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DOE/EPSCoR TRAINEESHIP PROGRAM
PROGRESS REPORT
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Submitted by

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INTRODUCTION

This Progress Report reviews the University of Wyoming's approach to implementing the DOE Traineeship Program, and briefly describes the research performed by our DOE/EPSCoR Trainees during the academic year, 1992-1993. A review of the DOE/EPSCoR Traineeship Program in the first year, AY 1991-92 is included to give the foundation upon which the current program has been constructed. A summary discusses the impact of the Traineeship Program at the University.

YEAR ONE, 1991-1992

In the first year of the Traineeship Program supported by Department of Energy EPSCoR funding, the University of Wyoming made good progress toward the objective of increasing the supply of highly trained engineers and scientists with interests in energy-related disciplines.

IMPLEMENTATION

After notification of the initial funding of our DOE-EPSCoR Traineeship proposal, the DOE-EPSCoR Committee decided to emphasize the recruitment of new domestic graduate students in targeted disciplines, with special attention to under-represented minorities. To maximize the impact of the DOE funding, a competitive award process was implemented, starting with a general notification to faculty that traineeships would be awarded for graduate students working on energy-related research projects. Faculty were invited to submit brief proposals documenting appropriate research projects, the academic records of the proposed students, and a proposed budget. A review committee, composed of the Project Director, the Dean of the College of Engineering, and the Dean of the College of Arts & Sciences, met to decide which students would be funded and what the level of funding would be. A stipend of $1000/month, to include summer months, was deemed adequately competitive at the University of Wyoming. Considering the University's contribution toward tuition and fee costs and the mix of Wyoming resident and nonresident students, we found that the average funding needed for each student was approximately $14,700 for the funding year, allowing the award of 17 DOE

traineeships. Seventeen students were selected the first year, distributed among departments as listed in Table 1.

Table 1. Number of DOE/EPSCoR Traineeships, 1991-1992, by University Department.

Department	Number of Trainees
Chemical Engineering	2
Chemistry	1
Civil Engineering	1
Electrical Engineering	3
Environmental Biology	2
Geology & Geophysics	3
Mathematics	2
Mechanical Engineering	1
Petroleum Engineering	1
Statistics	1

RESEARCH ACTIVITIES

The research activities of each of these students is summarized in our 1992 progress report (DOE Report No. DOE/ER75665-1). As a group, these students and associated faculty had an important influence on research at the University of Wyoming, improving our focus on energy and the environment, increasing the number of students actively engaged in research at the University, and laying the foundation for increased student involvement in research in the following years.

YEAR TWO, 1992-1993

During the second year of the Traineeship Program, the University of Wyoming continued to make good use of this funding to increase the supply of young engineers and scientists trained in energy-related fields by involving University graduate students in ongoing

critical research. These traineeships also helped the University to build research programs in key departments toward more competitive levels.

IMPLEMENTATION

The competitive selection process developed during Year 1 of the Traineeship Program was again used successfully during Year 2. The DOE/EPSCoR Committee (rather than a committee composed of the Project Director and two Deans, as in Year 1) made the selection of trainees, starting with a clean slate at the beginning of Year 2 and meeting several times during the biennium as positions became available. The stipend of $1,000 per month (a total of $14,700 per year, with average tuition, fees, and travel included) was continued; the additional cost to the Trainees of tuition increases during 1992-1993 was absorbed by the University. The $14,700 annual cost per Trainee allowed an average of 17 Traineeships to be active at any given time; eight students continued their Traineeships from Year 1 and 9 new recipients were selected during Year 2.

Table 2. Number of DOE/EPSCoR Traineeships, 1992-1994, by University Department.

Department	Number of Trainees
Chemical Engineering*	2
Chemistry	3
Civil Engineering	1
Electrical Engineering	5
Geology and Geophysics	5
Mathematics	1
Mechanical Engineering	4
Petroleum Engineering*	3
Range Management	1
Zoology	2

*The Chemical Engineering and Petroleum Engineering departments were combined November 1, 1993 into the Chemical and Petroleum Engineering Department. In this report, they are treated as separate departments.

RESEARCH ACTIVITIES

Since graduate students who were completing their degrees left the program and others replaced them, the research activities summarized here include various students who have been active during the program, not all of whom have as yet completed their work.

Chemical Engineering Department

Paul Jacobs has been a Trainee during Years 1 and 2 of the Program, and will finish his DOE/EPSCoR Traineeship August 31, 1994. He will complete a Ph.D. dissertation on *The Chemical Modification of Cobalt-Molybdate Catalyses Supported on Gamma-Alumina to Improve Coal Liquefaction Performance* in the spring or summer of 1994.

Paul's faculty associate in his project is his advisor, Dr. Henry Haynes. At least eight publications and presentations have resulted from Paul's research.

Mark Welegala was a Trainee during Years 1 and 2 of the Program, and finished his DOE/EPSCoR Traineeship August 31, 1993

The objective of Mark's research has been to build an electronic containment device for single-crystal sorption uptake experiments and to obtain diffusion coefficients for a simple zeolite-adsorbate system. As the required cell geometry differs significantly from conventional designs currently in use, design software was also developed to aid in stability and applicability for his specific crystal size. To enhance the quality and tailor the size of his zeolites and to eliminate any possible commercial contamination, lab samples were grown for his use.

Mark's faculty associate in his research is his advisor, Henry Haynes.

Chemistry Department

Scott Campbell has been a Trainee during Years 1 and 2 of the Program, and will finish his DOE/EPSCoR Traineeship during 1994. He plans to complete a Ph.D. dissertation on *The Electronic Structure of Molecular and Solid-State Transition-Metal Sulfide Systems* in the spring of 1996.

Scott's research has focused on the electronic structure of molecular and solid-state transition-metal sulfide systems. His initial calculations, recently completed, considered several six-coordinate trigonal prismatic molybdenum-sulfur complexes. These calculations enabled Scott to interpret the bonding in $[Mo(CO)(PPh_3)(^{bu}S_2)_2]$ ($^{bu}S_2$ = 3,5,-di-t-butyl-1,2-benzenedithiolate($^{2-}$)). This complex is unusual in that carbon monoxide (CO) doesn't normally bind to a high-oxidation-state metal; this complex formally contains a Mo^{4+} center. Scott's

calculations showed that while it is correct to view the metal in this complex as a Mo^{4+} center, the sulfur-containing dithiolate ligands are very strong electron donors. They provide sufficient electron density to the metal center to bind the CO ligand. In effect, electron density is transferred from the sulfurs, *through* the metal orbitals, to the CO ligand.

Scott's faculty associate in his research is his advisor, Suzanne Harris. Two manuscripts are completed or in preparation.

Chris Schnabel was a Trainee during Years 1 and 2 of the Program, and finished his DOE/EPSCoR Traineeship August 31, 1993. He is completing his Ph.D. dissertation, (Fluoroalkyl)phosphine Complexes of Rhodium and Iridium, in December 1993.

Chris spent a two-week internship at Los Alamos National Laboratory during the summer of 1992, where he worked with Carol Burns in the INC-1 (Inorganic and Nuclear Chemistry) Group. His research involved the synthesis of new (fluoroalkyl)phosphine complexes of the actinide elements, particularly uranium, with the goal of designing robust actinide complexes with novel physical and chemical properties. Preliminary results were obtained which indicated that such complexes are feasible, although in the limited time full characterization of these compounds was not achieved. A continuing collaboration with the INC-1 Group on developing the chemistry of (fluoroalkyl)phosphine actinide complexes resulted from Chris's internship.

Chris's research focused on the development of novel homogeneous transition metal catalysts for selective hydrocarbon cracking (petroleum reforming) and dehydrogentation using fluorocarbon-protected transition- metal complexes.

Chris's faculty associate in his research is his advisor, Dean Roddick.

During his DOE/EPSCoR Traineeship, he received a National Science Foundation Grant, Hydrocarbon Activation and Decarbonylation Chemistry of Iridium and Ruthenium Fluoroalkylphosphine Complexes, November 1993-1997, for $293,500.

Four publications have resulted from Chris's research work.

Electrical Engineering Department

Victor Bershinsky has been a Trainee during Year 2 of the Program, and will finish his DOE/EPSCoR Traineeship August 31, 1994. He intends to finish his M.S. thesis on An Instrument for the Measurement of Electrical Power Consumption, Efficiency, and Load Balancing of Electric Motors in the spring of 1994. During the academic year, Victor works in the Electric Motor Testing and Training Center at the University of Wyoming.

Victor participated in internships during the summers of 1992 and 1993 at Naval Petroleum Reserves No. 1, under the direction of Lt. Commander Lee Thomas, U.S.N., and Naval Petroleum Reserve No. 3, under the direction of Lieutenant Bill Shoemaker. Research involved developing a testing procedure that would allow the testing of a large number of motors that were operating in these oil fields and determine if the motors were operating efficiently. In addition to developing the test procedure, Victor has been designing an instrument that will test the efficiency of an electric motor that is operating with only a small amount of process interruption. This meter estimates the operating efficiency of an electric motor on the basis of the input power to the motor and the motor's rated horsepower. The development of this meter is the topic of Victor's thesis.

Thomas Nichols was a Trainee during Year 2 of the Program, and will finish his DOE/EPSCoR Traineeship during 1994.

The ability to accurately determine motor loading and efficiency in the field is crucial for implementing cost-effective energy saving programs. Thomas's research concerns a new method, based on the motor manufacturer's efficiency versus load curve, to estimate motor loading and efficiency.

Thomas's faculty associate in his work was his advisor, Sadrul Ula.

Damon Van Buren has been a Trainee during Year 2 of the Program, and will finish his DOE/EPSCoR Traineeship August 31, 1994. He will complete an M.S. thesis on A Combined Series-Active, Shunt-Passive Filter Approach to the Removal of Power System Harmonics in the spring of 1994.

Damon participated in internships during the summers of 1992 and 1993 at Naval Petroleum Reserve No. 1, under the direction of Lt. Commander Lee Thomas, U.S.N., and Naval Petroleum Reserve No. 3, under the direction of Lieutenant Bill Shoemaker. Field measurements involved comparing motor power input with rated output to get an indication of motor operating efficiency.

Damon's research involves the removal of harmonics from a power system using an active filter in conjunction with a shunt passive filter. The standard approach for correcting a problem with harmonics is to install a passive filter at the point where there is an excess of harmonics; this approach is often ineffective. Damon's research has found that the addition of an active filter will greatly improve the performance of the passive filter, without the need for large

power handling capability. The hardware for his research has been constructed, and he has run extensive computer simulations on the effectiveness of the filter under different conditions. Damon has begun testing the passive/active filter combination with light loads, and this testing should be completed during the spring of 1994.

Brenda Bujanowski has been a Trainee during Year 2 of the Program, and will finish her DOE/EPSCoR Traineeship August 31, 1994. She plans to complete her M.S. thesis on System Identification with Application to Power Systems in December 1994.

Brenda participated in an internship at the Pacific Northwest Laboratories in Richmond, Washington, June 7 through August 6, 1993. PNL is operated by the Battelle Memorial Institute under contract with the Department of Energy. Working under Dan Trudnowski, Brenda evaluated recent commercial software for use in system identification of power systems, and performed related tasks.

Brenda has conducted a background study of system identification as applied to power systems, and has investigated the implementation and testing of three different algorithms; results of these investigations were presented in an Electrical Engineering Graduate Seminar April 16, 1993, and were expanded into the paper cited below.

Brenda's faculty and mentor associates in her work have been her advisor, Dr. John Pierre, and Don Pierre and his students at Montana State University.

One publication has resulted from Brenda's research.

Geology & Geophysics Department

Jack Diebert has been a Trainee during Year 2 of the Program, and will finish his DOE/EPSCoR Traineeship August 31, 1994. He plans to complete a Ph.D. dissertation on *Sedimentology, stratigraphy, and sequence stratigraphic analysis of the Cenomanian-Turonian Greenhorn transgressive-regressive cycle of southwestern Utah* in the fall of 1994.

During the summer of 1993, Jack completed an industry-related internship. He examined Cretaceous sandstone outcrops in southern Utah with petroleum geologist Gus Gustason of British Petroleum, Alaska. The sandstone outcrops were ancient analogs for many shallow marine and fluvial sandstone reservoirs. The purpose of the internship was to examine, discuss, and analyze lithologic variations within interbedded sandstone and mudstone units that produce flow heterogeneities within petroleum reservoirs. The internship provided valuable information concerning type, scale, and extent of flow heterogeneities involved in the production of

hydrocarbons from these types of sandstone reservoirs. This information allowed Jack to more accurately quantify flow units and flow boundaries in his analog outcrop study.

Jack will continue to analyze data collected to date, using photomosaic cross sections indexed by careful sequence stratigraphy to derive the expected dimensions of shallow marine shoreface sandstone bodies.

Jack's faculty associate has been his advisor, James Steidtmann, and his chief mentor has been Gus Gustason of BP.

Jack's research has resulted in three professional presentations.

Anthony Hoch has been a Trainee during Year 2 of the Program, and will finish his DOE/EPSCoR Traineeship August 31, 1994. He plans to complete his Ph.D. dissertation on The Dissolution Mechanism of Iron-Bearing Augite in Volcanic Tuff, , Snowshoe Mountain, Colorado in the fall of 1995.

Early in the summer of 1993, Anthony became affiliated with the U.S. Geological Survey, Water Resources Division, National Research Program in Boulder, Colorado. He spent several days a week, through the summer, working in the laboratory of Michael Reddy of the U.S.G.S. It is from this association that his dissertation project emerged.

Although he is working alone on this project, Anthony has made regular presentations at a weekly seminar on work in progress attended by Dr. Drever's six graduate students.

Anthony's faculty associates and mentors include his advisor, Tim Drever, Ron Frost, George Vance (Soils Department), Daniel Buttry (Chemistry Department), and Michael Reddy (U.S.G.S.).

Anthony will submit an abstract of his results to date to the American Geophysical Union for their National Meeting in Baltimore in May 1994.

No publications or presentations have resulted from Anthony's work while a DOE/EPSCoR Trainee, to date.

Scott Johnson has been a Trainee during Year 2 of the Program, and will finish his DOE/EPSCoR Traineeship during 1994. He plans to finish his M.S. thesis on *Groundwater Circulation Along Fault-Cored Structures* in May 1994.

Scott is hoping to participate in an internship doing groundwater research at the Hanford Nuclear Weapons Site during the summer of 1994.

The essence of Scott's thesis project is to identify the geologic factors that cause

localization of permeability in the attenuated parts of major range-bounding thrust faults in the Wyoming Foreland Province. His project area straddles the Hanna Basin and Shirley Mountains, and his effort is focused on well-indurated Paleozoic and Mesozoic sedimentary rocks in the hanging wall of the Shirley Mountain thrust fault. The permeability architecture in this zone has been found to be dominated by minor fractures associated with the faulting and folding, and by intergranular permeability within the clastic units.

Scott's faculty associates and nonfaculty mentors are his advisor, Peter Huntoon, Tim Drever, Todd Jarvis (Weston Groundwater Engineering), Jim Case (Wyoming Geological Survey), and personnel at the Wyoming Water Resources Center (University of Wyoming) and the State Engineer's Office in Cheyenne.

Directly as a result of Scott's participation in the DOE/EPSCoR program, Scott's advisor, Peter Huntoon, obtained a grant, *Permeability Architecture along the Attenuated Traces of Major Range-Bounding Wyoming Foreland Thrust Faults.*, Wyoming Water Center FY 1994 States Grants Program, for $25,917.

Debi Maucione was a Trainee during Years 1 and 2 of the Project, and finished her Traineeship in May 1993. She finished her M.S. thesis, *Seismic Reflection Delineation of Abnormally Pressured Zones in the Powell Field of the Powder River Basin, Wyoming*, in December 1993. She is currently pursuing her Ph.D. in Geology under the direction of Dr. Ron Surdam.

Debi recently spent six months participating in an internship with Amoco Production Company, working in both the International Business Unit and the Worldwide Exploration Business Group.

Debi's research as a Trainee contains two results of importance for the oil and gas industry. First, she has used older data that is available but currently not being used, and through application of modern technology (processing software and interpretative work stations) has obtained further information that helps to delineate accumulations of hydrocarbons associated with abnormally pressured zones in sedimentary basins. That is, her method uses available resources to find additional accumulations of hydrocarbons. Second, she has shown that additional information about rock properties can be obtained from attribute analysis of reprocessed seismic sections. This information in turn can help in the delineation of abnormally pressured hydrocarbon accumulations.

Debi interacted frequently with other students in Scott Smithson's geophysics research group, particularly Yue Wang, Dan Willert, Nathen Weber, John Buggenhagen, John Rivas, Nick Boyd, Paul Valasek, Sharon Kubichek, and, in Ron Surdam's diagenesis research group, Lars Hubert.

Debi's faculty associates and mentors were her thesis advisor, Scott Smithson, Ron Surdam, Bill Iverson (Petroleum Engineering Department), Vlademir Serebryakov (visiting researcher from Russia), Marty Williams (Amoco, Denver), and Roger Harris (Amoco, Houston).

Four publications have resulted from Ms. Maucione's research.

Mathematics Department

John Spitler was a Trainee during Years 1 and 2 of the Program, and finished his DOE/EPSCoR Traineeship in August 1993. He plans to finish his Ph.D. dissertation on *Modeling Nonlinear Elastic Waves Using a System of Conservation Laws* in the spring of 1995.

During May 1992, John visited the Oak Ridge National Lab, where he met with Dr. Robert Ward, Director, to discuss the possibility of incorporating techniques developed there for handling nonlinearities that arise in modeling contaminate flow in both porous media and the atmosphere. The visit led to attacking the seismic problem from the standpoint of a system of nonlinear conservation lows. John presented results of this work at the 1993 SIAM Geoscience Conference.

John worked on modeling techniques important in seismic prospecting. Forward solving routines for two- and three-dimensional finite difference models utilizing linearized versions of the governing equations have been developed in recent years, and work well away from sources and interfaces. The focus of John's research work was the development and analysis of schemes that include the nonlinear terms at interfaces in particular.

John interacted frequently with other students in Richard Ewing's research group in the Mathematics Department, particularly Hong Wang and Jien Shen, both of whom will earn, or have earned, their Ph.D.'s at Texas A&M University with Ewing.

John's faculty associates and mentors include his former advisor Richard Ewing, his present advisor Myron Allen, Patrick O'Leary, and James Sochaki (George Mason University).

Mr. Spitler has presented one paper based on this work.

Mechanical Engineering Department

Wayne Foslien has been a Trainee during Year 2 of the Program, and will finish his DOE/EPSCoR Traineeship during 1994. He plans to complete his M.S. thesis on *Temperature Gradient Metamorphism of Snow, Using Mixture Theory* in May 1994.

Wayne participated in an internship at Battelle Pacific Northwest Research Laboratories (PNL) in Richland, Washington from May 24 to July 24, 1993, working under Lucia Liljegren in the Analytical Sciences Department. His work involved deriving the particle-fluid interaction termis in the turbulent kinetic energy equations for two-phase flow. His work helped verify that Dr. Liljegren's work was correct. He also started deriving the turbulent dissipation interaction terms, and Dr. Liljegren is planning to perform experiments to verify that the form of these interaction terms is correct. She will submit a paper, with Wayne as coauthor, that includes his work to *Physics of Fluids*.

Problems of a multiphase nature were the driving force behind the development of the continuum theory of mixtures. Modern mixture theory is founded on the idea that a multiphase continuum may be modelled as a collection of superimposed continua so that each constituent is assumed present at every point on the continuum. Wayne is investigating application of the continuum mixture theory to problems involving thermomechanical interactions. The specific problem under investigation is the temperature gradient metamorphism (TGM) of a snow cover. TGM is one of the key mechanisms responsible for acid pulse flushing of snow packs. Acid buildup in snow is often attributed to pollutants from coal-fired power plants. Acid pulsing occurs when as much as 50-80 percent of the acid in a snow cover is released during the first significant spring melt, causing destruction of fragile environments. Wayne's current task is writing mathematical models of temperature gradient metamorphism of snow using mixture theory.

Wayne's faculty associate is his advisor, Andrew Hansen, and his mentor for this research is Lucia Liljegren (PNL).

No publications or presentations have resulted from Wayne's work while a DOE/EPSCoR Trainee, to date.

Petroleum Engineering Department

Shari Kenuit was a Trainee during Year 2 of the Project and hopes to finish an M.S. degree in 1994.

Spontaneous potential logs of wells in Big Hollow, a deflationary hollow, show saline water in the Muddy Sandstone at a depth of 870 feet and fresh water in the Cloverly Formation at a depth of 1,000 to 1,140 feet. These two sands are separated by an aquitard, the Thermopolis Shale. Groundwater recharge to the Cloverly Formation appears to originate at an outcrop southeast of Big Hollow. Because the Cloverly is continually being recharged, its water is relatively fresh. The Muddy Sandstone is very heterogeneous; it is a shaley sand with fluvial channels cut into the formation. It is these channel sands that make the Muddy an oil producer. The water present in the fluvial sands is probably not subject to surficial recharge because of the geometry of the sands. Because these channel sands do not receive recharge, the water seen on the well logs is probably irreducible connate water and is therefore more saline than the Cloverly Formation water. Verification of this idea is impossible at this time because of the paucity of subsurface data for the area. This study will be the basis of Shari's research.

Stan Lawrence has been a Trainee during Year 2 of the Program, and will finish his DOE/EPSCoR Traineeship August 31, 1994. He plans to complete his Ph.D. dissertation on *The Determination of Fracture and Joint Orientations in the Subsurface to Facilitate Hydrocarbon Exploration in Tight Gas Sands* in the fall of 1995.

Stan brings 17 years of work in major oil companies to his project. Researchers at the DOE Petroleum Energy Research Laboratory in Bartlesville, Oklahoma, who have similar interests to Stan's in oil and gas exploration and production in Wyoming, provided him with documents on his research topic not available in Wyoming. Stan's subject area requires a mature knowledge of several traditional engineering disciplines that must be integrated to produce a viable solution. Geology, geophysics, and petroleum engineering combined with digital signal processing of data acquired via remote sensing have dominated Stan's research efforts.

Stan's faculty associates in his research are his advisor, M.P. Sharma, and Bill Iverson, because of Bill's expertise in geophysics.

No publications or presentations have resulted from Stan's work while a DOE/EPSCoR Trainee, to date.

Timothy Pope has been a Trainee during Year 2 of the Program, and will finish his Traineeship August 31, 1994. He plans to complete his M.S. thesis on *The Scalability of Core Flood Data* in the spring of 1995.

Tim made a four-day visit to EGG Research Company at INEL in Idaho during the

summer of 1993. Eric Robertson, a former student at the University of Wyoming, was Tim's sponsor for the visit: he gave Tim a tour of the facility, and demonstrated an interfacial tension machine that they had developed.

Tim is currently (January 1994) assembling and debugging a core flooding apparatus that he will be using to acquire unsteady-state, and possibly steady-state, relative permeability data as well as dynamic capillary pressure data. He has also designed a data collection for the core flood experiments: the data collection system integrates the data from two pressure transducers and an analytical balance, all connected to a PC.

He looks forward to starting his coreflood experiments in the near future.

Tim's faculty associates in his research are his advisor, Norman Morrow, and Brian Towler. Tim has contributed to a paper that may be published by Dr. Towler in the near future.

No publications or presentations have resulted from Tim's work while a DOE/EPSCoR Trainee, to date.

Range Management Department

Susan Hasenjager has been a Trainee during Year 2 of the Program, and will finish her DOE/EPSCoR Traineeship August 31, 1994. She plans to complete a Ph.D. dissertation on *Computerized Plant Species Selection for Mineral-Land Reclamation* in the spring of 1995.

She is currently building a menu-driven computer model and compiling a database. A comprehensive literature review will be the basis of a technical review article for the Journal of Range Management. Susan's research will result in a user-friendly database and retrieval system, menu-driven model, manual, and technical review. The objective of her research is to provide a viable method for determining appropriate mixtures of plant species for mine reclamation.

Susan's faculty associates in her research are her advisor, Jeff Powell, William Laycock, and Gerald Schuman, Larry Munn, and Jeff Murphy (Plant, Soil, and Insect Sciences Department).

No publications or presentations have resulted from Susan's work while a DOE/EPSCoR Trainee, to date.

Zoology Department

John Baldwin was a Trainee during Years 1 and 2 of the Program, and finished his Traineeship August 31, 1993. He completed his M.S. thesis, *Foraging Ecology and Movements of Wintering Waterfowl in the Fraser River Delta, British Columbia and the Puget Trough*, in December 1993.

John participated in an internship at the Battelle Pacific Northwest Laboratories at Sequim, Washington, during the summers of 1992 and 1993. He assisted for several weeks in seagrass research and the writing of management guidelines for the types of bays and estuaries in that area for the State of Washington.

John's study area was a large marine bay with extensive tidal flats in southwest British Columbia and northwest Washington. He completed two extensive eight-month field seasons in the area. His task was to describe the ecology of this system, the effects of the spread of an introduced seagrass, and the importance of this system to wintering and migrating waterfowl. There was a void of knowledge in these areas; and as this bay is very susceptible to oil pollution from several refineries and shipping lanes, data was needed to aid in protecting the wildlife, but also to protect oil companies from unnecessary litigation in the event of an accident.

Six publications have resulted from this research.

Aïda Farag was a Trainee during Years 1 and 2 of the Program, and finished her Traineeship September 31, 1993. She completed her Ph.D. dissertation,*The Physiological Impairment of Brown Trout (*Salmo Trutta*) and Rainbow Trout (*Onchorynchus mykiss*) Exposed to Metals Via the Water and Diet in the Clark Fork River, Montana*, in December 1993.

Aïda's planned visit to Oak Ridge National Laboratory in the fall of 1993 was postponed because of the hosts' scheduling problems. She currently plans to visit the Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee, to be hosted by Dr. Sig Christensen, in the near future. She has been invited to give a seminar and discuss possible future collaboration.

Aïda has a postdoctoral position with the U.S. National Biological Survey, at a field station of the National Fisheries Contamination Research Center in Jackson, Wyoming. The project leader, Dan Woodward, has conducted research of the effects of metals, fuel oil, products of oil shale, and pesticides on freshwater fish.

Aïda found the health of the fish population in the upper Clark Fork River to be impaired

because of elevated concentrations of As, Cd, Cu, Pb, and Zn in the surface water and the aquatic invertebrates. The metals in the environment were associated with high concentrations of tissue metal residues, products of lipid peroxidation and metallothionein, and presence of microscopic Cu inclusions and scale loss. High concentrations of tissue metal residues and products of lipid peroxidation were also associated with decreases in growth and survival.

Nine publications have resulted from Ms. Farag's research.

SUMMARY

These brief descriptions of individual research projects demonstrate the wide scope of energy-related research that the DOE-EPSCoR Traineeships have initiated in Wyoming. The availability of this funding has encouraged many talented students to continue their education in fields of interest to DOE. These additional bright, energetic graduate students have improved the educational atmosphere for everyone. The visibility of the DOE program has sharpened the focus of the science and engineering departments on the energy-related research of importance to Wyoming and DOE.

The original proposal indicated that any increases in tuition and fees for graduate students would be absorbed by the University. As promised, UW has made up this difference, and has considered it as a contribution to the DOE-EPSCoR Traineeship Program.

The DOE-EPSCoR Traineeship Program has been and continues to be coordinated with a university-wide effort to develop and improve graduate programs and undergraduate curricula, and to form interdisciplinary centers for energy-related research where the training of young engineers and scientists can be carried out in an optimal educational environment. Three such new research centers have been formed: the new, multi-college School of Environment and Natural Resources (SENR), to implement undergraduate, graduate, and research programs in environmental and natural resource studies; the Institute for Energy Research (IER), to pull together the University's strengths in fundamental and applied research into the emplacement, history, delineation, and production of Wyoming's valuable hydrocarbon resources; and the Western Coal Consortium, initiated in the Chemical and Petroleum Engineering Department to bring major Wyoming coal companies into joint research efforts with University faculty.

The impact of the DOE Traineeships in Wyoming has been substantial and very positive.

It has not only increased the number of students studying in energy-related disciplines, but has also increased the quality of their graduate research. The program has also increased the visibility of DOE in Wyoming and has helped us focus our attention on the energy and environmental graduate education which is so essential to our University and our State.