Waterlines

WESTERN REGIONAL AQUACULTURE CENTER

2012
ANNUAL REPORT

Alaska • Arizona • California • Colorado • Idaho • Montana • Nevada • New Mexico • Oregon • Utah • Washington • Wyoming

We are pleased to present this revised and enhanced version of *Waterlines.*

We retain the usual features of our annual newsletter, and beginning with this issue, *Waterlines* will also serve as our annual accomplishment report to USDA/NIFA. It includes summaries of the activities and impacts of all research and outreach projects funded by WRAC for the time period of September 1, 2011 through August 31, 2012.

Photo: Mike Rust/NOAA

USDA

United States Department of Agriculture
National Institute of Food and Agriculture

in this issue

Photo: Tom Grundy/photos.com

WHY AQUACULTURE IN THE UNITED STATES?

- 84% of the seafood consumed in the United States is imported, raising concerns about safety and quality, and contributing to the largest trade deficit of any agricultural commodity.
- More than 70% of this imported seafood is produced by aquaculture.
- Capture fisheries are fully exploited and cannot satisfy the increased consumer demand based on the growing recognition of the importance of nutritious seafood in a healthy diet.
- Aquaculture contributes significantly to rural inland and coastal local economies with much shorter delivery distances.
- US aquaculture production is only about $1.2 billion annually, compared to world aquaculture production, which is $100 billion annually.

WHAT IS THE WESTERN REGIONAL AQUACULTURE CENTER (WRAC)?

Designated as one of five regional aquaculture centers under USDA/NIFA (US Department of Agriculture/National Institute of Food & Agriculture), WRAC serves the 12 states in the western region of the United States—Alaska, Arizona, California, Colorado, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming.

Mission

To support aquaculture research, development, demonstration, and education to enhance viable and profitable US aquaculture production for the benefit of consumers, producers, service industries, and the American economy.

Unique Features

Industry-driven: Seeks industry input to address priority needs of growers; focuses on applied projects and disseminating new knowledge and best practices for maximum impact.

Rigorous science: Shares expertise and facilities within the region to accelerate scientific problem solving, thereby optimizing resource efficiencies and avoiding duplication of effort.

Collaborations: Leverages in-kind and monetary contributions from partners; integrates research, extension, and industry efforts to support productivity, new jobs, and businesses.

How does WRACwork?

With broad representation throughout the western region, WRAC's governance groups include:

Board of Directors: primary policy-making body for WRAC. The Board reviews projects recommended for funding and authorizes inclusion into the annual Work Plan submitted to USDA.

Industry Advisory Council (IAC): composed of representatives from the industry and associated services within the 12 western states.

Technical Committee (TC): composed of two subcommittees:

- The Research Subcommittee includes representatives from participating research institutions, state or territorial public agencies as appropriate, and nonprofit, private institutions.
- The Extension Subcommittee includes representatives from state Extension Services—both Land Grant and Sea Grant.

The IAC and TC work jointly to make recommendations to the Board of Directors regarding new and continuing regional projects, project modifications, and project terminations.

ACKNOWLEDGMENTS

WRAC gratefully acknowledges the contributions of the many Principal Investigators and Participating Scientists involved in all research and outreach projects. We particularly appreciate the assistance of the chairs of our Board, IAC, and TC, and those serving as Project Monitors.

We also thank the scientists and aquaculturists from across the country who contributed their expertise and valuable time to review WRAC project proposals and publications. Without their help, it would be impossible to maintain the high quality of this program.

Additionally, we thank the College of the Environment and the School of Aquatic and Fishery Sciences at the University of Washington for serving as the Host Institution for WRAC.

Photos, clockwise from top: Ron Hardy, Courtesy of K. Fitzsimmons, Wendy Sealey, Courtesy of Alaska Sea Grant, Courtesy of M.Fritz



WRAC Project Highlights

September 1, 2011–August 31, 2012

Full annual reports available at:
http://depts.washington.edu/wracuw/research/current_research.html

1 Optimizing Dietary Protein and Energy Utilization to Improve Production Efficiency of Tilapia in the Western United States

Annual Progress Report (project start date & duration: 2010, 3 years)

PRINCIPAL INVESTIGATORS: Wendy Sealey, *US Fish and Wildlife Service (USFWS), Bozeman Fish Technology Center*; Rick Barrows, *USDA, Agricultural Research Service (ARS) Trout Grains Project*; Kevin Fitzsimmons, *University of Arizona*

Outreach Representative: Gary Fornshell, *University of Idaho Extension*

Industry Advisor: Tark Rush, *Desert Springs Tilapia*

Project Monitor: Chhorn Lim, *USDA ARS Aquatic Animal Health Research Unit*

ISSUE: Tilapia is the second most-consumed farmed fish after carp and the most widely grown of any farmed fish. In pond culture, natural feed organisms account for 30–50% of overall growth of tilapia; therefore, many current diet formulations developed for pond culture may not maximize growth and health of intensively reared tilapia.

RESPONSE: The long-term goal is to optimize commercial tilapia diet formulations for the intensive culture systems within the western United States. This goal involves: 1) identifying the optimum dietary protein-to-energy ratios in practical diets for two different size classes and species of tilapia, and 2) evaluating the ability of vitamin supplementation to improve growth performance at different protein-to-energy ratios, and 3) evaluating potential formulations to pilot-scale on-farm trials.

RESULTS: Our results demonstrate that in the absence of natural food, higher levels of dietary protein and lipids are required for maximizing growth of juvenile tilapia; however, these results were not recapitulated in larger fish.

IMPACTS & POTENTIAL IMPACTS: Using these data, farmers can choose the best diets to maximize growth in juvenile fish and reduce cost/gain during grow-out of large tilapia.

Photos: Courtesy of Wendy Sealey



2 Cost-effective, Alternative Protein Diets for Rainbow Trout that Support Optimal Growth, Health, and Product Quality

Annual Progress Report (project start date & duration: 2010, 3 years)

PRINCIPAL INVESTIGATORS: Wendy Sealey, *USFWS, Bozeman Fish Technology Center;* Rick Barrows, *USDA/ARS-Hagerman Fish Culture Experiment Station;* Chris Myrick, *Colorado State University;* Gibson Gaylord, *USFWS, Bozeman Fish Technology Center;* Carolyn Ross, *Washington State University*

Outreach Representative: Gary Fornshell, *University of Idaho Extension*

Industry Advisor: David Brock, *Rangen, Inc.*

Project Monitor: Chris Nelson, *Nelson and Sons, Inc.*

ISSUE: Raising fish in the farm environment requires continuous feeding with minimal environmental impact. As growers work to develop feed formulations with protein sources that rely minimally on capture fish, it is critical to evaluate the quality of the various feed formulations as they impact growth and quality of the fish.

RESPONSE: The long-term goal is to develop diet formulations that use alternative ingredients and are cost-effective, while maintaining growth, health, and quality. This project will: 1) identify commercially available alternative ingredient combinations that meet production needs, 2) further refine amino acid balance as a means of reducing interactive growth depressions when novel combinations of ingredients are used, and 3) compare formulations for growth, fish health, product quality, and consumer acceptance.

RESULTS: Combinations of alternative ingredients that support growth and health in trout diets were evaluated in laboratory and on-farm trials. Study results have been compiled into a database, "Nutrient Digestibility of Fish Feed Ingredients." Two ingredient combinations without fishmeal, one based on plant proteins and one using terrestrial animal proteins, were able to support excellent trout growth efficiency, fish health, and product quality while reducing total dietary protein levels from 45% to 40%.

IMPACTS: The data generated can be used by researchers to improve study designs for assessing performance of alternative ingredients. Adoption of these procedures for formulation of commercial trout diets can reduce total dietary protein levels while utilizing more sustainable and cost-effective ingredients, and thereby improve sustainability of the aquaculture industry.

—WRAC Project Highlights continued on page 6

Photos: Courtesy of Wendy Sealey

3 Optimizing the Larval Nutrition of Marine Finfish Aquaculture Species Along the West Coast

Annual Progress Report (project start date & duration: 2011, 3 years)

PRINCIPAL INVESTIGATORS: Mark Drawbridge, *Hubbs-SeaWorld Research Institute*; Michael Rust, *NOAA Fisheries, Northwest Fisheries Science Center*; Chris Langdon, *Oregon State University*; Rick Barrows, *USDA/ARS-Hagerman Fish Culture Experiment Station*

Outreach Representative: Fred Conte, *University of California Davis*

Industry Advisor: Jim Parsons, *TroutLodge*

Project Monitor: Ken Cain, *University of Idaho*

ISSUE: Extensive capture fisheries closures, a large national seafood trade deficit, and heightened awareness of food security provide a strong impetus for the western states to develop sustainable marine finfish aquaculture. Because marine fish larvae are typically challenging to rear, the larval phase of culture is widely recognized as key to viable commercial production of marine finfish.

RESPONSE: The goal of this project is to develop nutritional approaches that enhance the performance, survival, and quality of larval marine fish in culture. Researchers are focusing on two marine finfish species with excellent commercial aquaculture potential: white seabass and California yellowtail. Once the larvae consume the yolk sac a few days after hatching, they are fed rotifers or brine shrimp, which are relatively easy to mass-produce and which can be nutritionally enriched. After this live-feeds phase that lasts several weeks, the fish are weaned onto an artificial feed or microdiet. Initial studies on live feeds have sought to: 1) optimize the timing of transition from one zooplankton type to another based on prey selectivity, 2) improve understanding of the consumption rate of live feeds, and 3) examine the effects of various feeding and enrichment regimes on larval performance. The researchers have also compared custom-formulated microdiets with commercial feeds to begin the process of customizing microdiets for each species.

RESULTS: Researchers have confirmed the utility of inert "markers" as an investigative tool for studying feeding behavior of larvae. Results have led to modified feeding strategies for live feeds, including a switch to a different commercial enrichment formulation that yields significantly improved growth and quality. Also, by incorporating certain chemical compounds or "attractants" into the microdiets, researchers have increased feeding incidence of the larvae at an early age. This, coupled with development of an open formulation microdiet that performs on par with the top commercial diet, holds great promise for development of new and improved custom diets.

IMPACTS: The results of this work and the associated methodologies are expected to be partially or fully transferable to the culture of other marine and freshwater species throughout the United States.

Photos: Courtesy of Mark Drawbridge

4 Environmental and Endogenous Factors Affecting Egg Quality and Caviar Yield in Farmed Sturgeon

Annual Progress Report (project start date & duration: 2011, 4 years)

PRINCIPAL INVESTIGATORS: Serge Doroshov, Bernard May, Ermias Kebreab, *University of California Davis*; Barbara Rasco, *Washington State University*; Molly Webb, Chris Guy, *USFWS, Montana State University*; Terry Patterson, *College of Southern Idaho*

Outreach Representative: Fred Conte, *University of California Davis*

Industry Advisors: Peter Struffenegger, *Sterling Caviar*; Ken Beer, *The Fishery*; Linda Lemmon, *Blind Canyon Aqua Ranch*; Leo Ray, *Fish Breeders of Idaho*

Project Monitor: Jason Mann, *EWOS Canada*

ISSUE: Sturgeon farming in the western region is a thriving and growing industry. Because both the quality and yield of caviar are key factors in the continued economic viability of this industry, it is important to evaluate the elements that impact these key factors.

RESPONSE: The goal is to improve the yield and quality of caviar produced on sturgeon farms in the western region. Researchers, in collaboration with farms in California and Idaho, are conducting feeding trials to determine the effects of high- and low-energy diets on: 1) roe yield and caviar quality, 2) energy partitioning and deposition of fat and protein in the ovary of pre-pubertal fish, 3) chemical and sensory properties of the caviar, 4) crude chemical composition and adiposity of the ovary, and 5) ovarian adiposity and roe yield.

RESULTS: Feeding trials with maturing females have been conducted at two farms in California (Sterling Caviar, The Fishery) and one in Idaho (Fish Breeders of Idaho). Caviar has been harvested from seven-year-old females, and samples were collected for genetic analyses, proximate analysis of the ovary tissue and screened eggs, and sensory evaluation of the caviar. Monthly sampling of pre-pubertal fish began at age 18 months for energy partitioning and will continue through age 30 months. Sampling of one-year-old pre-pubertal fish for the effects of dietary energy on accumulation of ovarian fat in early development was completed and samples are being processed.

IMPACTS: Based on the outcome of this project, the industry may be able to develop an appropriate dietary regime for caviar-producing sturgeon and a broodstock mating plan to reduce ovarian adiposity, which will allow sturgeon farms to improve production and quality of caviar and to compete successfully on the national and world markets.

Photos, left to right: Joel P. Van Eenennaam, Courtesy of Barbara Rasco, Joel P. Van Eenennaam; Caviar box inset: Courtesy of Molly Webb

WRAC Out-of-Cycle* Project Highlights

September 1, 2011–August 31, 2012

Global Analysis of Eelgrass (*Zostera marina*) Standing Stock and Yield

Termination Report (project start date & duration: 2011, 1 year)

PRINCIPAL INVESTIGATORS: Jennifer Ruesink, Micah Horwith, S. Alexandra Hart, *University of Washington*

ISSUE: The current uncertainty surrounding regulatory action on eelgrass management has the potential to dramatically decrease shellfish aquaculture production on the West Coast. WRAC previously supported research on the impacts of shellfish culture operations on estuarine systems, including eelgrass, and has recently expanded that interest to include introduced Japanese eelgrass.

RESPONSE: To help clarify the issue, this project examined eelgrass (*Zostera marina*) biomass research findings from around the world to provide a point of reference for future regulatory policy.

RESULTS: While the study demonstrated that in the published literature, eelgrass biomass around the world is highly variable geographically and seasonally, an encouraging finding for West Coast shellfish aquaculture is that *Z. marina* populations measured in the eastern Pacific (West Coast) reached higher biomass on a per-area and per-shoot basis than in the eastern or western Atlantic, and shoots also had higher production-per-biomass ratios.

IMPACTS & POTENTIAL IMPACTS: The results of the project will be published and distributed to managers, regulators, and growers. This information will improve the understanding of eelgrass dynamics for managers and industry, thus impacting regulatory policy decisions.

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* Out-of-cycle projects are designed to address immediate research needs or opportunities that arise outside the regular funding cycle.

Photos, left to right: Alan Trimble, Charles "Si" Simenstad

Aquarius 3.0

Annual Progress Report (project start date & duration: 2011, 3 years)

PRINCIPAL INVESTIGATORS: Fred Conte, *University of California Davis*; Gregg Langlois, *California Department of Public Health*; Dan Cheney, *Pacific Shellfish Institute*; Teri King, *University of Washington*

ISSUE: State health departments are responsible for overseeing shellfish harvests to ensure that shellfish are safe for human consumption. When rainfall washes fecal coliform into shellfish growing areas, shellfish harvesting often ceases, which results in loss of revenue.

RESPONSE: A new sanitation model and software (*Aquarius 2.0*) was developed to process rainfall and fecal coliform data and adjust harvest closure rules. *Aquarius 3.0* adds a second model (Pearl) and a unique tidal component, all designed to evaluate and manage growing areas and provide more sensitive and accurate analyses of sanitation conditions in shellfish production bays. It incorporates a feedback loop between the models that allow analysis, adjustment of rainfall closure rules, then re-analysis of the data to evaluate the safety of such adjustments.

IMPACTS & POTENTIAL IMPACTS: The models rapidly handle massive datasets and associated calculations with precision that provides time-saving advantages to the commercial industry and public health agencies. The innovative concepts associated with the programs will provide increased consumer safety and a greater confidence in the products of the shellfish industry. Using *Aquarius 3.0* to analyze the variables of rainfall volume, fecal coliform, and tidal activity, the number of hours/days that growers will have to shut down their oyster operations can potentially be reduced resulting in increased profits.

Photos, left to right: filipe varela/photos.com, Yovonne Autrey-Schell/photos.com

In The Press & At The Podium

from FY2012 WRAC-funded projects that are featured on pages 4–9

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Ruesink J, Fitzpatrick J, Dumbauld B, Hacker S, Trimble A, Wagner E, and Wisehart L. 2012. Life history and morphological shifts in an intertidal seagrass following multiple disturbances. *Journal of Experimental Marine Biology and Ecology*. 424:25–31.

PRESENTATIONS

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Conte F and Ahmadi A. "Sanitation models Aquarius v2.0, planning for Aquarius 3.0, and an introduction to a new sanitation model, Pearl," Washington Shellfish Growers Conference, Union, WA. March 2012.

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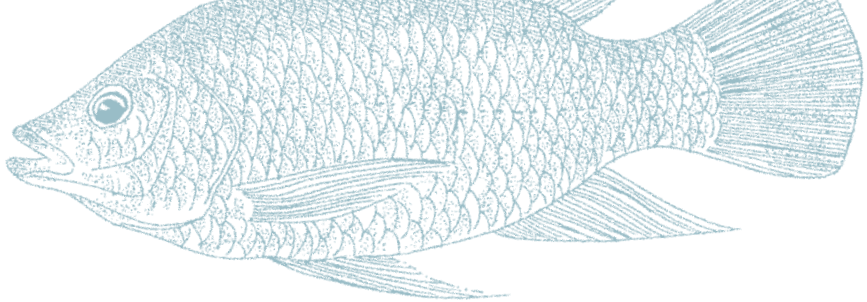
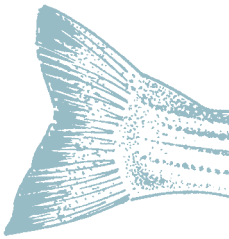
Gaylord G, Sealey W, and Barrows F. "Evaluation of ingredient combinations from differing origins (fishmeal, terrestrial animal protein and plants) and two different formulated nutrient targets on rainbow trout growth and production efficiency," U.S. Aquaculture America, Las Vegas, NV, Feb 2012.





Gille D, Schreier D, May B. "Identification of quantitative trait loci associated with caviar yield and ovarian adiposity in white sturgeon *Acipenser transmontanus*," Plant and Animal Genome XX, San Diego, CA, Jan 2012.

Hooley C, Barrows F, Paterson J, and Sealey W. "Examination of the effects of dietary protein and lipid levels on growth and stress tolerance of tilapia *Oreochromis niloticus*," Fish Feed Nutrition Workshop, Pine Bluff, AR, Sept 2011.

Hooley C, Barrows F, Paterson J, and Sealey W. "Examination of the effects of dietary protein and lipid levels on growth and stress tolerance of tilapia *Oreochromis niloticus*," US Aquaculture America, Las Vegas, NV, Feb 2012. (USAS Abstract Award: Spotlight Award Competition).

Hooley C, Rosentrater K, Gaylord G, Barrows F, and Sealey W. "Examination of the effect of a mycotoxin deactivation product to improve growth and nutrient utilization in juvenile rainbow trout *Oncorhynchus mykiss* fed high protein distiller's dried grains," Fish Feed Nutrition Workshop, Pine Bluff, AR, Sept 2011.

Hooley C, Rosentrater K, Gaylord G, Barrows F, and Sealey W. "Examination of the effect of a mycotoxin deactivation product to improve growth and nutrient utilization in juvenile rainbow trout *Oncorhynchus mykiss* fed high protein distiller's dried grains," U.S. Aquaculture America, Las Vegas, NV, Feb 2012.

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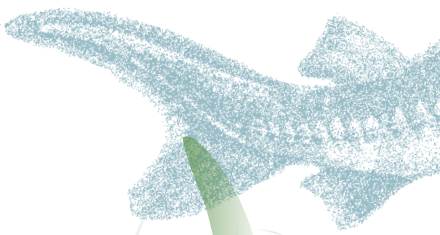
Sealey W, Gaylord G, Barrows F, Ross C, Myrick C, and Fornshell G. "Alternative protein research in rainbow trout," U.S. Trout Farmers Association Meeting, Twin Falls, ID, Sept 2011.

GRADUATE THESIS

Hooley C. Examination of the effects of dietary protein and lipid on growth and stress response of Nile tilapia cultured in high intensity systems. Montana State University, Bozeman, MT.



Interview *with* Steve Harbell

> "After a long career with Washington State University Extension and the University of Washington Sea Grant Program, it's great for me to look back on how the aquaculture industry has evolved over that period of time."

Photos: Courtesy of Steve Harbell

Steve Harbell, retired Washington State University (WSU) Cooperative Extension Agent for Grays Harbor County, Washington, looks back on his 30-year career and involvement with aquaculture. Steve, a member of WRAC's Board of Directors, Extension Subcommittee, and Strategic Planning Committee, has served as Chair of the Extension Subcommittee, Chair of the Executive Committee, Chair of the Long-Term Impacts Ad-Hoc Committee, and Chair of the Editorial Committee. His contributions to WRAC have been invaluable. He is currently working part-time with Washington Sea Grant teaching Marine Vessel Safety Training for the commercial fishing industry and Seafood Handling and Safety for retail food store meat-cutters in Washington State. We look forward to his continued involvement with WRAC.

Please tell us a bit about your background, your early career choices, and how you got your start in marine science and aquaculture.

I've always had a strong interest in the natural sciences and might have pursued a career in a number of different fields, but chose to focus on fisheries in my undergraduate degree at the University of California Davis. Then, during graduate school at the University of Washington College of Fisheries, I studied fisheries pathology. This was a great way to combine various natural science disciplines, including microbiology. What could be better? I worked on defining the pathogenesis of the bacterial disease Vibriosis, which was threatening the development of the salmon net pen industry in Washington at the time. Fortunately, I had the opportunity to work at the National Marine Fisheries Service Montlake Lab and Manchester Field Station, which really piqued my interest and experience in aquaculture.

Following graduate school, I was interested in other aspects of aquaculture, so I joined the US Peace Corps as a fisheries pathologist at Central Luzon State University in the Philippines and worked on developing the tilapia and carp freshwater aquaculture industry. What a contrast to the salmon and trout culture systems in the Northwest.

This also introduced me to some of the fundamentals of outreach that I would use later in my career. In 1978, I accepted my first position with Washington State University as an aquaculture Extension agent in Kitsap County, where the salmon net pen industry was continuing to develop. Shortly afterward, I moved to the coast of Washington for a joint Extension position with WSU and Washington Sea Grant to work with a variety of marine industries including shellfish aquaculture.

Can you tell us about the early days of WRAC?

In the late 1980s, the US Department of Agriculture developed the regional aquaculture program, including the new Western Regional Aquaculture Consortium, and I participated in its first development meeting in Seattle. This regional program was a great opportunity to strengthen our research and outreach aquaculture efforts in Washington. Through a long and determined process, the organization developed, eventually adding the remaining seven western states to the original five.

A great deal of credit should be given to both those in the university community and in the aquaculture industry who made this possible. It was not easy and not without a few bumps in the road.

What WRAC projects and activities are you most proud of?

I feel that WRAC has been extremely effective over the years because of its focus on industry priority issues, and because of the cooperation of everyone in the organization. For me, I'm most pleased with the integration of research, extension, and industry participation in WRAC projects that provides for strong science, effective outreach, and great application potential for project results. As we more carefully evaluate the organization's impacts, it's clear that the return on investment for WRAC projects has been tremendous.

My involvement in the organization has greatly strengthened my working relationship with researchers, Extension staff, and aquaculture industry members throughout the West, improving my ability to provide high-level technical assistance to clientele here in Washington. In my own area on the coast of Washington, WRAC shellfish projects have been critical in maintaining a high level of production in the face of significant challenges.

How would you compare WRAC aquaculture research when you were just starting out with current research?

Over its 25-year history, WRAC's organizational structure and policies have been refined and strengthened, matching the unique needs of the western region. Our research and outreach projects are more targeted, with greater potential for industry impact. The proposal review process has become more thorough and competitive, while maintaining the flexibility to consider new ideas and immediate industry needs.

So how does our vision of aquaculture 40 years ago compare with what really happened over the years?

Although the salmon culture industry did not develop as we expected in the Northwest, our shellfish and trout industries have flourished, and in the western region, new species like white sturgeon and tilapia have grown tremendously. We also have new opportunities in marine fish culture, and improved genetics, nutrition, and culture techniques for traditional species.

What plans do you have for your future?

My current part-time position with Washington Sea Grant gives me the chance to continue my work with marine industries on the Washington coast, and also spend more time with my family, and doing the fun things in life. It's clear that WRAC is well-positioned to continue its important support for the aquaculture industry in the western region for years to come.

Spotlights *on the* West

A Tribute to Chris Nelson

—Ron Hardy

Nelson & Sons operated as a family business in Murray, Utah, for three generations until it was purchased in 2008 by Skretting, an international fish feed manufacturing company based in the Netherlands.

For the past 20 years, Nelson & Sons was run by three cousins—Chris, Richard, and Dana Nelson. The company was a dominant force in fish feed development, supplying trout feed and specialty feeds to industry and to state and federal hatcheries throughout the western states.

After several years of transition from Nelson & Sons to Skretting USA, Chris and Richard retired in 2012. Skretting USA hosted a dinner during the Aquaculture America Conference in Las Vegas in 2012 to honor Chris, Richard, and Dana for their many contributions to the aquaculture industry.

During the cousins' tenure, Nelson & Sons worked with the fish nutrition research community, regularly supplying small batches of feed ingredients and experimental feeds to scientists. They also supported professional fisheries and aquaculture organizations, providing financial assistance for meetings and serving on committees and boards.

Chris served on WRAC committees for two long periods, starting in the early 1990s and again in the early 2000s as a member of the Industry Advisory Council. In this capacity, he demonstrated his knowledge and leadership, earning the respect of his industry colleagues and of researchers and extension members.

Chris was always a positive force within WRAC, particularly in ensuring that research projects were well grounded with respect to their potential contributions to the industry. He was particularly skillful at presenting a coherent summation of various points of view and a clear path forward to lead committees to a consensus and productive outcomes.

WRAC was very fortunate that Chris was willing to donate his time to committee meetings and other WRAC activities, and his presence will be greatly missed by his colleagues and friends. Now, Chris will devote his time to family, travel, and especially to improving his golf game, which was already quite good.

Richard, Dana, and Chris (right) Nelson at the Aquaculture America Conference, where they were honored for their many contributions to the aquaculture industry.

Photos: left: Ron Hardy; background spotlights: L_amica/photos.com

Updated website in the works

WRAC staff is working on the website to give it a new, invigorated look, facilitating easy sharing of aquaculture information. Look for it Fall 2013 at:

http://depts.washington.edu/wracuw

Ray RaLonde wins award from Sea Grant program

Ray RaLonde, WRAC Board of Directors Representative from Alaska, received the "Superior Outreach Award" from the national Sea Grant program at a conference in Alaska in September 2012. The award was given in recognition of his outstanding leadership, teamwork, and accomplishment by Sea Grant Extension personnel.

Ray, Alaska Sea Grant Marine Advisory Aquaculture Specialist, received the award for his career-long pursuit of safe subsistence and personal use harvest of shellfish in Alaska and for his tireless devotion to diversifying through aquaculture the economies of isolated coastal communities in Southcentral and Southeast Alaska.

Ray RaLonde, with his wife Izzy, receiving the Superior Outreach Award from the National Sea Grant Program In September 2012.

Photos: Debbie Granger above; in web image: Mike Rust/NOAA

Long-term Impacts *of* WRAC Research & Outreach

Complete article was printed in March 2013 and is available at: *http://depts.washington.edu/wracuw*

AUTHOR: Steve Harbell, *University of Washington*
CONTRIBUTORS: Gary Fornshell, *University of Idaho*; Debbie Granger, *University of Washington*; Ron Hardy, *University of Idaho*; Ray RaLonde, *University of Alaska*; John Sherwood, *Montana State University*

ISSUE

In the early 1990s, nutrients in aquaculture effluent waters came under increasing regulatory scrutiny because of their role in stimulating unwanted algal and aquatic plant growth in public waterways. As a result, a number of states developed regulations to restrict the amount of phosphorus, nitrogen, and fecal solids allowed in the discharge water of freshwater fish culture facilities. At the time, these regulations threatened to dramatically reduce production by the trout industry.

WHAT HAS BEEN DONE

Because phosphorus is the nutrient with the greatest impact on algae and plant growth in freshwater, WRAC funded two research projects that focused on determining ways to reduce phosphorus levels in hatchery discharge water.

1. Pollutant reduction in salmonid aquaculture by diet modification (1993–1996)

Principal Investigators: R. Barrows, F. Dong, G. Fornshell, N. Haard, R. Hardy, W. Lellis

The initial three-year research and outreach project developed and evaluated feeds for juvenile, grower, and broodstock salmonids. The goal of the study was to reduce levels of enriching nutrients, mainly phosphorus, in the effluent water of fish production facilities. Because feeds are the source of phosphorus in fish production systems, emphasis was placed on reducing total phosphorus levels in feeds, determining dietary phosphorus requirements of salmonids at various life stages, and ensuring that levels of available phosphorus in feeds were sufficient to meet the nutritional needs of the fish.

In the first phase of the project, strategies for reducing the level and/or increasing the bioavailability of phosphorus in key feed ingredients were developed and tested. In the second phase, the dietary requirement for phosphorus at various life history stages was examined.

2. Development of economical, high-performance, low-polluting feeds and feeding strategies (1997–2001)

Principal Investigators: F. Dong, R. Hardy, R. Barrows, S. Chen, D. Brock, G. Fornshell, N. Haar

A second project focused on further development of economical, high-performance, low-polluting feeds and feeding strategies. The study included additional efforts to reduce phosphorus discharge levels in aquaculture facility effluents.

In vitro methods to estimate phosphorus bioavailability and protein digestibility for a number of common feed ingredients were developed and values were measured. The *in vitro* methods

Photo: Richard Gunnion/photos.com

were developed because they are faster and less expensive than *in vivo* methods, which require fish feeding trials and laborious chemical analyses. The effects of particle size on nutrient digestibility were investigated because ingredient particle size is an important factor in fish feed manufacture: the smaller the particle size, the higher the energy consumption for grinding and sieving the feed material. For growers, the higher the feed digestibility, the better the feed utilization efficiency and the lower the cost of production. From an environmental perspective, higher feed utilization efficiency results in less waste excretion and lower pollution potential. Thus, finding the optimum balance between ingredient particle size and feed digestibility and utilization is an important aspect of producing economical and environmentally friendly feeds. Determining the optimal grinding size contributes to reducing the effluent load, reducing feed production costs, and maintaining better feed conversion.

RESULTS

- Phosphorus levels in feeds can be reduced for grow-out rainbow trout without affecting weight gain or product quality.
- Supplementing feeds with citric acid to reduce phosphorus pollution is effective provided that total dietary phosphorus is lowered at the same time.
- Determining the bioavailability of phosphorus in key feed ingredients allows feed manufacturers to modify standard diets to achieve lower phosphorus discharge rates and feed costs.
- Higher feed utilization efficiency results in lower costs for producers and decreased waste excretion and pollution potential.
- Farm-scale testing validates the effects of dietary changes on production efficiency and the economics of production.
- Sensitive and rapid indicators for dietary deficiency of phosphorus are necessary to determine the minimum dietary requirement level of phosphorus for large, commercial-size fish.

—continued on page 18

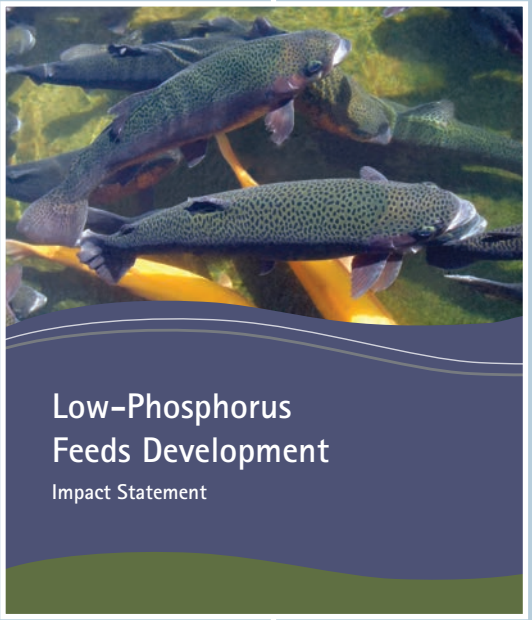


Photo:Richard Gunion/photos.com

IMPACT HIGHLIGHTS

- Prevented a 20% loss in trout production.
- Allowed higher production levels worth more than $6 million/year in Idaho alone.
- Permitted efficient low environmental-impact trout production by reducing phosphorus levels in feed by nearly 40% without affecting growth of fish or product quality.

- These studies developed standards for feed ingredient grinding to optimize feed utilization and nutrient digestibility while maintaining sufficient particle size to allow indigestible material to be recovered and removed from fish farm effluent water.
- Information on the calcium and ash concentrations of feed ingredients and apparent digestibility of phosphorus provides a relatively easy way for the feed industry to avoid using feed ingredients that increase phosphorus pollution.
- Information from the studies on apparent dry matter, protein, and mineral digestibility coefficients in common aquatic feed ingredients is widely used by feed manufacturers.
- A new method of assessing the dietary phosphorus requirement of rainbow trout that shortens the time required to evaluate the phosphorus availability of feeds and feed ingredients by 75% was developed and validated.

INDUSTRY PERSPECTIVE (excerpts)

Chris Nelson, ***Silvercup Feeds***
Because of this research in the mid 1990s, we were able to start producing low-phosphorus feeds (less than 0.8% phosphorus) with no fish health concerns for commercial, state, and federal fish hatcheries in Arizona, Idaho, Michigan, and Vermont, where EPA or other agencies had put stringent requirements on phosphorus discharge. This research also led to further research with extruded nutrient dense diets that dramatically improved feed conversion rate and thereby reduced phosphorus effluent even more.

Randy MacMillan, ***Clear Springs Foods***
These projects provided fundamental insight into how we might reduce our total phosphorus environmental footprint. The impact of calcium and citric acid in this regard was very helpful. The studies helped lead to the development of high-energy, nutrient dense feeds, which are now the standard in the industry. The economic impact of high-energy nutrient dense feeds is significant both in terms of improved feed conversion and reduced phosphorus discharge.

Leo Ray, ***Fish Processors of Idaho***
The phosphorus input reductions made possible by new low-phosphorus feeds from the WRAC projects enabled us to continue to maintain annual production of 1,500,000 pounds, rather than having to reduce that production by 20% in order to meet the phosphorus limits set by EPA.

David Brock, ***Rangen Feeds***
The projects provided some much-needed baseline information on the nutritional physiology of phosphorus in salmonids. The quality of the research was exceptional and it provided the field nutritionist with solid data on which to base our formulation decisions. It influenced some of our purchasing decisions as well.

This project provided a springboard for research into nutrient dense feeds. Had we not had the good phosphorus data resulting from this project, nutrient dense feeds had the potential to ruin a lot of fish.

As good quality water becomes scarce, this project will continue to pay dividends for the industry.

STUDENTS SUPPORTED

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Denise Skonberg, *University of Washington*
Leon Yogev, *University of Washington*
Shozo Sugiura, *University of Washington and University of Idaho*
V. Weerasinghe, *University of California Davis*

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