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ISSUE 2002-03 SUMMER 2002

Farming Clams in Coastal Bays

Don Webster, Maryland Sea Grant Extension, Eastern Shore Agent

Shellfish aquaculture in Maryland has always been synonymous with oyster farming, the rearing of oysters on leased bottom grounds primarily in Chesapeake Bay. In contrast to other Atlantic seaboard states, including Virginia, Maryland's harvests primarily came from public grounds though acre for acre, leaseholds were more productive than public grounds. Public and private production are almost moot now — parasitic diseases, namely MSX and Dermo, are so widespread that oyster harvests from both are at all time lows. Hard clam production is a very different story. According to the USDA Census of Aquaculture, hard clams had a $58 million dollar farmgate value in 1998.


Don Meritt

Though Maryland has hardly been a leader in hard clam aquaculture — production in Florida and Virginia alone accounted for $27 million in 1998 — growers in the state have begun getting into the hard clam business. Hard clam aquaculture (*Mercenaria mercenaria*) is generally limited to the state's coastal bays because salinities in Maryland's portion of the Bay are generally not high enough to support production.

The Maryland Sea Grant Extension Program (SGEP) has been working with growers in a number of ways, for instance, in the formation of a shellfish nursery and producer cooperative, in monitoring grow-out trials, and in conducting a background survey of the presence of QPX, a parasitic disease that has impacted hard clams in the northeast, though has not shown up in the Bay region. While clam production in Maryland has had its ups and downs, growers are optimistic that they will be able to turn a profit.

Sea Grant Extension faculty recently organized a hard clam workshop in Snow Hill, Maryland, for current and prospective growers. It was sponsored in cooperation with the Maryland Seafood Cooperative, the Worcester County Department of Economic Development, and Gordon Shellfish, Inc. Economic Development Director Jerry Redden, a long-time supporter of efforts leading to responsible development in the county, has been instrumental in helping to promote the aquaculture industry — Snow Hill is the center of the clam aquaculture industry in the coastal bays.

The workshop covered a number of issues related to the business of clam aquaculture. Beginning with an overview of the industry that included information on its growth and potential, topics that followed were designed to provide a solid foundation for those wanting to farm these organisms. Included were talks on culture methods in other areas and their potential applicability to the Maryland bays, the types of bottom ground most suitable to clam farming, how to assess a potential lease, procedures for obtaining an aquaculture lease from the State of Maryland, permits required for farmers, data collection, and potential markets for products.

Workshop participants then got together in nearby Public Landing at Gordon Shellfish, Inc., a local shellfish nursery. They had a tour of the facilities where Steve and Christy Gordon raise seed clams and oysters during the summer months. Gordon Shellfish has become a leading supplier of seed to local producers and to producers in other states as well. Nearby leased bottom is used to grow market-sized clams.

The Gordon Shellfish operation was helped with research funding from the Maryland Industrial Partnership program (MIPS), a University of Maryland program that supports researchers who work with entrepreneurs in getting new ideas into commercial practice. MIPS funding helped Gordon Shellfish develop an upweller system with filtered removal of large particles to assist shellfish seed in obtaining only water with the needed phytoplankton for maximum growth.

Sea Grant Extension specialists demonstrated several planting techniques, among them, the use of soft bags, rigid plastic mesh containers, and predator exclusion netting. Attendees were advised to use the method that most closely matched the type of operation that they were intending to develop. For example, producers who were growing large numbers of clams intended for marketing at the same time would generally find that netted areas are the best method. On the other hand, producers who were producing smaller numbers of clams on a regular basis would likely find bag production to better meet their needs.

To learn more about farming hard clams in Maryland's coastal bays, visit *Maryland Aquafarmer Online* for previous articles — for example, www.mdsg.umd.edu/Extension/Aquafarmer/Winter02.html#1 and www.mdsg.umd.edu/Extension/Aquafarmer/Winter01.html#3. To learn about opportunities with the University's Maryland Industrial Partnerships, see www.erc.umd.edu/MIPS/

For more information on shellfish aquaculture, please contact Don Webster at 410-827-8056 or dw16@umail.umd.edu.

Maryland Legislation on Aquaculture Development

Don Webster, Eastern Shore Area Agent

Maryland aquaculture and the seafood industry could have a brighter outlook given the progress in a new state aquaculture plan and active involvement by the Maryland General Assembly. In the long run, they could help guide aquaculture development over the next ten years and aid the recovery of markets lost by the decline of wild seafood harvests in recent decades.

The draft of the new state aquaculture plan, which is now in final form by the Maryland Department of Agriculture, updates the original plan that helped the industry develop through the 1990s, as the state grappled with how to assist the fledgling industry. Now that major problems and roadblocks have been identified, the new plan should guide better coordination among state agencies in their responses to permits, while helping entrepreneurs develop businesses more effectively. While the plan has taken some time to complete, the final document should provide significant help in trying to move the industry along.

On the legislative front, the General Assembly passed legislation in the 2002 session that should provide insight into the needs and potential of the industry. House Bill 662, which established a Task Force to Study the Economic Development of the Maryland Seafood and Aquaculture Industries, passed both houses unanimously and was signed by the Governor; it sets up two task forces to study economic development. One task force will concentrate on the Maryland seafood industry while the other is directed at aquaculture. The two groups will coordinate their work and report back to the General Assembly before September 30, 2004, with their findings and recommendations. The Aquaculture Task Force must assess the status and economic potential of the industry and consider the economic, technical and educational requirements for its development. The group is to study the paths and results of other states, and review and evaluate legislative and regulatory issues and permitting procedures for the industry. The committees are composed of a broad range of interest groups, including specified membership from industry, processors, research and educational fields. Some 40 members will be on both task forces.

House Bill 353 and Senate Bill 493, passed unanimously and signed by the Governor as well, calls on the state to conduct research into the Asian oyster *Crassostrea ariakensis* to judge its benefits for aquaculture in the Bay and to determine proper security measures that must be taken for preventing its release to the wild. In the long run, this bill could affect actions that impinge on the future of the Bay oyster industry, which has been so decimated by the prevalence of parasitic diseases. With the Maryland harvest down to some one hundred thousand bushels and Virginia's at around twenty thousand last year, the introduction of a non-native oyster that appears to thrive despite MSX and Dermo disease and outmatches the native oyster in growth could have significant commercial potential, let alone ecological value. Because oysters feed by filtering algae from the water, they remove nutrients as well — a major factor in the deterioration of water quality is the excessive nutrient loading from waste treatment plants, land runoff and airborne deposition that fuel the growth of algae.

The implications of the new legislation and revised state aquaculture plan could promote the start-up of new aquaculture-based enterprises — coordinated research, training, and development could help increase production, provide employment in rural areas, as well as quality seafood products.

For House Bill 662, see http://mlis.state.md.us/2002rs/Signings/signed.htm; for House Bill 353 and Senate Bill 493, see http://mlis.state.md.us/2002rs/billfile/HB0353.htm

For information on the Maryland Aquaculture Plan, please contact Don Webster at 410-827-8056 or dw16@umail.umd.edu

Finfish Feeds: A Guide to Handling and Storage

Steven Hughes, University of Maryland Eastern Shore

One of the most expensive production costs for any fish farming facility is feed — depending on the species and the feeding efficiency, that cost can represent 40 to 60 percent of total rearing costs. Therefore anything that can be done to minimize wastage will help make an aquaculture operation more cost effective.

Because fish feeds are very fragile, improper handling and storage can lead to their being unusable and possibly even detrimental to fish. A first consideration is handling feed when it arrives at your facility. (Though most of these comments assume the use of bagged feeds, the same principles can be extended as well to bulk feeds.) When unloading feeds do not throw or drop the bags: both of these practices can break up the pellets, leaving a higher percentage of "fines," very small particles or dust. Walking on the feed bags or stacking them over 10 bags high also leads to the pellets being crushed and should be avoided.

Fingerlings or larger fish will not feed on fines because they are too small for fish to effectively locate and swallow. Fines should be discarded — don't try feeding them to fish: fouling of the water can occur, which will overload biofilters and solids removal systems, and lead to higher nutrient values for effluents. In other words, you are throwing money away.

When storing feeds, try to keep them in cool, dry areas away from direct sunlight. Many of the essential nutrients contained in feeds are highly sensitive to light

and heat; exposure to these conditions can significantly shorten their shelf-life. As a general rule of thumb, establish a regular rotation for feed stocks and try to stock dry feeds (moisture contents below 10 percent) for no more than 90 days. This time can be extended to about 150 days if unused feed is kept in a refrigerator. Consider reducing the time, particularly in the summer, if storage space is in outdoor metal bins or sheds.

Bagged dry feeds should always be stored on pallets or slats and away from walls: this allows air to circulate around the bags and helps control both the temperatures and the amount of moisture which the bags are exposed to. Such an arrangement also allows you to see if any bags have broken or if rats, mice and other vermin have come in for lunch.

When rearing species which require the use of moist feed (greater than 28 percent moisture) or semi-moist feeds (18-25 percent moisture), different storage arrangements should be made. All of the semi-moist feeds must be stored in a refrigerator and only the feed to be used each day should be left out at room temperature. Moist feeds will require a freezer for storage and feed should only be removed from cold storage immediately before it is going to be used; at room temperatures it will spoil in a matter of hours.

Exposure of dry feeds to excessive moisture or leaving moist and semi-moist feeds out of cold storage can lead to rapid growth of molds. It is never a good idea to use any feed which has actively growing mold cultures; even if you lose money by discarding such feed, you could well profit in the long run. Many fish species are quite sensitive to the toxins secreted by molds and though you may feel that you can discard that portion of the feed with mold, toxins do leach from them very rapidly and can contaminate pellets that show no signs of mold growth. It is always more cost effective to throw out suspect feed than to take a chance at causing health problems for your fish.

These few suggestions should help you to reduce your bottom line, at least in relation to feed costs. More specific information on the particular feeds you are using should be available from feed manufacturers. This is an extremely important component of any aquaculture operation and you should never hesitate to ask questions of your commercial sources or anyone else whose experiences can help move your operation forward.

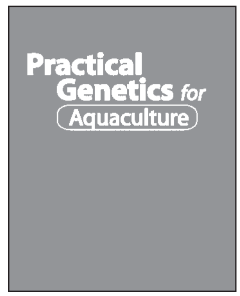
For more information, contact Steve Hughes at 401-651-7664 or sghughes@mail.umes.umd.edu.

Book Review

Aquaculture Genetics — The Difficulty of Simplifying

Practical Genetics for Aquaculture **by Greg Lutz.**
Iowa State Press, A Blackwell Publishing Company, 256 pp., Ames, Iowa, $79.99. www.iowastatepress.com

Standish K. Allen, Jr., Virginia Institute of Marine Science



Aquaculture has undergone revolutionary development over the last several decades. We hear that it is the world's fastest growing agri-industry, growing 11 percent a year since 1984. Like agriculture, aquaculture is a varied and multidisciplinary endeavor and includes such disciplines as physiology, nutrition, environmental management, engineering, and, of course, the subject of this review, genetics. Within genetics alone there are a myriad of subject areas that have strong parallels to agricultural genetics. Aquaculture has an additional wrinkle, namely the cohabitation of both domesticated and wild forms of the same species in the same aquatic ecosystem. Consider as examples the use of domesticated salmon within the range of wild populations, enhancement programs for marine species, commercial shellfish farms, or widespread stocking of freshwater fish for recreation.

Greg Lutz's *Practical Genetics for Aquaculture* is a broad review of many aspects of aquaculture genetics: qualitative traits (i.e., general genetics), quantitative traits (i.e., selection, heritability, inbreeding), hybridization, chromosomal genetics (i.e., cytogenetics of uniparental inheritance and polyploidy) and sex determination and control. In addition, individual chapters cover control and induction of maturation and spawning, transgenic aquatic organisms, and genetic threats to wild stocks. His audience, Lutz writes, is the "non-geneticist with an interest in aquaculture." In this, I would think that audience would especially include hatchery operators and Extension agents. My reading of the book says that the "simplified" discussions of the genetic principals at the beginning of each chapter require some pre-existing knowledge of genetics to make sense of the discussions.

These introductory sections are not written for the layperson. In some cases, imprecise writing obscures the basic principles. For example, in a paragraph on dominance at the beginning of the book, five consecutive sentences use "this" or "these" so that by the fifth sentence, nothing is clear. Sometimes the author uses a term such as locus (actually loci), before defining it later in the book. At other times, small omissions leave examples unclear, such as the failure to fully explain pre-meiotic duplication as a precursor to chromosome manipulation in shellfish. Given the vast amount of introductory material that needs to be covered for the illustrations that follow (with limited space for detailed explanation), there is an implied assumption — though the book is written for the non-geneticist — that the reader is or has been versed in introductory genetics.

The strength of this book is its review of scientific research on aquaculture genetics, with a concentration on references from about 1990 on. While such a contemporary review in one volume is a handy reference, the downside is that these are not complete reviews (stressing warm fresh water species), nor are the reviews (or "illustrative investigations and applications," as they are called) couched in any context of classic work that preceded the 1990s. For example, there is no discussion of the selective salmon breeding program that the Norwegians established in the early 1970s, far in advance of the industry itself — it has become a classic case study of selective breeding in aquaculture. An aquaculturist (partly versed in genetics) might get the impression that aquaculture genetics is a fairly new field. At other times, work of preeminent and practical scientists in the field, such as that of Dr. Yonathan Zohar in fish endocrinology, is omitted entirely.

The principal problem in writing a book of this breadth is that the author has to be almost omniscient, that is, he must have a complete grasp of so many subjects, in order to distill them to their essence, especially in a straightforward prose. While my research and applied efforts are in the field of shellfish genetics, I feel I could give a simplified, scientific-based explanation of genetics in only one area, namely polyploidy. The challenge of writing about all aspects of aquaculture genetics, especially in their real-world application, is daunting — the author deserves credit for trying.

Overall, while the book provides an appetizer for the various principals of aquaculture genetics from a very contemporary standpoint, the illustrations are not always very practical; rather they are more often reviews of research. Based on the "practical genetics" of the title, I was looking forward to a description of how the various genres of genetics were put into actual practice rather than a review of the research. An example of the lack of a practical context for a discussion on research is in the section on "bivalve studies" under "polyploidy," which describes the "unusual approach of triploid in bivalves" using electrofusion. Electrofusion is interesting perhaps, but practical? Certainly not. On the subject of polyploidy, the author argues that "tilapia may arguably be the singly most appropriate species for large scale production of functionally sterile seed in the aquaculture field today." However, there is neither a discussion of the triploid grass carp industry that has been steadily producing triploid carp for twenty years, nor a mention of the use of triploid oysters in the industry of the Pacific Northwest of the United States.

In my reading, the chapter on "control and induction of maturation and spawning" was truly the most useful, guiding the practitioner through many practical considerations of the process. However, like the rest of the book, it was weak or inaccurate for shellfish species. For example, the author seems to assume seratonin injections are a ubiquitous tool in shellfish culture. While it is a frequent subject of research papers, it is infrequently used in minor species. The chapters on transgenics and genetic threats are short — brevity is appropriate for the transgenic chapter since this is a "practical" text and the use of transgenics in aquaculture — though it is becoming reality in other countries — is not yet close in the U.S. The genetics threat is a more complicated issue because of the intermingling of domesticated and wild species in the same ecosystems; the review of this problem is exceedingly weak: while it skips marine species altogether, it also fails to make the most meaningful citations — review papers.

So what is the hatchery operator to do? The truly practical text for genetics of aquatic species has not been written. The problem is exactly the one that Lutz probably faced in dealing with so much subject area in one book — too much specific information because of the tremendous diversity of species and breeding systems. For now, the best resource for the interested hatchery manager (hopefully somewhat versed in genetics) is the local extension office or university department that deals with this type of research. The operator should have a predisposition for practical genetics, because it is not as simple as Lutz says in Chapter One: " . . . virtually every aquaculture industry in every region of the world . . . can generate positive gains in productivity over a comparatively small period of time through the application of simple principles of selection and breeding." The real impediment to this dream of genetics-for-all is the very practical question of exactly how do you go about it. It's just not as simple as reviewing the literature.

Dr. Standish Allen is Professor of Marine Science and Director of the Aquaculture Genetics and Breeding Technology Center, Virginia Institute of Marine Science, College of William and Mary.

Valuing the Chesapeake: New Studies Underway

Doug Lipton, Marine Resource Economist

That there are significant linkages between a healthy Chesapeake Bay and a healthy regional economy will be self-evident to most people who live and work in the bay watershed. An abundance of fish and shellfish, for example, obviously promote well-being across a spectrum of economic sectors — harvesting, processing, service industries, restaurants, tourism. When certain species of fish become scarce, when oyster populations are so depleted by disease as they are, when a potentially toxin-producing dinoflagellate is the subject of major media attention that the seafood industry suffers from consumer fears, economic well-being is affected. While strong ethical arguments alone can be made for restoring fisheries and underwater grass habitats, or reconstructing oyster reefs, economic-based arguments can play significant roles in policy making. Economic valuation of changes in the quality and quantity of market and non-market based bay-related goods and services can often provide important contributions to stakeholder groups in evaluating competing restoration objectives and priorities. Additionally, economic research on market-based incentive systems and regulatory frameworks can also play an important role in policymaking. While economics will not be the sole basis of policy decision-making, economic analyses can help evaluate options and their potential implications for various sectors of local and regional economies.

To draw attention to the link between the restoration of the health of Chesapeake Bay and the health of our economy, Maryland Sea Grant Extension has partnered with the National Oceanographic and Atmospheric Administration (NOAA), and chief economist Rodney Weiher, in order to produce a series of studies on the role of economics in Chesapeake Bay management and restoration. The aim is to draw attention to the linkages between Bay restoration and the economy. Now underway are initial studies that include the following:

- An Introduction to Economics and Chesapeake Bay Restoration and Management. Doug Lipton, Maryland Sea Grant Extension.

- Valuing Commercial and Recreational Fisheries. Ivar Strand, Professor Emeritus, University of Maryland College Park.

- Economics of Riparian Forest Buffers. James Casey, Washington and Lee University, Virginia.

- Market-Based Approaches to Chesapeake Bay Management Dennis King, Chesapeake Biological Lab, and Len Shabman, Virginia Tech.

Other notable economists in the region will be participating in developing future topics for the series.

One of the goals in is to reinvigorate the discussions regarding economics that were part of the Chesapeake Bay management discourse during the 1980s. In 1985, the late Eugene Cronin, former director of the Chesapeake Biological Laboratory, worked with several economists to convene a series of conferences on the Economics of Chesapeake Bay Management. Some of the seminal economic research on valuing the environment was presented as preliminary findings at these conferences. For example, in 1989 Ivar Strand presented initial estimates of recreational fishing values that became the basis for estimating how the value of recreational fishing changes with changes in angler catch rates.

At the 1985 conference, James Kahn, now at Washington & Lee University, presented a paper, "The Functional Relationship Between Economic Damages and the Loss of Submerged Aquatic Vegetation in the Chesapeake Bay." Kahn pointed out the need to link changes in SAV to changes in productivity of the ecosystem, and then to changes in the economic benefits society derives from the ecosystem. The example he uses is the link between SAV biomass and the health of the striped bass commercial fishery.

This concept of linking Chesapeake Bay ecosystem restoration to economic benefits that was discussed in these early Economics of Chesapeake Bay Management conferences may have presaged what was to come in the Chesapeake 2000 agreement which calls for the following: "By 2007, revise and implement existing fisheries management plans to incorporate ecological, social and economic considerations, multi-species fisheries management and ecosystem approaches.

This planned series of papers will provide some understanding of the challenges and opportunities for accomplishing the goal of ensuring that a healthy Chesapeake Bay ecosystem provides for a healthy regional economy.

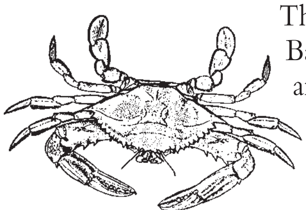
For more on economics and the Chesapeake Bay, see the Maryland Sea Grant website, www.mdsg.umd.edu/ Extension/economics.html. Lipton also wrote an article on valuing oysters in Bay restoration — see www.mdsg.umd.edu/Extension/

Aquafarmer/Fall99.html#2. For further information on the current series of studies, please contact Doug Lipton, 301-405-2140 or dlipton@arec. umd.edu

Research Update

Reckoning the Age of Blue Crabs

Matt Hall, Chesapeake Biological Laboratory



The blue crab is king in Chesapeake Bay. In the decade between 1991 and 2000, Bay watermen brought in more than 30 percent of the total worldwide catch of *Callinectes sapidus*, the species name meaning "beautiful swimmer." In Maryland, blue crab harvests account for some 60 percent of watermen earnings at the dock. Given the economic importance of blue crabs to the region, it is understandable that indicators of declining harvests in recent years — for example, low recruitment and low spawning stock sizes — have given rise to a great deal of concern, if not worry, by many stakeholder interests.

These concerns led to the Bi-State Blue Crab Advisory Committee (BBCAC) that has explored different strategies to reduce fishing pressure and promote sustainable harvesting (see www.mdsg.umd.edu/crabs/manage.html for details). New regulations in Maryland, for example, have raised the minimum size of harvestable hard crabs from 5 inches (127 mm) to 5-1/4 inches (133 mm). (Size limits have been increased for soft crabs and peelers as well.) This size-based regulation assumes that blue crab size is a direct determinant of age and that younger, seemingly immature crabs will be left to spawn and contribute to harvests in future years. However, what if crab size is not directly related to crab age? What kind of impact could incorrect age determination have on the way that management targets for sustainable yield are computed?

The question has no easy answer, largely because determining the age of a crab has been notoriously difficult to do. Mechanical tags cannot be used as they are with fish because the tag would be discarded along with the shell when the crab molts — and crabs molt numerous times over their lifetime. Nor do crabs or other crustaceans produce any other hard parts such as otoliths, the earbones of fish, which grow in layers and, in effect, lay down a record of a fish's life history such as its rate of growth and the chemical environment it has inhabited. If otolith analysis was once "far out," it is now one of a number of tools that researchers use in answering a host of questions having to do with population dynamics. Scientists have been searching for such innovative techniques to do the same for crabs.

At the Chesapeake Biological Laboratory (part of the University of Maryland Center for Environmental Science), Se-Jong Ju, Rodger Harvey and David Secor are among those researchers. They have been exploring the use of biochemical markers in blue crabs that might be related to determining their age.

Such techniques have to deal with a number of environmental variables that affect growth. For example, a late onset of winter (i.e., warm temperatures through fall into early winter) could prolong conditions favorable for growth, and lead to crabs of larger-than-expected size the following year. In addition, crabs breed over a long season that lasts from late spring through early fall; therefore, crabs spawned in June will have a three-month head start in growth over crabs spawned in August of the same year (although there is evidence that crabs spawned late in the season make up the difference by growing rapidly the following spring).

Ju and his colleagues found that scientists studying the aging of other crustaceans were able to measure quantities of lipofuscin, a reaction product that accumulates in neural tissue such as the eye stalk and brains. The cells of neural tissue experience a slow turnover rate when compared with cells from other tissues. Therefore, lipofuscin accumulation in the crab is relatively constant — because it seems to increase as the crab ages, lipofuscin concentration, they felt, could serve as an index of age.

Having a potential age indicator, the researchers designed experiments to test its effectiveness. In the laboratory, Ju measured the amount of lipofuscin in eye stalks by using a spectrofluorometer, an instrument that bombards the sample of lipofuscin with energy that causes it to fluoresce, or glow. The spectrofluorometer measures the degree of fluorescence, which Ju translated into the quantity of lipofuscin present in the sample.

With the help of Chesapeake Bay watermen, Ju collected blue crabs from three sites in the Bay, measured their carapace widths, and collected eyestalk tissue for analysis. He also raised crabs from larvae in the laboratory and in enclosed ponds so that he would be able to measure lipofuscin levels of known-age crabs that he could then compare with lipofuscin measures from wild-caught crabs.

The preliminary results of these experiments were striking. When analyzed by size (carapace width), wild-caught crabs fell into two age classes, less than one-year old and greater than one-year old. However, when the same crabs were analyzed for lipofuscin content, three broad age classes emerged — less than one year old, between one and two years old, and two years old and greater. These lipofuscin-based age categories corresponded with those determined by studying crabs of known age from the laboratory and pond experiments.

These findings suggest that current size-based aging methods (i.e., carapace width) may not be fully accurate. Ju also found what appears to be two major spawning events within the same year, one in early spring and another in late summer. Some crabs spawned early in the spring would be capable of achieving a carapace width of harvestable size (greater than 120 mm) by the end of their second year and would be misclassified as over two years of age by the size-based system. In other words, a disproportionate number of crabs between one and two years of age may be harvested before they reach full maturity. According to these findings, growth rate in crabs may be faster than originally thought and the abundance of harvestable crabs may be strongly influenced by the number of immature crabs that reach harvestable size.

These findings, Ju cautions, are preliminary. More work needs to be done before this method could reliably supercede traditional size-based methods. However, the unique characteristics of the lipofuscin age pigment and rapid advances in the routine use of biochemical markers combine to make this technique promising for determining the age of blue crabs for better aiding in the management blue crab stocks.

For more information on biochemical approaches to determining the age of crustaceans at the Chesapeake Biological Laboratory, see http://cbl.umces.edu/~harvey/MOGEL/crab.htm. Matt Hall is a faculty research assistant at the Chesapeake Biological Laboratory.

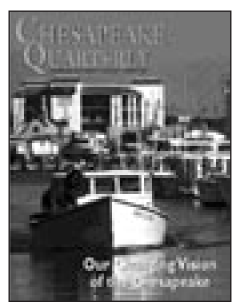
Publications

Open Ocean Aquaculture IV: From Research to Commercial Reality. Mississippi Sea Grant. Some 45 extended abstracts that cover major thematic issues in marine policy and social/economic impacts; ocean engineering; environmental impacts; and candidate species and logistics/operations. Publication No. MASGP-01-006, 95 pp. No charge. Phone: 228-818-8836; www.masgc.org

Proceedings of 1999 Marine Ornamentals Conference. Hawaii Sea Grant. Nineteen papers cover coral and fish nutrition, resource management, aquarium equipment, and economics. Publication. No. UNIHI-SG-CP-00-04, 127 pp. No charge. Phone: 808-956-7410; www.soest.hawaii.edu/SEAGRANT

Proceedings of the Fourth International Conference on Recirculating Aquaculture, 2002. Print and CD-ROM versions available. The CD-ROM includes pdf files of papers from four years of conferences — 1996, 1998, 2000 and 2002. $25 (international orders, $30). The print proceedings for 2002 (651 pages) is $45 (international orders $50). Contact Virginia Tech, 119 Food Science and Technology Building, Virginia Tech, Blacksburg 24061, phone 540-231-2075 or e-mail to cfast@vt.edu

New Sea Grant Magazine: *Chesapeake Quarterly*



Maryland Sea Grant has begun publishing a new magazine called Chesapeake Quarterly that focuses on synthesis and analysis of research and how it is used by managers, politicians, environmental groups and citizens to understand, regulate and protect the Chesapeake Bay. Its aim is to provide an academic perspective on research and policy in the Chesapeake region. The new publication replaces Maryland Marine Notes, the newsletter on research, education and outreach produced by Maryland Sea Grant from 1982-2001. The summer 2002 issue of Chesapeake Quarterly highlights paleontology and the Chesapeake and the work of scientist Grace Brush. Each issue, with expanded information and color photographs, is also available on the web at www.mdsg. umd.edu/CQ. For a paper copy of the current issue, or to receive a free subscription for future issues, write connors@mdsg.umd.edu, call 301-403-4220, or visit the CQ online site.

Upcoming Conference

Sixth International Conference on Shellfish Restoration. The conference will provide an opportunity for resource managers, users, community leaders and government officials to discuss approaches for restoring coastal shellfish ecosystems through management, enhancement and restoration efforts. Case studies of successful projects will be presented. For more information contact Elaine Knight at Elaine.Knight@scseagrant.org or 843-727-6406. Visit the web at www.scseagrant.org/icsr.htm for more information.

We've Moved!

Maryland Sea Grant has moved its offices to new quarters in College Park, Maryland. Our new address is: Maryland Sea Grant College, 4321 Hartwick Road, Suite 300, College Park, Maryland 20740, phone: 301-403-4220, fax: 301-403-4255. All electronic mail and world wide web links remain the same.

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Sea Grant
University of Maryland

Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, University of Maryland, College Park, and local governments. Thomas A. Fretz, Director of Maryland Cooperative Extension, University of Maryland, College Park.

The Maryland Sea Grant Extension Program is a joint effort of the Maryland Cooperative Extension and the Maryland Sea Grant College, supported in part by NOAA Office of Sea Grant, Department of Commerce.

MARYLAND COOPERATIVE EXTENSION
U.S. DEPARTMENT OF AGRICULTURE
UNIVERSITY OF MARYLAND, COLLEGE PARK
COLLEGE PARK, MARYLAND 20742
OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

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The **Maryland Aquafarmer** is a quarterly publication of the **MARYLAND COOPERATIVE EXTENSION SERVICE, UNIVERSITY OF MARYLAND COLLEGE PARK AND EASTERN SHORE** with support from the **MARYLAND SEA GRANT COLLEGE PROGRAM**. This publication is mailed free of charge to those interested in aquaculture research and education. Address corrections are requested. The publication is also accessible on the World Wide Web through the Maryland Sea Grant College home page. Our address is:

www.mdsg.umd.edu/MDSG/Extension/Aquafarmer/index.html

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