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## AQUACULTURE SITUATION AND OUTLOOK REPORT 2007: WEST VIRGINIA

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Buckhorn Trout Farm, Pendleton County. Photo: Ken Semmens

hatcheries produced 744,057 pounds of trout (brook, brown, rainbow, and golden rainbow) in 2005-06. Federal facilities important to the aquaculture industry include the USDA-ARS National Center for Cool and Cold Water Aquaculture, the Leetown Science Center, and the White Sulphur Springs National Fish Hatchery.

WV Aqua grows arctic charr as a food fish and is the largest private producer in the state. The fingerlings are grown indoors and utilize recirculated mine water. Fish are processed at WV Aqua's processing plant and distributed fresh nationwide. Custom smoking is done by a business in Kentucky. Estimated annual live weight production is between 300,000 and 400,000 pounds.

Three resident businesses offer a variety of fish, plants, and other products for warm water ponds and distribute throughout the state. They compete with businesses in Arkansas which send trucks to local farm supply stores. These vendors sell catfish, bass, sunfish, baitfish, koi, carp, and other species.

Often, fee fishing businesses do not grow the fish they need, rather they are purchased from a distributor who obtains the fish from a variety of sources and delivers them as needed. Trout are the fish of choice during the cool months and catfish are the fish of choice during the warm months. Catfish are purchased from growers south of West Virginia where the growing season is longer.

The West Virginia Aquaculture Association (WVAA) is the only state-wide producer organization.

### Industry Trends and Outlook

Trout is the fish most commonly grown by West Virginia producers. According to the USDA National Agricultural Statistics Service data, West Virginia reported 21 operations in 2005-06 with sales valued at \$1,145,000. At this time nearly all the trout grown are distributed to the recreational market, including nearly 30 fee fishing locations.

The West Virginia Division of Natural Resources is the largest single producer of fish in the state. It operates two warm-water and seven cold-water hatcheries. The warm water hatcheries produce muskellunge, walleye, channel catfish, hybrid striped bass, paddlefish, black bass, sauger, blue catfish, and shovelnose sturgeon fingerlings. The cold-water

## Emerging Issues and Critical Needs

Utilization of mine water for production of salmonids:

- “Impaired” water has value to aquaculture industry. It could be a significant resource to development of the West Virginia Aquaculture industry.
- Development of a profitable, processor-based trout enterprise has not yet been successful in the long term.

Recreational use of farm raised fish:

- Increasingly, private water is managed to support recreational activities. West Virginia vendors are increasing their market share for stocking warm water ponds.
- Private recreational enterprises which focus on fishing are being developed. Landowners are creating habitat, lodging, and seek to market the fishing experience.
- Fishing events are developed which utilize both public and private water.
- There is an effort to create a program which will use lottery funds to purchase live fish from private producers to stock public water to increase tourism.
- The stocking of streams by private individuals for recreational opportunities is growing faster than the traditional pay-pond format. Individuals utilize the stocking of large trout (1.5 pounds+) into a pay-to-fish format in streams which flow across their property. Issues of stream ownership and access have surfaced since the inception of this new pay fishing technique
- Viral Hemorrhagic Septicemia issues in adjacent states create incentive to utilize water sources in West Virginia.



WV Aqua in Mingo County. (Photo: Ken Semmens)

## Cultured Species List

- Black crappie (*Pomoxis nigromaculatus*)
- Black sandshell mussel (*Ligumia recta*)
- Blue catfish (*Ictalurus furcatus*)
- Bluegill (*Lepomis macrochirus*)
- Brook trout (*Salvelinus fontinalis*)
- Brown trout (*Salmo trutta*)
- Bullfrog (*Rana catesbeiana*)
- Channel catfish (*Ictalurus punctatus*)
- Common carp (*Cyprinus carpio*)
- Fathead minnow (*Pimephales promelas*)
- Golden rainbow trout (*Oncorhynchus mykiss*)
- Goldfish (*Carassius auratus*)
- Grass carp (*Ctenopharyngodon idella*)
- Hybrid bluegill (*Lepomis macrochirus* x *L. cyanellus*)
- Hybrid striped bass (*Morone chrysops* x *M. saxatilis*)
- Koi (*Cyprinus carpio*)
- Largemouth bass (*Micropterus salmoides*)
- Mucket (*Actinonaias ligamentina*)
- Muskellunge (*Esox masquinongy*)
- Northern riffleshell (*Epioblasma t. rangiana*)
- Notched rainbow mussel (*Villosa constricta*)
- Paddlefish (*Polyodon spathula*)
- Pistol grip mussel (*Tritogonia verrucosa*)
- Plain pocketbook mussel (*Lampsilis cardium*)
- Pocketbook mussel (*Lampsilis ovata*)
- Purple wartyback mussel (*Cyloniaias tuberculata*)
- Rainbow mussel (*Villosa iris*)
- Rainbow trout (*Oncorhynchus mykiss*)
- Sauger (*Sander canadensis*)
- Shovelnose sturgeon (*Scaphirhynchus platyrhynchus*)
- Smallmouth bass (*Micropterus dolomieu*)
- Striped bass (*Morone saxatilis*)
- Three ridge mussel (*Amblema plicata*)
- Tilapia (*Oreochromis niloticus*)
- Walleye (*Sander vitreus*)
- Wavy-rayed lamp mussel (*Lampsilis fasciola*)
- White bass (*Morone chrysops*)
- White crappie (*Pomoxis annularis*)
- Yellow perch (*Perca flavescens*)

## Addressing Industry Needs

Researchers, Extension specialists, resource managers, industry associations and concerned stakeholders all play a role in addressing industry needs. The following sections outline the new initiatives and recent accomplishments in these areas.

## Aquaculture Research

The following research is being conducted at West Virginia University:

- **Rainbow Trout Genome Project** The focus of the rainbow trout genome project is to develop genetic/genomic resources (e.g. microsatellite markers, linkage maps, ESTs, BAC libraries and microarrays) and utilize them to identify genetic elements that control economically important production traits such as fillet quality, embryogenesis, growth rate, feed efficiency and disease resistance. The ultimate goal is to use this knowledge in selective breeding programs to develop more desirable strains of rainbow trout for efficient production. This project is in collaboration with the USDA-ARS National Center for Cool and Coldwater Aquaculture.
- **Aquaculture Product and Marketing Development Project (APMDP)** at West Virginia University is a market-oriented, multidisciplinary effort that is administered through the Davis College of Agriculture, Forestry and Consumer Sciences. Individual objectives of the project focus on the following disciplines: Marketing, Agricultural Economics, Animal Science, Food Science, Engineering, Recreation and Parks, Horticulture, and Extension. The project seeks to focus on two economic development opportunities associated with aquaculture development in West Virginia - flowing water systems, and niche markets.
- **Marketing** Marketing studies have been conducted to identify and assess market opportunities for aquaculture products in both recreational and food fish markets. Surveys of the fee-fishing industry have focused on four areas -- the general fishing population, people who patronize fee-fishing establishments, visitors to West Virginia where fee-fishing is not the primary purpose of the visit, and managers of fee-fishing businesses. Surveys have also focused on businesses (restaurants, supermarkets, institutions) that purchase fish as part of the food fish market industry. The second phase of this objective initiated a market-driven network for providing Appalachian aquaculture products to the recreational fee-fishing market. The third phase is focusing on development of targeted, fishing-based recreational travel packages for visitors to West Virginia. The travel packages would include lodging, meals and recreational activities where fee-fishing would represent one of the activities. Efforts also will be made to implement a cooperative approach to marketing



West Virginia University at Dogwood Lake in Monogalia County.  
(Photo: Ken Semmens)

among small producers and to assess the market potential for recreational fee-fishing in rivers and streams.

- **Recreation and Parks** This work focuses on use of fish for recreation in the private rather than public sector. Investigators seek to identify and quantify the impact of management variables on costs, revenues and profitability of food and recreational fishing enterprises and to assess demand and develop marketing strategies for recreational fee fishing packages as complementary recreational activities. Investigators are also working to determine standards of quality for fishing programs that stock hybrid striped bass and hybrid bluegill sunfish, and determine the stability of demand behavior for a changing fee fishing market.
- **Agricultural & Resource Economics** Economic feasibility is a key piece of the puzzle. Project investigators started with trout and have since looked at other species suitable for hill land such as hybrid bluegill. In addition to profitability, we estimated economic risk using a combination of tools such as enterprise (or cost and return) budgets, capital investment techniques and economic models. To date, the economics of both production and processing assuming different operational sizes (small, medium and large) have been analyzed. In addition, firm-level analyses, as well as aggregate, economic development impacts for both the food fish and fee fishing sub-sectors have been examined. The economics of mine water aquaculture in flow-through systems from the producers' perspective, have been studied, and, in collaboration with other investigators, profitability-risk characteristics of alternative

combinations of species and sizes, and marketing alliances for various market segments (i.e., processing, stocking and fee fishing) will be studied. In the process, researchers will identify economically optimal feeding and harvesting rates, given alternative product price/feed cost ratios, feed conversion rates and stocking rates. On the recreation side, researchers plan to evaluate the relationship among anglers, various attributes of recreational fishing (in both private and public settings) and statewide economic development. The goal is to provide information that can be used by the industry, policy makers and other clientele groups to build a sustainable aquaculture industry in hill country.

- **Food Science and Technology** Investigators in this objective are focusing on product quality and product development. The effect of water quality and stress on the consistency and quality of fresh trout fillets and value added smoked trout products have been examined. The effect of culture conditions, post-harvest handling and antioxidant feeding on product quality has been investigated. Investigators have also characterized the impact of varying CO<sub>2</sub> and O<sub>2</sub> levels on growth efficiency, nutrient utilization and fillet attributes of rainbow trout and arctic charr. This work was in collaboration with Cornell University and The Conservation Fund's Freshwater Institute. Potential new products may be obtained with "cold set" technologies for production of value-added trout products. Researchers seek to develop value-added food based on proteins and lipids recovered from trout processing by-products and to evaluate the feasibility of fortifying rainbow trout fillets with heart friendly omega-3 fatty acids.
- **Animal Science** Animal science researchers work with a diversity of species to answer both basic and applied questions. Investigators seek to characterize the impact of varying CO<sub>2</sub> and O<sub>2</sub> levels on growth efficiency, nutrient utilization and fillet attributes of rainbow trout and arctic charr. They are also examining the metabolic aspects of growth and efficiency of nutrient use in different strains of rainbow trout. In order to produce fish for the recreational market, investigators have conducted production and nutrition experiments to evaluate hybrid bluegill sunfish as an alternative species for fee-fishing businesses, and are examining genetic diversity in green sunfish to assist development of superior hybrids. Another experiment is evaluating the production of all-female triploid brook trout to produce large fish for recreational markets.

- **Civil Engineering** New materials provide new opportunities. Researchers have designed and constructed three systems using a honeycomb fiber-reinforced polymer (HFRP). This material is relatively light and stiff and is being tested as an alternative to concrete. Two pilot scale modular raceway systems have been installed for production of trout, one using treated mine water and another using spring water. In collaboration with a NRAC project, a floating raceway using HFRP material was constructed and installed. We seek to optimize performance and minimize costs of HFRP raceway systems to enhance profitability of trout production and to develop HFRP tanks for field assembly from flat panels.
- **Engineering – Simulation Tool Development** The objective is to provide a flexible and user-friendly software tool to help fish growers to plan, simulate and analyze raceway systems. The software is named "Raceway Design and Simulation System" (RDSS). The approach has been to develop RDSS so that the user has as much flexibility as possible in configuring the raceway and determining the economic impact of any given scenario in that raceway. The software tool has been developed in an Excel<sup>®</sup> programming environment using the VBA programming language. A generalized raceway system, consisting of any number of tanks in series with multiple parallel raceways may be modeled. The software allows the user the capability to simulate scenarios in which fish cohorts (of different species) may be placed in different tanks at different times. The program then simulates the growth, optimal feed rate, oxygen consumption, nitrogen production, oxygen replenishment via



Mountain State Trout Hatchery in Pendleton County. (Photo: Ken Semmens.)

weirs and/or other reoxygenation technologies, and a variety of other factors crucial to the successful operation of a commercial raceway. The program output documents all fish movement, feed requirements and other parameters relating to the fish growing process. Basic economic information on the cost of feed, cost of fingerlings, and revenue from sales as a function of time is also included in the output. The current version of the software and an extensive users' manual are available at the project's website: <http://www.caf.wvu.edu/afmdp/disciplines/engineering/chemengineer.shtml>



Guyses Run in Marion County. (Photo: Ken Semmens)

- Environmental Engineering** Determining the feasibility of growing trout in water from acid mine drainage treatment plants will be an ongoing focus of aquaculture research at WVU. Following a technical assessment of impaired water resources near the WVU campus in Morgantown, a pilot scale flowing water system was designed and installed. We continue to evaluate production of rainbow trout in a modular raceway system using water from an acid mine drainage treatment plant. In collaboration with other investigators, we have conducted feeding trials, examined trout fillet quality analyzed the flesh of trout grown in treated mine water for accumulation of heavy metals and PCB in excess of recommended amounts. A secondary focus of this objective has been effluent management. We collected baseline water quality data from select trout production facilities in West Virginia and characterized the resulting effluent. We seek to develop designs for increasing the efficiency for removal of solid wastes from the quiescent zone in raceway systems producing trout.
- Horticulture** The project objective is to determine the efficacy of plants for removal of soluble nutrients in a flowing water system for producing trout. In collaboration with environmental engineers, watercress will be evaluated as a tool to recover dissolved nutrients like nitrogen and phosphorous from water leaving the experimental raceway system at the Reymann Memorial Farm. Operational conditions which affect nutrient removal and watercress growth will be determined.

Annual grants for the APMDP are awarded by USDA/CSREES to the WVU Agricultural and Forestry Experiment Station. The Principal Investigator is Kenneth J. Semmens, P.O. Box 6108, Morgantown, WV 26506-6108, (304) 293-6131 Ext. 4211, [Ken.Semmens@mail.wvu.edu](mailto:Ken.Semmens@mail.wvu.edu) .

The mission of the National Center for Cool and Cold Water Aquaculture (NCCCWA) is to support and

enhance the nation's cool and cold water aquaculture production through research and technology transfer. The goals of the program are to improve production efficiency, aquatic animal health, and product quality through the development of economically and environmentally sustainable commercial systems and practices. Research emphases include applied genetics and breeding, integrated aquatic animal health, aquaculture engineering, nutrition, physiology, culture and management, and product quality. The focus of the research programs is cool and cold water aquaculture species including, but not necessarily limited to rainbow trout, Arctic char, and striped bass.

The following research is being conducted at the NCCCWA:

- Application of remote sensing techniques to address impacts of agriculture on water quality and fish habitat within the Chesapeake Bay watershed
- Host, pathogen and environmental interactions in cool and cold water aquaculture
- Identification and characterization of genes affecting cool and cold water aquaculture production
- Utilizing genetics for enhancing cool and cold water aquaculture production
- Development of sustainable land-based aquaculture systems
- Genome sequencing and identification of virulence factors in *Flavobacterium psychrophilum*
- Transcriptome analyses in salmonids
- Genetic and diet effects on growth rate and reproduction in the rainbow trout strains of Troutlodge, Inc.
- Production of An Integrated Physical and Genetic Map for Rainbow Trout

- Evaluation of Genotype by Environment interactions in rainbow trout
- Evaluation of selected rainbow trout lines fed grain-based diets under farm scale conditions
- Functional genomics research for rainbow trout aquaculture production
- Production for superior rainbow trout broodstock by genetic manipulation
- Production of a physical map for the rainbow trout genome using high throughput DNA fingerprinting

Learn about additional research conducted by the National Center for Cool and Cold Water Aquaculture at: <http://www.ars.usda.gov/Research/Research.htm?modecode=19-30-00-00>

The Freshwater Institute <http://www.freshwaterinstitute.org> is a nationally recognized program of the non-profit Conservation Fund <http://www.conservationfund.org>, a 501(c)(3) organization based in Arlington. Recognizing the value of clean water resources, the Freshwater Institute works with government, industry, nonprofits and individuals to shape sustainable, environmentally responsible solutions to water resource management. Over two decades, The Conservation Fund's Freshwater Institute has become one of the nation's premier research and development facilities dedicated to the sustainable use of water. From its campus in Shepherdstown, West Virginia, the Institute's staff combines applied research, engineering, and economic development skills to show the critical role fresh water resources play in the achievement of economic and environmental goals. Freshwater Institute projects provide demonstration of practices or development of technology that meet concern for environmental protection and the recognized need for fair return on investment. The Freshwater Institute has four primary focus areas:

- **Pioneering Aquaculture Research and Technology Development** Under a Cooperative Agreement funded by the U.S. Department of Agriculture, Agricultural Research Service, the Freshwater Institute is working to develop more cost effective and environmentally compatible land-based finfish production systems that utilize intensification and water recycling technology consistent with biological, environmental and food security objectives. Water recirculating systems are highly valuable because they conserve water and concentrate effluent into smaller and more treatable discharges. However, these systems need improvement to become more economically viable to compete with traditional salmonid culture systems. For these reasons, research is conducted

to develop and evaluate functional, operational, and economic efficiencies through close integration of engineering, biological assessment, and water quality maintenance within large-scale recirculating systems. Waste management technologies are also evaluated, and an integrated approach has been conceptualized and developed to improve aquaculture waste management by linking waste reduction to culture system design and management. Concurrent animal health studies explore common and emerging infectious and non-infectious diseases and potential management strategies. All together, this ARS-funded project has produced significant advances in numerous aspects of recirculating aquaculture system technology. To demonstrate a practical and environmentally compatible alternative to current fish farming practices, the Freshwater Institute operates a commercially relevant recirculating fish farm system that produces approximately 30 tons of market-sized rainbow trout or Arctic char annually. This research has been used to improve the production efficiency of rainbow trout and Arctic char, as well as Atlantic salmon smolt, tilapia, cobia, and barramundi, sturgeon, and hybrid striped bass that are cultured within large-scale recirculating aquaculture systems at public and private fish culture facilities in North America and around the world.

- **Fish Health and Aquatic Veterinary Consulting** The Aquaculture Veterinarian at the Freshwater Institute provides the following services: fish health management and welfare consulting; disease prevention and control programs; biosecurity plans; assistance with fish health certification for



The Freshwater Institute, Jefferson County. (Photo: The Conservation Fund)

interstate and international fish transport; disease diagnosis and treatment; and producer education through industry extension. As well, the Aquaculture Veterinarian oversees the health and humane treatment of on-site fish populations, and is actively involved with in-house research to further the understanding of health and disease in recirculating aquaculture systems, and to improve the welfare of production animals in these settings.

- **Technology Transfer and Engineering Services** Technology developed at the Institute has been implemented by stakeholders in West Virginia and across the country. From Arctic Char production in Mingo County, WV to Atlantic salmon restoration in the Northeast to Pacific salmon restoration in the Northwest, solutions developed by the Institute are providing far-reaching benefits. Technology transfer is provided in informal communications throughout the year and in a classroom setting twice per year reaching over 50 stakeholders. Detailed engineering assistance is also provided to enable technology implementation for individual clients on a contract basis. Engineering services focuses on design of intensive fish culture systems, but also includes feasibility studies, influent and effluent water treatment systems, environmental permitting, construction management, and full facility delivery.
- **Watershed Assessment and Planning** The solutions to today's water pollution challenges lie in the development of a broad understanding of aquatic impacts at the watershed scale and the willingness to work across the boundaries of discipline and jurisdiction to bring innovative ideas and approaches to bear. The Freshwater Institute uses geospatial technologies to assess watersheds and develop plans for their restoration and management. These technologies allow us to place community needs in a geographic and economic context in order to provide the most benefit possible to the citizens of West Virginia and their aquatic resources. Watershed assessment is used to identify watersheds with the most critical water quality problems, restoration opportunities, and barriers to economic development. Planning efforts include development of watershed restoration strategies from local to regional scales; the Institute is currently involved in water quality trading and Chesapeake Bay restoration efforts. Water quality trading provides opportunities for point sources, such as aquaculture to maintain environmental performance with minimal cost.

In West Virginia, the Freshwater Institute has



John Davidson with dual drain tank / partial reuse system.. Photo: The Conservation Fund

completed several projects in support of aquaculture, including:

- Fish culture systems design and construction management at the Mingo County Redevelopment Authority's Arctic Char Hatchery (Delbarton, WV);
- Design and construction of an integrated tilapia and basil/vegetable producing greenhouse to demonstrate the feasibility of using natural gas from shut-in wells in an alternative to traditional agriculture (Tallmansville, WV);
- Hatchery evaluation and planning at the White Sulphur Springs National Fish Hatchery (White Sulphur Springs, WV)
- Hatchery effluent treatment conceptual design at the Spring Run State Fish Hatchery (Dorcas, WV)
- Spring water development design for Mountain Meadows Trout Farm (Scherr, WV)
- "Freshwater aquaculture in Appalachia: Infrastructure development for an emerging industry"
- "An economic feasibility study of trout production using a flow through tank system: An alternative enterprise for the Appalachian region"
- "Economic analysis of non-traditional water resources for aquaculture in West Virginia"
- "West Virginia mine water inventory site summary"
- "Water quality criteria, uptake, bioaccumulation, and public health considerations for chemicals of possible concern in West Virginia mine waters used for culture of rainbow trout"

- “Arctic char: Development of production technologies suited to water resources in Appalachia”

The Natural Capital Investment Fund (NCIF) was established by The Conservation Fund in 2000 to provide financing to natural resource-based businesses that will advance sustainable economic development <http://www.ncifund.org>. NCIF focuses its activities on the following sectors: sustainable/value-added agriculture; sustainable forestry & value-added forest products; renewable energy & energy efficiency; heritage & eco-tourism; green building; and recycling. NCIF provides subordinated debt and equity financing to new and expanding businesses in these sectors, especially those that are unable to obtain sufficient financing from conventional sources. As an affiliate of the Freshwater Institute, NCIF is interested in working with and has supported aquaculture business in West Virginia.

Investigators at West Virginia State University, Department of Biology/Biotechnology are conducting research on the molecular and genetic/genomic basis of feed efficiency. The objective is to combine classical nutrition with modern molecular techniques to understand the differences in feed efficiency within the same and/or among different stains/families of channel catfish and rainbow trout. To explore this possibility investigators will study the interface between dietary manipulations and mitochondrial functions in feed efficiency and possibly determine the potential role of nutrients and non-dietary factors (genetics) in the molecular modulation of mitochondrial functions (protein and gene expression levels) relating to feed efficiency.

Other research activities include the determination of the nutritive value of recovered protein from treated poultry wastes from thermophilic anaerobic digester as dietary supplement for aquaculture. By-products recovered from biological treatment of poultry wastes may provide a cheap alternative protein source for cultured fish.

Investigators have collaborated with WVU on trout yield verification trial, and National Center for Cool and Cold Water Aquaculture, National Warm Water Aquaculture Center at Mississippi State University, and USDA-ARS Catfish Genetic Research Unit on understanding the molecular mechanism for differences in feed efficiency.

Bethany College, in collaboration with West Virginia University, investigators are studying the genetics of green sunfish.

White Sulphur Springs National Fish Hatchery is a

disease-free broodstock hatchery that maintains two strains of rainbow trout as part of the National Broodstock Program. Broodfish are grown, spawned and each year approximately 7.5 million eggs are shipped all over the United States. Shipments are made to tribal, state, and other national fish hatcheries. These production hatcheries rear the eggs and grow the fish to a stockable size.

Investigators are also developing a freshwater mussel propagation program aimed at restoring imperiled species in the mid-Atlantic and southeastern states of the U.S. Ongoing research with Virginia Tech seeks to improve aquaculture technology for the restoration of threatened and endangered freshwater mussel species in West Virginia and southern Appalachia

## Aquaculture Extension

West Virginia University is the primary aquaculture extension program in the state. Many different methods are used to reach a diverse group of stakeholders. The year begins with a state wide meeting known as the Aquaculture Forum. WVU grows fish at two locations with flowing water systems. These facilities are utilized for research and demonstration and are made available to classes, visitors, and for workshops. A web site is maintained for extension and for communicating research results. A quarterly newsletter is distributed and articles are submitted to popular publications. Responses to requests for literature and information are made via email, and telephone. When these methods are not sufficient, site visits are scheduled to meet directly with the stakeholder. Research results are presented at regional and national meetings and published in scientific journals. Specific activities include:



The Lincoln County High School aquaculture lab (Photo: Dan Miller)

- Coordinating with local groups to develop recreational fishing opportunities and formats for fairs and festivals, etc. Examples include the Pendleton County Trophy Trout Rodeo, and the Mountain State Arts and Crafts Festival Kids Fishing Derby.
- Demonstrations and presentations about trout production to youth organizations and schools.
- Educate county agents, farm supply stores, and the general public about where and how to purchase fish from local producers.
- Conversion of an acid mine discharge water treatment plant into a county fishing park in Marion County.
- Encourage use of mine water as an aquaculture resource. As a result of one request, a mining company was granted the nation's first aquaculture site as a post-mining land use permit, saving reclamation costs of \$450,000.
- Work closely with producers interested in finding and evaluating water sources
- Work closely with producers to develop plans for managing solid waste and effluents.

The program directly serves current and future West Virginia producers of fish for food and recreational purposes and processors of food fish and has conducted activities in more than 15 counties. Over 100 individuals annually attend the Aquaculture Forum and other aquaculture presentations and approximately 400 requests for information are received annually. Over 100 visits to specific sites are conducted annually. Technical assistance has assisted with development of five new production facilities in and near West Virginia. Aquaculture extension also provides services such as water quality testing, testing for contaminants, disease diagnosis, etc. and develops tools which will positively impact the aquaculture industry in West Virginia.

## Aquaculture Education

Students statewide are presently receiving exposure to career development opportunities in aquaculture through the secondary agricultural education program. In many cases, aquaculture instruction is infused in the advanced agriscience curriculum. Students are afforded some excellent opportunities for "hands-on" instruction through agricultural education aquaculture labs. These labs have been made possible by local partnerships, private foundation monies and special appropriations by the West Virginia Legislature. In some cases aquaculture is delivered via specialty courses - semester or year-long.

New River Community and Technical College, an accredited two year college, with campuses in Bluefield, Beckley, Greenbrier Valley and Nicholas County, WV offers an Associate Degree in Aquaculture. The course includes instruction in the basic principles of aquatic and marine biology; health and nutrition of aquatic and marine life; design and operation of fish farms, breeding facilities, culture beds, and related enterprises; and related issues of safety, applicable regulations, logistics, and supply.

The Morgantown campus of West Virginia University offers undergraduate and graduate level courses that include Aquaculture Management and Recreational Pond Management. They are offered annually through the Division of Resource Economics.

West Virginia State University at Institute, West Virginia offers undergraduate and graduate courses in aquaculture that include Principles of Aquaculture, Aquatic Animal Nutrition, and Biology of Fishes. There are Masters Degree in Biotechnology and aquaculture is offered within the curriculum track called organismal/environmental biotechnology. There is also an MA degree in Biotechnology suitable for education students who do not need research based degree.

## Aquaculture Resources

The National Aquaculture Association, and the US Trout Farmers Association and the Striped Bass Growers Association have their national office in West Virginia:

11 West Washington Street, Suite One  
 Charlestown, WV 25414-1529  
 Telephone (304) 728-2189



Hill ponds are not often drained so cages are handy for small operations that harvest as needed (Photo: Ken Semmens)

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