsen et al. (1996)	Mark-recapture	0.02 - 0.07	-	Louisiana, USA	45 - 68
Minello et al. (2008)	Catch-curve	0.03	-	Texas, USA	10 - 70
Baker & Minello (2010)	Catch-curve	0.18, 0.08	-	Texas, USA	11 - 70
Present Study	Mark-recapture	0.01, 0.13	0.00-0.08, 0.05-0.20	Louisiana, USA	29 - 50
Present Study	Length-frequency	0.03, 0.05	0.00-0.05, 0.04-0.07	Louisiana, USA	5 - 60