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AN ECONOMIC DESCRIPTION OF THE FLORIDA SHELLFISH CULTURE INDUSTRY

Chuck Adams[1] and Leslie Sturmer[2]

[1]University of Florida
Gainesville, FL 32611
cmadams@ufl.edu

[2]University of Florida
Cooperative Extension Service
Cedar Key, FL 32625
lnst@ufl.edu

The shellfish culture sector represents an important component of the commercial marine aquaculture industry in Florida. The industry is primarily composed of hard clam hatcheries, nurseries and grow-out operations. However, other candidate species are currently being examined as viable additions to the industry. Providing a current assessment of the industry, in terms of number of growers, acres under cultivation, seed sales, clams harvested, grower revenues, average prices, and other descriptors is problematic given the recent cessation of periodic statewide industry survey efforts. Such information is needed to provide an accurate estimation of the economic importance of shellfish culture on a national basis. Some current descriptive information and historical data are available to provide insight into the local/statewide economic presence and important of the industry. The most recent secondary data will be presented that describe the shellfish culture industry in Florida. In addition, historical and recent economic impact assessments will be presented and changes over time, in terms of pricing, out of state sales, key market channels, and other factors, will be discussed.

TEMPERATURE THRESHOLD OF NORTHERN HARD CLAMS AND EVALUATION OF BACKCROSSED F1 HYBRIDS (*MERCENARIA MERCENARIA* X *M. CAMPECHIENSIS*)

Melissa A. Broderick[1], Shirley Baker[2], John Scarpa[3], and Leslie N. Sturmer[4]
[1]University of Florida
School of Forest Resources and Conservation
Gainesville, FL 32653
melabroder@ufl.edu

[2]University of Florida
School of Forest Resources and Conservation
Gainesville, FL 32653
sbaker25@ufl.edu

[3]Harbor Branch Oceanographic Institute at Florida Atlantic University
Aquaculture and Stock Enhancement Program
Fort Pierce, FL 34946
jscarpa1@hboi.fau.edu

[4]University of Florida
Cooperative Extension Service
Cedar Key, FL 32625
lnst@ufl.edu

Mercenaria mercenaria is an important aquaculture species in Florida. Florida water temperatures are at the upper temperature range of the northern hard clam and high mortalities in the summer months may be a result of the combined stress of high temperatures, extreme salinities, and low dissolved oxygen. Our group has been exploring a variety of breeding methods (triploidy, hybridization, backcrossing) to develop a hardier clam for the industry. The objectives of my research were 1) to determine the upper chronic temperature limit of *M. mercenaria* and, 2) to evaluate the performance of backcrossed F1 hybrids (*M. mercenaria* X *M. campechiensis*) in laboratory challenges. Challenges mimicked summer stressors in Florida: oxygen stress (<3ppm), high temperature (32°C), and various salinities (15, 25, 35ppt). The upper chronic temperature limit was 38°C; all *M. mercenaria* died within 28 hours of exposure after acclimation. In the first of two challenges, family and cross were not significant factors in mean survival time, however treatments (hypoxia, 15ppt) were significant. Understanding temperature limits in Florida strains of *M. mercenaria* will contribute to potential management of summer mortality events and further development of hardier clam strains for Florida, including the current examination of backcrosses.

ADDRESSING BIOFOULING IN FLORIDA'S HARD CLAM *MERCENARIA MERCENIARIA* AQUACULTURE INDUSTRY: PERFORMANCE OF TWO NET COATINGS

Eric J. Cassiano[1], Amanda Croteau[2], Geoffrey Smith[3], Leslie Sturmer[4], and Shirley Baker[5]

[1]Eric J. Cassiano
University of Florida
School of Forest Resources and Conservation
Program in Fisheries and Aquatic Sciences
Tropical Aquaculture Laboratory
1408 24th Street S.E.
Ruskin, FL 33570
ericcass@ufl.edu
813-671-5230 ext. 114

[2]Amanda Croteau
University of Florida
School of Forest Resources and Conservation
Gainesville, FL 32653
amanda.croteau@gmail.com
352-273-3621

[3]Geoffrey Smith
University of Florida
School of Forest Resources and Conservation
Gainesville, FL 32653
geoffreyhsmith@ufl.edu
352-273-3601

[4]Leslie Sturmer
University of Florida
Cooperative Extension Service
Cedar Key, FL 32625
lnst@ufl.edu
352-543-5057

[5]Shirley Baker
University of Florida
School of Forest Resources and Conservation
Gainesville, FL 32653
sbaker25@ufl.edu
352-273-3627

In Florida, northern hard clams *Mercenaria mercenaria* are typically cultured in polyester mesh bags on open-water leases in near shore coastal waters. During this phase of production (~1.5

years), bags are subjected to natural conditions, including biofouling. Biofouling can compete with clams for resources, impede harvesting efforts, and intensify equipment upkeep. Some clam growers treat bags with an alkyd-based coating that stiffens the bag, thus reducing predation. However, no coating is currently being utilized to specifically reduce biofouling. In a preliminary evaluation, two foul release coatings—a photoactive release coating (A) and a silicone-based release coating (B)—were compared to the standard alkyd coating (C) and uncoated netting (D, control). Thirty-six treated netting pieces (30cm x 30cm) were attached to PVC racks and deployed for three or six months on two lease areas near Cedar Key, Florida. At three months, netting treated with Treatment B coating had significantly less coverage of biofouling than other treatments and significantly less wet weight of biofouling than other treatments except Treatment A. At six months, netting coated with Treatment B had significantly less wet weight of biofouling than other treatments. Implications for use of foul release coatings within hard clam aquaculture are discussed.

EFFECTS OF PRIOR SALINITY ACCLIMATION ON SALINITY TOLERANCE FOR THE SUNRAY VENUS CLAM *Macrocallista nimbosa*

Hannah Kolb[1], John Scarpa[2], and Leslie N. Sturmer[3]

[1]Florida Institute of Technology
Melbourne, FL 32901

[2] Harbor Branch Oceanographic Institute at Florida Atlantic University
Aquaculture and Stock Enhancement Program
Fort Pierce, FL 34046
jscarpa1@hboi.fau.edu

[3]University of Florida
Cooperative Extension Service
Cedar Key, FL 32625
lnst@ufl.edu

The sunray venus clam (SRV), *Macrocallista nimbosa*, is showing promise as a potential aquaculture candidate for Florida shellfish growers. Salinity tolerance of this species has been examined using step-change challenges and found to range from 16-40 ppt, but prior salinity acclimation was not taken into account. This study examined the effect of prior salinity acclimation on salinity tolerance. SRV clams (n=13-4, ~36 mm length) acclimated to salinities of 16, 24, 32 and 40 ppt from a prior experiment were subjected for 18 days to different salinity treatments in duplicate as follows: 16 to 12, 14, and 16; 24 to 12, 24 and 40; 32 to 12, 16 and 32; and 40 to 16 and 24 ppt. SRV calms acclimated to 16 ppt were found to survive rather well (83 and 88%) when exposed to lower salinities (12 and 14). In general, SRV clams experiencing a salinity change of $\geq$12 ppt had no survival regardless of initial salinity acclimation. Hemolymph osmolality of surviving clams followed water osmolality (R^2=0.9991). Large juvenile SRV clams in growout may be more resilient to lower salinities (12-16 ppt) when acclimated to lower salinities and if change is gradual versus abrupt. This work was supported by NOAA/FL Sea Grant.

HELPING THE FLORIDA CLAM INDUSTRY SURVIVE THE SUMMER

Liliana Lloreda[1], William Krebs[1], John Scarpa[1], Leslie N. Sturmer[2], and Shirley M. Baker[3]

[1]Harbor Branch Oceanographic Institute at Florida Atlantic University
5600 U.S. Hwy 1 North
Aquaculture and Stock Enhancement Program
Fort Pierce, FL 34946
llloreda@hboi.fau.edu
jscarpa1@hboi.fau.edu
wkrebs@hboi.fau.edu

[2]University of Florida
Cooperative Extension Service
Cedar Key, FL 32625
lnst@ufl.edu

[3]University of Florida
School of Forest Resources and Conservation
Gainesville, FL 32653
sbaker25@ufl.edu

Florida is at the southern-most limit of the northern hard clam *Mercenaria mercenaria*, where subtropical temperatures allow for a longer growing season and shorter production time. However, increased summer temperatures have led to mortalities of market size clams, impacting the industry. In a previous study examining heat-tolerance and triploidy, it was found that heat shock proteins (Hsp) may be a suitable biomarker for development of a heat-tolerant clam. In the current study, individual variation and potential inheritance of Hsp70 is being examined. A survey of cultured and wild groups of clams (total n=540) found that hemolymph Hsp70 levels varied within and between groups; size or age may be a factor. Clams classified with high- and low-expressing Hsp levels were spawned individually to produce three putative high- and three low-Hsp families. Families were reared as similarly as possible and planted recently in the field. If Hsp levels in progeny are correlated to parental Hsp levels and if high-Hsp families exhibit higher survival in the field and under laboratory challenges, Hsp may be considered a biomarker for selective breeding of heat-tolerant hard clams that would assist the Florida cultured clam industry. Support by USDA and Sea Grant (R/LR-A-47).

HATCHERY AND FIELD-NURSERY CULTURE OF BACKCROSSED HYBRID (*MERCENARIA MERCENARIA, M. CAMPECHIENSIS*) HARD CLAMS

John Scarpa[1], Leslie N. Sturmer[2] and Shirley Baker[3]

[1]Harbor Branch Oceanographic Institute at Florida Atlantic University
Aquaculture and Stock Enhancement Program
Fort Pierce, FL 34946
jscarpa1@hboi.fau.edu

[2]University of Florida
Cooperative Extension Service
Cedar Key, FL 32625
lnst@ufl.edu

[3]University of Florida
School of Forest Resources and Conservation
Gainesville, FL 32653
sbaker25@ufl.edu

Nothern hard clam *Mercenaria mecenaria* production in Florida has seen various mortality events resulting from hurricanes, low salinities, and high water temperatures. The local southern hard clam (*M. campechiensis*) hybridizes readily with *M. mercenaria*. An examination of the parental species and their reciprocal crosses under commercial conditions has been reported. Differences in performance of hybrids indicated that backcrossing of hybrids to the northern hard clam may improve upon some performance measures. Four individual families of backcrossed hard clams were produced using single-parent crosses from our cultured hybrid and parental families. Spawning was induced by thermal stimulation with clams maintained in separate containers. Larvae were cultured separately utilizing standard hatchery practices of daily water change and batch feeding of microalgae. Larvae were transferred to downwelling systems for metamorphosis after approximately 7 days culture. No noticeable differences were observed during hatchery culture. Clams were cultured further in a land-based flow through system before being placed into nylon mesh bags for field-nursery culture near Cedar Key (Gulf of Mexico) and Sebastian (Indian River Lagoon). Preliminary analysis of growth and condition index data for nursery clams reared to grow-out seed size at Sebastian indicated no differences. Results for Cedar Key will also be presented. This work was supported by USDA-CSREES.

EXTENSION'S ROLE IN THE DEVELOPMENT AND SUSTAINABILITY OF A SMALE-SCALE HARD CLAM AQUACULTURE INDUSTRY ON FLORIDA'S GULF OF MEXICO COAST

Leslie N. Sturmer

University of Florida
Cooperative Extension Service
Cedar Key, FL 32625
lnst@ufl.edu

The commercial hard clam *Mercenaria mercenaria* culture industry on Florida's Gulf of Mexico coast traces its roots back to job retraining programs for underemployed fishermen during the mid-1990's. Resulting efforts by Harbor Branch Oceanographic Institution, the University of Florida, and Florida Sea Grant helped in the successful development of a viable industry. Educational efforts in these programs focused on production techniques for the hatchery, nursery and growout phases of the culture process. Early extension efforts were directed toward specific hurdles found in the path of the developing industry, such as seed production, product quality, industry organization, and risk management. This presentation focuses on current integrated research and extension activities addressing the sustainable development of hard clam aquaculture by increasing yield, farm efficiency and profitability. Specific programmatic areas are advancement of management practices, genetic stock improvement, and species diversification. Examples of successful industry-driven projects, such as access to "real-time" water quality and weather information at lease areas and evaluation of the culture and market potential of the sunray venus clam *Macrocallista nimbosa*, will be provided. Further, annual workshops allow faculty to present findings and progress on these projects as well as obtain feedback and direction from the industry.

IMPROVING HARD CLAM PRODUCTION IN FLORIDA THROUGH CULTURE OF BACKCROSSED HYBRIDS (*MERCENARIA MERCENARIA, M. CAMPECHIENSIS*)

Leslie N. Sturmer[1], John Scarpa[2], William White[3], and Shirley Baker[4]

[1]University of Florida
Cooperative Extension Service
Cedar Key, FL 32625
lnst@ufl.edu

[2]Harbor Branch Oceanographic Institute at Florida Atlantic University
Aquaculture and Stock Enhancement Program
Fort Pierce, FL 34946
jscarpa1@hboi.fau.edu

[3]University of Florida
School of Forest Resources and Conservation
Cedar Key, FL 32653
wrwhite@ufl.edu

[4]University of Florida
School of Forest Resources and Conservation
Gainesville, FL 32653
sbaker25@ufl.edu

The need for a hardier clam strain has become evident as shellfish growers in Florida report below average survivals or total losses during prolonged hot summers. The local southern quahog *Mercenaria campechiensis* may have suitable production characteristics for Florida environments and readily hybridizes with the northern hard clam *M. mercenaria*, but gapes during refrigerated storage. We previously reported on parental species and their hybrid crosses. Differences in hybrid performance indicated that backcrossing of hybrids to the northern hard clam may improve some measures. Five families of backcrossed hard clams were produced using multi-parent crosses from hybrid and parental stocks. No differences were noted between stocks during larval and nursery culture in the hatchery. In field nursery, survival of backcross stocks (71-82%) was greater than hard clam controls (65%). At harvest, 66% of backcross stocks yielded higher survival (81-91%) and production (34-38kg/bag), compared to hard clams (79%, 31kg/bag). After 10 days in refrigerated storage, survival of backcross stocks (97-99%) was similar to hard clams (100%). Although gaping was higher in the backcross stocks (4-17%) versus hard clams (3%), these results are commercially acceptable. This breeding approach can increase summer survival and productivity of cultured hard clams while maintaining product quality standards.

APPLYING A SOILS-BASED APPROACH TO CLAM AQUACULTURE IN FLORIDA

William R. White[1], L. Rex Ellis[2], Leslie N. Sturmer[3], and Todd Z. Osborne[4]

[1]University of Florida
School of Forest Resources and Conservation
Cedar Key, FL 32625
wrwhite@ufl.edu

[2]Univeristy of Florida
Soil and Water Science Department
2169 McCarty Hall, PO Box 110290
Gainesville, FL 32611
rexellis@ufl.edu

[3]University of Florida
Cooperative Extension Service
Cedar Key, FL 32625
lnst@ufl.edu

[4]University of Florida
Soil and Water Science Department
106 Newell Hall, PO Box 110510
Gainesville, FL 32611
osbornet@ufl.edu

Relationships between terrestrial agriculture and soils have been thoroughly investigated; yet links between shellfish aquaculture and subaqueous soils have only recently been examined. As infaunal bivalves spend a majority of their life buried, traditional soil characterization is being applied in Florida to the production of the northern hard clam *Mercenaria mercenaria* and a potential new aquaculture species, the sunray venus clam *Macrocallista nimbosa*. Results will be discussed for ongoing studies determining effects of hard clam farming intensity and varying fallow times after harvest on soil properties (bulk density, organic matter and particle size distribution). Soil type preference for the sunray venus clam was preliminarily determined from a six-month *in situ* mesocosm study that revealed variations in production characteristics. Sunray venus clams grew larger (11.0g) and had fewer deformities (2.2%) in sandier soils (>95% content) than clams (9.6g, 18.7% deformities) in soils that contained more silt (>4%). In addition, soil properties at commercial leases were sampled and characterized to evaluate suitable for sunray venus culture. Industry-acceptable production (survival, 55-71%; weight, 11.3-23.0g) occurred at leases that contained higher sand (>87%) and lower silt (<2.5%) content. Understanding these soil relationships is critical to increasing productivity, directing management practices, and selecting lease sites.