

Hagerman Fish Culture Experiment Station Annual Report for 2000-2001



EXECUTIVE SUMMARY

1. The Idaho State Legislature authorized the Department of Parks and Recreation to purchase property on Billingsley Creek, near the Hagerman Station, for preservation and park development. The property includes a commercial trout farm that will be operated as a research farm by the Hagerman Station, beginning next year. This facility will greatly enhance the Station's research capability, and position the Station as a national leader with respect to research facilities.
2. The University of Idaho signed a memorandum of understanding with the Columbia River Inter-Tribal Fish Commission (CRITFC) to make the Hagerman Station the principal facility for CRITFC's genetic analysis of Pacific salmon stocks, and to facilitate future research, teaching and extension endeavors with CRITFC.
3. Station scientists were awarded 12 new grants and contracts in 2000, plus eight continuing grants and contracts were renewed. Funding from these grants and contracts totaled \$1,100,460, of which \$460,334 was new and \$640,126 was continuing. In addition, ARS support for its scientist at the Station (\$300,000) continued, and \$38,000 for operating expenses was received from the State of Idaho. A portion of this funding was used to support students and research activities on the UI Moscow campus and for indirect cost support to the UI.
4. The Idaho Legislature funded a second faculty position at the Hagerman Station in the field of genetics. This position has been filled by Dr. Matt Powell.
5. Station scientists published 43 scientific papers, book chapters, and popular articles, plus made 17 presentations at various regional, national, and international scientific and technical meetings.
6. Station scientists conducted collaborative projects or assisted researchers from the University of Idaho campus, College of Southern Idaho, Boise State University, Idaho State University, Washington State University, the University of Washington, the U.S. Fish & Wildlife Service, the National Marine Fisheries Service, Bonneville Power Administration, the Columbia River Inter-Tribal Fish Commission, and many other agencies and non-government organizations. In addition, Station scientists worked closely with the Idaho Department of Fish and Game on endangered species issues.

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Research capabilities at the Station were greatly enhanced during the year by the acquisition of property by Idaho Department of Parks and Recreation that included the Gold Springs trout farm parcel. This commercial trout farm will be operated by the Hagerman Station and used to conduct farm-scale research studies to enhance the productivity and reduce the environmental impacts of trout farming in the Magic Valley. The farm is located approximately 4 miles from the Station, making it easy to oversee from the Station. Converting the farm from a production facility to a research facility will lower the numbers of fish being reared and thereby reduce the amount of nutrients in farm effluents. This change will improve the water quality of Billingsley Creek, which is the receiving water for hatchery effluents.



**Top view of Idaho Springs farm
(formerly Gold Springs Trout Farm)**

Acquisition of the Gold Springs trout farm (to be re-named Idaho Springs) will have a significant impact on the University's aquaculture program. First,

it greatly expands research possibilities for the Station, both in terms of research scope and in terms of potential grants and contracts that the Station can pursue. Second, it provides facilities for expanded outreach and training opportunities, both for professional training and for UI undergraduate and graduate students. Third, it provides a facility to conduct research projects on subjects not suited for funding through competitive grant programs, but that are important topics for Idaho's aquaculture industry and Idaho state agencies. Such projects will be self-funded through sale of fish at the end of research trials. In short, acquisition of Idaho Springs makes the Hagerman Station's fish culture facilities unique in the world, thereby increasing the stature and visibility of the UI's aquaculture program, providing the foundation for future growth and success at the Hagerman Station.

Progress on construction of additional facilities at the Hagerman Station continued during the year. This construction has been planned for several years in connection with the UI's Agricultural Biotechnology Initiative and includes expanded research, administrative, and distance learning facilities on the grounds of the Hagerman Station. An architectural firm has been selected for the project, and initial design criteria are being developed. Construction is expected to begin in Spring, 2002 and to be completed over the next year.

The activities of the Station continue to be organized into two functional groups:

- **The Center for Sustainable Aquaculture**

- **The Center for Salmonid and Freshwater Species at Risk**

The Center for Sustainable Aquaculture focuses on the major issues facing the aquaculture industry. Currently the Center has research programs in four programmatic areas:

- **Environmentally-friendly feeds and alternate feed ingredient evaluation**
- **Reducing the impact of aquaculture on the aquatic environment**
- **Genetic improvement of trout performance using marker-assisted selection**
- **Development of an ornamental fish industry in Idaho**

The Center for Salmonid and Freshwater Species at Risk focuses its efforts on genetic analysis of fish populations in the context of conservation biology. The activities of this Center are summarized as follows:

- **Genetic analysis of fisheries stocks for fisheries managers**
- **Real-time genetic monitoring of spawning salmon from endangered chinook and sockeye populations**
- **Development of new genetic tests to assess disease status, fitness, and other important characteristics of wild fish populations**

- **Tissue archive for threatened and endangered fish species**

Some Station research activities do not fall clearly into either of these two general Centers, but rather are connected with both. An example of such research is a continuing study conducted in partnership with the USFWS on phased-feeding of hatchery steelhead trout to prevent fish from becoming too large and fat before hatchery release. Another is a study being conducted with Dr. Rick Barrows, USFWS, Bozeman MT, to prevent fin erosion in hatchery-reared steelhead trout by dietary supplementation. Both of these studies are carried over from last year and are directed at improving the quality and post-release survival of hatchery-reared steelhead trout, but both contain elements of interest to commercial aquaculture. A third example is an on-going study being conducted in collaboration with the National Marine Fisheries Service and Bonneville Power Administration on the nutrition needs of Pacific salmon being raised in captive salmon breeding programs by state agencies. The current focus of this research is on the establishment of a 'wild fish template' based upon chemical analysis of wild fish. The concept is to characterize key biochemical components typically found in wild fish, such as tissue fatty acid profile and tissue levels of certain minerals, and use this information to customize formulations of diets fed to hatchery-reared fish so that hatchery fish are more closely mirror wild fish. Concurrently, the physiological significance of key biochemical constituents of fish will be assessed to better understand their role in salmon

smolt quality and post-hatchery release survival. The findings from this research are pertinent to the commercial aquaculture sector, and this linkage is an example of the synergies that are possible from research conducted at the Station.

In 1998, Congress authorized the funding of two programs within the Agriculture Research Service (ARS), USDA, which benefit the Hagerman Station, and in 2001, another Congressional funding initiative was passed that further benefits the Station. First, a USDA Agricultural Research Service (ARS) scientist position was created at the National Small Grains Germplasm Research Facility, Aberdeen, Idaho, to be assigned to the Hagerman Station. This position was filled in March 2000 by the selection of Dr. Ken Overturf, a quantitative geneticist and molecular biologist. Dr. Overturf has begun research on selective breeding and performance testing of rainbow trout stocks and strains. He has hired a skilled assistant, Dan Bullock, and together they are developing a research program that utilizes the latest biotechnology methods to identify genetic markers that are associated with improved growth, disease resistance, and ability to utilize novel feed ingredients from grains, especially those grown in Idaho. They are also expanding their program into the emerging area of functional genomics, which is the study of portions of the genome (DNA) that are actually expressed during growth, development, disease challenges, and maturation. Dr. Overturf has been successful in obtaining state-of-the-art laboratory equipment for his program that greatly enhance the scope and efficiency of his research. Acquisition

of the latest robotic equipment to isolate and prepare DNA and mRNA for analysis has positioned this program at the forefront of not only fish genetic research, but genetic research in general.



Dr. Ken Overturf and Dan Bullock, ARS scientists, with new genetic analysis equipment at the Station

Dr. Overturf has also been examining the nutritional and growth effects of different cereal grain cultivars when used in formulated fish feeds. This work involves studies using similar cultivars that vary only in their protein or oil content and the results when they are used in replacing fish meal and fish oils in formulated fish feeds. Further studies of cereal grains includes barley cultivars that vary over a range of 50 to 95% in phytic phosphate reduction and its effect on effluent and mineral absorbance in fish. The information gathered from this research will be incorporated with genetic enhancement of rainbow trout for the generation of stocks and feeds suited to each other for growth and reduced harmful effluents.

The second ARS program authorized and funded by Congress is based at the University of Alaska, in cooperation with ARS, The Oceanic Institute in Hawaii, and the University of Idaho,

Hagerman Station. The program funds research to develop higher and better uses for seafood processing waste and fisheries by-catch in Alaska, including the production of low-ash fish meal.

The Idaho trout industry is the principal market in the USA for low-ash fish meal, which is a key component in low-pollution (environmentally-friendly) trout feeds. The Hagerman Station's role in this effort is to evaluate products produced in Alaska as fish feed ingredients with respect to nutritional and low-pollution value. This project is funded for five years, through 2003, and received an increase in total funding to \$2 million in 2001.

The newest ARS program to be funded by Congress through UI initiative was just recently signed into law, and directs money to the National Cool and Coldwater Aquaculture Center, in Leetown, WV, to create a new ARS scientist position in fish nutrition and feed technology, and to support rainbow trout broodstock rearing and progeny testing at Idaho Springs. This area is central to long-term research direction of ARS, and we expect this program to expand in the future.

Benefits of Station Programs to Industry and Agencies

Research studies conducted at the Station are directed toward solving problems faced by the aquaculture industry in Idaho and by agencies responsible for managing Idaho's fisheries resources. Examples of tangible benefits accruing to the State of Idaho from research conducted at the Hagerman Station are the following

- **TMDLs for trout farmers**

Developing information on the availability of phosphorus in common feed ingredients used in trout feeds. This information has further reduced the amount of phosphorus released in trout farm effluent water per ton of trout produced. Three years ago, TMDLs were implemented on trout farms releasing water into the mid-Snake River section, and a 20% reduction in the quantity of phosphorus was mandated, with an additional 20% reduction scheduled over a five-year period. This degree of reduction seemed impossible without curtailment of production, but it now seems attainable, in large part because of a high degree of understanding of dietary phosphorus requirements, the bioavailability of phosphorus in feed ingredients, and an understanding of antagonistic interactions that occur in feeds when certain feed ingredients and/or combinations are included in the diet.

- **Selenium and cutthroat trout**

The Idaho phosphate mining industry requested assistance in 1999 to assess the effects of selenium on cutthroat trout in the Blackfoot River system in

southeastern Idaho. Three objectives were identified: (1) determine the effect of selenium on wild fish in the river, as measured by the incidence of deformed fry in spawns; (2) determine the acute effects of selenium in the diet of fry and fingerling cutthroat trout; and (3) determine the long-term effects of dietary selenium intake on reproductive performance and fry quality of cutthroat trout. The first two objectives have been completed, and the third objective will be completed in 2002. No evidence was found to suggest that selenium exposure of maturing cutthroat trout in the Blackfoot River reduced egg viability or increased the percentage of deformed fry, the most sensitive measure of assessing selenium exposure in fish. Further, no evidence of acute toxicity of selenomethionine, the form of selenium found in the food chain of wild cutthroat trout, was seen in cutthroat fry or fingerlings, even at high selenium intake levels.



Collecting milt from a Blackfoot River cutthroat trout

Finally, no evidence has been seen yet to suggest that the levels of selenium found in wild cutthroat trout from the Blackfoot River system are sufficiently elevated to impair reproductive performance in the fish. Although only

a few fish have matured and spawned in the trial being conducted at the Hagerman Station, more are expected to mature this year, allowing definite conclusions to be made concerning this critical issue to the state of Idaho.

- **Genetics of cutthroat trout**

Management and conservation of Yellowstone cutthroat trout (Idaho's state fish) have become high priorities for the U.S. Fish and Wildlife Service and the Idaho Department Fish and Game due to population declines throughout their historic native range. In August 1998, several conservation groups collectively petitioned the U.S. Fish and Wildlife Service to list the Yellowstone cutthroat trout as a threatened species under the Endangered Species Act (ESA). Currently, Yellowstone cutthroat trout are recognized as a "species of special concern" by the IDFG. Population declines have been attributed in part to extensive historical stocking of non-native, hatchery raised, rainbow trout which have hybridized with or replaced Yellowstone cutthroat trout populations in many areas. A project to describe the current genetic status of Yellowstone cutthroat trout populations in Idaho was begun last year by The Center for Salmonid and Freshwater Species at Risk. The focus of the investigation was to examine the extent of hybridization with non-native rainbow trout within the Snake River Basin. Non-lethal genetic samples from every major drainage containing Yellowstone cutthroat trout in Idaho were sampled by IDFG. The samples were analyzed and found to contain much less hybridization than previously assumed by petitioners to the USFWS. The information was turned over to the IDFG and formalized in a

memorandum by them to the USFWS regarding the petition for listing Yellowstone cutthroat trout. This information along with other biological data collected on Yellowstone cutthroat trout resulted in the petition being “set aside” in February 2001. Thus, a “blanket” listing of Yellowstone cutthroat trout throughout its range, similar to the one imposed on bull trout, was ruled unnecessary.

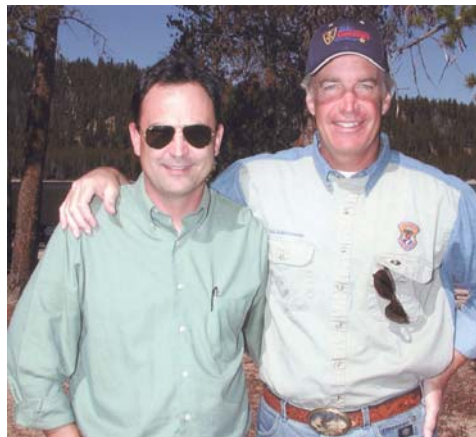
- **Novel fish disease diagnosis**

Agencies responsible for managing and restoring Idaho’s salmon stocks must check all returning fish for the presence of a chronic disease called “Bacterial kidney disease” and discard any fish found to carry disease organisms over a specified level. Kidney tissue is removed at the time of spawning and subjected to analysis by a method called ELISA. This method is accurate at mid to upper lower ranges of pathogen load but less accurate at moderate to low levels of pathogen loads, which is precisely the range of concern in broodstock salmon. Thus, using the ELISA test, it is not uncommon to mistakenly determine that a fish should be discarded when in reality it should be kept, and vice versa. Hagerman researchers have developed an entirely new method of measuring pathogen loads in salmon using the latest technology in molecular biology. Ken Overturf and Matt Powell are using quantitative mRNA measurements of bacterial genetic material in fish kidney samples to choose which fish should be kept for spawning purposes. The new test, for which a patent has been applied, is 5x more sensitive than the ELISA test, and is more rapid and less expensive as well. Currently, funding is being sought

to expand the use of this test to the field level.

- **Endangered sockeye salmon**

Governor Dirk Kempthorne and Dr. Matt Powell after releasing sockeye salmon into Redfish Lake.



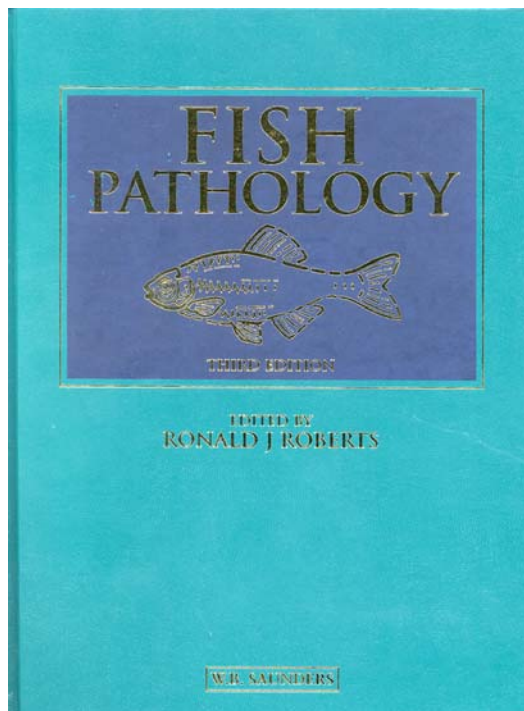
Genetic Research at the Station continues to provide information on the relatedness of every endangered sockeye returning to Redfish Lake, Idaho in a collaborative effort with the Idaho Department of Fish and Game, the National Marine Fisheries Service and the Shoshone-Bannock Tribes. In 2001 a total of 26 sockeye made the 850 mile journey back to Redfish Lake. Each fish was taken into captivity until its genetic identity could be obtained. Then, a portion of the returning fish were released to spawn naturally in the lake in September while a few were kept as a safeguard in the hatchery. The genetic information is used to protect and preserve the genetic diversity remaining in the Redfish Lake sockeye and to construct “spawning matrices” so that individuals in the hatchery can be crossed to avoid problems with inbreeding. The genetics program in Hagerman also constructs spawning matrices for three captively-raised, threatened chinook salmon populations

in Idaho from the Lemhi River, East Fork Salmon River, and the West Fork Yankee Fork Salmon River. This is the only “real-time” genetic analysis program for endangered Pacific Salmon in the United States. The sophisticated molecular genetic equipment at Hagerman allows a complete genetic identity and/or pedigree to be constructed within just a few hours for every returning fish.

- **Ornamental fish research**

Research is progressing at the Hagerman Station, and over sixty species have been acquired and are being studied for their suitability for spawning and rearing in Idaho water. A small research tank arrangement has been installed to allow studies of fry feeds and feeds for spawning fish to be evaluated.

- Professor Ron Roberts completed the new edition of his renowned text “Fish Pathology” while associated with the Hagerman Station. This text is the standard reference used worldwide by scientists involved with fish disease diagnosis and treatment, and having Prof. Roberts use his Hagerman affiliation in the book gives the Station worldwide recognition.



“Fish Pathology, Third Edition” by Professor Ron Roberts, Distinguished Visiting Professor, Hagerman Station.

Future Activities

- **Capital construction:** As mentioned earlier, planning for capital construction associated with the UI Biotechnology Initiative began in 2001, with actual construction to begin in 2002 and completion anticipated in 2003. Construction will include a wet-laboratory addition to house a quarantine and disease challenge wet lab, support laboratories in pathology histology, and microbiology, a tissue and gene bank, a distance learning, conference, and lecture center, and additional offices. Architects are examining options to construct a two-story building containing

laboratories on the first floor and offices and conference room on the second, or perhaps to limit the entire addition to a single story involving modification of the existing administrative office and laboratory building.

- **Partnerships:** Collaborative agreements are in place between the Aquaculture Research Institute and CRITFC, and between the Institute and the Bozeman Fish Technology Center, USFWS. The latter links our programs in fish nutrition with their program in feed manufacturing technology, and our program in genetic analysis of fish populations with their field and laboratory work with native fish in Montana. The agreement is a true partnership in that both parties benefit from the strengths of the other.
- A collaborative arrangement with CRITFC (Columbia River Inter-Tribal Fish Commission) will be established. The purpose of the arrangement will be to formalize existing activities undertaken with CRITFC in the area of genetic analysis of salmon, steelhead, and lamprey stocks, and to undertake further collaborative studies, provide training and educational opportunities for Native Americans, and to seek funding for capital construction to expand construction beyond that funded through the UI Biotechnology Initiative.

Personnel

Employment increased at the Station in 2000-2001 to 15 scientists, technicians, and support personnel, up from two in 1996-1997. An additional four students were employed during the summer term. This increase was funded entirely by grants and contracts awarded to Station scientists; no state support was used to employ personnel. However, the Idaho Legislature authorized state support of operating expenses for the year, which in light of the legal limitations concerning the use of research funds to support operating expenses, was extremely helpful in the management of the Station. In addition to direct support of personnel at the Hagerman Station, research grants supported an additional 10 graduate students and staff positions at the UI Moscow campus, through the Aquaculture Research Institute. Thus, the efforts of scientists at the Hagerman Station resulted in 25 positions within the University of Idaho system. At the Hagerman Station, Dr. Jack Cheng, a Ph.D. graduate of Kansas State University; completed the first year of his two-year postdoctoral fellowship through the Animal and Veterinary Science Department, College of Agriculture. Dr. Cheng works in the area of fish nutrition and feed development. As mentioned earlier, Dr. Ken Overturf hired an assistant in his ARS project.

Active personnel are listed below:

Dr. Ronald W. Hardy, Director;
Professor, Animal and Veterinary
Science, College of Agriculture
(Fish Nutrition)

Professor R.J. Roberts, Visiting Distinguished Professor (Fish Pathology)

Dr. Madison S. Powell, Assistant Professor, Research Faculty, Animal and Veterinary Sciences / Fish and Wildlife Resources (Fish Genetics)

Dr. Ken Overturf, ARS Scientist (Genetics & Molecular Biology)

Dan Bullock, ARS Research Technician

Dr. Jack Cheng, Post-Doctoral Fellow (Fish Nutrition)

Michael Casten, Hatchery Manager

Luke Carrothers, Asst. Hatchery Manager

Jana L. Cole, Administrative Assistant

Tracy Brown, Office Assistant

Carol Hoffman, Scientific Aide (Fish Nutrition)

Lori Ambrose, Laboratory Assistant

Joel Green, UI Pre-doctoral student (Fish Nutrition)

Jon Bender, Hatchery Assistant,

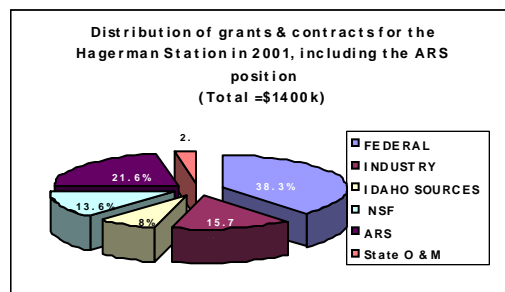
Travis Jacobson, Hatchery Assistant, CSI student

Stephanie Weber, Laboratory Assistant (Left in Sept. 2001)

The Station also employed two undergraduate student interns during summer 2001.

Research Projects and Funding

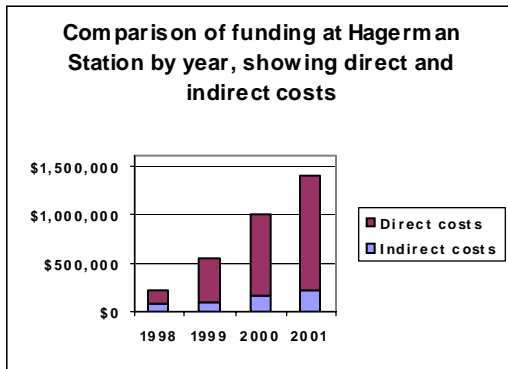
Funding for the operation of the Station and for salaries for all personnel during the 2000-2001 fiscal year, except for Dr. Hardy's salary, was supplied by grants and contracts obtained by Station scientists. This includes funding for Dr. Overturf's and Dan Bullock's salaries and research, which comes from USDA/ARS. Beginning in FY2002, a second state-supported faculty position was established at the Station. As mentioned above, for the 2000-2001 fiscal year, the Idaho State Legislature allocated an operating budget of \$38k for the Hagerman Station. This is the first time that dedicated state funds have been available to operate and maintain the Station.



The Station continued to expand its funding in absolute terms and in terms of support from a wider range of grantors and contractors. In 2000, a higher proportion of funds came from federal sources than in 2001.

In total, \$1,100,460 of funding for various research projects was awarded to Station scientists in 2001, compared to \$709,000 awarded in 2000. ARS funding added an additional \$300,000 to

the Station. In 2001, Station scientists contributed a higher amount of indirect costs (funds going directly to the UI administration to pay for overhead) than in the past, a total of \$227,318. This exceeded the amount of state funds expended at the station in FY01. Funding has increased in each of the five years that the UI has operated the Station, and at present, total funding is approximately 7x that received from state funds, which is at the top end of the excellent range for university scientists.



The total shown above includes UDSA/ARS support for Dr. Overturf, an additional \$300,000 that is spent in support of Station research over and above funding from grants and contracts awarded to Station scientists.

Of the total grants and contracts to the Station in 2001, the Center for Sustainable Aquaculture received \$852,845, and the Center for Freshwater and Salmonid Species At Risk received \$247,615. Funding comes from federal grants and competitive awards, from industry, both within Idaho and outside of Idaho, and from a long list of agencies, organizations, and businesses, mostly as fee-for-service contracts.

Specific Research Projects

A summary of the research projects undertaken by the station in 2000-2001, including a brief description of the goals and objectives of each project, is listed below.

Title of Project: High Performance Aquatic Feeds

Agency: Western Regional Aquaculture Center/USDA
 Amount: \$79,000 per year (\$14k at UI)
 Term: 4/1/97 to 3/31/01
 PI: Ronald W. Hardy, AVS
 Co-PI: Faye M. Dong, Univ. of Washington
 Frederick T. Barrows, USFWS
 Norman B. Haard, UC, Davis
 Shulin Chen, Washington State University
 Gary Fornshell, UI Extension

Goal & Objectives: The goal of this research project is to develop high performance feeds for aquaculture that are economically superior to and are utilized by fish at a higher rate than current feeds. Feeds in which a higher proportion of essential nutrients are retained and used for growth by the fish must contain a balance of available essential nutrients at levels close to dietary requirements. To achieve this goal, feeds containing alternate protein sources treated to increase nutrient availability and formulated to balance essential nutrient levels will be developed and tested for growth performance of fish and for levels of unassimilated nutrients being released in aquaculture effluent water.

Title of Project: Evaluation of phytase supplementation of trout feeds

Agency: Hoffman-LaRoche, Basel,
Switzerland
Amount: \$11,964
Term: 12/1/00 to 6/30/02
PI: Ronald W. Hardy, AVS

Goal & Objectives: The goal of this research was to determine the effectiveness of a new phytase product that was expected to be more effective at lower temperatures than the first generation product.

Title of Project: Wild Salmon Smolt Template

Agency: National Marine Fisheries
Service
Amount: \$22,453
Term: 11/99-11/00
PI: Ronald W. Hardy, AVS

Goal & Objectives: The goal of this work is to analyze wild chinook and sockeye salmon obtained by Idaho Department of Fish and Game from stream traps in various Idaho watersheds. Fish will be analyzed for proximate and tissue fatty acid composition, and for body shape, and the data will be compared to hatchery-reared fish. The concept is to obtain information that will lead to changes in diet and feeding practices in restoration hatcheries to produce fish that are similar to wild fish.

Title of Project: Alaska Seafood Processing Waste Recovery

Agency: ARS/University of Alaska
Amount: \$95,000 per year
Term: 9/1/99 to 8/31/04
PI: Ronald W. Hardy, AVS

Goal & Objectives: The goal of this study is to measure the nutritional value

of fish meals and other products recovered from Alaska seafood processing waste and by-catch as components of fish feeds. In year one, efforts were concentrated on production and testing low-ash fish meal for low-pollution trout feeds. In year two, production processes will be modified to determine effects on fish meal quality.

Title of Project: Captive salmon broodstock diet development

Agency: BPA through NMFS
Amount: \$63,177 per year
Term: 12/1/99 to 6/30/02
PI: Ronald W. Hardy, AVS

Goal & Objectives: The goal of this project is to conduct studies on experimental diets designed to rear chinook salmon to maturity in captivity. Specifically, dietary protein and energy intake will be varied with season to correspond with periods of growth dormancy and periods of rapid protein accretion. Additional efforts will be made to enable cryptic coloration in smolts and spawning coloration in adults raised in hatcheries to mimic that seen in wild fish.

Title of Project: Lipid metabolism in diploid and triploid rainbow trout

Agency: none
Amount: unfunded, pilot study with Dr.
Bob Ellis (BSU)
Term: 9/99 to 6/01
PI: Ronald W. Hardy, AVS
Co-PI: Michael Casten, HFCES

Goal & Objectives: This research study was undertaken to obtain information on growth, metabolic efficiency, whole body fat levels and feed intake of diploid and triploid rainbow trout fed high and

low-fat diets. Information obtained will be used to develop future proposals, given the fact that triploid females, which are sterile, are being increasingly mandated in aquaculture situations where escapement of fish could threaten wild stocks through interbreeding.

Title of Project: Evaluation of Idaho barleys as fish feeds

Agency: Idaho Barley Commission
Amount: \$3,000
Term: 1/01-12/01
PI: Ronald W. Hardy, AVS

Goal & Objectives: This funding was given to supplement USDA/ARS funding that is used to determine the digestibility of hull-less and hulled strains of barley and to obtain other information that will lead to higher use of barley in feeds for fish.

Title of Project: Idaho Water Quality Initiative

Agency: Environmental Protection Agency
Amount: \$491,320 over three years
Term: 11/98 – 10/01
PI: Ronald W. Hardy, AVS
Co-PIs Ernest L. Brannon, ARI
Leland Mink, Water/Energy Resources Research Institute
Ronald Crawford, IMAGE

Goal & Objectives: This grant is to support research leading to improvements in Idaho water quality. Specifically, research is being conducted to develop information that will help reduce nutrient loads of animal/aquaculture waste materials entering public waters. Collaborating UI scientists are conducting research to apply novel slurry bioreactors for

efficacy in treating confined animal and fish culture wastes; and to develop field techniques for recovery of the Magic Valley aquaculture water supply quality associated with waste infiltration from confined animal industries.

Title of Project: Evaluation of low-phytate varieties of corn and barley

Agency: USDA/ARS (Aberdeen, ID)
Amount: \$13,000
Term: 9/30/99 - 9/30/00
PIs: Victor Raboy, ARS
Ronald Hardy, HFCES

Goal & Objectives: This project is aimed at evaluating the apparent digestibility and retention of phosphorus from low-phytate grains using rainbow trout and channel catfish, with the aim of developing low-polluting feeds.

Title of Project: USDA Cooperative Agreement, Grains & Fish

Agency: USDA/ARS (Aberdeen, ID)
Amount: \$50,000
Term: 9/30/99 - 9/30/00
PIs: Ronald W. Hardy, AVS,
Darrell Wesenberg, ARS.

Goal & Objectives: This project is aimed at evaluating the apparent digestibility and retention of nutrients in various barley cultivars.

Title of Project: Novel protein from corn

Agency: Wilson Genetics/Novartis
Amount: \$48,968
Term: 6/1/00 – 5/31/01
PIs: Ronald W. Hardy, AVS.

Goal & Objectives: This project is aimed at evaluating a new corn protein as a constituent of feeds for fish.

Title of Project: Amino acid supplementation of white corn gluten meal

Agency: Wilson Genetics/Novartis
Amount: \$30,755
Term: 12/1/00 – 11/30/02
PIs: Ronald W. Hardy, AVS.
Goal & Objectives: This project is a follow-up study to determine if amino acid supplementation would permit higher amounts of white corn gluten meal to be used in trout diets to replace fish meal protein.

Title of Project: Carotenoid pigment deposition in trout fed white or yellow corn gluten meal

Agency: Wilson Genetics/Novartis
Amount: \$49,995
Term: 6/1/01 – 5/31/02
PIs: Ronald W. Hardy, AVS.
Goal & Objectives: This project is aimed at evaluating a new corn protein as a constituent of feeds for fish.

Title of Project: Synthetic lysine in fish feeds

Agency: Heartland Lysine
Amount: \$18,400
Term: 4/1/01 – 12/31/01
PIs: Ronald W. Hardy, HFCES
Jack Cheng, HFCES

Goal & Objectives: The value of synthetic lysine to balance feeds based upon alternate proteins will be examined.

Title of Project: MHA in fish feeds

Agency: Aventis Corporation
Amount: \$18,105
Term: 10/15/00 – 5/31/01
PIs: Ronald W. Hardy, HFCES
Jack Cheng, HFCES

Goal & Objectives: The value of methionine hydroxy analog as a source

of methionine in trout feeds will be examined.

Title of Project: Distillers Dried Grains with Solubles in fish feeds

Agency: Kansas Corn Commission
Amount: \$5,000
Term: 1/15/01 – 10/31/01
PIs: Ronald W. Hardy, HFCES
Jack Cheng, HFCES

Goal & Objectives: DDGS produced by various processes as a by-product of ethanol production was assessed as a potential feed ingredient for fish.

Title of Project: Conservation aquaculture of Kootenai River white sturgeon

Agency: Kootenai River Tribe
Amount: \$500
Term: 1/1/98 – 12/31/01
PI: Ronald W. Hardy, AVS
Michael T. Casten, HFCES

Goal & Objectives: This contract supports the rearing of two year classes of Kootenai River white sturgeon.

Title of Project: Conservation aquaculture of Snake River white sturgeon

Agency: IDFG, CSI
Amount: \$1,000
Term: 1/1/98 – 12/31/01
PI: Ronald W. Hardy, AVS
Michael T. Casten, HFCES

Goal & Objectives: This contract supports the rearing of Snake River white sturgeon from hatching to the juvenile stage for release into the Snake River.

Title of Project: Acquisition of a Super-critical CO₂ lipid extractor

Agency: USDA/CGIRS
Amount: \$15,730
Term: 11/15/99 – 11/14/00
PI: Ronald W. Hardy, AVS

Goal & Objectives: This grant supported the acquisition of a super-critical CO₂ lipid extractor (1/2 purchase price) as a core piece of analytical equipment for the Station. The new lipid extractor is being used to determine the fat content of feed ingredients, fish feeds, fish tissues, and other samples for numerous research studies. The equipment uses CO₂, compressed to very high pressure where it becomes a liquid, to extract lipids from samples. This eliminates the use of organic solvents, also eliminating storage and disposal problems with solvents, and improving safety in the analytical laboratory.

Title of Project: Meat & bone meal as a protein source in fish feeds

Agency: Proteins & Oils Institute,
National Renderers Assn.
Amount: \$18,105
Term: 1/1/01 – 12/30/01
PI: Ronald W. Hardy, AVS
Jack Cheng, AVS

Goal & Objectives: This project is designed to evaluate poultry by-product meal supplemented with synthetic amino acids as a replacement protein for fish meal in fish feeds.

Title of Project: Effects of constant or intermittent winter feeding on steelhead trout smolt quality

Agency: USFWS, Hagerman National
Fish Hatchery
Amount: unfunded, collaborative study
Term: 1/1/99 – 12/31/02 (continuing)
PI: Ronald W. Hardy, AVS
Bryan Kenworthy, USFWS

Goal & Objectives: This study is part of a multi-year, multi-disciplinary study of effects of intermittent feeding during winter months on the quality of steelhead trout smolts produced in hatcheries. The Station's responsibility is to conduct proximate analysis on samples of fish taken through time to assess the effects of feeding regime on body composition and visceral fat reserves.

Title of Project: Evaluation of surimi wastes as components of trout feeds

Agency: USDA/SBIR/BioOregon, Inc.
Amount: \$15,000
Term: 6/1/00 – 5/31/01
PI: Ronald Anderson, Bio-Oregon
Ronald W. Hardy, AVS
Michael T. Casten, HFCES

Goal & Objectives: Bio-Oregon used a variety of processing methods to produce fish meals, which were evaluated in feeds for rainbow trout in this Phase 1 SBIR project.

Title of Project: Evaluation of surimi wastes as components of trout feeds

Agency: USDA/SBIR/BioOregon, Inc.

Amount: \$51,296

Term: 6/1/01 – 5/31/02

PI: Ronald Anderson, Bio-Oregon
Ronald W. Hardy, AVS
Michael T. Casten, HFCES

Goal & Objectives: Products rated highest in Phase 1 study will be further assessed in rainbow trout grow-out studies in this Phase 2 SBIR project.

Title of Project: Evaluation of trout starter feeds

Agency: Bio-Oregon, Inc.

Amount: Donated feed ingredients and feed

Term: 3/1/98 – 6/30/99

PI: Dennis R. Roley, Bio-Oregon
Ronald W. Hardy, AVS
Michael T. Casten, HFCES

Goal & Objectives: The Station conducted several short-term feeding trials for Bio-Oregon to compare their new flaked feed with traditional pelleted or crumbled starter feeds for rainbow trout.

Title of Project: Cutthroat Trout & Dietary Selenium

Agency: Montgomery-Watson (Idaho Phosphate Consortium)

Amount: \$127,898

Term: 6/1/99 – 5/31/02

PI: Ronald W. Hardy, AVS
Madison Powell, HFCES

Goal & Objectives: This contract supports a study of the effects of various

dietary levels of selenium on growth, health, and reproductive performance of cutthroat trout. Two strains of cutthroat trout, Henry's Lake and Blackfoot River, are being fed experimental diets containing incremental levels of selenomethionine to determine the long-term effects of dietary selenium. In addition, genetic analysis of the cutthroat is being conducted.

Title of Project: Partnerships in Innovative Technology

Agency: National Science Foundation - EPSCoR

Amount: \$545,000 over three years

Term: 10/1/00 – 9/30/03

PI: Dean Charles R. Hatch

Co-PIs: Ernest L Brannon, ARI

Ronald W. Hardy, ARI

Madison S. Powell, ARI

Goal & Objectives: The goal of this funding is to leverage current expertise in fish genetics and nutrition into improved broodstock production, for both rainbow trout and ornamental fish, and to bring scientists from BSU, ISU, IDFG, USFWS, Tribal nations, and the private sector into collaborative research projects.

Title of Project: Genetic analysis of *Oncorhynchus nerka* and chinook salmon

Agency: Bonneville Power Administration

Amount: \$135,000 per year

Term: 1/1/93 – ongoing

PI: Madison S. Powell, HFCES

Co-PIs: Ernest L. Brannon, ARI

Goal & Objectives: This ongoing project uses several genetic analyses to monitor and evaluate the progress of federally endangered Snake River

sockeye salmon. The project also provides technical assistance to the captive broodstock programs underway at IDFG and NMFS attempting to restore both sockeye and chinook populations.

Title of Project: Assessment of Walla Walla River Steelhead.

Agency: Cloumbia River Inter-Tribal Fish Commission

Amount: \$53,000

Term: 2/1/01 – 1/31/02

PI: Madison S. Powell, HFCES

Co-PIs: Andre Talbot, CRITFC

Goal & Objectives: The objective of this project is to reassess current genetic and life history information on steelhead population structure in the Wall Walla River and to provide management alternatives in light of more recent genetic information.

Title of Project: Assessing genetic variation among Columbia Basin white sturgeon

Agency: Bonneville Power Administration

Amount: \$140/000 per year

Term: 1/1/99 – 3/31/02

PI: Madison S. Powell, HFCES

Co-PIs: Paul J. Anders, ARI

Goal & Objectives: This ongoing project uses several genetic analyses to evaluate the structure of white sturgeon populations between each dam on the Columbia and Snake Rivers. The project also provides technical assistance to various agencies and tribes attempting to restore these populations.

Title of Project: Genetic analysis of Kamchatka Peninsula, Russia rainbow trout

Agency: Wild Salmon Center

Amount: *in kind service*

Term: 3/1/01 – 8/31/02

PI: Madison S. Powell, HFCES

Co-PIs: Richard N. Williams

Sergey Pavlov, Moscow

University, Russia

Don Proebstel, Wild Trout

Center

Goal & Objectives: This project uses several genetic analyses to evaluate the population structure of rainbow trout from the Kamchatka Peninsula, Russia.

Title of Project: Genetic analysis of chinook salmon in the Methow River

Agency: Columbia River Inter-Tribal Fish Commission

Amount: \$60,000

Term: 5/1/01 – 7/31/02

PI: Madison S. Powell, HFCES

Co-PIs: Andre Talbot, CRITFC

Goal & Objectives: This project uses microsatellite and mitochondrial DNA analyses to test the relatedness of returning chinook salmon in several Columbia River tributaries including the Methow River where the population is listed as endangered.

Title of Project: Genetic analysis of rainbow trout and redband in Oregon desert basins

Agency: USFWS

Amount: \$5,600

Term: 1/1/01 – 7/31/01

PI: Madison S. Powell, HFCES

Goal & Objectives: This project uses mitochondrial DNA RFLP and microsatellite DNA analyses to evaluate

the population structure and identity of rainbow trout and redband trout from the Harney-Malheur Basin in Oregon.

Title of Project: Breeding matrix for threatened Snake River chinook salmon

Agency: Idaho Department of Fish and Game

Amount: \$8,000

Term: 7/1/98 – ongoing

PI: Madison S. Powell, HFCES

Goal & Objectives: This project provided genetic identities and a breeding plan for captive, threatened chinook salmon from the East Fork Salmon River. The purpose was to breed individuals that were the most distantly related in order to avoid inbreeding problems.

Title of Project: Development of genetically enhanced fish and feeds for aquaculture utilizing specialized grains

Agency: USDA/ARS

Amount: \$226,000

Term: 2001-2005

PI: Ken Overturf, HFCES

FEE-FOR-SERVICE GENETIC ANALYSIS OF FISHERIES STOCKS AND POPULATIONS

In addition to the projects listed above, the following agencies contracted the HFCES to conduct limited genetic analysis of samples from specific fish stocks or populations within their jurisdiction. This service is provided as a 'fee-for-service' to these agencies, meaning that it is provided 'at-cost'.

Current and Previous Contracting Agencies:

- Idaho Department of Fish and Game
- Montana Department of Fish, Wildlife and Parks
- Oregon Department of Fish and Wildlife

- Oregon Department of Environmental Quality
- Nevada Department of Wildlife
- Kootenai Tribe of Idaho
- Columbia River Inter-Tribal Fish Commission
- Nez Perce Tribe
- Confederated Tribes of the Warm Springs Reservation
- Makah Tribe
- Confederated Tribes of the Umatilla Indian Reservation
- Henry's Fork Foundation
- Nature Conservancy
- Montgomery Watson Inc.
- U.S. Fish and Wildlife Service
- Bureau of Land Management (2 regions)
- U.S. Forest Service
- National Marine Fisheries Service

Previous Fee-For-Service Contracts: approximately \$80,000

Current Fee-For-Service Contracts: approximately \$35,000

Pending Fee-For-Service Contracts: approximately \$70,000

Collaborating Scientists, Students, and Interns

1. Dr. Bob Ellis, Boise State University, collaborating scientist in fish nutrition & biochemistry.
2. Dr. Ken Rodnick, Idaho State University, collaborating scientist in fish genetics & physiology.
3. Dr. Gary Thorgaard, Washington State University. Fish for Dr. Thorgaard are being raised at HFCES.
4. Dr. Shulin Chen, Department of Biological Engineering, Washington State University, in connection with

a long-term research study on reducing pollution from fish farms.

5. Sage Chaiyapechara and Ken Liu, graduate students, University of Washington, School of Fisheries, in connection with collaborative research studies on high-performance trout feeds being conducted at the Station.
6. Dr. Dennis Roley, Bio-Oregon, Inc., to assist with cooperative studies on a new salmon fry diet being developed by Bio-Oregon.
7. Dr. Sergey Pavlov, Moscow State University, Moscow, Russia, to conduct collaborative studies of genetic stock structure of steelhead trout from the Kamchatka Peninsula.

In addition, the Station hosted a number of meetings and workshops during 1999-2000.

1. Idaho Aquaculture Association, board meetings and other general membership meetings, held quarterly.
2. Technical Oversight Committee Meetings for Endangered Snake River Sockeye Salmon and Threatened Snake River Chinook Salmon, November, 2000 & 2001.
3. Short course on fish disease diagnosis and prevention, held at HFCEs in September 2000 & August 2001 for Idaho trout industry.

4. Dr. Donald Campton, USFWS, and Dr. Andre Talbot, CRITFC and other principal investigators of the BPA funded "Columbia River Chinook Salmon and Steelhead Population Structure" project to coordinate research activities.

Meetings and Presentations

Ronald W. Hardy:

January, 2001: World Aquaculture Society, Annual Meeting, Orlando, Florida.. Presentation entitled "*Fish Meal: Production trends, historical uses and future outlook.*"

June, 2001: Idaho Aquaculture Association, Annual Meeting, Twin Falls, Idaho To present "Research highlights from the Hagerman Station."

September, 2000 and 2001: Invited lectures (3) in short course presented by Texas A&M University on Fish Feeds and Nutrition.

November 2000 and January 2001, World Aquaculture Society Board meetings.

February, 2001. Sultanate of Oman to conduct a program review of College of Agriculture at Sultan Qaboos University.

March 2001, Bangkok, Thailand, to attend VICTAM, Asian Feed Industry meeting and trade show.

May, 2001. Kodiak, Alaska for research team meeting on ARS Seafood Waste Utilization Project.

September, 2000 and April, 2001: Committee on Animal Nutrition, National Research Council, Washington DC.

Prof. R.J. Roberts:

July, 2001: Short course at Hagerman Station, "Fish Disease Diagnosis and Treatment."

Madison S. Powell:

- February 2001: Oregon American Fisheries Society Chapter: Presentation: "Distributions of Redband Trout in Idaho and Oregon"
- February 2001: Idaho American Fisheries Society Chapter: Plenary Lecture: "Genetics: The Value and Limitations of this Interdisciplinary Approach" and "Implications to the Management of Disease in Salmonids: Using Quantitative PCR for the Detection of IHNV and BKD"
- March 2001: Magic Valley Fly Fishermen "Pacific salmon conservation in Idaho"
- May 2001: White Sturgeon Management Working Group Meeting: "*Genetic Analysis of white sturgeon in the Snake River*"
- June 2001: Landcatch Inc., Stirling, Scotland
Invited lectures: "*Conservation Aquaculture*" And "*Using individual based assignment tests for broodstock identification*"
- June 2001: American Fisheries Society Fish Health Section, Victoria B.C. Presented: "*Quantitative PCR for the detection of *Renebacterium salmoninarum* in chinook salmon*"
- August 2001: Sawtooth Fish Hatchery: Presentation to university and state legislative liaisons: "*Sockeye salmon and chinook salmon conservation in Idaho*"
- August 2001: American Fisheries Society, Annual Meeting, Phoenix AZ. Presentation: "*Phylogeographic Distributions of Redband Trout in Idaho and Oregon Using Mitochondrial DNA*"
- October 2001: U.S.Fish and Wildlife Service, Hatchery Management Workshop. Presented: "*Quantitative detection of *Renebacterium salmoninarum* in chinook salmon: refining broodstock selection.*"

November 2001: International Wild Pacific Salmon Conference, Seattle Washington.

November 2001: Western Fish Disease Center, Seattle Washington. Invited lecture for Applied Biosystems: "*Uses of quantitative PCR for the detection of disease in salmonids*"

Ken Overturf:

- June, 2000: Idaho Aquaculture Association, Annual Meeting, Twin Falls, Idaho. "Use of molecular biology in marker-assisted genetic selection for rainbow trout."
- January, 2001: World Aquaculture Society, Annual Meeting, Orlando, Florida.
"Quantification of specific mRNA transcripts in differentiated tissues for assaying growth rates in trout."
- April, 2001: The Cultivation of Salmon II, "*Molecular analysis of growth and for disease detection in salmonids.*" Bergen, Norway
- April 2001: Landcatch, Ltd. "*Molecular methods for analysis of quantitative traits in salmonids.*" Glasgow, Scotland
- May 2001: "*Molecular biology and genetics in aquaculture research.*" WSU, Pullman, WA.
- May 2001: "*Management of aquaculture species in the molecular age.*" UofI, Moscow, ID.
- June 2001: Idaho Aquaculture Association, Annual Meeting, Twin Falls, Idaho. "*Genetic enhancement of rainbow trout for the utilization of dietary small grains.*"
- October 2001: National Center for Cool and Coldwater Aquaculture, Leestown, West Virginia. "*Genetics and selection in trout and small cereal grains.*"
- November 2001: Buhl Kiwanas, Buhl, Idaho "*Genetics and their manipulation for selection.*"

Michael Casten:

June, 2000 and 2001: Idaho Aquaculture Association, Annual Meeting, Twin Falls, Idaho.

January, 2001: World Aquaculture Society, Annual Meeting, Orlando, Florida.

Jack Cheng:

American Association of Cereal Chemists annual meeting. November 5-9, 2000. Kansas city, Missouri. Two posters entitled: "Effects of moisture content, processing water temperature and immersing time on water stability of pelleted shrimp diets" and "The role of hard red winter wheat and its fractions in water stability of pelleted shrimp diets".

World Aquaculture Association annual meeting. January 21-25, 2001. Orlando, Florida.

American Society of Animal Science annual meeting. July 24-28, 2001. Indianapolis, Indiana. Three oral presentations entitled "Protein requirement re-evaluated for juvenile rainbow trout (*Oncorhynchus mykiss*)", "Apparent nutrient digestibility of fishmeal and poultry by-product meal diets for juvenile Pacific white shrimp (*Litopenaeus vannamei*)", and "Fish meal diet has higher apparent protein digestibility but lower digestibility for DM and fat than feather meal diets for juvenile Pacific white shrimp (*Litopenaeus vannamei*)"

Short course: Aquaculture Feed Preparation, Nutrition, & Feed Management. August 26-31, 2001. College Station, Texas.

"Rendered animal protein meals in aquaculture feeds". July 4-15, 2000. Invited by National Renderers Association. Presented in seven cities in the People's Republic of China, Taiwan, and the Philippines.

"Extrusion technology and its application in feed industry" and "Aquafeed manufacturing technology". September 24-October 22, 2001. Invited by American Soybean Association. Will present in ten cities of the People's Republic of China.

Joel Green:

Dietary Factors Affecting Phosphorus and Nitrogen Retention and Excretion in Rainbow Trout – presented at the Idaho Legislative Briefing, November 15, 2000, University of Idaho, Moscow, Idaho.

Reducing Aquaculture Effluent Nitrogen Through Nutrition: Determination of the Optimum Dietary Amino Acid Pattern for Rainbow Trout (*Oncorhynchus mykiss*) – presented at Aquaculture 2001: the Annual Meeting of the World Aquaculture Society, January 22, 2001, Orlando, Florida.

Effects of stream habitat enhancement on distribution and abundance of steelhead trout (*Oncorhynchus mykiss*) and chinook salmon (*Oncorhynchus tshawytscha*): a long-term evaluation of instream structures in the Crooked River, Idaho – presented at the 131st Annual Meeting of the American Fisheries Society, August 22, 2001, Phoenix, Arizona.

The optimum dietary amino acid pattern for rainbow trout – poster presented at the 131st Annual Meeting of the American Fisheries Society, August 20-23, 2001, Phoenix, Arizona.

Teaching and Outreach

- ❑ Conservation Genetics Course (Wildlife 503) University of Idaho (Powell)
- ❑ Genetic Guidelines for Fisheries Management (U.S. Forest Service) workshop. (Powell)
- ❑ Technical training workshop for Automated Fragment Analysis (Powell).
- ❑ Short course on Fish Disease Diagnosis and Treatment, HFCES, Sept. 2000, two-days, 25 attendees (Roberts, Fornshell & Hardy).
- ❑ Fish Nutrition and Feed Production, Texas A&M University, three lectures,

August 1999 and 2000, 55 attendees
(Hardy)

Publications

Ronald W. Hardy

- Sugiura, S.H., Dong, F.M., and Hardy, R. W., 2000. Primary responses of rainbow trout to dietary phosphorus concentrations. *Aquaculture Nutrition*, 6: 235-245.
- Scolari, M., Luzzana, U., Stefani, L., Mentasti, T., Moretti, V.M., Valfre, F., Lopez, C. and Hardy, R.W. 2000. Quantification of cholesterol oxidation products in commercial fish meals and their formation during storage. *Aquaculture Res.* 31 (10): 785-791.
- Hardy, R.W., 2000. World's largest feed company. *World Aquaculture*, 31(3): 12-14.
- Hardy, R.W., 2001. The Nutritional Pathology of Teleosts. In: *Fish Pathology*, Third Edition, R.J. Roberts (editor). W.B.Saunders, London. Pp. 347-366.
- Hardy, R.W. and Barrows, F.T., 2002. Diet Formulation and Manufacturing. In: *Fish Nutrition*, 3rd Edition, J.E. Halver and R.W.Hardy (editors). Academic Press Inc., New York, NY.
- Barrows, F.T. and Hardy, R.W., 2002. Nutrition and Feeding. In: *Advances in Fish Hatchery Management*, G. Wedemeyer, editor. USFWS.(In press)
- Rathbone, C.K., Babbitt, J.K., Dong, F.M. and Hardy, R.W. 2001. Performance of juvenile coho salmon *Oncorhynchus kisutch* fed diets containing meals from fish wastes, deboned fish wastes, or skin-and-bone by-product as the protein ingredient. *J. World Aqua. Soc.*, 32(1): 21-29.
- Hardy, R.W., 2000. Nutritional deficiencies in commercial aquaculture: likelihood, onset, and identification. In: *Nutrition and Fish Health*, Chhorn Lim and Carl D. Webster (editors). Food Products Press, New York. Pp. 131-147.
- Overturf, K. and Hardy, R.W. 2001. Myosin expression in trout muscle: a new method for monitoring specific growth rates for rainbow trout *Oncorhynchus mykiss* Walbaum on varied planes of nutrition. *Aquaculture Research*, 32(4): 315-322.
- Hardy, R.W., 2001. The Fifth International Symposium on Aquatic Nutrition. *Aquaculture Magazine*, 27 (2): 54-58.
- Hardy, R.W., 2001. Urban Legends and Fish Nutrition, Part 2. *Aquaculture Magazine*, 27 (2): 57-62.
- Hardy, R.W., 2001. Alternatives to fish oil. *Aquaculture Magazine*, 27 (3): 51-54.
- Hardy, R.W., 2001. One size doesn't fit all. *Aquaculture Magazine*, 27 (4): 51-54.
- Forster, J. and Hardy, R.W., 2001. Measuring efficiency in intensive aquaculture. *World Aquaculture*, 32(2): 41-45.
- Sugiura, S.H., Gabaudan, J., Dong, F.M. and Hardy, R.W. 2001. Dietary microbial phytase supplementation and the utilization of phosphorus, trace minerals and protein by rainbow trout [*Oncorhynchus mykiss* (Walbaum)] fed soybean meal-based diets. *Aquaculture Research*, 32(7): 583-592

Madison S. Powell

- Anders, P. and M.S. Powell. *submitted 12/01*. Genetic diversity among white sturgeon (*Acipenser transmontanus*) in the Columbia River based on mitochondrial d-loop sequence divergence. *Molecular Ecology*.
- Gamprel, K. A., K. J. Rodnicik, H. A. Faust, E. C. Venn, M. T. Bennett, L. I. Crenshaw, E. R. Keeley,, M. S. Powell, and H. W. Li. *submitted 7/01*. Metabolism, swimming performance, and tissue biochemistry of high desert redband trout (*Oncorhynchus mykiss* spp.): Evidence for phenotypic differences in physiological function. *Canadian Journal of Fisheries and Aquatic Sciences*.
- Campbell, M., J. Dillon, and M.S. Powell. *in press*. Introgressive hybridization of

cutthroat trout in Henry's Lake, Idaho.
Trans. Amer. Fish. Soc.

Anders, P.J., D. L. Richards, and M. S. Powell.
2001. The First Endangered white sturgeon population (*Acipenser transmontanus*): Repercussions in an altered large river-floodplain ecosystem. American Fisheries Society Special Symposium (on sturgeon). Book due out December.

Overturf, K., S. LaPatra, and M. Powell. 2001. Real-time PCR for the detection and quantitative analysis of IHNV in salmonids. *Journal of Fish Diseases*. 24:325-333.

Brannon, E.L., M.S. Powell, D.E. Campton, A. Talbot, and T.P. Quinn. 2001. Columbia River Chinook Salmon and Steelhead Population Structure. Report for Bonneville Power Administration. 97pp.

Powell, M.S. and P.J. Anders. 2001. Genetic variation among Columbia Basin white sturgeon populations. Annual Report. Bonneville Power Administration, Portland, OR.

Powell, M.S. and J.C. Faler. 2001. Genetic analysis of endangered Snake River sockeye salmon using mitochondrial DNA. Annual Report. Bonneville Power Administration, Portland, OR.

Ken Overturf

Overturf, K. & R.W. Hardy. 2001. Myosin expression levels in trout muscle: a new method for monitoring specific growth rates for rainbow trout *Oncorhynchus mykiss* (Walbaum) on varied planes of nutrition. *Aquaculture Research* 32, 315-322.

LaPatra, S.E., Batts, W.N., Overturf, K., Jones, G.R., Shewmaker, W.D. & J.R. Winton. 2001. Negligible risk associated with the movement of processed rainbow trout, *Oncorhynchus mykiss* (Walbaum), from an infectious haematopoietic necrosis virus (IHNV) endemic area. *Journal of Fish Diseases* 24, 399-408.

Overturf, K., LaPatra, S. & M. Powell. 2001. Real-time PCR for the detection and

quantitative analysis of IHNV in salmonids. *Journal of Fish Diseases* 24, 325-333.

Jack Cheng

Cheng, Z.J., K.C. Behnke, and W.G. Dominy. 2001. Effects of moisture content, processing water temperature and immersing time on water stability of pelleted shrimp diets. *Journal of Applied Aquaculture*. (In press).

Cheng, Z.J., K.C. Behnke, and W.G. Dominy. 2001. Effect of poultry by-product meal diets on growth and body composition of the juvenile Pacific white shrimp (*Litopenaeus vannamei*). *Journal of Applied Aquaculture*. (In press).

Cheng, Z.J., K.C. Behnke, and W.G. Dominy. 2001. Effect of feather meal diets on growth and body composition of the juvenile Pacific white shrimp (*Litopenaeus vannamei*). *Journal of Applied Aquaculture*. (In press).

Cheng, Z.J., K.C. Behnke, and W.G. Dominy. 2001. Defatting poultry by-product meal and feather meal improves pulverizing efficiency and particle size. *Journal of Applied Aquaculture*. (In press).

5. Cheng, Z.J., R.W. Hardy, W.G. Dominy, and K.C. Behnke. 2001. Rendering animal protein: Application in shrimp feed. *Feed International China Edition*. 17 (1):28-30.

Joel A. Green

Green, J.A., Hardy, R.W. and Brannon, E.L. 2002. Effects of dietary phosphorus and lipid levels on utilization and excretion of phosphorus and nitrogen by rainbow trout (*Oncorhynchus mykiss*) 1. Laboratory-scale study. *Aquaculture Nutrition, in press*.

Green, J.A., Brannon, E.L. and Hardy, R.W. 2002. Effects of dietary phosphorus and lipid levels on utilization and excretion of phosphorus and nitrogen by rainbow trout (*Oncorhynchus mykiss*) 2. Production-scale study.

Authors: Aquaculture Nutrition, *in press*.

Other Notable Activities

Ronald W. Hardy

1. Appointed to the National Research Council (Natl. Acad. Science.) Committee on Animal Nutrition, 2000-2002
2. Elected as Vice President of the World Aquaculture Society, 2001-2002
3. Continued as permanent columnist for "Feeds and Nutrition" in Aquaculture Magazine
4. Co-editor of international scientific journal, *Aquaculture Research*

Madison S. Powell

1. 1999-present Fisheries Genetics Consultant (Montgomery Watson Inc.)
2. 1998-present White Sturgeon Genetics Workgroup. (Bonneville Power Admin.)
3. 1996-present Technical Oversight Committee for Threatened Snake River Chinook Salmon. (Bonneville Power Admin.)
4. 1995-present Technical Oversight Committee for Endangered Snake River Sockeye Salmon. (Bonneville Power Admin.)

Ken Overturf

1. Appointed to the Research Subcommittee, Western Regional Aquaculture Center, 2001-2003.

Ronald J. Roberts

1. Completed 3rd Edition of "**Fish Pathology**" for Academic Press. This reference book is the standard text in the field of fish diseases throughout the world., and will list his affiliation at UI, Hagerman.
2. Continued as permanent columnist for "Feeds and Nutrition" in Aquaculture Magazine.