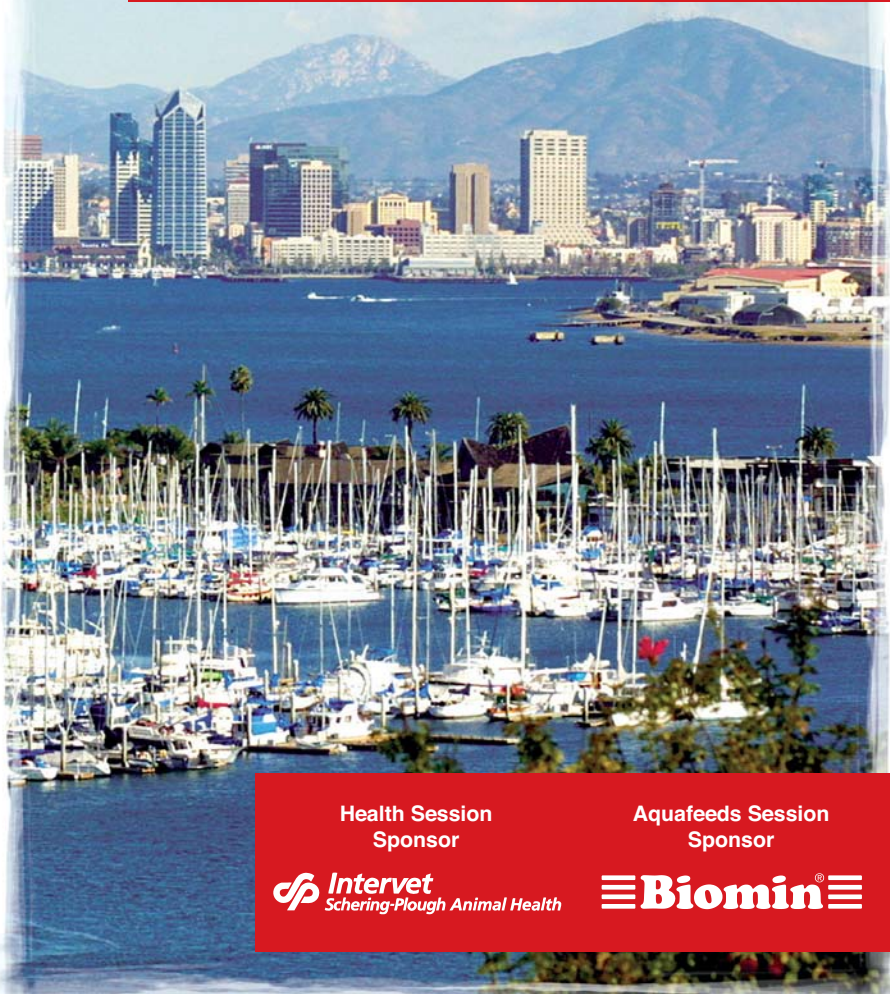


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CONSUMER ACCEPTANCE OF CULTURED SUNRAY VENUS CLAMS *Macrocallista nimbosa* IN FLORIDA

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The sunray venus clam *Macrocallista nimbosa* is being considered as an alternative species for commercial hard clam growers in Florida. Current trial production efforts appear successful. Hatchery and growout costs appear to be similar to hard clams. However, the market acceptance of the cultured sunray clam needs to be demonstrated with the Florida market area. A group of four restaurants in north central Florida agreed to participate in a market acceptance study. Each restaurant received cultured sunray venus clams each week for a period of four weeks. The clams were delivered properly tagged, as live shellstock, in styrofoam boxes, with cool packs enclosed. The chefs in each restaurant were encouraged to serve the clams utilizing any preparation method they chose and to charge any price they wished. The wait staff were instructed to ask each patron who consumed sunray venus clams to complete a brief table side questionnaire. The questionnaire solicited the patron's perception of various attributes of the sunray venus clam they just consumed, as well as patron demographic information. A total of 239 completed questionnaires were obtained from the four participating restaurants. Of the patrons who completed at least some portion of the questionnaire, 51.9% and 48.1% were male and female, respectively. Regarding respondent age, 21.3% were under the age of 30, while 39.1% were between the ages of 50 and 64. The majority of the respondents (80.7%) had resided in the southeast US for the longest portion of their lives. In addition, 92.8% of the respondents currently resided in Florida, while 87.4% of the respondents were Caucasian. Regarding product attributes, a majority (84%) of the respondents indicated the appearance was "Excellent", whereas 13% indicated that the product was "Very Good" and a total of 3% indicated that the product appearance was "Good" to "Poor". A similar ordinal pattern is seen for the other attributes, with the majority of respondents indicating that "Taste", "Texture", and "Tenderness" were either excellent or very good. The sunray venus clam possesses a grit pocket, which is located on the siphon end of the animal and is quite noticeable in wild animals. However, only 11% of the respondents indicated the presence of "grittiness" in the clams. An overwhelming majority (94%) of the respondents indicated they would order this product again at the price they paid for it. In addition, 97% of the respondents indicated they would recommend this product to others. The findings provide insight into the viability of sunray venus clams as an alternative candidate culture species.

HYBRID CLAMS (*Mercenaria mercenaria*, *M. campechiensis*) FOR FLORIDA, USA, AQUACULTURE: LABORATORY EVALUATION

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The northern hard clam, *Mercenaria mercenaria*, is an important aquaculture species in the state of Florida. Over the past decade, mortality events resulting from hurricanes, low salinities, and, potentially, high water temperatures have affected production. The local southern quahog *Mercenaria campechiensis* may offer improved production characteristics and hybridizes readily with the northern hard clam. Therefore, a rigorous examination of parental species and their crosses under laboratory and commercial conditions was conducted. The objective of the laboratory evaluation was to compare responses of hard clams, southern quahog clams, and their hybrids in controlled challenges of salinity, oxygen, and temperature. Parental species and their crosses, representing two families, were exposed to salinities of 15 or 25 ppt and hypoxic (~2 mg/L) or normoxic (>5 mg/L) dissolved oxygen levels at a constant temperature of 32°C (90°F) for 28 days. Clams were observed for mortality every 24 hours. Survival analysis was used to calculate mean survival time. A 3-factor ANOVA was performed to test the null hypotheses that there were no effects of treatment, cross, family, or interaction on mean survival time. The experiment was conducted twice with two sizes of clams; 19 mm shell length (SL) in September 2008 and 35 mm SL in May 2009. For the 19 mm SL clams, cross had a significant effect on survival; *Mercenaria mercenaria* x *M. campechiensis* (M x C) had a greater mean survival time than *M. mercenaria* x *M. mercenaria* (M x M). Treatment had a significant effect on survival; mean survival time was shorter upon exposure to 15 ppt (14 days in 15 ppt vs. 27+ days in 25 ppt), regardless of oxygen level. Family also had a significant effect on survival. Results of the trials with 35 mm SL clams will also be presented. Among the parental species and crosses examined at the 19 mm SL size, M x C was the least sensitive to stressors; whereas M x M was the most sensitive, as indicated especially in response to 15 ppt + hypoxia. Of the two families examined under low salinity conditions, Family B had a mean survival 2.6 days longer than Family A. Although low salinity (15 ppt) conditions shortened mean survival time of all crosses and families, hypoxia (~ 2 mg/L) had relatively little impact on mean survival time. The advantages of M x C appear to be even greater at the 35 mm SL size. Our study shows that (1) the hybrid cross, *Mercenaria mercenaria* x *M. campechiensis* (M x C) may offer improved stress resistance, (2) genetic background may play a significant role in response to stressors, and (3) hard clams are relatively insensitive to hypoxia. Implications for the hard clam aquaculture industry in Florida will be presented. This work was supported by USDA-CSREES.

NON-TRADITIONAL BIVALVE SPECIES FOR FLORIDA AQUACULTURE: PROSPECTS AND CONSTRAINTS

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Federally funded job retraining programs during the 1990s provided an infrastructure to introduce shellfish aquaculture as an alternative employment opportunity to many rural communities along Florida's west coast. Since then, Florida has seen a dramatic increase in aquacultured shellfish production. The clam industry grew from \$1.2 million (41 farmers) in 1991 to \$19 million (393 farmers) in 2007. However, the industry is built on a single species, the hard clam *Mercenaria mercenaria*. An industry based exclusively on one species can suffer economic instability due to market fluctuations or losses from disease. Diversifying the Florida shellfish culture industry by developing farming technology and markets for other bivalve species and products may mitigate production and market risk, thereby enhancing economic stability and growth of the industry. There has been considerable investment in researching the potential of other bivalve species (Fig 1), such as angel wings *Cyrtopleura costata*, bay scallops *Argopecten irradians*, and blood arks *Anadara ovalis*, for diversification of the hard clam industry in Florida and the southeastern U.S. Unfortunately, none of these species are being cultured commercially today because of either culture or market limitations. The sunray venus clam *Macrocallista nimbosa* (Fig 1) is currently being examined as a culture species for Florida hard clam culturists. This clam species was commercially fished in Florida during the 1970s. Although natural growth rates were estimated to be high, its patchy distribution limited commercial exploitation. Growth experiments using marked wild individuals suggested that these clams attain a length of three inches (40 g hole) within 12 months; similar in time to hard clams in Florida. A comparison of prospects and constraints for the four species will be presented.

Figure 1. Examples of bivalve species examined for Florida aquaculture: A) Angel Wing clam, B) Blood Ark, and C) Sunray Venus clam.

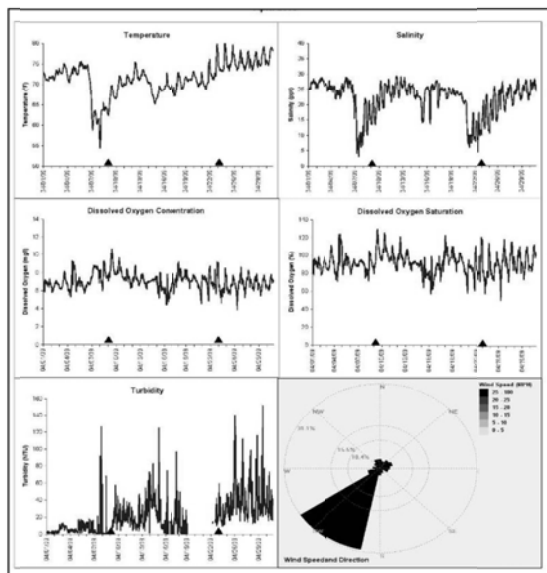


DECISION-SUPPORT TOOLS FOR SMALL-SCALE CLAM GROWERS IN FLORIDA

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The Florida hard clam culture industry is a dramatic success story. During the 1990s, shellfish aquaculture was introduced in rural communities along the Gulf of Mexico coast through job retraining programs designed for displaced workers in the commercial fishing industry. Today, there are over 350 small-scale businesses providing an economic impact of \$49 million. To assist this emergent and important industry, several applied projects have been implemented, which allow growers to make informed and timely management decisions. A monitoring process was developed in 2002 to provide real-time and archival water quality and weather information. Monitoring stations deployed at selected aquaculture lease areas provide measurements of 11 parameters. Local information may be immediately accessed via a website. Archived data is provided in “farmer-friendly” monthly and annual graphic formats. Adoption of remote sensing technologies allows growers and wholesalers to better plan for activities such as planting and harvesting. In addition, these data are used in documenting crop losses for U.S. Department of Agriculture (USDA) crop assistance programs. This project is supported by the USDA Risk Management Agency. Other projects developed to assist growers include 1) inexpensive data loggers that are deployed in clam culture bags at multiple leases to provide detailed, broad coverage of water temperatures; 2) an Excel-based software program that facilitates record keeping and inventory management; and 3) a web-based pictorial guide that identifies over 150 organisms found in, on, and around clam culture equipment providing information on their effects to the clam crop and what a grower might do to lessen those effects.

FIGURE 1. Archived water quality and weather information at an aquaculture lease area in Florida,



EVALUATION OF THE SUNRAY VENUS CLAM *Macrocallista nimbosa* FOR DIVERSIFICATION OF THE HARD CLAM CULTURE INDUSTRY IN FLORIDA

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The sunray venus clam *Macrocallista nimbosa* was commercially fished in Florida during the 1970s. Although natural growth rates were estimated to be high, its patchy distribution limited commercial exploitation. The sunray venus clam is now being evaluated as a potential new aquaculture species to diversify the hard clam *Mercenaria mercenaria* aquaculture industry in Florida. Wild broodstock were collected, conditioned, spawned and larvae reared through setting: pediveligers (~220 (m) appeared at 7 days at 26-28oC and 28-30ppt. Land-based culture of juveniles occurred in downwellers with a 46-63% return. Sunray venus seed production techniques appear to be similar to those standard for hard clams. Production performance of sunray venus clams under field nursery and growout conditions was examined during 2007-8. Sunray venus clam seed (about 118,000; 9.3-18.5 mm shell length, SL) were field-planted in nursery systems (soft bags and hard cages) at densities of 100-550/ft². After 42-119 days, survival ranged from 32-94% and daily growth rate was 0.12-0.25 mm SL. Sunray venus juveniles (27 mm SL; 10 mm shell width, SW) were further cultured in hard cages at densities of 42-55/ft². After 11 months, sunray venus (61-67 mm SL, 22-23 mm SW, 30-37 grams total weight, 8.1-9.1 condition index) were harvested for market perception tests. Survival ranged from 50-82%. Production performance of sunray venus grown in soft bags, soft bags with internal frames, and bottom plants for a year at densities of 38-70/ft² will also be reported. To date, field nursery and growout culture methods for sunray venus clams are exhibiting little difference from hard clam methods. Although current trial production efforts appear successful, problems with shell deformities, which appear to be substrate-related, must be resolved. The market acceptance of the cultured sunray venus clam was demonstrated within the Florida market area. Four restaurants participated in a study with each restaurant receiving a given number of cultured clams each week for a period of four weeks. A survey solicited the restaurant patron's reaction to various attributes of the sunray venus clams they consumed. Survey findings provided insight into the acceptance of cultured sunray venus clams as a viable seafood product and the willingness of consumers to purchase the product again. This information will help growers assess the viability of sunray venus clams as an alternative candidate culture species. This research was supported by Florida Sea Grant (Projects R/LR-A-44 and 45).

FIGURE 1. Cultured sunray venus



CULTURE OF HARD CLAM HYBRIDS (*Mercenaria mercenaria*, *M. campechiensis*): RESULTS OF GROWOUT PRODUCTION TRIALS

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The Florida hard clam aquaculture industry is a dramatic success story with over 350 small-scale businesses providing an economic impact of \$49 million. Yet, it has expanded primarily through increased acreage and number of growers rather than increased productivity. Over the past decade, mortality events resulting from hurricanes, low salinities, and, potentially, high water temperatures have affected production. The industry is based primarily on the “notata” variety of the northern hard clam *Mercenaria mercenaria*, which may not be suited for some Florida environments. The local southern hard clam *M. campechiensis* may have improved production characteristics for Florida environments and readily hybridizes with *M. mercenaria*, but is known to gape during refrigerated storage. Therefore, a rigorous examination of production characteristics of these species and their hybrids has been undertaken. Cultured *M. mercenaria notata* and wild *M. campechiensis* were used as broodstock and production of reciprocal hybrids was accomplished. Three families were reared under commercial conditions during 2008-9. Survival among families in land and field nurseries ranged from 73-82% and 73-86%, respectively. Differences at these stages were not evident. Approximately 248,000 seed (shell length 15-22 mm) were planted in the fall of 2008 for replicated comparison of stocks, densities (5.6-7.9 per square meter), and gear (bottom bag versus bottom plant). Plants were sampled every four months and harvested one year later. In addition, ten growers planted 190,000 seed on commercial leases in three counties for site comparison. At harvest, parental stocks and their hybrids were evaluated for survival, growth (shell length, shell width, total weight, meat weight), condition index, reproductive status, health, and shelf life in refrigerated storage. Market acceptance was documented via a consumer acceptance study and characterization of sensory attributes for appearance, texture, basic tastes, aroma, and flavors. Results of these production trials and implications for the hard clam aquaculture industry in Florida will be presented. This work was supported by USDA-CSREES.

FIGURE 1. From left to right samples after 8-months of growout of *Mercenaria mercenaria* (*Mm*), hybrid ($\text{♀}Mm \times \text{♂}Mc$), hybrid ($\text{♀}Mc \times \text{♂}Mm$), and *M. campechiensis* (*Mc*).

