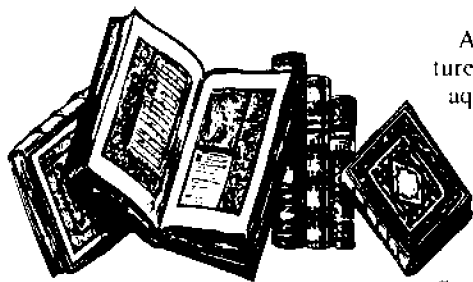


Sea Grant Depository

# Aquaculture

## Delaware Aquaculture Resource Guide

by John W. Ewart and Joseph G. Farrell  
University of Delaware  
Sea Grant Marine Advisory Service



A great deal of literature is available about aquaculture, but locating and evaluating the most useful information is a time-consuming process. This resource guide identifies a variety of contacts

and other sources of information we think will be helpful to anyone in Delaware interested in learning more about aquaculture. The guide is subdivided into sections on contacts for technical information and assistance in Delaware; other regional/national programs; newsletters, magazines, and other periodicals; reference books and manuals; aquaculture equipment and supplies; and aquaculture associations.

We have avoided compiling an exhaustive bibliography or comprehensive list of trade associations or industry suppliers. Rather, we have included local/regional contacts wherever possible and have identified other sources of information with application to aquaculture in Delaware and the Mid-Atlantic region.

Many of the reference books and periodicals listed in this resource guide are in the collections of the libraries at the University of Delaware, Delaware State College, and the National Agricultural Library and may be acquired by your local library through interlibrary loan. All aquaculture publications at the University of Delaware are accessible through DELCAT, a computerized card catalog system containing all of the publications held at the main campus in Newark and the Marine Studies campus in Lewes. Books, periodicals, and other materials are listed by author, title, subject, and keywords. Contact your local library for additional information on interlibrary loan and the DELCAT system.

Aquaculture is in the early stages of development in Delaware. There are no "recipe books" for success. Proper planning and understanding of the key elements of aquatic production systems, marketing, and applicable permits and regulations is essential. The only way to really find out whether aquaculture is right for you is to know all that you can before investing large amounts of your time, effort, and money. This guide is meant to be a starting point.

### Technical Information and Assistance

The Delaware Department of Agriculture (DDA) conducts commodity marketing programs and provides a competitive grant

program for alternative agriculture. The DDA is developing a technical assistance and marketing program to assist aquaculturists and to promote Delaware aquaculture products. The Secretary of Agriculture chairs the Delaware Aquaculture Advisory Council.

The Delaware Aquaculture Advisory Council was created to work with the Secretary of Agriculture to address technical, economic, and legal/regulatory issues affecting industry development.

In December 1989, Governor Castle established the Delaware Aquaculture Task Force, composed of individuals from state government, industry, and academia, to evaluate the status and potential of aquaculture in Delaware and to prioritize and recommend future action in research and technology, economics and marketing, and legal/regulatory issues. The task force concluded that the potential contribution of aquaculture to Delaware's future economic development was significant and recommended that the state develop a comprehensive program to promote and support growth of an aquaculture industry.

"The Delaware Aquaculture Act"—passed by the 135th General Assembly in June 1990 and signed by Governor Castle the following month—designated aquaculture as an agricultural activity and named the Department of Agriculture the lead agency for promoting and coordinating aquaculture in Delaware. The legislation also authorized creation of the aquaculture advisory council.

For more information about the Delaware Aquaculture Advisory Council or aquaculture programs, contact *Department of Agriculture, Marketing and Product Development*, 2320 South DuPont Highway, Dover, DE 19901, (302) 739-4811; 1-800-282-8685 (DE).

The University of Delaware Sea Grant Marine Advisory Service conducts educational programs and applied research in aquaculture and is developing an information-resource center consisting of technical reports and manuals, extension fact sheets, and videos. Other programs include business management, seafood marketing, and consumer education. Contact: *Marine Advisory Service*, University of Delaware, Graduate College of Marine Studies, 700 Pilottown Road, Lewes, DE 19958-1298, (302) 645-4346.

Delaware Cooperative Extension conducts applied agricultural research and extension education programs in crop production, farm financial management, water quality/conservation, and

The Delaware Aquaculture Information Series is designed to provide practical information about aquaculture production and development in Delaware. The series is produced by the University of Delaware Sea Grant College Program with the cooperation of the Delaware Cooperative Extension Service, Delaware State College, and U.S. Soil Conservation Service. The series is supported by a grant from the Delaware Department of Agriculture.



alternative agriculture. These programs may have applicability to potential aquaculturists. Contact:

*New Castle County Cooperative Extension*, Townsend Hall, Univ. of Delaware, Newark, DE 19717-1303, (302) 451-2506.

*Kent County Cooperative Extension*, 4601 S. Du Pont Highway, Dover, DE 19901, (302) 697-4000.

*Sussex County Cooperative Extension Research and Education Center*, R.D. 2, Box 48, Georgetown, DE 19947, (302) 856-7303.

**Delaware State College** conducts applied research in aquaculture and provides formal training in fisheries management. Contact: *Delaware State College*, Department of Agriculture and Natural Resources, Dover, DE 19901, (302) 739-4929.

**The U.S. Soil Conservation Service (SCS)** implements a national soil and water conservation program in cooperation with landowners and local conservation districts; provides on-site evaluation for ponds, including soil borings, and will assist with design and lay-out for aquaculture production ponds. Conservation Districts conduct programs which may provide cost-sharing for ponds, irrigation ditches, and water-control structures. Contact:

*New Castle Conservation District*, 6 People's Plaza, Newark, DE 19702, (302) 834-3533.

*Kent Conservation District*, 3500 S. Du Pont Highway, Dover, DE 19901, (302) 697-6176.

*Sussex Conservation District*, 408 N. Du Pont Highway, Georgetown, DE 19947, (302) 856-7215.

*U.S. Soil Conservation Service*, 1203 College Park Drive, Dover, DE 19901, (302) 678-4175.

**The Delaware Department of Health and Social Services** provides water-quality analytical services for well water on a fee-for-service basis; approves water quality for shellfish growing areas, and inspects shellfish processing plants. Contact: *Department of Health and Social Services*, Division of Public Health, Jesse S. Cooper Building, Federal & Water Streets, Dover, DE 19901, (302) 739-4731.

**The Department of Natural Resources and Environmental Control (DNREC)** manages and protects state natural resources through regulations and permits for surface and groundwater use, finfish propagation, shellfish leases, wetlands, wastewater, and solid waste; provides pond consultations for problems associated with fish populations and aquatic weeds (Division of Fish & Wildlife); and provides environmental permit coordination through the Development Advisory Service (DAS). Contact: *DNREC*, 89 Kings Highway, P.O. Box 1401, Dover, DE 19903, (302) 739-4506.

**The Small Business Development Center** provides management assistance and services to Delaware's small businesses, including management counseling, training seminars, and literature. Contact: *Small Business Development Center*, Purnell Hall, Suite 005, University of Delaware, Newark, DE 19716, (302) 451-2747 or 1-800-222-2279 (Kent and Sussex counties).

**The Delaware Development Office** provides manpower training, site location assistance, statistics, and tax information on Delaware and assistance in obtaining financing. Contact: *Delaware Development Office*, 99 Kings Highway, P.O. Box 1401, Dover, DE 19903, (302) 739-4271.



Illustrations throughout by Thomas Batten.

## Delaware Aquaculture Publications

***Delaware Aquaculture Task Force Final Report***. The final report of the Aquaculture Task Force, chaired by Lt. Governor Dale F. Wolf and Secretary of Agriculture William B. Chandler (vice-chairman), defines the status and potential of aquaculture in Delaware and provides important background information in three areas: marketing, regulations and permits, and research and technology. Each section includes a series of specific recommendations for future development of an aquaculture industry in the state. Copies of the report are available from the Delaware Department of Agriculture, the Sea Grant Marine Advisory Service, or your county Cooperative Extension office.

***Delaware Aquaculture Information Series***. The resource guide you are reading is part of this series, which is designed to provide both general and technical information on aquaculture development in the state. Current publications in the series range from an overview of the potential for aquaculture in Delaware to a guide to aquaculture permits and regulations, and articles on fish and crawfish culture. Future publications will cover important issues affecting aquaculture development in Delaware and new advances in aquaculture research and technology. The series is available from the Sea Grant Marine Advisory Service, your county Cooperative Extension office, or the Delaware Department of Agriculture.

## Other Regional and National Programs

**Aquaculture in the Mid-Atlantic** is a regional conference sponsored by the Land and Sea Grant Colleges of Maryland, Virginia, and Delaware, and other state agencies, aquaculture associations, and private foundations. The conference, held each year in early June, brings together industry, government, and academic representatives to discuss current issues and new developments concerning regulations and permits, production technology, business management, and marketing. The conference rotates among different Mid-Atlantic sites each year. For more information, contact the Delaware Sea Grant Marine Advisory Service or your local Cooperative Extension office.

**University of Maryland Aquaculture Programs and Services**. The Maryland Aquaculture Bill of 1988 appropriated funds to the University of Maryland to serve as the lead institution in developing and implementing programs in research, extension, and education in support of the state's aquaculture industry. The Cooperative Extension and Sea Grant Extension Services have developed a series of programs and publications to provide Marylanders with general and technical information on aquaculture. *Aquaculture: A Guide to Programs and Services of the University of Maryland Systems* includes a schedule of public workshops on a variety of topics related to aquaculture production and management. These programs are held throughout the year at most county Cooperative Extension offices in Maryland and are open to interested Delawareans on a space-available basis.

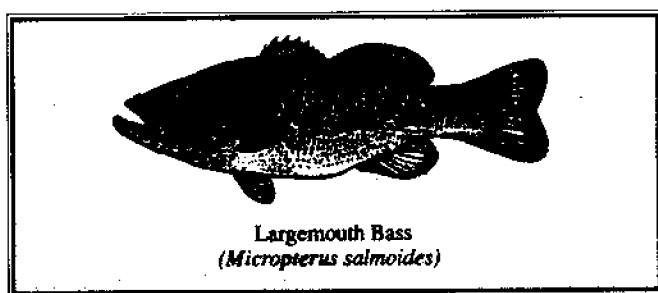
Maryland and Delaware's long history of interstate cooperation and exchange of extension information and resources in agriculture also applies to aquaculture as it develops in the region. Planning is under way to conduct future joint extension programs with the University of Maryland. Please keep in mind, however, that the Delaware Sea Grant Marine Advisory Service or your county Cooperative Extension office should be your first point of contact for aquaculture information or to request individual technical consultation/assistance. For more information, please contact the Delaware Sea Grant Marine Advisory Service or your local Cooperative Extension office.

**USDA Regional Aquaculture Centers**. Between 1987 and 1988, Congress appropriated funds to the U.S. Department of Agriculture to establish five regional aquaculture research and

development centers. The objective of the centers is to administer cooperative and collaborative research and extension education programs in aquaculture having regional or national application.

Projects addressing national and regional research priorities are developed in association with colleges and universities, state Departments of Agriculture, federal facilities, private research institutions, and industry. All projects sponsored by the centers include support for extension and technology transfer to ensure rapid application of new innovations and other research findings by industry. Program specialists from state Sea Grant Marine Advisory and Cooperative Extension Services often participate in these projects and also serve as primary public/industry information contacts for the regional centers.

Delaware is considered part of the Northeast Regional Aquaculture Center (NRAC). Other states represented by the Northeast Center include Connecticut, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, Vermont, and West Virginia, plus the District of Columbia. NRAC publishes a quarterly newsletter that provides general information on aquaculture development nationally plus current information on regional research priorities, new and completed projects, and other center activities. For more information about the Northeast Regional Aquaculture Center and its programs, contact NRAC, Southeastern Massachusetts University, N. Dartmouth, MA 02747, (508) 999-8157.



**The Aquaculture Information Center.** Located in the National Agricultural Library (NAL), this facility serves as a focal point for those interested in obtaining current and retrospective literature about aquaculture. The Aquaculture Information Center acquires books, periodicals, and other aquaculture-related materials of value from the entire aquaculture community. Services provided by the National Agricultural Library include the following:

- ◆ Produces the AGRICOLA computerized data base, an index to more than 2 million books and articles relating to all aspects of agriculture including production, management, harvesting, marketing, and economics of aquatic animals and plants.
- ◆ Acquires books, journals, maps, slides, films, videos, and microcomputer software through purchase, gifts, and exchange from all countries and in all languages.
- ◆ Lends books and photocopies journal articles of documents not available locally.

NAL's reference services are designed to guide library users in securing information for business, research, and study. The Reference Branch is staffed by subject specialists who will aid you in the following ways:

- ◆ Assist you in accessing NAL's extensive collection on a broad range of agricultural subjects, including many aspects of aquaculture.
- ◆ Identify current research conducted by U.S. Department of Agriculture research agencies.

- ◆ Furnish you with a Quick Bibliography on a timely topic in agriculture, including "Aquaculture: Development Plans and Marketing" and "Shellfish Culture" or with a short guide to literature on specific subjects such as milkfish culture or hybrid striped bass. For more information and a list of the latest Quick Bibliography Series, contact Reference at (301) 344-1204.

For specific information on aquaculture, contact *Aquaculture Information Center*, National Agricultural Library, Room 304, Beltsville, MD 20705, (301) 334-3704.

**Fish and Wildlife Service, U.S. Department of the Interior.** Private aquaculture, public aquaculture, and public fishery management are interrelated in a variety of ways. These interrelationships - past, present, and future - make service to private sector aquaculture a public interest and a responsibility of the Fish and Wildlife Service.

The Fish and Wildlife Service has a national aquaculture coordinator, six regional aquaculture coordinators, four Fish Technology Centers, and nine Fish Health Centers that provide information and services directly to fish farmers. In addition, nine research centers or stations and many of the 37 Cooperation Fish and Wildlife Research Units conduct research and provide information of value to the aquaculture industry. The 75 fish production units of the National Fish Hatchery system provide practical testing and demonstration of techniques and information developed inside and outside the Fish and Wildlife Service. Names and addresses of individuals and offices to contact for information and assistance in the Mid-Atlantic region are provided below.

*Information and General Services.* The offices of the national or regional aquaculture coordinators are the best places to contact for general information. If you need assistance with a matter that requires the attention of a specialist at a field office, the aquaculture coordinators will direct you to the appropriate person.

*Fish and Health Services.* Inspection, diagnosis, and certification services are available to private farmers, as staff and finances permit, through nine Fish Health Centers located throughout the country. Call national or regional aquaculture coordinators for information on services in your area.

*National Aquaculture Coordinator Service, U.S. Fish and Wildlife Service.* ARLSQ 820, 18th & C Streets, N.W., Washington, DC 20240. Attention: John G. Nickum. Telephone: (612) 725-3500, ext. 3447.

*U.S. Fish and Wildlife, Region 5, Fish Technology Center,* P.O. Box 155, Lamar, PA 16848, Attention: Michael A. Hendrix. Telephone: (717) 726-4247.

*Fisheries Academy.* Operated by the Fish and Wildlife Service, U.S. Department of the Interior, in Leetown, West Virginia (70 miles northwest of Washington, DC), the Fisheries Academy offers courses in fisheries management and aquaculture. Fisheries Academy courses are designed not only for people responsible for day-to-day operation of fish production facilities, but also for those responsible for management. Instructors include world-known authorities in fish husbandry and production techniques, fish diseases, genetics, and aquaculture. Courses and other training programs offered by the Fisheries Academy are open to individuals from the federal and state governments, conservation groups, and private businesses. A catalog covering training programs, course descriptions for the 1990-91 academic year, audiovisual training courses, videotapes, and other information about the Fisheries Academy is available by contacting *Fisheries Academy*, Fish and Wildlife Service, United States Department of the Interior, Rt. 3, Box 49, Kearneysville, WV 25430.

## Newsletters, Magazines, and Periodicals

Because they are produced several times a year, the following publications are some of the best sources for up-to-date information on all aspects of aquaculture research and development. This is only a partial listing of what is available, and subscription rates are listed where applicable. While it is certainly not necessary (or economically feasible) to receive all of these publications, we do recommend that you examine these magazines and newsletters to decide which ones are most informative for you. Some of these publications are free, and many professional associations and publishers often will provide complimentary samples of their publications upon request. Most of these publications, especially the technical journals, which can be quite expensive, are carried by the University of Delaware's libraries in Newark and/or Lewes and may be available locally through interlibrary loan.

**Alternative Aquaculture Network Newsletter.** Published quarterly by the Alternative Aquaculture Association, Inc., P.O. Box 109, Breinigsville, PA 18031. Subscription rate: \$14/year.

**Aquaculture.** Technical journal published monthly by Elsevier Science Publishing Co., Inc., Journal Information Center, 655 Avenue of the Americas, New York, NY 10010, USA (212) 633-3750.

**Aquaculture Magazine.** Published monthly by Aquaculture Magazine, Subscription Dept., P.O. Box 2329, Asheville, NC 28802. Subscription rate: \$15/year, includes Annual Buyer's Guide.

**Aquacultural Engineering.** Technical journal published by Elsevier Science Publishing Co., Inc., Journal Information Center, 655 Avenue of the Americas, New York, NY 10010, USA, (212) 633-3750.

**Aquaculture Situation and Outlook Report.** Published twice a year by Commodity Economics Division, Economic Research Service, United States Department of Agriculture. Subscriptions are available from ERS-NASS, P.O. Box 1608, Rockville, MD 20849-1608 or call 1-800-999-6779. \$12/year.

**Catfish News/Aquaculture News.** Industry newspaper published monthly by Aquacom, Inc., P.O. Box 4566, Jackson, MS 39296, (601) 853-1989. Subscription rate: \$20/year.

**Coastal Aquaculture.** Newsletter published quarterly by Texas Agricultural Extension Service, Texas A&M Research & Education Center, Rt. 2, Box 589, Corpus Christi, TX 78410. Subscription rate: Free.

**Fisheries.** Magazine published bimonthly by the American Fisheries Society, 5410 Grosvenor Lane, Bethesda, MD 20814. Subscription rate: \$43.50/year.

**Journal of Applied Aquaculture.** Published quarterly by Food Products Press, Inc., 10 Alice Street, Binghamton, NY 13904-1580, 1-800-342-9678.

**Journal of Shellfish Research.** Technical journal published quarterly by the National Shellfisheries Association, c/o Thomas Soniat, Dept. of Biological Sciences, Nicholls State University, P.O. Box 2021, Thibodaux, LA 70310, (504) 448-4700. Subscription rate: Included with membership in NSA.

**Journal of the World Aquaculture Society.** Technical journal published quarterly by the World Aquaculture Society (WAS), 143 John M. Parker Coliseum, Louisiana State University, Baton Rouge, LA 70803, (504) 388-3137. Subscription rate: Included with WAS membership.

**Maryland Aquafarmer.** Newsletter published quarterly by the Cooperative Extension Service, University of Maryland, P.O. Box 519, Easton, MD 21601. Subscription rate: Free.

**National Shellfisheries Association (NSA) Quarterly Newsletter.** Published by the National Shellfisheries Association, c/o Thomas Soniat, Dept. of Biological Sciences, Nicholls State

University, P.O. Box 2021, Thibodaux, LA 70310, (504) 448-4700. Subscription rate: Included with membership in NSA.

**Northeast Regional Aquaculture Center Quarterly Newsletter.** Published by the Northeast Regional Aquaculture Center, Southeastern Massachusetts University, North Dartmouth, MA 02747. Subscription rate: Free.

**Practical Aquaculture and Lake Management.** Newsletter/magazine published bimonthly by Aquaculture Advisory Service (AAS), P.O. Box 1294, Garner, NC 27529-1294, (919) 772-8548. Subscription rate: \$18/year.

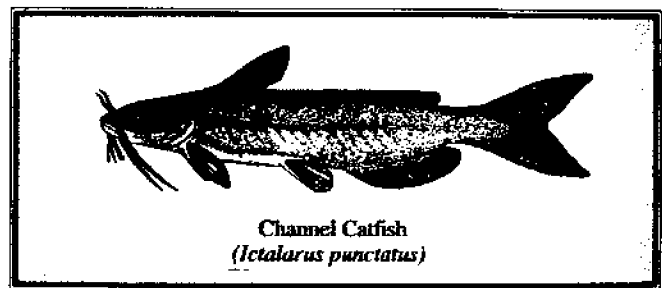
**Seafood Business.** Trade magazine published bimonthly by Journal Publications, 21 Elm Street, Camden, ME 04843. Subscription rate: \$20/year.

**Seafood Leader.** Trade magazine published bimonthly by Waterfront Press Co., 1115 NW 46th Street, Seattle, WA 98107. Subscription rate: \$18/year.

**The Progressive Fish-Culturist.** Technical journal published quarterly by The American Fisheries Society (AFS) and the U.S. Fish and Wildlife Service. Contact: AFS, 5410 Grosvenor Lane, Suite 110, Bethesda, MD 20814. Subscription rate: \$19 per volume.

**Water Farming Journal.** Industry magazine published monthly by Water Farming Journal, 3400 Neyrey Drive, Metairie, LA 70002. Subscription rate: \$15/year.

**World Aquaculture Magazine.** Published quarterly by the World Aquaculture Society, 143 John M. Parker Coliseum, Louisiana State University, Baton Rouge, LA 70803, (504) 388-3137. Subscription rate: Included with WAS membership.



Channel Catfish  
(*Ictalurus punctatus*)

## Selected Reference Books and Manuals

The following publications are useful sources for both general and technical information on various aspects of aquaculture. Many of the books are in the collections at the University of Delaware, Delaware State College, and National Agricultural Library and may be acquired by your local library through interlibrary loan. Texts can also be ordered through local bookstores and some aquaculture equipment suppliers. The International Standard Book Number (ISBN) is included for book ordering purposes. Copies of most of the manuals are available by contacting the address provided.

Content descriptions for several of the titles listed here were adapted from the Argent Aquaculture Reference Library Catalog. For additional listings and descriptions of aquaculture books, consult the reference library catalog, available at no charge from Argent Chemical Laboratories, 1-800-426-6258.

### General Aquaculture Information

**A Manual of Chemical & Biological Methods for Seawater Analysis.** T. Parsons, 1985, Pergamon (ISBN 0-08-030287-4). 173 pp. Documents the key methodologies for the chemical, physical, and biological characterization of seawater.

**Audiovisuals for Aquaculture.** Prepared by Eileen M. McVey, U.S. Department of Agriculture, National Agricultural Library,

Aquaculture Information Center, Beltsville, MD 20705. Lists audiovisual materials on aquaculture and related subjects in VHS, slide set, and filmstrip formats.

**Aquacultural Engineering.** F. Wheaton. 1977. Krieger (ISBN 0-89874-788-0). 708 pp. Part I defines physical properties of aquatic systems. Part II highlights principles of engineering for design and operation of culture systems. Additional chapters focus on process control, filtration, pumping, and aeration.

**Aquaculture Management.** J. Meade. 1989. Van Nostrand Reinhold (ISBN 0-442-20570-8). 175 pp. Summarizes principles of fish culture and aquaculture systems and their management.

**Aquaculture: The Farming & Husbandry of Freshwater & Marine Organisms.** J. Bardach. 1972. Wiley (ISBN 0-471-04826-7). 868 pp. Gives an excellent overview of world aquaculture. Complete analysis of all cultured aquatic species.

**Aquaculture Training Manual.** D. Swift. 1985. Fishing News Ltd. (ISBN 0-85238-136-0). 135 pp. Provides fundamental information concerning the principles of aquaculture systems. Part I deals with special chapters on growth, nutrition, and reproduction. Part II specifically concentrates on culture methodology of salmonids, catfish, tilapia, carp, milkfish, mullet, shrimps, oysters, and mussels.

**Bioeconomics of Aquaculture.** P. Allen. 1987. Elsevier (ISBN 0-444-42301-X, I-102-84). 352 pp. Synthesizes biological, engineering, and economic factors into a unifying framework of analyses through modeling approach.

**Design & Operating Guide for Aquaculture Seawater Systems.** J. Huguenin. 1989. Elsevier (ISBN 0-444-87157-8). 264 pp. Provides design, construction, and operating information on seawater systems.

**Engineering Aspects of Intensive Aquaculture.** M. Timmons, et al., eds. 1991. Northeast Regional Agricultural Engineering Service NRAES-49, 152 Riley-Robb Hall, Cornell Univ. Cooperative Extension, Ithaca, NY 14853-5701. Proceedings from aquaculture symposium on intensive production systems held April 4-6, 1991. Topics include closed systems, system design, water quality, engineering, and management considerations.

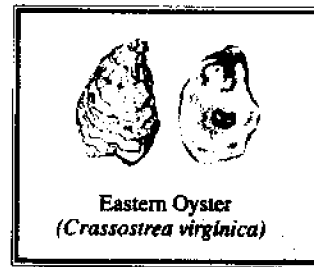
**Fish & Invertebrate Culture: Water Management in Closed Systems.** S. Spote. 1979. Wiley-Interscience (ISBN 0-471-02306-X). 179 pp. Covers almost all aspects of water quality with detailed chapters on filtration, disinfection of water, and physical adsorption. Other sections deal with seawater, buffering of water supplies, toxicity, and disease prevention, and even analytical methods.

**Freshwater Vegetation Management.** E. Gangstad. 1986. Thomas Publications (ISBN 0-913-70236-6). 380 pp. An authoritative text on the subject of freshwater vegetation management.

**Fundamentals of Pesticides Self-Instruction Guide.** G. Ware. 1989. Thomson Publications. 274 pp. Excellent volume on terrestrial and aquatic pesticides. Instructs readers on pesticide formulations, plus chapters on insecticides, herbicides, fungicides, and bactericides. Self-instruction book with exercises throughout the text.

**Introduction to Freshwater Vegetation.** D. Riemer. 1984. AVI (ISBN 0-87055-448-4). 207 pp. Introduces the reader to the basics of aquatic botany, limnology, and management of ponds and lakes.

**Methods for the Microbial Examination of Fish and Shellfish.** B. Austin. 1989. Halsted Press (ISBN 0-470-21486-4). 317 pp. Practical aspects of microbiological techniques and descriptions of methods for isolation and characterization of bacteria, fungi, and viruses from fish and shellfish.



Eastern Oyster  
(*Crassostrea virginica*)

**Nutrition and Feeding of Fish.** T. Lovell. 1988. Academic Press (ISBN 0-121-94055-1). 260 pp. Treatise for commercially important fishes from diverse culture systems, including cold-water fish, warm-water fish, crustaceans, pond cultures, and artificial cultures.

**Ponds—Planning, Design, Construction.** U.S. Department of Agriculture, Soil Conservation Service, Agricultural Handbook #590. 1982. Good source of general information and requirements for building a pond for watershed management.

**Practical Aquaculture Literature II, A Bibliography.** Compiled and edited by Eileen T. McVey, Deborah T. Hanfman, Mona F. Smith, and Ann Townsend Young. 1989. U.S. Department of Agriculture, National Agriculture Library, Aquaculture Information Center, Beltsville, MD 20705. Covers aquaculture species and subjects, selected periodicals, newsletters, books, bibliographies, directories, and state publications; state extension specialists in aquaculture and fish and wildlife; associations, and the Regional Aquaculture Centers.

**Principles and Practices of Pond Aquaculture.** J. Lannan. 1986. Oregon State University Press (ISBN 0-87071-341-8). 246 pp. Excellent volume on pond aquaculture. Part I deals with pond dynamics and cycles. Part II addresses culture practices. Part III details modeling of pond culture systems.

**Principles of Warmwater Aquaculture.** R. Stickney. 1979. Wiley-Interscience (ISBN 0-471-03388-X). 375 pp. Warm-water aquaculture comprehensive text covering the basics of water systems and culture methods, water quality, feeds and feeding, nutrition and growth, reproduction, breeding and genetics, disease and parasitism, harvesting, processing, and economics.

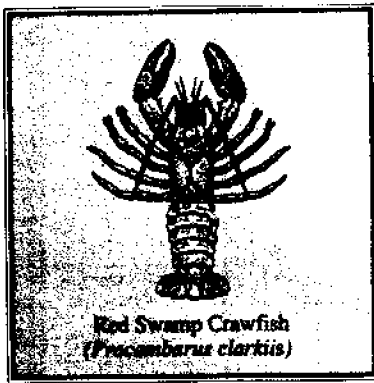
**Quality Assurance of Seafood.** C. Gorga. 1988. Van Nostrand Reinhold (ISBN 0-442-23053-2). 245 pp. Provides background and practical information needed to process and preserve high-quality seafood.

**Standard Methods for the Examination of Water & Wastewater.** L. Clesceri. 1989. American Public Health (ISBN 0-87553-181-8). 2,134 pp. Contains every conceivable method for the chemical, biological, and physical analysis of freshwater, brackish water, and seawater; biological contaminants and pollutants are covered in detail. Includes sampling techniques, statistical methods, laboratory apparatus and reagents, safety, determination of general water-quality parameters, metals, toxicity tests for aquatic organisms, automated analysis, aquatic botany, and a special section, with color plates, on the identification of aquatic organisms.

**The Freshwater Aquaculture Book: A Handbook for Small Scale Fish Culture.** W. McLarney. 1984. Hartley and Marks. (ISBN 0-88179-018-4). 583 pp. Introduction to traditional farm ponds, concepts of pond fertilization, and feeding practices. Introductory "hands on" volume for backyard aquaculture.

**The Merck Index.** M. Windholz. 1983. Merck (ISBN 0-911910-27-1). 2,208 pp. Contains monographs for over 10,000 chemicals, biologicals, and drugs. Monographs typically include structural formulas, chemicals, trivial, trade, and generic names, physical data, preparative methods, therapeutic uses, toxicology, and references.

**The Merck Veterinary Manual** (6th ed.). C. Fraser. 1986. Merck (ISBN 0-911910-53-0). 1,677 pp. Discusses current knowledge in diagnosis, treatment, toxicology, and pharmacology.



Finfish

**The Seafood Industry.** R. E. Martin and G. Flick (eds.), 1990. Van Nostrand Reinhold (ISBN 0-442-23915-7). 480 pp. Latest coverage of seafood classification, biology, products, by-products, processing, packaging, merchandising, labeling, plant cleaning, sanitation, transportation, distribution, and warehousing.

- Bacterial Fish Pathogens: Disease in Farmed and Wild Fish.** B. Austin, 1988. Halsted Press (ISBN 0-470-20765-5). 364 pp. Excellent introductory volume on freshwater and marine bacteriology of fishes.
- Cage Aquaculture.** M. Malcolm, 1987. UNIPUB (ISBN 0-85238-148-4, FN124). 352 pp. Provides global view of cage-based aquaculture systems from perspectives of site evaluation, design and construction methods, culture techniques, and management problems.
- Channel Catfish Culture.** C. Tucker, 1985. Elsevier (ISBN 0-444-42527-6). 657 pp. Serves as manual for the industry and a compendium on biology of channel catfish. Excellent resource for all aquaculturists.
- Culture and Propagation of Striped Bass and its Hybrids.** R. M. Harrell, J. H. Kirby, and R. Vernon Minton, eds. 1990. Striped Bass Committee, Southern Division, American Fisheries Society, 5410 Grosvenor Lane, Suite 110, Bethesda, MD 20814. A comprehensive manual that provides practical information on striped bass and hybrid striped bass biology, production, management, genetics, parasites, and diseases.
- Fish Culture in Warm Water Systems: Problems & Trends.** R. Shilo, 1989. CRC Press (ISBN 0-849-34743-2). 259 pp. Provides trends in warm-water aquaculture systems, flow-through and recirculating systems, aquaculture potential of some Amazonian fish, cultivation of African catfish in flow-through tanks, and cage culture of tilapia.
- Fish Nutrition** (2nd ed.). J. Halver, 1988. Academic Press (ISBN 0-12-319651-5). 797 pp. Details all elements of fish nutrition.
- Fish Viruses and Fish Viral Disease.** K. Wolf, 1988. Cornell University Press (ISBN 0-8014-1259-5). 480 pp. Fully describes viral diseases of principal world culture species: catfish, eels, carp, salmonids, etc.
- Genetics for Fish Hatchery Managers.** D. Tave, 1986. AVI (ISBN 0-87055-532-4). 299 pp. Professional and practical text on genetics for fish hatchery managers.
- Guidelines for Striped Bass Culture.** E. Bonn, 1976. American Fisheries Society (ISBN 0-913235-20-2). 110 pp. Manual style written by culturists. Popular with growers and researchers involved in intensive farming of hybrid striped bass.
- Hatchery Manual for the White Sturgeon.** S. Doroshov, 1989. ANR Publications California (ISBN 0-931876-84-2, 3322). 104 pp. "Hands-on" information regarding genetics, embryology and larval development, broodstock life stages, and fingerling production.
- Intensive Fish Farming.** A. Shepherd, 1988. BSP Professional (ISBN 0-63201-904-2). 404 pp. Highly readable coverage of fish physiology, intensive farming systems and husbandry prac-

tices, breeding and propagation, nutrition, health, culture techniques in various countries, polyculture, and future prospects.

- Introduction to Fish Physiology.** T. Smith, 1982. TFH Publications (ISBN 0-87666-549-0) (PS785). 353 pp. Subjects include osmoregulation, circulatory system, respiration system, metabolism, digestion, muscle function, sensory organs, endocrine system, and reproduction.
- Principal Diseases of Marine Fish and Shellfish, Vol. 1: Diseases of Marine Fish,** 2nd ed. J. Sindermann, 1990. Academic Press (ISBN 0-12-645851-0). 499 pp. Review of diseases of cultured, captive, and wild stocks of marine fishes documenting infectious and noninfectious diseases.
- Simon & Schuster's Complete Guide to Freshwater & Marine Aquarium Fishes.** M. Oliver, 1976. Simon & Schuster (ISBN 0-671-22809-9). 310 pp. Comprehensive monograph documenting key freshwater and marine species.
- Tank Culture of Striped Bass Production Manual.** W. M. Lewis, R. C. Heidinger, and B. L. Tetzlaff, 1981. Fisheries Research Laboratory, Southern Illinois University at Carbondale, Carbondale, IL 62901. Covers all aspects of hybrid bass production in a water reuse system.
- Textbook of Fish Culture: Breeding and Cultivation of Fish,** 2nd ed. M. Huet, 1986. Scholium International (ISBN 0-85238-140-9). 428 pp. A culture textbook covering more than 100 species of fish.
- Textbook of Fish Health.** G. Post, 1987. TFH Publications (ISBN 0-87666-5-99-7, H-1043). 208 pp. Comprehensive volume on fish disease and health. Covers bacterial, viral, and parasitic diseases of fish.
- The Biology & Culture of Tilapias.** R. Pullin, 1982. International Special Book, published by ICLARM (Philippines). (ISBN 971-04-0004-5). A source book for tilapia biologists and culturists.
- The Manual of Fish Health.** C. Andrews, 1989. Tetra Press (ISBN 3923880375). 224 pp. Written for aquarium keepers and health specialists, but a good aquaculture resource.
- You & Your Aquarium: A Complete Guide to Collecting and Keeping Aquarium Fishes.** R. Mills, 1987. Knopf (ISBN 0-394-72985-4). 288 pp. Reviews state-of-the-art technology for cool-water and tropical, freshwater and marine species.
- Water Quality Management for Pond Fish Culture.** C. Boyd, 1985. Elsevier (ISBN 0-444-42054-1). 318 pp. Classic technical overview of water quality science.

#### Shellfish

- Clam Mariculture in North America.** J. Manzi, 1989. Elsevier (ISBN 0-444-87300-7). 461 pp. Analysis of historical and recent developments. Covers all aspects of biology, culture, genetics, and management.
- Crustacean & Mollusk Aquaculture in the United States.** J. V. Huner and E. E. Brown, eds. 1985. AVI (ISBN 0-87055-468-9). 476 pp. Extensive volume from leaders in the culture of crayfish, freshwater prawns, penaeid shrimp, lobsters, oysters, clams, mussels, abalones, soft-shelled blue crab, and spiny lobsters. Details on each organism's culture, biology, environmental requirements, disease, predators, and other factors affecting commercial economics.
- Freshwater Crayfish: Biology, Management and Exploitation.** D. Holdich and R. Lowery, 1988. Timber (ISBN 0-88192-105-X). 498 pp. Worldwide review of crayfish biology and culture.
- Design of Recirculating Blue Crab Shedding Systems.** R. Malone and D. Burden, 1988. Depart. of Civil Engineering, and Louisiana Sea Grant College Program, Center for Wetland Resources, Louisiana State University, Baton Rouge, LA 70803-7507. 76 pp.

Good overview of crab shedding system design with useful information on system components, mechanical and biological filters, system operation and water quality management.

**Manual for Growing the Hard Clam *Mercenaria*.** M. Castagna and J. Krauter. 1981. Special Report in Applied Marine Science and Ocean Engineering No. 249. Sea Grant Program, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA 23062. 110 pp. \$3.00. Practical information on all aspects of hard clam culture from hatchery production through grow-out.

**Manual for Handling and Shedding Blue Crabs (*Callinectes sapidus*).** M. Osterling. 1988. Sea Grant Program, Virginia Institute of Marine Science, College of William and Mary, Gloucester Point, VA 23062. 100 pp. \$6.00. Practical information on all aspects of crab shedding, including facility design and construction, crab handling, operations, marketing, and packaging.

**Red Swamp Crawfish: *Biology and Exploitation*.** J. V. Huner and J. E. Barr. 1991. Louisiana Sea Grant College Program, Center for Wetland Resources, Louisiana State University, Baton Rouge, LA 70803-7507. An excellent updated version of the 1980 edition that covers all aspects of crawfish production.

### Aquaculture Equipment and Supplies

The growth of the aquaculture industry in the United States is reflected in the increasing number of companies providing equipment, supplies and other services. Just about all of the companies listed (marked with an asterisk) will send you a free catalog of their product line and current prices and many have toll-free 800 numbers you can call. *Note: Inclusion in the directory of suppliers does not imply an endorsement by the authors.*

**ADPI Enterprises, Inc.,** 3621 "B" Street, Philadelphia, PA 19134, 1-800-621-0275, FAX: (215) 739-8480. Manufactures plastic nets and material for use in finfish and shellfish culture.

**\*Aqua fauna Bio-Marine, Inc.,** P.O. Box 5, Hawthorne, CA 90250, (213) 973-5275, FAX: (213) 676-9387. Offers a full line of larval feeds and diets, equipment, and specialty products for aquatic production.

**\*Aquatic Eco-Systems, Inc.,** 2056 Apopka Blvd., Apopka, FL 32703, (407) 886-3939, FAX: (407) 886-6787. Full line of aquaculture equipment and accessories, from aerators and air pumps to water test kits and weed cutters.

**\*Area, Inc.,** P.O. Box 1303, Homestead, FL 33090, (305) 248-4205, FAX: (305) 248-1756. Specializes in aeration equipment and supplies, plus aquaculture instrumentation and accessories.

**\*Argent Chemical Laboratories,** 8207 152nd Avenue, NE, Redmond, WA 98052, 1-800-426-6258, FAX: (206) 885-2112. Full line of chemical products, plus specialty feeds, scientific supplies, and equipment.

**Bonar Plastics, Ltd.,** Morristown, NJ 07961, (201) 984-9509. Molded polyethylene fish hatchery tanks and raceways.

**\*Champlin Net Company, Inc.,** 401 Front Street, P.O. Box 788, Jonesville, LA 71343, 1-800-551-5183. Nets, buoys, traps, and other commercial fishing supplies and accessories.

**\*E. C. Geiger, Inc.,** Rt. 63, Box 285, Harleysville, PA 19438-0332, (215) 256-6511 or 1-800-443-4437, FAX: (215) 256-6110. Greenhouses and related supplies and equipment.

**\*Engineered Systems and Designs,** 3 South Tainall Street, Wilmington, DE 19801, 1-800-742-4325. Water-quality instrumentation.

**\*Florida Aquafarms, Inc.,** 5532 Old St. Joe Road, Dade City, FL 33525, (904) 567-8540, FAX: (904) 567-3742. Full line of aquaculture supplies and equipment, specializing in products

for intensive culture. Live foods such as microalgae, rotifers, Artemia, and Daphnia.

**\*Fritz Aquaculture,** P.O. Drawer 17040, Dallas, TX 75217, 1-800-527-1323, FAX: (214) 270-0179. Full line of pumps, aerators, chemicals, and other aquaculture equipment and supplies.

**Glass Boat Works, Inc.,** Willis Wharf Road, P.O. Box 674, Exmore, VA 23350, (804) 442-6033. Standard or custom fabricated fiberglass tanks and raceways.

**\*Hach Company,** P.O. Box 389, Loveland, CO 80539, 1-800-227-4224. Water test kits, reagents, and related supplies.

**Hulls Unlimited-East, Inc.,** P.O. Box 70, Deltaville, VA 23043, (804) 776-9711. Fiberglass tanks, bioreactors, oxygenators, and fish culture systems.

**\*LaMotte Chemical Products Company,** P.O. Box 329 Chestertown, MD 21620, (301) 778-3100 or 1-800-344-3100, FAX: (301) 778-6394. Water test kits, reagents, and related supplies.

**\*Mail Order Pet Shop,** 60 South Second Street, Suite M, Deer Park, NY 11729, (516) 595-1717. Aquarium supplies, equipment, books, and miscellaneous accessories.

**\*Memphis Net and Twine,** 2481 Mathews Avenue, P.O. Box 8331, Memphis, TN 38108, 1-800-238-6380 or (901) 458-2656. Fish farming and related equipment.

**MFG Justin Tanks, Inc.,** Georgetown Industrial Park, 8 Cedar Creek Avenue, Georgetown, DE 19947, (302) 856-3521, FAX: (302) 856-3527. Fiberglass tanks, fabrication.

**\*Otterbine/Bareho, Inc.,** R.D. 2, Box 217, Emmaus, PA 18049, (215) 965-6018. Aerators, oxygen meters, and pumps.

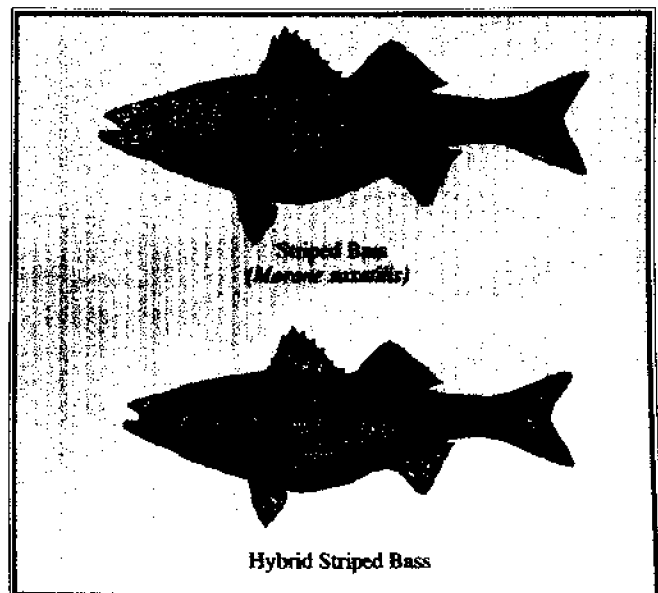
**\*Power House, Inc.,** 2682 West Patapsco Avenue, Baltimore, MD 21230, 1-800-243-4741 or (301) 525-1111, FAX: (301) 525-2851. Aerators, oxygen meters, and other instrumentation.

**\*Red Ewald, Inc.,** P.O. Box 519, Kames City, TX 78118-0519, 1-800-531-3606, FAX: (512) 780-4272. Fiberglass tanks and related equipment, custom fabrication.

**\*Taylor Technologies, Inc.,** 31 Loveton Circle, Sparks, MD 21152, 1-800-638-4776 or (301) 472-4340, FAX: (301) 771-4291. Water test kits, reagents, and related supplies.

**\*YSI, Inc.,** 1725 Brannum Lane, Yellow Springs, OH 45387, 1-800-343-4357 or (513) 767-7241. Oxygen meters.

**\*Ziegler Brothers, Inc.,** P.O. Box 95, Gardners Station Road, Gardners, PA 17324, 1-800-842-6800 or (717) 677-6181, FAX: (717) 677-6826. Aquaculture feeds, equipment.



## Local/Regional Suppliers of Fish and Shellfish for Stocking and Related Services

**Delmarva Aquatics**, P.O. Box 349, Odessa, DE 19730, (302) 378-8652. Consulting, systems design and construction, seed stock (fingerlings), and marketing assistance.

**Delmarva Ecological Laboratory, Inc.**, 941 Lorewood Grove Road, Middletown, DE 19709, (302) 378-8069. Consulting, marketing assistance, and fingerlings. Finfish available include striped bass, hybrid striped bass, sunfish, largemouth bass (all sizes), catfish, minnows, hybrid sunfish, cages, aeration systems.

**Heaven Sent Farms**, R.D. 3, Box 249, Frankford, DE 19945, (302) 732-9843. Crawfish broodstock.

**Mercenaria Manufacturing**, R.D. 1, Box 293-B, Millsboro, DE 19966, (302) 945-875. Hard clam seed.

**Pyramid Farms**, 4340 Egypt Road, Cambridge, MD 21613, (301) 228-1757. Crawfish broodstock.

## Aquaculture Associations

The following partial list represents a cross-section of international, national, and regional professional and/or industry associations with interest or involvement in aquaculture development. Most of these organizations hold an annual meeting and keep their memberships informed with newsletters and other publications. They will provide additional information on membership, annual dues, and other programs and services on request.

**American Fisheries Society**, 5410 Grosvenor Lane, Suite 110 Bethesda, MD 20814, (301) 897-8616, FAX: (301) 897-8096. Publications: *Fisheries Magazine* (included with membership), *The Progressive Fish Culturist* and numerous other special publications. The American Fisheries Society is dedicated to the conservation, development, and wise use of recreational and commercial fisheries; promotion of all branches of fisheries science and practice; and exchange and dissemination of knowledge about fish, fisheries, and related subjects.

**Associated Koi Clubs of America**, 340 Mariposa Drive, Camarillo, CA, 93010, (805) 482-0556. Publication: *Koi USA*.

**Catfish Farmers of America**, 1100 Highway 82E, Suite 202, Indianola, MS 38751, (601) 887-2699, FAX: (601) 887-4409. Publication: *Catfish Journal*.

**Delaware Aquaculture Association**, P.O. Box 543, Dover, DE 19903. Publication: Newsletter.

**Diamond State Aquarium Society**, P.O. Box 4059, Delaware City, DE 19706, (302) 368-2331. Publication: *Gravel Gossip Newsletter*.

**International Association of Astacology**, P.O. Box 44650, University of Southwestern Louisiana, Lafayette, LA 70504, (318)

231-5239, FAX: (318) 231-5395. Publications: *IAA Quarterly Newsletter* and *Directory of Astacologists* (included with membership). Membership in the International Association of Astacology (IAA) is open to anyone interested in the study of freshwater crayfishes or their exploitation.

**Maryland Aquaculture Association**, P.O. Box 641, Salisbury, MD 21803. Publication: Newsletter.

**National Aquaculture Association**, P.O. Drawer 1569, Shepherdstown, WV 25425, 1-800-626-3301, FAX: (304) 876-2251. Publication: The *NAA Newsletter* is published in the *Water Farming Journal*. The National Aquaculture Association (NAA) is a non-profit organization whose purpose is to unite all segments of the U.S. aquaculture community into one major nationwide organization. Membership in the NAA is open to all persons and organizations interested in U.S. aquaculture.

**National Ornamental Goldfish Association**, 6916 Black's Mill Road, P.O. Box 308, Thurmont, MD 21788, (301) 271-7475, FAX: (301) 271-7059.

**National Shellfisheries Association (NSA)**, c/o Thomas Soniat, Department of Biological Sciences, Nicholls State University, P.O. Box 2021, Thibodaux, LA 70310, (504) 448-4700. Publications: *Journal of Shellfish Research* and the *NSA Quarterly Newsletter* (included with membership). The National Shellfisheries Association (NSA) is an international organization of scientists, management officials, and members of industry dedicated to the formulation of ideas and promotion of knowledge pertinent to the biology, ecology, production, economics, and management of shellfish resources.

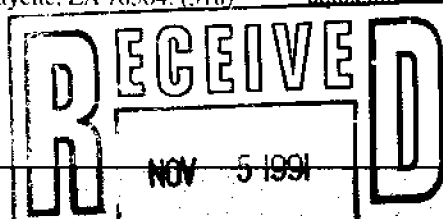
**National Tilapia Association**, Kirkwood College, P.O. Box 2068, Cedar Rapids, IA 52406.

**New Jersey Aquaculture Association**, 1623 Whitesville Road, Toms River, NJ 08755, (908) 349-1152, FAX: (908) 505-8941.

**Pennsylvania Aquaculture Association**, 930 Tulpehocken Road, Richland, PA 17087, (717) 866-2461. Publication: Newsletter.

**Striped Bass and Hybrid Bass Producers' Association**, c/o UNC Sea Grant, Box 8605, North Carolina State University, Raleigh, NC 27695-8605. Publication: *Striper News Newsletter*. A new, non-profit organization established to promote the advancement of the commercial cultivation of striped bass and its hybrids.

**World Aquaculture Society**, 143 John M. Parker Coliseum, Baton Rouge, LA 70803, (504) 388-3137, FAX: (504) 388-3493. Publications: *World Aquaculture Magazine* and *Journal of the World Aquaculture Society* (included with membership). The World Aquaculture Society is the oldest and largest international professional society devoted to the advancement of the aquaculture industry, science, and technology worldwide.



### Acknowledgments

This publication was produced by the University of Delaware Sea Grant College Program. The authors would like to thank Tracey Bryant, editor, and John H. Bunting, graphic artist; David Barczak, graphic designer; and Pamela Donnelly, production manager, for their assistance in developing this publication. They would also like to thank R. Taylor, W. Bason, B. Petrosky, D. Wujewicz, S. Griffith, and W. Sammons, Jr., for their manuscript review and constructive comments.

For more information about this series, please contact John Ewart, aquaculture specialist, or Joe Farrell, marine business specialist, University of Delaware Sea Grant Marine Advisory Service, 700 Pilottown Road, Lewes, DE 19958-1298. Phone: (302) 645-4346.