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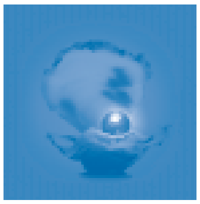

AQUATIC SCIENCE 2020 WORKSHOP REPORT

Montreal, Quebec
May 6-8, 2003

Over a century of science
Plus d'un siècle de sciences
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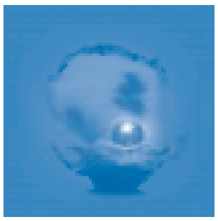
TABLE OF CONTENTS



The two discussion papers cited in this report are available as follows:

Beecher, Bob and Evan Thomas. 2003. The Future of Aquatic Science in Canada (Freshwater Emphasis).
Canadian Technical Report of Fisheries and Aquatic Science 2475

Rice, Jake. 2003. The Future of Aquatic Science in Canada (Oceans Emphasis).
Canadian Technical Report of Fisheries and Aquatic Science 2474

FOREWORD

Aquatic science provides the foundation for conservation, management and safety aspects of Canada's waters and waterways. On May 6 through 8, 2003, the Department of Fisheries and Oceans hosted a workshop in Montreal, Quebec, titled "Aquatic Science 2020." The workshop brought together more than 150 participants – departmental scientists, other members of the scientific community and stakeholders – to discuss the future of aquatic science in Canada, the importance of science to the Department's decision making, engagement and partnerships and other issues and implications.

Two discussion papers were distributed to participants prior to the workshop, and these served as springboards for workshop activities and discussions. The format of the workshop included presentations, question and answer sessions, table discussion exercises, and plenary reports.

The purpose of this report is to provide an overview of the workshop discussion highlights and messages, which represent a snapshot of the future of aquatic science in Canada in the short and longer term. The report outlines the ideas developed over the course of the workshop, which will be considered as part of the strategic planning exercises underway in the Department. The compelling results of this workshop will help provide a vision for future policy and program decisions within Science Sector and the Department.

Wendy Watson-Wright

Dr. Wendy Watson-Wright
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INTRODUCTION

The aquatic science community has to anticipate emerging needs years, sometimes decades, in advance. The first step in this process is to identify the major drivers or expectations of the Canadian public in terms of aquatic science. The next step is to identify the areas and activities in which aquatic science will have to excel in order to meet these needs or expectations. The final step is to consider the future human resources requirements, particularly in terms of scientific specialties, and the institutional arrangements which will best deliver science to Canadians.

Canada's waters and waterways significantly contribute to Canada's economy. Commercial fisheries landings are currently valued at approximately $2 billion/annum, of which $83 million comes from freshwater. Recreational fishing in Canada involves about 20% of the population, and results in expenditures of over $6 billion. Canada's growing aquaculture industry has a total value of about $600 million. The value of offshore hydrocarbons exceeded the landed value of commercial fisheries in Atlantic Canada. Canadians own 2 million recreational boats and spend about $2 billion annually on this activity. Commercial shipping contributes more than $1.1 billion to Canada's economy, and is growing rapidly. While complete aquatic tourism figures are hard to obtain, whale-watching in the St. Lawrence Estuary alone generates more than $100 million annually.

Equally important are the social and cultural contributions of the waters and waterways to Canadian values and the Canadian way of life. Canadians attach a value to their aquatic ecosystems for heritage, culture and physical and emotional well-being that is not measured in dollars.

FACTORS DRIVING SCIENCE

Summary of the Discussion Papers

The background discussion papers outlined the following expectations of the Canadian public from aquatic science, reflecting environmental, technological and societal considerations.

- More participative governance and inclusive science.

Canadians will take as given the integrated, inclusive decision-making processes promised in the Social Union Contract and embodied in Canada's Ocean Act and various co-management initiatives. Inclusive and integrated management planning approaches will be expected for all ocean areas with the federal government as the decision-maker on important marine and freshwater issues.

- Demand for an ecosystem approach.

The use of a holistic ecosystem approach will be a necessity to preserving biological diversity in response to institutional and public demands to ensure healthy species and habitats. The application of ecosystem based management will be especially important in northern waters where ecosystems are particularly sensitive and subject to significant modifications as a result of climate change.

- Demand for a national climate service.

With continuing climate change and increased risk of catastrophic events, Canadians will expect better weather and climate forecasts. These forecasts will depend critically on ocean-atmosphere coupled models requiring much new information on the role of the oceans in global and regional climate change.

- Priority of conservation and biodiversity.

With few exceptions, conservation and biodiversity will be more important than fisheries management as influences on public expectations of science. Themes such as invasive species and recovery of species at risk will exercise significant leverage in demands for science support and decision-making.

- Emergence of social sciences as a complement to natural sciences.

The social sciences will emerge as a complement to the aquatic sciences and provide an additional source of knowledge for conservation and management of aquatic resources and ecosystems. Social scientists will play an important role in the human, resource and community interactions.

- Adopting objective-based management.

Management of ocean resource use will be risk based, and structured around quantitative objectives and conservation reference points. The Precautionary Approach will have evolved substantially, but the concepts of being risk averse relative to reference points associated with serious harm to the resource and ecosystem, and decision-making based on pre-agreed control rules, will be entrenched in management practice.

- Opening of a navigable Northwest Passage and greater development in the North.

By the mid 2020s, global warming will result in a Northwest Passage that is navigable for several months a year. This will pose environmental threats and risks of harmful interactions with marine life, particularly migratory marine mammals. Faced with the risk of challenges to Canadian sovereignty and security in northern waters, Canada will accept but regulate shipping in these waters.

- Demand for near-real-time access to data.

Canadians will expect full, near-real-time access to the data and information holdings of government. These demands for better access will have to be accommodated in a setting where technological advances are continually expanding the ability to collect information on more components of the ecosystem, and with greater spatial and temporal resolution.

- Extensive mariculture of a core of native species.

First, there will be extensive mariculture of several species of white-fleshed roundfish and shellfish. Second, with a forecast human population of 35.4 million for the year 2021, there will be an increasing demand for seafood. Currently, water farming and aquafeeds are the two fastest growing production systems on the planet and this growth will continue.

- Attention to reducing the gap between the North and South.

The economic gap between North and South will have reached such a magnitude that Canada, along with many other developed countries, will treat equity and capacity building in under-developed countries as a priority. In this connection, science effort will be devoted to sharing knowledge and technology with less economically advantaged states.

Summary of the Workshop

Based on these expectations, the workshop identified the following key drivers that will shape the future requirements, activities and institutional structure of science within the Department.

Competing Resource Demands

An ever-increasing diversity of users will emerge and overall demand for aquatic resources will increase. There will continue to be traditional commercial and recreational users, as well as increased resource demands related to aquaculture, tourism, offshore oil and gas, mineral exploration and harvest fisheries, as well as demands for fresh water. These competing demands may be in conflict with one another.

Aquatic science will need to consider all users: commercial users cannot be considered the only or the priority users. There will be a simultaneous co-existence of multiple resource users and the Department will need to treat each with a "fair application" of access vs. resource protection/management. There will be a need for an integrated use of aquatic resources and ocean spaces and integrated science.

Human Population Growth

Closely related to competing resource demands is the growing population, both in Canada and globally. In Canada, population growth will continue to create development pressures, particularly in freshwater and coastal zones. More people mean more human activity – recreational, commercial and industrial. Water use will increase as will the importance of conserving Canada's freshwater resources.

Climate/Environmental Change

The effects of climate change are already an issue for the aquatic sciences. Implications of climate change include greater climate variation and more extreme events, changes in water temperature, a decrease in the amount of freshwater, biogeographic shifts, an increase in invasive species, and stresses on species at risk. Climate change means that environments are not in a "steady state" and science can not always use the past to predict the future.

The Department will have a responsibility to adapt to change. There will need to be a long-term commitment to environmental monitoring. Science will need to focus on ways to mitigate the impacts of climate change on Canadians.

Crises/Conflicts

The diversity of resource users and of social values will lead to an increase in the number and intensity of conflicts. Conflicts will also arise because of a lack of information and misinformation, and science will have a key role in providing unbiased information to support conflict resolution.

Departmental credibility will be measured by its reaction to crises and conflicts, which will need to be handled with impartiality and balance. A proactive approach will be needed to prepare for the unpredictable. It will be important to be able to rapidly react to changing circumstances – for example, an environmental version of SARS. In this connection, the Department needs the right people in the right place at the right time – which raises issues of recruitment and retention. Generalists will be needed to deal with a range of unanticipated problems.

Technology

Technology will continue to change the way science is performed by providing new tools and improving data capture and exchange. The quality of modelling will improve and alter how research is done and its effectiveness. With increasing use of the internet and features such as web-based mapping, technology will continue to make geographic location less relevant. It will also play a role in enabling the rapid integration of discovery and innovation.

Effective use of technology is important. Technology can help to remove silos, and increase science's capacity for sharing knowledge horizontally across disciplines.

Technological advances will continue to support greater efficacy of industries that impact aquatic ecosystems (fishing, oil and gas, aquaculture, etc). Science will have to assess the impacts of more advanced industries on ecosystems.

Communications

There is a communications gap between science and the public and decision makers. Science has a key role to play in proactively keeping stakeholders, policy makers and the public informed and aware. Information should be provided about the effects of key impacts on aquatic ecosystems, such as climate change and invasive species.

A good information base is needed and existing and new sources of information must be integrated to provide improved access and sharing.

A technically knowledgeable public will have increased access to information, which could lead to improved understanding and support for key issues. Communications within the Department should be strengthened to support leadership and ensure credibility.

Economics and Funding

Traditionally, certain species (high value and/or high visibility) tend to get priority attention and funds. Funding needs to be balanced to ensure fundamental science has long-term sustained support.

Funding is needed to provide the new and expensive technologies essential to ensure effective management and integration of discovery and innovation, and to ensure that Canadian aquatic scientists can continue to play a lead role.

The availability of funds will depend on the economic health of the country.

Globalization

Canada's international responsibilities and expectations, such as obligations under the United Nations Convention on Law of the Sea and the Convention on Biodiversity, will continue to drive Canadian science. Canada's international commitments should be reviewed on an ongoing basis for relevancy in terms of costs and benefits.

Global markets will also influence science – for example, there will be increasing demands in the international marketplace for "ecological certification" of products as well as for food safety standards and other consumer issues.

Canada's sharing of freshwater and ocean resources with other countries, such as the United States, Mexico, Greenland and the Soviet Union, will also increasingly come into the picture.

National Policy and Legislation

The link between policy and science needs to be tightened. Parliamentarians, including federal, provincial/territorial, municipal and those of other countries, need to be engaged and informed in order to build the political will that must be in place to support aquatic conservation and management efforts. The engagement and awareness must be based on valid information. Science has a responsibility to help promote well-informed participation in the policy setting process through education and communications.

Jurisdictional issues, political parties, federal-provincial relations and international implications all bear on the setting of policy. There is also a role for First Nations, which will increase as involvement in resource management grows and cultural values influence treaty agreements.

Legislated priorities and responsibilities will influence direction, for example, the requirement to set priorities in the context of sustainable development.

There is a need to form policy with an understanding of its cumulative effects. For example, policy is needed to ensure a commitment to sustainable use of ecosystems and protection of biodiversity.

Public/Societal Expectations

Societal demands and perceptions are continually evolving. The Department needs to be able to identify and understand public expectations and respond to changing social values. With this knowledge, it can develop education and information tools in order to build public confidence and support and to develop accurate perceptions of risk.

Public expectations may include access to clean and healthy aquatic resources, credible science, real-time advice, and user-friendly, timely, accurate, transparent information. This demand for knowledge will increase. The public seeks practical, short-term solutions as well as long-term outcomes on fundamental issues. The public in 2020 will be well informed and knowledgeable both in terms of information and government.

SCIENCE ACTIVITIES IN 2020

Summary of the Discussion Papers

The background papers set out the following activities that will be central to meeting public expectations for aquatic science in 2020.

- Science certification and audit processes.

Many individuals and groups will work with academic and government professionals in carrying out science activities, and the professional science community will have techniques, institutions and traditions for setting performance standards for diverse science activities and for auditing performance.

- Centrality of structured review and advisory processes.

Formal processes for peer review and provision of scientific advice will be in place as necessary steps for screening the technical contributions of all groups, as a pre-condition to allowing any technical analyses to be accepted as part of the factual basis for discussion of options. The peer review and advisory processes will have to be perceived as impartial – as fora where the technical legitimacy of analyses and interpretations are evaluated on a level playing field.

- Data integration and management.

While networking with many partners who provide input and use products, government will have to lead in the creation and maintenance of integrated datasets and databases. The public will demand it, as part of good governance, and because private sector control of major data sources will be both unacceptable and unaffordable.

- Indicator based status and trends monitoring.

Provided that adequate resources are available, indicator-based status and trends monitoring will be provided on issues such as commercial stock status, coastal planning, mitigation of cumulative effects, harvesting multiple commercial species, managing bycatch, evaluating impacts of energy and aquaculture projects, recovering species at risk and diverse other tasks.

- Developing and testing mitigation and recovery strategies.

Science experts will be expected not just to detect that some activity is at a level that is no longer sustainable, but also to advise on how to fix the problems caused by the activities and on how to avoid future problems. The Species at Risk Act foreshadows these expectations by requiring that programs be actively pursued to recover species designated at risk.

- Expanding knowledge of the water column and seafloor.

An increased understanding of the physical and chemical properties of the water column and seafloor will be essential for supporting management of diverse ocean industries. Many parties will participate in the collection of data on the water column and seabed and government agencies will need to be involved in the long-term infrastructure for ocean observation and prediction systems.

- Developing new aquatic industries.

In addition to the ongoing aquatic industries, new ones are likely to develop in areas such as bio-technology, particularly marine pharmaceuticals and bio-remediation methodologies, and instrumentation for durable operation under harsh environments. Whereas government may be a minor partner in the actual research and development of these industries, it will be a key focus for planning, auditing and effects monitoring.

- Building bridges to social sciences.

Bridges will be built between the natural and the social sciences with social scientists from many fields, including economics, sociology and anthropology, working together with aquatic scientists to achieve common aims. Once the disciplines are working together effectively, management tools will change with economists conducting more complete cost-benefit analyses of management options and providing a better information base to support decision-making.

- Doing science in the North.

With continuing climate change and increased development, sovereignty, biodiversity and security issues, Canada's northern aquatic ecosystems and resource users will face mounting pressures. The failure to invest in research in the North over the past decades will place ever increasing pressures on government to act in a committed, serious, integrated and long-term manner. Strengthened partnerships will be essential among all science interests, between science and industry, and between the science community and Northern peoples.

SCIENCE ACTIVITIES IN 2020
Summary of the Workshop

Activities

The workshop identified the following activities that will be needed to meet the expectations of the Canadian public for aquatic science information and knowledge in the future.

Competing Resource Demands

Aquatic science will need to monitor, understand, and predict the effects of decisions made with regard to how resources are used. The public will want to know the effects of resource use on an ecosystem. This will require the gathering of baseline information on habitats and species, site assessments for aquaculture, monitoring and assessment activities, such as dynamic resource and ecosystem mapping, and the use of modelling tools to predict consequences and risks. Coastal zone models to weigh trade-offs, including economic evaluations of ecosystems and their components, may be needed. A team approach that is more focussed on ecosystems than specific species will be most effective. Team leaders should be from the Department, with team members drawn from universities, the Department and other groups.

Human Population Growth

Aquaculture will be driven by an increased population and by consumer demand for healthy protein options. Food safety and quality as well as environmental issues will need to be addressed. Long-term monitoring from baseline parameters and environmental indicators, risk analysis, modelling, and geomatics activities will be required. Other implications from human population growth include increased use of waters and waterways for recreational, commercial and industrial activities.

Climate/Environmental Change

We need to understand climate variability and climate change as they affect the resilience of ecosystems. Canadians will want to know how climate change is affecting habitats and species within ecosystems, as well as its effects on industry and coastal communities. They will want to see that negative impacts are minimized and positive impacts are responsibly used to full advantage. Aquatic science activities include long-term monitoring and ongoing analyses, remote sensing, anthropological studies, identification of "indicator species", and validation of model results.

The Department should lead in the creation of web-based conceptual models to link aquatic science data in Canada, from small freshwater studies to deep ocean studies. Such conceptual models would be used to show how aquatic issues are linked, where knowledge exists and where knowledge is needed, and to provide a snapshot of the current state. All organizations collecting data on aquatic environments would be involved.

Change in human systems must also be considered, so a multidisciplinary approach is crucial. Responsibility for "science" among different federal departments will need to be integrated and organizational arrangements must encourage the sharing of information.

Crises/Conflicts

Conflicts and crises will always be present in the management of aquatic resources; however, through planning, communication and building on lessons learned, they can be better managed and resolved. Science has to support a common understanding of "the facts" in order to allow objective debate around difficult and potentially confrontational issues through educational, outreach and communications activities. Communications with the public must be open and transparent, around a framework that includes an independent review process. Past events should be documented, analyzed and lessons learned shared. It would also be effective to develop knowledge around anticipating conflicts, governance issues and balancing needs of interest groups. Long-term objectives are required.

Technology

New technologies will provide the ability to perform research and analysis better and faster. New technologies will also play important roles in remote sensing, bio-engineering for aquaculture and long-term weather predicting. Science should lead or facilitate the development of selected technologies, for example remote operated vehicles.

Technology will improve data collection, storage, analysis, retrieval and dissemination capabilities. Science has a role to play in ensuring a standardization of information technology tools to facilitate information gathering and sharing across departments, stakeholders and disciplines. Developments in information management technology will enable development of decision support systems based on information from widespread sources, and such systems should be built by and maintained within the Department.

Technological advances in commercial and industrial areas will need to be monitored and assessed in terms of risk and environmental impact. Innovation in areas such as deep sea oil exploration and extraction may be rapid and science must be prepared to respond.

Communication

The Department has a key role in providing objective, unbiased and authoritative information on aquatic science. There are at least three types of communications to be considered: internal (scientist to scientist), internal (with the rest of the Department), and external to clients and partners (which may include stakeholders, other government departments, provinces, universities and the public). Communications with other countries also needs to be considered.

All communications need to be transparent, timely and reflective of decisions. Communication should raise awareness of issues and demonstrate science successes as well as the imperfections and limitations of science.

Communication also promotes effective collaboration between political, administrative and other disciplines. Formulation of objectives for aquatic ecosystems and their management is an interaction between government and stakeholders in which clear communication is an essential element.

Achieving communications objectives requires efficient use of emerging technologies. Publicly funded data should be freely available – but meaningful interpretation, context and purpose should be provided along with the information.

Economics and Funding

It is acknowledged that the state of the economy will determine research dollars – and that science may suffer during periods of economic downturn. Further, the proportion of funding to universities and government may change over time. However, scientific excellence must be maintained regardless of the economy and funding. The overall, ongoing goal should be a strong, vibrant scientific community. The Department should strive to ensure stability with respect to science capacity.

Funding is also driven by the political agenda and government position. The challenge is to raise awareness and be adaptive to changing needs and priorities. A national focus is also beneficial. A specific percentage of the Department's science budget should be allocated to mission-oriented basic science.

Activities should be designed to ensure excellence of scientific staff and results. Opportunities for continued learning should be encouraged. Other activities include networking, radical change to stock assessment and establishing centres of excellence.

Aquatic sciences contribute to strong economies. The Department could investigate whether its science might be a revenue source, for example, through sales to other countries.

Globalization

A full inventory of international laws, treaties, agreements and protocols and Canada's responsibilities under them is needed, along with an inventory of all current science activities to meet those responsibilities. International obligations should be prioritized based on current and future resources. Certain areas are particularly important for international science: the Arctic, the Great Lakes and international fishery and environmental treaties.

Activities related to international responsibilities include boundary delineation, seabed mapping, technology transfer, data sharing, communications, and in-house training to raise awareness of obligations. The Department has a role to play in providing training to third world scientists.

National Policy and Legislation

There will be a continuing need to bring stakeholders and Canadians into the policy making process. For this to be effective and meaningful, stakeholders need to be well-informed. Science has a role to provide cohesive information and knowledge to enable informed, meaningful contributions to national debates.

New policies may be needed to support a "vision of the future." Scientists and policy makers need to be closely connected, possibly through a formal framework, to remain aware of current and future situations.

Activities include clarification of roles, data management and communications. Science activities focus on developing a geomatics protocol, defining ecosystem indicators and monitoring ecosystems.

Public/Society Expectations

The knowledge provided by science supports safety and security, which are key roles of government. There are many public expectations related to the work of science, including aspects of safe marine transportation, sustainability of the environment, timely and up-to-date information, Canadian sovereignty in the Arctic and participation in decision-making. The Department should organize public dialogue/consultation on key issues and provide credible advice as required.

The public expects science to provide management and policy decision makers with information and advice so that decisions are based on sound scientific knowledge and understanding. This results in strong public confidence. This requires strong communication activities and skills, particularly on sensitive issues.

CROSS-CUTTING ACTIVITIES

The following activities are of a cross-cutting nature, as they apply to a number of the key drivers:

- Ecosystem monitoring/predicting
- Modelling
- Risk assessment and management
- Remote sensing and use of innovative observational technologies
- Information and data management to support sound decisions
- Communications
- Working in interdisciplinary teams

SPECIALIZATIONS

In connection with the activities, the workshop identified the specializations that will be needed to meet the expectations and requirements of the key drivers. These include:

- Human resources from pure and applied natural sciences, including aquatic scientists and technicians with specialization in hydrography, oceanography, meteorology, chemistry, biology, physics, ecology, eco-physiology, taxonomy, aquaculture and engineering. These people will be early adapters of new technologies related to these fields as well as geomatics, remote sensing, remote operated vehicles, etc.
- Practitioners of social sciences, such as economists, anthropologists, ethicists and social scientists.
- Risk assessors and modellers.
- People skilled in organizational management, policy design and analysis, team leadership, and facilitation.
- Communicators who can effectively disseminate science knowledge to Canadians, stakeholders and decision makers.
- Information and data managers, knowledge workers, educators, data collectors, synthesisers and interpreters.
- Conflict remediation specialists.

Overall, a team approach is recommended.

IMPLICATIONS FOR SCIENCE IN THE DEPARTMENT

Summary of the Discussion Papers

Departmental scientists and support staff will continue to do world class original and creative science to increase knowledge and to aid in decision-making in all science activities of the Department. Career opportunities will continue to be provided to engage and maintain the brightest and the best aquatic scientists available. Consideration will, however, need to be given to a number of challenges to the status quo. Some key ones include:

- The science done in government will be conducted much more with teamwork inside and partnerships outside. The partnerships will be with much more diverse types of collaborators locally, nationally and internationally.

- A core role of science will be to provide settings for peer review and application of science conclusions as advice. In areas where the science is carried out within the Department, it will have to be demonstrated that public interest is best served by having the science done within the Public Service.

- Much science will be performed outside government and academia. Departmental Science will have to take on a new identity as the place where quality standards are established. Aquaculture and fish health may be the first areas to complete this transition of role.

- Direct linkages to the social sciences will be needed and will be obtained by hiring a critical mass in these disciplines or through formal collaborative arrangements with academic centres.

- More hydrography and oceanography is urgently needed in the North. Failure to commence such work within the next 10 years could lead to serious issues for marine transportation and for understanding the role of arctic waters in climate change. It will be equally important to study the fragile Arctic ecosystem and to monitor the effects of climate change.

- Flexible and effective mitigation and recovery strategies will be a growth area in aquatic sciences. Government will be expected to create them, and to guide how they should be applied.

- The mapping of the marine and fresh water areas, their bottom characteristics and key water column attributes will hopefully be complete. These datasets will, nevertheless, need maintenance and updating.

- Science staff will be required to change both research emphasis and geographic locale more often throughout their research careers. Experts will be expected to contribute substantially to training and capacity building of many Canadian groups outside government. Staff will also be expected to accept assignments in the developing world.

These challenges will stress the science sector's ability to adapt and to preserve existing strengths while building new ones. Building new strengths will require adding or augmenting several scientific disciplines or forging strong linkages in academia or the private sector. These include: taxonomists and general ecologists, social scientists, data managers, mitigation and recovery scientists, quantitative experts, modellers and scientists with expertise in chemistry, biochemistry, and molecular biology. Skills are also required in running review and advisory meetings and providing science advice to the inclusive, integrated planning and decision groups.

AQUATIC SCIENCE 2020:

Workshop Perceptions of a Preferred Future

Best Practices and Elements of Success

Transformation does not mean abandoning all activities that have been done in the past for new ones. There are many systems, structures and approaches that have worked well and that will continue to be effective into the future. Scientific disciplinary knowledge will continue to be the bedrock on which science programs are built. Transformation provides the opportunity to carefully consider the core factors and elements that we do well, in order to retain, nurture and build on these best practices and successes.

- **High quality science results**
  Excellence in aquatic science will be an explicit goal and will be rewarded. Scientists will be committed and truly engaged in solving problems. Research will be of consistently high quality and, even in the face of fiscal crisis, there will be strong data series that will continue to be important as the move is made towards ecosystem-based approaches. Furthermore, the Department will continue to be strong in hydrography, oceanography, mapping and natural sciences connected with physical, chemical and biological processes.

- **Support to universities and independent science institutions**
  Collaboration between university and government scientists will continue to be positive at the working level and very productive. Departmental science infrastructure and networks will provide beneficial support to outside science institutions but the Department will not sit alone in judgement of what constitutes “good” science.

- **Strong team around clear goals**
  The departmental science team will continue to support its mandate and core activities. Strong project management skills will still exist and improvements will have been achieved in program management. Priorities will be clearly defined, based on needs of Canadians, and teams will be accountable for meeting their goals.

- **Cooperation with stakeholders**
  Citizen engagement, client consultation, the participation of clients in data collection and on-going inclusiveness with the fishing industry will be strong science characteristics.

- **Science management capacity**
  DFO Science will have established a mission-oriented research environment that provides focus and which differs from an academic environment. Four elements of Science will be monitoring, targeted research, information/data management, and provision of advice and products. The Department will have used these elements to build programs based on addressing long-term issues while maintaining a capacity to deal with shorter-term crises. Front-line work will be connected as directly as possible to policy makers. These elements will be well communicated to other scientists and to departmental policy makers to ensure strong science management capacity. The peer review process with a broad range of participants will continue to achieve positive results.

Shaping Our Preferred Future – The Long Term

In 2020, the view that "government can do it all" will have been replaced with a collaborative approach that balances and distributes responsibility, tasks and knowledge amongst many partners. These partners will be drawn from academia, industry, other federal government departments, provincial and territorial governments, First Nations and non-governmental organizations.

Aquatic science will adopt a multidisciplinary, cross jurisdictional, ecosystem approach that is based on partnerships and teams. It will consider a broad scope of influences, factors, issues and concerns and involve a broad range of disciplines, including the social sciences.

Departmental science will play a key leadership role, facilitate partnerships and priority setting, and deliver excellent service and programs for Canadians to protect, manage and sustain Canada's waters and waterways.

Elements and factors for the preferred future for the Department include:

Multidisciplinary, horizontal team approach

- Science crosses departments, jurisdictions, and disciplines.
- The multidisciplinary approach complements the ecosystem approach.
- Disciplines and specializations encompass the full spectrum of science specialization. Social scientists are included in the mix.
- Silos and walls are replaced with networks, sharing and collaboration.
- Planning and identification of research and science priorities is a joint, inclusive process.
- Based on priorities, teams have clear goals and timelines and are accountable for meeting them.
- Formal standards are in place for assessment programs.

Funding and facilities

- Financial structures are in place that support and facilitate collaboration amongst partners.
- Long-term science objectives are supported with stable, long-term funding.
- Short-term "issues" are supported by special funding.
- "Thematic-based funding" reduces duplication and improves efficiency without changing total Canadian expenditures on research.
- Departmental labs, vessels, equipment and facilities are cutting-edge; investments are made in the development and deployment of new instruments/technologies. This contributes to the recruitment and retention of excellent talent.
- Formal structures linking university and government science programs are in place.

Ecosystem approach

- Science crosses boundaries, jurisdictions, regions.
- The ecosystem approach complements the multidisciplinary approach.
- The Department acts as a catalyst to bring partners together and in setting priorities.
- Ecosystem clusters are defined; baseline studies focus on ecosystem clusters; ecological integrity/ environmental quality guidelines are in place.
- Priorities, teams and tasks are tied to ecosystems, not regions or species.
- Priorities are long-term. Flexibility enables rapid response/adaptability to change.

Communication

- Science communicates openly about plans, activities, successes and lessons learned.
- Communications are transparent, timely and credible.
- Audiences have been identified and are targeted accordingly. Audiences may include the scientific community, other government departments, non-governmental organizations, governments of other countries, and Canadians.
- Communication is proactive.
- Increased awareness and understanding through credible information helps offset conflict.
- Team-based communication strategies are in place.
- Communications training is provided.

- **People are a priority**
  - The expertise of departmental employees allows aquatic science to identify and meet challenges and change.
  - Personal and professional development and innovation are encouraged and fostered.

- **Information management and technology**
  - The Department manages an information resource that collects, analyzes and disseminates aquatic science information.
  - Information is provided to Canadians at no cost.
  - Technology is used to support "virtual institutions" and teams. Location rarely limits collaboration.

Moving Toward the Future – The Near Term

There are a number of areas for departmental focus and effort in the near term (five years) in order to secure this envisioned future and continue to deliver a high level of appropriate programs and services to Canadians in a cost-effective and efficient manner. These include:

- taking the lead in defining ecosystem-based clusters and organizing and managing an efficient system for collecting, analyzing and sharing baseline information;

- making data management a much more important part of the science responsibility and having structured processes for quality control, integration, providing value-added products, and building and maintaining user-friendly portals;

- applying coupled ocean-atmosphere models as operational tools and interpreting the outputs;

- structuring science in support of management decision-making around choosing effective indicators and reference points, and then evaluating risk within that framework;

- developing new or refining existing frameworks, systems and infrastructure tools to manage the Department's activities and finances, such as risk management and accountability frameworks and priority setting tools;

- conducting a full review and inventory of existing equipment, labs, vessels, research centres, etc., in order to evaluate where improvements and additions are required, where efficiencies could be improved, or where redundancies or duplications exist;

- reviewing international agreements and responsibilities in terms of costs, obligations and timeframe and building awareness across the Department on responsibilities related to these agreements;

- developing mechanisms to facilitate networking of scientists, such as conferences, societies, and virtual institutes and providing training to support these mechanisms;

- reviewing existing interdepartmental relationships, identifying areas where collaboration should be enhanced and new areas for collaboration, particularly in freshwater;

- identifying the range of institutions that have a role in fostering either hard or soft science, in order to develop ways to integrate and build on the mandates, capacities, interests and perspectives of these institutions;

- developing a series of integrated projects that deal with the variety of issues within an ecosystem, for example the Arctic, Great Lakes, Georgia Basin, with five to ten year horizons, taking a "big picture" approach with less emphasis on stock assessment and more emphasis on multidisciplinary scientists working at the ecosystem level;

- establishing formal collaborative mechanisms linking universities and governments;

- creating a "what needs to be done and by whom" inventory and looking at areas where greater efficiencies could be achieved; and

- identifying key audiences and developing communications mechanisms. The aim needs to be to communicate science in a "courageous" manner.

Notes