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*"Privatization Through Partnership: A Program to Assist the Institute of Biology of Inland Waters to Move From Government Support to Self-Sufficiency"*

US AID/IREX PROJECT No. U4V061

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**A. INTRODUCTION:**

Russia is experiencing a difficult social, economic and political transition from reliance on centralized governance to a market-based economy. In the more remote regions, obtaining goods and services and providing a financial base with which to support a local economy without central government support are often much more difficult than in larger centralized cities. Historically, large cities in Russia have served as centers from which goods and services are redistributed to remote locations. Cities and towns remotely located from Moscow or St. Petersburg have relied on economic opportunities provided by government-supported academic and research institutions. Although this reliance is expected to change under economic restructuring, the present Russian government continues to direct the activities of many institutes of the Russian Academy of Sciences (RAS), but with much lower levels of support.

The RAS consists of more than 500 institutes distributed over 11 time zones. Under the old Soviet system, these institutes and laboratories were supported by the government to conduct basic research, with the result that Russian science is among the best in the world. However, with the collapse of the Soviet system and the transition to democratic governance and a market-based economy, the Russian government can no longer afford to support this research at public expense. Already, the government has been unable to pay salaries to the staff of these organizations for months at a time. Hence, a likely avenue towards self-sustainment is through privatization, either as a for-profit or non-profit organization. This project proposes to assist our sister institution, the Institute of Biology of Inland Waters (IBIW) in Borok, Russia to move in that direction.

**B. SPECIFIC ACCOMPLISHMENTS DURING THIS PROJECT:**

**B.1. Overall Training Components:**

To begin the formal training component for our Russian partners, we submitted the Training Implementation Plan for the five scientists, as well as the TIP for the senior scientists expected to visit in mid-October. In addition, we submitted a second Memorandum of Training. The Russian scientist trainees (J. Flerov, V. Komov, Y. Gerassimov, A. Roussinov, and G. Tchuiko) arrived in Clemson on August 29, 1995. The Russian senior scientists (Alexander Ivanovich Kopylov, Vladimir Vjacheslavovich Khalko, Boris Alexandrovich Flerov, and Pavel Pavlovich Umorin) arrived on October 16, 1995.

The initial training program primarily involved getting the Russian scientists comfortable in a training and research routine at Clemson University. Specifically, the trainees learned aspects of aquaculture: establishing the physical plant, stocking and feeding rates, maintenance procedures for the physical plant and fish health, and the financial aspects (costs, rates of return, the economic aspects of different aquaculture alternatives (e.g., choice of species, feed, temperature, size of enclosure, etc.) of establishing such a venture. The majority of this training component took place in the Departments of Aquaculture, Fisheries and Wildlife (AFW), and Agricultural and Applied Economics. Three of the Russians (Flerov, Gerassimov, Roussinov) had their primary responsibilities in this area of training.

The specific skills developed by the two individuals (Tchuiko and Komov) with responsibilities in the contaminant assessment/consulting component of this training included learning the economic aspects of conducting ecological risk assessments: they helped in sampling, chemical analyses, establishing teams of experts, and began to learn about hourly charge and overhead rates, and how to write proposals. In writing proposals (each participated on at least one), they learned how to build an economically viable team to work with government or industry in a cost-effective manner to assess the hazard of contaminants in freshwater ecosystems and recommend mitigation measures.

A primary skill learned by Tchuiko was the analysis of organic contaminants (such as PCBs, dioxins, pesticides, etc.) via gas chromatography and high- pressure- liquid- chromatography (HPLC). A primary skill learned by Komov is understanding *Dreissena* (zebra mussel) life history dynamics and controls, as this is a problem in the US and Russia and could easily lead to future cooperative studies. This component of training took place primarily at the Department of Environmental Toxicology and the Institute for Wildlife and Environmental Toxicology (TIWET).

The Russians audited a number of courses at Clemson: Please note they did not take classes for credit or for a degree program; merely, they had asked to sit in on lectures or seminars to enhance their understanding of certain topics. Gerassimov and Tchuiko sat in on a course in "English for Foreigners;" Flerov and Roussinov audited a basic agricultural economics course, all participated in seminars in Aquaculture, Fisheries & Wildlife or Department of Environmental Toxicology. During Spring semester, Komov and Tchuiko audited a course in Animal Biomarkers, taught in the Department of Environmental Toxicology.

## **B.2. Establishing a routine at Clemson University:**

During their initial weeks in the US, we brought them up-to-date concerning life in Clemson: we helped them to obtain Social Security numbers, Clemson University Faculty identification cards, and a checking/savings account at a local bank. J. Flerov, A. Roussinov and G. Tchuiko obtained SC State driver's licenses. They obtained a vehicle via Flerov's brother, who lives in Birmingham, AL. They purchased full auto insurance for their local travel using their own funds. Drivers licenses were necessary for several reasons: First -and unfortunately- there is no public transportation system in Clemson or surrounding towns. One must have access to a car to get to grocery stores, downtown, the campus, and out to the TIWET, located approximately 4 miles from the Clemson University campus. For the eight month duration of the Russians' stay in Clemson during each year, it was deemed untenable for US team members to be on-call to ferry the Russians everywhere locally. In addition, elements of training at the Clemson University aquaculture facility required the trainees to drive a University truck to haul fish, water, feed, and other materials. Clemson University policy requires a valid South Carolina state driver's license to operate university vehicles. Finally, a driver's license is required to establish a personal checking account and to sign up for utilities at the local address in Clemson for the Russians: 253 N Clemson Blvd., #1.

During September, we began the training program with visits to the various Clemson University academic departments within which the Russians have undertaken their specific programs of training. Specifically, we oriented them to departmental affairs, such as the use of E-mail, LANs, purchasing, and personnel. In addition, they learned how to use the library and other Clemson University resources (e.g., bookstore, mail room, copying).

All participants gained from the synergy involved in this multi-disciplinary program. All trainees learned safety aspects of aquaculture and contaminant research, such as those described in Occupational Health and Safety seminars at Clemson, Animal Research and Chemical Hazard protocols.

## **C. 1995 ACTIVITIES:**

### **C.1. Fisheries Economics.**

Jack Flerov and Alexei Roussinov attended two workshops put on by the Clemson Extension economics program: "Managing for Success" in Statesville, North Carolina. This was a training program for NC extension agents to help them develop business management programs of their own. "Controlling Your Business with Financial Management" 12/5/95 in Saluda, South Carolina was a second workshop attended in basic financial management techniques for dairy producers. The principles involved are applicable in a wide range of business situations.

Messrs. Flerov and Roussinov also attended two courses in the Management Department at Clemson University: Mgt. 301 "Principles of Management" and Mgt. 422 "Small Business Management." These classes included full participation in all activities, including a team project to work through the steps of developing a management plan for a proposed enterprise.

## C.2. Fisheries Aquaculture.

During the June 13-July 11, 1995 visit to Borok, we (Schwedler, Collier and English) carefully evaluated the situation at IBIW from a biophysical standpoint. Following a series of meetings with our Russian colleagues, we refined the aquaculture plan of work. Whereas the major objectives of the project remain intact, we made modifications to enhance the potential success of the project.

There are severe thermal/temporal restraints that affect the grow-out time of common carp (*Cyprinus carpio*), the fish selected for culture. In the wild, these fish require 28 months from egg to market size (350 g.). Fortunately, the IBIW scientists had been working on a heated, indoor recirculating system which we adapted to grow advanced fingerlings (100 g.) to be stocked into cages. These advanced fingerlings required only one season (four months) caged in the reservoir to grow to market size. Using the recirculating system and cages in the reservoir, commercial producers are expected to grow fish to market size within 16 months. The IBIW scientist, Yuri Gerassimov, has a Russian patent on the recirculating technology and with our assistance will be able to demonstrate how this technology can be used to economically address the thermal/temporal problems for aquaculture in the Rybinsk region.

The revised aquaculture objectives became:

1. To develop and evaluate biologically and economically the recirculating system designed to grow advanced fingerlings;
2. To develop and evaluate biologically and economically cage culture techniques used in the Rybinsk Reservoir;
3. To compare toxicant levels in culture fish with those of wild caught fish.

Procedures For Achieving These Aquaculture Objectives Include:

A Recirculating System, in which carp fingerlings will be grown from 10 g. to 100 g. We expect 3000 fingerlings will be produced in this system. While US scientists were in Borok, the fish rearing, settling, heating and biofiltration tanks for the system were physically installed in the IBIW Ichthyology laboratory. The system required the installation of electricity, plumbing, pumps and air blowers, accomplished during the Summer/Fall of 1995. Power, flow, pump and aeration requirements were engineered collectively under the direction of Clemson University aquaculture engineering experts. The cage system was designed to grow fish from 100 g to 350 g. Stocking rates were 300 fish per 1.5 m<sup>3</sup> cage. One cage culture demonstration facility was located at the Borok IBIW. Other cage culture facilities were located at selected sites on the Volga River as private participants became partners in the project. Partners were expected to market most of the cultured fish for their own profit.

Cage-culturing partners came from the Borok "fishing brigade" and the fish processing facility at Breitovo. Both groups appeared to have excellent fish marketing skills, technical ability to produce fish in cages and access to the Rybinsk Reservoir. Partners received technical help from the Borok IBIW experts, and were provided with 100 g fingerling carp, fish feed, cages and other needed material to complete the project.

Within both early stages of the aquaculture project, we evaluated the production characteristics of carp. Characteristics were collected for fingerling production in the recirculating system as well as for marketable carp grown within the cage culture system. Production characteristics included density and average stocking weight, deaths during culture period, and cause of deaths. We also required harvest data, including average weight and number of fish harvested. Feeding records were required to determine feed conversions and cost/benefits ratios. We developed an Excel-based computer program that allowed the managers of the recirculating and cage culture systems to keep weekly records of average fish weight, fish deaths, and harvests. We incorporated the required records into a data base used in a program to calculate the remaining number of fish and biomass in individual fish rearing containers (recirculating system or cage).

Using this output, the Excel program calculates the recommended feeding rates per production container. There is also a column

where the actual amount of feed provided may be recorded. The formulas in this program should enable the producers to keep fish growing at a maximum rate, eliminate wasted feed and deterioration of water quality, and maximize profits. At the end of the growing season the fish were harvested and marketed through local fish marketing outlets. At the termination of the study the growth characteristics, including individual growth rates, feed conversion rates, survival and overall production, will be used to ascertain biological feasibility. The input costs were used with the marketing data collected to evaluate the economic feasibility of the two-tiered system.

The use of cage culture partners who are not professional aquaculturists and were not linked to the Borok IBIW added some variability to the project. We had decided to pursue this route for two reasons. We felt that it would give us a better idea of the potential for "real-world" success using non-professional growers and marketers and enable us to use multiple sites in the reservoir. We also felt that the use of partners would expedite the transfer of technology and serve as an effective advertising tool for the technology, services and supplies that may be part of the effort to privatize IBIW.

During early meetings with our Borok IBIW colleagues, we collectively constructed a list of materials and work to be completed. These lists required final costs and receipts to be complete, as they were necessary for auditing and inventory control. We feel this component assisted in accountability for the project and more importantly, helped familiarize our IBIW colleagues with bookkeeping, importance of cost effectiveness and accountability required in the privatization process of IBIW.

Two aquaculture systems were constructed in Clemson, each matching one extant in Borok. The systems, a fluidized bed biofiltration and trickling tower biofilter, were developed to acquire skills in construction and operation. These systems were stocked with fish in early December 1995.

Two additional research projects were initiated during this period. These projects helped to train the Russian scientist (Gerassimov) involved and provide useful data for the demonstration project in Russia. One research project involved an assessment of feeding behavior at low temperatures and protocols for feeding fish at low temperatures. The information is useful in understanding fish feeding strategies in low-temperature waters of spring and fall. The second research project assessed fish feeding behavior when offered food in different areas of the culture vessels.

Results of the activities underway at Clemson at that time influenced the project in Borok. Modifications suggested by Gerassimov improved the design and fish management practices in Borok. On October 13, G. Tchuiko, J. Flerov, Y. Gerassimov, V. Komov and W. English presented a seminar to the Department of Aquaculture, Fisheries and Wildlife on the components of this project, an overview of Russian fisheries and aquaculture, and on the facilities available at the IBIW.

### C.3. Fisheries Contaminants.

The two Russian scientists on this aspect of the project (Komov and Tchuiko) developed two research projects, researching contaminant uptake into fish tissues (kidney, muscle and brain). Komov developed a biouptake study using bass as a model and looked at the manner in which mercury is taken up via the aquatic food chain. Tchuiko spent much time analyzing metals and organic contaminants from fish, mussels, water and sediments taken from 15 sites within the Rybinsk Reservoir during the summer sampling trips. The metals were analyzed at the Univ. of Georgia Analytical Chemistry laboratory. Metals measured include zinc, copper, lead, cadmium, mercury. Organic contaminants included dieldrin, polychlorinated biphenyls (PCBs) and poly-aromatic hydrocarbons (PAHs).

One manuscript on this project was prepared during this period (Appendix A). The lead author is V. Komov. La Point wrote and submitted a description of the project to SETAC News, a quarterly publication of the Society of Environmental Toxicology. It was published in late January, 1996.

### C.4. Training with the IBIW Senior Scientists.

During October and November, four scientists from the IBIW visited Clemson University: the IBIW Director, A. Kopylov, and three others, B. Flerov, V. Khalko, P. Umorin. On October 18, we held an open-house and toured Clemson University facilities. In late October, there were tours of the U.S. Fish & Wildlife Walhalla National Fish Hatchery (trout), with a detailed explanation of all phases of trout production. An overview of nuclear and hydropower generation was provided by personnel of the Duke Power facility in northern Oconee County, SC.

In November, the group toured the National Biological Service (now U.S. Geological Service) Laboratory in Columbia, Missouri. Future cooperative activities were planned, as were publications in areas of mutual interest. La Point presented an overview of this project to the NBS scientists. The next day, the group traveled to St. Louis, to Monsanto Company and visited with their Environmental Affairs department. In attendance from Monsanto were two Vice Presidents, one for Regulatory Concerns and the second from their Agricultural Chemicals division. The discussions concerned how to interact with Russians and the interest Monsanto has in conducting cooperative ventures with Russian contacts.

The next visit was to Detroit, Michigan. In (or near) Detroit, we visited the NOAA Great Lakes Research Laboratory and discussed sediment sampling techniques and water quality programs. We also visited the USEPA Gros Ile laboratory, the principal laboratory for the EPA involved with Great Lakes contaminants. The visit was very productive, as it led to a discussion on some cooperative work on the Rybinsk Reservoir and the Great lakes. Following this visit, the Russians returned to Clemson.

During November 7 and 8, we conducted tours of various cold-water fisheries facilities. The tour began in western North Carolina, first touring the C.R. Brown trout and salmon processing plants, the trout feed mill and several different trout and salmon production facilities. There was also a tour of the trout and salmon cage culture facility, located on the Biltmore estate in Asheville, NC. Another facility was visited in Fletcher, NC. This facility produces trout meal and has a "high-tech" recirculating production facility.

On November 12, a tour of the midlands and coastal region of the East began. First to be visited was the Littleneck Clam Farm in Charleston, SC. Clam culture techniques and water quality concerns were discussed. On November 13, there was a tour of the South Carolina Department of Natural Resources laboratory on Fort Johnson, near Charleston. The laboratory conducts research concerned with a variety of environmental concerns, particularly with water quality and contaminant effects on marine and near-shore fish. On the same day we toured the National Marine Fisheries Laboratory (NOAA), also on Ft. Johnson. We were provided an excellent tour of the facility and spent considerable time discussing common concerns and interests in water quality research and management. On November 14, a tour of catfish culture techniques was provided at the B&M Catfish farm, a private farm in South Carolina. On November 15 and 16, tours of the North Carolina State University catfish culture facility, Horn Point Environmental laboratory, University of Maryland at Cambridge, MD. During these tours, culture of catfish, striped bass, oysters and discussions of contaminants and management ensued. On November 16, we traveled to Washington, DC to meet with IREX personnel and to meet with Senator Strom Thurmond, South Carolina.

#### **D. 1996 HIGHLIGHTS:**

During this year, our activities focused on three aspects of the project: 1) conducting a sampling program on bowfin to determine mercury uptake into fish via the aquatic food chain, 2) attending a workshop sponsored by USAID/IREX in Moscow, Russia, and 3) finalizing abstracts for presentation at an international meeting of the Society of Environmental Toxicology and Chemistry (SETAC).

The IREX workshop in Moscow was organized to help several of the 15 Russian and seven Ukrainian US AID/IREX projects through their second year of funding. I (La Point) attended, as did Drs. Hammig, B. Flerov and A. Kopylov. It was a valuable meeting, as information was presented about shipping items to Russia, the necessity for constant communication between partners, and changes in visa requirements. We were able to learn from the other projects how theirs was being conducted. We also discussed the costs of developing "extension" programs in Russia and the difficulties in identifying and establishing a clientele.

##### D.1. Fisheries Economics.

During September, Drs. Hammig and English visited Borok to help with fish marketing tasks and to ensure the completion of the first phase of caged fish culture within the Volga River, near Borok. They discussed the results of carp cage culture with the private cooperator. He was very enthusiastic about the prospects for future operations in the Volga River, culturing fish in cages from docks. The potential for developing such a market is vast (in his opinion). We expected that the idea would rapidly catch on and more "fish farming" occur. This has been, in fact, what ensued.

The Russian trainees in Clemson produced a draft brochure describing the IBIW scientific and monitoring capabilities for distribution to environmental consulting firms, industrial companies, and regulatory agencies. The brochure (Appended to this report) describes the applied research capabilities and background of the IBIW and specifies their approach to environmental assessment and mitigation. The brochure was finalized during the fourth quarter of 1996 and early 1997.

The October draft of our marketing plan was discussed with A. Kopylov, Director IBIW, Dr. B. Flerov, Head of the laboratory of Physiology and Toxicology, Dr. V. Khalko, Deputy Director, and Dr. I. Grechanov, Head of the IBIW pond facilities -- during their visit. The marketing plan developed provided a means for high quality applied research, consulting, and technological services ultimately aimed at protecting human health, environmental quality, and species diversity. The ecological education plan development could be offered in Russia and internationally. Successful implementation of this marketing plan would strengthen the reputation of the IBIW, win recognition from existing and potential clients, and increase income to move IBIW toward financial independence. Contacts made during our tour of Western U.S. consulting firms, copper and oil facilities, and environmental laboratories and participation in SETAC were invaluable.

The second draft of the marketing plan was circulated for criticism. The next step was to design and implement the plan. This was conducted cooperatively, of course, with IBIW leadership. Target dates for specific activities were stated but the plan needed the

flexibility to accommodate commercialization with Russia and the dynamics of potential national or international customers.

During 1996, Flerov and Roussinov studied management - entrepreneurship and received training in elements of consulting. Further, they undertook courses in Principles of Marketing and Services Marketing. The main purpose in taking these courses was to gain an understanding of marketing. They also participated in various management seminars provided by CU Extension Services. The interactive program "Consulting Contract" was used to learn elements of contract law, costing services, and the composition of consulting agreements. These activities will conclude in mid-May. Messrs. Flerov and Roussinov had agreed to prepare three seminars -- marketing, management and consulting services -- which they prepared to give to institutions similar to the IBIW, state owned and private firms in Russia. These activities and products complemented those produced by Drs. Schwedler, English and Gerassimov on aquaculture and from Drs. La Point, Tchuiko and Komov on toxicology. In addition, Flerov, Kosalopov, and Roussinov learned micro-computer techniques involving Eudora Pro (for WWW purposes), Netscape, HTML, Microsoft Word, Excel and PowerPoint.

Dr. Gene Mancini (ARCO) suggested several improvements in the IBIW brochure to revise the text and make it more amenable for commercial use. Photos were selected to illustrate the brochure. The brochure was printed on March 31, 1997. The IBIW brochure was reviewed by colleagues in private industry within the US (see "Fisheries Contaminants," below). After final review, the brochure was printed and distributed. As a new component of this development, a web page was planned. The web page would use the information presented in the brochure, including a list of laboratories, principal scientists, contact information, publications available, and history of the IBIW.

#### D.2. Fisheries Aquaculture.

The summer program took place, as follows: On June 3, T. Schwedler and J. Collier traveled to Borok to help with the aquaculture (caged fish) program. They returned to Clemson on June 17. The second visit by Schwedler and Collier began on July 21. This second trip ensured the smooth conduct of the caged fish program. They returned on August 4.

During the winter of 1996/97, they reconfigured the existing recirculating system and continued yield verification studies. The maximum carp density reached in this study was 75 kg/ cubic meter of water using a 10% exchange rate. In addition to the existing recirculating system, a new commercial scale recirculating fish production system was constructed. The new system used the latest technology to evaluate the feasibility of producing fish during the winter. The new system uses trickling biofilters and solids separation technology based on the previous year research results. The system also incorporated the use of generator derived oxygen and oxygen saturation technology. The anticipated capacity of the system is calculated at a little over two metric tons. Currently the system has an estimated biomass of 800 kg and the initial targeted weight of 1 metric ton should be reached by May 1, 1997.

#### D.3. Fisheries Contaminants.

In South Carolina, tissues (brain, blood, kidney, muscle and gonad) from six bowfin were analyzed for heavy metals. Biomarkers of exposure or effect for which we searched included cholinesterase inhibition, histopathological conditions and overall fish "aspect" (external lesions, condition, etc.). The samples collected during the summer of 1996 from fish, sediments and benthos in Rybinsk Reservoir (Volga River) were submitted to the Chemistry laboratory at the Univ. of Georgia, and analyzed by Dr. P. Bush. Metal analyses includes cadmium, chromium, cobalt, copper, iron, manganese, nickel, lead and zinc. The analyzed samples were coordinated with sampling locations on the Rybinsk Reservoir. These results were presented at SETAC during the fall (November 17 - 21, 1996).

Continuing the assessment of sediment and water quality in Rybinsk Reservoir, on July 2, T. La Point and C. Robinson traveled to Borok for the sediment contaminant assessment program. They returned to Clemson on July 21.

The third task conducted included writing seven abstracts, five for platform presentation, two for poster, all of which were presented at the SETAC meeting in Washington, DC in November 1996. The papers were presented during a session on "Ecological Risk Assessment in Developing Countries." La Point co-chaired the session and highlighted the studies conducted on the Rybinsk Reservoir. The abstracts were submitted to and accepted by the SETAC Annual Meeting Program Committee.

During July, the US team involved in contaminants research visited Borok to participate in the contaminants survey of Rybinsk Reservoir. We collected information on water and sediment quality, fish and invertebrate tissues, and mapped sources of contamination. The tissues were processed in Borok and brought to the US for residue analyses. Nine metals were analyzed: cadmium, chromium, cobalt, copper, iron, manganese, nickel, lead, and zinc.

As natural resource development continues to increase within Russia, we expected much more interest in US or international firms wishing to make contact with potential consultants in Russia. We had been asked by several firms to be introduced to the Russian trainees and Scientists. Hence, during August, activities involved establishing the travel program for the autumn Senior Scientist Visit (with visits planned to a consulting firm in Ft. Collins, CO, an aquatic toxicity testing facility at the University of

Wyoming, a mining company (Kennecott) in Salt Lake City, an oil company (ARCO) in Los Angeles; arranging meetings with their executive staffs at each location, hotels, vans, etc.), in filling in PDF forms for the two new Russian participants (D. Kosalopov and I. Grechanov), in completing the 1996/97 technical implementation plan (TIP), in reviewing the US AID budget for 1996/97 (making sure we have the funds and to ensure compliance with travel procedures), in training a new Administrative Assistant (Ms Cathi Coutu) on this project, in making arrangements for a Ph.D. student to take over the responsibilities Dr. C. Robinson held on this project, (Dr. Robinson has accepted a job in Switzerland). In addition, La Point, Tchuiko, Komov, B. Flerov, and A. Kopylov, began preparations for the five papers presented at SETAC in November, 1996.

The Russian trainees, G. Tchuiko, Y. Flerov, V. Komov, D. Kosalopov, and A. Roussinov arrived in Clemson for their second academic year of training on September 18. They each immediately immersed themselves in work or research. For example, Flerov and Roussinov drafted the brochure to be distributed to various firms and agencies on the training trip in October. Tchuiko, Komov and Kosalopov engaged in aquatic contaminants research, primarily at TIWET.

The new partnership with Slavich, the photochemical production facility in Pereslavl, has had a strong impact on the ability of the IBIW to continue applied research despite less Russian government funding. As Slavich, itself, has contacts with companies in the US (such as Eastman Kodak and Shell), we expect this to be an important development in the project.

### D.3. Training with the IBIW Senior Scientists.

The planned visit by the Senior Russians, the scientist trainees, V. House and T. La Point took place and introduced the IBIW staff scientists to various US consulting firms and industrial operations. The meetings and contacts that took place are specified as follows:

#### 1. Fort Collins, Colorado; ENSR Consulting & Engineering, Inc.

The group left Clemson SC for Fort Collins CO on Wednesday, October 23. T. La Point had been invited by the Colorado State University (CSU) to present a seminar on our USAID/IREX program to the CSU "Colloquium in the Life Sciences". The seminar presented our approach to this program of research and development in the Jaroslavl region and described in some detail our training program. We were hosted by Professor Will Clements and Dr. Elisabeth Harrahy, CSU Dept. of Fisheries & Wildlife. An audience of approximately 80 people was in attendance. After the seminar, we were part of a round-table discussion on social and political events in Russia and on pollution problems in both countries. The CSU faculty were extremely interested and enthusiastic.

The following day was spent with scientists and managers of ENSR Consulting, Inc. in Fort Collins. Our host was Dr. William Stubblefield, Senior Manager. We were joined by various ENSR scientists and Dr. Russell Tait, an Australian scientist from EXXON Oil Company (presently stationed at EXXON corporate headquarters in Houston, TX). He is with the EXXON International Programs division and is responsible for establishing their oil development program in the Sakhalin Islands, off the eastern coast of Russia. We spent most of the day discussing EXXON's interests in Russia and how they see the need for using "locals" (or at least nationals) to guide the company through the regulatory maze of rules concerning oil well siting, water quality issues, and oil pollution effects. A critical component of our discussion concerned just how the IBIW could serve as an environmental consulting service to EXXON (or any other firm, for that matter). This was an enjoyable, educational exchange in which ENSR provided examples of what and how they respond to industrial requests for applied environmental monitoring or testing. The Russians were a little shaky at first, in that they wanted to discuss "what they do" in aquatic research; however, with prompting from V. House and B. Stubblefield, they quickly came to understand the objective focus required for applied environmental research (e.g., "EXXON needs an answer, not just more research!").

On Friday, October 25, we met with CSU faculty who have had research activities in Russia and discussed with them the potential for future interactions. Around noon, we left Ft. Collins and traveled to Laramie, Wyoming to visit the University of Wyoming Red Buttes Laboratory. This facility is one of the two leading university aquatic toxicity testing facilities in the US. We toured it, met with Prof. Harold Bergman, Dr. Joseph Meyer, Prof. Robert Jenkins, and the Red Buttes research staff. Prof. Bergman has expertise in fish physiology, with an emphasis on contaminant effects. He is a full member of the EPA Science Advisory Board, a past President of SETAC, and is presently on an advisory committee to Carol Browner, Director, U.S. EPA. Prof. Bergman has invited Tchuiko, Kopylov and/or Komov to visit his laboratory to learn techniques in gill physiology; we hope to consider this if funding and time allow.

On Saturday, October 26 we met with a group of University faculty who have had research and economic exchanges with Russia. Also, we toured the University electron microscopy laboratory and the University, in general. During the evening, we were guests at an informal reception hosted by Bergman.

#### 2. Salt Lake City; Kennecott Utah Copper Corporation.

On Monday, October 28, we met with Dr. Elaine Dorward-King, Vice President of Environmental Affairs for Kennecott Utah

Copper Corporation (KUC), and Dr. William Adams, also in KUC Environmental Affairs. Dr. Adams is a member of the USEPA Science Advisory Board and is personally responsible for most of the sediment toxicity testing procedures presently used by Fish & Wildlife, USEPA, and private firms. He is very widely known and highly respected as a sediment contaminant specialist.

On Tuesday, October 29, we toured the KUC Copper Mountain facility, outside of Magna, UT. The tour emphasized aspects of metal toxicity in soil and surface water, pollution prevention techniques related to metal processing, slag waste and process water effluent control, and site remediation. Kennecott Corporation has entered into numerous discussions to reclaim lands which were contaminated with earlier (late 1800's and early 1900's) mining and refining processes. KUC is a company owned by a British firm, RTZ. The parent company has mining interests throughout the world and is interested in mineral development in Russia (Siberia and the Ural Mountains).

During our tours and discussions at KUC headquarters, Dr. Dorward-King described the global program of RTZ, her involvement with regulatory agencies in the US and Europe, and what the mining industry needs in terms of environmental expertise. She noted the need for better information on metal fate in soils and sediments and on a better understanding of the bioavailability of metals in surface waters (as opposed to measures of "total recoverable" metal concentrations). We further discussed issues related to metal mining, processing, and effluent monitoring. The waste disposal issues were similar to problems faced by the mining interests anywhere in the world. The innovative approaches taken by KUC may provide a model for similar development in Russia. If nothing else, the IBIW scientists are now able to take this information back to Russia and be able to discuss these issues with mining interests within their country. They also now have a solid "network" established through KUC to RTZ and may be able to use that to their consulting advantage.

### 3. Atlantic Richfield Oil Company (ARCO), Los Angeles, California.

From Thursday, October 31 through Tuesday November 5, we were hosted by Atlantic Richfield Oil Company (ARCO). This company, through the director of Corporate Environmental Affairs, Dr. Eugene Mancini, was astounding in its interest in meeting and hosting the IBIW scientists. They provided us with a corporate discount rate for hotel rooms, provided a tour bus for our use in travels to the various ARCO operations (terminal, refinery, pumping fields), and provided a bus for us to "sightsee" in Los Angeles on Saturday, Nov. 2. They invited their representative from ARCO International Office, Ms. Vicki V. Ottensman, an Environmental Engineer to be present and meet with us. Ms. Ottensman arrived in LA from Houston, TX. In short, this was a highly successful and thoroughly enjoyable meeting. The specifics follow:

On Friday we met with Dr. Mancini and toured the ARCO terminal in LA/Long Beach Harbor. The focus was on pollution prevention, both atmospheric and aquatic, and on cleanup procedures. We were able to "walk through" the process used to recover and maintain oil residues spilled while transferring oil from tankers to oil storage tanks on land. In addition, we were able to see and speak with the emergency preparedness team, a separate company called "Clean Coastal Waters." The company has several vessels, each loaded with oil recovery equipment and supplies to soak up any spills. Interestingly, a "spill" in the harbor is of regulatory concern (and reportable!) if it is as little as one (1) gallon! It was remarkable that there was no smell of oil in the air nor any sheen of oil on the harbor waters: The Russians were astounded at the effort expended to minimize spills and gaseous discharges. As at KUC, this information will be something they can take back home to teach and discuss with professionals, as their oil industry begins to more fully develop.

As mentioned earlier, ARCO has a joint venture in operation with LUKOIL, a privatized Russian oil development company. [The largest share-holder is Russian Vice President, A. Chernomyrdin] The agreement presently in force between LUKOIL and ARCO is to develop the oil reserves surrounding the north and west side of the Caspian Sea, surrounding the area where the Volga enters into the sea. We discussed what issues ARCO needs to address, in terms of environmental pollution. Their concerns include: siting of oil wells, disposal (and toxicity of) the drilling mud, the need for general information on environmental regulatory statutes in Russia and/or the regions, pipeline siting, spill response, recovery and remediation procedures, equipment for such, etc. In short, we had an extensive discussion about how the IBIW could interact with LUKOIL-ARCO, and how they might actually go about it. Ms. Ottensman has a visit to Moscow planned for mid-November and hopes (either on this trip or her next one) to visit the IBIW.

The potential for scientific exchanges or development of contract research for the IBIW has never been greater. The Russians received training in marketing their abilities - in a very direct and "hands-on" manner through their discussions with ENSR, KUC, and ARCO. Further, several of them now have an opportunity to collaborate with academic scientists at either Colorado State University or the University of Wyoming; this expands their network in the USA.

For each company visited, Dr. Kopylov handed out copies of the IBIW brochure describing their capabilities in environmental toxicology and chemistry. At each location, they received comments and suggestions on how to improve the brochure; hence, it became a "living" document and was revised as necessary.

### 4. 17th Annual Meeting of the Society of Environmental Toxicology and Chemistry (SETAC), Washington, DC.

The entire group attended the 17th Annual Meeting of SETAC in Washington DC. Five posters and one platform presentation

were accepted and presented at the meeting. All presentations stem from research directly sponsored by this US AID/IREX project. In addition, however, we had the opportunity to present related work on the upper Volga by IBIW colleagues of the Russians. This related work was presented as four additional posters.

During the month of December, the project concentrated on cultural aspects of the exchange. Specifically, US AID and IREX had agreed for the spouses and children of the Russian trainees to visit the USA during this time. Hence, they were introduced to local hosts, regional sites of interest, and visits to other cities (Atlanta, Charleston, Washington DC, etc.). Please be advised that no project travel or per diem funds were expended during these cultural excursions. Travel costs for the spouses and children, as well as "vacation travel" costs for the Russian trainees were from their personal funds.

## **1997 HIGHLIGHTS:**

During the Spring of 1997, activities continued on three aspects of the project: 1) analyzing the mercury concentrations in bowfin to determine mercury uptake into fish via the aquatic food chain; 2) analyzing the metal concentrations in sediments, fish tissues and benthic invertebrates collected during the summer of 1996; and 3) determining the requirements and needs of the IBIW trainees in preparation for return to Russia.

Samples of extracted fish tissues and sediments were provided to Dr. P. Bush, Univ. Of Georgia Ag. Analytical Services to analyze for heavy metals. We received the results on March 1, 1997.

Two manuscripts were completed, one by Tchuiko ("*Comparative in-vitro study of acetylcholinesterase and butyrylcholinesterase inhibition in brain and blood serum of several freshwater fish by DDVP, an organophosphorus pesticide*") and the second by Komov ("*Landscape influences on hydro-chemical budgets of small bog lakes in northwest Russia*;" these are further described in Appendix A. Further work continued on the IBIW brochure (it was completed in March). Roussinov and Flerov took a course on developing home pages and began to plan one for the IBIW. However, we encountered a few problems.

On February 21, 1997, the Russians had their email accounts canceled by Clemson University. The administration stated that "they -the Russians- were neither employees, staff nor students; hence, may have no accounts." [This circumstance resulted from the recent shift of the Russians from being incorrectly paid a taxable salary to a correct, non-taxable stipend, a recommendation I had made 1.5 years earlier!.] The project could not afford to pay what the University wanted to charge for CPU time. Because such computing funds for University departments are otherwise considered "funny money," I found this to be very frustrating and hugely annoying. After one month, however, we regained their status and they could use the University computer system. The Russian trainees purchased equipment and supplies and we arranged for these to be shipped to Russia. They departed for Borok in April, 1997.

## **F. SUMMARY**

Successful completion of this project has shown that scientists at Borok have developed new technologies to grow fish and that they may be hired by individuals and companies to consult in the development of these aquaculture systems. The aquaculture personnel at Borok IBIW have all the intellectual and mechanical expertise necessary to setup and manage these production systems. They may also assist with marketing of the fish produced. (All or portions of fish production technology can be contracted through the IBIW). In addition, the IBIW may wish to serve as a supplier of technology (warm water recirculating system), goods (fingerlings, feed, supplies) and services for the emerging fish culture industry. Our evaluations indicate that the technical and economic feasibility of the project is positive. We had selected a species of fish which appears to have marketability and can be produced in a system that continues to rely on low inputs and low technical skills customized for conditions encountered in the Jaroslavl Region. Russian and American scientists involved believe that the project can help the institute move towards economic stability while providing the public with a new market-based industry to enhance the economy and increase the quality of fish for human consumption.

We had successfully established an enthusiastic partnership. The training had a positive effect on the development of outside contracts, cooperators were obtained, and we achieved concrete results with the culturing program. Efforts to develop the eco-tourism business have not met with as much success.

## **G. PLANS FOR THE TRAINEE PROGRAM BEYOND USAID/IREX FUNDING:**

The IBIW has successfully competed in obtaining a grant with their colleagues at the U.S. Geological Service laboratory in Columbia, Missouri. We had hoped for some contracts to ensue with the multi-national firms based in the US or western Europe. However, the companies have been slow to move into Russia until the legal environment changes. We find presently that the Ministry for Environmental Protection has been "down-sized" to a Department (personal communication, Prof. Roman Zlotin, Moscow State University). Consequently, it has less enforcement power than before and it's ability to enforce environmentally-safe development of natural resources is "almost nil." The consequences for the IBIW scientists is that consulting funds may be slow in developing. However, when they do become available, the IBIW should be in an excellent position to gain from its

experience in this USAID/IREX project.

## **APPENDIX A**

List of products from the US AID/IREX grant to SCUREF and Clemson University.

### **Brochures**

Roussinov, *et alia*. The Institute for Biology of Inland Waters; descriptive brochure.

### **Journal Articles (in English), Paper Presentations (in English)**

Komov, V.T., I.K. Stepanova, V.I. Lazareva, C.T. Robinson. "Spatial and temporal aspects in water chemistry of lakes in Darwin Reserve, Northwest Russia." Arch. Hydrobiol., 139, 1, 129-144, March 1997.

Robinson, C.T., T.Y. Huang, V.T. Komov, G.M. Chuiko, and T.W. LaPoint. "Use of Bowfin (*Amia calva*) as Bioindicators of Freshwater Systems."

Chuiko, G.M. "Comparative In vitro Study of Acetylcholinesterase and Butyrylcholinesterase Inhibition in Brain and Blood Serum of Several Freshwater Fish by DDVP, an organophosphorus pesticide."

Zhgareva, N.N., V.T. Komov, and C.T. Robinson. "Diets of perch (*Perca fluviatilis* L.) in three lakes differing in trophic status."

Komov, V.T., I.K. Stepanova, and V.I. Lazareva. "Atmospheric Deposition and Water Chemistry of Lakes in Darwin Reserve, Northwest Russia."