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Project Summary

Protection of River Basins, Lakes and Estuaries, Fifteen Years of Cooperation Toward Solving Environmental Problems in the USSR and USA

Robert C. Ryans, editor

In 1987, the United States of America (USA) and the Union of Soviet Socialist Republics (USSR) completed 15 years of cooperation in the field of environmental protection. In recognition of this anniversary in the on-going program, participants in three projects of the agreement contributed papers to a commemorative document describing recent activities and providing an historical perspective on joint research in the area of water pollution prevention.

Overviews are provided of joint activities in water planning and management, in protection and management of water quality in lakes and estuaries, and in effects of pollutants on aquatic organisms and ecosystems. Among the papers are discussions of water quality management strategies and modeling techniques for water protection (USSR) and of mass balance approaches and nonpoint agricultural measures in water quality management (USA). Other contributions address predictive models of water body conditions and problems in investigating petroleum pollution (USSR) and describe mesocosms for evaluating ecosystem health and water quality research in the Great Lakes (USA). Finally, papers are presented regarding ion exchange in fish and biotesting of aquatic environments (USSR) and describing aquatic toxicity test methodologies and ammonia toxicity and metabolism in fish (USA).

This Project Summary was developed by EPA's Environmental Research Laboratory, Athens, GA, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

In 1972, the United States of America and the Union of Soviet Socialist Republics launched a joint program of cooperation and exchange of scientific information on problems of environmental pollution. Since then, the USA-USSR Agreement on Cooperation in the Field of Environmental Protection has helped both countries in their pollution control efforts.

Among several activities addressing different environmental media under the Agreement is the Working Group on Cooperation in the Area of Water Protection. Included in the interests of this Working Group are three projects—Project 02.02-11 "River Basin Water Quality Management," Project 02.02-12 "Protection and Management of Water Quality in Lakes and Estuaries," and Project 02.02-13 "Effect of Pollutants on Aquatic Organisms and Ecosystems: Development of Water Quality Criteria."

In recognition of the 15th anniversary in the on-going program, participants in these three projects contributed papers to a commemorative document describing recent activities and providing an historical perspective on joint research. Introducing this collection of papers is an overview provided by the Co-chairmen of the USA-USSR Agreement on Cooperation in the Field of Environmental Protection, Mr. L.A. Thomas, Administrator of the U.S. Environmental Protection Agency, and Mr. Y.A. Izrael, Chairman of the USSR State Committee for Hydrometeorology.

Contributing their views of the 15 years of progress are the Co-chairmen of the USA-USSR Working Group on Cooperation in the Area A of Water Pollution Prevention, Mr. V. V. Adamkus, Regional Administrator, Region V, USEPA, and Mr. A. K. Kuzin, Director, All-Union Research Institute for Water Protection. Introductions to the collected papers are provided by Project Co-leaders: Mr. V. J. Saulys, Chief, Remedial Program Staff, Great Lakes National Program Office, Region V, USEPA, and Mr. Kuzin (02.02-11); Dr. R. C. Russo, Director, Environmental Research Laboratory, USEPA, Athens, GA, Dr. W. R. Swain, Professor, University of Amsterdam, The Netherlands, and Dr. A. M. Nikanorov, Director, Hydrochemical Institute, USSR State Committee for Hydrometeorology and Control of the Natural Environment (02.02-12); and Dr. R. A. Schoettger, Director, National Fisheries Contaminant Research Center, U.S. Fish and Wildlife Service, Columbia MO, Dr. Russo, and Dr. N. Butorin, Director, Institute of Inland Waters, USSR Academy of Sciences (02.02-13).

Titles, Authors and Abstracts of the 12 Papers

"Strategy of Water Planning and Evaluation," by A. V. L'vov and A. K. Kuzin, All-Union Scientific Research Institute of Water Protection, USSR Ministry of Reclamation and Water Management, Kharkov—The importance of water protection in national economies requires the selection of optimal strategies for water quality planning and management. Water quality management is a continuing process of idea formation, of planning and achieving corresponding water protection measures, of evaluating results, and of establishing new goals. Comprehensive water protection programs must be based on an ecosystem approach, the determination of pollution sources must be based on the mass balance approach, and the determination of protection efficiency must be based on a combination of technological and basin approaches. Management priority must be that of resource-saving technology, which is nature protective and economical at the same time.

"A Mass Balance Approach to Water Quality Management in the Great Lakes," L. E. Fink, Great Lakes National Program Office, USEPA, Region V, Chicago, IL, and P. L. Wise, Science Applications International Corporation, McLean, VA—The mass balance, or total load management, approach seeks to control the total rate of entry of toxic pollutants from any source or location. Basic to the approach are wasteload allocation models that must be tested and verified through comparison with actual monitoring results after all significant sources are identified and quantified and after source controls are implemented. The mass balance approach is a working conceptual framework in which to implement total load management of toxic substances so that the interim water quality goals can be achieved in a systematic and focused fashion, without abandoning the long-term goal of zero discharge of toxicants into the Great Lakes ecosystem.

"Water Quality Modeling and Development of Water Protection Programs," Y. V. Yermenko and G. A. Sukhorukov, All-Union Scientific Research Institute of Water Protection, USSR Ministry of Reclamation and Water Management, Kharkov—The most important direction of improvement of a management system for water protection and rational use of water resources is the use of program-objective methods of control and planning. These methods are based on the extensive use of mathematical modeling and optimization of water protection measures. Realization of simulation requirements applicable to water basins is attained by joining the models of large scale discharge influence and other factors affecting water quality and the models of local discharge influence. It is mainly in the large scale discharge models that the circulation influence of water masses is considered as well as the full transformation of substances under the influence of biochemical factors. The local discharge models are relatively simple and extend to areas from the site of pollutant discharge to the control point.

"Identification of Pollutants Subject to Nonpoint Agricultural Measures in the Maumee River Basin," J. B. Morrison, Purdue University, West Lafayette, IN—Management of nonpoint pollutio sources requires the same kind of carefu identification of impaired uses, importar pollutants and appropriate contro strategies that is necessary for poin sources. In the Maumee River Basin, th impaired use of a resource (Lake Erie has been identified (eutrophicatio resulting from nutrient imbalances). Th pollutant responsible for the impaired us (phosphorus) has been identified an programs for its control (reduced so erosion resulting from less intensiv tillage and other soil conservatio measures) have been developed. Poten tial consequences of this effort (increase nitrate concentrations , increased use c chemicals for weed control) have bee identified. If care and judgment ar employed, pollution management wi result in restoration of the resourc without the creation of new and unex pected consequences.

"Present State of Model Bank fo Predictive Water Body Conditions," A. M Nickanorov, A. B. Gortsko, A. A Matveyev, and M. G. Yereshukova Hydrochemical Institute, USSR Stat Committee for Hydrometeorology an Control of the Natural Environmen Rostov-on-Don—Mathematical model provide quantitative evaluations of wate basin and channel conditions and predic the response of water ecosystems unde the action of given factors. Simulatio techniques for intrabasin processes ar classified as descriptive models, predic tive models, or optimization models. Th more complex the system to b simulated is, and the more this system i influenced by external factors, the mor complex does the process of building model for predictive purposes become Problems encountered in developin predictive models can be overcome mor easily and quickly with the use of expe systems. Expert systems applied t intrabasin process models satisfy th modern requirements of science an increase the efficiency of theoretica investigations in hydrochemistry an hydrobiology.

"Historical Synopsis of Great Lake Water Quality Research and Manage ment and Future Directions," W. I Richardson, Large Lakes Researc Station, USEPA, Grosse Ile, MI, and J. I Paul, Environmental Research Labora tory, USEPA, Narragansett, RI—In 197 the U.S. Environmental Protectio Agency was just becoming involved wi major pollution control efforts on th North American Great Lakes. Seve

water quality issues were related, most notably, to eutrophication and the resultant impacts on drinking water, fisheries, and recreation. Through the use of monitoring studies and mathematical modeling, much has been accomplished in understanding cause-effect relationships and in managing water quality. Most notable was the establishment of target loadings for phosphorus. With eutrophication declining, effects of toxic substances became the major environmental issue for the Great Lakes in the 1980s. Initial monitoring and research into cause-effect relationships has indicated that rational management of toxics is and will continue to be a difficult problem.

"Procedural-Methodological Problems in Investigating Petroleum Products in Continental Surface Waters," A. G. Stradomskaya, Hydrochemical Institute, USSR State Committee for Hydrometeorology and Control of the Natural Environment, Rostov-on-Don—Surface waters have an extremely complex, diverse and dynamic chemical composition, determined by a great variety of formation and transformation factors. Investigating petroleum product contamination of surface water is made much more difficult by the wide range of organic substances that are introduced through production process effluent and household waste. To obtain correct information on the total amount of petroleum products, the analyst must consider the volatile and nonvolatile hydrocarbons, the tars, and the asphalts. Variants of gas and liquid chromatography-mass spectrometry and highly efficient liquid chromatography have been used successfully in identifying petroleum products.

"Use of Mesocosms in Evaluating the Health of Aquatic Ecosystems," S. J. Lozano, University of Wisconsin-Superior, Superior, WI—Methods for assessing pollutant effects on aquatic systems are numerous, including single-species bioassays and experiments in microcosms, in natural water bodies, and in enclosures within a lake or stream. With the use of whole systems and mesocosm techniques and proper experimental design and analysis, it is possible to quantify the effect, persistence, and movement of pesticides and other toxicants. Mesocosms are ideal for measuring primary and secondary effects. The results from these mesocosm experiments are of vital interest to the experimental ecologist and resource manager. When the symptoms of ecosystem distress can be related to specific effects of different classes of chemicals, environmental managers will be better able to regulate levels of toxic substances in aquatic systems.

"Ion Exchange in Fish under Extreme Effects of a Varied Nature," G. A. Vinogradov, V. T. Komov, and V. B. Tagunov, Institute of the Biology of Inland Waters, USSR Academy of Sciences, Borok—A study of ion exchange in fish establishes that the catching and laboratory handling of fish are the same type of stress factor, inducing disturbances of the ion balance between the organism and medium through intensification of sodium and potassium diffusion into the external medium. Ion exchange characteristics become normal in the restorative period. Sodium losses drop repeatedly and sodium absorption from the water increases as a result of the fish's acclimation to the salt shortage in the water. Polychlorpinene increases sodium loss from the organism. Other pesticides in different concentrations do not have such an effect.

"Aquatic Toxicity Test Methodologies: An Update for the 1980s," M. G. Henry, National Fisheries Center-Great Lakes, U.S. Fish and Wildlife Service, Ann Arbor, MI, and R. A. Schoettger, National Fisheries Contaminant Research Center-Columbia, USFWS, Columbia, MO—Hazard assessment methodology is constantly being refined in the face of escalating industrial, domestic, and agricultural point and nonpoint input of contaminants to water supplies. Integral to hazard assessment is the determination of the biological effects of single compounds and mixtures on environmental populations. Since the first technical exchange between the USA and USSR, a collaborative program of toxicity testing and application has been carried out by American and Soviet researchers. These tests include microbial, biochemical, physiological. and behavioral assays using a number of organisms. Future research will incorporate issues such as resistance, reversibility of effects, and continued development of test approaches that use fish and invertebrates of common indigenous distribution in the two countries.

"Biotesting of Aquatic Environments Based on the Behavioral Reactions of Aquatic Animals," V. A. Nepomniashchikh and B. A. Flerov, Institute of the Biology of Inland Waters, USSR Academy of Sciences, Borok—Numerous methods are available currently for testing the effect of water quality on the behavior of aquatic animals. The primary focus is on establishing behavioral indicators of contamination and on forecasting the ecological effect of changes in these indicators caused by poisoning. In nature, the animal's behavior is composed, not of individual reactions, but of integrated complexes of various forms of behavior that are united by a common goal--for example, feeding or reproduction. From the ecological standpoint, it is important to study the effect of water quality on the attainment of these goals and not on the individual behavioral characteristics. To this end, research had involved the examination of behavioral complexes associated with medicinal leeches and caddisworms exposed to toxicants. Results indicate the animals' behavior to be a sensitive indicator of water quality.

"Ammonia Toxicity and Metabolism in Fishes," R. C. Russo, Environmental Research Laboratory, USEPA, Athens, GA, D. J. Randall, Department of Zoology, University of British Columbia, Vancouver, BC, and R. V. Thurston, Fisheries Bioassay Laboratory, Montana State University, Bozeman, MT—To understand the toxicity of ammonia to fish, it is important to understand its chemical equilibrium in water In aqueous solutions, ammonia assumes both ionized and unionized chemical forms. The relative concentrations are principally a function of the pH, temperature, and ionic strength of a given ammonia solution. Ammonia is an end product of protein metabolism, and because it is toxic, it must be excreted or converted to less toxic compounds such as urea or glutamine. Short-term exposure of fish to high concentrations of ammonia causes an increase in gill ventilation, hyperexcitability, convulsions, and then death. These symptoms are most likely the result of a direct effect of ammonia on the central nervous system. Effects of chronic exposure to lower concentrations include tissue damage and decreased reproduction.

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The complete report, entitled "Protection of River Basins, Lakes and Estuaries, Fifteen Years of Cooperation Toward Solving Environmental Problems in the USSR and USA," (Order No. PB 89-129 688/AS; Cost: $36.95, subject to change) will be available only from:
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