MARKETING PRODUCTS AND SERVICES

OF SCIENCE BRANCH, MARITIMES REGION OF

FISHERIES AND OCEANS CANADA

Identification of Opportunities and Barriers

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1.0 BACKGROUND

In 1997, the Canadian Federal Government spent $1.525 billion on intramural research and development (R&D) in government laboratories. These research laboratories of Canadian government departments and agencies are under increasing pressure to show that they are not only contributing to the health and physical well-being (i.e., clean air and water, sustainable food supply, etc.) of Canadian citizens as a result of this financial support but also to the national innovation infrastructure of Canada through wealth and job creation. These latter objectives are to be accomplished by, among other actions, improved transfer of government developed scientific knowledge and technology to, and increased interaction and collaboration with Canadian industry.

The Canadian government has made technology transfer a priority of every science-based government department and agency. In a series of reports issued in March, 1996, under the general title, "***Science and Technology for the New Century***", the government outlines its plan to "*allow Canada to take advantage of the worldwide economic shift to knowledge based industries* " (Gov. of Canada, 1996, p. 1). Among other things, the plan calls for improved management of science and technology (S&T) activities within the federal government. One aspect of this improved management is to encourage better management and commercial exploitation of intellectual property developed within government departments and agencies.

The section of the Summary of these reports entitled, "Annex: Commitments to Actions" states, among other things:

5. The transfer of knowledge and technology is an explicit objective of federal S&T, and departments and agencies will be closely evaluated on their efforts in meeting it.

6. All science-based departments and agencies will develop strategies for promoting partnerships and collaborative S&T arrangements with industry, the provinces, universities, and other stake holders.

9. Federal departments and agencies will take measures to improve access to their facilities and encourage an open-door approach to others engaged in scientific research.

16. The transfer of knowledge and the sharing of scientific information and data with Canadian researchers, schools, universities, libraries and industry will be a key function of all federal departments and agencies.

These particular "commitments to action" fall under the general heading of technology/knowledge transfer from government laboratories to industry or academia. The commitments do not call for government laboratories to charge for technology/ knowledge transfer, but declining A-base resources are forcing the laboratories into looking for additional revenues in order to maintain the viability of their laboratories.

Thus technology transfer, which includes not only the transfer of hardware, but also knowledge, expertise, and use of unique facilities, that involves cost recovery and/or revenue generation is an increasingly important objective of science-based government laboratories.

This study identifies the actions that Science Branch of the Maritimes Region of Fisheries and Oceans Canada must take to improve the marketing of its existing and new "science products and services", and the changes that must be made to existing DFO organizational processes and procedures if Science Branch is to be able to approach prospective adopters of, or clients for their science products and services in a more business-like manner.

1.1 DFO Vision and Mandate

Vision - ***To be a world leader in oceans and aquatic resources management***.

DFO's technology transfer activities and marketing of science products and services must be examined in the context of its mandate and long-term priorities and goals (http://www.mar.dfo-mpo.gc.ca/e/vision_e.htm).

DFO's mandate is "***to promote understanding, conservation and optimum use of marine resources and the aquatic environment for the benefit of present and future generations***" and "***to meet its responsibilities for navigational safety, environmental protection and marine industry support***".

The Department's long-term priorities and goals are to:

- Know and understand oceans aquatic resources
- Manage and protect the fisheries resource
- Manage and protect the marine environment

- Maintain marine safety
- Facilitate maritime trade, commerce and ocean development
- Enhance Canada's international relations with respect to fisheries and oceans.

A considerable part of this mandate is for the "Public Good". Thus, a considerable amount of the work conducted by Science Branch is in support of DFO's regulatory role. This includes managing the fisheries by establishing and enforcing catch levels of different species, and implementing and enforcing regulations to minimize the effects of industrial activities on marine and freshwater habitats.

The Canadian government has commitments to contribute to international oceanographic and global climate research programs. Science Branch is also responsible for much of the research, data collection and analysis for Canada's contributions to these programs.

1.2 Draft Science Strategic Plan 2005 Workshop Documents

As part of the background review, draft documents from the DFO 2005 Workshop held in Hull, Quebec, in March, 1998 were examined. The documents are notable for their lack of any reference to "industrial clients", "wealth creation", "revenue generation" or "technology transfer".

The only statements that come close to having a direct industrial theme are contained in the Program Priorities. They are:

- Provide scientific support for the sustainable development of aquaculture in Canada; and
- Address key challenges related to the aquaculture industry.

It is significant that we have not been able to find any explicit statement to the effect that part of the role of DFO is to support and assist Canadian fisheries and oceans industries in being nationally and globally competitive (i.e., to support wealth and job creation in Canada).

Thus, it appears from the documentation, that the culture in DFO is on stewardship, protection and sustainable use of natural resources and not on the long-term viability of commercial exploitation of those natural resources. This is a subtle but important distinction when trying to promote greater involvement and interaction with the private sector.

2.0 METHODOLOGY

Information contained in this report is drawn from numerous sources. An extensive review of the R&D management literature dealing with technology transfer from government laboratories to industry was conducted. One-on-one meetings with senior and middle level laboratory managers were held at the Bedford Institute of Oceanography in Dartmouth, Nova Scotia, the Gulf Fisheries Centre in Moncton, New Brunswick and the St. Andrews Biological Station in St. Andrews, New Brunswick. A very limited number of interviews were also held with senior DFO personnel in DFO Headquarters in Ottawa.

Focus groups/workshops were later held with researchers and scientists at the same locations in the Maritimes. While most Science Branch groups were well represented at the focus groups, only one person from each of Marine Fish and Invertebrates Divisions participated. A list of interviewees and focus group participants is provided in Appendix I.

The focus group/workshops started with a brief overview by one of the consultants on the latest management research findings on the government-to-industry technology transfer process, and the Canadian federal government's policies on technology transfer and commercialization.

Both the Science Branch interviewees and focus group participants were asked to identify the "science products and services" that they currently market or transfer to their client groups and new products and services that they believe would be useful for current or new clients. From among these products and services, they identified a number that could have commercial potential **if** the appropriate tools and financial mechanisms are in place.

Interviewees and focus group participants also identified numerous barriers to technology transfer within the Department of Fisheries and Oceans and other issues that must be addressed if technology transfer and commercialization is to be a genuine priority of the Department. The level and types of support required by the scientists to enable and encourage them to participate in technology transfer and marketing activities were also discussed. Discussion questions are attached as Appendix II.

This report would be remiss if it did not mention the high degree of cynicism among the Science Branch interviewees and the focus group participants that anything positive would result from this study. Several participants said that what they were telling us about impediments to technology transfer and commercialization had all been said before at previous focus groups or to other consultants.

A total of thirty seven interviews were held with Science Branch industry clients, fisheries and aquaculture associations, provincial government representatives, and with personnel in DFO headquarters and other government departments.

Interviews were held with Science Branch clients/partners and with representives from industry associations to determine their level of satisfaction with the technology transfer activities of Science Branch. As requested by the client, these interviews did not emphasize the

commercial aspects of technology transfer. However, private industry and industry associations, other than fisheries associations, were asked whether they would be willing to pay for specialized services or products. A list of associations contacted is provided in Appendix III.

Because of the timing of this study (early Spring), it was very difficult to get marine firms to respond to our requests for information. Thus only a limited number of industrial responses were obtained. As is normal practice, we promised the respondents anonymity. To list the companies we talked to would breach that promise.

Information was also gathered from officials in other federal and provincial government departments and agencies about their relationship with DFO and/or their financial arrangements to handle externally acquired funds. A number of people within DFO were also contacted to obtain information on whether DFO had any financial arrangements with Treasury Board on dealing with revenues from technology transfer activities, whether guidelines on doing business with the private sector were available or planned, etc.

Information on the activities of some foreign fisheries and ocean sciences organizations was obtained from the Internet and from communications with personnel in the organizations.

Information on AES Commercial Services and on CISTI's fee structure for services was obtained from the Internet and discussions with personnel.

Note that in this report we use the collective term fishermen to refer to men and women who earn their living from catching fish.

3.0 LITERATURE REVIEW

The literature on government-to-industry technology transfer is quite extensive. Although much of it is on the U.S. situation, some important lessons can be learned from it, especially in the area of "best practices" and what clients look for when they consider approaching a government laboratory for assistance. Canadian studies on technology transfer were also reviewed and their findings are presented in this section.

3.1 The Changing Role of Government Research Laboratories

Historically, the primary, generic role of government laboratories has been to conduct R&D in areas that either the academic sector or the private sector has been unable, or unwilling to conduct research. This has resulted in government laboratories being engaged in R&D in support of their internal mandates of policy development, regulation (e.g., setting health and safety standards) and national security (e.g., developing weapon systems). Involvement in R&D associated with commercialization and wealth/job creation not associated with the defence industry tended to be limited to those areas related to the 'Public Good' for which there was no private or academic interest (e.g., a cure for a disease that affected few people or people who could not afford the cure), or very specialized, expensive facilities were required that were beyond the ability of private or academic sector organizations to finance, such as space exploration launch vehicles or large reactors for nuclear science.

In the past ten years, however, governments around the world have been encouraging their laboratories to play a more active role in the economy of their nations. They want their government laboratories to be significant contributors to wealth and job creation in the private sector through greater involvement in industrial R&D projects.

Thus the pressure or encouragement for the Canadian government laboratories to be more involved in the industrial innovation infrastucture of the country is not unique to Canada. This puts greater pressure on government R&D managers to operate in a more business-like manner while still working under the yoke of outdated bureaucratic rules and financial regulations that are more appropriate for the former role of government laboratories. In that role, most, if not all of the monies for R&D activities came from government appropriations. Today, this is no longer the case.

This conflict between being more business-like and still having to operate under inappropriate bureaucratic rules was noted in a 1989 OECD study entitled, "The Changing Role of Government Research Laboratories". The OECD authors stated that the "*congenital problem of government research establishments [is] the incompatibility between, on the one hand, the public sector's administrative and financial rules, etc., and on the other hand, the very nature of research activities*". They also note that "*this incompatibility becomes even more detrimental when it is no longer merely a matter of conducting research but also of promoting its use within the economy and society*".

The authors of the OECD report argue that, "***it is essential for government research establishments to be allowed greater autonomy in order for them to be genuinely integrated within the country's research system***....".

The authors warn that, "***the legitimate importance of the function of transferring knowledge and know-how should not, however, be over-emphasized to the detriment of the research function proper. Knowledge and know-how have to be produced before they can be transferred, so the potential for high calibre research must be developed and maintained***". Government laboratories should be careful not to sacrifice a "*minimum level of independent research needed to maintain their scientific potential and their capacity for renewal over the medium to long terms*" on the altar of political or commercial expediency.

Not withstanding the dangers, Canadian government laboratories have an important role to play in strengthening the economy. In fact, the mandates of some departments and agencies (e.g., Agriculture and Agri-Food Canada, NRCan, National Research Council of Canada, Atomic Energy of Canada) have always had a strong emphasis on providing scientific and technological support to Canadian industry, whereas in others, the opportunity to directly support Canadian industry is a secondary concern to their policy, regulatory or internal client mandates (e.g., Environment Canada, Health Canada, R&D Branch of the Department of National Defence).

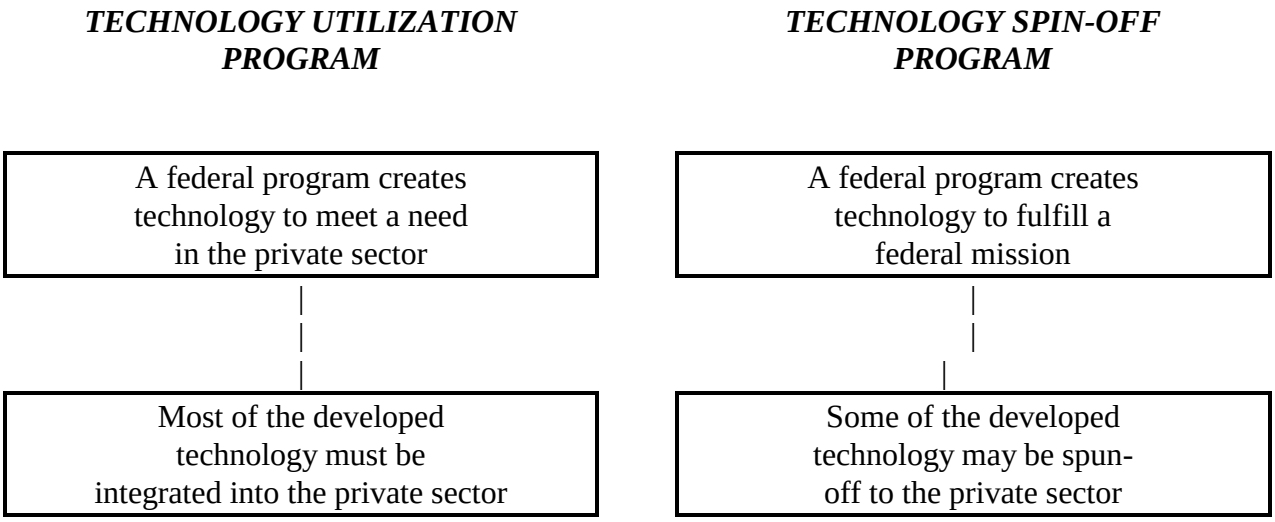
3.2 Types of Government Technology Transfer Programs

Technology Utilization Program

In a technology utilization type technology transfer program, the mission of the government laboratory is to improve or create technology specifically for use in the private or non-government sector. The principal mission of the laboratory can only be achieved if technology transfer takes place successfully. Examples of government laboratories primarily involved in technology utilization type transfer in the U.S. are those conducting R&D in agriculture, mining, energy conservation and fisheries.

Technology Spin-Off Program

A technology spin-off technology transfer program tends to be associated with government laboratories involved in environmental, health or defence type research where the primary results of the research are targetted at meeting the department or agency's own internal policy or regulatory mandate, or needs of their internal client. Only some of the technology, know-how, or expertise developed in the laboratory is appropriate for transfer to the private sector and it may be used for purposes other than for what it was originally created. In this case, the primary mission of the department or agency can be met even if technology transfer efforts are ineffective.



The strategy employed by a department or agency to identify transferable technology (hardware, expertise, know-how) to the private or non-government sector is dependent on the mandate or mission of the laboratory. In the case of a department with a mandate to transfer technology to the private sector (technology utilization), the non-government end-user's needs would be pre-eminent in planning the research program and, therefore should involve considerable consultation with the end-user. Thus the identification of the potential value of the research results to the private sector would take place prior to the approval of the research project past any preliminary work to determine feasibility. It would form part of the decision to fund or continue funding a research project. In departments that have technology transfer as a spin-off activity, their strategy is to put in place a system by which they can quickly identify "dual use" technology or expertise that will benefit industry as well as their internal departmental client. Industrial or external client input, while still very important, would come after the research project has been initiated, rather than before.

In a single department or agency, there may be R&D groups whose output is destined for the private sector, and other groups whose focus is on supporting regulatory or policy activities. Thus a department may employ both types of technology transfer strategies depending on the particular circumstances. This is certainly the case in DFO where R&D is conducted both in support of the private sector (e.g., aquaculture) and in setting regulations and quotas (e.g., fisheries, habitat management, environmental sciences).

3.3 Unrealistic Expected Payoff from the Licensing of Intellectual Property

Politicians and senior bureaucrats who have little contact with R&D laboratories sometimes have a general expectation that government laboratories are a repository of a large amount of commercializable technology and one only needs to uncover it to start the money rolling into federal coffers.

Experience, however, teaches that "cash cows" are not grazing in government laboratories in the form of licensable technology. In the U.S., the various Acts of Congress to promote technology transfer have not resulted in a significantly large percentage return on the U.S. government's large investment in internal R&D. In the U.S. in 1986, for example, only 5% of 30,000 government patents were licensed for commercial use. By 1990, revenues from licenses had only reached $9.7 million on an expenditure of $20 billion in 700 laboratories. A recent communication with officials of the U.S. Federal Laboratory Consortium, indicated that no current statistics exist on license/royalty fees earned, but it is believed that some U.S. government science-based departments and agencies earn anywhere between one and five million dollars, with the National Institutes of Health being an exception, earning approximately $35 million per year.

Maria Papadakis (1995), in a major review of the U.S. federal laboratory system, observes that, "*the vast majority of the [U.S. federal laboratory] system (about 80% of the laboratories) has no meaningful role in American competitiveness, while the remaining laboratories are characterized by powerfully entrenched agency missions with circumscribed economic roles*". She notes that much of the R&D of the federal laboratories flows directly to the government or to regulated organizations for achieving government-imposed performance standards in health, safety, environmental quality, etc. She concludes that, "*in order for federal laboratories to contribute to competitiveness, they must have explicit missions to do so*". She further states that, "spin-off transfers" are the best that can be hoped for from those laboratories that have some commercial orientation".

In the U.K., efforts to commercialize technology from the Ministry of Defence in the late 1980s were unable to even cover the costs of the commercialization effort.

In Canada, Canadian Patents and Development Limited (CPDL) which was responsible for the management and marketing of patents from all Canadian government departments and agencies had revenues in the order of $2 million per year, which were not enough to cover its annual operating costs. CPDL was finally disbanded in 1993.

This does not mean that departments should ignore licensing, but they should have realistic expectations on the revenue that can be generated by the licensing of patents. In a review of Canadian government departments' technology transfer activities (Clarke, November, 1996), respondents to the study stated that "contracting in" (i.e., where a government laboratory conducts research, for a fee, for an external client) was a much larger source of funds, by several orders of magnitude. *One departmental respondent said that his department receives approximately $100,000 annually in royalties, but earns $10 million from R&D contracts*.

3.4 Reasons Companies Approach Government Laboratories

Several American studies have examined why companies engage in commercial interactions with government laboratories.

Barry Bozeman and Maria Papadakis (1995) found that companies approach government laboratories to:

- gain access to the skills, knowledge and unique expertise of the federal laboratory scientists and engineers; and
- equipment and facilities;

in order to:

- engage in pre-competitive research;
- develop new products and services;
- improve existing products or services; and
- solve a technical problem.

These authors noted that "obtaining [finished] technology" was mentioned in only 24% of the cases of technology transfer examined, leading them to suggest that, "a narrow focus on licensing and tangible technology transfer can underestimate the commercial role of the federal laboratories".

Everett M. Rogers et al., (1998), in a study of U.S. Cooperative Research and Development Agreements (CRADA), found that companies entered into collaborative R&D agreements with government laboratories for the following reasons:

- to obtain new technology/information/patents;
- to save money in developing a process or product;
- to save costs;
- to improve research ability within the company;
- to obtain a new product;
- to use unique facilities or materials; and
- to save time.

There is no reason to assume that Canadian companies differ in their reasons for entering into collaborative or commercial relationships with Canadian government labs.

3.5 The Best Technology Transfer Mechanism

There are many ways of transferring technology (e.g., conferences, journal publications, reports, etc.) but all researchers of the technology transfer process agree that the most effective method for transferring technology or expertise from the originating laboratory to the adopting organization is to transfer the scientists or engineers who developed the technology or expertise to the organization that is adopting it.

Clearly no organization wants to lose its inventive people every time they transfer technology to an adopter or client, so other practices are utilized in order to encourage a close working relationship between originator and adopter. These include temporary assignments of the originating scientist or team to the adopting organization for a short period to assist them in the adoption/commercialization, or collaborative development of the technology into a final product or service for the market place.

3.6 Factors and Practices Associated with Successful Technology Transfer

The following is a brief summary of the factors and best practices that management researchers in the U.S. and Canada have identified that encourage the transfer of technology from government laboratories to industry. More details about these factors can be found in the Stargate Consultants reports entitled, "Principles and Practices Adopted by Canadian Science-based Government Departments and Agencies to Facilitate Technology Transfer to the Private Sector", (Clarke, November, 1996) and "Review of R&D Management Literature Concerned with Technology Transfer Between Government Laboratories and Industry", (Clarke, August, 1996).

Major Personnel Factors that Promote Government to Industry Technology Transfer

- Government originators are willing and able to work with the adopters throughout the transfer process;
- Reward and recognition in the government department encourages their people to spend time and effort on technology transfer activities (i.e., positive reinforcement);
- Technology transfer champions are identified and encouraged;
- Technology transfer teams made up of originators and adopters are created early in the transfer process to facilitate the transfer; and
- Government personnel are provided with training so that they understand their role in the technology transfer process.

Major Organizational Factors in the Government Laboratory that Promote Government to Industry Technology Transfer

- Management, at all levels in the department, sends out a clear message of support and encouragement for technology transfer activities;
- Organizational culture recognizes technology transfer and commercial-ization as legitimate, valued activities;
- Technology transfer is shown to be important to the organization by having it report to a senior manager;
- Adequate resources are assigned to support the technology transfer/ commercialization process;
- Exchanges of personnel between originator and adopter are permitted;
- Adopters are allowed access to government facilities; and
- Bureaucratic rules and "red-tape" are eliminated.

Major Intellectual Property Factors that Promote Government to Industry Technology Transfer

- Originating government laboratory makes its position on the disposition of intellectual property clear to prospective adopters or R&D project collaborators;
- Government laboratory is willing to provide exclusive (sole) licenses, at least to an area of application;
- Intellectual property management system in the government laboratory is "user-friendly" for the government scientists to use (i.e., not a lot of time-consuming administrative procedures that take researchers away from their research and administrative and IP support is readily available); and
- Government scientific personnel are knowledgeable about IP management practices.

Major Government Marketing Factors that Promote Government to Industry Technology Transfer

- Industry is encouraged to have input into setting the laboratory's research agenda;

- Potential adopters are involved early in the technology development;

- Government laboratory personnel (e.g., business development/technology transfer officers) proactively learn about their industry(s) technological needs and requirements;

- Adequate financial resources are allocated for visits to firms, conference attendance and workshops/seminar presentations;

- A focussed marketing approach is used wherever possible (i.e., personal contacts with clients, open-houses specifically for a particular group of firms, etc.); and

- Effective use of all forms of media to advertise the technology, expertise and facilities available at the government laboratory, especially the Internet.

3.7 Factors and Practices Associated with Impeding the Technology Transfer Process

The same studies that have identified the factors or practices that promote successful technology transfer have also identified those that impede transfer from government laboratories to industry. The following negative practices have been taken solely from Canadian sources that have identified these practices to be prevalent in Canadian government science-base departments.

Major Personnel Factors/Practices that Impede Government to Industry Technology Transfer in Canada

- Resistance to working with industry (e.g., culture not supportive)

- Orientation of government researchers towards publication rather than patents;

- Reward and recognition system does not support working with industry; and

- Lack of significant rewards/recognition to the whole innovation team (i.e., non-compliance with the 1993 Treasury Board Policy on Awards to Inventors and Innovators).

Major Organizational Factors/Practices that Impede Government to Industry Technology Transfer in Canada

- Lack of real commitment by senior departmental managers to seriously promote technology transfer/commercialization (i.e., no real political will, mixed messages);

- Inadequate equipment that cannot conduct the level of R&D sophistication needed to meet the needs of clients;

- Lack of adequate human and financial resources to support technology transfer;

- Risk of becoming dependent on external industrial funds that might dry up leaving researcher with no support as his/her A-base has been allocated elsewhere;

- Use of poorly trained business development/technology transfer officers who have little no understanding of how their industry operates; and

- Stifling departmental bureaucracy and "red-tape" that, for example, slows down decision-making concerned with licensing.

Major Intellectual Property Issues that Impede Government to Industry Technology Transfer in Canada

- Disagreements with industry over the ownership of intellectual property;

- Confusion about the application of the 1991 Treasury Board policy on ownership of IP resulting from government procurement contracts (i.e., departments ignoring the policy);

- Departments take a hard line on ownership (i.e., if they have anything to do with developing IP, even if client pays or contributes considerable expertise, government owns); and

- Reluctance of government departments to provide exclusive (sole) licenses to firms.

Major Marketing Issues that Impede Government to Industry Technology Transfer in Canada

- Lack of funds for demonstration projects;

- Marketing/business development people physically distant from the researchers;

- Inadequate financial support for business development offices to finance travel, especially multi-day visits by government researchers to industry to identify needs;

- Difficulty in identifying an adopter firm with adequate capabilities and resources; and

- Inadequate use of the laboratory's web-site to advertise the laboratories capabilities and willingness to work with industry (i.e., material out-of-date, not business-friendly).

The main theme of the literature is that most of the impediments are self-inflicted by departments with short-sighted managers.

In order to encourage greater technology transfer and commercialization, government laboratories must make it easy for the private sector to learn about what is going on in the laboratories. More importantly, the government laboratories must encourage their scientific staff to meet with their counterparts in the private sector to learn of their needs and problems, and areas of mutual interest.

Technology transfer is mainly an activity between scientific people who respect each other, not an activity between organizations and their administrators.

3.8 Measuring the Impact of Successful Technology Transfer

A major question arises on how to measure the success of a technology transfer activity. Is success measured from the perspective of the originator, or from that of the adopter. While the private sector must use "commercial" factors to evaluate success, government laboratories must use a broader set of factors that include impact on the public good, as well as commercial indicators.

Public Good

The following factors were proposed by Canadian government scientists while attending a recent Stargate workshop on technology transfer as being appropriate measures of the success of technology transfer activities that deal specifically with public good issues:

- effective regulations that demonstrably improve the quality of air, water and food supplies;

- people adopt the suggested methodologies or advice;

- meeting the public's expectations for advice and information;

- improved environmental/health standards;

- well drafted government policies that required scientific input; and
- creating a new public awareness of environmental factors, e.g., UV ratings.

Wealth Creation

Although usually put into its own category, wealth and/or job creation are also forms of "public good", and should, therefore, be considered as an important part of the role of every government laboratory.

Because new technology can result in job loss or reduction, wealth creation and job creation should be evaluated in combination to obtain a more accurate overall picture of the impact of the technology transfer activity.

Value to the Adopting Firm

The following are factors or reasons why a company will interact with a government laboratory (Bozeman and Papadakis, 1995, Holden and Konishi, 1996, Roessner, 1993). They can be used as measures of technology transfer success involving the private sector.

- number of technical papers authored jointly with industrial researchers;
- company patents and invention disclosures directly attributable to collaborative work with government researchers;
- new development projects undertaken by firms as result of interaction with a government laboratory;
- technical problems solved, or dead-ends avoided as a result of information obtained from government laboratories;
- new markets entered more quickly with the assistance of a government researcher;
- new products or processes developed;
- new internal technical capabilities developed;
- existing products or processes improved; and
- new international markets penetrated.

One point of agreement among the various authors is that, while seductively easy, assessing a government laboratory's value to the private sector solely through measures such as royalty or license fees returned to the government laboratory is "not a very useful tool for technology transfer managers in the short term" (Carr, 1992). Such a measure is too limiting and will substantially underestimate the full value of the government laboratory to industry (Roessner, 1993). Much of what is transferred to the private sector is in the form of advice and information which is not covered by any kind of formal agreement or license, is difficult to measure and is rarely captured by any statistics. Nevertheless, this form of technology transfer is important to the private sector and government departments should receive credit for it.

Thus in assessing the value of technology transfer activities from a government laboratory to industry, the assessor must use many factors, and not only those that can be measured in terms of dollars and cents returned to the laboratory.

4.0 ACTIVITIES OF FOREIGN GOVERNMENT FISHERIES AND OCEANS LABORATORIES

As part of this study, information was requested from some foreign counterparts to DFO on their technology transfer/commercialization activities. Unfortunately, our requests for information were mostly ignored.

In a telephone conversation with an official of the Woods Hole Oceanographic Institute, in Massachusetts, we were told that most of their funding comes from the National Science Foundation and National Oceanic and Atmospheric Administration. The rest of their funding comes from philanthropic donations and membership donations. Industrial engineering contract work in the ocean sciences area is a very small source of funds. Thus commercial activities are not a major theme.

Despite the lack of cooperation, we did examine the web-sites of several fisheries and oceans organizations. Although there was not a great deal of marketing information, the mandates and other information provided on the web sites indicated that the organizations have a more industrial support orientation to their activities.

4.1 Australia

Fisheries Research and Development Corporation

Formed as a statutory corporation in July, 1991, FRDC is a national organization responsible to its stakeholders for (http://www.frdc.com.au/home.html):

- planning, funding and managing research and development programs, and

- facilitating the dissemination, adoption and ***commercialization*** of the results of research and development.

This last objective is a strong endorsement of technology transfer and commercialization activities that is not seen in DFO material.

One of its Programs is called Industry Development and has as its goal, "***To enhance the competitiveness and resilience of the Australian fishing industry***".

Department of Primary Industries and Energy - Fisheries Division

Within this industry oriented department, DPIE is the Fisheries Division. Its objective is to, "promote the efficient utilisation of Australia's fisheries resources in an ecologically sustainable manner through provision of strategic advice and appropriate administrative arrangements" (http://www.dpie.gov.au/dpie/annual-report/ar97/programs/ sub1_3.html).

One of the performance measures by which the Division's strategies are to be judged is:

"the quality and effectiveness of advice and information given to the Minister and major client groups on fisheries issues, including ***industry development***, ***aquaculture***, recreational fishing, research, ***marketing*** and other post harvest issues".

Again, industry concerns are explicitly mentioned.

One of the projects being undertaken is called "SeaQual". It is a joint initiative of DPIE, the Fisheries Research and Development Corporation and the Australian Seafood Industry Council to "help achieve the change necessary to maintain and increase the ***competitiveness*** of Australia's seafood industry".

Australia has recently established an Aquaculture Cooperative Research Centre to bring together the aquaculture research centres and the aquaculture industry with the objectives of (O'Sullivan, 1997):

- increasing the overall quality of research through collaboration and exchange of skills;

- providing skilled graduates and technologists to the aquaculture industry; and

- solving the critical technical issues limiting the progress of major aquaculture sectors and ***enable the industry to put these solutions into practice***.

4.2 United Kingdom

Centre for Environment, Fisheries and Aquaculture Science (CEFAS)

CEFAS is an Executive Agency of the Ministry of Agriculture, Fisheries and Food created on April 1, 1997 from the former Directorate of Fisheries Research (http://www.cefas.co.uk/whoweare/whoweare.html).

CEFAS, with an annual turnover of 25 million pounds, undertakes a wide ranging program of short and long-term research, monitoring, assessment, training and consultancy in all aspects of the marine and freshwater environments.

The CEFAS web-site, which is quite "business-friendly" makes it clear that they are interested in doing contract research and consultancy for government departments and the private sector, even in regulatory areas. (i.e., "Benefit from our knowledge of the regulatory process to ensure that your business deals with the demands and impacts of changing legislation in the most cost effective and efficient way").

They list among their customers the EU industry (oil, water, chemical, pharmaceutical, agro-chemical, marine) as well as regulators and enforcement agencies.

4.3 New Zealand

National Institute of Water and Atmospheric Research (NIWA)

NIWA's web-site advertises the research and consulting services they offer in the areas of fisheries and aquaculture, and the geological, biological and physical oceanography of oceans, coastal waters, estuaries and harbours. Among the services they list are:

- marine taxonomy
- aquaculture and fisheries management
- sea surface temperature charts
- site surveys for petroleum companies
- nutrient modelling and
- identification and review of the phytoplankton associated with toxic algal blooms for shellfish farmers.

In addition, the web-site indicates NIWA's interest in providing their services internationally.

They also have a Commercial Server that people must pay to access. It provides information (SST Data) to fisherman that assists them in determining where to fish.

Overall, these foreign web-sites give the impression of a culture within their respective organizations that is attuned to doing business with the private sector as well as carrying out their "Public Good" roles.

5.0 SCIENCE BRANCH TECHNOLOGY TRANSFER SUCCESSES

Science Branch has had a number of noteworthy successful transfers of technology to the private sector and has also received funding or in-kind contributions for some of its research and survey activities through partnership agreements with the private sector, provincial governments, and other research organizations.

Although the focus of this report is on actions Science Branch should take to improve and facilitate technology transfer and marketing of its science products and services, past activities must not be overlooked as they can provide insight into the factors that contributed to the successful technology transfers or to contributions to programs.

Personnel from the Ocean Sciences Division have developed a variety of equipment and instrumentation to assist them in their survey and monitoring work and recognized that some of the technologies developed would obviously be useful for research or private sector organizations engaged in similar survey and monitoring activities. As a result, some of the technologies or expertise have been licensed to private sector companies for further development and commercialization. These include:

- the Optical Plankton Counter, an instrument that rapidly counts and sizes zooplankton, fish eggs and other aquatic organisms which is licensed to Focal Technologies Inc., Nova Scotia;

- a Moving Vessel Profiler, and the SeaHorse© Climbing Moored Ocean Profiler which are used for collecting data on the oceans at various depths and which have been licensed to Brooke Ocean Technologies, Nova Scotia;

- an Ice Thickness Monitoring System which measures ice floe thickness, location, water temperature and pressure and transmits data via a satellite telemetry link. This is licensed to Axiom Engineering Limited, Newfoundland; and

- the Batfish which is a remotely controlled towing vehicle that supports biological, chemical and physical sensors for upper ocean and shelf research or monitoring, and which is licensed to Guideline Instruments Limited, Ontario.

The success of these technology transfers has been attributed by the industrial recipients, in great part to the individual government science personnel involved in them, their understanding of the business climate and the market place, their cooperation with the companies in developing and testing prototype equipment, and to their assistance in marketing activities in the form of answering technical queries regarding the technology at trade shows or by telephone.

One BIO scientist, Dr. Alex Hermann, recently received a 1998 award from the Federal Partners in Technology Transfer, an interdepartmental technology transfer committee, for his successful transfer of technology that formed the basis of the Optical Plankton Counter manufactured by Focal Technologies. Dr. Hermann and his group contributed not only to the technical development of the instrumentation but also to the overall business planning. A company respondent said that one of the reasons they agreed to take part in the transfer activity was Dr. Hermann's understanding of "what it takes to make a product work in the real world".

In addition, financial contributions for oceanography research and environmental studies have been received from Canadian oil exploration companies and from foreign sources, including U.S. oceanographic institutes and universities. Some of the problems in accepting funding from foreign sources because of the lack of appropriate financial mechanisms within DFO are discussed later in this report.

On the fisheries side, one major success story is the co-management of the Snow Crab fishery in the Southern Gulf of St. Lawrence. Research on the snow crabs has resulted in development of survey and mapping techniques to estimate the abundance and distribution of snow crab. The research program initially funded by DFO was going to be discontinued because of lack of government funding, but the Snow Crab Fisheries Associations felt that it was a valuable program and has provided funding (over $400K annually) and in-kind contributions (over $300K annually) to ensure that the program continues. Thus the work met a need of the industry and was supported. The Japanese snow crab fishing industry is also interested in acquiring access to the techniques used in the Canadian fishery.

Contributions, both financial and in-kind, have also been received from associations and private companies for survey and tagging programs in other fisheries.

In total, in 1997/98, external financial contributions for Science Branch joint projects in the Maritimes Region, when we exclude CHS, amounted to $2.4 million and for other types of contributions amounted to $2.3 million. The bulk of the financial contributions were in the Oceans ($0.89 million) and Environmental ($0.91 million) sciences, with most of this from foreign sources. The bulk of the external funding for fisheries projects came through the Snow Crab program. It is interesting to note that aquaculture received only $187,400 in financial contributions, although this is the area that is specifically mentioned in DFO's strategic plans as an area for industrial development.

Other technology transfer type activities include the Science Branch personnel involved in the snow crab project producing a newsletter for the Snow Crab fishermen on their activities and other items of interest to the fishermen, and the Communications Officer at St. Andrews

producing articles on research activities at St. Andrews for publication in a local newspaper and has exhibits on the Station at local exhibitions during the summer. More recently personnel in St. Andrews have been involved in “hands-on” workshops concerned with aquaculture.

These types of activities not only provide information to the local fishing and aquaculture communities but also enable the local communities to understand the value of the work done by DFO Science Branch.

While harder to document, it is clear from the many favourable comments from industrial interviewees that DFO scientists have been very helpful in providing advice and information to the private sector on day-to-day problems when asked. This informal form of technology transfer is vital, especially to small firms that generally cannot afford to hire consultants to solve a problem.

6.0 RESULTS OF SCIENCE BRANCH INTERVIEWS AND FOCUS GROUPS/ WORKSHOPS: SCIENCE BRANCH PRODUCTS AND SERVICES

The main activities of each Division, their current products and services and those that personnel felt may have commercial potential are discussed. As noted earlier, only two representatives from the fisheries groups attended the focus group sessions. However, information was obtained during individual interviews with some personnel from fisheries.

6.1 Fisheries

6.1.1 *Marine Fish Division*

The mandate of the Marine Fish Division is to increase understanding of the factors that affect the distribution and abundance of commercially important fish species by studying fish populations and communities and evaluating the impact of human activities on fisheries production. The division is also responsible for research on sea mammals, including seals, right whales and harbour porpoises. The Division conducts evaluations of fish stocks (annual for some species, every 2-3 years for others), research on population ecology (growth, reproduction, distribution and migration) and community ecology (interaction among species), and evaluates fisheries management systems.

The current products of the Division are mainly information in the form of stock status reports, technical reports, scientific papers, advisory documents, databases, and presentations at workshops and seminars. The Division provides the results of surveys and research to the fisheries communities through the fisheries associations, workshops, RAP, etc. Other major clients for information are Advisory Boards, DFO fisheries managers, fishermen, fish processors, other users of the oceans, including recreational fisheries, and the scientific community.

In recent years a decline in some of the fish stocks has resulted in the closure of the cod fishery and considerably reduced quotas in other fisheries. License fees have increased as have "*mandatory costs of dockside monitoring, observer fees, costs for harbour authorities and changes to EI regulations*". (The East Coast Report, p. 17). The fisheries community also believes that new partnerships will result in increased fees for fishermen. Perhaps because of this report and the negative publicity the department has had because of the decline in the commercial fisheries, considerable concern was expressed about charging the commercial fisheries community for any Science Branch products or services.

Although, this may not be an ideal time to charge the marine fisheries communities for advice and information, some areas where there may be potential for cost recovery or commercialization were identified. These include:

- Helping developing countries to set up research labs or educating them in how to design surveys (this is done now but only direct expenses are recovered).

- Selling data or specialized data sets to consultants.

- Charging for time involved in reviewing environmental impact assessments

- Consulting services (i.e., charging for providing expert advice). At present, because of the attitude of the Canadian fishing industry to DFO, the potential market for such services might be international rather than regional or national.

- Software and software products. The recreational fisheries industry is a potential customer for models of fish distribution and there may also be applications for software or software products in the international market.

6.1.2 *Invertebrate Fisheries Division*

This Division is responsible for providing management advice and conducting research on invertebrate fisheries species, which include lobsters, scallops, snow crab, shrimp, hard-shell clams and mussels, and marine plant fisheries of Irish moss, rockweed and kelp.

In addition to invertebrate and marine plant stock assessments, current products and services of the Division include advice to resource managers and the industry, scientific and technical publications on biology of the species and the factors that influence population dynamics and marine plants stocks, sampling and analytical techniques to improve assessment methodology, support for the mollusc aquaculture industry by providing information on growth, survival and reproduction of molluscs, and mollusc habitat, stock maps of snow crab and a newsletter for the snow crab industry.

Potential revenue generating products of the Division that were identified include:

- Software packages

- Data

- Mapping of catches

- Charts of bottom topography

- Expertise on tagging

- Scallop bed enhancement technology

- Application of the successful snow crab mapping technologies to other species.

The Division receives financial support from fisheries associations for some of its programs, notably the snow crab mapping and scallop bed enhancement technology programs. There may be potential for joint projects or financial support from other invertebrate fisheries. There may be also be international markets for these technologies and for expertise on tagging programs.

6.1.3 *Diadromous Fish Division*

This Division conducts research on, assessment of, and enhancement techniques for anadromous (Atlantic salmon, striped bass, alewife, blueback, herring, smelt, American shad) and catadromous (American eel) species.

The current products and services of the Division include biological advice for managing existing fisheries; information on rehabilitation and enhancement of diadromous fish stocks and on the effects of environmental changes and industry practices on diadromous fish resources; and advice on mitigation measures for ensuring fish passage and protecting freshwater fish habitat.

The Division is divesting its hatcheries program (except for one hatchery in Mactaquac, New Brunswick) and the hatcheries are being taken over by not-for-profit community groups. Therefore, although advice and expertise might be an area that has potential for cost-recovery, it is felt that the not-for-profit groups do not have the financial resources to pay for expertise and advice. The economic benefits are seen as the return of the fishing industry to the communities.

A few years ago, DFO hatcheries had the opportunity to sell excess fish to local commercial salmon hatcheries as their fish stock was deemed to be of higher quality than that of other hatcheries. However, permission to sell stock took two years to obtain by which time potential clients had lost interest. As a result of the hatcheries divestment, sale of excess fish stock is not a potential source of revenues.

6.2 Aquaculture

The Aquaculture Division supports sustainable development of marine aquaculture with the goal of developing an aquaculture industry that is economically competitive and environmentally sustainable. Research is conducted on current commercial finfish and shellfish species and on potential new species for aquaculture development. Some of the present research areas are the causes and methods of eradication of diseases and parasites, fish nutrition, development of feed formulations and management techniques. Research into new species include culture technologies, seed collection techniques and grow out technologies.

The Division also conducts environmental research aimed at understanding the interactions between aquaculture activities and the aquatic environment to determine maximum production levels that are environmentally sustainable.

The products of the Division include advice to regulators and managers on issues related to shellfish research and habitat alteration, aquaculture techniques, marine and shellfish grow-out technologies, advice to industry on nutrition, diseases, habitat, etc., nutrient analysis of feeds and biological samples, feed formulations and feeding experimental design, scallop enhancement and scallop aquaculture techniques, training in broodstock management, and supply of finfish eggs.

New products and services that may not have immediate commercial potential but nevertheless have considerable value include identification of harmful algal blooms, identification of fish diseases, pollution models and pollution detection and remediation techniques.

Products and services that may have commercial potential include:

- Advice and information on aquaculture techniques, including management techniques
- Development of new techniques (e.g., types of tanks, feeding regimes)
- Software - in conjunction with Ocean Sciences Division, a model is being developed to assist in determining the optimum location for fish farms (factors include coastal oceanography, fish holding capacity, shellfish carrying capacity)
- Marine fish eggs for new aquaculture industries (e.g., halibut)
- Facilities, equipment and fish for training and pilot scale industry development
- Standard reference diets for fish and other species. Standard reference diets that have been formulated are currently being exploited in Europe.

Some interviewees and focus group participants expressed concern about the ability of the smaller, fledgling companies to pay for products and services. Aquaculture is regarded as a tool for economic development in some of the areas that have been hardest hit by the decline of the fisheries, and the provincial governments are promoting aquaculture as a means of economic recovery. Although there may be immediate commercial benefit to the department by selling expertise, some people felt that in the long run there may be more economic benefit to Canada by helping industries to become established and thrive, and thereby create employment in economically depressed regions.

6.3 Ocean Sciences Division

The mandate of the Ocean Sciences Division is to describe accurately the processes, events and features of the coastal regions, the continental shelf and the offshore. The Division conducts research on ocean circulation in the Northwest Atlantic, the Labrador Sea and the

Arctic Ocean; the coastal ocean climate; coastal habitat; fisheries oceanography which involves studies on the interaction of fish populations and oceanographic conditions; operational oceanography in support of marine transportation and safety, marine pollution and coastal zone management; and marine ecosystem productivity. The Division also maintains databases on a wide variety of oceanographic information and provides ocean data information services.

In support of its mandate, the Division has developed and is continuing to develop a range of oceanographic equipment to enable measurements of various oceanographic parameters to be made. Some of the technology developed in the Division has been successfully transferred to the private sector for commercialization. These include buoying systems, an ice thickness sensor, an ocean microstructure profiler and an optical plankton counter. The Division also develops models for interpreting oceanographic data.

Clients include policy makers, other government departments, industry, the public and the research community. The Ocean Science Division contributes data and know-how to international climate research programs.

In addition to scientific and technical papers, press briefings, etc., other products and services of the Division include:

- Data and data products on physical oceanography, climatology, ice conditions, etc. These include specialized data sets, numerical codes for use in modelling, graphical displays and electronic versions of model fields, models of currents and water levels, etc.
- Oceanographic instrumentation
- Sea ice and ocean properties forecasts and assessments
- Advice on marine engineering and fisheries problems
- Educational material

Products and services that may have commercial potential include:

- Data sets and value-added data products
- Tools to integrate various types of data
- Model code
- Models of the ocean environment (limited market)

- Numerical circulation and forecast models for emergency response and impact assessment

- Know-how and expertise that could continue to generate "grants' from the U.S. (problems in obtaining funds from the US are discussed later)

- Some instrumentation and sampling equipment used in environmental effects monitoring programs

- Aquaculture advice and services (e.g., optimum location of facilities based on oceanographic data)

Servicing and calibration of instruments, and oceanographic field support were mentioned as areas of expertise and although they appear to be opportunities for commercialization or cost recovery, the scientists said that the Division lacks the staff to be able to provide these as a "service".

One of the problems mentioned was the limited market for oceanographic equipment and site specific ocean information, e.g., there is no mass market for models of ocean environment information. The demand for ocean models or data sets of a specific area may only be one or two. When instrumentation is licensed to a company for commercialization, the company has presumably done market research and believes that the market is sufficient for it to make a profit on the instrumentation.

6.4 Marine Environmental Sciences Division

This Division conducts marine contaminants research and marine habitat research in support of DFO's mandates for the management of fish habitat and marine environmental quality with the objectives of maintaining healthy fish habitat, restoring the productive capacity of damaged habitat and improving existing and creating new fish habitat in selected areas where the production of fisheries resources can be increased.

Products and services include expertise in marine chemistry, biology, toxins, etc., analytical chemistry services, analytical measurement of components of the marine environment, expertise in sampling design and sample preparation, environmental assessments, toxic chemicals data, and advice on remediation of contaminated sites. Clients include regulators, researchers and industry. Analytical services are provided free for small numbers of samples. If clients have large numbers of samples to be analyzed, they are referred to commercial labs.

Current and new products and services that may have commercial potential include:

- Data products (many are one-off)

- Analytical services (chemical, biological, bioassays)
- Developing methodology and guidelines for analytical work and assistance in interpreting results;
- Adapting lab-based analytical systems for in-situ measurements (e.g., chemical sensors in oceanographic instruments)
- Instrumentation for monitoring biological effects of potential pollutants in aquatic environments
- Charts
- Use of specialized facilities and equipment
- Publications

Scientists in the Marine Environmental Sciences Division were especially sensitive to potential conflict-of-interest situations and how they are perceived by the industry. They were also dubious about local markets for some of their products or services given that environmental monitoring could result in more regulation for marine industries, or dictate where aquaculture facilities or oil wells, for example, can or cannot be established. Therefore, some of the scientist believe that industries might be reluctant to participate in or contribute to studies, the results of which could adversely affect their operations.

In addition, if the Division accepts money or other contributions from a company for an environmental assessment prior to that company drilling an oil well in an offshore area, the results could be seen by the public as being biased. There is definitely a conflict (actual and/or perceived) between the Division's role of protecting the marine habitat and engaging in joint projects with or being funded by potential polluters.

As in the Ocean Sciences Division, development of systems for in-situ monitoring etc., would require inputs of money and expertise before the technology is in a form where it could be licensed to the private sector, and the potential markets may be small.

6.5 Habitat Management Division

This Division administers the habitat provisions of the Fisheries Act and the Canada Oceans Act. The mandate of the Division is to protect and to prevent damage to fish habitat. The Division administers the habitat provisions of the Fisheries Act in both freshwater and marine environments, coordinates assessments and administers habitat regulations under the Navigable Waters Protection Act.

The role of the Division is regulatory and there are few opportunities for marketing their products and services. The Division develops guidelines for activities such as forestry or culvert construction and training courses for consultants on conducting environmental assessments. They also provide information and advice on habitat restoration.

As the primary focus of training and advice is to prevent habitat degradation or to remediate the environment, it is felt that charging for services would be counterproductive.

6.6 Ocean Act Coordination Office

The Ocean Act Coordination Office was created to implement the Act.

7.0 BARRIERS TO TECHNOLOGY TRANSFER AND COMMERCIALIZATION

During the interviews and focus group sessions, numerous internal impediments to technology transfer and commercialization of products and services were identified. Some of the impediments mentioned are not unique to DFO but are also present in other science-based government departments. These **must be addressed** before Science Branch embarks on a serious program of marketing its products and services. Also discussed at the sessions were philosophical issues of the public good role of DFO and the role of government scientists.

7.1 Culture of DFO Scientists

> ***Technology transfer is not formally a goal or objective of DFO Science*** - Senior BIO Manager, 1998.

One of the major problems identified by the consultants during interviews and at the focus groups is that of the attitudes of some of the scientists to the whole issue of marketing and commercialization. Most of the research scientists in the Maritimes Region were hired by the Department of Fisheries and Oceans many years ago at a time when research budgets were plentiful, scientists had considerable freedom to select their areas of research, and performance appraisals and promotions emphasized papers published in refereed journals. Their national and international reputations among their peer groups was perhaps more important to many of the scientists than the practical benefits of their work to local industry. The psychological contract the scientists had with the Department was to conduct excellent research and be international experts in their fields.

However, times have changed and the DFO scientists are being asked to change with them. Science A-base budgets only cover the salaries of a much smaller number of people. The government is in a cost-recovery mode for products and services and scientists are now being asked to go out and seek new sources of funding to enable them to conduct their research, including research to fulfill their basic mandates. Most of the scientists accept that research partnerships or joint agreements with other organizations must become a way of boosting research funds, as long as they are not in, or seen to be in a conflict-of-interest situation. Many of the scientists, however, have considerable difficulty in accepting the idea of charging for their services or for data. These scientists believe that the tax-payers of Canada have already paid for the research they do through the tax system, that data and information should be made freely available to anyone who wants it, including the international research communities, that they should not have to “go forth and market” their products and services, and that charging for products and services puts them in a conflict-of-interest with the private sector as they would be competing with consultants. More than one commented that if he had wanted to become a consultant he would have joined the private sector. Some scientists also pointed out that industry wants short-term research that will provide quick answers to problems and that the long term research that will result in benefits to all Canadians will be sacrificed in efforts to obtain money.

[This is a real danger if too much emphasis is placed on revenue generation at the expense of generating new knowledge that will be of benefit to clients in the future.]

To counteract this resistance to marketing and commercialization among its older scientists (who form the majority), Science Branch must take steps to change the culture of the laboratories. Managerial support and encouragement are essential. It was obvious from discussions with some of the managers and from comments raised by some participants at the focus group sessions, that there is not one hundred percent support among managers for marketing and commercialization activities. Managers must "buy into" the idea that marketing, increased technology transfer efforts, and, where possible, commercialization are now activities required of all government laboratories and they must provide support to their scientists to enable them to adjust to the new reality. If their managers resist marketing and commercialization, individual efforts by the scientists to carry out the government directives to increase technology transfer will be frustrated.

Some of the resistance of the present scientists could be overcome by appropriate training, adequate administrative support in the financial and intellectual property areas, and through real incentives to transfer technology. It should be noted that in the training area, several government departments and agencies such as Environment Canada, Natural Resources Canada, and the National Research Council have, in the past few months, contracted with Stargate Consultants Limited to provide technology transfer workshops.

Any new researchers and scientists who are hired must understand that marketing and commercialization of their services and products are among the duties expected of them and that they must be prepared to work more closely with the private sector.

7.2 DFO Policies and Procedures

> ***DFO is trying to operate in today's environment with yesterdays' financial tools*** - NRCan manager familiar with DFO internal procedures

The consultants heard many complaints about internal DFO policies, procedures and practices that do nothing to encourage technology transfer or commercialization and that often act directly against such activities. There was also considerable confusion about what DFO policies and procedures on commercialization are, or even whether any exist. Even within the same building, scientists had different opinions on what they could or could not do in relation to things such as signing non-disclosure forms, the types of accounts that could be used to ensure monies received for joint projects would be used on the projects, how to deal with money from the private sector, and whether doing work for a private sector client constituted contracting-in, which most believe they should not do.

It is not surprising that such confusion exists. According to senior DFO officials in Ottawa, the Department does not have any guidelines on doing business with the private sector. Other government departments have such guidelines, most of which are based on Treasury Board document series "Stretching the Tax Dollar". For example, Environment Canada has recently produced a policy to guide their employees in their commercial dealings with non-government sectors. Entitled, "***National Policy for Commercialization in Environment Canada: Working in the Marketplace***", it outlines the ground rules for commercialization activities in Environment Canada. In general, the scientific staff in the Maritimes Region were not aware of either the Treasury Board publications nor what other departments were doing. Some knew that the Atmospheric Environment Service charges for data, as they have had to pay for it, and though there was general awareness that the government was changing over to a cost-recovery/revenue generation mode, knowledge of the financial mechanisms to accomplish this was almost non-existent.

Some of the scientists have been approached by companies either to work on joint projects with them or to do specific research work for them, and have been asked to sign a company non-disclosure agreement as the company wishes the nature of the work to remain confidential. Some scientists said that they could not sign such non-disclosure agreements with companies and could not undertake work if a non-disclosure agreement was part of the deal. One said three opportunities to do work for industry has been lost in the past three years because they could not sign the non-disclosure agreements the companies wanted as part of preliminary exploratory conversations. Yet another scientist at the same site said that they could sign non-disclosure agreements as part of joint projects.

A senior official in Ottawa said that scientists should not sign company non-disclosure agreements until the agreement has been vetted in Ottawa. He was concerned that an agreement may be too all-encompassing. Realistically, companies will not put up with delays associated with having officials in Ottawa check out their non-disclosure agreements before they can talk to a DFO scientist in the Maritimes; they will simply look elsewhere for assistance. This difficulty could be overcome if DFO developed a simple non-disclosure agreement that scientists can use if a company wants to talk to them about a confidential matter. The scientist would be able to discuss the agreement with his/her local manager and sign the agreement without referral to Ottawa. A suggestion to the Ottawa official that a simple non-disclosure form be developed and distributed to the labs was summarily dismissed without explanation.

Some DFO scientists mistakenly believe that the Access to Information Act prevents them from holding corporate information in confidence. In fact, under the Act, company confidential information provided to DFO does not have to be disclosed to third parties.

Other government departments such as Environment Canada, NRC and CRC regularly sign non-disclosure agreements with companies and undertake company-confidential work. Companies may want Science Branch to conduct research for, or work on joint projects with them, but do not want the results of the work made freely available to competitors. This type of work could be a source of income for Science Branch, if the type of work falls under the mandate of the Department. Non-disclosure agreements often have clauses that allow

publication of results at a later date, usually after steps have been taken to protect any intellectual property arising from the work

7.2.1 Financial Administration Problems

At the moment, DFO does not have any arrangement with Treasury Board (e.g, an MOU) to respend monies earned from conducting research or providing expertise to others. We were advised that DFO approached TB three years ago to obtain such an agreement but was turned down. Without this financial tool, DFO has no hope of marketing and commercializing its expertise or know-how and gaining benefit from it. Consulting and contracting in of R&D projects will remain a drain on operating budgets and hence, something to avoid.

There was also considerable confusion in the laboratories about what kinds of financial arrangements could be made for receiving external funding to do research or for joint projects, and also problems about how to treat money received from foreign governments, specifically the U.S. If the Ocean Sciences Division, for example, receives a request to conduct a funded study on behalf of one of the Oceanographic Institutions in the U.S., the U.S. institution considers the funding as a grant which is paid after the work is done. However, the Department seems to have no mechanisms for dealing with grants, and Science Branch has to draw up a joint partnership arrangement to deal with the money.

Another problem is the restrictions associated with Specified Purpose Accounts. If an outside U.S. government agency would like work done by Science Branch it will usually want to pay for the work after the results have been delivered. However, under the rules of a Specified Purpose Account, funding must be received before a project is undertaken. This puts DFO's administrative procedures at odds with that of the U.S. granting agency. Other departments faced with similar situations have been able to convince the U.S. agency to advance some of the funds at the beginning, and make progress payments as the project proceeds. In this way both bureaucracies are satisfied.

New financial mechanisms and tools to deal with problems of this nature must be in place before the Maritimes Region offers its services on a fee-for-service or cost recovery basis.

7.2.2 Slow Decision-Making

"Inflexible" and "rigid" were among the terms used to describe internal administrative procedures at DFO. Invariably these caused delays in making decisions. In order to operate in a more business-like manner, DFO and Maritimes Branch will have to change many of its procedures to be able to operate within the time frames required by its industrial clients. For example, we were told it can take up to six or seven months to negotiate an agreement for a joint project. Some delays in negotiating joint provincial/federal/industry cooperations, however, are attributed to provincial government red tape.

Some delays are also caused by the scientists' lack of knowledge of the systems and procedures that Maritimes Branch already has in place to assist in negotiating agreements and partnerships.

Head office personnel in Ottawa having to be involved in decisions or negotiations involving the private sector also adds to delays. One industrial respondent reported that he waited three months for a response to a question about licensing from DFO Headquarters.

Much of the work of Science Branch involves working with aquatic species whose life cycles and habits mean that there is a short window of opportunity for conducting surveys, collecting seed, etc. We were told of one case where approval to hire a technician came two months after the field work had started. The section could not wait for the paperwork to be completed, hired the technician, paid him out of the A-base budget and then tried to recover the money after the fact.

As partnerships are about the only way Science Branch can at present obtain access to outside resources, the Partnerships Coordinator and the associated Finance Officer should ensure that all scientists in Maritimes Region know who they are, how they can assist in negotiations, and the various types of financing that can be arranged for joint projects or partnerships. This could be done through half-day workshops at all locations at which attendance should be compulsory, and by developing a set of printed procedures and guidelines for distribution to all staff and also made accessible through the Intranet. Print is suggested as some scientists seem to read only e-mail from their scientific colleagues and ignore e-mail from DFO administration units.

7.3 Aging Workforce

One of the biggest problems facing DFO Science Branch and other science-based government departments is their aging workforce (Auditor General of Canada, 1994). This was pointed out by both the DFO scientists themselves, and association and industrial interviewees. The Branch has a vast store of information, know-how and experience embedded in its scientific community - an aging and recently, a rapidly retiring community - and has not had the funds or person years to be able to hire new staff so that this knowledge can be passed on to new generations of scientists. In essence, the Branch is rapidly losing its corporate scientific memory and unless rejuvenation occurs quickly, in five years the Branch will have very little in the way of knowledge or products to transfer, let alone commercialize. One scientist said that although he was in a position to take early retirement, he had decided to stay on because he is hoping that he will be able to pass on his knowledge and experience to a potential successor. Unfortunately, many scientists have retired with no successors.

It is understood that funds have been allocated to DFO to hire new scientists. However, this funding is only guaranteed for a period of two years. Individual laboratories will have to come up with new money to keep these people on. Most scientists embarking on a research career would like some assurance of long term employment in order to be able to complete

research projects. Two years is much too short, especially in the biological field. One scientist said that areas earmarked for hiring new scientists are those that have a high political profile, not necessarily those where new staff are needed to enable long term programs to continue or to replace scientists who have retired or been laid off. If Maritimes Branch plans to rely on funding from commercialization of its products and services to continue its research programs, then it must conduct extensive consultations with existing and future clients (internal and external) to identify their scientific needs and requirements, and hire new permanent staff to ensure that client short-term and long-term needs can be met.

7.4 Out-of-Date Equipment

World Class Scientist + Antiquated Equipment = Mediocre Science

Another problem mentioned by association interviewees and a number of DFO scientists was their out-of-date equipment. Some of the equipment in the laboratories is a few generations old and there has been no money to replace it. This puts Science Branch at a severe disadvantage if it wants to encourage companies or consultants to come into the labs to use its expertise and equipment. Out-of-date equipment may be inadequate to do the kind of research to the level of sophistication needed by clients. As noted in the literature review, one of the major reasons firms approach government laboratories is to access unique and one presumes, up-to-date equipment. One scientist said he was embarrassed when submitting papers on his research to journals because the equipment, and therefore the methods he used, were so out-of-date.

New equipment would also enable many analytical procedures to be conducted more efficiently and accurately. Science Branch cannot compete, on either time or cost effectiveness, with universities, private labs, or IMB which tend to have more modern equipment, nor with foreign governments that have privatized their fisheries labs and purchased new equipment.

Out-of-date equipment will not attract potentially world class new researchers to DFO either as employees or post-docs who have used more modern equipment during their university training.

If Science Branch considers marketing its products and services internationally, which at the moment is discouraged, it will face severe competition from both foreign government and commercial labs. If these labs can provide services faster and cheaper on modern equipment, contracts for expertise and services will go to them and not to Science Branch.

It is also not inconceivable that DFO Science Branch may face competition for their services in Canada from foreign government laboratories aggressively marketing their skills and expertise, backed up by modern equipment, into the Canadian market.

7.5 Perceived Conflict-of-Interest

Environmental impact studies to assess the probable effects of industrial activity (aquaculture, forestry, mining, off-shore drilling, etc.) on inland or marine waters appear to offer opportunities for soliciting funds from the private sector for joint projects or for charging for expertise and services.

Many scientists believe, however, that the need to obtain outside funding or other support (in-kind, use of vessels, etc.) through partnering or joint venture arrangements to conduct surveys, monitor the environment or conduct research on specific chemicals to determine the effects of industrial activity on the environment puts them in a conflict-of-interest situation. A number of potential conflict situations were discussed, especially in relation to environmental and habitat studies. Another point raised was that if the results of such studies produce results unfavourable to the industry (such as new regulations or limitations on industrial activity), there will be considerable reluctance by any other members of that industry to fund projects or to contribute to joint projects.

The issue of the publicity Health Canada has had recently over the proposal to accept test results of pharmaceutical companies instead of doing independent testing was raised. Many of the scientists believe that DFO could find itself in a similar situation with respect to the environment if it accepts money or support from industrial sources for some environmental studies. One person from NRCan, with whom we discussed this issue, said that they do not touch projects where they might be seen as being in a conflict-of-interest situation.

7.6 Impact of Science Personnel Reductions

A major problem raised at the focus groups was that recent personnel reductions in Maritimes Branch have severely limited the ability of the remaining scientists to conduct the research required in support of the Department's basic mandate. Any extra work required to market their services or to provide new services that could bring funding to the Department, will be very difficult for the scientists. Time spent making contacts, responding to requests, attending meetings, developing and marketing products, will all detract from the time available for doing their scientific work. At present, some groups cannot undertake jobs that are labour-intensive because they do not have the personnel required to do them. Although there are some government programs for hiring technical help, people hired under them have to be trained for the job, which is time-consuming, and they have to be paid. The divisions do not have the resources for doing this.

Science Branch personnel have developed various types of oceanographic measuring instruments that have been successfully commercialized. [e.g., plankton counter to Focal Technologies). They have ideas for a number of others, such as in-situ analytical monitoring instruments. However, they do not have, and have not been able to hire personnel with the engineering or electronic expertise to take the ideas and develop them to a more transferable stage.

The personnel cutbacks in the Maritimes Region were also mentioned by a number of the industry and association interviewees. They have seen programs cut - the freshwater programs were specifically mentioned - and reductions in others. One industry interviewee said that there were some technologies in Oceans Sciences Division that, with further work, might have commercial potential in the ocean instrumentation market, but that the Branch did not have the personnel to develop the technologies. Another said that seriousness of the cutbacks is now becoming apparent to the fisheries and aquaculture industries. The initial round of cutbacks probably went unnoticed but now the impact is being felt on a day-to-day basis. The personnel reductions together with the reductions in funding and emphasis on joint projects made one industrial interviewee question whether DFO was getting out of research altogether. There was obvious concern among other industry interviewees about whether there will be a continuing research activity in the Department. One aquaculture association interviewee stated that while DFO still has some world class people, their lack of government support and up-to-date equipment is putting them behind other researchers in Norway and Scotland who receive considerably more support from their governments. Some industrial interviewees voiced similar concerns.

7.7 Lack of Support Staff Reducing Time for Science

> ***Conducting research is becoming a part-time activity*** - Research Manager, St. Andrews Biological Station

Most of the scientists said they were overburdened by increasing volumes of paperwork and decreasing numbers of, or no support staff. Secretarial and clerical help have all but disappeared and scientists find themselves dealing with paperwork involved in reconciling charge accounts, hiring contract or term staff, and all the other form filling, letter writing and typing formerly done by secretarial or clerical personnel. All of this detracts from the time spent doing their scientific work and some of the scientists said they have to work evenings and weekends to catch up. Some scientists said that the creation of a super-region (Maritimes) has led to more bureaucracy and paperwork, and has also increased the amount of time spent in travel and making conference calls. One person said that the latest reorganization has led to greater inefficiencies in the system. Attempts to use teleconferencing as a substitute for travel were said to be not satisfactory due to the limitations of the existing equipment.

The scientists see any marketing or commercialization activities as adding to the burden of paperwork and red tape. Thus they are reluctant to become involved and reduce even more the limited time they have available for science. It is a waste of tax payers' dollars, and not the most efficient use of resources to have highly paid and extremely knowledgeable scientists spending their time doing clerical jobs. The scientific staff require support staff to reduce their administrative burdens so they can concentrate on science.

8.0 INDUSTRY AND ASSOCIATION INTERVIEWS

8.1 Fisheries

The fisheries associations are the major points of contact between Science Branch and the industry. Among other things, the associations represent their industries on Fisheries Advisory Committees, provide support to surveys, provide information on catches, landings, etc., and distribute information from Science Branch or other DFO Branches to members.

From the comments of the fisheries representatives, it is clear that little or no distinction is made between Science Branch and fisheries management groups within DFO. When stock status reports are received just before (or sometimes after) the season has opened, or when politicians make pronouncements on total available catches (TACs), Science Branch receives as much flak as the politicians and fisheries management groups do. If the role of Science Branch in providing input to fisheries management decisions is not understood by the fishermen, then there are obviously communications problems between Science Branch and the fishermen.

Other indications of communications problems surfaced during interviews with fisheries association representatives. Most of them believe that insufficient weight is given to input of fishermen to stock status reports. The fishermen know when the stocks are increasing or decreasing, based on their catches, the locations of the fish and their experience. Some said the scientists do not listen to the fishermen but tend to want information that will support their own beliefs on the status of the stocks. At some of the consultative meetings, there is a feeling that some of the scientists are trying to push their points of view and are trying to get concensus for what they believe should be done, rather than having a truly consultative process.

There is also a feeling that the scientists are telling the fishermen what to do rather than consulting with them. On sentinel fisheries, the scientists tell the fishermen where to fish rather than going to the traditional fishing grounds.

There have been some problems with the surveys and two industry representatives specifically mentioned a survey last year using the Alfred Needler research vessel that did not use a fishing skipper or fishing crew. The survey seems to have been fraught with problems, in part because of the lack of fishing experience by the people on the vessel, and the results of that survey will not be held in high regard by the fishing community. It is believed that it would be better if the scientists spent more time with the fishermen on board their vessels and conducted surveys from the fishing boats.

There have also been problems in some of the tagging surveys which appear to have been caused by inadequate communications, delays in starting projects, problems in setting up the surveys, and the scientists' questioning of the information provided by the fishermen. One person suggested that the scientists might be afraid of the results of some of the surveys if the results don't support their own beliefs.

In fairness, the fisheries representatives believe that some of the major problems in Science Branch are related to the cutbacks in funding and personnel in DFO. They said that Science Branch is underfunded and needs more qualified personnel to do the work that is needed. Because of the lack of funds and personnel, a lot of work on the fish stock that should be done, is not being done. Some specific areas identified as requiring more research include:

- lobster migration patterns
- lobster habitat
- the best times of the year to fish so that fishing is not done during spawning seasons (one person noted that the US has closed the roe herring fishing)
- tagging of herring to determine migration patterns
- composition of migration herring stock
- more detailed information on spawning of herring stocks
- more work on scallop enhancement
- annual shrimp concentration patterns
- research on why some bays are more productive than others
- more electronic log-book reporting

It was also suggested that more use could be made of satellite tracking technology to determine fish and lobster movement and sonar for measuring herring biomass.

Suggestions for improving communications between scientists and fishermen included having scientists going out into the fishing communities during the fishing seasons and talking to the fishermen rather than having the fishermen going to meetings in Moncton; and more workshops or information meetings in the communities. Though not explicitly stated, it appears that some of the scientists should improve their listening skills. One association representative said that the scientists sometimes use very technical language and terminology that may not be understood by some of the fishermen and that the scientists should ensure they use terminology that is understood.

When dealing with scientists on a one-to-one basis, there appears to be few problems as the scientists readily discuss problems or provide information. As one association representative put it, “the science door in Moncton is open”. However, the same person also had problems in dealing with Ottawa as there “the science door is closed” and suggests that people in Ottawa spend more time in the Maritimes.

8.2 Aquaculture

> ***"Aquaculture is the really big growth area and DFO is missing the boat"*** - Government Agency Representative

The aquaculture industry is important to the economy of the Maritimes Region. The three Maritimes Provinces have both finfish and shellfish aquaculture industries. Shellfish aquaculture is well established in Prince Edward Island with the main cultured species being mussels and oysters. Newer species include quauhogs and scallops. In Nova Scotia and New Brunswick the shellfish aquaculture industries are less developed but are growing quickly. Finfish aquaculture has been more important in Nova Scotia and New Brunswick. One association interviewee, however, said that over-regulation of the industry by DFO is restricting its growth. The spokesperson said that regulations that are appropriate for wild stocks are being applied to aquaculture where it doesn't make any sense. This point of view was confirmed by a senior manager in DFO who said that the regulatory side of DFO does, on occasion, make decisions concerning aquacultural products (e.g., size of cocktail oysters) that are not supportable. There is also some concern that DFO aquaculture research is directed more at improving or protecting wild stocks than at farmed stocks.

There is concern in the industry about the total level of effort given to aquaculture research within DFO. The closing of the labs in Halifax and moving aquaculture research to New Brunswick has not been a popular initiative, especially, naturally enough, in Nova Scotia. But, as someone in PEI pointed out, at least there was a lab in Nova Scotia to close. PEI has not had any DFO aquaculture research labs on the Island. The cutbacks in personnel and funding for research are a major concern in the industry, especially at a time when the industry is growing and there are numerous research requirements, though not a lot of money within the industry at this time to put into research.

The Atlantic Zone Aquaculture Science Committee, where industry representatives, provincial governments and Science Branch personnel meet to determine and prioritize research is regarded as a good process of ensuring that the research needs of industry are made known to DFO. Even though there may not be funding to do much of the research identified, the industry feels that Science Branch is taking a step in the right direction by communicating more with and understanding the needs of the industry. This apparently was not always the case.

The role of the National Research Council's Institute of Marine Biosciences in aquaculture research was raised by some interviewees, who wondered at the logic of the federal government in having NRC invest money and personnel in aquaculture research while cutting back DFO funding. It should be noted that the decision to enter the aquaculture field was NRC's, not the governments. One association interviewee believes that NRC identified a gap in DFO's ability to service and support the industry and is moving in. In Nova Scotia, the aquaculture industry is tending to turn more to the IMB for advice or information now that DFO has moved aquaculture out of the province.

The Provincial Departments of Fisheries and Aquaculture provide veterinary and health services to the industry and PEI has set up an Aquaculture and Fisheries Research Initiative, a separate company that conducts applied research for industry.

The industry on the whole believes that the role of DFO should be in longer term research such as:

- development of new species;
- finfish aquaculture other than salmon;
- improved management techniques;
- health and diseases;
- nutrition (e.g., first feeding diets for larval fish such as halibut and other flat fish, weaning diets);
- genetics to produce faster growing species.

One industry spokesperson felt that DFO was overemphasizing salmon aquaculture to the detriment of other fish species, such as flat fish. Scotland and Norway are doing much more research into these other types of finfish aquaculture and the industry in Canada has to go to these countries for information and for fish feed for these species. This respondent also commented that for assistance with fish feed questions, he prefers to work with the IMB which has recently acquired a world class fish nutrition expert.

One association interviewee felt, that DFO should get out of aquaculture as they are "***clearly not an advocate of aquaculture***". A senior DFO manager confirmed that within DFO is a group of managers who do not believe in or support aquaculture.

The ability of the industry to pay for long-term research at this time seems to be an issue. Many of the producers are small, some are part-time operations and in some areas, the industry is still in the development stage. However, some funding for research is available through other federal or federal/provincial programs. One industry representative feels that industry money for joint projects should not be used to supplement the Science Branch A-base budget.

On an individual level, the Science Branch aquaculture personnel are seen as providing valuable assistance and there have been no problems working with the scientists. The problems appear to be with the Department in general and its support (or lack thereof) for aquacultural research and the over-regulation of aquaculture. There was an obvious sense of frustration with the cutbacks in research funding that have resulted in reductions in personnel to do the research and the issue of joint projects or partnerships being raised as the only way to have any research done.

Some members of the aquaculture industry feel that aquaculture should be moved to Agriculture and Agri-Foods Canada. However, it appears that the main reason for this view are the relatively generous support programs that AAFC has for the agriculture industries. One interviewee said a recent economic study showed that the amount spent of agri-foods is 800-fold more than on fish. Two interviewees said that if DFO had programs similar to those of AAFC to support the aquaculture and aqua-foods industries, the industry would be quite happy to stay under DFO. An association interviewee pointed out, however, that even if aquaculture was transferred to AAFC, the industry would still face the regulatory arm of DFO which might become even more onerous to producers. At the moment, according to one aquaculture association representative, AAFC is turning down requests for funding by land farmers who are being encouraged by regional AAFC offices to diversify their farms production into aquaculture. This is a confusing situation for the farmers.

8.3 Oceanography

The Ocean Sciences Branch has successfully licensed a number of technologies to the private sector for commercialization. The success of the technology transfers is attributed to the inventors' understanding of the industry, and of the needs of business in bringing a new product to the market place. The technologies have been developed to a relatively mature stage and the inventor has worked with the adopting company in developing and testing the prototypes to bring them to a marketable stage. The inventor is also involved in development and testing of a second generation product of one of the technologies.

The know-how and experience of the government inventors, their willingness to answer questions from potential and actual purchasers, and support provided by attending trade shows with the manufacturers to answer questions about the technologies have all helped to make the products successful.

Oceanographic equipment is a small, niche market but at least one of the products, the optical plankton counter, may have application in other industries. One interviewee said that the Ocean Physics groups has a lot of ideas but they have not been able to tackle many new projects because of the cutbacks, and the rate of progress has slowed down.

The Ocean Sciences group also provide support to Canadian oceanography companies by field testing new equipment for them. One company representative said that support for the Canadian companies through government purchase of new equipment would help them in their marketing efforts to other governments. However, Science Branch does not have the money now to buy the new equipment, even though it would be useful to them in their research work.

The industry recognizes that the Ocean Sciences group has extensive experience and know-how that could be useful to Canadian companies in the ocean equipment or ocean surveying industry and that the scientists could provide support to companies by acting in a consulting capacity. However, Science Branch does not have the mechanisms in place to enable

the companies to include the DFO scientists on project teams when the company bids on international contracts. At present, the paperwork required and the time involved means that the company would not be able to meet the deadlines required of the bidding process.

One interviewee said that it would be useful to have someone in the Maritimes to deal with when negotiating licenses for technology transfer and noted that the person with whom they deal with in Ottawa has never visited the company to see the equipment first hand or to meet with company personnel. Other government departments have taken steps to overcome this distance problem by either having their patenting agents visit the labs at least monthly (NRC), or arranging for a local patent agent to service the lab (DND in Alberta).

Another industrial respondent was very satisfied with their working relationship with DFO oceanographic personnel, "On a working basis, our relationship with DFO is working quite well". This respondent recognized that retirements from DFO will become "quite a problem" in the near future as many of the people he deals with are within a few years of retirement.

When asked about needed research, this respondent saw the need to rationalize what industry sees as its monitoring and research mandate versus what the government perceives as needed. Specifically he saw a need for more research to better understand the impact of oil-based drilling muds on marine animals. In particular, is the concern that regulations will be adopted on the percentage of oil in the muds that has no toxicological scientific basis. (i.e., what is the degree of toxicity of oil-based muds, and what is a scientifically supported safe level). While noting some administrative problems over equipment purchases, they have been able to get around such problems by providing equipment to DFO along with in-kind contributions as their share of a collaborative project. This respondent noted that if government personnel want to work with industry, they will have to examine their administrative procedures and streamline them to make them more cost-effective (i.e., more timely and easier to implement).

In response to the question whether there might be an international market for DFO expertise, the interviewee said, yes. He thought that a lot of the toxicology expertise and monitoring devices were probably good candidates for markets in areas such as Libya, and other African countries that are conducting offshore developments.

A different industrial respondent also echoed this satisfaction with BIO personnel saying that he had found them "very technically competent". He felt that if they were to increase their interaction with the private sector, DFO would have to list the services they wished to offer, along with the cost of these services. They would have to get out more and talk to potential clients and not just rely on brochures or web-sites as their sole marketing tool. This respondent warned, however, that the regulatory role of DFO makes his firm somewhat hesitant in making greater use of DFO scientific capabilities. He is worried that information that might be collected on a research project would be handed over to the regulation arm of DFO.

Another industrial interviewee said that DFO scientific staff were quite approachable. If he needs assistance, he contacts the researcher directly. He added that he specifically avoids going through the management hierarchy to contact a scientist.

8.4 Fish Processing

One industrial representative said that in the past they have made use of DFO scientific personnel in such as areas as the use of slush ice to preserve Silver Hake.

Areas which this representative felt needed further research was in the improvement of shelf-life and texture stabilization of alternate species, and in the mixing of protein from different sources and still have what could be called a fish product.

The respondent stated when asked whether they had approached DFO recently about conducting needed research that, "we assume that DFO doesn't have the capability of doing this type of research". They go to TUNS for assistance from people with world class reputations.

The respondent believed that because of DFO's loss of expertise to retirements, and the poor state of their equipment, that DFO is no longer the industries' first choice as a source of advice and assistance, except where some personal contacts between a DFO researcher and an industry client already exist He believed that IMB (NRC) was much more proactive with the private sector.

He thought it ironic that industry, at the time, thought that the research conducted by the Fisheries Research Board was too academic, yet in reality it put Canada ahead as world leaders in fisheries. He felt that much of that expertise was lost with the demise of the Fisheries Research Board.

9.0 PRODUCTS ANALYSIS AND ASSESSMENT

9.1 Fisheries

In the Fisheries Divisions, the emphasis on marketing activities in Atlantic Canada should be directed at improving communications with the industry and thereby improving the public image of the Divisions. If this can be done over the next two or three years, then the industry may be more amenable to conducting joint projects with the Divisions.

The problems with the local fisheries and fishing communities should be resolved before any marketing activities outside the region are undertaken. If the Fisheries Divisions regain credibility and trust among the local communities, they will be better able to market their services outside the Maritime region.

As a result of the cutbacks, the Fisheries Divisions do not appear to have the resources to provide adequate services to the local communities so it is unlikely they will have the resources to expand their territory.

9.1.1 *Marine and Diadromous Fisheries*

Notwithstanding the above statements, there are some products and services that may have potential for cost recovery, if not immediately, then in the future if resources are adequate.

Products and Services with Commercial Potential

The major markets for Marine and Diadromous Fisheries Division products or services are other DFO Branches. As discussed above, methods for cost recovery of these should be explored.

Data and Data Products

Data are given free to consultants and freely exchanged with other researchers. After monitoring data requests for a period of six months, the Division should have information on the kinds of data requested, the amount of work that has to be done to put the data in the form requested, and the people requesting the data. The types of data or data products that could be sold should be determined and the markets identified. It is believed that the consulting industry may be the main market for data products. If the monitoring shows this to be the case, then the consulting industry should be approached by the Business Development Officer to determine the kinds of data or data products that are required and the best means of delivery.

Software and Software Products

It is believed there is potential in the recreational fisheries industry for models of fish distribution. The costs of and time involved in acquiring the information for input to the models (e.g., from satellite tracking data), operating the models and making them available on the Internet should be determined. Some models are available now, free of charge, through the Internet. Use of these models and the potential markets for others should be determined. If the demand is high enough to warrant the costs of maintaining and running the models, charges for access to the models should be established.

There may be some demand for software for stock assessment in the international market. Market research is required on the types of software currently available from other sources and whether there would be a market for licensing software developed by the Division.

Consulting Services

Potential exists in the international marketplace for providing consulting services on survey design, interpreting results, setting up research facilities, fish health, etc. Areas with potential include Africa and South America.

Division personnel also review Environmental Impact Statements. This should also be considered as an area for cost recovery for the time that staff take to review these documents and comment on them.

9.1.2 *Invertebrate Fisheries*

This Division has been successful in obtaining funding for its snow crab programs from the Snow Crab fisheries associations. When funding for a five-year project was discontinued, the fisheries associations felt the project was important enough for them to contribute funding to it so that the program could continue. Support from other fisheries associations is also received for the scallop bed enhancement technology program.

These programs should be analyzed to determine the key factors that made them successful (often the major key success factors are the enthusiasm and drive of the people involved and their communications skills). The Department is moving towards co-management of all fisheries and with more input to fisheries management, successful fisheries industries will have both the money and the interest in contributing to programs that will ensure a sustainable industry.

The Division should explore the possibilities of applying some of the technologies developed in these programs, e.g., mapping of snow crab catches, to other invertebrate fisheries, either in Canada or abroad. If the technologies can be applied to other fisheries, then appropriate fisheries associations should be approached to obtain financial input to the programs.

Some of the technologies developed on snow crabs is being transferred to Japanese researchers, on an expenses only basis. This appears to be a missed opportunity for revenue generation through consulting fees and possibly, through licencing technology or expertise.

Scallop bed enhancement technology should also be explored as a potential licensing or consulting opportunity.

Software and Software Products

If other countries are interested in licensing the software products developed by the section, and in obtaining the know-how to operate and interpret the models, Science Branch will require mechanisms for receiving payment for both consulting services and technologies. It is estimated that the investment by DFO to build the expertise in the snow crab area is over $4 million. This investment will not be recovered, but consulting and licensing fees will help the programs to continue.

Charts

Charts of bottom topography were identified as perhaps having commercial potential. With the surge in eco-tourism there may be a market in recreational sports, e.g., diving or in

recreational fisheries. Appropriate sports associations or companies promoting eco-tourism in the region and the CHS should be consulted on the potential market for this type of chart. The demand for a chart of any specific area is unlikely to be large. However, if a large enough market is identified, the charts could be distributed via the channels CHS uses to reach the recreational market for its products.

Consulting Services

The Division has expertise in setting up and operating tagging programs that may have potential in the international marketplace. Expertise in scallop bed enhancement technologies might also be marketable to the international community. IDRC programs should be explored as a means of exploiting this expertise.

9.2 *Aquaculture*

The aquaculture industry has tremendous growth potential, especially with the worldwide decline in wild fish stocks and the growing world population. In 1990, aquaculture's contribution to the world fisheries harvest was 49%. It is predicted that by the turn of the century, total world aquaculture production will reach 22 million tonnes (Aiken and Sinclair, 1995). Aiken and Sinclair quote an FAO report that estimates that 55 million tonnes of food grade aquaculture products will be required by the year 2025 to meet projected demand, and that realistically, with good management, 40-45 million tonnes might be achieved.

There is obviously potential for the Canadian aquaculture industry on both coasts to contribute significantly to world demand for seafood products and, in the process, to generate employment for both aquaculture workers and the seafood processing industry. There are also opportunities for more land-based aquacultural activities such as the use of abandoned open mining pits to grow fish, as is being done now in Northern Ontario. However, if it is to grow and prosper, the industry will require considerable and sustained research support. Recommendations on what will be required to provide the support needed for a viable aquaculture industry are beyond the scope of this report. Actions to support the industry will require a change in the attitudes of politicians and bureaucrats to aquaculture and the diversion of funding from programs aimed at supporting dying fishing industries.

As noted earlier, there is some confusion among the aquaculture industry on the roles of Science Branch and the Institute of Marine Biosciences. According to an item on its web site, aquaculture is now the major focus of the IMB (70% of its work) and DFO and the industry were consulted to ensure that NRC would complement existing aquaculture research capabilities. It appears however, that despite the consultations, the industry in unclear why the IMB changed its focus and who is doing what. Science Branch and the IMB are obviously in competition for apparently scarce industry dollars to conduct research, but the research areas of the two organizations ideally should not overlap.

Although some shellfish aquaculture facilities in PEI and salmon facilities in New Brunswick are well established, in other areas of the Maritimes, the aquaculture industry is still in a fledgling stage. Some of the scientists and industry representatives believe that some sections of the industry cannot yet contribute financially to research programs through joint partnerships. The associations try to obtain funding for joint research with DFO through some of the federal or provincial programs. However, methods of deferring contributions from the industry until such time as the industry segment has become commercially viable should be explored. For the present, the wealth and job creation that accompany the building up of an industry should be adequate return for DFO support.

Consulting Services

In all areas of aquaculture, methods of cost reduction through improved management techniques, is a major concern. The Aquaculture Division can provide advice and information on improving management techniques, equipment, diet and nutrition, feeding regimes, etc. As some of this advice might be to small farmers trying to become established, some kind of deferred payment system could be worked out to take effect when the operation becomes commercially viable.

Software

A model to assist in determining the optimum location of fish farms is being developed in conjunction with Oceanography Division. If this model is tested successfully, the possibility of licensing it to aquaculture associations should be considered. Its applicability to coastal conditions in other countries should be explored.

Fish Health

Causes of fish diseases and development of pharmaceuticals or non-pharmaceuticals to prevent or cure diseases is an area of research important to the industry. One interviewee felt that Science Branch does not provide sufficient resources to this area of research. This is an area where support for joint projects might be sought from the pharmaceutical industry. Cures for fish diseases are important to international industry and support could also be sought from outside Canada.

Diet and Nutrition

Improved feed and feeding regimes can result in reduced costs to farmers. A standard reference diet has been developed for salmon and is being produced abroad with no financial returns to the Department. Other standard reference diets can be developed. Standard reference materials are sold by other government departments and agencies (IMB, NRCan) and mechanism for Science Branch doing the same should be developed.

Feed companies should be approached as a possible source of funding for joint projects in diet and nutrition.

9.3 *Ocean Sciences*

Ocean Sciences Division has successfully licensed a number of technologies to the private sector. The Division has developed other instruments and technologies that are potential candidates for licensing. Most of them require additional work to bring them to a stage where they could be transferred to an industrial adopter. Both Science Branch personnel and industry representatives said the Division does not have the personnel to work on developing current or new technologies, and until this situation changes, development of new instrumentation will be slow. A solution used by other government departments and agencies is to enter into a collaborative R&D agreement with a potential manufacturer who provides the missing expertise in return for a license to exploit the technology. If a Canadian adopter cannot be found, then foreign adopters are approached.

Technologies

Oceanographic instrumentation is a small niche market and companies must consider whether instrumentation can be developed, produced and sold for profit. The Ocean Sciences personnel who have been working with industry know the market potential for the instruments they develop. They should however, consider whether some of the technologies they have developed for oceanographic instruments could be applied to instrumentation that is used by other industries, and when developing new instrumentation, consider whether there might be other applications. Optical detection methods used in one type of sensor might be used in a sensor for some other application, not necessarily within the DFO mandate, or in-situ monitoring devices may have applications in environments other than aquatic. A Business Development Officer could follow up any ideas with industry.

Consulting Services

Ocean Sciences Division staff have the knowledge and expertise in oceanographic surveying to provide consulting services in both the domestic and international markets. Domestic companies have a great respect for the scientists and would sometimes like to be able to have personnel from the Division as part of a consulting team when bidding and working on projects in both the Canadian and international markets.

There are also opportunities for working on projects through IDRC and for Oceanographic Institutes in the United States and perhaps other countries. As discussed earlier, at present, the mechanisms for working with or receiving money from international organizations are cumbersome and opportunities for revenue generation are being lost.

In conjunction with Aquaculture Division, the Oceanography Division can provide advice to the aquaculture industry on the optimum location of facilities.

Data and Data Products

The Division has amassed vasts amounts of data through its ocean surveys. These data are made freely available to anyone who wants it. There are opportunities for selling value-added data if the mechanisms are in place. Ocean Science Division is now paying for meteorological data from Atmospheric Environment Service of Environment Canada and British Meteorological Office, which dispels the argument that data should be freely available to the research community. Oceanographic data is also of interest to offshore mining and drilling companies.

Software and Software Products

The Division has developed or is developing software to handle the data it has collected. These software products - oceanographic models, model code, data integration tools - may have a small niche market. There may also be opportunities for licensing software to other organizations.

9.4 *Marine Environmental Sciences*

This Division mainly provides services to other Divisions. If Strategic Business Units (SBUs) are set up, cost recovery for services to other SBUs should be explored.

Although environmental monitoring and surveying projects appear to be an opportunity for joint projects with industry, the issue of conflict-of-interest and appearance of bias should be resolved before any projects are undertaken.

Analytical Services

The ability to provide analytical services to external organizations should be determined. With the present staffing levels and elderly equipment, this is probably not feasible. However, with new staff and new equipment, the Division may be able to offer services to consultants and other industrial clients. Those in areas not presently offered by private laboratories should be offered first. If there is a demand for new services, these should be added as time and personnel permit.

Instrumentation

Within the Division are a number of ideas for instrumentation for in-situ monitoring. As with Ocean Sciences Division, additional time and expertise will be required to fully develop instrumentation to a stage where it could be licensed to a company for further development and production. As noted above, it is more effective is such further development is done as part of a collaborative agreement with a potential manufacturer. Although the market may be small in the oceanographic sector, in-situ monitoring equipment has applications in other industries. These should be explored in consultation with potential manufacturers.

Consulting Services

Personnel in the division have considerable expertise in environmental monitoring and could provide consulting advice to companies that are required to monitor the environment in the vicinity of their off-shore operations. There is a difference between providing advice on setting up a monitoring program and doing the actual monitoring, and advice is a legitimate area for, at least, cost recovery.

The Division also reviews Environmental Impact Statements, which can be time consuming and which should be another area for, at least, cost recovery.

10.0 TYPES OF FINANCIAL ARRANGEMENTS USED BY OTHER GOVERNMENT DEPARTMENTS TO FACILITATE TECHNOLOGY TRANSFER AND COMMERCIALIZATION

The following provides a quick overview of some of the financial tools used by other science-based departments to encourage technology transfer and other working relationships with the private sector.

Most other government departments have been more entrepreneurial than DFO in seeking flexible ways of handling funds from external sources. Most of the science-based departments have respending authority from Treasury Board.

Although Specified Purpose Accounts are now used by DFO, the Department appears to be one of the last science-based departments to make use of this type of account to handle external money. Some departments such as the Canadian Forest Service of NRCan makes heavy use of this mechanism.

Most other departments are following the 1993 Treasury Board policy on rewarding the whole innovation team, not just the inventor. For example, NRCan, NRC, and AAFC provide for an award of 15% to the named inventor, and the remaining 20% goes to the downstream key developers. In NRC and AAFC, the marketing/technology transfer people can also share in the award.

The Communications Research Centre (CRC) has an arrangement with Treasury Board that allows it to receive fee-for-service revenue within a month of receiving payment from a client. They are limited to retaining only $5 million in one year.

NRC can also retain fee-for-service income. They have, for example, a set fee structure for analytical services. When working for a foreign client, NRC charges whatever the market will allow.

Unique among the science-based departments is Geomatics Canada's $8 million dollar Revolving Fund. A Revolving Fund is a continuing authorization by Parliament to make

payments out of the Consolidated Revenue Fund. Similar to a line of credit, this funding mechanism, with full retention of all revenue and no year-end constraints on spending, gives Geomatics Canada the ability to recover full costs from Canadian clients, including other federal government departments, and the freedom to charge market prices to international clients. [Geomatics personnel are encouraged to go after international projects and, unlike DFO, are not confined to looking only at Canada]. A major strength of the Fund is that it allows Geomatics Canada the ability to respond, on behalf of and in partnership with industry, to major international opportunities. Such opportunities often arise with little notice and with very little time to submit proposals. Generally, these opportunities require immediate expenditures, such as the preparation of proposals, bid bonds, performance bonds and risk insurance. The Fund allows for rapid response to these financial demands.

Agriculture and Agri-Food Canada makes use of their Matching Investment Initiative (MII) to support technology transfer through collaborative research projects with industry. AAFC funds the MII through re-allocation of its A-base; in 1998/99 the amount available to the MII is approximately $35 million. Funds do not flow to the industry partner but are used to support AAFC's share of the collaboration. Matching is done on a dollar for dollar basis. Local Establishment Directors have delegated authority to enter into agreements up to $75,000.; and DG's up to $150K. Monies from the industrial partner are put into a Specified Purpose Account for the collaborative project.

In order to avoid being accused of unfairly competing with the private sector for consulting contracts, NRC has a clause in their contract agreements that states in effect that the client has agreed to work with NRC because of their unique expertise and facilities. Thus competition is on expertise, not cost.

11.0 RECOMMENDATIONS ON ADMINISTRATIVE CHANGES DFO MUST MAKE TO SUPPORT A MARKETING AND COMMERCIALIZATION PROGRAM

11.1 Provide A-base Budgets for Science in Support of "Public Good" and Regulation

Science Branch should not have to depend on funding from outside sources to conduct the surveys and research required to support the regulatory or "Public Good" role of the Department.

The Department of Fisheries and Oceans should identify those scientific activities that are essential to support its mandate and its regulatory role. Data collected in support of Canada's and DFO's commitments to international programs should also be clearly identified. These are areas that should be supported under the Department's A-Base budget and the laboratories should not be put in a position of relying on outside funding through partnerships or joint research projects with industry to carry out their mandated work for the "Public Good". If the Government of Canada and the Canadian public are not prepared to pay for research for the public good through the tax system, then one must ask why the work is being done.

Recommendation #1: The A-Base research and development budget of the Department be increased so that it covers the costs of research, surveys and monitoring necessary to support the regulatory role of the Department.

Recommendation #2: Establish procedures and fee structures to enable the Branch to charge for access to data that was originally collected in support of the DFO mandate but that is also of value to outside agencies or consultants.

11.2 Establish New Financial Arrangements with Treasury Board

Unlike many other government departments, DFO has no financial arrangements with Treasury Board to respend any monies earned (e.g., MOU, Revolving Fund, etc.) to enable it to strengthen the viability of its laboratories by conducting business with the private sector. At present, monies earned go into the Consolidated Revenue Fund. Until appropriate financial mechanisms are in place, it will be very difficult, if not virtually impossible, for Science Branch to encourage its scientific staff to offer products or services for sale. The only mechanism that can be used at present to bring money into the labs is a joint partnership arrangement, and although this is useful in some cases, areas where there may be potential commercial opportunities have been identified where joint partnership arrangements are not appropriate.

Recommendation #3: DFO should try again to negotiate an agreement with Treasury Board for the retention and respending of externally earned revenues in order to provide the research laboratories with the financial tools they require to do business with the private sector, and to accept "grants" or monies from foreign institutions.

11.3 Develop Policies, Procedures and Guidelines for Doing Business with the Private Sector

As discussed earlier, most of the scientists do not know how to and have little interest in doing business with the private sector. During one focus group when the issue of guidelines came up, there was general laughter and a couple of the scientists pointed out that policies are needed first, before the guidelines. Unfortunately, it was not really a joke. DFO has no policies on what kinds of business activities can be undertaken by the scientists, what activities are deemed "Public Good", what kinds of products or services cost recovery or revenue generation can be applied to, what activities would put the Department in a conflict-of-interest situation, how to deal with non-disclosure agreements, what activities can be contracted-in, etc. These policy issues must be addressed first before procedures and guidelines can be developed.

Procedures and guidelines should include, but should not be necessarily limited to:

- types of information, data or advice that can be given free-of-charge and that for which fees should be charged;
- how to deal with requests for information, data or advice for which payment is required;
- administrative assistance available in the region, and persons in the region who should be involved in negotiating contracts and financial arrangements;
- how to deal with non-disclosure requests and development of a simple non-disclosure agreement form that can be used prior to discussions about possible consulting assignments or collaborative R&D projects;
- types of financial arrangements that can be made and the situations for which each is appropriate;
- the ability under the Access to Information Act not to disclose private sector company information that has been provided in confidence;
- what constitutes conflict of interest and how to deal with such requests;
- the activities can be contracted-in and those that cannot.

Science Branch must ensure that policies and procedures on doing business with the private sector or foreign clients are communicated to and understood by **all** staff. Procedures and financial arrangement for conducting joint or collaborative R&D projects must also be communicated to all staff.

Recommendation #4: DFO develop policies on doing business with the private sector that identify the types of business activities that can be undertaken on a commercial basis. Policies must be developed in consultation with senior management in Science Branches in the regions.

Recommendation #5: After policies have been developed, regional managers in Science Branch should develop procedures and detailed guidelines for their scientific personnel on how to do business with the private sector.

Recommendation #6: After policies, procedures and guidelines have been developed, workshops should be presented for scientists and administrative staff, on what DFO policies and procedures are on doing business with the private sector and international clients. In addition, each scientist should be given a **printed** copy of the procedures and guidelines for easy reference. Information on the Intranet is not sufficient.

Recommendation #7: The Partnership Coordinator and the Financial Officer (and if available, the Business Development Officer) should conduct workshops on joint project and other types of R&D agreements.

11.4 Contracting-In Research

The issue of what constitutes contracting-in, and whether the Branch can conduct contract research came up at every focus group session. Comments included "we can't contract-in research" and "contracting-in means that we would be competing with the private sector". Other Canadian government departments are not squeamish about seeking contract work; neither are foreign government fisheries and oceans laboratories.

The issue of policy and guidelines on contracting-in has been discussed above. The issue of "competing with the private sector" implies that the private sector has the same kinds of knowledge, expertise, data, facilities, equipment, etc., that Science Branch has. In some areas this is true. Consultants may have similar knowledge and expertise, and retired DFO personnel may well join the ranks of consultants. Many labs will have better facilities and equipment. However, if products and services of Science Branch are offered at a fair market price, and include all overheads (see Treasury Board Guidelines on Costing of Government services), the public and private industry should be free to seek and pay for specialized services and advice from Science Branch personnel. If another country, or an overseas company would like to contract the services of Science Branch, then rates equivalent to the industry norms for international consulting companies should be charged (i.e., a "profit" should be made that can go towards the purchase of, for example, new equipment). If this is done, Science Branch cannot be accused of undermining the competition.

Recommendation #8: Establish national and international fees at fair market rates, using Treasury Board guidelines for Costing of Government Services, for products and services of Science Branch.

11.5 Promote the Marketing of DFO Laboratory Expertise Internationally

It appears that some senior managers in DFO believe that working on international projects takes away from their mandate. This is very short-sighted. Collaborative projects overseas invariably result in a two-way flow in information and expertise that the DFO personnel can bring to bear on Canadian problems.

International projects may possibly be the only real source of new money that DFO can go after. This money, with the appropriate MOU with Treasury Board in place, could finance new equipment, personnel and facilities.

International projects presently done through IDRC could be used as a vehicle to identify other collaborative or consulting opportunities. Through such international projects, DFO can re-build its international reputation and possibly attract more international funding for projects in Canada.

Recommendation #9: DFO remove any administrative impediments to marketing its science products and services internationally and signal to its staff that appropriate international projects can be supportive of its mandate.

11.6 Provide Rewards and Recognition for Technology Transfer Activities

11.6.1 *Financial Rewards from the Licensing of Intellectual Property*

Under present interpretation of the 1993 Treasury Board Awards to Inventors and Innovators Policy, DFO awards 35% of revenues from licensing of IP to the inventor. The remainder of any income goes to general revenues in DFO. In other government departments, the remainder of any income is returned to the originating laboratory. This allows the laboratory management to share the benefits of commercialization with those scientists who do not have an opportunity to develop licensable intellectual property by using the returned revenues to purchase new equipment or fund conference travel, attendance, etc.

In addition, many government departments more closely follow the intent of the 1993 Policy and have arrangements whereby the "Innovation Team" shares in the 35% of any revenues (i.e., revenues do not just go to the named inventor). These provide incentives for the laboratory personnel to work with the inventor and further develop the technology for transfer and licensing to the private sector.

Recommendation #10: DFO follow the intent of the 1993 TB Policy and share the 35% award with the innovation team, and that any remaining revenues be returned to the originating laboratory to be used at the discretion of the Director, for improving the equipment, products and services of the laboratories.

11.6.2 *Performance Appraisal and Promotion*

Although the performance appraisal guidelines for DFO state that technology transfer activities should be taken into account, most of the scientists believe that they form a very minor part of any deliberations and that publication of papers is still the primary basis of evaluations and promotions. One person said that staff are not even thanked by their managers if they take extra efforts to work with the public.

Technology transfer is a people process. Successful technology transfer, including transfer of know-how, requires the developer of the technology or the knowledge to spend time with the client or adopter and this usually will take him or her away from their primary scientific work with resultant reduction in publications. If technology transfer and/or working with the private sector is to become part of the scientists' duties, formal recognition must be given for these activities.

Recommendation #11: Ensure that recognition for technology transfer activities is a genuine part of the performance appraisal process and be included on an equal basis with papers published when scientists are being considered for salary increases or promotion.

Recommendation #12: Provide mechanisms that enable and encourage scientific staff who were involved in the initial development of a technology or expertise to transfer to the adopting organization, on a temporary basis, to ensure the success of the transfer.

11.7 Rejuvenate the DFO Workforce

If Science Branch is to continue to have the expertise and knowledge available to support its public good research, internal clients, Canadian industry and also to continue its long-term scientific research programs, it needs an immediate influx of young scientists. Young scientists are needed to bring new ideas and new research knowledge and methods into the laboratories, to infuse enthusiasm into the workforce, and to be recipients of the vast store of knowledge and experience resident in the present workforce. If this is not done, there will soon be nothing for Science Branch to commercialize, as knowledge, know-how and experience are important aspects of technology transfer.

Recommendation #13: Identify areas where new scientific personnel are essential to provide scientific advice and know-how to existing and future, internal and external clients, and immediately embark on a program to hire new indeterminate staff. Institute a long-term program to ensure that new scientific staff are hired on an on-going basis to maintain the corporate memory and to bring "fresh blood" to the Branch. Ensure all new hirees know that marketing and commercialization activities will be part of their duties.

11.8 Replace Out-dated Equipment and Improve Working Conditions

The consultants were struck by the poor working conditions in some of the laboratories. One of the buildings at St. Andrews has been without a corridor ceiling for two years. Equipment is obsolete. The working conditions and out-of-date equipment will not help in attracting new, young scientists to St. Andrews. At other DFO laboratory locations, scientists also work with obsolete equipment.

Recommendation #14: DFO and Maritimes Region embark on a program to replace old and obsolete equipment and facilities to enable the scientists and support staff to work more efficiently and effectively and to enable Science Branch to offer laboratory services to clients and to attract new staff.

11.9 Provide Clerical/Administrative Support Personnel

It is a waste of tax-payers money, and extremely frustrating for highly educated scientific staff to be saddled with clerical work that would be done more appropriately and effectively by trained clerks or administrative staff. Working within the bureaucratic administration system takes skills and knowledge that most scientists do not have. Thus scientists will take more time to accomplish some clerical duty than would a trained clerk. The time the scientists take in doing clerical work cuts into their time for science.

Recommendation #15: Provide the research laboratories with clerical and administrative support personnel to handle the administrative duties.

12.0 RECOMMENDATIONS FOR MARKETING ACTION IN THE SCIENCE BRANCH MARITIMES REGION

12.1 Establish a Business Development Office in the Maritimes Region

The Maritimes Region requires a Business Development Office to coordinate business development in the region's laboratories and to provide marketing and support services to the Divisions. It is not adequate to have business development activities run out of Ottawa.

Scientists, especially older ones as are found in Science Branch, usually have had no training, and often little interest in marketing or business. A few, through their technology transfer activities and other dealings with the private sector, have acquired knowledge about how the private sector operates. However, the scientists should not be responsible for the primary marketing and commercialization activities of Science Branch.

Instead, a Business Development Officer should be hired for the Maritimes Region to set up the Business Development Office. Duties of the Business Development Officer should include marketing Science Branch's current products and services, seeking out new business opportunities, conducting market research, negotiating R&D contract and license agreements, maintaining up-to-date marketing material, including a "business-friendly" web-site, and following up collaborative and licensing leads provided by the scientists.

The Business Development Officer should be hired from outside of government. Ideally, he or she should have both a science and a business background, and experience in business development and/or marketing in the fisheries/aquaculture/biotechnology sector. The position should not be filled from within the Department as government personnel in general do not understand how private industry operates. For additional information on the establishing of government business development offices please refer to the Stargate Consultants report entitled, "Review of Business Development Activities in Government and Private Sector Research Institutes in the UK and Holland" (Clarke, 1997). The Business Development Officer must be provided with the financial resources to enable the incumbent to visit prospective clients (not only in the Maritimes), to travel to meetings, conferences, etc., and to support other marketing activities. This work cannot be done sitting in an office waiting for clients to appear.

Initially, one Business Development Officer should be hired. If the business development is successful and brings income to the laboratories, a marketing person should be hired for each laboratory, with overall coordination of marketing and business development activities provided by a regional Business Development Office.

Recommendation #16: Science Branch, Maritimes Region establish a Business Development Office, hire a Business Development Officer from the private sector to run it, and provide the office with adequate financial resources.

12.2 Establish Strategic Business Units

Although there is some overlap, the divisions of Science Branch serve different markets and should be treated as Strategic Business Units (SBUs in management jargon), with a business and marketing plan developed for each as part of an overall business plan. Although the products or services of each unit may be the same (data, data products, consulting services), the markets/clients for the products and services are different and will require different marketing strategies.

The obvious segmentation into business units follows the present division of science activities within Maritimes Region. However, other forms of segmentation, such as market or client served, could be explored. Some of the units within a Division provide support services to other government departments or to other DFO divisions, e.g., some of the analytical services of the Marine Environmental Sciences Division, so the markets for their services include the other divisions or SBUs within the Branch, as well as industry.

The major market for the products and services of some of the Divisions is the regulatory arm of DFO. Examples include stock assessments and some environmental studies. On the other hand, Aquaculture Division's primary clients are or should be, industry. It must be recognized that units whose clients are primarily internal to DFO or government will not have the revenue generating potential of units whose clients are primarily external.

Within many companies and some government departments, SBUs "charge" other SBUs for their products and services. Money may be not necessarily change hands, but can be transferred at the head office level from one budget to another for the time one division spends doing work for other divisions or parts of the overall organization.

Recommendation #17: Establish Strategic Business Units within Science Branch based on the most appropriate structure to service clients.

Recommendation #18: Explore the possibility of SBUs within DFO "charging" other DFO SBUs for products and services and implement already existing mechanisms to recover costs of providing services to other government departments.

12.3 Prepare a Five Year Business Plan

The Business Development Officer should be responsible for coordinating development of a business plan, that will include a marketing plan for Science Branch. The plan should identify realistic business opportunities in aquaculture, oceanography, fisheries and environmental sciences. The plan should have, for each Strategic Business Unit, business objectives, a technology development plan, a marketing plan, and a financial plan. Concrete goals and milestones should be set. Criteria on evaluating the success of business operations should also be established. The purpose of the plan is to serve as a guide for the Branch in conducting business with the private sector.

Recommendation #19: Science Branch develop a five year Business Plan that is updated annually.

12.4 Establish Rates for Products and Services

There are a number of steps that must be undertaken before commercialization activities begin. These include establishing rates for the various types of services that will be offered on a cost recovery basis and for access to the various types of data and data products. It is assumed that people and resources will be available to provide the services. There must also be appropriate, simple systems set up to collect fees.

A representative from the Commercial Services Division of AES said that AES does not charge fees for data per se; they charge fees for "access to the data". This rather fine distinction gets round the problem of charging for raw data, the collection of which has already been paid for by the Canadian taxpayer. Charges are also made for value-added services, customized products, etc. AES also licenses some of its software either directly to end users or through a third party.

The AES representative said that raw data can be distributed to researchers for free; however, if that researcher, who may be a university professor who also does consulting work, uses that data for commercial gain, a charge is made for it. The scientists must be aware of the conditions attached to a researcher receiving free data.

AES uses a variety of mechanisms to receive payment for access to data through the Internet. These include use of credit cards, passwords for access to some databases, and pages set up for clients with specific needs.

12.4.1 *Data and Data Products*

Internal market research should be conducted to determine the current market for Science Branch data and data products. This should be done by keeping track of requests for data (types of data, from whom, etc.) for a period of at least six months. From this the major markets (researchers, educational institutes, private industry, national, international etc.) can be identified and the types of data each requires.

It is suggested that AES be consulted to determine how they established their rates for access to data and for value-added data products. (AES's rates for access to data and data products, and for their other commercial services can be found on their web site at www.tor.ec.gc/commercial/aep_catalogue_english.htm#PriceList).

A considerable amount of data can be distributed through the Internet and different types of mechanisms can be used for allowing access to the data and for collecting payment for its use.

Use of passwords, prepayment for time spent using the data-bases, charging for downloading data, etc. should all be explored and the most appropriate mechanisms set up. Other data can be distributed on CD ROM, on paper, as charts, or via a 1-900 number service.

It is suggested that the Canadian Hydrographic Service be consulted to determine whether Science Branch can cooperate with CHS to use the same distribution channels for some maps and charts, if there is a large enough market for them.

Recommendation #20: Science Branch establish rates for access to data and for value-added data products for both internal DFO, other government (both Canadian and foreign) and non-government clients.

Recommendation #21: Determine the most appropriate medium for distribution of each type of data or data product. Make use of the Internet, where appropriate, as means of access to some data and data products and determine the most appropriate on-line method of collecting fees. Determine the most appropriate method of collecting money for other data products (charge accounts, deposit accounts, etc.).

12.4.2 *Consulting Services*

The Treasury Board Guidelines on Costing Government Services should be used as a basis for establishing rates for consulting services to Canadian industry and organizations. Rates for consultation on the international market (other governments, foreign industry) should be based on fair market rates and not just what can be charged to a Canadian client.

CISTI, for example, charges $90.00 per hour plus costs of searches for its reference services. The Atmospheric Environment Services of Environment Canada has a hourly rate for $87.00 for “consultation”.

Recommendation #22: Science Branch establish rates for consulting services to Canadian and foreign clients.

12.4.3 *Laboratory Services*

The scientists identified various laboratory services that they currently provide free of charge. With appropriate staff and equipment, some of these services could be offered on a cost recovery basis without Science Branch being in competition with the private sector. Fees for different types of laboratory services (analytical, diagnostic, etc.) should be established for the laboratories that could offer these services. This should be done after consultation with other government departments and with local laboratories that offer similar types of services. Rates must not exceed or undercut those of commercial laboratories for similar types of services.

Recommendation #23: Establish rates for each type of laboratory service that could be offered.

12.4.4 *Use of Facilities and Equipment*

Science Branch has facilities and equipment that companies and consultants do not have but that they may want to use for brief periods for specific tests. A number of NRC laboratories (e.g., the Institute for Marine Biosciences and Institute for Marine Dynamics), and universities (Dalhousie/TUNS) charge companies for use of their facilities and equipment, and the services of a technician to operate them. It is suggested that Science Branch consult with NRC and Dalhousie University on the logistics involved in enabling private sector or other researchers to use their facilities and how rates for their use are determined.

Recommendation #24: Identify facilities and equipment that could be used by the private sector and establish rates for their use. In addition, determine whether a technician would be required and/or available to operate the equipment and include the costs of the technicians in the rates.

12.5 Establish Mechanisms for Providing Consulting Services

At present, DFO does not have procedures in place to enable the scientists to provide consulting services on a full cost recovery or revenue generation basis. Some scientists do provide consulting services through IDRC or CIDA, usually with direct expenses only being paid (occasionally there is full cost recovery), or the scientists may use their vacation time to act as consultants. If a scientist is providing consulting services through IDRC, his or her work is not being done back home, and usually no money is being received to hire a temporary replacement. The only return to the Branch is enhancement of its international reputation.

An industry representative said that when bidding on foreign contracts, the company would sometimes like to include a person from Science Branch on the consulting team but that DFO has no mechanisms in place for responding to such requests in a timely manner. Senior management responses (usually from Ottawa) take longer than the time for bidding allows with the result that opportunities for Science Branch personnel to be involved are lost. The same industrial respondent said the he doesn't face the same decision delays when dealing with the Geological Survey of Canada housed at BIO.

One of the scientists said that he had been asked for consulting advice by a US company, but because US travel takes three months to be approved by Ottawa, even if costs are paid for by another organization, the opportunity to travel to the US to provide the services was lost. As noted earlier Geomatics Canada is set up to respond quickly to international contracting opportunities.

A representative from IDRC believes that there are international opportunities for DFO to market its services abroad. Opportunities in the salmon industries and the fish health area were specifically mentioned. IDRC projects could be used to identify new opportunities abroad.

DFO could also partner with Canadian companies to offer a complete package of services (capital, expertise, etc.).

Recommendation #25: Establish policies, guidelines and mechanisms to enable Science Branch personnel, with the approval of local management, to respond to consulting opportunities in a timely manner, and provide consulting services, in both the domestic and international markets, on a cost recovery or profit basis without getting entangled in internal bureaucratic red tape.

12.6 Provide Technology Transfer Training for Scientific Staff

Scientists can do a great deal to bring business to the laboratories without adding too much to their work load. They need to be sensitized to look out for business opportunities for and in the laboratories and know what they should do if an opportunity arises. Talking with industry colleagues at conferences, listening to the problems of local industry at workshops, being aware of the kinds of protection that can be obtained for intellectual property and the procedures that should be followed, looking for other uses of technical procedures that they may develop in the laboratory are all activities that could bring collaborative R&D opportunities or funding to the laboratory. Information on opportunities identified can then be passed on to the Business Development Officer for follow-up action.

Recommendation #26: Provide training in technology transfer for bench-level scientists and their immediate managers to enable them to work more effectively with the Business Development Office, their senior managers and with the DFO intellectual property manager.

12.7 Improve Promotional-Marketing Activities

As discussed earlier, DFO and Maritimes Region require appropriate policies, procedures and financial mechanisms in place before Science Branch is in a position to commercialize most of its products and services to bring financial returns to the laboratories. However, there are a number of activities that the Branch can undertake now to make industry aware of its research activities and to generate interest in partnering with industry on joint projects.

12.7.1 *Produce Brochures on Research Areas Targetted at Industry*

The Branch needs to let industries in the different sectors know it is interested in working with them and show how the work it does could be useful to companies. A series of eye-catching, up-to-date brochures or information sheets should be produced that give information about the laboratories, the areas in which they work, the equipment and facilities, kinds of information or services they can provide, and the fact that the Branch is looking for collaborative R&D partners. The name of a contact person for each area should also be provided. The contact person would normally be the Business Development Officer. Until one is hired, someone should be designated as the "business" contact. Appendix IV is an example of an information sheet produced by the IMB.

These brochures should be distributed at any events held at the laboratories (e.g., open houses, seminars, etc.,) when people from industry will be visiting and should also be given to scientists to take with them to conferences and seminars or when visiting companies. Associations should be provided with copies.

Recommendation #27: Produce attention-getting brochures designed to inform industry of Science Branch's interest in working with or for industry.

12.7.2 *Develop Laboratory Web Sites*

The Science Branch web-site is not business oriented and should be redesigned. The Science Branch home page should provide direct access to individual laboratory web-sites. Individual laboratory web-site home pages should provide quick access - no more than one click away - to information of interest to potential clients on research areas, services, facilities, technologies for transfer or licensing, data available (preferably for sale), etc. Visitors to the web-sites should know that the Branch is "open for business". The individual Branch web-sites should be maintained at the regional level and the information should be kept current. It is suggested that the NRC web-site be used as a model.

Recommendation #28: Re-design the Science Branch web-site and develop individual laboratory web-sites to make them business-oriented. Web-sites should be maintained locally.

12.7.3 *Use Conference and Trade Show Attendance to Market the Branch*

As recommended earlier, scientists should be provided with training to recognize marketing and collaborative research opportunities, and information on what to do when they have a "business" lead. Conferences and trade shows that attract industry or foreign government researchers are ideal places for networking with prospective clients. DFO scientists while attending conferences should be sensitive to comments by their industrial or foreign government colleagues that indicate technical problems that might be solvable by DFO staff through consulting contracts or collaborative R&D projects. In order to remind their scientific staff of the need to be alert to potential opportunities, some organizations provide them with a "Business Opportunity Leads" form that they can give to their business development officers when they return from conferences. On this form, the scientist can provide information on the opportunity and the name and phone number of a contact person. Leads that result in new monies or collaborative opportunities coming to the Branch should be recognized and the scientist suitably rewarded.

Recommendation #29: Develop, and provide Science Branch scientific staff with "Business Opportunity Lead" forms and establish an appropriate award system for leads that result in new business

12.7.4 *Use Targetted Industry Open Houses to Market Specific Lab Capabilities*

General open houses are not as effective in attracting industry interest as ones that are specifically targetted at an industrial client group. Open houses, targetted at a specific industry segment should be held, as necessary, to advise potential industrial clients of collaborative opportunities and of expertise and know-how available. This will bring industry people to the laboratories and enable them to talk to the DFO scientists about the work they do and its applications to industry, and to see the equipment and facilities. Targetted open houses should be scheduled for the off-season in the particular industry and attendance should be by invitation.

Recommendation #30: Organize targetted industry specific open houses

12.7.5 *Compile a Database of Prospective Clients*

A searchable database of companies or organizations in the fisheries and oceans area that gives information on the work they do, the technologies they use, and key contact people should be compiled and maintained by the Business Development Office. The scientists can contribute information to the database by providing information on companies and organizations they deal with and other sources, such as Industry Canada's database of companies on its *Strategis* site, can be used to obtain information on potential client organizations. The database can then be used for targetted marketing activities and to identify companies that are potential licensees of technology, or users of products and services of Science Branch.

Recommendation #31: Compile a data base of potential Science Branch client organizations

12.8 Improve Science Branch Public Image

Although we found a great deal of respect for individual DFO scientists and the work they do by the people they deal with in industry and other federal and provincial government departments, DFO as a whole, has a very negative image in the Maritimes region. This is due to the decline in the fish stock, the political nature of the fisheries and the fact that access to Canadian fishing grounds are used as a negotiating tool in international agreements. In the fisheries communities in particular, there seems to be no distinction made between DFO's science role and its regulatory role. Therefore decreased quotas, or increased license or observer fees, new regulations on industrial activity, etc., increase the negative image of DFO. This negative image affects all of Science Branch, not just the fisheries or regulatory/enforcement Divisions.

There is an urgent need to increase public awareness of the "Public Good" aspect of work Science Branch does to protect fisheries resources and prevent further degradation of the environment. Public good work includes that done to increase knowledge about the aquatic environment, the effects of pollution or industrial activity on the environment, the ecology of aquatic fauna and flora, how changes to the ocean affect global climate, etc.

The general public may not know about or understand why some of this work is necessary. The benefits of this type of work can be "marketed" through activities such as:

- developing or assisting in developing "educational modules" on oceanography, fish habitat, the environment, etc., for different levels of school students (e.g., a grade 11 course on oceanography is being developed in conjunction with the Oceans Act Implementation Office);

- participating in or sponsoring Science Fairs (e.g., judging, donating a prize for the best exhibit in a marine environmental category);

- writing articles for "general readership" magazines (e.g., Canadian Geographic and similar publications) or weekend "magazine sections" of newspapers;

- holding open houses for the general public;

- preparing a travelling exhibit for display at local or regional fairs, or school or college career days;

- preparing videos on some of the research activities of the Branch and their practical applications, e.g., (aquaculture, instrumentation) for use with travelling displays, in schools, at public meetings, or for local media;

- developing contacts with science reporters in the local media and encouraging them to publish or air information on new products or developments, or other activities of the Branch that would be of interest to local industries or communities.

- using the web site to tell the public in non-technical terms about the benefits of the research

These types of activities, some of which can be classed as "Public Relations" should be done through local communications staff and the Business Development Officer with the cooperation of the scientists as necessary for reviewing material prior to publication. The communications officer at St. Andrews already does some of this type of work. There should be a coordinated effort by the Maritimes Region to increase the Public Relations efforts of the Communications Branch and improve the public image of DFO. Instead of reacting to crises or doing damage control, the Communications group should take a proactive approach to communications. When the public and industry know and understand what Science Branch does, not only will Science Branch improve its public image, but industry may be more inclined to come to Science Branch for assistance or advice and more inclined to pay for it.

Recommendation #32: The Business Development Office, in conjunction with the Communication Office, develop a marketing/communications plan to promote the public good aspect of Science Branch work.

13. CONCLUSIONS

The status quo is not an option.

This study has identified a number and variety of science products and services that could bring revenues to Science Branch **if** the Department develops and implements policies and procedures that will facilitate business with the private sector or foreign clients and provides the Branch with appropriate financial mechanisms that will enable it to use any revenues generated to support and improve the facilities of the laboratories.

For Science Branch to improve the marketing of its science products and services to prospective clients, it must take a more business-like approach to its interaction with those prospective clients as has been done by many other Canadian government departments and agencies.

While Science Branch has had successes in transferring and/or commercializing technology and expertise to external organizations, this success has come about more because of the persistence, dedication and abilities of the individuals involved, rather than a culture or management system that supports the transfer or commercialization of DFO developed technology or expertise. At the personal level, the relationship between Science Branch scientists and their private sector counterparts appears to be very good, which is a major facilitator of technology transfer.

Science Branch must take control, at the regional level, of the marketing of their science products and services; it cannot be done efficiently or effectively from Ottawa. In order to be effective, the Maritimes Science Branch must be provided with the administrative and financial tools and freedoms to be able to work efficiently with the private sector or external clients. Decisions concerning collaborative R&D projects, consulting projects and market identification, national and international, should be made locally so that they can be made in a timely manner. Clients will not wait around for slow-paced, bureaucratic centralized decision-making.

The culture within Science Branch, while not opposed to working with external clients, needs to be changed so that scientists are sensitive to and can recognize “business opportunities” and are more amenable to working on research projects identified by their clients. The reward and recognition system should reinforce this change in culture.

The loss of expertise through retirements, the lack of new research scientists in the system, the out-of-date equipment and facilities, and the lack of a business development focus all contribute to making the marketing of science products and services much more difficult.

Science Branch should not look to Canadian private sector sources as an immediate source of significant new funds for the laboratories. Because of the present weakness of the fishing industry, the fledgling nature of the aquaculture industry, and the small size of the ocean instruments business, the “payoff” for the government’s investment in the research and

technology transfer of the Science Branch should be measured in terms of long-term economic benefits to Canada such as the return of a limited fishing industry to coastal communities and the creation of a strong, globally competitive aquaculture industry.

Science Branch should emulate other government departments and aggressively pursue international clients as they are most likely the most immediate source of new funds for the Branch.

As noted above, however, none of this will come about under the present administrative and financial system, or the negative attitudes of some senior DFO managers towards international projects and aquaculture.

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