

NCRAC Journal

From the Director's Office

Welcome to the Winter 1995-96 issue of the North Central Regional Aquaculture Center (NCRAC) Journal. Since the last issue appeared, NCRAC has undergone numerous changes, mostly due to the elections held during our Annual Program Planning Meeting.

Brent Culver was elected to chair the Industry Advisory Council (IAC). He succeeds Dave Smith, who ended his second two-year term of office as chair of the IAC. We are deeply indebted to Dave for the outstanding leadership he provided during his tenure as IAC chair. Thanks Dave!

Curt Stutzman was elected to be IAC's at-large member on the Board of Directors-- a position Brent held for the last two years. Brent and Curt, are automatically members of the IAC's Executive Committee. Jerry Kahn was elected to be the third member of that committee.

Also new aquaculture association representatives from Michigan, Minnesota, Missouri, and Nebraska have been appointed to the IAC, beginning their three-year terms January 1, 1995/96. The current state aquaculture association representatives from to the IAC will end their terms December 31, 1996. For all of those individuals who have served, or are serving, on the IAC, we thank you for your efforts and insight.

Members of the Technical Committee (TC) have re-elected

Paul Brown and Ron Kinnunen as chairs of the research (TC/R) and extension subcommittees (TC/E), respectively. As chairs of those two subcommittees, they are also members of the respective Executive Committees. In addition, Bob Summerfelt and Anne Kapuscinski were elected as TC/R Executive Committee members, and Terry Kayes and Dave Klinkebiel were elected as TC/E Executive Committee members. A fourth member of the TC/E Executive Committee is Dave Petritz, Administrative Advisor to the Extension Work Group.

During the Annual Program Planning Meeting in Minneapolis, MN, last February, the Board of Directors approved funding for walleye, yellow perch, hybrid striped bass, and extension projects. These two-year projects began September 1, 1995. The Board also approved development of projects on sunfish, tilapia, waste/effluents, and alternative species. One-day workshops were held May 22-24, 1995, in Chicago for the purpose of identifying Work Groups to write project outlines for sunfish, tilapia, and waste/effluent projects. Those project outlines as well as one being developed for alternative species were submitted to the NCRAC Office last fall, have been reviewed and will be considered for approval by the Board in February..

As you read this issue of the NCRAC Journal, you also will notice a listing of publications for each project in the NCRAC Project Highlights section. Please

keep in mind that this list is only for those NCRAC-funded publications that have appeared in print during 1994 and 1995; pre-1994 publications, and those currently in preparation, are not listed. For a complete list of all NCRAC publications past and present, please contact the Publications Office.

In closing, please feel free to contact me or Joe Morris, the Associate Director at Iowa State University, if you have any questions, need assistance, wish to voice concerns, or just want to talk about aquaculture in the North Central Region. We are here to serve your needs, and your input is essential for the continued growth and development of aquaculture, not only in our region, but throughout the United States.

Sincerely,

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National News

National Coordinator Named for Aquaculture New Animal Drug Applications

The Joint Subcommittee on Aquaculture identified the need for a National Coordinator for Aquaculture New Animal Drug Applications (NADAs). The Coordinator will support the growth of U.S. aquaculture by facilitating the process of obtaining approvals for safe and effective new animal drugs for aquaculture. Specifically, this individual will:

- Coordinate and advocate data development efforts;
- Reduce duplication of effort and deter waste or inappropriate research;
- Organize the partnerships needed for successful NADAs;
- Act as liaison with federal agencies, including the FDA, USDA, NRSP-7 Minor Use Animal Drug Program, U.S. Fish and Wildlife Service, National Biological Service, and various state agencies;
- Work closely with the aquaculture industry, the scientific community, veterinarians, and other aquatic animal health specialists;
- Assist the industry and pharmaceutical and chemical companies in the preparation

and submission of NADA applications.

A part-time (less than 15 %) coordinator position was funded in FY 1993 and 1994 with support from USDA and FDA. Based on that experience, the decision was made to seek substantial additional funding to support at least a half-time position. To date, more than \$100,000 in funding commitments have been received from 15 government agencies, private associations, and other organizations.

A position description and job announcement were distributed in late January 1995. Applications from candidates were evaluated and ranked by a screening committee representing the aquaculture industry, technical community, and federal government. Based on this review, Rosalie (Roz) Schnick was selected for the position. Roz recently retired from the National Biological Service, where she was a registration officer at the Upper Mississippi Science Center in LaCrosse, WI. She has 28 years of professional experience with aquaculture drug approvals and registration of chemicals used in fish culture or fisheries management. She is well-known and highly regarded by the interna-

Rosalie (Roz) Schnick

tional aquaculture community. Roz began her duties in May 1995, on a three-quarter-time basis.

To date:

1. After the investigational new animal drug application (INAD) for 17 α -methyltestosterone (MT) for tilapia was canceled by the Center for Veterinary Medicine (CVM), Roz arranged a meeting with the industries affected, the sponsor, and CVM to determine data requirements, establish an action plan, and develop procedures for a new INAD. A letter inviting participation in the new INAD was sent out July 14, and the revised

A Annual Calendar 1995

February

Board of Directors meeting to approve NCRAC's FY95 projects for funding; joint session of Industry Advisory Council and Technical Committee to align priorities for FY96.

April

USDA issues NCRAC's FY96 grant. Effective start date June 1.

application and protocol were received for review from Auburn University in August 1995. The review process is continuing.

2. Roz has been traveling in her new job -- five aquaculture conferences, two workshops, six INAD coordination meetings, two committee meetings, three sponsor meetings, and several meetings with congressional staffs on the Chemical-Drug Registration Program at La Crosse, WI.
3. The INAD/NADA coordination activities centered on consolidation of 22 new INAD requests with existing INAD holders and major developments on diquat, MT, LHRHa, and hydrogen peroxide.
4. A major effort was made to maintain the Chemical-Drug Registration Program at La Crosse, WI, after the House of Representatives proposed severe reductions in the FY96 appropriations for the National Biological Service (NBS). The NBS Director stated that the program would not survive if the appropriation remains below \$140 million in the conference between the Senate and the House. Major support has to come from the aquaculture community for the program to survive.

Roz can be contacted by telephone (608) 781-2205. Her Internet address is: rozschnick@aol.com.

Activities of the Working Group on Quality Assurance in Aquaculture Production

By Gary E. Stefan and Dr. Gary L. Jensen

The need for approved animal drugs to treat the multitude of disease conditions that exist in aquaculture production has severely challenged, and in numerous cases, constrained the industry's ability to function. It is not until an individual, organization, or industry is challenged, however, that its strength and fortitude become evident. If the actions of those individuals who have participated in the Federal Joint Subcommittee on Aquaculture's (JSA) Working Group (WG) on Quality Assurance in Aquaculture Production are any indication, then aquaculture is as strong as any industry anywhere.

The federal JSA was created by Congressional legislation and is chaired by the Secretary of the U.S. Department of Agriculture's designee. It consists of represen-

tatives from 24 federal agencies and serves as an interagency coordinating body that addresses diverse aquaculture issues. To address issues of national importance, the JSA may establish working groups or task forces, which frequently include public-and private-sector representatives. Presently, the JSA reports to the National Science and Technology Council through the Committee on Health, Safety, and Food.

The dramatic growth of aquaculture during the 1980s heightened the Food and Drug Administration's concern about the potential for misuse of animal drugs in production facilities. These concerns were strengthened by the knowledge that only five compounds were approved for use in aquatic species and only four of those were being marketed. In 1989, the FDA initiated a survey of 80 catfish, trout, and crawfish producers. The following year, the agency also conducted an extensive review of the literature available to producers on drug use in aquaculture production.

Although they were carried out independently, the results of these two surveys reinforced one another. The literature survey showed that producers lack information on: 1) the drug

May

Revisions of board approved FY96 projects due in NCRAC. NCRAC submits FY96 plan of work, containing project outlines, to USDA for approval. Workshops to develop FY97 project outlines.

August

USDA issues approval of FY96 plan of work; NCRAC issues subcontracts to participating institutions.

September

FY96 projects begin.

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approval process; 2) approved drugs; 3) requirements for using approved drugs properly. There was, however, an abundance of information on the use of unapproved compounds.

The field survey found that unapproved compounds were present in most production operations. These compounds correlated well with those promoted in the literature.

Recognizing the lack of authoritative information and the wide availability of misinformation, the FDA made a decision to focus initially on education as the primary means of addressing the potential misuse of drugs and chemicals in aquaculture. The first step in this process was the presentation of these findings to a special meeting of the JSA and representatives of the catfish, trout, and crawfish industries during November, 1990. The decision was made at this meeting to establish a special forum in association with the JSA composed of representatives of federal and state agencies, industry, and academia to address drug and chemical use in aquaculture.

The forum's title, "Working Group on Quality Assurance in Aquaculture Production," was chosen to reflect the interrelationships that exist among the use of drugs and chemicals, other aquaculture production practices, and the safety and wholesomeness of aquaculture products marketed to the American consumer. The original mission of the WG was to coordinate efforts to increase understanding of and compliance with federal requirements regarding drug and chemical use

in aquaculture production. Over time, these efforts have expanded to include coordination of efforts to develop data to support FDA approval of new animal drugs for aquaculture species.

It is important to point out that the WG is not a decision-making body. It merely provides a forum within which to raise issues and discuss their impact. Individuals present their opinions or the positions of their respective organizations. Discussions then follow regarding their impact and what actions, if any, may be needed. It is up to the participants and their respective organizations to take any actions they deem appropriate.

Participation in the WG has always been open to anyone or any group that wishes to attend. Attendance has grown from about a dozen at the first meeting in 1990 to 50 or more at the more recent meetings. The only things asked of participants are that they seek positive solutions for the challenges facing aquaculture and actively work on issues being addressed by the WG. A partial listing of groups that have participated in WG meetings follows:

FDA-Center for Veterinary Medicine; FDA-Center for Food Safety and Applied Nutrition; USDA-Animal and Plant Health Inspection Service; USDA-Cooperative State Research, Education, and Extension Service; USDA-National Agricultural Library; USDI-Fish and Wildlife Service; USDI-National Biological Service; Environmental Protection Agency; USDC-Sea Grant Program; various state fish and wildlife agencies;

National Association of State Aquaculture Coordinators; Regional Aquaculture Centers; National Aquaculture Association; catfish, trout, crawfish, atlantic salmon, tilapia, striped bass, shrimp, shellfish, ornamental fish, tropical fish and bait fish associations; National Research Support Project No.7 (formerly IR-4); animal drug manufacturers; animal feed manufacturers; animal drug distributors; American Veterinary Medical Association; Canadian Salmon Health Consortium; Bureau of Veterinary Drugs (Canada); Department of Fisheries and Oceans (Canada); National Fisheries Institute; and the Western Regional INAD Project.

A number of positive actions can be attributed to the discussions that have taken place at meetings of the WG. These actions have been taken by individuals or organizations independently, but the necessity for them has been identified as a result of WG discussions. Examples of some actions include:

- **Improved communication between the federal regulatory agencies and aquaculture producers on animal drug and chemical use.** This has included better communication by the agencies about legal responsibilities of producers as well as better communication by producers with the agencies about production practices.
- **Establishment of a database of drug and chemical information on compounds used in aquaculture production.** This effort was undertaken by the USDA-ES in support of the Food Animal Residue Avoid-

ance Databank in cooperation with regional access centers at the University of California-Davis, North Carolina State University, and the University of Illinois, with assistance from the University of Florida. The EPA initially supported this effort by free subscription, and later discount subscription, to its Pestbank CD-ROM database.

- *The FDA, EPA, and USDA-APHIS cooperated to develop written guidance on the regulatory requirements for obtaining approval to market animal drugs, pesticides, and biologicals for aquaculture uses in the publication "Federal Regulation of Drugs, Biologicals, and Chemicals Used in Aquaculture Production."* A cooperative government/industry effort was undertaken to print and distribute this information to the aquaculture industry.
- *The Catfish Farmers of America and the U.S. Trout Farmers Association developed producer quality assurance programs for their respective producers.* Additional efforts are underway by the National Aquaculture Association and the Northeast Regional Aquaculture Center to develop generic quality assurance programs for other finfish and shellfish producers.
- *The USDA-Extension Service, working in conjunction with the FDA, EPA, and USDA-APHIS developed the publication "Guide to Drug, Vaccine, and Pesticide Use in Aquaculture," containing information on the proper use and listing of these compounds approved for aquaculture.* Funding to

print and distribute the guide has been provided by both government agencies and industry.

- *The FDA provided speakers, and industry groups organized sessions to provide training on how to obtain investigational new animal drug exemptions in order to conduct studies and develop data to support formal approval of needed aquaculture drugs.*
- *Supported by funds from USDA-CSREES, the North Central Regional Aquaculture Center established a part-time position to help coordinate the development of aquaculture INADS.* The FDA, and the USDA Regional Aquaculture Centers, and the private sector have also provided funding to help support this effort.
- *Aquaculture producer groups and the federal and state fish hatchery representatives prioritized their drug needs and submitted them to the FDA for review.* The FDA evaluated the compounds and identified those which required the least information to obtain FDA approval. Each group then selected those compounds for which they wished to pursue FDA approval.
- *The FDA also determined that some compounds used in aquaculture, which met the definition of animal drugs, were so common and innocuous that it was not necessary to require a formal new animal drug approval at the present time.* The Agency declared that 18 compounds were of Low Regulatory Priority and would be available to producers if they were

used under certain narrowly defined conditions.

- *The WG provided a forum for discussion that has helped efforts to increase the availability of veterinarians to aquaculture producers.* This is critical, because veterinarians are the only individuals who can, under certain conditions, legally prescribe the extra-label use of drugs to treat animals and diseases for which there are no approved drugs.
- *The WG provided a forum to exchange information on efforts to develop data to support formal FDA approval of new animal drugs.*
- *The National Aquaculture Council coordinated an effort to develop data on the various life stages of individual species of food fish.* These data were submitted to the FDA to provide scientific justification for reducing the human food safety data needed to obtain approvals for drugs needed during early life stages of these respective species.
- *The USDA-Northeast Regional Aquaculture Center provided funds to produce a video of an INADS workshop conducted in 1993.*

Current activities of the WG are focusing on the coordination of efforts to develop complete data packages to support formal FDA approval of needed aquaculture drugs. This goes beyond previous efforts which concentrated on the more critical need of providing the industry with access to at least some of the needed drugs. Industry education continues to be a high priority. Every group needs to

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put forth a consistent message to insure clear understanding about what constitutes proper use of animal drugs.

The WG has provided a forum to facilitate positive accomplishments in the area of animal drug and chemical use. Although progress and the pace have quickened, for aquaculture, the challenges ahead imply a lengthy journey. Future efforts of the WG will continue to support actions that will lead to additional approved new animal drugs for aquaculture species.

Examples of topics which may be discussed by the WG include: 1) funding a full-time national NADA Coordinator; 2) identifying mechanisms for obtaining data on potential markets for aquaculture drugs; 3) improving mechanisms for disseminating accurate and consistent information on proper use of animal drugs and chemicals in aquaculture production and 4) increasing producer participation in aquaculture industry quality assurance programs.

The combined efforts of all the participants in the WG have made it successful. The WG would not even exist, however, if it were not for the vision of Dr. R. Oneal Smitherman, who recognized the importance of such a forum to aquaculture and the support of Dr. Henry S. Parker, who has made it possible for the WG to continue to exist.

Source: Salmonid: The Official Journal of the United States Trout Farmers Association. Volume XIX, Number 1, Spring 1995.

Aquaculture Information Abounds on Computer Network

URBANA, IL -- With a few computer keystrokes, anyone can easily access aquaculture information through the new AquaNIC computer system. The World Wide Web address is <http://www.purdue.edu/aquanic/>. AquaNIC is a gateway to the world's electronic resources in aquaculture--on every topic from quality assurance to catfish to aeration devices.

One of the system's unique features is its linkage to other aquaculture databases on the Internet, said LaDon Swann, Illinois-Indiana Sea Grant aquaculture extension specialist. This allows users to gain information found on the more than 45,000 networks linked together worldwide, said Swann, who is also a specialist with Cooperative Extension Service (CES) at Purdue University and the University of Illinois and a member of the AquaNIC development team.

Another important benefit of this system is access to a great deal of information with rapid turnaround time. Users can peruse information, choose what interests them, and quickly retrieve what they need. In this way, they know just what they are getting instead of relying on a description of a publication or asking for a fact sheet that may not meet their needs.

AquaNIC's directory contains a wide variety of information from Cooperative Extension, Sea Grant, and other agencies. For example, users who choose the NEWSFLASHES category

receive timely pieces of information with broad appeal. This category would describe proposed and new rule changes related to national initiatives (HACCP), quality assurance, aquaculture effluent, new drug approvals, etc.

The AquaNIC gateway's searching capability allows users to focus on whatever they are looking for, making each search individualized. For example, one can retrieve catfish marketing information from a specific locale by entering "catfish and marketing and Mississippi." This search would list all publications containing those three words.

Most documents can be viewed on a computer monitor, downloaded via modem, or received as hard copy. If users have appropriate software, they can view photographs or videos with sound on many topics and items, such as aquaculture equipment in use or fish being fed by automatic feeders. This visual component helps users better comprehend what is written and helps avoid confusion, said Swann.

Those who would benefit from using AquaNIC include: university and other staff affiliated with outreach programs; university-based aquaculture specialists and local Extension Service educators; individuals in the private sector seeking aquaculture information, including calendar items; teachers and professors who want updated, timely information on current issues; researchers who wish to network electronically with colleagues and learn of federal research grant opportunities; employees of government

agencies who wish to share and exchange information; and students and others interested in aquaculture-related job announcements. There is no charge to use AquaNIC. If a user does not have access to the Internet, however, several commercial carriers charge a monthly fee to provide a link to AquaNIC, including DELPHI, CompuServe, and Prodigy.

AquaNIC is maintained at Purdue University in West Lafayette, IN, and is supported by the libraries of Purdue University, Purdue University Cooperative Extension Service, University of Illinois Cooperative Extension Service, the Illinois-Indiana Sea Grant Program, and the USDA Cooperative Extension Service.

AquaNIC was initiated by a grant from the USDA Extension Service and is directed by a national advisory committee which consists of representatives from CES, the Sea Grant Marine Advisory Service, and private industry.

If you have information to include on AquaNIC or would like assistance in accessing the system, contact Mark Einstein at meinstei@www.ansc.purdue.edu.

New Hormone Used by Hatcheries

A human hormone that hatcheries use to make fish spawn doesn't linger in live sport fish and disappears in cooked ones, two researchers from Southern Illinois University at Carbondale have found.

Human chorionic gonadotropin (HCG), a hormone found in

pregnant women, breaks down in fish bloodstreams within 14 to 35 days, depending on the fish species and on the water temperature of the holding tank, said Christopher C. Kohler of SIU-C's Cooperative Fisheries Research Laboratory. It cooks out of fish in a couple of minutes.

We did this study to show that there's not a serious problem with this hormone and that there's a way to test for it, Kohler said.

As part of their restocking programs, many hatcheries capture female sport fish, inject them with chorionic gonadotropin and then turn them loose when they've released their eggs. A lot of fish won't spawn in captivity; the hormone gives them the push they need.

"They did it for years with no questions asked, but now the Food and Drug Administration considers this a drug subject to regulation," Kohler said. "If they're concerned, we have to be concerned."

Kohler and former SIU-C graduate student Anita M. Kelly used a human pregnancy test kit that depends on blood samples for results in their research. They injected seven species of fish with the hormone, then screened blood samples at intervals to see how long it took for the hormone to disappear.

Their results suggest an easy way for hatcheries to allay any fears that the hormone might end up in the human food chain.

Kohler hopes to begin an animal safety study soon that, along with work planned by Auburn University, should lead to full FDA approval of the

hormone for treating fish. It is already approved for cattle and swine.

Source: *Aquaculture Magazine*, Vol 21, No. 3. 1995.

New Executive Director of the National Aquaculture Association (NAA) Named

Richard E. Bohn has been named executive director of the NAA, succeeding the late Joe McCraren. Bohn also will serve as executive director of the U.S. Trout Farmers Association, which shares facilities with NAA in Shepherdston, West Virginia. He will handle the day-to-day operations of both associations.

Bohn has served eight years as an associate professor and extension agent for the Sea Grant Program at the University of Maryland and has been a leader in producing the annual Aquaculture in the Mid-Atlantic Conference. He headed the program committee for the combined Mid-Atlantic/Aquaculture Expo VIII conference in Washington, D.C. last June.

Bohn has a masters degree in fisheries from the University of Washington and a bachelor's degree in biology from Oregon State University. He began his coast-to-coast aquaculture career by picking oysters in Washington state. He later worked in Oregon and Washington salmon hatcheries and for two large oyster producers. Prior to moving to Maryland, he served as aquaculture specialist at the Virginia Polytechnic Institute of Marine Science.

Source: *Water Farming Journal*, Vol. 11, No. 1, January 26, 1996.

Regional News

Request for Proposals

The North Central and Northeastern Regional Aquaculture Centers (NCRAC and NRAC) have earmarked approximately \$100,000 for an Inter-regional Research Initiative on aquaculture waste management with an emphasis on discharge of phosphorus. The project, or projects are to be inter-regional in nature, utilize an inter-regional team approach and rely on in-place equipment and facilities to achieve the objectives. Indirect costs, "brick and mortar" construction funds and student tuition remission costs are not allowed. The copies of each proposal must be received by NCRAC no later than 4 pm on March 1, 1996. Handwritten and facsimile transmissions as well as proposals received after the deadline, will not be considered. All inquiries and submissions should be addressed to: Dr. Ted Batterson, Director, North Central Regional Aquaculture Center, Room 13 Natural Resources Building Michigan State University, East Lansing, MI, 48824-1222. Telephone: (517) 353-1962; Fax: (517) 353-7181; E-mail: batters2@pilot.msu.edu.

Walleye Workshops Scheduled for Spring and Summer

Two walleye culture workshops sponsored by the North Central Regional Aquaculture Center are now being planned for this spring and early summer.

The first workshop will be held in early May 1996 to

demonstrate the technology for tank-culture of walleye fry on formulated feed. The target audience for this workshop will be primarily tribal, state, and federal hatchery biologists. Attendance will be limited to approximately 20 to 30 with a cost of about \$50. The fee includes lunch, 2 coffee breaks, handouts, and a copy of the new North Central Regional Aquaculture Center Walleye Culture Manual.

A second workshop will be conducted in mid-June 1996 and will focus on training pond-reared fingerlings to formulated feed. Audience for this workshop will include more private sector growers.

For more information, please contact Robert Summerfelt (Iowa State University) at 515-294-6107, Ron Kinnunen (Michigan Sea Grant Extension) at 906-228-4830 or Jeff Gunderson (Minnesota Sea Grant Extension) at 218-726-8715.

Regional Yellow Perch Workshop Held In Michigan

A Yellow Perch Aquaculture Workshop co-sponsored by the North Central Regional Aquaculture Center, Michigan State University Extension, Michigan Sea Grant Extension, and the Michigan Aquaculture Association was held June 15 and 16, 1995, at Spring Lake, MI. More than 50 individuals from six states and Ontario, Canada attended. The workshop highlighted the results of research funded by the North Central Regional Aquaculture Center to enhance the potential for commercial perch culture in the

region. Workshop participants had an opportunity to meet and discuss yellow perch culture with NCRAC researchers and established perch farmers.

Interest in yellow perch farming is the result of the high value of yellow perch as a food fish in the Great Lakes region. Its popularity is largely based on its traditional use at local events such as the Friday-night fish fries. Perch is renowned for its delicate flavor, lack of cooking odor, and excellent food-storage qualities. Commercial harvest of wild stocks of yellow perch traditionally has not met market demand. Recent declines in wild stocks have resulted in additional limits placed on recreational and commercial yellow perch fishing in southern Lake Michigan, which will further reduce the available perch supply. Yellow perch fillets have retailed at more than \$11 per pound, reflecting the reduced supply conditions.

Topics presented during the workshop included: "Advancing Commercial Aquaculture Development," presented by Dr. Ted Batterson, Director North Central Regional Aquaculture Center; Bob Craig, Director of Agriculture Policy and Special Projects, Michigan Department of Agriculture; and Bob Baldwin, President, Michigan Aquaculture Association; "Spawning and Incubation," presented by Dr. Terry Kayes, University of Nebraska, Lincoln; "Intensive Fry Rearing," presented by Fred Binkowski, University of Wisconsin-Milwaukee; "Fingerling Production in Ponds," presented by Dr. Terry Kayes; "Food Fish Production in Ponds and Cages," presented by Dr. Terry

Kayes; "Food Fish Production in Flowing Water Systems," presented by Chris Starr, Bay Port Aquaculture; "Floating Raceways," presented by Dan Selock, Mid-Continent Fisheries; "Federal Grant Opportunities," presented by Forrest Williams, Bay Port Aquaculture; "Economic Considerations," presented by Jean Riepe, Purdue University; Jonathan Ferris & Don Garling, Michigan State University. Workshop participants also were given the opportunity to tour the nearby Bay Port Aquaculture facility, which has been producing yellow perch for the last six years. Their perch are produced in raceways using heated water from an adjacent power plant. Bay Port has cooperated on a number of NCRAC perch project objectives.

The conference was videotaped by Jim Ebeling of Ohio State University. Copies of the video tape will be available at cost in the near future through Jim or Don Garling.

For additional information or a copy of the video tape, contact:

Don Garling
Dept. of Fisheries and Wildlife
9 A Natural Resources, MSU
East Lansing, MI 48824
(517) 353-1989

Jim Ebeling
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1864 Shyville Road
Piketon, OH 45661
(614) 289-2071

Annual Minnesota Aquaculture Conference and Tradeshow

The Combined North Central and Ninth Annual Minnesota Aquaculture Conference and Tradeshow was held February 17 and 18, 1995, in Minneapolis, MN. Four hundred and thirty one participants attended, including speakers and 52 vendors. Topics covered were: "Planning for Success," "Management Considerations," "Yellow Perch Culture," "Wall-eye Culture," "Commercial Recirculation Aquaculture," "Fish Health Management," "Aeration, Water Quality, and Growth Monitoring," and two general aquaculture information sessions. Numerous NCRAC-sponsored researchers, extension specialists, as well as members of the Industry Advisory Board and the Board of Directors were speakers or moderators for this conference.

Reclamation Efforts Recognized

The Interstate Mining Compact Commission (IMCC) announced the recipients of its annual national reclamation awards. Named after the late charter executive director of the IMCC, the Kenes C. Bowling National Mine Reclamation Awards are presented to mining operations in coal and noncoal categories that have demonstrated excellence in reclamation based on achievement in the areas of compliance, contemporaneous reclamation 'drainage control' bond release (or reclamation success), and

innovativeness.

The winner in 1995 in the coal category was Mid-Continental Fuels, Inc. for its Mine #1 located in Williamson County, in Johnston City, IL. Mine #1 was a secondary or carbon recovery operation on a portion of a former underground mine. All reclamation was completed contemporaneously, and the site has subsequently been converted to a successful fish farming operation with six full-time employees. Mid-Continental Fisheries has an established market for 100,000 pounds of fish annually, has expanded the operation into manufacturing and distribution of the Caillouet Floating Raceway System, and has developed a market for all processed fish wastes converted to a high nitrogen fertilizer.

Mid-Continental Fuels of Johnson City, IL, was also recognized by the Illinois Department of Natural Resources (DNR), Office of Mines and Minerals, for innovative reclamation in recovering coal from an acid-producing waste site left from a previous operator and creating, in its place, a commercially viable aquaculture facility that markets 100,000 pounds of fish annually. The company has demonstrated that drastically disturbed areas contaminated with coal wastes can be economically mined and reclaimed and then transformed into viable commercial assets providing both income and employment opportunities.

Getting to know . . . Bay Port Aquaculture Center

Growing Interest in Yellow Perch Culture in Michigan

A new aquaculture operation has become established in Michigan. Bay Port Aquaculture is unique in that it is a cooperative endeavor associated with a Consumer Power Plant facility

on the shores of Lake Michigan. While yellow perch are native to the North Central Region, they do grow best when water temperature is 20-22°C (68-72°F), which is where the Consumer Power Plant facility becomes involved; its heated discharge water helps to maintain ideal

growing temperatures year-round.

Christopher Starr, manager of the Bay Port Aquaculture facility adjacent to the power plant, indicated three reasons why good progress has been made at this location: a good supply of heated water coming from the three electrical generating units; good water quality; and good cooperation from Consumer Power.

When they first started their operation in 1990, Bay Port had a smaller capacity of 1894 L/minute (500 gallons/minute) through the facility. Now they have a capacity of 7576-9470 L/minute (2,000-2,500 gallons/minute), with proposals for expansion in the next year or so. In the winter, only heated discharge water is used in the operation, in the summer, primarily Lake Michigan water from the power plant intake is used. During the spring and fall, these two water sources are mixed to obtain appropriate water temperatures for the facility.

The first year's demonstration facility (Phase I) was supported by a National Science Foundation (NSF) grant through the Small Business Innovative Research (SBIR). Dr. Donald Garling, professor and fish culture specialist from the Department of Fisheries and Wildlife of Michigan State University, was a key interactive partner for this SBIR effort. After the first year, they were able to secure funding a second year through NSF for a Phase II

Chris Starr of Bay Port Aquaculture holding a yellow perch.

to provide the necessary research efforts to bring this fish culture operation into its commercialization phase. They were able to study densities in which the fish can be grown in raceways with varying water flows and temperatures. Starr indicated that it may be possible under this raceway system to grow two to three times the numbers of perch than is prescribed for trout under similar culture conditions.

Starr indicated that the process of raising the fish encompasses several phases. Before spawning in the spring, the fish require a period of lower temperatures in physiological preparation for spawning. When conditions are right, the eggs are stripped from the females. These ribbons are stretched out, fertilized with sperm from several male perch, and incubated.

Once the eggs are laid and fertilized, they take 10-14 days to hatch, depending on water temperature. Upon hatching, it was found to be very difficult to rear and feed the tiny larvae after the yolk sac is absorbed. Little is known about early feeding behavior. Thus, researchers found it necessary to use managed farm ponds where there is good algal production with adequate quantities of zooplankton available for the newly hatched fry, which are about 5 mm (0.20 inch) at the time of hatch. The newly hatched fry are immediately

taken to these farm ponds; once they have reached 25-50 mm (1-2 inches) the fingerlings are brought back to the hatchery/growout facility at Bay Port Aquaculture and fed artificial feed pellets. After 30 days, hatchery biologists can estimate the percentage that will not take artificial feed readily. Generally, approximately 10% will not take artificial feeds and are discarded.

After the young fingerlings are brought back from the outside farm ponds, it usually takes them 11-14 months to reach market size in the raceway system of Bay Port Aquaculture.

The present arrangement with Consumer Power Plant involves a straight lease agreement, which is quite economical at present. Once the fish culture operation and production levels are established, some portion of the production proceeds will go back to the power plant company as part of the lease agreement.

Another interesting note is that sometimes there is an excess of yellow perch fingerlings that could be sold to interested parties to restock bays and ponds. Chris indicated that they sell for \$.25-.55 a piece depending on size. The sale of these fingerlings usually takes place after they have been conditioned to artificial pellet feed.

Presently, commercial fisheries are not interested in raising yellow perch in the Great Lakes region, as a large sports fishery

grows this species. Gear and season regulations are getting more restrictive toward commercial harvest.

The operation at Bay Port Aquaculture is up-to-date with computers already in place to monitor temperature, water flow, and power. Thus far, there is little problem with disease.

With this operation at Bay Port Aquaculture and the research findings that will be available, others will want to get involved in the culture of yellow perch using heated effluent. Several places throughout the North Central Region have this heated water source, but for now Bay Port Aquaculture is the only yellow perch culture facility using a heated water source in Michigan. Chris indicated that if everything goes well in the future, this operation could expand to produce as much as 100,000 lbs of market fish per year.

In addition to this operation, other yellow perch operations have become established in other states such as Iowa, Nebraska, Ohio, and Wisconsin; however, many of these operations are only to supply eggs, fry, or fingerlings, and few have produced food-size fish. Recently, a NCRAC-sponsored workshop was held in Michigan, see the related story in this issue.

(Source: Ken Chew, Western Regional Aquaculture Center)

Getting to know . . . Jeff Malison

Jeff Malison

Jeff Malison has been at the University of Wisconsin - Madison since the late 1970s, when he first started to work on his Master of Science degree. He attended Tulane University in New Orleans from 1972-1974, and obtained his Bachelor of Science degree from the University of Wisconsin-Stevens Point in 1976. At this time, he was interested in warm-water streams. In 1980 and 1985, respectively, he received Master of Science and Doctor of Philosophy degrees from the University of Wisconsin-Madison. Jeff's graduate research focused on endocrinology/reproductive physiology.

In 1990, Jeff was appointed assistant director of the University of Wisconsin-Madison Aquaculture Program. After the long-term director Clyde H. Amundson retired, Jeff was appointed the director in 1995.

While in his current position, Jeff's research has focused on: 1) physiology and endocrinology, 2) genetics, and 3) development

of practical aquaculture technology for various species including yellow perch and walleye. He has also done substantial research on the culture of various salmonids. Jeff has also served on graduate committees for students of other faculty.

Jeff has focused many of his presentations to fish farmers on the usefulness of understanding fish physiology. Jeff indicated that many veterinarians are aware that 80% or more of disease-related problems in fish farming are not related to the pathogenicity of any disease organism but rather to stresses that have a negative effect on fish and make them subject to these organisms, such as *Columnaris*, which is similar to the common cold. Fish normally can fight these organisms off when they are in a healthy condition.

Jeff said "nutrition, handling, the quality of the rearing environment in total are all possible stress-related factors. The importance will become especially apparent in some of the new species we haven't domesticated yet." The domestication process selects for animals that tolerate unavoidable stresses of rearing. Research facilities that are available to Jeff are located at Lake Mills Hatchery, operated by the Wisconsin Department of Natural Resources, and the laboratory on the Madison campus.

Although Jeff's appointment is primarily that of a researcher, he has been active in giving presentations to the public about aquaculture. In 1996 or 1997, he will host a regional workshop on yellow perch culture.

Lake Mills Hatchery, Wisconsin Department of Natural Resources

Getting to know . . . LaDon Swann

LaDon Swann grew up in rural Tennessee in a family with three sisters. He entered Tennessee Technical University in 1978 and graduated in 1982 with a B. S. degree in wildlife management. As with many individuals who change their career focus, he changed his educational interest to the exciting world of fisheries management. LaDon completed his M. S. degree in fisheries biology from Tennessee Tech in 1985.

Once LaDon graduated, he obtained valuable experience in the aquaculture field. He spent two and a half years in the Peace Corp in West Africa as an aquaculture extension agent working with *tilapia*. As with many other Peace Corp veterans, he considers this experience extremely valuable in his current professional life.

After his Peace Corp stint, he worked as an assistant project leader for the Non-native Fisheries Lab of the Florida Game and Fish Commission. After that, LaDon worked as a Peace Corp Trainer in South Carolina, then worked on a tropical fish farm in Florida.

Feeling the need to return to the extension service, LaDon began working in December 1989 for Purdue University in the position of Aquaculture Specialist for the Illinois/Indiana Sea Grant. This position is split equally between the Cooperative Extension Services and Sea Grants of the University of Illinois and Purdue University.

During fall 1992, LaDon started his Ph.D. program at Purdue University and is scheduled to complete this degree either Fall 1996 or Spring

1997. His research is focused on the reproductive physiology of yellow perch and angel fish. At the same time, LaDon is continuing his job as Aquaculture Specialist.

LaDon has been extremely productive since his arrival in this region. He has been the editor of proceedings from several workshops that focused on recirculating systems and cage culture, as well as being involved in state and regional workshops on fish diseases, fish transportation, business planning, and hybrid striped bass culture. Among his numerous extension publications, LaDon is either the sole author or the leading writer of NCRAC

publications on topics such as transportation of fish in bags, use of salt in aquaculture, overview of aquaculture, niche marketing of aquaculture products, and cage culture. LaDon was the leader in a successful nationwide video conference entitled "Investing in Freshwater Aquaculture" that was downlinked across the United States. He was able to oversee the production of a NCRAC video based on this conference, as well as another video on hybrid striped bass production in cages. This is an impressive list of work, particularly because he has been able to do this while working toward his Ph.D.

LaDon Swann

1994-95 NCRAC Project Highlights

Project: North Central Regional Aquaculture Extension

(Iowa State University, Kansas State University, Michigan State University, University of Minnesota, University of Missouri, University of Nebraska-Lincoln, Ohio State University, Purdue University, Southern Illinois University-Carbondale, University of Wisconsin-Milwaukee)

Major actions included:

- Provided in-service training for CES and Sea Grant personnel and other landowner assistance personnel in basic aquaculture in Illinois, Minnesota, Iowa, Kansas, Nebraska, and Wisconsin.
- Delivered workshops on: general aquaculture in Minnesota, Missouri, Nebraska, Wisconsin, Illinois, Indiana, and Missouri; yellow perch and hybrid striped bass culture in Ohio; and yellow perch and crawfish culture in Illinois and Indiana.
- Delivered in-service training programs to vocational agriculture and science teachers on basic aquaculture in Illinois, Iowa, Michigan, and Wisconsin.
- Conducted hands-on training sessions and field site visits to aquaculture operations in Ohio, Indiana, Illinois, and Michigan. Field-tested a workshop on polyploid induction in sunfish for commercial fish producers in Michigan.
- Planning began in 1994 for the 1995 North Central Aquaculture Conference held in conjunction with the NCRAC Annual Meeting, Minnesota Aquaculture Conference, and the Great Lakes

Fish Disease Control Committee meeting in Minneapolis, MN.

- Chaired a session entitled "Reservation Aquaculture Projects" at the Great Lakes Regional Native American Fish and Wildlife Conference held in Green Bay, WI, and chaired the Program Committee for the 1994 Governor's Conference on Agriculture: "Wisconsin Aquaculture 1994."
- Participated in the development of the United States Trout Farmers Association's quality assurance program (HACCP).
- Helped conduct a survey of crayfish producers in the NCR and completed a report on *Orconectes immunis* for inclusion in the Crayfish Work Group report.
- Produced a script for a videotape for novice fish farmers on the basics of marketing aquaculture products in the NCR.
- Provided NCRAC Economics and Marketing Work Group with information relevant to the work group's efforts to develop cost of production budgets and expected revenues for the commercial production of food-sized hybrid striped bass, walleye, and yellow perch in the NCR.
- Assisted in writing and developing the NCRAC Walleye Culture Manual edited by Bob Summerfelt of Iowa State University.
- Developed the "Missouri Aquaculture Directory" and the "Aquaculture in Missouri" newsletter to enhance aquaculture educational programs and development in Missouri.
- Developed materials for

aquaculture handbooks, which will be distributed to each NCRAC-designated extension specialist, and selected CES and Sea Grant field staff.

- Completed two additional technical bulletins and one video that were provided to all members of the extension network.

At the 1992 NCRAC Program Planning Meeting, the Industry Advisory Council expressed a need for technique-centered educational tools to help farmers and prospective aquaculturists rear high-priority fish species. To meet this need, NCRAC extension participants have focused their program efforts on the following: hybrid striped bass (workshop proceedings), walleye (culture manual and workshop), yellow perch (culture guide and videos), sunfish (culture guide and videos), and aquaculture product marketing (video).

Publications

NCRAC Technical Bulletin Series

- #107 "Niche Marketing Your Aquaculture Products," 1995, written by L. Swann, Purdue University and J. Riepe, Purdue University.
- #110 "Cage Culture of Fish in the North Central Region" 1995, written by L. Swann, Purdue University; J. Morris, Iowa State University; and D. Selock, Southern Illinois University, and J. Riepe, Purdue University.

Project: Aquaculture Economics, Marketing, and Policy for the North Central Region

(Illinois State University, Michigan State University, University of Nebraska-Lincoln, Purdue University, Southern Illinois University-Carbondale)

Major actions included:

- A review of the literature on hybrid striped bass (HSB) production and production costs is being summarized in an annotated bibliography.
- Two large fish farms in Arkansas and one in Missouri were visited to discuss HSB production and gather production information.
- An extensive walleye production/culture literature review is being conducted to discover any research findings that might be useful in ascertaining the cost of production for walleye under intensive and extensive culture regimes.
- The cost of production was identified and analyzed for advanced walleye fingerlings in intensive and extensive culture systems.
- Budget costs are being researched for cage culture, pond culture, and tank culture for yellow perch.

Project: Advancement of Yellow Perch Aquaculture

(University of Nebraska-Lincoln, Ohio State University, Purdue University, University of Wisconsin-Madison, University of Wisconsin-Milwaukee)

Major actions included:

- Significant progress was made at certain sites at testing selected research-based production technologies. The project is successfully building and/or expanding working relationships among NCRAC researchers and certain regional fish farmers, testing various research-based technologies under practical production conditions, transferring knowledge from academia to the private sector, and identifying private producers who are both capable and willing to sustain a collaborative technology evaluation and demonstration effort. Several of the original private-sector collaborators have either met or have worked hard to meet their project commitments, including Pleasant Valley Fish Farm (Nebraska), Sandhills Aquafarm (Nebraska), and Coolwater Farms, LLC (Wisconsin).
- Researchers at the University of Wisconsin-Milwaukee calculated the labor, supplies, and utility costs for the commercial-scale, intensive culture of yellow perch fingerlings in tanks at the Aquaculture Institute University of the Wisconsin System Great Lakes Research Facility. Based on this information, the cost of intensively culturing these fish from sac fry to 74-day posthatch in tanks was \$0.0842 per fingerling. These costs did not include capital costs nor depreciation for

facilities and equipment.

- Studies on pond fingerling production by the University of Wisconsin-Madison are being conducted using ponds of various sizes at Coolwater Farms, LLC, and the Lake Mills State Fish Hatchery. Study topics include the use of selected high-fry stocking densities and early pond harvest to maximize pond fingerling production and then use of underwater lights and vibrating feeders to habituate fingerlings to formulated feeds while they remain in the ponds. In general, pond fingerling production has been highly variable, ranging from 0-610,000/ha (0-1,507,290 acre). All indications are that this high variability has been due to extreme variations in zooplankton populations, despite extensive efforts to monitor zooplankton and using fertilization and aeration to maximize pond productivity.
- Ohio State University researchers have transferred pond-reared yellow perch into inside tanks. Initial findings suggest that the best initial size for habituation of yellow perch to intensive tank rearing using conventional starter feeds would be larger than 15 mm (0.6 in.) total length.
- Studies to determine the commercial-scale feasibility of raising food-size yellow perch in different types of production systems while comparing the best available diets were initiated in open ponds at Pleasant Valley Fish Farm, in raceways at Sandhills Aquafarm, and in large net-pens at Red Hook Fisheries. The field trials conducted failed to produce substantive results.

1994-95 NCRAC Project Highlights

Project: Advancing Hybrid Striped Bass Culture

(Iowa State University, University of Nebraska-Lincoln, Ohio State University, Purdue University, Southern Illinois University-Carbondale, University of Wisconsin-Madison, University of Wisconsin-Milwaukee)

Major actions included:

- Research at Purdue University was designed to formulate and mix dry dietary ingredients and facilitate manufacturing of small pellets with the help of colleagues at the U.S. Fish and Wildlife Service, Fish Technology Center, Bozeman, MT. Three diets were formulated in the first year of this project, containing two distinctive flavor additives that would be considered legal to use.

- Facilities to intensively rear larval white bass were established at Ohio State University, Southern Illinois University-Carbondale (SIU-C), and UW-Milwaukee.

- Studies at SIU-C showed that good fertility can be achieved in white bass eggs using cryopreserved spermatozoa. Studies of sperm morphology at Iowa State University (ISU) indicated that some cryopreserved seminal samples (about 20% of those evaluated) showed clumping. Samples that exhibited clumping and adhesion showed no motility upon thawing, whereas samples where sperm morphology was normal and no clumping occurred became motile upon thawing.

- Studies at SIU-C showed that good fertility can be achieved in white bass eggs using cryopreserved spermatozoa. Studies of sperm morphology at Iowa State University (ISU) indicated that some cryopreserved seminal samples (about 20% of those evaluated) showed clumping. Samples that exhibited clumping and adhesion showed no motility upon thawing, whereas samples where sperm morphology was normal and no clumping occurred became motile upon thawing.

Studies at ISU also showed that best motility was routinely

obtained when samples were activated with water before being completely thawed. This agrees with the results of fertility tests conducted at SIU-C; better fertility has routinely been obtained when cryopreserved semen is only partly thawed before being combined with eggs.

Publications

Kohler, C.C., R.J. Sheehan, C.

Habicht, J.A. Malison, and T.B.

Kayes. 1994. Habituation to captivity and controlled spawning of white bass.

Transactions of the American Fisheries Society 123:964-974.

Project: Culture Technology of Walleye

(Iowa State University, Max McGraw Wildlife Foundation, Michigan State University, University of Minnesota, University of Nebraska-Lincoln, University of Wisconsin-Madison)

Major actions included:

- University of Minnesota investigators and Aurora Aqua, Inc., a commercial walleye aquaculture enterprise, reared pedigreed families of walleye. They will be used as the parent generation to develop a domesticated line of walleye selected for high performance in different indoor systems for food-fish production.

- Iowa State University and University of Wisconsin-Madison investigators undertook comparisons of the performance of purebred and hybrid walleyes produced from several stocks of walleye, the Rock Lake walleye

(RLW), Rock Lake hybrids (RLH), Spirit Lake hybrids (SLH), and Genoa hybrids (GH). Fertilized eggs of all four groups were incubated and hatched at the ISU fish culture laboratory. Fingerlings were transported by ISU personnel to the UW-Madison fish culture site at the Lake Mills State Fish Hatchery, Lake Mills, WI, where the fingerlings were reared to food size by UW-Madison personnel.

- Tank culture of hybrid walleye was conducted at ISU. Statistically significant differences in survival and growth (TL and weight) were observed at 30 d posthatch; the mean lengths of all hybrid groups were significantly greater than that of the RLW. At the 30, 44, and 58 d posthatch sampling times, the SLH were significantly longer and heavier than any other group.

- Field trials at the Max McGraw Foundation were undertaken to demonstrate transfer of the intensive fry-rearing technology developed at ISU and the Iowa Department of Natural Resources Rathbun State Fish Hatchery, and to obtain biological and production costs for intensive (tank) and pond-culture methods to produce 30 d old and advanced (150 mm [5.9 inches]) fingerling walleye. The culture techniques were successful in getting fry on feed and inflating their gas bladder.

- McGraw Foundation personnel trained some of the pond-reared walleye to formulate feed in 1.2 and 1.5-m (3.9 and 4.9 ft.) diameter circular tanks. Larger tanks yield longer and heavier fish. Feed conver-

sion was 1.7 in the small tanks and 1.4 in the large tanks.

- University of Nebraska-Lincoln (UN-L) investigators evaluated pond aeration, fertilization, and fry-stocking density in ponds at the North Platte State Fish Hatchery, North Platte, NE. This study revealed consistently high levels of dissolved oxygen (DO) in all ponds and no appreciable aeration, fertilization, or stocking-rate effects on survival (71-81%) or on the size (37-44 mm [1.5-1.7 in.] TL) of fish harvested.

- In a second UN-L study, the effects of stocking rate and continuous aeration on walleye fingerling production in 1 m deep ponds were investigated. Neither stocking rate (405,000/ha vs 607,500/ha [1,000,740/acre vs 1,501,110/acre]) nor aeration had a significant effect on survival (69-79%) or the total biomass of fish harvested per pond (126-166 kg/ha [112-148 lb/acre]). To date, UN-L investigators have demonstrated that (using appropriate pond stocking, fertilization, and harvesting strategies) the number of walleye fingerlings that can be produced per unit of pond surface area (ha or acre) can be increased by a factor of 1.6-3.2 above presently established standards, with no significant detrimental effect on survival and only a comparatively small reduction in fish size.

- A study by UW-Madison workers found that walleyes harvested from ponds at 20 mm TL (0.8 in.) and habituated to intensive culture conditions and formulated feeds had higher mortalities than those harvested at 30 mm TL (1.2 in.). In a

separate study, UW-Madison researchers conducted a preliminary evaluation of a system to feed-train fingerling fish to formulated feeds in ponds by using vibrating feeders with underwater lights. The system relies on the photopositive response of many small fingerling fishes and has been used very successfully with yellow perch.

Publications

Vargas, G. 1994. A behavioral study of feeding aggression in walleye (*Stizostedion vitreum*). Report for the Minnesota Biological Sciences Summer Research Program, University of Minnesota, Department of Fisheries and Wildlife, St. Paul.

Project: Culture Technology of Centrarchids (Sunfish)

(Illinois Natural History Survey, Iowa State University, Michigan State University, Pittsburgh State University, Purdue University, Southern Illinois University-Carbondale)

Major actions included:

- An evaluation of both cold and pressure shocks of varying magnitudes, initiation times (time after mixing egg and sperm), and durations to determine the optimum treatments to produce tetraploid bluegill has been completed at Michigan State University. Of the 10 pressure treatments examined, none were successful in producing tetraploids. Relative survival ranged from <1 to 34% for bluegill exposed to cold shock treatments or pressure shock treatments, respectively.

- Pure stock white, diploid F₁ hybrid and triploid F₁ hybrid crappies (via pressure shock) were produced at the Sam Parr Biological Station by Illinois Natural History Survey (INHS) personnel during spring 1994, with assistance from personnel from Southern Illinois University-Carbondale (SIU-C). Fry were stocked into grow-out ponds at SIU-C.

- White crappie, which survived transport-related mortalities early in the summer of 1993, were placed into two 2-m³ (71-ft³) cages during July 1993 at Pittsburg State University (PSU). Each cage initially contained 2.2 kg (4.9 lb.) of fish/m³. Fish were fed BioDiet at 3% of their body weight divided into twice daily feedings. Feeding behavior was noted and any mortalities counted at feeding time. This trial was terminated November 1993 as water temperatures approached 32°C (90°F) and feeding activity ceased.

- Survival over the 104 d feeding trial was 77% and 81% for each of the two cages. Less than half of the crappie had converted to the artificial diet. Those that did convert exhibited a significant weight increase; mean weights increased from 25.8 g (0.9 oz) to 46.7 g (1.7 oz). These fish were then moved indoors to a closed loop system for further feeding trials and fish density determinations.

- In spring 1994, black, white, and F₁ hybrid crappie 85-100 mm (3.3-3.9 in.) TL were obtained from the INHS Sam Parr Biological Station for the feeding trial at PSU. Because of the long distance between the two locations, significant effort was

1994-95 NCRAC Project Highlights

made to decrease stress. These efforts included: (1) additives, 0.5% NaCl, PolyAqua®, and AmQuel®, (2) supplemental oxygen, and (3) transportation at night.

- Mortalities peaked at different times for the different species, regardless of cage location. Dead fish appeared to be non-feeders. Feeding activity was consistently highest for the black crappie, intermediate for hybrid white crappie, and lowest for white crappie. Black crappie would congregate near the surface at feeding time and splash vigorously as feed was provided.

- In general, crappie have proven to be much less tolerant to handling, more difficult to train for prepared diet acceptance, and more susceptible to disease-related mortalities than have all the *Lepomis* species evaluated in a similar manner. However, black crappie, in general, have survived better and been more easily trained to accept prepared feeds than white crappie, with the hybrid performing intermediately. Also, SIU-C researchers have been unable to develop triploid induction methods for crappie that provide both high survival and high rates of triploidy, unlike the success which was accomplished with *Lepomis* species.

- Research at Purdue University has been focused on establishing the dietary lysine requirement of hybrid bluegill. To date, three separate studies have been conducted in this area using three different experimental diets. Six weeks of feeding,

growth and feed efficiency indicated a dietary lysine requirement of 1.2-1.4% of the dry diet with juvenile fish (approximately 3-5 g [0.11-0.18 oz] initial weight). Using that value, other essential amino acid requirements have been predicted and are available for preliminary diet formulation.

Publications

Bryan, M.D., J.E. Morris, and G.J. Atchison. 1994. Methods for culturing bluegill in the laboratory. *Progressive Fish-Culturist* 56:217-221.

Project: Culture Technology of Salmonids

(Michigan State University, University of Nebraska-Lincoln, Ohio State University, Purdue University, Southern Illinois University-Carbondale, University of Wisconsin-Madison)

Major actions included:

- Triploid all-female fish attained a mean size of 857 g (1.9 lb) by the end of 320 days, compared to 609 g (1.34 lb) and 642 g (1.4 lb) for the mixed-sex diploid and all-female diploid trout, respectively. Further, at 17°C (63°F), the all-female trout showed substantially lowered activity. Temperature affected relative activity levels between the two genetic treatments, however. All-female trout were more active than mixed-sex trout below about 12.7°C (55°F), whereas mixed-sex trout were more active than triploids above 12.7°C (55°F).

- Heat shocks produced 100% triploids in rainbow trout. Only

60% and 80% of the putative triploids were indeed triploids in the chinook and coho tests, respectively, however.

- Survival for diploid and triploid rainbow trout did not differ. Triploid coho salmon and chinook salmon, however, died significantly sooner than their diploid counterparts in stress tests. Triploid coho and chinook have not survived as well as diploids during hauling, but no differences in survival have been seen between diploid and triploid rainbow trout during hauls.

- Researchers at Michigan State University completed collection of chinook and coho salmon feces and feeds from the Platte River Hatchery (Honor, MI) in June 1994. Phosphorus (P) analysis of the samples was completed in late August 1994.

- Researchers at Purdue University completed analyses from the first salmonid project and found that both apparent and true availability of phosphorus from feedstuffs fed to rainbow trout were higher when they received feedstuffs of animal origin (fish meals) than plant protein feedstuffs. Addition of phytase to the diet significantly increased absorption of phosphorus from plant feedstuffs. Phosphorus absorption was not additive, however.

Publications

Riche, M. 1993. Phosphorus absorption coefficients for rainbow trout (*Oncorhynchus mykiss*) fed commercial sources of protein. Master's thesis. Purdue University, West Lafayette, IN.

Project: Culture of Crayfish in the North Central Region

(Kansas State University, University of Minnesota, Purdue University, Southern Illinois University-Carbondale)

Major actions included:

Questionnaires were developed and sent to individuals in the region who grow or harvest crayfish. Fourteen surveys were returned (19.2%), and results from those were tabulated and are summarized below.

Production in the region:

Approximately 6,045 kg (13,300 lb) of crayfish are grown in the North Central Region with gross sales of \$53,500. Species grown were divided among *Orconectes virilis*, *O. immunis*, *O. nais*, and *O. rusticus*. Because of incomplete surveys, it was not possible to specifically divide production among the various species. Personal knowledge of the work group members indicates that these figures are underestimations of total regional production.

Monoculture or polyculture with fish: 71% of respondents indicated they grew crayfish in polyculture situations with fish, while 28.6% indicated monoculture production systems. Most of those who indicated polyculture were growing crayfish in the same systems with fathead minnows (55%). Other combinations included crayfish and: (1) bluegill, red ear, and channel catfish (11%); (2) golden shiner (11%); (3) catfish and fathead minnows (11%); and (4) golden shiners and goldfish (11%). Of those polyculture systems, only 22% of respondents indicated that crayfish were the primary species.

Markets: Of the 14 respondents, 11 (79%) listed their market as hard-shell crayfish for the bait market, 2 listed soft shell bait, 5 listed human food, 1 listed shedding stock for soft shell producers, 5 listed pond stocking, and 1 listed other.

Potential for expansion:

Producers felt that bait markets for both hard and soft crayfish and human markets for hard shells and tail meat offered the best potential for expansion.

Economic return: Respondents felt that tail meat for human consumption and hard shell crayfish for bait offered the best potential for economic return on investment.

Prioritized problem areas:

Crayfish markets and growth rates were the problem areas ranked most important. Choice of species, water quality management, feeds, culture techniques, legal constraints, reproduction, and harvest techniques were problem areas ranked as important. Only the area of diseases was ranked low on the list of priorities.

- Research at Purdue University was designed to evaluate pond culture of native species. Species evaluated in the first year included *Orconectes virilis*, *O. rusticus*, and two distinct populations of *O. immunis* and *Procambarus acutus*. Growth of all four species was similar, ranging from an average of 13-15 g (0.46-0.53 oz) per individual. Yield ranged from a high of 505 kg/ha (450.5 lb/acre) for *O. virilis* to lows of 280 and 290 kg/ha (250 and 259 lb/acre) for the stream population of *O. immunis* and *P. acutus*, respectively. Yield of *O. rusticus* averaged 422 kg/ha (376 lb/acre), and yield of *O.*

immunis, which came from the mine pit lake, averaged 350 kg/ha (312 lb/acre). After harvest in November, all species were restocked to evaluate reproductive ability of one-year-old females. All species produced good-quality eggs in the spring of 1994. In mid-July 1994, three ponds were restocked with small young-of-the-year (YOY) crayfish from other ponds at 3/m² (32/ft²).

- *P. acutus*, *O. virilis*, and *O. immunis* were evaluated in a polyculture situation at Southern Illinois University-Carbondale (SIU-C). Three management strategies were examined. Feeding prepared diets and artificial aeration/destratification was compared with feeding alone during the 1993 growing season. Seining was used for harvest. During the 1994 growing season, feeding and aeration/destratification in ponds left filled over the winter were compared with a production method similar to that employed in the South-- namely, fall-winter draining, planting of a cover crop (winter wheat and wild rice in the spring), spring flooding, and harvest via trapping. The latter water-level management scheme was expected to influence population dynamics in the polyculture crayfish community.

A complete harvest of research ponds was conducted in the fall before both production years. Crayfish YOY were stocked into all ponds in the spring of each production year to supplement natural production. Three replicate ponds for each experimental condition were used in 1993, but replication was increased to four in 1994.

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No significant difference was detected in yield of harvestable-size YOY crayfish between the aerated/destratified ponds and ponds that were not aerated in the 1993 study. However, mean survival, growth rate, and water quality (dissolved oxygen), however, were all significantly better in the aerated/destratified ponds.

Publications

Brown, P.B. 1994. Pond production of crayfish. Workshop on Getting Started in Commercial Aquaculture Raising Crayfish and Yellow Perch, Jasper, IN, October 14-15, 1994.

Project: Status of Bait Industry in the North Central Region

(Iowa State University, Ohio State University, Southern Illinois University-Carbondale, University of Wisconsin-Stevens Point)

Major actions included:

- The many species and sizes used were identified; the most important baitfish was the fathead minnow and nonfish bait was the night crawler. About two-thirds of baitfish were harvested from the wild; the rest were cultured. Nonfish bait was more than 50:50 wild vs cultured. Availability varied seasonally, and shortages were identified. Values of various fish and nonfish baits were estimated: baitfish composed 64%, and nonfish bait, 36%. Bait mortality was a problem for 50% or more of wholesalers and retailers. Better temperature control and handling and

transport would probably reduce mortality.

- The 107 respondents who reported growing baitfish on the 1990 survey of fish growers in the Economics and Marketing Project were resurveyed about their baitfish enterprises, the sales of baitfish, and the costs of producing those baitfish during 1993. From the 10 useable responses, the data provided were not sufficient for detailed budget analysis. Four of 10 reported sales of less than \$10,000 during 1993 while only one reported baitfish sales in excess of \$40,000. Nearly all operations could break even--i.e., cover their reported costs--within the sales class in which they reported.

- The value of the industry was estimated in six state economies (Illinois, Michigan, Minnesota, Ohio, South Dakota, and Wisconsin) For all six combined, the total minimum estimated value in 1992 was about \$165 million for baitfish and \$92 million for nonfish bait.

- A list of rules and regulations affecting the bait industry was assembled for the 12 states in the NCR. Several species of important baitfish that are harvested from the wild were identified for investigation of potential for fish culture. At least one, the emerald shiner, will be studied with funding from another source.

Publications

Brown, G. J. 1994. Cost analysis of trout production in the North Central States. Master's thesis. Ohio State University.
Meronek, T. G. 1994. Status of

the bait industry in the North Central Region of the United States. Master's thesis. University of Wisconsin, Stevens Point.

Project: Characterization of Aquaculture Effluents from Four Types of Production Systems

(Illinois State University, Iowa State University, University of Nebraska-Lincoln, Ohio State University, Purdue University, University of Wisconsin-Milwaukee)

Major actions included: POND PRODUCTION SYSTEM

- **Fairport Fish Hatchery, IA.** Water quality was monitored in four culture ponds stocked with channel catfish (*Ictalurus punctatus*) fingerlings during 1993. During the course of the growing season, water temperature, nitrates, and total suspended solids levels decreased while dissolved oxygen, ammonia, un-ionized ammonia and 5-day carbonaceous (organic) biological oxygen demand (CBOD₅) increased. Analysis of data at harvest revealed that total phosphorus and total solid levels increased substantially in the pond effluents compared with those within the ponds. Toward the latter stages of fish harvest, CBOD₅ levels significantly increased within the ponds; effluent quality significantly deteriorated, with increased levels of total phosphorus, total nitrogen, CBOD₅ total solids, and total suspended solids.

- **Rathbun Hatchery, IA.**

Levels of several nitrogenous and phosphorus compounds at a flow-through aquaculture facility, demonstrated at sites closest to the culture facility, were elevated when compared with levels from sites at the water intake and Chariton River. Invertebrate groups, both zooplankton and macroinvertebrates, did not differ between the upstream and downriver stations. The overall conclusion concerning this data set is that the effects of aquaculture effluents from this hatchery are minimal at best on both chemical and biological factors. High flows resulting from 1993 flood conditions caused increased dilution of aquacultural effluents.

- **Kloubec Fish Farm, IA.**

Two ponds had elevated levels of nitrites, and three ponds had elevated levels of nitrates, when compared with results from earlier sampling periods. CBOD₅ levels, however, decreased in all ponds during the sampling period. The two ponds with the highest levels of CBOD₅ later in the sampling period had been harvested the previous month. The act of seining probably resulted in a direct increase in CBOD₅ levels relative to those ponds that have not been harvested.

RACEWAY PRODUCTION SYSTEMS

- **Sandhills Aquafarms, NE.**

Several water-quality parameters continued to differ consistently above vs below the aquaculture facility, particularly dissolved oxygen, pH, ammonium-nitrogen, total nitrogen,

orthophosphate, and total phosphorus. Total suspended solids and turbidity showed no consistent trends. While temperature and biochemical oxygen demand (BOD) seemed to exhibit relatively little difference above and below the facility (although even these differences were consistent), downstream decreases in dissolved oxygen and pH and increases in ammonium-nitrogen, total nitrogen, total phosphorus, and orthophosphate were evident. These data clearly indicate that water quality was altered downstream from the facility in both 1993 and 1994.

- **Rushing Waters, WI.**

Alterations in water quality occurred in the effluents of the three chains of raceways when compared with the source waters entering at the head of each raceway chain and the water quality of the combined effluent in the creek leaving the property. Increases in BOD, total suspended solids, total ammonia nitrogen, nitrite-nitrogen, soluble reactive phosphorus, and total phosphorus were evident. Under typical production conditions, these changes were slight, but on at least one occasion, raceway cleaning activities created more elevated conditions of total suspended solids and total phosphorus in the creek leaving the property.

The effluents from the earthen production raceways had slightly lowered levels of nitrate-nitrogen than did the source waters. Dissolved oxygen levels in the groundwater well sources tended to be slightly lower than in the effluents from the race-

ways. Use of aerating devices in the rearing units kept dissolved oxygen levels high, and the level in the newly pumped well water probably had not yet had enough contact with the atmosphere to reach full saturation before sampling. Source water samples were taken from an open reservoir rather than from groundwater wells, and water from this reservoir had slightly higher levels of solids, ammonia, and phosphorus than the well-water sources. This difference was slight, however, in comparison with the general differences between the source waters and the effluents.

CAGE CULTURE

PRODUCTION SYSTEMS

- **Trout Culture, OH.** Freshwater Farms of Ohio's trout cage culture operation had no negative impact on the water quality of the quarry lakes or the receiving water of the discharge. In fact, in most cases, significant improvement occurred because of the diluting effect of the quarry discharges.

- **Channel Catfish Culture, OH.** The impact of the small-scale cage catfish cage culture operation at Piketon Research Center-Ohio State University is not easily characterized because of the input from the Center's wastewater treatment plant. Still, most water quality parameters were typical of catfish production ponds.

RECYCLING SYSTEMS

- Illinois State University reports that a complete analysis has been conducted on the effluent from a second commercial-scale recirculating system.

Aquaculture Activities

February

February 16-17

Wisconsin Aquaculture Association Aquaculture
Conference in Wausau, WI

Contact: Theresa

(608) 224-5137, FAX (608) 224-5110

February 23-24

Catfish Farmers of America Annual Meeting
Opryland Hotel, Nashville, TN

Contact: Catfish Farmers of America office

Phone: (601) 887-2699

March

March 4-5

Smoked Seafood Conference, Seattle, Washington

Contact: Smoked Seafood Conference '96

2743 56th Ave. SW

Seattle WA 98116

Fax (206) 933-7937

March 8-9

10th Annual Minnesota Aquaculture
Conference & Trade Show in Alexandria, MN

Contact: Larry Belusz

(800) 253-9884 Ext. 4566, FAX: (612) 762-4501

March 12-14

International Boston Seafood Show

Hynes Convention Center, Boston, Massachusetts

For information: Diversified Expositions

P.O. Box 7437

Portland, Maine 04112-7437

Phone (207) 772-3005, Fax (207) 772-5059

March 22-24

Fish Canada '96

Maritime Coliseum/ Arena Complex, Moneton
New Brunswick Canada

For information: Denex Group Inc.

192 Joseph Zatzman Dr., Unit 13

Darmouth, NB, B3B 1N4, Canada

Phone: (902) 468-4999, Fax (902) 468-2795

July

July 19-21

Successes and Failures in Commercial
Recirculating Aquaculture

Contact: Conference Registration Office

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NCRAC Journal is printed

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