University of Florida IFAS Cooperative Extension Service

THE BIVALVE BULLETIN

July 2011
Vol. XV No.2

INSIDE THIS ISSUE:

Clams are "Green"	1
Global Seafood Industry	1
Environmental Benefits	2
Carbon Fixation by Clams	3
Research Updates	4
CLAMmunications	6

*The entire article on "Shellfish aquaculture—In praise of sustainable economies and environments," World Aquaculture 34(4), can be viewed at the East Coast Shellfish Growers Association's website, www.ecsga.org.

Florida Clam Culture is a "Green" Industry—Spread the Word*

The usefulness of ecolabeling in creating a market-based incentive for environmentally-friendly production was recognized several decades ago. Since then ecolabeling schemes have been developed in most industrialized countries for a wide range of products and sectors. The idea that ecolabeling would lead to improved management of marine capture fisheries is of more recent origin. It was first promoted by the World Wildlife Fund (WWF) through their Marine Stewardship Council (MSC) initiative in 1997. Today, there are 256 fisheries engaged in the MSC certification program. Considerable efforts have also been directed toward raising seafood awareness of consumers. These resulting campaigns (e.g., dolphin-safe tuna, Give Swordfish a Break) aim to affect the seafood demand and lead to a sustainable seafood supply. Although there are indicators of some regional successes, lack of support by Asian markets and proliferation of self-serving seafood labels are but two of the many limitations of these campaigns. Third-party certification programs are also being implemented for aquaculture with standards developed for shrimp, salmon and other species that address environmental issues (e.g., mangrove and wetland destruction), social concerns (e.g., child labor and worker safety), food safety (e.g., use of antibiotics and pesticides) and traceability. Aside from ecolabels and certification programs, many non-governmental organizations and aquariums have launched campaigns to influence consumer behaviors. Consumers can consult seafood wallet cards to determine which seafood are ecologically best or worst to eat. However, seafood industry leaders attest it is retailers, not consumers, who are the driving force behind corporate social responsibility and seafood certification. Continue on Page 2

The Global Seafood Industry: A Perspective on Consumption and Supply

Seafood is perhaps the largest international commodity with trade exceeding US $60 billion per year. Almost 200 countries supply seafood products to the global marketplace consisting of over 800 commercially important species of fish, crustaceans and mollusks. Through the current day, the supply of seafood has kept up not only with a rapidly increasing population but also with increases in per capita consumption. However, global capture fisheries are at their maximum sustainable yield and while aquaculture continues to grow, it may have difficultly keeping pace with global demand. Following is a discussion about the trends and future outlook for seafood consumption and supply.

Trends in Global Seafood Consumption Between 1960 and 2003, the world's population rose from 3 to 6.3 billion, an increase of 110% with an annual growth rate of 1.7%. In 2003, fish accounted for about 16% of the animal protein consumed worldwide and in some Asian countries the proportion ranged as high as 30 to 50%. For about one billion people, seafood is the primary source of animal protein. According to the Food and Agriculture Organization of the United Nations (FAO), seafood consumption increased from 38 million tons in 1960 to 137 million tons in 2003, an increase of 260%, representing an annual growth rate of 3%. Growth in per capita fish consumption has increased from about 28 pounds per year in 1960 to about 48 pounds per year in 2003. While most of the increased demand has been met by growth in capture, or "wild" fisheries, the last twenty years have seen the rapid expansion of global aquaculture. By 2025, the global population is expected to grow to 8.5 billion, a further increase of 35%. Assuming no increase in seafood consumption, global seafood demand during this period would grow by a further 50 million tons, or 37%. However, current trends show continued increases in seafood consumption. This represents a major challenge for the seafood industry.

Trends in Global Seafood Supply Between 1960 and 2003, fish emerged as one of the largest export commodities in the world, dwarfing global trade in coffee, cocoa, rubber, sugar, tea, tobacco and rice. Developing economies which control key fishing grounds are playing an increasingly important role in the global seafood industry with their share of global exports having grown from 37% in 1976 to 48% in 2003. The world's capture fisheries are highly concentrated with 10 countries accounting for almost 70% of total production. The catch of wild fish has increased by 30% over the last 20 years Continue on Page 2

Cultured Clams are "Green" (continued)

Now is the time for the shellfish aquaculture industry to extol the virtues of filter feeding bivalves – clams, oysters and mussels – by giving them their due as key players in ecologically sustainable aquaculture in marine environments and as environmentally sensitive monitors and water purifiers. Promoting shellfish culture is promoting sound resource stewardship and a clean environment. Unfortunately and unfairly, aquaculture has become an all inclusive term, especially when used by special interest and advocacy groups to protest some coastal farming. All aquaculture is not created equal and should not be treated as such.

Molluscan shellfish aquaculture is, by definition, a "green" industry. Shellfish growers are committed to water quality from the day molluscs spawn to the day the finished product is eaten by the consumer. Shellfish grown in approved, certified waters provide a safe, nutritious, healthy food source. In addition, the act of shellfish feeding improves water quality by removing particulates and some unwanted nutrients from the waters. As highly efficient water purifiers, they provide a net gain for the environment. Molluscs feed at the base of the food chain—think vegetarians.

Public health standards, under which shellfish aquaculture operates, demand clean waters. Commercial shellfish harvests can only take place in growing waters that have been certified through the National Shellfish Sanitation Program, a stringent set of standards adopted by all shellfish-producing states and operated under the Food and Drug Administration. Failure to meet these standards causes an immediate closure of the water to harvest. The NSSP also ensures the sanitary control of product during processing and transportation. Molluscs are tagged by both the grower and dealer so product can be traced back to when and where it was harvested, resulting in product accountability. In Florida, clam growers are certified through the Department of Agriculture and Consumer Services and abide by a set of best management practices developed to ensure their farming operations are environmentally friendly.

So now is the time to spread the word—Florida farm-raised clams are "green"!

This colorful informational sheet could accompany every clam shipment. To obtain a copy, contact the Shellfish Aquaculture Extension Office.

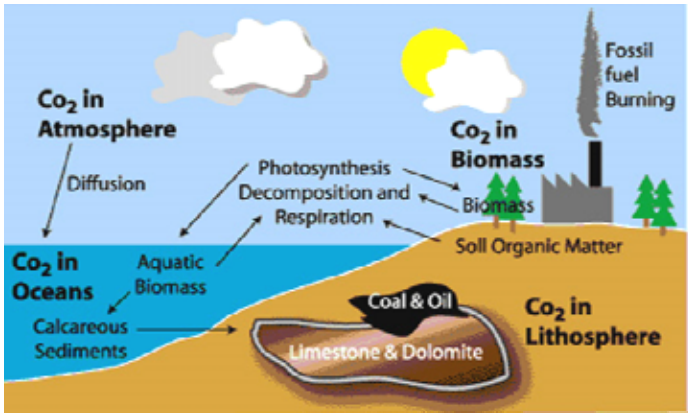
Global Seafood Industry (continued)

peaking at about 90 million tons in 2003.The growth in total catch is somewhat misleading as specific fish stocks have been successively exploited and depleted. In 1994, the FAO estimated 60% of the world's fisheries are being fished at or beyond their maximum productivity and that no fisheries remain to be opened up. Seafood supplied through aquaculture has increased from about 10 million tons in 1984 to 47 million tons in 2003, representing an 8.5% annual rate of growth. To put this in a different perspective, in 1984 aquaculture represented 12% of world fisheries production while in 2003 it had risen to 38%. According to FAO, aquaculture is expected to exceed 50% of the world's edible seafood supply by 2025. Asia with a long history of cultivating fish, dominates the industry accounting for 90% of world output. China is the major player; Southeast Asian and Latin American countries are growing rapidly; Europe and the U.S. are focusing on temperate species, such as salmon, trout and molluscs.

Future Outlook While the forecasted demand for increased seafood consumption is bullish, the availability of supply is less certain. Under improved management conditions, capture fisheries might yield an additional 15 million tons on a sustainable basis. This still leaves a gap of 35 to 50 million tons over the next 20 years. Aquaculture has room for expansion, but FAO's estimate is that production could increase by only about one third, or 15 to 20 million tons, by 2025. Thus, in the most optimistic scenario, where oceans are wisely managed and aquaculture flourishes in a sustainable manner, the world's demand for fish may not be met. Significant changes must be made immediately in fisheries management, which is immensely complex involving allocation rights over a global resource and many other issues. Despite these difficulties, the past few years have seen a flurry of activity, at international and national levels, aimed at shifting fisheries management onto a less self-destructive course. Likewise, aquaculture must be managed in a way that better protects the structure, productivity, and diversity of entire aquatic eco-systems. In advancing aquaculture production, the shellfish culture sector stands to become a significant contributor to ensuring global seafood security.

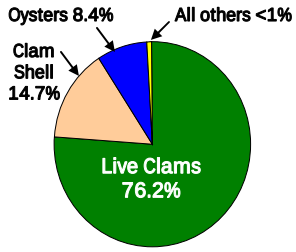
Carbon Fixation by Florida Cultured Clams by Dr. Patrick Baker, UF SFRC Fisheries and Aquatic Sciences

Introduction Carbon dioxide (CO_2), a major greenhouse gas, dissolves in water and is incorporated by shell-producing organisms into calcium carbonate ($CaCO_3$). $CaCO_3$ from mollusks and other organisms can persist indefinitely as limestone. In contrast, the carbon contained in most plant and animal tissues return to CO_2 in a few years, at most. Molluscan shellfish aquaculture, therefore, has two products—food for humans and long-term storage of greenhouse gases. Shellfish aquaculture practices, however, do not produce merely the shells of the product species, but also attached or associated shell-bearing animals, such as oysters and snails. Under lease siting provisions, shellfish aquaculture is conducted in areas that did not previously support shellfish populations, so most of the associated shell can be considered production that would not have otherwise occurred. This study was conducted to quantify shell production and carbon association with the culture of hard clams in Florida. The shells of clams mineralize carbon as calcium carbonate, providing a long-term sink for atmospheric carbon dioxide. In addition to the clams sold to the market, there are discarded or dead shells as a byproduct of the industry, plus the shells of associated fouling organisms.



Methods Two lease areas near Cedar Key were sampled for this study—Dog Island to the east (27 clams bags) and Gulf Jackson/Pelican Reef to the west (9 clam bags). Clam bag samples were collected from October 2009 through July 2010 during regular harvests. Samples were selected randomly by clam growers from the bags they had retrieved on that date. Each was processed by the clam grower using standard methods, and then the discarded shells and bag were given to the researcher. Live clams were counted and a random subsample of 20 clams was measured to estimate average shell weight of the sample. Shell mass per clam bag was determined by adding the estimated weight of the market clams, the estimated weight of the oysters attached on the bags, and other shell that was saved and cleaned. The total weight was then multiplied by 0.96, the fraction of shell that is $CaCO_3$, and then by 0.12, the fraction of $CaCO_3$ that is carbon.

Results Almost all shell material (>99%) over 5 mm was accounted for by marketable clams (76.2%), shells of dead clams (14.7%), and oysters (8.4%). The remaining shell fraction (<1%) was divided amongst 39 additional species. Six-month exposure studies of clam and oyster shells showed no significant dissolution, inferring (as suggested by the fossil record) that clam shells are a stable form of carbon storage. Laboratory analysis of shells showed that cleaned, dried clam or oyster shell is about 96% calcium carbonate (the remainder is a protein matrix), and calcium carbonate is 12% carbon by weight. Using these values to adjust mineralized carbon values in samples, total carbon mineralization represented by each clam sold and by the total clams sold by Florida growers in 2007 (185 million, Adams et al. 2009) was estimated.



Content of Clam Bags (%)

Here's the numbers:

- 921 clams per bag (average) in these samples,
- 22.5 kg (50 pounds) of shell ($CaCO_3$ only) per bag,
- 24.4 grams (0.86 ounces) of $CaCO_3$ (including associated shell) fixed per clam,
- 2.93 grams (0.1 ounce) of carbon fixed in total shell material for each clam sold, and
- 536 metric tons, or 1.2 million pounds, of carbon fixed in 2007 by Florida clam farms.

Summary It is important to note that the above results were obtained using existing clam farming methods; nothing needs to be changed to produce this long-term carbon storage. It is anticipated that this information will be of use to clam growers at least one and possibly two ways. First, given public concerns regarding the sustainability of seafood (including aquaculture), clam growers can add greenhouse gas storage to the list of ways in which clams are "green." Second, if carbon credits ever become a commodity, clam growers have a value-added byproduct already at hand for which the industry now has a quantitative estimate. Clam growers may calculate carbon fixation for their farms by simply multiplying the number of clams harvested in a year by 2.93 grams, then adjusting for clam shell, oysters, and other species in their harvested bags by dividing that number by 76.2%.

For additional info, contact Patrick Baker at (352) 273-3629 or pbaker@ufl.edu. This research was funded through a grant from the Florida Sea Grant College Program.

EAT A CLAM, SAVE THE EARTH! Every clam you eat represents about 3 grams of carbon removed from the atmosphere.

RESEARCH UPDATE The following projects were discussed at this year's Clam Industry Workshop.

Stock Improvement through Hybridization and Backcrossing F1 Hybrids with Hard Clams

John Scarpa, Harbor Branch Oceanographic Institute at Florida Atlantic University (HBOI-FAU) and Leslie Sturmer, University of Florida (UF)

The Florida hard clam culture industry is based primarily on the "notata" variety of the northern hard clam *Mecenaria mercenaria*, which may not be suited for some Florida environments. The local southern hard clam *Mercenaria campechiensis* may have production characteristics more adapted to warm waters and readily hybridizes with the hard clam, but is known to gape during refrigerated storage. An examination of these species and their hybrids under aquacultured conditions was undertaken. We utilized cultured *M. mercenaria notata* (M) and wild *M. campechiensis* (C) as broodstock to produce five families that each contained the pure (♀x♂: MxM, CxC) and hybrid (MxC, CxM) groups. Parental clams were spawned in individual containers to prevent unwanted fertilization. Protein allozyme analysis of progeny indicated that at least one parental clam was already a hybrid in two of the five families. This genetic analysis reflects the difficulty of using visual characteristics to differentiate between species that naturally hybridize.

Three families, which each contained the two pure and two hybrid groups, were reared under commercial conditions during 2008-9. Differences at early culture stages were not evident. Growout seed planted in the fall of 2008 were harvested a year later. At that time, parental and hybrid groups were evaluated for survival, growth, reproductive status, and shelf life in refrigerated storage. The pure CxC group performed the worst overall. Hybrid groups (MxC, CxM), depending on family, outperformed the pure MxM group in growth and total production (lbs/bag). However, both hybrid groups exhibited reduced shelf life and increased gaping during storage compared to pure MxM, although the MxC hybrid resisted gaping longer than the CxM hybrid. This may indicate a maternal effect.

Hybrid clams are as functional reproductively as the pure stocks. By using backcross breeding, we are attempting to reduce gaping and increase shelf life during storage while maintaining production characteristics. Backcrossing is the crossing of a hybrid with one of its parental species in order to achieve offspring with a genetic identity that is closer to its parent, but with the addition of the characteristic of interest. Five individual families of backcrossed clams were produced using single-parent crosses from the cultured hybrid and parental families. No noticeable differences were observed in the hatchery and land-based nursery culture. Clams were reared to a seed size of 18-20 mm in length during the summer of 2010 in Cedar Key for replicated growout trials. The pure hard clam control had the lowest field nursery survival (62%), while survival of the four backcross groups ranged from 71 to 81%. Field nursery culture was also examined in the Indian River at three industry partner leases. Survival of clams varied between leases with a low of 14% to a high of 63%, which may indicate environmental, predation or protocol differences. However, in general, at each lease site backcross hybrid clams had 20 to 45% greater survival as compared to the pure hard clam control. This increased survival may be caused by heterosis, which is superior performance as compared to inbred lines, increased genetic diversity from the original hybridization or an unknown factor. Stocks will be harvested in September 2011 after being exposed to field conditions during a second summer. This research is supported by an USDA NIFA Grant.

Selection for Heat Tolerance in Florida Hard Clams using Biomarkers

Shirley Baker and Leslie Sturmer, UF; John Scarpa, HBOI-FAU

Climate change will certainly have an effect on worldwide agriculture; crops that are currently near climate thresholds, such as clams, are likely to suffer. There is a need for a heat-tolerant clam strain if the Florida industry is to reduce current summer mortalities and adapt to future climate change. For the past several years, researchers at UF and HBOI-FAU have been examining the utility of two basic breeding techniques, triploidy and hybridization, for increasing production in Florida waters. Growth and survival of triploid clams in the field and laboratory produced mixed results, with no major advantage of triploid clams for Florida culturists. The project team is currently examining the utility of interspecific hybridization and backcrossing of F1 hybrids to the hard clam. These studies demonstrated that thermal tolerance in clams is under genetic control. In both projects we produced families from single-parent crosses, with parents selected at random from available broodstock. Some families consistently performed better than others.

All Clam Industry Workshop presentations can be viewed at the website, http://shellfish.ifas.ufl.edu.

Our work suggests that heat shock proteins may be the mechanism whereby different strains of clams tolerate high temperatures. Heat-shock proteins (Hsp) are involved in formation, transportation, and degradation of proteins. Some Hsp increase when cells are exposed to elevated temperatures, or other stressors that damage proteins, and are referred to as inducible. Other forms of Hsp are synthesized under non-stressful conditions for cellular housekeeping and are referred to as cognates. In a previous project, we found that a hard clam family having approximately twice as much cognate Hsp compared to two other families, also had significantly greater survival (93% compared to 28% and 39%) after heat challenge. In addition, other studies indicate that changes in metabolic rate in response to thermal stress may play a role in survival and could also be heritable. Together, these data suggest that using biomarkers of thermo-tolerances, such as Hsp, we can target particular genetically distinct groups for selective breeding, thus reducing the time and resources needed for strain development. This research, supported through the NOAA National Sea Grant Marine Aquaculture Research Program, will provide the necessary data during 2011-13 to assess if biomarkers, or indicators, can successfully be used in selective breeding programs for thermal tolerance in cultured hard clams. Development of more robust clam strains would represent an important gain over reliance on unselected stocks.

Examining Relationships between Clam Farming Activities and Aqueous Soil Properties

Rex Ellis, Todd Osborne and Bill White, UF

Sediment characteristics, such as type, particle size and permeability, seem important for clam production; especially since clams spend the majority of their lives buried in the bottom substrate. This project to be initiated this summer will complement the recently completed USDA-funded project in which we conducted a survey of surface soil properties at the Dog Island High-density Lease Area near Cedar Key to determine spatial patterns within the lease area. The goal of this study is to assess the differences in soil properties on leases under various cultivation levels, to determine the influence of harvest techniques on subaqueous soils, and to investigate if farming practices can be modified to maximize beneficial characteristics of soils on leases. We intend to: 1) Compare and contrast soil properties at two shellfish aquaculture lease areas on both high and low intensity farmed sites, 2) Compare soils in farmed portions and in adjacent un-farmed portions seasonally to determine reference conditions and any long-term changes to soils by clam farming activities, and 3) Analyze soils and landscapes immediately before and after harvesting clam bags and after varying fallow times to determine physical and chemical changes to soils due to harvesting. Soil maps created from the analyzed data will be made available to clam farmers. Further, this research will provide science-based information to be used by growers in their decision making. For instance, a grower may choose to rotate farming to different portions of a lease to maintain high soil productivity if it is found that longer fallow times result in soil properties favorable for clam growth.

Focus on the Potential of Sunray Venus Culture and Marketability

John Scarpa, HBOI; Leslie Sturmer, Chuck Adams, Laura Garrido and Steve Otwell, UF

Over the past five years, research and extension faculty, along with industry partners, have evaluated the aquaculture and market potential of the sunray venus *Macrocallista nimbosa*. Presentations at this year's workshop summarized results to date. Seed production, nursery and growout field trials have shown sunray venus can be reared on an experimental basis using techniques similar to those for hard clam culture. Consumer acceptance has been evaluated in local Florida markets. Currently, the project team is developing simultaneously the technology with industry to target information gaps and potential barriers to commercialization of this species and reduce the potential for failure. Eighteen industry partners are currently determining production performance of the sunray venus at existing lease areas. Further, over the past six months, five wholesalers have facilitated an assessment of product attributes by shipping sunray venus harvested from field trials to 30 "downstream" wholesalers accompanied with a survey. Responses are providing vital information on existing market channels and distribution standards. The sunray venus was introduced at the International Boston Seafood Show in March to a wide range of buyers. Over 250 visitors, who sampled sunray venus at the *Fresh from Florida* Pavilion, were asked to provide their reaction. Both studies demonstrate strong market acceptance to this new product and will help industry better understand its market development potential. Funding is provided by the Florida Sea Grant College Program.

ABOVE: Chef Peter Stefani of The Island Room in Cedar Key, FL serves sunray venus clams at the Boston Seafood Show. LEFT: Leslie Sturmer surveys interested seafood buyers.

CLAMmunications

New Seafood HACCP Guidelines

Update Session: Tuesday, July 12, 1-5 PM, Orlando

The Food and Drug Administration (FDA) just released a new edition of the Seafood HACCP Guidelines that will influence all harvest, processing, transport and storage operations conducting commerce in the U.S. The effective date for implementation is immediate because the guidelines are simply an update for existing regulations. Anticipating this, a series of special Seafood HACCP Update Sessions have been scheduled. The half-day sessions are FREE and open to any person or firm. Attendance is recommended for both new and experienced personnel from commercial operations and regulatory programs. The sessions are provided by the Seafood HACCP Alliance in cooperation with the FDA.

Florida Sea Grant will conduct an Update Session at the Marriot Hotel-Orlando airport on July 12 from 1 to 5 PM. There is no registration fee, but pre-registration is necessary to assure available space. To pre-register and view the schedule for sessions, go to www.AFDO.org under Training/ Seafood HACCP Alliance training. Complete address information is included at this link. Attendees should obtain a copy of the FDA HACCP Guide in advance for use during the session. Visit the UF bookstore, http://ifasbooks.com, to purchase the new FDA Guide and the revised seafood HACCP training manual online. Credit cards are acceptable.

Clam Industry Task Force Meeting

Monday, July 18, 1-4 PM, Winter Haven

The first meeting of the year of the Statewide Clam Industry Task Force is scheduled to be held at the Department of Agriculture and Consumer Services' Florida Citrus Building, Nora Mayo Hall located in Winter Haven on July 18. Agenda items include CITF structure, leases and BP claims process. Contact your industry representative or the DACS Division of Aquaculture (Phone: 850-488-4033) for more information.

Clam Crop Disaster Assistance Programs

To be eligible for coverage in the Noninsured Crop Disaster Assistance Program, or NAP, for crop year 2012, you must apply and pay the applicable service fee ($250 per crop) at your USDA Farm Service Agency local office by September 1. The pilot clam crop insurance program administered by the USDA Risk Management Agency recently underwent an independent review. Many of you participated in listening sessions held this past January. In a report to the Federal Crop Insurance Corporation (FCIC), Promar International staff recommended terminating the program due to steadily declining participation, allegations of fraud and challenges in operating the program. However, the FCIC Board of Directors has decided to extend the pilot program through crop year 2012 with modifications.

Florida cultured clams are a "GREEN" sustainable industry—Spread the word!

Bivalve Bulletin
July 2011
This newsletter is published through the University of Florida Cooperative Extension Service. For more information, contact

Leslie Sturmer-Taiani
UF/IFAS Shellfish Aquaculture Extension Program
Cedar Key Field Lab
P.O. Box 89
Cedar Key, FL 32625
Phone: (352) 543-5057
E-Mail: LNST@ufl.edu
Http://shellfish.ifas.ufl.edu

NONPROFIT ORG.
U.S. POSTAGE
PAID
BRONSON, FL
PERMIT NO. 5