Pacific Fisheries Resource Conservation Council

A Crisis in Fisheries Education:

Council Advisory

Prepared by
Dr. Paul H. LeBlond

September 2001

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For further information about this document and about the Pacific Fisheries Resource Conservation Council (PFRCC), contact:
Pacific Fisheries Resource Conservation Council
800 Burrard Street, Suite 590
Vancouver, BC, Canada V6Z 2G7
Telephone 604 775 5621
Fax 604 775 5622
www.fish.bc.ca
info@fish.bc.ca

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Pacific Fisheries Resource Conservation Council
Conseil pour la conservation des ressources halieutiques du pacifique

September 2001

The Hon. Herb Dhaliwal
Minister of Fisheries and Oceans
House of Commons
Ottawa

The Hon. John van Dongen
Minister of Agriculture, Food and Fisheries
British Columbia Legislature
Victoria

Dear Ministers:

The task of conserving and managing the Pacific salmon resource requires skills, knowledge and ability that are in short supply, and we appear to be approaching a crisis in the training and availability of fisheries scientists and managers.

The management of fisheries on sound conservation principles is crucial if we are to maintain both biodiversity and healthy salmon stocks across British Columbia. The human resources in the fisheries sector and the skills they apply are increasingly crucial to the success of activities intended to safeguard and enhance the prospects for salmon.

Acting on behalf of the Council last year, Paul LeBlond surveyed a group of informed and experienced stakeholders in the Pacific fisheries. The results revealed widespread concern about the future availability of people with the skills necessary to answer outstanding research questions and manage a sustainable salmon fishery.

The Council recognizes the challenge faced by academic institutions and fisheries agencies, particularly by Fisheries and Oceans Canada to replace retiring highly qualified personnel. Recruiting and retaining bright, well trained young people is an essential step towards building up the expertise required to understand fish populations and manage their harvest.

The Council also urges academic institutions to work together, in consultation with employers of fisheries technicians, scientists and managers, to design curricula and establish consistent and high standards to train fisheries personnel and equip them with the skills and expertise needed to manage a sustainable fishery.

Yours sincerely,

Hon. John A. Fraser
Chairman

590 - 800 Burrard Street
Vancouver. British Columbia
Canada V6Z 2G7

Tel/Tel: 1604) 775-5621
Fax/TE1e: 160-1) 775-5622
E-mail: info@ fish.bc.ca
Web Site/Site Web: uww.fish.bc.ca

590 - 800 rue Burrard
Vancouver. Colombie-Britannique
Canada V6Z 2G7

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1. Conservation Challenges

Canada's progress towards building a sustainable fishery and conserving Pacific salmon stocks will depend critically on the effectiveness of well-trained, imaginative and dedicated people.

The conduct of sustainable fisheries faces many daunting challenges. Improving methods of stock assessment, understanding the impact of climate change, introducing effective methods of selective harvest, and protecting salmon habitat on a long-term basis, to mention but a few, all require new knowledge and new perspectives.

The capacity of fisheries scientists and government regulators to meet those challenges appears to be in decline. Recent years have seen repeated instances of "missing salmon" arising from inaccuracy in counting fish. The management measures taken to protect species seem to have been ineffective and too late in many instances. And, the scientific capacity to understand and deal with the collapse of fish species seems to be sorely tested and found wanting.

Who, in the years to come, will develop the means of confidently assessing the numbers and movement and health of salmon along the Pacific Coast and in British Columbia's lakes and streams? Who will provide the reliable measurement and monitoring required to carry out the abundance-based management approach stipulated by the Pacific Salmon Treaty?

The fate of salmon at sea remains to this day a matter of largely unsubstantiated theory and speculation for biologists and oceanographers. Who will unravel the mysteries of the ecosystem and environmental interactions that determine how many salmon survive at sea and return to spawn? Who will provide the research and practical evaluation of the impact of climate change on Pacific salmon?

Who will have the skill and determination to put in place and enforce protective measures that will overturn the trend in degradation of spawning habitat? Who will be able to draw on the latest scientific knowledge to understand the ecology and genetics of salmon populations and the impacts of hatcheries and aquaculture? Who will guide government policies through the transition to a sustainable fisheries regime?

People who will manage and work in tomorrow's fishery and perform its supporting research will have to draw on a wide range of skills. Many people with complementary skills will have to begin working together. Are enough of these people being trained today? Are they learning the right skills?

These questions and others arose several times during the past two years in discussions among the members of the Pacific Fisheries Resource Conservation Council. They reflected the concern that Canada may not be able to carry out an effective salmon conservation strategy, given the current shortcomings in scientific knowledge, skilled personnel and managerial capacity. This situation appears to signify a crisis in fisheries education.

The Council decided to seek the views of stakeholders from across the fisheries sector, in order to obtain a range of perspectives and ideas on this matter. As a means of broadening the range of views available to the Council, senior fisheries managers, educators and scientists were polled by e-mail and asked for their views on issues in fisheries education.

While such a survey has no pretension of precision or completeness, it is nevertheless quite instructive since it brings to the table the views of experienced fisheries researchers, educators and others. The following message was sent to 65 people in Canada and the United States:

> Dear Friends of the Salmon,
>
> I am writing on behalf of the Pacific Fisheries Resource Conservation Council (PFRCC), an advisory body to the Federal Minister of Fisheries and Oceans and to the BC Provincial Minister in charge of fisheries, on the status of salmon stocks and to advise on strategic policies to ensure their conservation. You can find out more about the PFRCC at our web site at http://www.fish.bc.ca. At a recent meeting, the Council was alerted to a potential shortfall in quality and quantity of suitably trained personnel to provide research and management support for the conservation-based salmon fishery of tomorrow.
>
> Many voices have expressed alarm at a forthcoming lack of teachers, programs and trained personnel in ocean science and technology to research and manage the conservation-based fishery of the future (are we training enough students? are we teaching them the right things?) and to apply community-based systems (e.g., the Nisgaa agreement...) to marine resource management. This is likely not a local issue and I am consulting widely to assess the view of educators, researchers, fishermen, and fisheries managers on the issue. Would you mind taking a few moments to comment on:
>
> 1. Do you think there is a problem, and if so what is it?
>
> 2. What do you think should be done about it?
>
> With best wishes,
>
> Paul H. LeBlond
> for the Pacific Fisheries Resource Conservation Council

In addition to the views expressed by the respondents to the survey, the Council considered some other significant fisheries issues related to educational and expertise capabilities. Those issues related to educational programs, fisheries careers and the experience of the US fisheries education system, are outlined briefly in this advisory.

This cursory review of skill requirements and educational needs in Canada's fishery is meant for the benefit of fisheries managers and researchers, in federal, provincial and other jurisdictions, as well as for the consideration of educators in universities, colleges and technical institutions. It is also addressed to professional organizations of biologists, fisheries scientists, oceanographers, managers and fishermen who have a stake in the conduct of the fishery.

2. Responses And Perceived Problems

The survey elicited a significant level of response. Extensive answers were received from twenty-five people. Every respondent agreed that there was a "problem" or, rather, several problems. These ranged from the shortage of adequately trained personnel—with different emphases on the training required—to the systemic problems associated with the nature of fisheries education and management.

In sorting through the comments, it became apparent that there were eight broad themes that characterized most of the opinions that were expressed. Given the candid nature of some of the remarks, the Council decided not to attribute them to individuals or assign names to the quotes cited here.

Stock Assessment

Stock assessment consists of counting fish and interpreting the numbers. It is a basic requirement of fisheries management. Conservation policies must be based on valid information on how many fish there are and how many can be caught without endangering the population. Because sampling of fish populations is always incomplete and subject to considerable uncertainty, stock assessment requires sophisticated statistical analysis by people skilled in both biology and mathematics. Quite a few respondents were of the view that there is "a catastrophic shortage of good stock assessment people". This situation is not peculiar to the North Pacific salmon fishery. It also prevails in Atlantic Canada, as well as south of the border. "The lack of quantitative biologists has been identified by the National Marine Fisheries Service as a critical need", said one US respondent. Candidates with the requisite quantitative skills are not generally being attracted into fisheries programs. They are either not entering this field of study or are soon attracted to more professionally and financially rewarding professions, such as engineering, health sciences, and electronic commerce.

Sampling Technology

More accurate, faster methods of counting fish in the ocean are required to improve the basis for stock assessment. Developing new technology, such as acoustic methods, for fish detection requires the involvement of engineers and physicists. Chemical sampling of fish and of their food can also provide clues to the health of a population. Fisheries research and management requires the participation of scientific experts from many disciplines. However, there is limited investment in new technology and its applications in the fisheries, and scientists recognize that the resources for research are more readily available in other fields.

Understanding Ecosystem and Population Dynamics

Many of the scientists and educators who were polled emphasized that the problem is not just in counting fish and assessing their numbers, but in understanding their ecology. To quote one respondent: "Many graduates have a poor understanding of the ecological principles that govern the dynamics of animal populations." The need for a broader, more rounded education, greater multidisciplinarity, and a deeper grasp of ecological principles was stressed repeatedly. As another respondent put it: "One area that will need innovative thinking, and which will be very important in the next few years, is "whole-ecosystem" approaches and methods to evaluate ecosystem structure and functioning, albeit with usually very limited data."

Environmental Influences

Salmon live a large part of their life in the ocean. There is a general consensus that "too little is known about the process of marine survival and growth" and that "few of our graduate students in fisheries seem to acquire an understanding of how the ocean works and how that might influence salmon". The research related to salmon in their ocean phase has been given relatively little support and attention until recently. While this is an area of considerable opportunity for innovative scientific inquiry, it continues to receive relatively little funding support and offers limited research opportunities for new graduates.

Practical Fisheries Management

Educational concerns also extend to include operational staff, people with BSc and MSc degrees, or with training in other areas, who may not be called upon to conduct research, but who are in the front line of fisheries management and often rise to the top of the managerial hierarchy. As one respondent put it, fisheries managers do not manage fish. Instead, they "...manage people who usually kill fish and typically do it badly with less than adequate skills in human management". A lot more than just science is required to manage a fishery. The technical skills developed in fisheries education are rarely complemented by courses related to management and other disciplines.

Curriculum Needs

How are fisheries researchers and managers to be trained in order to fulfill all the functions expected of them? The comments by survey respondents touched on a variety of points and new approaches in fisheries curricula. Many of the comments focused on the need to train both experts and generalists in the areas identified above. Sample comments included:

> "... curricula are too heavily oriented towards single species management...";
>
> "... there is a need for more co-op programs...";
>
> "... we must train professionals with a background in the fishing industry..."
>
> "... a better education in theoretical and applied population ecology..."
>
> "... need more skills in people management..."
>
> "... need a more rounded understanding..."

Skills and Expertise

Given the range of skills and specialties required in fisheries science and management, ranging over the full gamut of natural and managerial sciences, the task of designing a curriculum that fits all needs is daunting. One of the comments offered was that too much depended on "a few interesting teachers", suggesting that there may be a need for some defined standards in fisheries education. Another perspective put forward was that the lack of job opportunities after graduation was a factor in the unwillingness on the part of some educators to train students in areas where they see no likelihood of employment. Since it is difficult to foresee where specialized jobs will be needed, "what is needed is more general and broad-based skills taught in formal education, with specific projects (e.g., undergraduate or graduate theses) dealing with how to apply these.

Foremost is math—at least to the level of understanding mathematical approaches and language, and their uses (and limitations) by computers."

Career Planning

In the wake of the federal program review and budget reductions, there were very few scientists hired by Fisheries and Oceans Canada over the decade of the 1990s. Leading scientists are approaching retirement age en masse. Their departure is leaving serious gaps in science capacity. In addition, successful government researchers are being lured away in increasing numbers by universities and industry, in Canada and abroad. This alarming situation was brought up by a number of the survey respondents. It is also well known to the senior managers of Fisheries and Oceans Canada, and was identified in the department's recent Strategic Plan. While the problem has been noted, there is much more to be done to mitigate the effects.

3. Education And Expertise Issues

In addition to the information provided from the survey, the Council noted some significant trends and findings available from other sources.

Fisheries Education Programs

The fisheries education programs of particular interest to the Council are those of British Columbia's own educational system. The courses offered through UBC, Simon Fraser, BCIT and Malaspina University College are considered first-rate, and have served to produce several generations of scientists and fisheries managers.

The question now is how these programs can meet the needs of students and fisheries organizations of the future. There are already curriculum proposals submitted to or put forward by BC universities and colleges aiming at improving fisheries education. Proposals that have come to the Council's attention focus mainly on the practical aspects of local marine resource management. While the specific nature of these proposals remains confidential, there is already some recognition by the academic community of the educational needs and opportunities associated with sustainable fisheries management.

One respondent from an eastern Canadian university explained their curricular focus: "We are attempting to offer scientific training in fisheries conservation based on three key elements:

1. involvement with real fisheries,
2. use of high technology to measure the ocean and the fish, and
3. lots of sea experience and ship time (our students know how to read charts, navigate, and find fishing grounds). Whether or not we are doing this right, time will tell. One disturbing fact is that most of our recent graduates (MSc, PhD and post-doctoral) are finding better opportunities outside Canada."

An obvious requirement will be for students in fisheries study programs to gain exposure to other fields, and to pursue more interdisciplinary research and studies. The initiative of the Fisheries Centre at UBC to form links with the Faculty of Forestry and Liu Centre for the Study of Global Issues is an example of the right direction.

Fisheries Careers

It has been generally assumed that the graduates of fisheries programs have gone into government or research institutions, either within departments and agencies or in educational institutions. However, that is no longer the typical or predominant career path, particularly since government cut-backs and consequent reductions in job opportunities in those public sector organizations.

Instead, fisheries science graduates are gravitating towards jobs working for consulting firms, resource industries, municipalities, aboriginal bands, aquaculture operators, community stewardship groups, and environmental advocacy organizations, among others. The creation of community partnerships for fish habitat restoration, for example, has led to an outsourcing of the scientific and project management expertise that used to be housed within government departments. The development of co-management models and pilot projects with aboriginal organizations has put an onus on them to employ and train their own scientific and technical fisheries experts and staff.

Experience of Others

A July 2000 event sponsored by the Ocean Studies Board of the US National Research Council provided a viewpoint on human resource needs in that country's fisheries, and its findings shed light on issues that are similar to Canada's.

The workshop focused on the growing need of the U.S. National Marine Fisheries Service for stock assessment specialists and social scientists. Participants identified a range of problems in recruiting adequate personnel, ranging from attracting students into the field, to providing work incentives.

Many of the issues raised were similar to those mentioned by the respondents of the Council's survey. Participants also discussed measures to reduce the need for the stock assessment, and introduce new management methods, technologies, and practices, such as contracting out. The executive summary of the workshop report is attached as Appendix I.

4. OPTIONS

Fisheries research and management require a wide scope of understanding and interdisciplinary perspectives. These include the insight to comprehend the biology of the target species and their response to the environment where they live, the quantitative ability to obtain useful estimates of natural populations, and the skills to manage the social and economic problems of a fishery pursued by competing groups of harvesters.

Who should decide what education fisheries scientists and managers should receive? There are clearly a variety of tasks to be performed by fisheries scientists and managers. One might expect a certain core knowledge to be common to all, with further specialization according to tasks to be performed. This kind of question is usually resolved within the professions by declaring certain topics to be of absolute necessity and insisting that they be covered in the curriculum of accredited educational institutions. Professionals, such as lawyers, physicians and accountants, all follow curricula approved by their professional associations. So do foresters, whose profession is much closer to fisheries. However, Canada lacks a fisheries organization of sufficient influence and authority to establish and implement such a program accreditation. It now seems to be the time for such an organization to be created.

An example of the process required for setting and adapting such a curriculum in a multidisciplinary field is offered by the American Geological Institute. It has been making progress in its efforts to develop new earth-science curriculum programs, and its experience is described in Appendix II.

The creation of a new institutional arrangement, perhaps a Canadian Fisheries Society, should be considered. It could be either an autonomous entity or as a section of an existing professional organization such as the Canadian Zoological Society. A professional fisheries organisation focused on Canadian issues might also arise as a special interest group of the Canadian Meteorological and Oceanographic Society, or as a national extension of an organization like the Nova Scotia Fishermen and Scientists Society. The existing Canadian chapter of the American Fisheries Society would seem to be the most appropriate nucleus, were it to develop into an association devoted more closely to broad national issues of Canadian fisheries. The choice of the organizational vehicle is, of course, up to the initiative of members of the profession.

However, the major employers of fisheries regulators, scientists and managers, especially the universities, Fisheries and Oceans Canada and provincial fisheries ministries, could play a role in encouraging their employees to create a suitable professional organization. It is rather surprising that Canadian fisheries scientists and managers have not already established a body of this sort to advance the intellectual development of their field and ensure the quality of professional services in an area of such great relevance and controversy. This advisory might perhaps be delivered to the 2002 meeting, in Vancouver, of the Canadian Conference for Fish Research.

In collaboration with, or even in the absence of, a professional organization of fisheries scientists and managers, academic institutions could take the lead by getting together on a regional level, starting with the Pacific Coast, to consult with employers of their graduates. That consultation should involve carrying out an in-depth analysis of fisheries curricula and skill requirements across the sector. Such initiatives would be a significant step forward in addressing the practical and research problems of a sustainable fishery.

The involvement of fisheries conservation advocacy groups, such as the Sierra Club, should be encouraged in any curriculum development process. The value of involving such groups in this

effort will ensure that values such as the precautionary principle and issues such as genetic diversity are built into curriculum and become core elements of the educational programs.

At the same time, fisheries education must begin to address and include more elements of traditional knowledge. The focus on scientific method needs to be balanced with the value that can be contributed by aboriginal experience and input that may seem unconventional in a society that is not accustomed to such wider considerations.

The role of the Pacific Fisheries Resource Conservation Council involves helping to build the elements that will enable the environmental sustainability of Pacific salmon. The Council intends to encourage the implementation of innovative fisheries curricula and help build the bridges between educational institutions and the employers of future fisheries graduates.

By advancing the skills and capacity of fisheries managers, Canada and British Columbia could significantly improve the level of public discourse on fisheries conservation and management and address the challenges described in this advisory.

APPENDIX I—RECRUITING FISHERIES SCIENTISTS

Workshop on Stock Assessment and Social Science Careers, Ocean Studies Board, Commission on Geosciences, Environment and Resources, National Research Council.
National Academy Press, Washington D.C. ISBN 0–309–07308–1

Executive Summary

The National Marine Fisheries Service (NMFS) employs many fishery scientists with diverse skills. The agency finds that the supply of fisheries biologists is adequate to meet most of its demand. However, increasing demands on the agency to understand fish populations and the social and economic conditions in fishing communities have created a need for additional experts in the fields of fisheries stock assessment and social sciences.

NMFS has developed plans to meet its anticipated staff needs in stock assessment and social sciences and asked the National Research Council (NRC) to convene a workshop to discuss the plans and suggest other actions the agency might take to ensure an adequate supply of experts in these fields. Approximately 30 individuals gathered in Woods Hole, Massachusetts on July 17, 2000 under the auspices of the NRC's Ocean Studies Board to discuss NMFS's plans. No attempt was made to reach consensus among the participants; thus, the suggestions recorded in this summary represent the personal views of workshop participants as summarized by NRC staff.

Information was presented by NMFS at the workshop about the need to hire additional individuals in stock assessment and social sciences. NMFS proposed several actions to boost recruitment and retention of NMFS employees, including:

- developing targeted recruitment programs and cooperative arrangements with universities;
- enhancing continuing education opportunities for NMFS employees;
- increasing recruitment of individuals from related fields;
- increasing diversity; and,
- building capacity in minority-serving institutions.

A number of bottlenecks, differing by institution, constrain enrollment in graduate schools. At the most basic level, some universities do not receive enough applications from individuals with relevant skills who can meet their entry requirements. In some cases, universities cannot provide financial support at the beginning of a student's graduate education, even though such support could be forthcoming later when the student possesses greater skills that could be applied to his other advisor's research projects. In other universities, both funding and qualified applicants are available, but the number of faculty or their infrastructural support limit the expansion of fisheries education programs. Foreign students often bring financial support with them and can surmount the other bottlenecks, but are ineligible for employment by NMFS and other federal agencies after graduation until they become permanent residents or U.S. citizens.

The supply and demand situation differs for stock assessment and social scientists. For stock assessment scientists, NMFS is the primary employer and demand is already large relative to the total supply. NMFSs' anticipated expansion in this area exceeds the present capacity of university programs. On the other hand, NMFS is a minor employer of social scientists; thus even relatively large changes in NMFS's hiring decisions would add only a few slots and have a relatively small effect on the overall pool of social scientists available. NMFS's anticipated expansion in this area

could probably be accommodated with little difficulty. A caveat, however, is that relatively few social scientists focus on fisheries and thus would require some persuasion to enter the field and time to learn the nuances of fishery issues.

Some suggestions for reducing the total demand for qualified scientists (including those at the Ph.D., Master's, and Bachelor's levels) may include (1) decreasing the regulatory requirements for fisheries, (2) managing more cautiously (e.g., setting lower total allowable catches) so that less information and analyses are required, (3) developing and implementing management methods that require less stock assessment and social science advice, or (4) increasing technological capabilities for performing analyses without increasing staff levels. Another way to reduce the demand for stock assessment and social scientists within NMFS—and possibly total demand—would be to contract out a greater percentage of stock assessment and social science analyses to universities or private consultants.

However, most of the workshop discussions focused on ways to increase the supply of stock assessment and social scientists in the event that NMFS receives funding for its plans. Workshop participants considered both traditional and more innovative approaches. Traditional approaches included increasing the availability of graduate and post-doctoral fellowships, funding faculty positions in universities, sponsoring programs to reach undergraduates, placing NMFS employees in academic institutions, and disseminating information about career and employment opportunities more broadly. NMFS already is using many of these approaches and has made progress in targeted graduate fellowships for stock assessment science and fisheries economics, and in offering NRC and other post-doctoral fellowships to bring new individuals into NMFS laboratories. Many participants felt that NMFS could make additional progress using these traditional approaches.

As suggested by some participants, the most obvious approach to attract more stock assessment and social scientists to NMFS would be to offer higher salaries for individuals with these specialties. This is a particular need for stock assessment scientists because their quantitative skills enable them to find work in other, more lucrative professions. If salaries cannot be increased to competitive levels, non-monetary incentives could be offered to make up for the salary differences. Examples include travel to professional meetings, support for individual career development, funding and release time to conduct research, and exposure to national-level policy and projects.

Some of the shortfall in qualified employees can be met by hiring individuals from related fields with similar skills, but these individuals often require additional training to acquaint them with problems specific to marine fisheries. As an alternative, intensive retraining of qualified staff might help reduce the current shortfall.

Other less obvious, but potentially productive, approaches to meeting NMFS staffing needs could include through scientific societies to find individuals in the academic or consulting communities who could fulfill NMFS' analysis needs, employing foreign scientists as guest researchers, nurturing applied mathematical ecology and population dynamics programs in universities, and sponsoring programs to reach high school students in an effort to influence their college careers.

APPENDIX II—EARTH SCIENCE EDUCATION

Agencies, Organizations Examine Options for Geoscience Education During AGU Spring Meeting (From *EOS, Transactions of the American Geophysical Union*, vol. 81, No. 25, p. 277. June 20, 2000.)

"Our goal is no less than to induce Earth science education nationally," said Bill Houston, education project manager for the American Geological Institute (AGI), in outlining the organization's efforts to develop reform-based Earth science curriculum programs.

Houston's presentation was part of a special session at the AGU's Spring Meeting to highlight efforts by the U.S. federal agencies and organizations—and one project in Australia—to support an integrated approach to geoscience education through a variety of partnerships.

Houston said AGI is partnering with scientific, educational and government agencies, and will commercially release curricula in August. The "Investigating Earth Systems" (IES) curriculum is geared toward students in grades 5–8, while the "Earth System Science in the Community" (EarthComm) curriculum targets 9th–12th graders. Both curricula emphasize student-driven inquiry, small group projects, and collaborative learning.

Work on the curricula involved a number of challenges concerning their development, marketing, adoption by 50 states and thousands of school districts, and implementation, Houston said. In targeting the curricula for adoption, for instance, the variability of students' understandings of geosciences need to be considered. In Maine, 58% of students in the 9th grade study Earth sciences. Some other states, however, do not currently have Earth science standards.

In another presentation, Charles Groat, director of the U.S. Geological Survey (USGS), discussed his agency's educational programs, and the need for integrative science, partnership, and a diverse workforce.

The USGS education program right now is "in a hiatus", according to Groat, in part due to lack of funding and program coherence. He said that while USGS is involved with some educational efforts, "there is no USGS education program", and the agency is exploring what more it should be doing in this area.

Groat said that a USGS education program could be in the agency's "enlightened self-interest," by helping to educate students who might consider geosciences as their profession.

The geosciences particularly need more people who understand integrative sciences as a way to approach complex problems, Groat said. He pointed to the agency's coastal programs as an example of the need for scientists in different disciplines—such as physical or biological processes—to talk to each other and understand the connections between issues.

Groat also stressed the need for more geoscientists who come from diverse backgrounds.

"I am convinced that if we don't get more people from different ethnic backgrounds into the scientific workforce, we're not going to have the scientific workforce we need," he said. Part of the problem, Groat stated, is that not enough minority students are studying the geosciences and entering the field.

But he added that there is a potential for a turn around in terms of more people from diverse backgrounds becoming interested in the geosciences, as they better understand the relevance of the field to their lives. *"A lot of the real science challenges today are solving problems of people*

congested in cities, which tend to be in some cases ethnic minorities who are disadvantaged to some degree, and they are the ones who are feeling the worst of the environmental impacts of big urban development," Groat said.

"Our integrative science is getting us more into those kinds of questions," he added. *"Whereas ten years ago, we wouldn't be thinking about environmental health threats to disadvantaged populations, or we wouldn't be thinking about the environmental impacts of urban sprawl—in the way that we think about it now—well, now we are doing science that affects the very populations that we would like to see in our workforce. So, maybe that will be a motivating factor for them, because they see it is relevant to things they care about."*

Other topics discussed during the session included an overview of Project 2061, an effort undertaken by the American Association for the Advancement of Science to reform science education in grades kindergarten through 12 to ensure that high school graduates are science-literate. Papers were also presented on education efforts and partnerships supported by the National Science Foundation, NASA, the American Meteorological Society, and others.

The session was jointly sponsored by the National Association of Geoscience Teachers and the AGU Committee on Education and Human Resources. The session was held in memory of former Washington, D.C. City Geologist James O'Connor, who had a passion for science education and shared his understanding of geology and the natural world with school children and the general public.

For further information, visit the AGU Web site: http://www.agu.org/meetings/sm00glan.html. Click on the education session, ED51A.

Randy Showstack, Staff Writer.

ABOUT THE AUTHOR

Dr. Paul H. LeBlond, FRSC

Paul LeBlond holds a Ph.D. in physics and oceanography from the University of British Columbia, a B.Sc. in maths and physics from McGill University, and a BA in humanities from Laval University. Following a post-doctoral fellowship in Germany, Dr. LeBlond served as Professor of Oceanography and Physics at the University of British Columbia until his retirement in 1996. He is now active in a variety of local, national and international ocean science and conservation forums. Before joining the Pacific Fisheries Resource Conservation Council, Dr. LeBlond was one of the original members of the Fisheries Resource Conservation Council for Atlantic Canada. He chairs the Science Advisory Council of Fisheries and Oceans Canada as well as the Science and Industry Advisory Board of the Institute for Pacific Ocean Science and Technology. Dr. LeBlond is a Fellow of the Royal Society of Canada.

590 – 800 Burrard Street

Vancouver, British Columbia

Canada V6Z 2G7

Telephone: (604) 775 – 5621

Facsimile: (604) 775 – 5622

E-mail: info@fish.bc.ca

www.fish.bc.ca