AN EVALUATION OF SHRIMP *Litopenaeus vannamei* STOCKING PRACTICES IN MINIMAL EXCHANGE SUPERINTENSIVE BIOFLOC CULTURE SYSTEMS

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Introduction

Accurately knowing the number of shrimp in a culture unit is critical for managers to estimate harvest size and to administer appropriate feed rations. If the population is underestimated, the animals will be under-fed, leading to poor growth. If the system is over-fed due to an overestimation of the population, unnecessary nutrients may cause oxygen depletion and toxic ammonia accumulation in addition to significant economic losses caused by wasted feed. In order to accurately know the population size, one must start with an accurate estimation of the stocking number. The mean weight of multiple groups of shrimp is commonly used to determine the quantity of shrimp, by weight, needed to stock at a particular density. However, some portion of shrimp that are stocked die due to the stress of handling and transport, but exactly how many succumb to stocking mortality is generally ignored.

This project had two goals:

1. Evaluate the most efficient number of samples necessary to accurately estimate the mean weight of juvenile shrimp prior to transfer.
2. Quantify the effects of stocking mortality and stocking error on population size present at the beginning of the growout period.

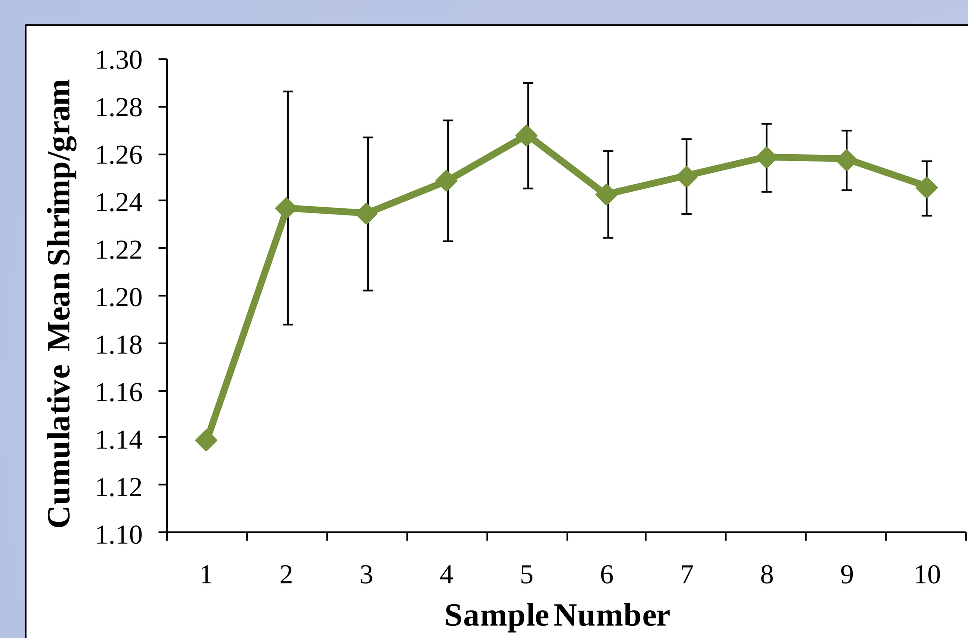
Materials and Methods

Shrimp were raised in a raceway nursery system for eight weeks. Groups of animals were collected and batches of approximately 200 g were weighed. Two people counted each batch of shrimp, the mean of the two counts was divided by the batch weight to determine the number of shrimp per gram. The cumulative mean and cumulative coefficient of variation (CV) were calculated with each new sample. Samples were collected and plotted graphically until the cumulative mean remained roughly constant. Equation 1 was calculated iteratively to quantify the number of sequential samples necessary to estimate the mean weight of animals with a 95% confidence interval no wider than 10% of the mean.

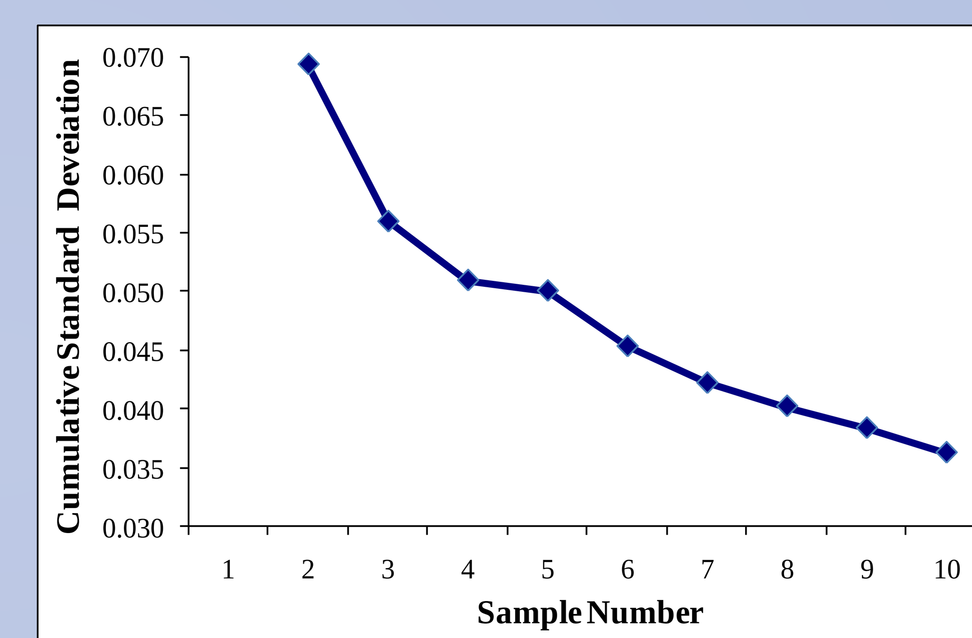
Ten well aerated, 1-2 m^3, outdoor tanks were filled with water from the nursery system and stocked with shrimp. Routine stocking practices were followed. Shrimp were moved by placing the weight equivalent of 250 individuals into two, 16 L buckets containing mixed water from both the nursery and the receiving tank. After an acclimation period, shrimp were gently placed into the tanks, with the goal of adding 500 shrimp per tank. Shrimp were held in the tanks for approximately 24 hours, after which the number of living shrimp from each tank was counted.

The raceway nursery system from which shrimp were sampled. Shrimp had been in the nursery for eight weeks prior to beginning this experiment.

Shrimp were hand counted for both experiments. We found that error between individual counters was minimal.



The cumulative mean individual shrimp per gram. Error bars represent one standard error (SE) around the mean. As sample number increased, the mean became more consistent and SE decreased.



Cumulative standard deviation of shrimp weight, calculated after each sample. As sample number increased, standard deviation decreased.

	Shrimp per Gram
Mean	1.246
Standard Deviation	0.085
Standard Error	0.027
Coefficient of Variation	0.069

Overall, end descriptive values after sampling 10, approximately 200 g batches of shrimp.

Equation (1) $n = (s^2)*(t^2_{0.05(2),10})/d^2$ *used to estimate necessary sample size*

Equation (2) $\text{mean} \pm SE*t_{0.05(2),10}$ *used to determine confidence intervals*

s = standard deviation; $t_{0.05(2),10}^2$ = test statistic; d = half width of desired confidence interval; P=0.05; 10 degrees of freedom (Zar, J.H. 1999. *Biostatistical Analysis*. Prentice Hall).

The ten tanks used to assess stocking mortality, each was stocked with 500 shrimp.

	Surviving Shrimp per Tank
Mean	453.80
Standard Deviation	36.18
Standard Error	11.44
Coefficient of Variation	0.08

Descriptive parameters of the shrimp remaining in each of the ten tanks after 24 hours.

Results and Discussion

We found that after ten, approximately 200 g samples had been counted, the CV for shrimp per gram was reasonably low at 6.9%. The cumulative mean became relatively consistent, and the standard error and standard deviation were each highly reduced after ten samples. Equation 1 indicated that 9.24 samples were required to achieve the desired 10% confidence bound around the mean, suggesting that 10 samples would be more than adequate. After the ten samples were counted, it was determined that shrimp in the nursery were 0.803 ± 0.061 g. The 95% confidence interval surrounded the mean by bounds of ± 0.049, a total width of less than 10% of the mean (Equation 2).

In the ten stocked tanks, a mean of 91.8% of the estimated stocked population survived after the 24 hour post-stocking period. One of the ten tanks had 4.8% more than 500 shrimp, still within the previously established confidence bounds. If the difference in shrimp numbers was due only to variation in weight estimates, it would be expected that more tanks would have survival numbers above 500. In fact, the mean loss of 8.2% of shrimp is well outside of the estimated stocking confidence bounds. This fact, as well as the presence of some dead shrimp, indicates that the 8.2% loss is likely due to stress-induced stocking mortality.

Conclusions

This project demonstrated that to accurately estimate the weight of post larvae shrimp in a nursery, at least ten samples are required to bring sampling variance to an acceptably low level, i.e. confidence intervals within 5% of the mean. Although these are still estimates, system managers benefit from knowing the reasonably narrow range of such error. Although additional samples would continue to reduce the cumulative mean deviation, the human labor and handling stress incurred by the shrimp probably do not justify the extra sampling. This study also indicates that roughly 8.2% of shrimp stocked into growout culture units may succumb to stocking-related mortality.

Both of the approaches described and the resulting data can provide shrimp culture managers with more accurate estimates of shrimp populations at the start of growout. Careful, sequential sampling of nursery systems will improve accuracy in meeting expected stocking densities. We recommend that stocking accuracy will be optimized by using ten samples to estimate mean shrimp weight when stocking shrimp into the growout culture unit. Survivorship studies like that described, but for a specific system and stocking protocol will better estimate the number of shrimp on the first day of growout. Application of these relatively simple approaches will optimize feeding, minimize waste accumulation, and improve harvest projections.

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