

## EPSCoR in Idaho:

FISH PHYSIOLOGY AND GENOMICS, DR. RONALD W. HARDY, TEAM LEADER.



EPSCoR Grand Challenge II — Fish Physiology and Genomics Group, Summer 2007.

The Experimental Program to Stimulate Competitive Research (EPSCoR) is a federal-state partnership whose objective is to stimulate research and development in states that traditionally have received less federal funds, such as Idaho. Idaho is currently making use of this opportunity in several research areas of strategic importance, such as fish physiology, genetics, hydrology and others. (More information on specific research areas and team objectives is available on the UI EPSCoR web site <http://www.webs.uidaho.edu/epscor/>).

The Fish Physiology and Genomics team, led by Dr. Ronald W. Hardy (Hagerman Fish Culture Experiment Station), plays an important role in the generation and discovery of new knowledge in the fields of adaption and growth when fish are

exposed to different conditions (e.g. varying carbohydrate levels, lipid profiles and photoperiods). This as an integral part of our goals to understand how nutrients flux across complex landscapes and different trophic levels. To accomplish these goals, the physiology team studies the mechanisms of energy partition with more influence in adaptation processes and how these processes evolve at the cellular and molecular levels. The research questions are:

- (1) How are structural lipids, energy pathways, and signaling lipids regulated in response to energy intake, photoperiod, and maturation?
- (2) Which genes are central to regulatory processes?
- (3) What links and pathways exist between environment, endocrine regulation, and nutrient partitioning?

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## Aquaculture Research Institute

The ARI newsletter will be produced semi-annually and available online in Adobe Acrobat format through [www.webs.uidaho.edu/aquaculture/](http://www.webs.uidaho.edu/aquaculture/). If you would like to be notified via email when the latest edition is available on our web page, please notify the editor at [aqua@uidaho.edu](mailto:aqua@uidaho.edu).

We would be happy to include appropriate contributions from those of you working in the field! Feedback and suggestions on how to improve this newsletter would also be appreciated.

This issue of the newsletter highlights various projects being conducted on the Moscow campus, the Hagerman Fish Experiment Station and includes various extension activities.

The Aquaculture Research Institute Newsletter provides information about aquaculture-related activities at the University of Idaho. It is intended to complement rather than duplicate the Idaho Aquaculture Association Newsletter, although some articles may overlap. Articles in this newsletter may be reproduced without permission, provided they are properly cited. Please feel free to submit comments or material you would like us to consider for publication to:

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*The Fish Physiology and Genomics Group, sampling rainbow trout at ARI coldwater wet lab.*

Two very different fish species are currently being used to address these questions. First, rainbow trout (*Oncorhynchus mykiss*) are used because of their ecological and economical importance in Idaho. In addition, rainbow trout have been the subject of numerous ecological, physiological and nutritional studies showing high responsiveness to changes in nutritional status and photoperiod. The widely studied zebrafish (*Danio rerio*) is also being used in our studies due to their importance as a model species in developmental and molecular biology. Zebrafish are native to the Ganges River in India and Burma and produce large quantities of eggs, quickly develop, and are easily manipulated. This species, is well studied and much of its genome is known, which allows for rapid identification of differentially expressed genes of interest.

The project involves researchers from the University of Idaho (UI) and Idaho State University (ISU) who are using several different approaches and both fish species to answer specific research questions. The Fish Physiology and Genomics team includes Dr. Barrie Robison (Department of Biology-UI); Dr. Kenneth Rodnick (Department of Biology-ISU); Dr. Rodney Hill (Department of Animal and Veterinary Sciences-UI); Dr. Gordon Murdoch,

(Department of Animal and Veterinary Sciences-UI) and Drs. Madison Powell and Ron Hardy (Hagerman Fish Culture Experiment Station).

Dr. Robison and his lab are studying gene expression in zebrafish. This information is used to compare rainbow trout and zebrafish under similar nutritional constraints. The synergy and potential to utilize the zebrafish model and rainbow trout model in studies in fish nutritional physiology are being assessed.

Dr. Rodnick and his students are focusing their research on understanding how the environmental variables such as temperature, dissolved oxygen, and diet affect physiological performance of fishes. Dr. Rodnick's primary interest involves the metabolic regulation of the cardiac function of salmonid fishes, with extensions to skeletal muscle and the identification of sex differences in cardiac energetics and performance of various fishes. The finding that adult trout and salmon experience coronary arteriosclerosis and potentially cardiac pathology extends this work to biomedical audiences. Ultimately, their work is also directed at helping the aquaculture industry understand nutrient utilization in trout and design better diets to promote efficient growth and health.

Dr. Hill and his lab are characterizing the Insulin-like Growth Factor axis of zebrafish and rainbow trout and how they respond under different levels of nutrition, particularly dietary carbohydrate levels. A main project is the characterization of the zebrafish insulin-2 gene to better understand the regulation of the expression of this gene and its role in embryonic development.

Dr. Murdoch and his lab are focusing on the response of rainbow trout white muscle to increasing dietary carbohydrates and different dietary lipid profiles. He is assessing the expression profiles of several genes related to muscle cell proliferation and differentiation. In addition, there is active collaboration with PhD candidate Jon Amberg (mentored by Dr. Hardy) on understanding nutrition's role in the regulation of cellular nutrient uptake in rainbow trout.



Drs. Powell and Hardy are concentrating on integrating the rainbow trout's response to changes in diet and environment. Their main research topics include the role nutrition plays on changes to (1) genetics, (2) somatic growth, (3) nutrient partitioning and (4) immune function. Dr. Hardy oversees all aspects of research funded through Idaho EPSCoR for the Fish Physiology and Genomics team.

Information from this project has been presented at several national and international meetings. The team is currently in the process of publishing results from numerous studies conducted to date.



*ARI Director Ron Hardy (R) and Dr. Ken Rodnick (middle) of ISU, weighing and recording rainbow trout at the Aquaculture Research Institute with graduate students.*

## The 3<sup>rd</sup> Annual Summer Science Camp



*Teachers and students learning fish anatomy. Led by Dr. Spall, ISU,*

**T**he 3<sup>rd</sup> annual Summer Science Camp (SSC) took place on June 11-15, 2007 at Challis, Idaho. This camp was sponsored by the Aquaculture Research Institute (ARI), Idaho State University (ISU) and Utah State University (USU). Funding for the SSC was provided by EPSCoR and the National Science Foundation (NSF).

The SSC has been well received and attended this year with 38 participants, including teachers and students from across the West. University of Idaho, Idaho State University and Utah State University faculty teamed up with students from the Coeur d'Alene Reservation, the Shoshone-Bannock reservation, and the Yakima reservation to study a variety of subjects ranging from Chemistry and Physics to Astronomy, and Emergency Medicine. Teachers (both elementary and high school) from across the state of Utah also participated.

All SSC students kept journals detailing what they observed and learned. The teachers wrote detailed lesson plans/ideas on what they learned and how this knowledge would benefit teaching and learning practices at their home institution. These were shared within the group and the best practices were discussed and improved.



*Student scientist testing the pH of water.*

## Ph.D. Candidates Jon and Shannon Amb



*This unique husband-wife team focuses their dissertation research on issues relative to aquaculture; however, there is a world of difference when it comes to their respective specialties.*

Call them a dynamic duo of research if you will. You can be most certain that when one is lingering in the offices of ARI, the other is likely to appear shortly thereafter. Both originally from Michigan, Jon and Shannon Amberg came to the University of Idaho to pursue higher education and explore the West. Currently, they are both Ph.D. candidates with Jon in the Department of Animal and Veterinary Sciences in the College of Agriculture and Life Sciences, working under the direction of Dr. Ronald Hardy, and Shannon in the Department of Conservation Social Sciences in the College of Natural Resources, working under the direction of Dr. Troy Hall. This unique husband-wife team focuses their dissertation research on issues relative to aquaculture; however, there is a world of difference when it comes to their respective specialties.

Jon has a Bachelor's degree in Fisheries and Wildlife and a Master's degree in Fisheries and Aquaculture from Michigan State University, in which his research focused on fish nutrition and growth physiology. His current dissertation research focuses on the intestinal physiology and development in fishes and the role that nutrients play in regulating the uptake of nutrients. He is focusing on three

different, yet integrated, components of this process. First, Jon is investigating the expression of the oligopeptide transporter, PepT1, in developing fish larvae. In a collaboration developed with Dr. Ivar Rønnestad at the University of Bergen in Norway, he is using PepT1 as a model solute carrier to assess expressional changes during larval fish development. PepT1 is a membrane bound transporter responsible for the absorption of the majority of the digested dietary proteins. Using quantitative real-time PCR and *in situ* hybridization to understand the physiological responses in fish to a variety of stimuli (such as prey type and density); Jon is working to determine whether the spatial and temporal expression of PepT1 in larval fish follows a gradual or saltatory pattern. This would provide insight into the protein requirements during critical early life stages of fishes, making this research important for local and global aquaculture industries, since larval rearing is one of the major constraints limiting growth.

Funded through Idaho EPSCoR, the second component of Jon's research focuses on the role of macronutrients in regulating nutrient transport in the digestive system, specifically the solute carriers responsible for the uptake of peptides and carbohydrates. He is analyzing the effects of different dietary protein sources (soy or fishmeal), carbohydrate levels (simple starches) and lipid profiles (menhaden or insect lipid) on the expression levels of carrier proteins at a transcriptional or gene level. Understanding these mechanisms will help in identifying high quality alternative protein sources, developing low pollution aquafeeds and/or stage specific feeds and improve drug delivery; all are important for the advancement towards a sustainable aquaculture industry.

Lastly, as part of Idaho EPSCoR, Jon is assisting in the investigation of the regulation of myogenesis (growth and differentiation) in white muscle tissue of rainbow trout that are fed diets containing different carbohydrate and



lipid profiles. Working in conjunction with Dr. Gordon Murdoch at the University of Idaho, Jon is helping evaluate the role carbohydrates play in the “programming” of satellite cells. He is also evaluating gene expression profiles for myogenic and lipogenic factors (genes responsible for the cell becoming a muscle cell or a fat cell). Understanding the mechanisms of muscle cell differentiation will help in the development of stage specific feeds that target muscle growth and/or lipid deposition.

Shannon has a Bachelor’s degree in Geography and Environmental Studies from Aquinas College and a Master’s degree in Geography and Conservation Biology from Ohio University. Though well versed in landscape and wildlife ecology, her research interests have always focused on the human element in the natural environment. Currently, with support from the UI/WSU Aquaculture Initiative, her research focuses on the social aspects of fisheries and aquaculture. Her dissertation, titled “Public Perceptions of Aquaculture: Influences of Media and Decision Heuristics on Perceived Risks and Benefits of Farmed Fish and Seafood,” is a mixed methods study that focuses on how consumers in the Pacific Northwest understand and form perceptions of risk about fish and seafood (in particular farmed fish and aquaculture). Additionally, it is an investigation of how media information highlighting health and environmental effects of farmed salmon has influenced the way people weigh risks and benefits, and how people use different decision processes (e.g., “rules of thumb,” heuristics, systematic weighting of alternatives, etc.) to come to judgment about personal consumption of farmed fish.

This research links analysis of media content with a qualitative analysis of public perceptions to investigate the effects of news information on public perceptions of farmed fish, understanding potential risks and benefits, and consumption decisions. First, Shannon analyzed temporal changes

in the frequency of statements about different types of risks and benefits regarding farmed fish in newspaper stories; then used discourse analysis of a subset of stories to examine journalistic use of language and quantification to understand how risks are framed. Her goal was to explore how journalists may rhetorically create (un)certainly about the safety of fish consumption. Finally, to understand public perceptions about farmed fish and seafood and to evaluate the impact of the media, she conducted nearly 100 semi-structured interviews with consumers throughout Washington and Idaho. Overall, the goals of this research include not only understanding public perceptions of farmed fish and the decision processes involved in choices about fish/seafood, but also linking media effects with risk perceptions.

Building on her dissertation research, Shannon has recently received a grant to conduct a large-scale, quantitative assessment of the factors that influence public acceptance and consumption of aquaculture products in the Pacific Northwest. This research will describe public beliefs and attitudes about the aquaculture industry in the region and investigate how these attitudes interact with other factors (e.g., price, preference, decision heuristics, etc.) to impact purchasing decisions. The results of this research could be used to better understand decision processes, identify market segments, and increase public understanding about risks and benefits of fish consumption.

If you ask them, Jon and Shannon will tell you that pursuing research specialties in the same field was a strategic choice for future employment at the same institution (wherever that may be). Jon’s just relieved that she won’t be competing with him for a position! Both plan to finish and defend their research during the spring semester of 2008. Both plan to continue their careers pursuing research at an academic or government institution.

## Teaching

Although the Aquaculture Research Institute (ARI) is not an academic department, we provide educational and research opportunities to students at both the undergraduate and graduate level. Because of the diversity of aquaculture sciences, graduate degree programs with an aquaculture emphasis may be designed for post-baccalaureate students enrolled in fisheries, biology, animal sciences, agricultural economics and engineering programs.

ARI Director Ron Hardy is a Professor in the Department of Animal and Veterinary Sciences (College of Agricultural and Life Sciences) and an adjunct professor in the Department of Fish and Wildlife Resources (College of Natural Resources). Associate Director for campus programs Kenneth Cain is an Associate Professor in Fish and Wildlife Resources, and Associate Director for Hagerman Matt Powell is an Assistant Professor in the Department of Animal and Veterinary Sciences. Each serves as major professor for graduate students enrolled in their respective departments. They also teach undergraduate and graduate courses, offer special topic classes and independent study projects.

*To protect Idaho's wild and cultured fishery resources, the Idaho Department of Fish and Game placed an embargo on all importation of live fish into the State of Idaho*

## **Viral hemorrhagic septicemia virus (VHSV) poses a substantial threat to Idaho's wild and cultured fish.**

*Submitted by: Gary Fornshell, Extension Aquaculture Educator, University of Idaho, Twin Falls, Idaho.*

**V**iral hemorrhagic septicemia virus (VHSV) is among the most important viral pathogens of fish worldwide and is listed as reportable by many nations and international organizations. Beginning in 2005, reports from the Great Lakes region indicated that wild fish had experienced massive die-offs from a strain of VHSV. The disease does not pose a risk to people, but VHSV has been found to naturally infect more than 40 fish species, including a number of ecologically, recreationally, and economically important fish (Table 1.)

Because of its broad host range and high virulence, the spread of the Great Lakes strain of VHSV poses a substantial threat to wild and cultured freshwater fish species nationwide.

It is not known how the disease arrived in the Great Lakes area. In the past, VHSV was thought to be a concern only for trout and a few other freshwater fish cultured in Europe. The disease was first detected in Lake Ontario in 2005 and has since been detected in Lake St. Claire, Lake Erie, and the St. Lawrence River, as well as Conesus Lake in New York state. Recently it has also been detected in inland lakes in Wisconsin and Michigan. Thus far the disease has not been detected in commercial aquaculture (fish farms) facilities.

In response to the severity of the virus, number of fish species affected by the virus, and the rapidity of its spread throughout the Great Lakes region APHIS issued an emergency order on October 24, 2006 prohibiting the importation of 37 species of live fish from two Canadian provinces into the United States and the interstate movement of the same species from the eight States bordering the Great Lakes. The emergency order has since been amended to allow live fish of VHSV susceptible fish species to move from the eight States bordering the Great Lakes provided certain conditions are met.

To protect Idaho's wild and cultured fishery resources the Idaho Department of Fish and Game placed an embargo on all importation of live fish into the State of Idaho from the Great Lakes basin July 2006 and in November 2006 prohibited importing live or unprocessed whole fish to be used for bait. It is illegal to use live fish as sportfishing bait in Idaho.

What can you do as a citizen of Idaho to prevent the introduction of VHSV into Idaho? There are numerous avenues for the virus to enter Idaho. Of greatest concern is the use of bait for sportfishing and 'bucket biologists.' Fortunately most of the baitfish for sale in Idaho are herring, surf smelt, or anchovies from the west coast. Processed minnows sold in preservative solutions are not affected by the ban. However, the virus can survive freezing temperatures below zero degrees Fahrenheit and as such frozen baitfish from the Great Lakes region pose a risk of spreading this deadly virus.

'Bucket biologists' are unethical individuals that take it upon themselves to 'enhance' sportfishing by moving fish illegally from one water body to another. For example, 'bucket biologists' introduced Lake trout into Yellowstone Lake with devastating consequences for the native cutthroat trout due to heavy predation by the Lake trout and completely knocked the ecosystem out of balance affecting species such as bears and eagles that depend on cutthroat trout for food. The

impacts of ‘bucket biology’ include the introduction of pathogens, noxious aquatic weeds, and nuisance aquatic species that can cost millions of dollars to manage and control.

Private ponds provide fishing enjoyment for kids and an opportunity for pond owners to create and manage their own personal fishery. However, private ponds if not regulated have the potential to introduce diseases and non-native fish species into water bodies that can seriously harm wild and cultured fish populations. The requirements for a private pond are relatively simple and easy. Contact your regional Idaho Department of Fish and Game office for permit requirements and a list of approved commercial fish hatcheries that can supply the appropriate certified disease-free fish species.

You can also help by reporting fish kills to the Idaho Department of Fish and Game so those fish can be analyzed to ensure that they are not carrying VHSV. As citizens of the great State of Idaho we have a responsibility to protect the natural resources we depend on for our recreation and economy for the enjoyment of others and future generations.

For additional information see the links below:

[http://www.aphis.usda.gov/vs/ceah/cei/taf/emergingdiseasenotice\\_files/vhs-greatlakes.htm](http://www.aphis.usda.gov/vs/ceah/cei/taf/emergingdiseasenotice_files/vhs-greatlakes.htm)

[http://www.aphis.usda.gov/newsroom/hot\\_issues/vhs/vhs.shtml](http://www.aphis.usda.gov/newsroom/hot_issues/vhs/vhs.shtml)

*Private ponds if not regulated have the potential to introduce diseases and non-native fish species into water bodies that can seriously harm wild and cultured fish populations.*

Table 1. Species listed by the World Organization for Animal Health as susceptible to VHSV			
Atlantic cod .....	<i>Gadus morhua</i>	Muskellunge .....	<i>Esox masquinongy</i>
Black crappie .....	<i>Pomoxix nigromaculatus</i>	Pacific cod.....	<i>Gadus macrocephalus</i>
Bluegill.....	<i>Lepomis macrochirus</i>	Pike.....	<i>Esox lucius</i>
Bluntnose minnow .....	<i>Pimephales notatus</i>	Pink salmon.....	<i>Oncorhynchus gorbuscha</i>
Brown bullhead.....	<i>Ictalurus nebulosus</i>	Pumpkinseed.....	<i>Lepomis gibbosus</i>
Brown trout.....	<i>Salmo trutta</i>	Rainbow trout.....	<i>Oncorhynchus mykiss</i>
Burbot.....	<i>Lota lota</i>	Redhorse sucker .....	<i>Moxostoma spp</i>
Channel catfish .....	<i>Ictalurus punctatus</i>	Rock bass .....	<i>Ambloplites rupestris</i>
Chinook salmon .....	<i>Oncorhynchus tshawytscha</i>	Rockling .....	<i>Onus mustelus</i>
Coho salmon .....	<i>Oncorhynchus kisutch</i>	Round goby.....	<i>Neogobius melanostomus</i>
Chum salmon.....	<i>Oncorhynchus keta</i>	Smallmouth bass .....	<i>Micropterus dolomieu</i>
Emerald shiner.....	<i>Notropis atherinoides</i>	Sprat.....	<i>Sprattus spp</i>
Freshwater drum .....	<i>Aplodinotus grunniens</i>	Turbot.....	<i>Scophthalmus maximus</i>
Grizzard shad.....	<i>Dorosoma cepedianum</i>	Walleye .....	<i>Sander vitreus</i>
Grayling.....	<i>Thymallus thymallus</i>	White bass .....	<i>Morone chrysops</i>
Haddock.....	<i>Gadus aeglefinus</i>	White perch.....	<i>Morone americana</i>
Herring.....	<i>Clupea spp</i>	White fish .....	<i>Coregonus spp</i>
Japanese flounder .....	<i>Paralichthys olivaceus</i>	Yellow perch.....	<i>Perca flavescens</i>
Largemouth bass .....	<i>Micropterus salmoides</i>		
Source: USDA, Animal and Plant Health Inspection Service (APHIS)			

# SCHEDULE OF EVENTS

**Idaho Annual Meeting 2008, American Fisheries Society, February 6-8, 2008.**  
Post Falls, Idaho. For more information go to website: [www.orafs.org](http://www.orafs.org).

**Aquaculture America 2008, February 9-12, 2008, Lake Buena Vista, Florida.**  
for more information, go to website: [www.was.org](http://www.was.org).

2008 Western Division Annual Meeting, May 4-9, 2008, Portland, Oregon.  
website is [www.orafs.org](http://www.orafs.org).

**World Aquaculture 2008, Busan Korea, May 19-23, 2008.**  
For more information, go to [www.was.org](http://www.was.org).

**AFS Fish Health Section Annual Meeting 2008, July 9-12, 2008.**  
Prince Edward Island, Canada.. For more information, go to website  
[www.upei.ca/FHS-AFS2008](http://www.upei.ca/FHS-AFS2008).

**2008 International Congress on the Biology of Fish. July 28-August 1, 2008.**  
Portland, Oregon. For additional information, website is [www-heb.pac.dfo-mpo.gc.ca/congress/](http://www-heb.pac.dfo-mpo.gc.ca/congress/).

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