Capacity Gap Analysis and Statement of Requirement

Federal Biosystematics Partnership

Final Report

June 2002

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EXECUTIVE SUMMARY

Purpose: This is not a report on the science of biosystematics. The purpose of this study is to:

- review existing biosystematics programming in federal departments and agencies;
- assess the current level of programming capacity, relative to departmental mandates in this area;
- identify gaps in the current federal programming framework, and;
- put forward a detailed action plan to fill these gaps.

Biosystematics: Biodiversity exists in three forms: genes, species and ecosystems. The organized study of biodiversity that seeks to recognize and identify organisms at the species level and to understand evolutionary and adaptive patterns and characteristics is known as *biosystematics.* Given the important role that biodiversity plays in the Canadian economy, biosystematics research is basic to the sustainable use of Canada's limited stock of this natural capital and, hence to a healthy economy, over the long term.

The federal business case for biosystematics: Biosystematics figures prominently in many federal programmes. Operational linkages to other programmes include non-tariff barriers on exports, bacteria, viral and parasitic human health risks, forest and agriculture pest control, endangered species management, aliens species in agricultural fisheries, wildlife, and habitats, ecosystem health monitoring and monitoring pollution impacts on wildlife (and hence humans). Weaknesses in the federal biosystematics programme have contributed to slow or ineffective responses to issues arising in these areas of public policy and have been costly.

Background: Canada's biological diversity is recognized as an important national asset with significant economic value. Canada's biodiversity is a primary source of inputs to the national agricultural, pharmaceutical, cosmetic, nutriceutical, natural health food and tourist industries.

In the early nineties, in order to help protect and manage this important natural capital, the major science-based departments and agencies of the federal government formed the Federal Biodiversity Group. In 1998, it was felt that the first priority to effectively managing stocks of biodiversity is to identify and quantify the resources and therefore, a Memorandum of Understanding (see Annex A) was established to create the Federal Biosystematics Partnership[1] (FBP). The purpose of the Partnership is to collaborate on research initiatives, undertake technology and knowledge transfer, raise awareness within government and the public, and ensure that biosystematic resources are effectively mobilized and deployed.[2]

Recently, partners have undertaken an assessment of their programming needs and provided these studies to the current FBP Chair FBP (Museum of nature). The FBP, in turn, has commissioned this study to provide the following deliverables:

- review individual assessments and present an updated standardized summary assessment (Annex B) on the status of biosystematics programming within each of the partner organizations;
- consolidate the findings into a federal assessment (Annex C), and;
- outline the way forward to address gaps that have been identified as part of this study.

[1] FBP membership includes: Natural Resources Canada (NRCan)(Canadian Forestry Service - CFS), Fisheries and Oceans Canada (DFO), Environment Canada (EC) , Agriculture and Agri-Food Canada (AAFC), Canadian Museum of Nature (CMN), and Parks Canada (PC).
[2] 1998 MOU signed by AAFC, DFO, CMN, NRCan and EC.

Assessment Summary

Human Resources: The federal government has lost approximately 60% of its biosystematics expertise since 1990. On average, departments report that they have less than half of the expertise (ie: internal skills to effectively study commercially or scientifically important species or populations) they require to fulfill their mandate.

Biosystematics Data: *Bioinformatics* is the application of information technology to biology (from genes to ecosystems) with the emphasis on persistent data stores. Bioinformatics requires specialized computers, software, storage capacity and transmission facilities. Capacity in this area is fundamental to preserving, enhancing and sharing biosystematics information.

There are virtually no dedicated resources to capture / convert existing information into digital format, thus furthering risk of deterioration, preventing enhancement and sharing, as well as presenting an obstacle to working with partners. By-and-large mechanisms and protocols are not in place at the national / departmental level to facilitate working more closely with partners; a key strategy to compensate for weaknesses in the federal programme.

The federal government is custodian to more than 40 million specimens / records. Fewer than 5%[3] have been documented in digital format. Three or six partners have established data capture / conversion standards to initiate the conversion process. It is critical that a federal standard be established that compliments national and international standards, to facilitate sharing and interoperability of databases amongst federal and non-federal partners.

Computing Capacity: Two of six partners have quantified their bioinformatics needs and started to acquire standard computing configurations to address these requirements. The other four partners characterize their bioinformatics capacity as limited or somewhat limited.

Research Assets: Research assets include office space, laboratory facilities, storage space and specimen collections. Although office and laboratory facilities are adequate, the extent of collections needs to be increased and four of six partners expressed significant concerns over the condition of their collections, mostly stemming from an acute lack of adequate storage facilities and limited resources to curate collections.

The Pathway Forward:

The issue analysis framework is comprised of three components: Human Resources, Physical Resources and Organizational Infrastructure. These issues provide a strategic framework to build performance improvement of the federal programme.

Human Resources

Challenges:

- Canada has lost research specialization across all taxonomic groups.
- Most federal systematists are in their mid-forties to mid-fifties in age. The government has also started to loose mid-career scientists, due to limited career advancement prospects.
- Fewer students are entering the field and universities are reducing programmes.

[3] Based upon rough estimates by interview participants. Further research is required to refine this figure.

- Few national / departmental strategies or mechanisms have been developed to take advantage of non-federal expertise, however, it is recognized that partnerships are considered a key component of the long-term federal biosystematics programme.

Actions Needed:

- Permanent biosystematic positions within secure programmes are required to reverse the above negative trends.
- Three of six partners have completed a detailed inventory of their expertise, this provides a solid basis for a much needed federal inventory.

Physical Capital

Challenges:

- Most partners have inadequate collection storage facilities and curatorial programmes.
- Federal data / information resources are at risk of being lost or severely degraded over the next 2 - 5 years without intervention.
- Data is scattered across and throughout departments in various formats, in hard and digital copy.

Actions Needed:

- Secure, A-based, funds are needed for partners to rationalize collections holdings and develop appropriate facilities and programmes to preserve these “national treasures” and to convert this information to a standard digital format. This includes:
    - data standards
    - computing resources
    - collection storage facilities

Organizational Infrastructure

Challenges

- Biosystematics is linked to many other federal objectives and programmes. The effectiveness of FBP has been limited by uncertainty about its scope and linkages to other federal programmes.
- No single Canadian institution will have sufficient resources to operate a comprehensive national programme.
- All partners agree that sharing data between partners is a win / win, but barriers presist.
- A founding objective of FBP is to increase awareness to ensure adequate support to the federal programme, this has not happened.
- The federal programme has deteriorated significantly over the last 10 years with serious financial and public policy implication.

Actions Needed:

- The scope and mandate of FBP needs to be reviewed and approved by the Science ADMs, then ratified at the Ministerial level.
- An effective governance structure is required to revitalize FBP.
- On-going leadership / involvement is required at the ADM level.
- Strategic partnerships and mechanisms to manage these relationships are required.
- The policies for sharing data / information, particularly the cost recovery aspects, should be reviewed to support partnership.
- A communications and awareness programme should be developed and put in place.
- With cooperative financial support from partners, a Memorandum to Cabinet, to secure permanent resources for the decentralized federal biosystematics programme, should be developed and tabled within two years.

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Purpose

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Introduction

The non-human living "things" that make up what Canada is are referred to collectively as biological diversity. This *biodiversity* is recognized as an important national asset with significant economic, social and environmental value. Attempts are presently underway to value Canada's range of biodiversity in economic terms; however, a broadly supported approach to such quantification has yet to emerge. Experts do agree, however, that Canada's biodiversity is a primary source of inputs to the national agricultural, pharmaceutical, cosmetic, nutriceutical, natural health food and tourist industries. Moreover, ecosystems are important natural capital, which comprise innumerable combinations of biodiversity that provide services such as air and water purification, which are invaluable.

Biodiversity exists in three forms: genes, species and ecosystems. The organized study of biodiversity that seeks to recognize and identify organisms at the species level and to understand evolutionary and adaptive patterns and characteristics is known as *biosystematics.* Given the important role that biodiversity plays in the Canadian economy, biosystematics research is foundational to the sustainable use of Canada's limited stock of this natural capital and, hence, to a healthy economy over the long term. The federal government plays a number of key roles in protecting and exploiting biodiversity, including: primary research; monitoring and reporting at the national level, programme coordination amongst provincial, aboriginal, academic and NGO stakeholders; regulation in areas of federal jurisdiction and international negotiations.

Biosystematics is fundamental to effective and efficient operations pertaining to the federal role. Clearly, the saying you can't manage what you can't measure is applicable to federal biodiversity programming efforts in that it is impossible to manage what you can't identify, and biosystematics is at the heart of biodiversity measurement.

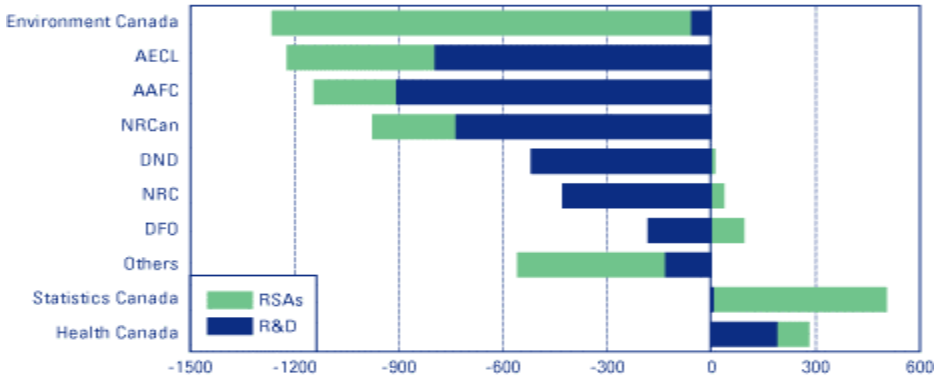
Background

In 1992, Canada became the first country to ratify the United Nations Convention on Biological Diversity. In 1993, the national Biodiversity Advisory Group made up of industry, academia, NGOs, aboriginal groups and governments, from all levels, came together to help guide the development of the Canadian Biodiversity Strategy, which was published in 1995, at the height of Programme Review.

Priority for expenditure reductions within Programme Review was focused onto areas that did not deliver *direct* services to the public. Science programming was hit hard:

> "… the departments most affected are those with mandates in the resource and environment sectors. Of the 15 largest federal S&T funders, two, Environment Canada and NRCan, have had their expenditures reduced by more than one quarter since 1993-94. DFO has decreased its S&T spending by 18%, AECL by 11% and Agriculture and Agri-Food Canada (AAFC) by 10%. These expenditure cuts have been accompanied by large reductions in the size of their S&T"[4]

Figure 4: Change in Size of the Federal S&T Work Force Between 1993-94 and 1998-99



Source: Statistics Canada
RSA – related science activities

[4] Building Momentum: A Report on Federal Science and Technology, Industry Canada, December 2000

Fallout from Programme Review was particularly damaging for biodiversity and biosystematics programming in federal departments. At the time, economic and social linkages to biodiversity were not well understood or defined, and during the mid-to-late 1990's biosystematics capacity was severely eroded.

Seeking to protect remaining biosystematic assets and reclaim lost capacity, several science-based departments and agencies established a partnership to help rebuild the federal programme. In 1998, the Federal Biosystematics Partnership (FBP) was formed through a Memorandum of Understanding. The purpose of the Partnership is to collaborate on research initiatives, undertake technology and knowledge transfer, raise awareness within government and the public of the importance of biosystematics, and ensure that biosystematic resources are effectively mobilized and deployed.

Recently, partners have undertaken an assessment of their programming needs and provided these studies to the FBP. The FBP, in turn, has commissioned this study to up-date the individual assessments and present a standardized summary assessment on the status of biosystematics programming within each of the partner organizations (Annex B), consolidate the findings into a federal assessment (Annex C), and outline the way forward to address gaps that have been identified as part of this process, (see page 12). This initiative is sponsoured by the Canadian Information System for the Environment (CISE) office at EC, administered by the Museum of Nature and guided by a steering committee from the Museum and CFS of NRCan. An interim report was tabled with members in late April to stimulate discussion and feedback from partners. Findings were presented and discussed during a regular FBP meeting, 21 May 2002, and Partners provided detailed refinements to their summary assessments following the meeting.[5]

[5] Due to issues beyond their control neither AAFC or PC have been able to provide final comments on their summary assessment at the time this version is being published.

Discussion

Biosystematics programming is very important to sustain biodiversity assets for the long-term health and prosperity of Canadians. Short-term economic imperatives led to the drastic reduction of biosystematic capacity in the 1990's. It is longer-term economic imperatives that drive the rebuilding of this programme

The rebuilding effort is complex. Past events and partners with differing mandates, which drive different values, create a multi-dimensional scientific, institutional, organizational and financial environment. This study is a first effort to baseline the operating environment so that threats and opportunities can be identified and a pathway forward defined.

As with many areas to federal scientific programming, many weaknesses are evident, including attracting, hiring and retaining quality scientists; identifying and funding timely research initiatives; balancing and coordinating internal and external science capacity, etc. Biosystematics, however, is a relatively small, high-value and specialized science. As such, it is affected by several unique challenges and it is these challenges that must be specifically addressed within an overarching federal science programme. This report and the recommendations contained within assume that recommendations put forward by the Council of Science and Technology Advisors, and the commitments to enhance national science capacity within Budgets 200 and 2001, apply equally to biosystematics.

Having said this, the issue of equitable funding to biosystematics is a principal concern and at the root of several, but not all programme weaknesses. Presently, federal biosystematics programming receives less than .5% of federal science funds.[6] This issue must be placed front and centre in discussions with Science ADMs.

[6] Natural Resources Canada, Canadian Forest Service, Biosystematics – Bioinformatics Needs Assessment, January 24, 2000, p.9

Strategic Framework

This study updates the individual departmental assessments, which were completed over the past 24 months. These assessments are consolidated and presented as a "federal overview", so that review and decision-making can be undertaken from the top down. Such an approach is required to rebuild biosystematics capacity so that programme resources can provide timely and effective integrated policy-science advice and guidance to address emerging and on-going threats, such as:

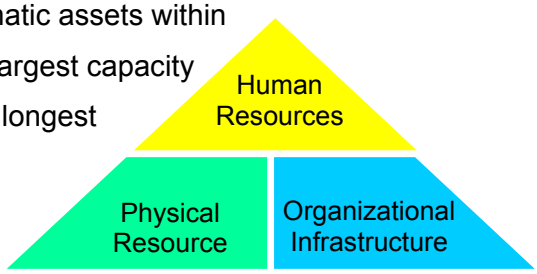
- perforation of non-tariff trade barriers
- threats to agricultural and resource-based industries from alien and invasion organisms
- threats to environmental and human health

This study also puts forward an action plan to create sufficient biosystematics capacity to operate an effective / appropriate federal programme, including internal capacity and internal / external linkages. The plan includes "defensive" actions to stem current asset loss and "offensive" undertakings to rebuild capacity, where necessary.

International tribunals associated with trade agreements are making trade decisions based upon biosystematics evidence, with potentially severe consequences for Canada. Recently, farmed salmon, PEI potatoes and lumber have all been targeted as "contaminated" and barred from import. Tribunal hearings are largely based upon the testimony of internally renowned experts. Canadian experts of this calibre are retiring or leaving government at an alarming rate.

The short term is defined as two years. During this phase, partners will complete and approve the plan, including collaborative funding (in terms of both internal human resources and O&M resources) for common objectives. Partners will also begin addressing many of the long-term issues within this two-year timeline; however, it is understood that results in these areas will not immediately forthcoming. Underpinning this approach is a sense of "guarded urgency".

The framework used to identify biosystematic issues and the framework upon which the action plan is based has three principal elements:



Human Resources are the most important biosystematic assets within the framework. This is also the element posing the largest capacity gap. Development of capacity in this area takes the longest and is potentially the most expensive, but critical to programme success, given that these assets are the source of creativity and innovation, a key component to the government's Canadian Opportunities Strategy. Human resources contain the largest part of intellectual capital. In a global knowledge-based economy, people come first. Federal intellectual capital in biosystematics is fundamental to knowledge accumulation and, ultimately, prosperity.

Physical Resources include collections of millions of irreplaceable specimens (plants, manuals, insects, fish, etc., some dating back over one hundred years), buildings (offices and laboratories and adequate storage facilities for specimens) and computers (hardware, software, data storage capacity and communications networks) needed to store, enhance and share information. These physical resources provide an important part of the platform from which the federal biosystematics programme operates. Shortcomings within this strategic component present a "limiting factor" to the more expensive human resource element.

Organization Infrastructure is the other part of the platform that supports the federal programme. To this point, it has been largely ignored, and departments and agencies have been operating mostly independent from each other. This is driven, in part, by an acute lack of resources for biosystematics and has engendered a competitive rather than a collegial operating environment within the partnership. This study creates a programming milestone that creates a watershed from which a more collaborative and cohesive programme flows. Organizational infrastructure will not materialize without effort, commitment and respect. The established MOU presents a starting point from which departments and agencies can organize, but much more work is required in this area.

Strategic Issues

The most significant issues are discussed below. A full listing and discussion of all issues identified during this study are outlined in the following section: *Assessment of Gaps and Recommended Remedies*.

Human Resources are practically irreplaceable within the programme, and threats to programme integrity come from several quarters. As with most professions, the succession gap is vast. As specialists retire, there are few younger scientists to fill the void. At CFS, the average age of systematists is 56; none are under the age of 45. This problem is exacerbated by declines in two other related areas. First, few young people are entering the field because of limited career possibilities and second, universities are not attracting new professors to maintain programmes for this reason. Presently, there is only one doctoral candidate in Canada. A new threat is also emerging. With recent growth in the biotechnology sector, the federal government is losing early and mid-career scientists.

Data is the lifeblood of the programme. It is present in many forms - some more resilient than others. Biosystematics data is contained in field notes, photographs, maps, specimens and digitized graphic and text records. This information is scattered across countless personal computers, file cabinets, storage lockers and basements of federal buildings. This represents the record of non-human life in Canada and, as such, is a national treasure. This treasure is presently neglected, and parts of it are being lost day-to-day.

At CWS a retiring scientist expressed concern about the potential loss of 35 years worth of data collection. A project was established to digitize survey and field note data, averting the loss of a $2.8 million investment. ($80K/yr. X 35yr.)

Biosystematics, as mentioned above, is a “data heavy” science. From DNA sequences to the size of detailed computer images; capturing, storing, transmitting and using this data presents a range of special problems. Biosystematics record keeping is so specialized that a new science has grown up around it. *Bioinformatics* is the application of information technology to biology (from genes to ecosystems) with the emphasis on persistent data stores. This includes research on, development of, and use of technological, sociological, and organizational tools and approaches for the dynamic acquisition, indexing, modeling,

dissemination, storage, querying, retrieval, visualization, integration, analysis, synthesis, sharing (including electronic research collaborations), and publication of data and information such that economic and other benefits may be derived from them by users in all sectors of society.

Data standards to ensure consistent and comprehensive documentation and facilitate interoperability are one of the most pressing priorities for the federal biosystematics programme. A weakness of the current programme is the lack of digital data. This prevents data transfer and mitigates against collaborative data enhancement. In as much as this is a fundamental weakness, it also provides an opportunity to create standards, at an early stage of digitization, through which data can be effectively transferred and shared, not only amongst the federal partners, but also amongst national and international partners and stakeholders. On the surface, data standards may seems straight forward to develop, however a variety of operating systems and data configurations present an imposing challenge to negotiate a federal standard that will mesh with non-federal and international partners and stakeholders.

The “Darwin Core” is internationally recognized as essential data and provides guidance to basic data structure within each record. Partners also need to identify the minimum national and international requirements for data structure before creating a federal standard. Such a standard is essential to facilitate collaboration, but it goes hand-in-glove with broader policy and cultural issues pertaining to data. Cost recovery for provision of federal data is a barrier to formulation of non-federal partnerships - partnerships that offer the potential to greatly enhance the value of existing data. Also, policies that embody organizational and institutional values need to be revisited to ensure that they embrace and foster collaboration on a global scale.

Bioinformatics (or biomatics) capacity is fundamental to preserving, enhancing and sharing biosystematics information. The informatics components of the federal programme are contained within the Physical Resources component of the strategic framework. Effective bioinformatics programming requires specialized computers, software, storage capacity and transmission facilities. More important than the physical resources, however, are the human

resources that need to be developed. Bioinformatics is a very specialized field of information management and requires specific attention within any human resource development strategy.

There is presently an absence of operating standards amongst federal departments and agencies for sharing of information and materials, accepting new or transferring materials, converting data to digital format and capturing new information. Standards for federal data structure (i.e. the Darwin Core) provide for inter-operability and improve the efficiency of information management functions at all levels, across all departments and agencies. Most partners agree that this is a very high priority for the FBP. As the FBP work plan "rolls out", issues such as this will be addressed in priority and, as such, provide assurance that any new resources will be attributed to the highest areas of risk.

Collection storage facilities are specialized climate controlled spaces that protect specimens from deterioration (humidity, parasites, mildew and fungi), while facilitating ready access to the material. With few exceptions, departments do not have adequate facilities to safeguard their specimen collections. These collections represent a huge federal investment in field research and documentation. Moreover, many date back over a century and as such are irreplaceable historical artifacts that are unique in the world. These are truly national treasures that are, for the most part, deteriorating in scientific and cultural value, day-to-day.

A-based funding of biosystematics programmes within departments has been significantly reduced over the past ten years. Lack of adequate financing has led to significant human resource problems, as well as, losses and on-going threats to the health of federal specimen collection assets. Moreover, the lack of adequate biosystematics capacity means that existing resources tend to focus on "burning issues" relating to trade disputes, human health risks, etc., and can not implement a strategic research agenda, including the development of partnerships.

Leverage remaining assets / expertise and systematics resources is key to bridging the current capacity gap. Budget cuts have eroded capacity over the past decade and "brain drain" and data[7] decay continue. In order to optimize existing federal resources biosystematics some practitioners have suggested there is a need to begin the rebuilding process through collaborative efforts, including:

- development of stronger networks,
- improved lateral movement of expertise across departmental boundaries,
- placement of collections strategically where they will receive the greatest care and use and where information relating to these collections can be best accessed partners.

The *federal biosystematics programme* is the combined departmental programmes. Presently these are developing at different rates and in different directions. This is a significant threat to effective federal biosystematics programming. The programme is, by and large, uncoordinated and disconnected. Improved strategic planning and coordination of limited resources will improve performance and hence return on investment. Many of the issues outlines below are significant public policy challenges and will take several years of persistent energy and resourcing to resolve. However, there are several low cost / short term actions that can be taken to "stem the bleeding" of biosystematics expertise and data assts from the federal system.

Issue Summary

Short-Term

- confirm FBP mandate
- fully quantify departmental needs
- financial management plan
- build networks
- implement communications plan
- data / metadata standards
- memorandum to Cabinet

Long-Term

- programme delineation
- HR strategy / NSERC
- collections inventory
- data conversion
- computing capacity
- collections storage
- federal partner strategy

[7] Biosystematics data takes many forms, including, field notes and photographs, specimens, hardcopy files, digital text and images as well as samples and sequences.

Federal Biosystematics Partnership

An Assessment of Gaps and Recommended Remedies

Summary Table

Issues / Gaps	Description	Action Required	Link	Priority	Lead
A. Human Resources					
1. Loss of Expertise	The federal government is losing its early-career systematics expertise to other countries and the private sector due to constrained career opportunities. Many other scientists are nearing the end of their careers. Most systematists are in their late-forties to mid-fifties.	**The loss of expertise is based in the reduced career opportunities for systematists.** This is potentially the greatest threat to the federal biosystematics programme and can only be solved within a meaningful and sustained biosystematics programme at the federal level.			
2. Reduced Career Up-take	Fewer students are entering the field of taxonomy because of the reduced career opportunities mentioned above.	**Committing long-term resources to permanent positions** within FBP departments and agencies is the only solution to this problem.			
3. Reduced Training Capacity	As fewer and fewer students register for graduate and post-graduate programmes, and combined with an aging teaching population, universities are reducing programmes.	**This issue is directly related to 1 & 2**, above. An NESRC chair would help to draw attention to this problem.			
4. Limited Skill Mix	In consideration of 1-3, above, Canada has lost specialization (Ph.D.-level research capacity) across all taxonomic groups.	As per a 2 & 3, above.			
5. Lateral Movement of Human Resources	In consideration of the need for coaching and mentors, and the need to place expertise in the highest priority areas, it is desirable to develop mechanisms that permit and facilitate lateral movement of human resources.	Biosystematics expertise is a valuable asset within the federal system and should be treated as such**. A detailed inventory of experts should be created and a long-term plan** (10 - 15 years) developed to attract new resources and encourage strategic placement of these resources.			
6. Attracting New Biosystematists	The demand for biosystematics expertise is rising. As noted in A 1, Canada is losing biosystematic expertise at the mid-career level. In order to meet the rising demand for systematists, the federal government must act soon to attract new biosystematics talent.	This objective can only be met if **A-based resources are committed to permanent positions** throughout the federal system, both in the NCR and the regions.			

7. Working with Non-Federal Partners	In the area of systematics, timely access to the world-wide system of experts is very important. With strategic placement of collections and with a partnering strategy in place, FBP will need to both attract and work more closely with experts from non-federal partners, retired and former federal staff.	**Develop a strategy that identifies areas where external expertise is needed / appropriate**, where to place and recruit internal expertise, how to approach external resources and agree who would approach them. This item links to the requirement for office / lab space.			
8. Growing Bioinformatics Capacity	Over the medium term, partners will be converting hardcopy data and standardizing digital data. This will create the need for specialized informatics professionals.	**Permanent conversion and maintenance programmes** will attract expertise in this area. Hardware and software standardization will facilitate a federal specialization that is functional and mobile across departmental boundaries. Information management is a huge body of knowledge and area of study within which biosystematics is under represented in Canada. Although NSERC has placed a high priority on this area, departments must take the initiative to **work with undergraduates** to help build capacity in this area.			
B. Physical Capital					
1. Data	Systematics data is scattered across and throughout departments. Data in hardcopy (paper files, maps, sketches and photographs) format is aging and at risk of deterioration. As well, it cannot be shared or easily verified or enhanced. Any digital data is in a number of formats, residing on individual PCs and servers.	The first step for consolidating **data holdings is inventory** and prioritization. **Standards** need to be established for this project in order **to initiate metadata development**. DFO has developed a "**Data Rescue" programme**. The programme identifies priorities for data capture, conversion and standardization. It will be funded as resources become available. This **model should be reviewed and adapted as applicable** amongst partners A real threat to data enhancement and optimization stems from cost recovery requirements. It has been suggested that **federal biosystematics information holdings** would be vastly increased in value if they were **provided freely under tight controls**. Therefore the federal cost recovery policy on this data should be reviewed and revised to facilitate partnering.			
2. Computer Hardware	The federal government is constantly upgrading its computer hardware. These types of acquisitions do not consider, however, the specialized computers required for three-dimensional modelling, data storage, transmission and retrieval, etc., of metadata detailed biosystematics data.	**Consist standards are important to expertise development, sharing and cost effective operations**. Since partners are beginning to acquire specialized computing tools in the area of bioinformatics, establishing a standard that encourages interoperability in this area should be a very high priority for FBP.			
3. Computer Software	FB Partners have made little progress in this area, and this provides an opportunity for standardization that should not be missed.	A study should be undertaken to **determine the collective strategic objectives of partners and a standardized approach to software acquisition should be developed** at the federal level and implemented locally as funds become available. **Discussions with suppliers may evolve to the "partnership" level** over time, to explore opportunities for pilot projects involving new technologies and the timely acquisition of hardware as funding opportunities occur. Recent events at the Museum may provide a model for such partnerships.			

4. Data Storage	Sophisticated software (e.g. 3D models and DNA sequences) will require very large server capacity.	**Storage space requirements should be predicted for all NCR and regional facilities and time-bound targets for acquisition of this space should be set, to facilitate planned and opportunistic procurement.** These estimates should be based upon the software platforms required by individual partners needs for data capture / conversion.			
5. Communication Networks	At this time, a decentralized network is assumed. Data will be stored locally (i.e. at NCR and in regional facilities) and distributed to users via the internet. Bandwidth limitations outside of large urban centres will constrain implementation of this strategy.	**A medium-term plan for connectivity should be developed** once data storage needs are more fully understood. This should be done in full consultation with service providers. This plan should consider emerging wireless technology and potential "high tech" partners.			
6. Data Entry / Conversion Protocols	Biosystematic information presently exists in three formats: paper, specimen and digital. It is clear that this information must be standardized in order to conserve, protect and enhance it. As previously mentioned, the lack of progress in this area may prove to be an advantage, as it means that partners are more likely to negotiate and refine their current format, than if they had sizable data holdings in an established departmental format. Development of a standard approach to data entry / storage is essential for domestic and international data sharing and enhancement. Moreover, the Global Biodiversity Information Facility agreement (signed by Canada in March 2001) requires that Canada make strides in this direction.	**A task force, led by AAFC** (Larry Speers is the GBIF data standards liaison), and comprised of Partners and non-federal representatives, should be struck immediately and given the mandate to **develop a Canadian standard for biosystematic data collection / conversion**. The Canadian standard must consider emerging international standards.			
7. Laboratories	Laboratory space is not an issue; however, the state of equipment and the infrastructure (electrical, cabling) required to accommodate modern systematics technology will need upgrading.	**Development plans on a facility-by-facility basis will be required.**			
8. Collection Storage Space	With a few notable exceptions,[8] the quality and quantity of storage space is an issue. Presently, federal facilities cannot accept "orphaned" collections because of limited space and inadequate storage conditions. This jeopardizes the health of and access to established collections.	After collection "rationalization" and "strategic placement" of existing specimens / collections and after discussions with non-federal partners have been concluded, a better understanding of space requirements will permit the **development of space quantity and quality estimates at each facility**.			

[8] High quality storage space is at a premium nationally. The relatively new CMN research facility has some surplus capacity and the AAFC Eastern Cereal and Oilseed Research Centre is over capacity.

9. Office Space	Although this issue varies in degree from department to department, the amount of office space at each facility limits permanent and visiting researchers.	As with other space requirements, several other aspects drive the need for office space, as outlined above. There is a widely supported view that **Canada needs a national facility as a focal point for federal biosystematics programming**.			
10. Specimen Collections	By any definition, these collections are one of Canada's national treasures. The collections in many facilities, however, are neglected and deteriorating. In many cases, these specimens are over 200 years old and provide unique opportunities in the areas of genetic research and natural history interpretation.	**A significant resource infusion is required** to address this problem; however, any estimate would be a guess in the absence of a detailed inventory, including standard criteria for establishing the current condition of specimens, their importance to the host organization, requirements for storage and maintenance and any rehabilitation. Such **an assessment framework should be established and an inventory undertaken**.			
11. Specimen Transfer Protocols	As the national collection is rationalized, there will be a need to transfer specimens to and from both federal and non-federal partners.	**Long-term custodial terms and conditions** should be established that include care and data capture / sharing. The Smithsonian Institute offers such an approach within its *Off-Site Enhancement Program*.			
12. Specimen Sharing Protocols	Clearly, no one organization can afford to support a full range of biosystematic activities, across all taxa.	In consideration of "FBP governance", below, there is a need to **develop policies and procedures to facilitate sharing and growth of specimen collections and data**.			
13. Federal Collections Inventory	With few exceptions, there are no comprehensive departmental inventories of specimens and, therefore, no "federal" inventory of collections can be created. Moreover, there is no sense of the nature of the requirement for such collections at the departmental level.	**A multi-phased approach is required**: 1. Partners should discuss and commit to streamlining the federal collection, where possible. 2. Based upon current and anticipated needs, each partner should establish their optimal collection holdings. 3. Partners should undertake an inventory of the composition and condition of their collections. 4. A gap analysis to determine what areas of the federal collection are lacking should be undertaken. 5. A strategy to work with federal and non-federal partners to close the gap should be determined.			
14. Strategic Placement of Resources	Presently, specimen collections are scattered throughout the federal system and receive varying degrees of care. The composition of these collections has evolved in an opportunistic manner and, as such, they contain a wide range of items that, in many cases, relate loosely to the research mandates of the host departments.	**Existing specimens need to be located where they will offer the greatest opportunity for use, receive the most care, and be properly documented for sharing with partners and stakeholders**. Based upon the federal inventory, above, and the policies and procedures discussed in section C, below, partners need to determine and negotiate long-term custodial responsibility for the federal collection. FBP and their non-federal partners should discuss and agree to a matrix of "nodes of expertise", where different portions of the federal collection ultimately should be housed.			
15. Links to Partners	Once the roles and responsibilities of the various FBP members have been clarified, there is a need to articulate, consult, document and then formalize the working relationships with NGO, institutional, provincial and international partners.	**Part of the FBP work plan includes developing and nurturing working relationships** with non-federal partners. A "partnering strategy" should be developed and implemented upon the relative strengths of each partner.			

16. Financial Management	Biosystematics is not a "line item" within Partner business plans. Therefore, resources that support systematics work in most departments are taken from other budgets or are provided from year-end slack. This means that there is no financial stability in systematics programming, making effective planning impossible. Moreover, because systematics is not considered within the business planning process targets and accountabilities are not set and performance is not monitored or reported. This means that biosystematics is not included in any substantial way within any *Departmental Performance Report*.	**Responsibility Centres within FBP departments need to establish a systematics component within their business plans** and include a line item in their budgets in support of this work. A financial management framework, i.e. the nature of resources to manage systematics assets and requirements, should be discussed and identified by FBP to ensure commonality within the federal financial management process. **Money can be transferred between departments in support of initiatives that support common priorities,** once the financial management structure is in place, and programme component / project leaders are identified. **The financial management strategy should contain a short-and long-term component**. In the short term, partners should create and contribute to a consolidated fund to finance the development of an MC and TB submission.			
C. Organizational Infrastructure					
1. FBP Raisond'être	FBP was formed in 1995 to deal with specific issues relating to biosystematics, at the federal level. Since that time, the priorities and the complexity of issues have magnified substantially. Although important to the biodiversity file, several FBP members have suggested that the mandate of the partnership is too limited to garner meaningful support at senior levels. It has been suggested that limiting the scope of FBP to biosystematics and related informatics issues mitigates against a wholesome treatment of other pressing biodiversity issues, such as alien species, ecosystem health, etc.	**The FBP Board, consisting of the Science ADMs** and senior managers from the Museum and Parks, should meet to discuss the validity of FBP in its current form. A briefing note should be prepared beforehand, and several options put forward, including: ♦ expanding the mandate beyond biosystematics to include other aspects of biodiversity programming ♦ consolidate the mandate and build linkages to emerging groups, such as BKIN ♦ dissolve the partnership			
2. Conflicting Values / Culture	Partners hold collections and data and undertake research for different reasons. For example, the Museum values a wide range of holdings within its natural heritage collection for the purpose of research and interpretation, whereas AAFC and NRCan are focused on commercially important specimens for active research and development. Different goals support different values and these can be an impediment to collaborative programming. Also, partners have been competing with each other for small "pots" of money over the past ten years. This has not encouraged collegial working relations among partners.	**Transparency** is important to address these concerns, particularly since jointly funded initiatives should seek to address collective priorities. Partner values need to be identified, d**ocumented and translated into operational mechanisms (i.e. mission statements, goals, objectives, priorities and work plans)** that ensure common resources are committed to collective priorities.			

3. FBP Governance	The FBP is formed under an MOU, which commits partners to share information and collaborate; however, to date, there is no formal structure beyond a chairperson. Meetings are convened bi-monthly or quarterly, and no governance instruments beyond the MOU have been put in place. The Partnership has no operating budget and operates essentially on the goodwill of the members.	**Ministerial endorsement** for FBP is required to secure a legitimate operating licence. **A governance structure** is required so that partners can optimize individual strengths, plan resource commitments, and work independently within a coordinated framework. An **annual report** on activities, accomplishments, plans and priorities should be t**abled with the Science ADMs**. **Health Canada, the Food Inspection Agency and the National Research Council** should be formally approached to become active members of FBP.			
4. Policy / Science Linkages	The Council of Science and Technology Advisors[9] have identified priorities and issued clear guidance on how scientific information is best considered within the policy process. This applies directly to biodiversity and specifically to biosystematics activities.	Implementing this **FBP "work plan" will ensure that the federal biosystematics programme confirms fully with** recommendations and guidance set out in the **SAGE report**. Implementing these recommendations assures partner departments and agencies that they are conforming to SAGE principles in the area of biosystematics.			
5. FBP Work Plan	Due to the highly decentralized nature of the FBP, initiatives are not well coordinated, nor strategic from a federal or national perspective. They relate mostly to the individual mandates of the host department or agency.	**Creation of a broadly supported work plan** is vital to effective partnering. Moreover, the work plan provides a mechanism to seek new funding through existing channels, as well as take advantage of short-term / unexpected funding opportunities. This "summary table" provides the starting point for development of such as plan.			

[9] Science Advice for Government Effectiveness (SAGE), A Report of the Council of Science and Technology Advisors, 5 May 1999.

6. FBP Roles & Responsibilities	Partners hold different expertise and physical resources; however, these cannot be optimized since a clear path forward has not been articulated.	**Clear roles and responsibilities** need to be assigned within the FBP work plan for effective partnering, to avoid duplication and overlap, and also to benefit from opportunities residing with non-federal partners.			
7. Leadership	Leadership is lacking in two areas. There is no senior manager (ADM) to lead / champion the file. Of equal importance, senior managers do not attend the semi-annual meetings to review progress, assign priorities and direct resources.	**A Science ADM needs to take on FBP leadership** for a two-year term. This individual would chair FBP meetings, coordinate financial management, facilitate preparation of central agency-related documentation and represent the federal programme national and internationally. **Attendance at regular meetings by Directors**, or their delegates, is an effective way to manage initiatives and share information and resources; however, it is critically important that **Science ADMs attend the bi-annual review meetings** (re: governance, above).			
8. Future Leaders	Over time, health and stocks of Canadian biodiversity will likely decrease to a "crisis" status, which in turn will generate the requirement for significant leadership. It is important that future leaders be aware of the important economic linkages and that they have a clear understanding the many and varied issues around biosystematics.	**Communications should be included as an on-going item** within the FBP work plan. One of the objectives of the original MOU was to raise awareness and support through communications – this was never done. The communication plan should outline the importance of systematics to biodiversity and target emerging senior managers to insure on-going future support to the federal programme.			

Conclusions and Next Steps

This report provides a “snap shot” of the various partners’ biosystematics programmes and the federal programme as a whole. Clearly, partners within the FBP believe that changes are required to enhance the effectiveness of FBP. This report identifies a range of issues that are barriers to improvement and offers several opportunities to improve the federal programme.

An FBP meeting will be convened in late July 2002, to discuss next steps. Presently, it is suggested that identification / confirmation of the FBP senior management champion (ADM) or champions should be followed closely by a workshop at which the action plan will be finalized and accountabilities assigned.

ANNEX A

Federal Biosystematics Partners
Memoranda of Understanding

Note: portions of this Annex contain confidential financial information and have been removed

MEMORANDUM OF UNDERSTANDING

between

AGRICULTURE AND AGRI-FOOD CANADA
CANADIAN MUSEUM OF NATURE
FISHERIES AND OCEANS CANADA
ENVIRONMENT CANADA
AND
NATURAL RESOURCES CANADA

Hereinafter referred to as the **Federal Biosystematics Partnership (FBP)**

Whereas the Government of Canada is committed to implementing the Convention on Biological Diversity and using the Canadian Biodiversity Strategy as a guide to its actions; and,

Whereas the Government of Canada is committed to identifying exotic diseases and pests of importance to agriculture, forestry, fisheries, and other resource sectors, in order to prevent their entry into Canada and control their spread; and,

Whereas a knowledge of systematics is of fundamental importance for Canada's rapidly growing biotechnology industry, and for the sustainable management of Canada's biological resources.

Purpose

The undersigned Parties will undertake collaborative endeavours including but not limited to research and technology transfer, to ensure that the importance of biosystematics is recognized, emphasized, and supported in Canada; and, to ensure that biosystematics expertise is effectively mobilized or deployed.

Principles

The legal and regulatory mandates and corresponding responsibilities of each Party will be respected and mutually supported.

Work Plans or Action Plans containing specific research, technical or operational details will be produced by the FBP. These then become parts of this MOU.

No Party shall take positions on behalf of the FBP without prior consultation and agreement of the other parties.

Where possible, Parties are to share and/or exchange data, resources, personnel, facilities or services to achieve agreed-upon plans and objectives in support of biosystematics activities.

Parties will promote biosystematics through communications and publications; striving to maximize efficiency, impact, and output.

Parties will promote education and professional development in biosystematics.

Parties will aim at the standardization of collection-based information.

The FBP will encourage and facilitate where possible, liaison between partners in the Canadian and international biosystematics communities; promoting complementary activities, coordination, cooperation, and avoiding overlap and duplication of work.

The FBP will provide a national focal point for Canada's participation in international biosystematics undertakings, including, *inter alia*. sharing of data and information, and standardization of nomenclature.

Provision

1. The FBP shall be managed by a committee and appropriate representation from each Party. Members shall select a chairperson to serve on a one-year rotation.

2. Each signatory to the MOU will identify appropriate representative(s) to sit on the committee.

3. The FBP shall meet at least annually or as needed, at the call of the chair or upon request by and of its members: to appoint working groups; approve action and project plans; select project leaders as required; ensure appropriate financial and administrative arrangements are in place; and monitor progress under this MOU.

4. The FBP will set up appropriate communication mechanisms for its operations, and each Party will take appropriate steps to communicate the FBP`s purpose and activities to the Canadian biodiversity community and other interested groups, e.g., animal and plant health/protection agencies.

5. The FBP will encourage the introduction of enabling technologies to increase access to biosystematics data and information.

The FBP will make provisions for inviting the participation of other agencies.

The FBP will be accountable to the signatories of this MOU.

.**Duration**

This MOU is of an unspecified term, but may be terminated or amended by anyone or more of the signing parties, upon written notification. Any signed subsidiary arrangements or agreements which commit resources to projects that are underway will remain in force until completion.

IN WITNESS WHEREOF, the following Departments have duly executed this Memorandum of Understanding:

Agriculture & Agri-Food Canada Canada

PER: _____
J.B. Morrissey
Assistant Deputy Minister
Research Branch
Agriculture & Agri-Food Canada

DATE: _____

Fisheries and Oceans

PER:_____
L.S. Parsons
Assistant Deputy Minister Oceans
Fisheries and Oceans Canada

DATE:_____

Canadian Museum of Nature

PER: _____
Joanne DiCosimo
President and CEO
Canadian Museum of Nature

DATE: _____

Natural Resources Canada

PER:_____
Yvan Hardy
Assistant Deputy Minister
Canadian Forest Service
Natural Resources Canada

DATE:_____

Environment Canada

PER:_____
Karen Brown
Assistant Deputy Minister
Environment Conservation Service
Environment Canada

DATE: _____

ANNEX B

Departmental and Agency

Summary Assessments

Canadian Museum of Nature

Objectives

The Canadian Museum of Nature (CMN) is mandated to increase interest in, knowledge of and appreciation and respect for nature, by establishing, maintaining and developing a collection of natural history objects for research and posterity.

Infrastructure

CMN has an extensive working collection, located at its research and storage facility on Pink Road in Aylmer, Quebec. This 20,478-square-metre facility includes 42 separate collection rooms and nine documentation rooms. There is also a permanent display collection located in the Victoria Memorial Building, 240 McLeod Street, in Ottawa.

Data

The Museum has an established programme of data capture (from non-digital formats) and conversion (from various digital forms) for biosystematic data. They are using a modified version of Multy MIMSY 2000. Presently, 467,000 records of a total 1.9 million have been converted to the new CSM standard.

Collections

In total the Museum cares for 24 major science collections of more than 10 million specimens. Paleontological specimens, minerals and all major taxa of plants and animals (vertebrates and invertebrates) are included in the holdings.

Staff

The life sciences research group maintains a permanent staff of eight research scientists (Ph.D. level), as well as research assistants (Masters level), collections specialists, and senior research associates (emeritus status). The current level of staffing represents just over 50% of 1990 levels.

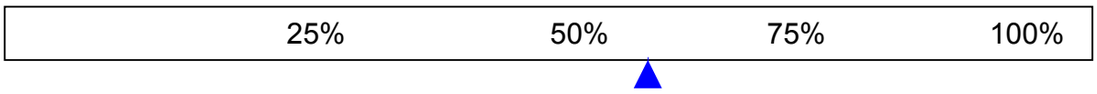
Issues

- Steady loss of research scientists, in particular the mid-90's; stable since then.
- Finite storage, research and office space mitigates against "adopting" orphaned collections.
- Limited financial resources to assist or participate in joint research / preservation off-site, with partners, especially work programs that occur at the national level.

Intellectual Capital: Permanent human resources capacity required to address mandated biosystematics-related responsibilities (i.e. Ph.D. expertise for all important taxonomic groups).

45%

Stock of Expertise: Current biosystematics staffing relative to 1990 level.



Working with Partners*:* Resources (agreements with partners, protocols for information /specimen /data exchange, "soundness" of network") necessary to optimize potential partnership relationships.

Biosystematics Data:

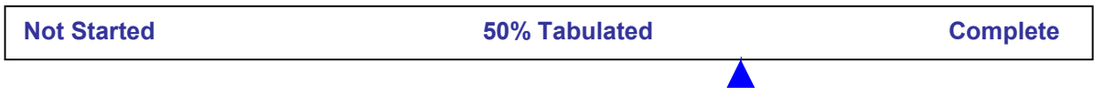
Permanent resources for data capture or conversion to standard format[10].

1 full-time
19 trained for part-time

Standard for the capture of new data or for conversion of existing digital information.

Yes

Extent to which biosystematics metadata has been entered.



National / department-wide mechanisms to transfer / share data with partners / stakeholders.

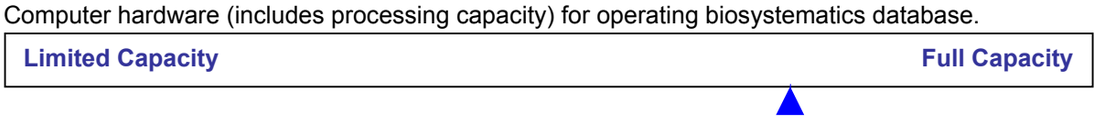
Yes

Computing Capacity:

Standard computing (hardware / software) configuration for data management.

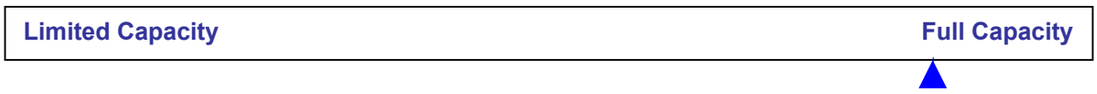
Yes

Computer hardware (includes processing capacity) for operating biosystematics database.

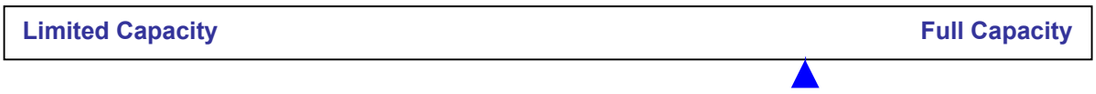


[10] For the purpose of this study, data exists in three formats: hardcopy, non-standardized digital and standardized digital. The overall objective is to convert all data to a single format.

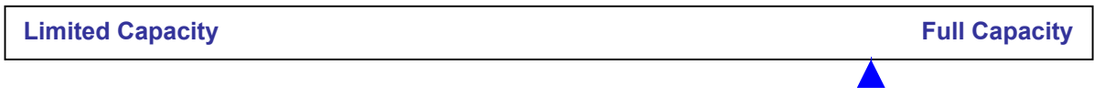
Computer software requirements for operating biosystematics database.



Data storage requirements for operating biosystematics database.

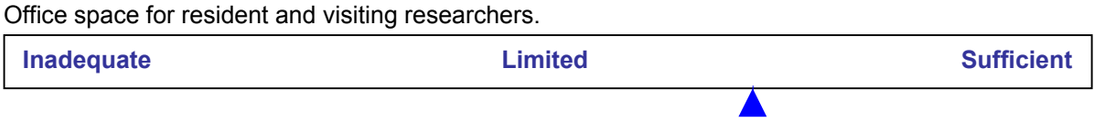


Data transmission requirements for operating biosystematics database.



Research Assets:

Office space for resident and visiting researchers.

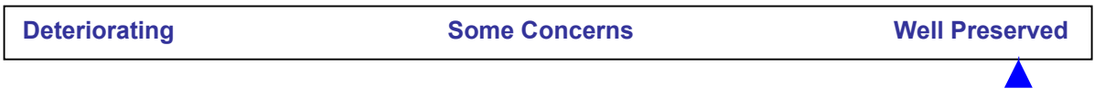


Laboratory facilities.

Collections storage space.

Extent of specimen collections relative to mandate.

Condition of collection(s).



Natural Resources Canada (Canadian Forestry Service)

Objectives

Research objectives for programming at the Canadian Forest Service (CFS) include research at the landscape, ecosystem, species and gene level. Special attention is paid to impacts of human activity and natural catastrophes, ecosystems at risk, alien forest pests and effective conservation measures of forest biodiversity.

Infrastructure

CFS has a decentralized research programme with five principle research facilities, including:

- Pacific Forestry Centre (BC)
- Great Lakes Forestry Centre (ON)
- Northern Forestry Centre (AB)
- Laurentian Forestry Centre (QC)
- Atlantic Forestry Centre (NB)

Other centres include the Corner Brook Research Division (NF), with links to: Nation Forest Insect and Disease Collection (ECORC) and the Petawawa Research Forest (ON)

Data

Data management is a significant challenge. When the Forest Insect / Disease Survey of Canada Database was recently moved from Petawawa to Fredricton the data was migrated to an Oracle platform This illustrated the numerous “broken links” between specimen holdings and data. Lack of full-time bioinformatics staff mitigates against timely up-date and on-going validation.

Collections

Specimen collections of diseases and pathogens, pests and their hosts are extremely important for research activities and provide information that is not easily stored in written or digital format. Regional collections are located at the Forestry Centres in BC AB, ON, QC, NB and NF. The CFS also contributes to the national entomological, mycological and fungal culture collections, located at the Eastern Cereal and Oilseed Research Centre, Agriculture and Agri-Food Canada (AAFC) in Ottawa.

Staff

CFS is responsible for research and knowledge transfer for 46 different taxonomic groups in forest entomology and forest mycology/pathology. Presently the Service has access to 17 research scientists with expertise for 22 different taxa. Typically, CFS staffs one entomologist / mycologist and one technician for each research centre. There are three scientists on permanent secondment with Agriculture and Agri-Food Canada at ECORC, who conduct research on specific entomological groups and care for the forestry portions of the Canadian National Collection, which is located at AAFC. There is no CFS presence in the mycological discipline to work with the forestry material contributed to the Mycological Herbarium (DAOM) or the Canadian Collection of Fungal Cultures at ECORC.

There is no CFS taxonomic expertise in nematology (the pinewood nematode was a major international plant quarantine issue in the 1985-1995 period). There are currently no nematological systematists working at either AAFC[11] or at CFS.

Issues

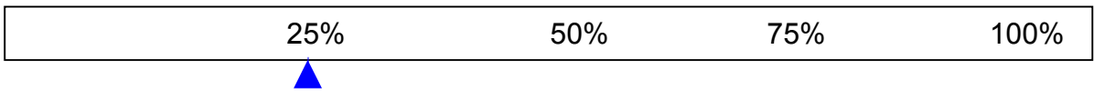
- Research programmes have very little operating budget which with to undertake new research projects.
- Lack of biosystematics capacity exposes Canada to non-tariff export barriers.
- Void in capacity to undertake research in the area of terrestrial fungi, arthropods and diagnostics, particularly relating to alien species.
- Incomplete identification and documentation of voucher specimens. In many sub-disciplines there are no Canadian specialists who can authoritatively identify material. Collected material must often wait for decades for another specialist to be developed, trained and employed.
- Most of the regional entomological, mycological and other arthropod collections have only a small portion of their holdings authoritatively identified by specialists.
- Many collections have only part of their holdings captured electronically. Most still rely on index cards, accession books, maps. For many species, current and accurate distributions can only be captured by exhaustively searching collections, re-identifying specimens and validating previous records.
- Living culture collections have already been abandoned or are at immediate risk at most centres.

[11] (Unless two lost resources from AAFC have been replaced very recently)

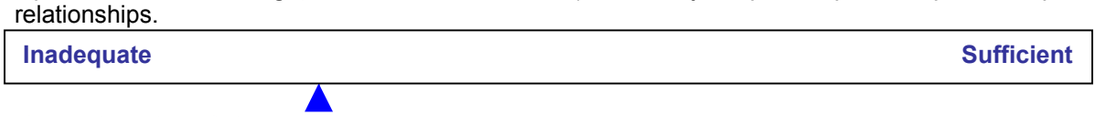
Intellectual Capital: Permanent human resources capacity required to address mandated responsibilities (i.e. Ph.D. expertise for all important taxonomic groups).

45%

Stock of Expertise: Current biosystematics staffing relative to 1990 level.



Working with Partners: Resources (agreements with partners, protocols for information /specimen /data exchange, "soundness" of network") necessary to optimize potential partnership relationships.



Biosystematics Data:

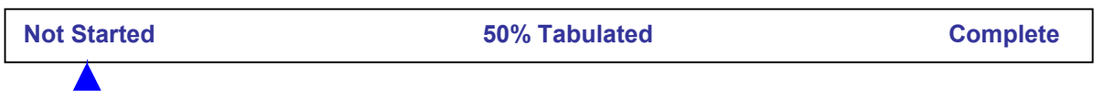
Permanent resources for data capture or conversion to standard format[12].

Part-time responsibility falls to 6 curators. No professional bioinformatics staff.

Standard for the capture of new data or for conversion of existing digital information.

Varies from centre to centre

Extent to which biosystematics metadata has been entered.



National / department-wide mechanisms to transfer / share data with partners / stakeholders.

No

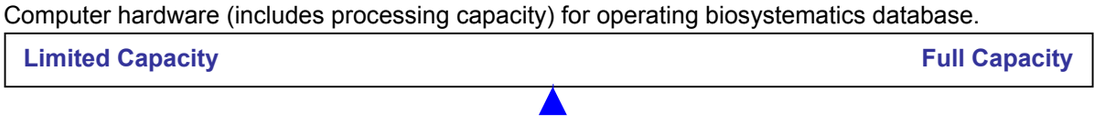
Computing Capacity:

Standard computing (hardware / software) configuration for data management.

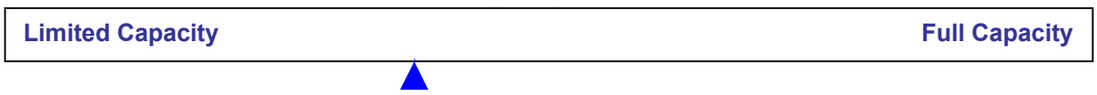
No

[12] For the purpose of this study, data exists in three formats: hardcopy, non-standardized digital and standardized digital. The overall objective is to convert all data to a single format.

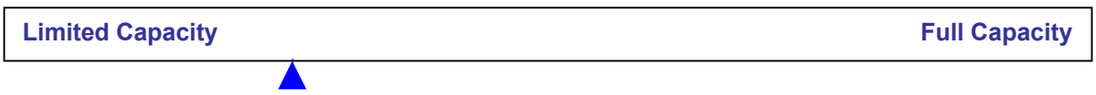
Computer hardware (includes processing capacity) for operating biosystematics database.



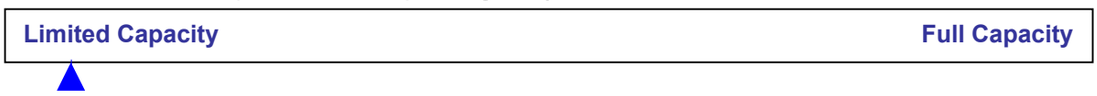
Computer software requirements for operating biosystematics database.



Data storage requirements for operating biosystematics database.

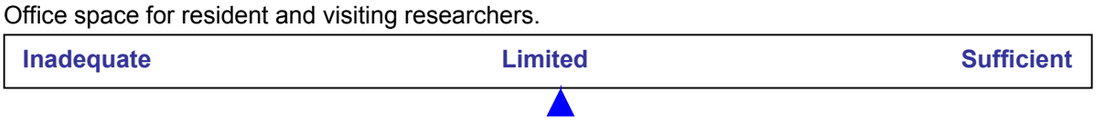


Data transmission requirements for operating biosystematics database.



Research Assets:

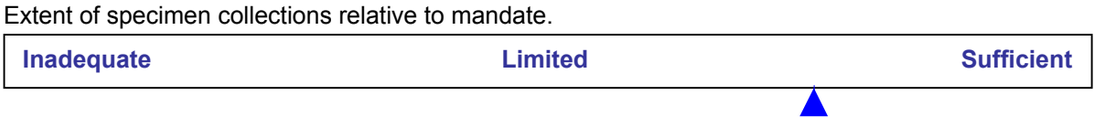
Office space for resident and visiting researchers.



Laboratory facilities.

Collections storage space.

Extent of specimen collections relative to mandate.



Condition of collection(s).

Fisheries and Oceans Canada

Objectives

The Fisheries and Oceans Canada (DFO) does not currently have a biosystematics. Programme. However biosystematics expertise is required as part of the overall science programme within the department. The purpose of the science programme is to better understand the marine environment and to inform conservation, protection and fisheries management decisions.

Infrastructure

DFO operates 12 regional research facilities:

Pacific Biological Station
Institute of Oceans Sciences (BC)
West Vancouver Laboratory
Cultus Lake Salmon Research Laboratory
Freshwater Institute (MN)
Bayfield Institute (ON)
Experimental Lake Area (ON)
Maurice Lamontange Institute (QC)
Gulf Fisheries Centre (NB)
St. Andrews Biological Station (NS)
Bedford Institute of Oceanography (NS
Northwest Fisheries Research Centre (NF)

Facilities range from field stations, with a small central laboratory, to extensive research facilities, which include offices, laboratories, collection storage facilities and permanent collections. Computing capacity up-graded for Y2K. No special bioinformatics hardware, periphery or networking.

Data

DFO does not have a bioinformatics standard, although species codes have been standardized and work is underway to develop one. Presently data is in both hardcopy and digital formats, scattered throughout individual offices, central filing systems, central servers and personal computers. It is suspected that a significant amount of pre-1980 data is still in hardcopy. DFO Science Sector has recently undertaken a “Data Rescue” project that will first identify data holdings, and prioritize data to be secured electronically.

Collections

The department does not have a collections policy and retains several scattered collections. There is currently no A-based programme for care and enhancement of these collections. Most collections are created through on-going research and retained within inadequate and increasingly scarce storage facilities. The department is currently facing difficult questions are to how to deal with its current collection inventory.

Staff

Although most biologists and technicians working within the DFO science programme have a degree of biosystematics skill there are no permanent positions undertaking biosystematics research or bioinformatics activities. The majority of biosystematics expertise remaining at DFO will be retiring with the next 5-10 year period.

Issues

- Low level of awareness of biosystematics needs within the department.
- Difficulty in tapping into Budget commitments to "double research" capacity, as announced in Speech from the Thorne.
- Will loose opportunities to create a comprehensive national-level collections as researchers retire from government and universities over the next five years.

Assessment

Intellectual Capital: Permanent human resources capacity required to address mandated biosystematics-related responsibilities (i.e. Ph.D. expertise for all important taxonomic groups).

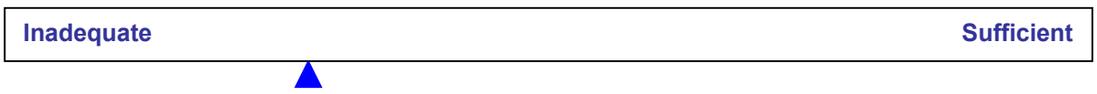
Unknown, but significantly lower

Changes in Stock of Expertise: Current biosystematics staffing relative to 1990 level.

25%	50%	75%	100%

Unknown at this time

Working with Partners: Resources (agreements with partners, protocols for information /specimen /data exchange, "soundness" of network") necessary to optimize potential partnership relationships.



Biosystematics Data:

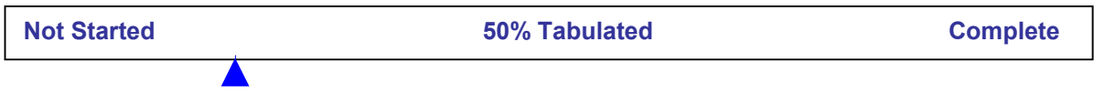
Permanent resources for data capture or conversion to standard format[13].

None

Standard for the capture of new data or for conversion of existing digital information.

No

Extent to which biosystematics metadata has been entered.



National / department-wide mechanisms to transfer / share data with partners / stakeholders.

No

(However, partnerships do exist on a regional basis.)

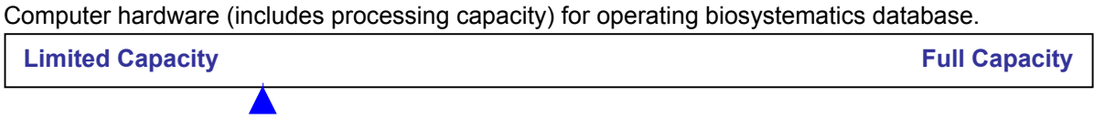
[13] For the purpose of this study, data exists in three formats: hardcopy, non-standardized digital and standardized digital. The overall objective is to convert all data to a single format.

Computing Capacity:

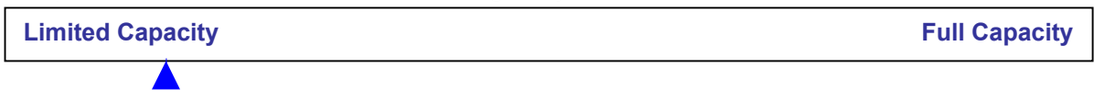
Standard computing (hardware / software) configuration for biosystematics data management?

No

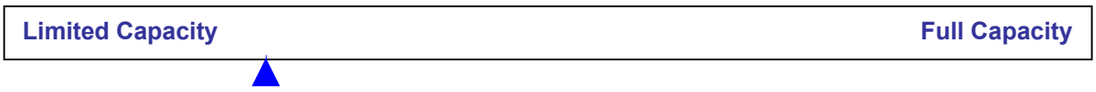
Computer hardware (includes processing capacity) for operating biosystematics database.



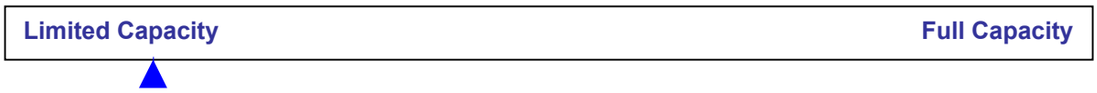
Computer software requirements for operating biosystematics database.



Data storage requirements for operating biosystematics database.



Data transmission requirements for operating biosystematics database.



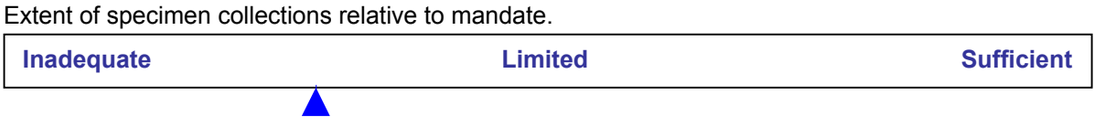
Research Assets:

Office space for resident and visiting researchers.

Laboratory facilities.

Collections storage space.

Extent of specimen collections relative to mandate.



Condition of collection(s).

Environment Canada

Objectives

Goals for Environment Canada (EC) in the area of biodiversity mostly relate to regulation, national coordination and administration of international agreements. The department does, however, requires taxonomic expertise in four areas: , wildlife toxicology, migratory birds, species at risk and alien species . The toxicology programme tracks level of toxics across a number of taxonomic groups for the purposes of ecosystem monitoring and human health protection, including the listing of priority substances for elimination, under the *Canadian Environmental Protection Act*..The migratory bird programme monitors bird populations for the purpose of determining their overall health status for management decisions, and to regulate incidental take and hunting under the *Migratory Bird Convention Act*. The species at risk programme maintains similar objectives of monitoring the health status of endangered species, and may in the future assume legal status under the proposed *Species at Risk Act*.. Management of alien species is an emerging issue for which EC provides national coordination in the absence of any existing coordination mechanism or overarching legislation.

Infrastructure

Extensive research facilities are located at the National Wildlife Research Centre in Hull, National Water Research Institute in Burlington. Saskatoon Hydrology Lab, St. Lawrence Centre in Montreal, Pacific Environmental Science Centre (Environmental Toxicology Section) in North Vancouver and the Toxicology Lab at the Environmental Science Centre in Moncton..

Data

EC retains many “legacy” datasets, which are difficult or impossible to use, as they typically lack data dictionaries. Much biosystematics research data, mostly accumulated through research projects, is contained in hardcopy files, hand-written field notes and on PCs. Without a comprehensive data conversion initiative this data are at risk of being lost over time.

Collections

Several reference collections exist, however, most specimens collected for toxicology research purposes are not suitable for preservation. Species at risk are taken alive and released. However, an extensive collection of migratory birds is maintained. Most research specimens are offered to museums as “gifts”. In addition to the bird collections, EC scientists maintain small research collections of crayfish, aquatic parasites and small forage fish (cyprinids, darters). The Canadian Wildlife Service in the past accumulated a major collection of parasites from northern ungulates (e.g. dall sheep) and snow geese. This well-documented collection was donated to the Canadian Museum of Nature, including all the original data sheets, as well as specimens.

Staff

EC has very limited biosystematics expertise. most are not at the Ph.D. level and are limited to identification of existing species, as opposed to description of new species, development of keys, etc. There is some work on parasites and fish, as well as birds.

Issues

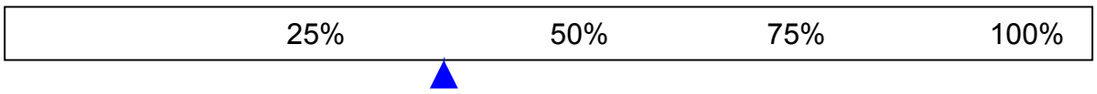
- Management of biosystematics data is inconsistent and receives a low priority.
- Internal cost recovery impedes sharing and enhancement of databases.
- Information management policies needs to be reviewed and updated within the biosystematics context.
- Metadata development has lagged and inhabits optimization of existing data.

Assessment

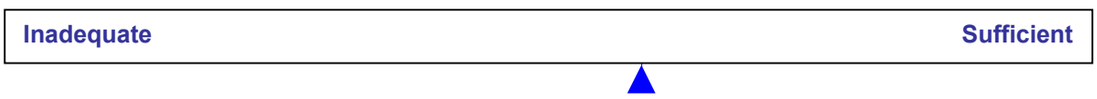
Intellectual Capital: Permanent human resources capacity required to address mandated biosystematics-related responsibilities (i.e. Ph.D. expertise for all important taxonomic groups).

<50%

Stock of Expertise: Current biosystematics staffing relative to 1990 level.



Working with Partners*:* Resources (agreements with partners, protocols for information /specimen /data exchange, "soundness" of network") necessary to optimize potential partnership relationships.



Biosystematics Data:

Permanent resources for data capture or conversion to standard format[14].

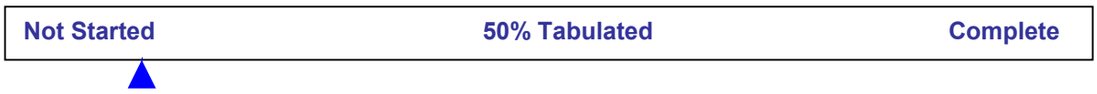
None

Standard for the capture of new data or for conversion of existing digital information.

No

[14] For the purpose of this study, data exists in three formats: hardcopy, non-standardized digital and standardized digital. The overall objective is to convert all data to a single format.

Extent to which biosystematics metadata has been entered.



National / department-wide mechanisms to transfer / share data with partners / stakeholders.

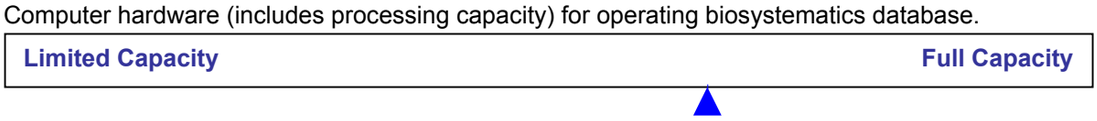
No

Computing Capacity:

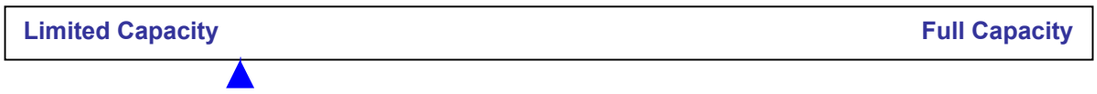
Standard computing (hardware / software) configuration for data management.

No

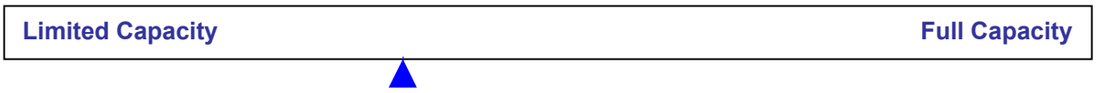
Computer hardware (includes processing capacity) for operating biosystematics database.



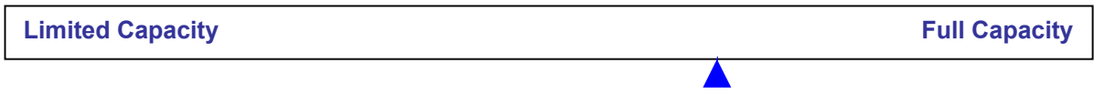
Computer software requirements for operating biosystematics database.



Data storage requirements for operating biosystematics database.

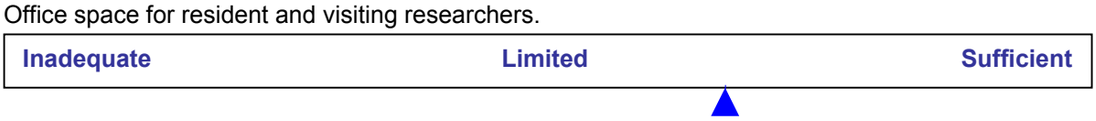


Data transmission requirements for operating biosystematics database.



Research Assets:

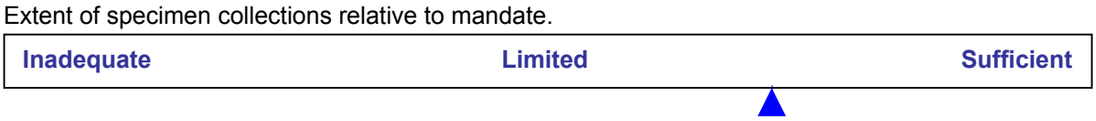
Office space for resident and visiting researchers.



Laboratory facilities.

Collections storage space.

Extent of specimen collections relative to mandate.



Condition of collection(s).

Agriculture and Agri-Food Canada

Objectives

Overall objectives of the research programme relate to productivity improvement and protection of crops. As such research programming, collections and data focus on crops, soils and soil organisms and micro organisms and on agricultural-related insect pests.

Infrastructure

Agriculture and Agri-food Canada (AAFC) operates 19 research centres focused on issues of national importance. The research programme at each of the centres reflects the type of industry in the agro-ecological region where they are located. Centres across Canada include:

Atlantic Cool Climate Crop Research (NF)
Crops and Livestock Research (PEI)
Atlantic Food & Horticulture Research (NS)
Potato Research (NB)
Soils & Crops Research & Development (QC)
Dairy & Swine Research & Development (QC)
Horticulture Research & Development (QC)
Food Research & Development (QC)
Eastern Cereal & Oilseed Research (ON)
Food Research Program (ON)
Southern Crop Protection and Food Research (ON)
Greenhouse and Processing Crops Research (ON)
Cereal Research (MN)
Brandon Research (MN)
Saskatoon research (SK)
Semiarid Prairie Agricultural Research (SK)
Lethbridge Research (AB)
Lacombe Research (AB)
Pacific Agri-food Research (BC)

Data

AAFC has a bioinformatics programme for capturing, storing and managing data. The programme is new and evolving. Protocols for data capture and conversion are in place, which include the Darwin Core as a baseline standard. Consolidation of AAFC biosystematics data holdings will be a challenge. About 1.5 million collection records have been digitized and are in a number of formats and scattered across the various research centres. About 300,000 records include Darwin Core data, but presently not are all georeferenced. Approximately 2 FTEs of technical capacity is currently dedicated to data capture and conversion. Metadata development will be a high priority in the coming years.

Collections

In total AAFC cares for 26 distinct collections containing approximately 17-20 million specimens. These collections are comprised of crop cultivars, other vascular plants, insects and nematodes. The collection is incomplete and evolving year-to-year. As an example, only one in seven mites have been classified and are represented in the AAFC collection.

Staff

27 research scientists at the Ph.D. level (13 entomologists and 14 botanists) are engaged in biodiversity programming. There are 12 emeritus positions and 6 technician support positions. The current level of staffing represents just fewer than 50% of mid-1980 levels.

Issues

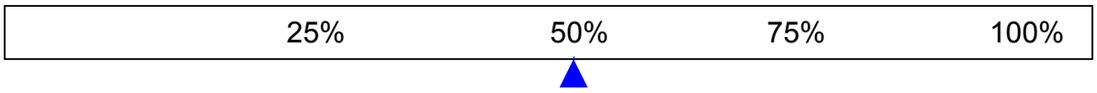
- Missing opportunities for private sector partnering. A strategy needs to be put in place.
- Missing opportunities to work more effectively with federal departments. Coordination and leadership elements need to be put in place at the federal level.
- Bioinformatics is not well recognized with AAFC, or more broadly in government, as an important information management priority.

Assessment

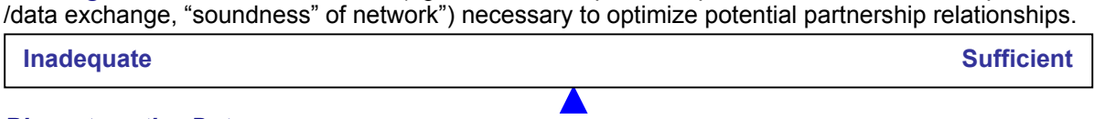
Intellectual Capital: Permanent human resources capacity required to address mandated biosystematics-related responsibilities (i.e. Ph.D. expertise for all important taxonomic groups).

65%

Stock of Expertise: Current biosystematics staffing relative to 1990 level.



Working with Partners: Resources (agreements with partners, protocols for information /specimen /data exchange, "soundness" of network") necessary to optimize potential partnership relationships.



Biosystematics Data:

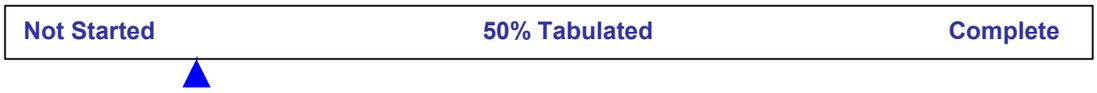
Permanent resources for data capture or conversion to standard format[15].

1 full-time

Standard for the capture of new data or for conversion of existing digital information.

Yes

Extent to which biosystematics metadata has been entered.



National / department-wide mechanisms to transfer / share data with partners / stakeholders.

Somewhat

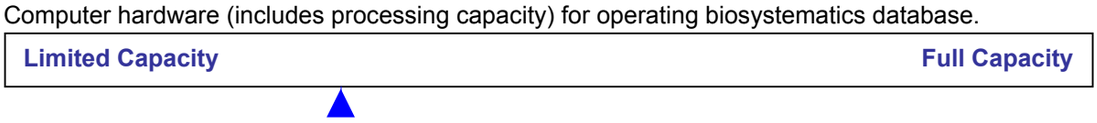
[15] For the purpose of this study, data exists in three formats: hardcopy, non-standardized digital and standardized digital. The overall objective is to convert all data to a single format.

Computing Capacity:

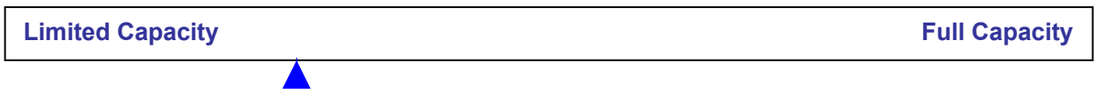
Standard computing (hardware / software) configuration for data management.

Somewhat

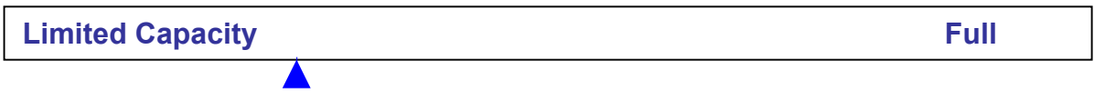
Computer hardware (includes processing capacity) for operating biosystematics database.



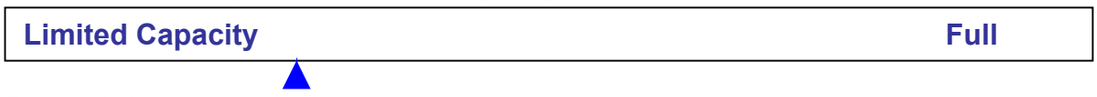
Computer software requirements for operating biosystematics database.



Data storage requirements for operating biosystematics database.



Data transmission requirements for operating biosystematics database.



Research Assets:

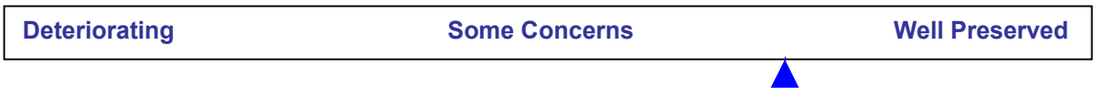
Office space for resident and visiting researchers.

Laboratory facilities.

Collections storage space.

Extent of specimen collections relative to mandate.

Condition of collection(s).



Parks Canada

Objectives

A primary objective for each park is to maintain ecological integrity. Biosystematics research in national parks supports overall park management at the ecosystem level and interpretation programming. Biosystematics is a component of ecosystem monitoring including, for example, species richness and alien species.

Infrastructure

Parks Canada (PC) research facilities are decentralized at the park level. Six "service centres" have been created (at different parks) to pool resources and provide support. Each park has a scientific advisory committee to draw in external expertise.

Data

A comprehensive review of PC capacity to "conserve ecological integrity" was conducted in 2000. It identified serious gaps in the areas of data collection and management. Since that time PC has established an automated inventory system, called *Species in Parks System* (SIPS). SIPS presently contains 40% of the PC species inventory. Records are kept at the population level. Data is a key input to management decisions.

Collections

The Park holds both research and display collections. However, research collections are generally "left over" from research projects and not granted any official status and hence no on-going funds are in place to maintain or enhance these collections. Typically these research collections are offered to museums or universities once the project has been completed, as there is usually not adequate storage facilities at the park level to protect against deterioration. Display collections are typically for park-level interpretive programmes and are limited in number and documentation. There are also about 20 herbariums through the parks system.

Staff

Canada's national parks have roughly 1/3 the scientific and technical capacity as American parks of comparably size, diversity and visitors. The scientific capacity currently includes 20 Ph.D.-level ecologists (plus 2 on contract) and about 60 staff with Master's degrees. There is a national botanist on staff and identification issues relating to vertebrates are generally not an issue. External partnerships with museums and AAFC provide capacity for insects, fish and invertebrates.

Issues

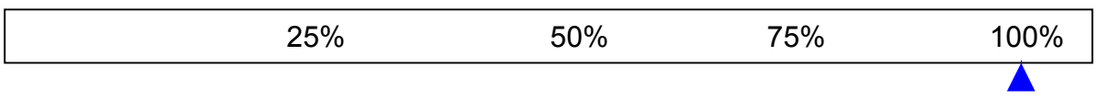
- Lack of internal capacity to respond to emerging issues.
- Effective organization and utilization of internal and external science / biosystematics resources.

Assessment

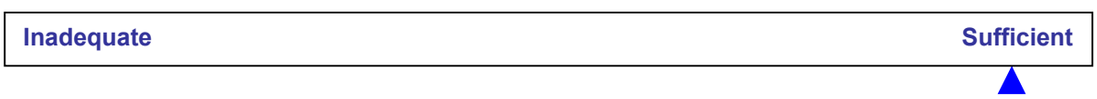
Intellectual Capital: Permanent human resources capacity required to address mandated biosystematics-related responsibilities (i.e. Ph.D. expertise for all important taxonomic groups).

45%

Stock of Expertise: Current biosystematics staffing relative to 1990 level.



Working with Partners: Resources (agreements with partners, protocols for information /specimen /data exchange, "soundness" of network") necessary to optimize potential partnership relationships.



Biosystematics Data:

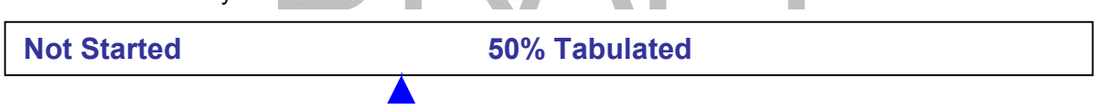
Permanent resources for data capture or conversion to standard format[16].

.25 technicians / park (37)

Standard for the capture of new data or for conversion of existing digital information.

Yes

Extent to which biosystematics metadata has been entered.



National / department-wide mechanisms to transfer / share data with partners / stakeholders.

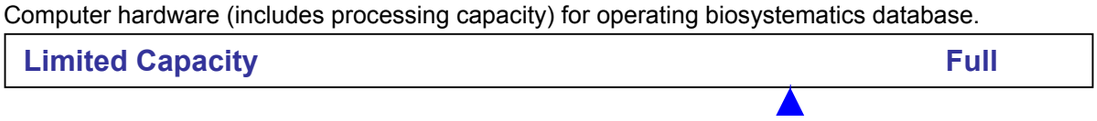
Yes

Computing Capacity:

Standard computing (hardware / software) configuration for data management.

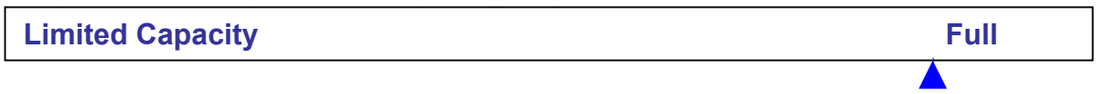
Yes

Computer hardware (includes processing capacity) for operating biosystematics database.

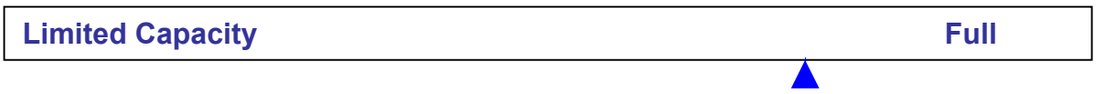


[16] For the purpose of this study, data exists in three formats: hardcopy, non-standardized digital and standardized digital. The overall objective is to convert all data to a single format.

Computer software requirements for operating biosystematics database.



Data storage requirements for operating biosystematics database.

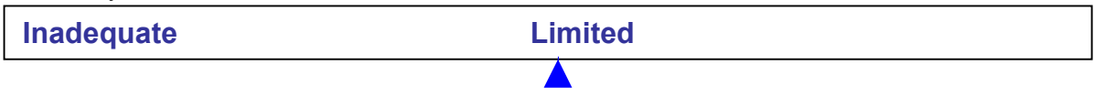


Data transmission requirements for operating biosystematics database.

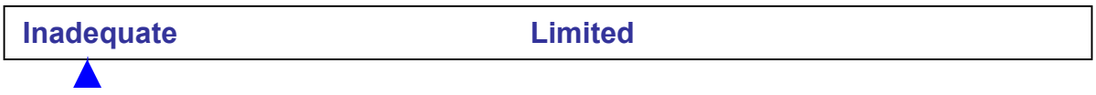
Research Assets:

Office space for resident and visiting researchers.

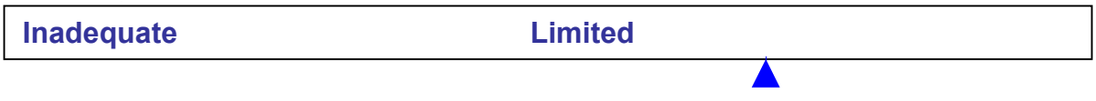
Laboratory facilities.



Collections storage space.



Extent of specimen collections relative to mandate.



Condition of collection(s).

ANNEX C

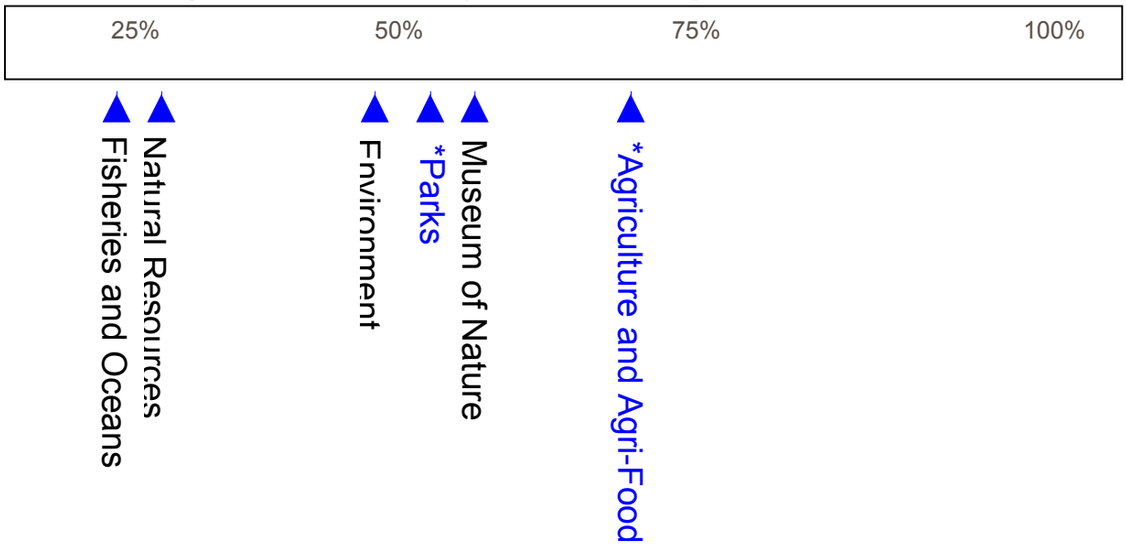
Federal Biosystematics Programme Capacity

Summary Assessment

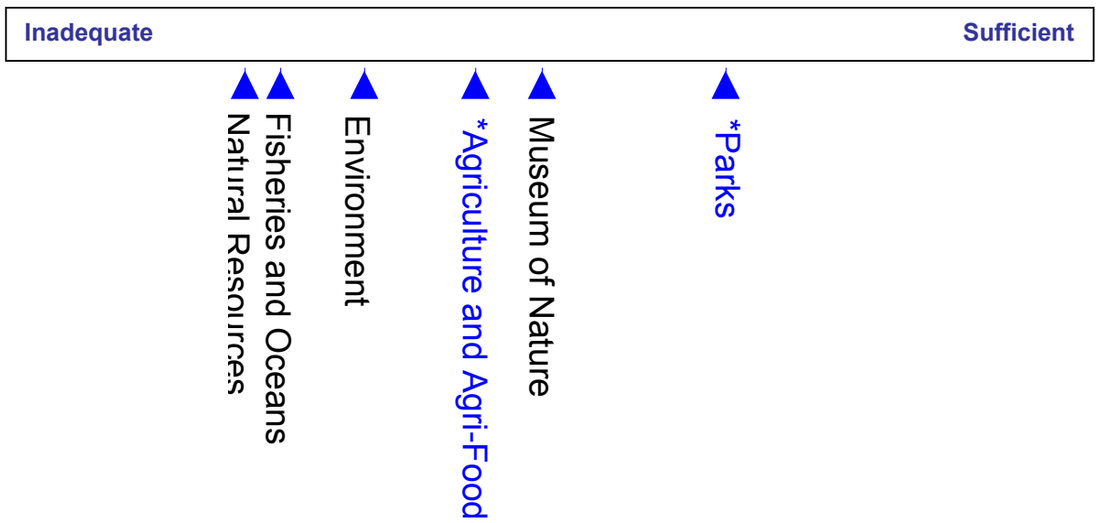
Federal Summary Assessment

Human Resources

Stock of Expertise: Current biosystematics staffing relative to 1990 level.



Working with Partners*:* Resources necessary to optimize potential partnership relationships.



* Draft: to be confirmed

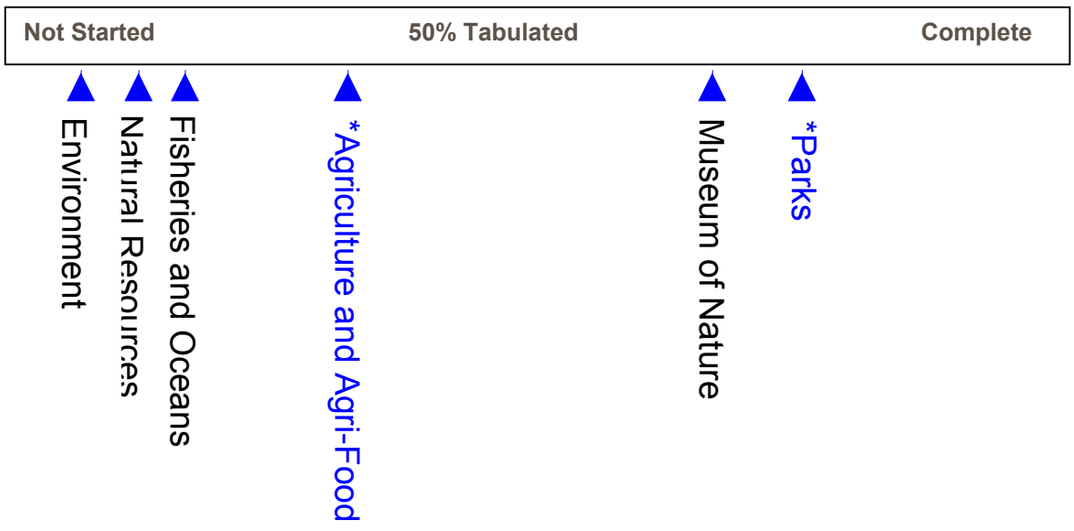
Permanent resources for data capture or conversion to standard format.

Agriculture and Agri-Food	1	Museum of Nature	1
Environment	0	Natural Resources	0
Fisheries and Oceans	0	Parks	several part-time

Standard for the capture of new data or for conversion of existing digital information.

Agriculture and Agri-Food	YES	Museum of Nature	YES
Environment	NO	Natural Resources	NO
Fisheries and Oceans	NO	Parks	YES

Biosystematics data has been tabulated (***metadata***)?



* Draft: to be confirmed

Biosystematics Data

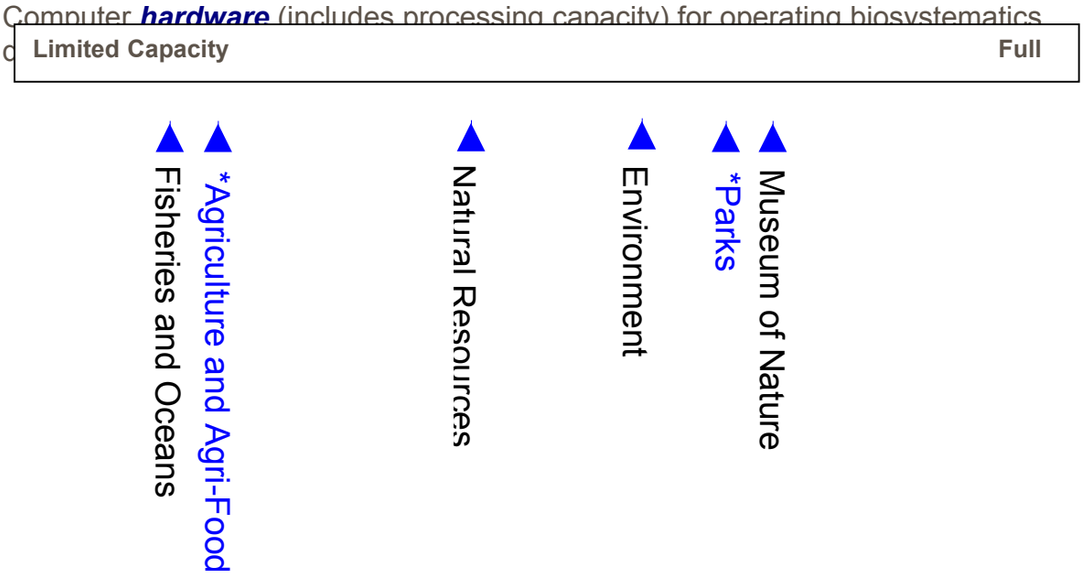
Mechanisms established to transfer data between partners / stakeholders?

Agriculture and Agri-Food	Somewhat	Museum of Nature	YES
Environment	NO	Natural Resources	NO
Fisheries and Oceans	NO	Parks	YES

Standard computing configuration (hard / software) for biosystematics data management.

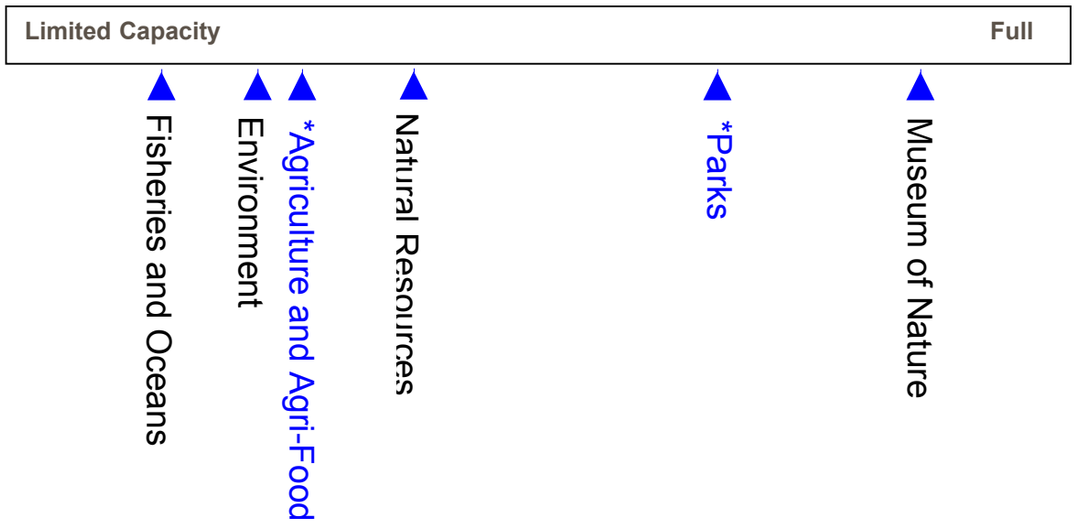
Agriculture and Agri-Food	Somewhat	Museum of Nature	YES
Environment	NO	Natural Resources	NO
Fisheries and Oceans	NO	Parks	YES

Computer ***hardware*** (includes processing capacity) for operating biosystematics d

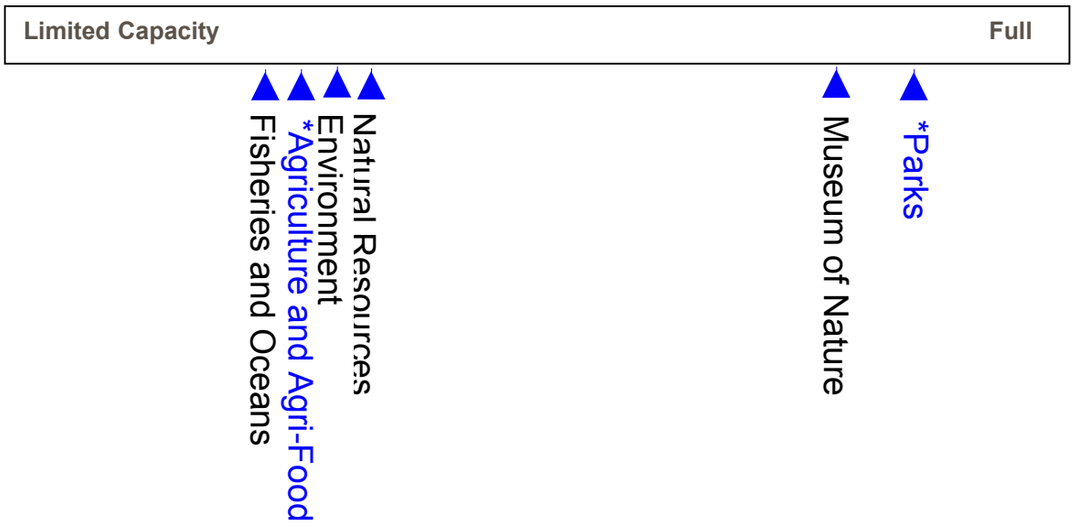


* Draft: to be confirmed

Computer software for operating biosystematics database?

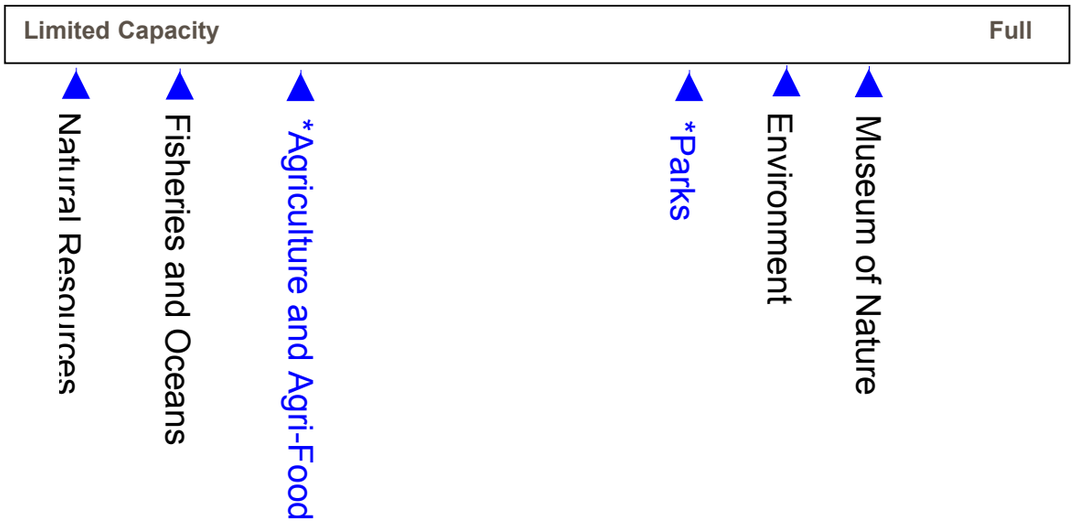


Data storage for operating database?



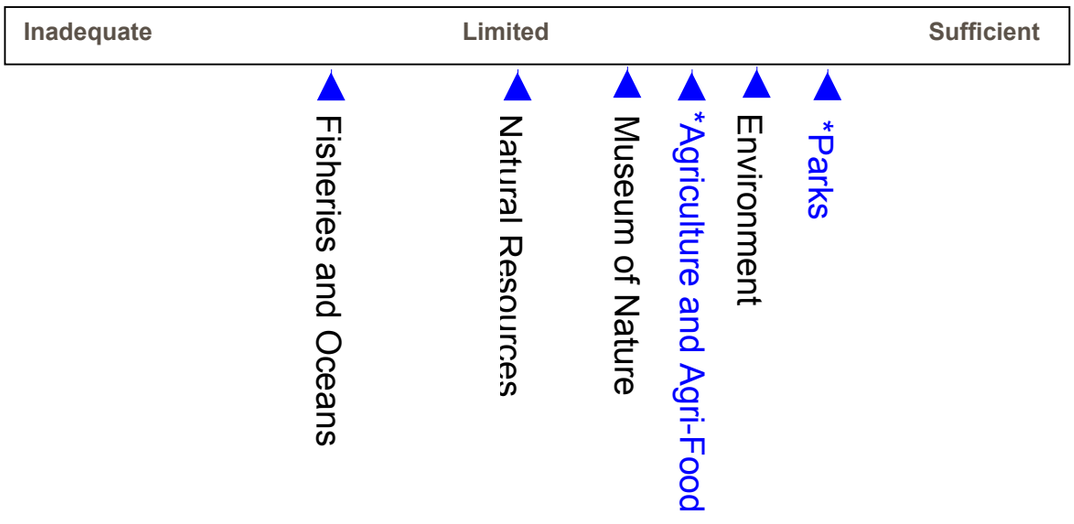
* Draft: to be confirmed

Data transmission for operating database?



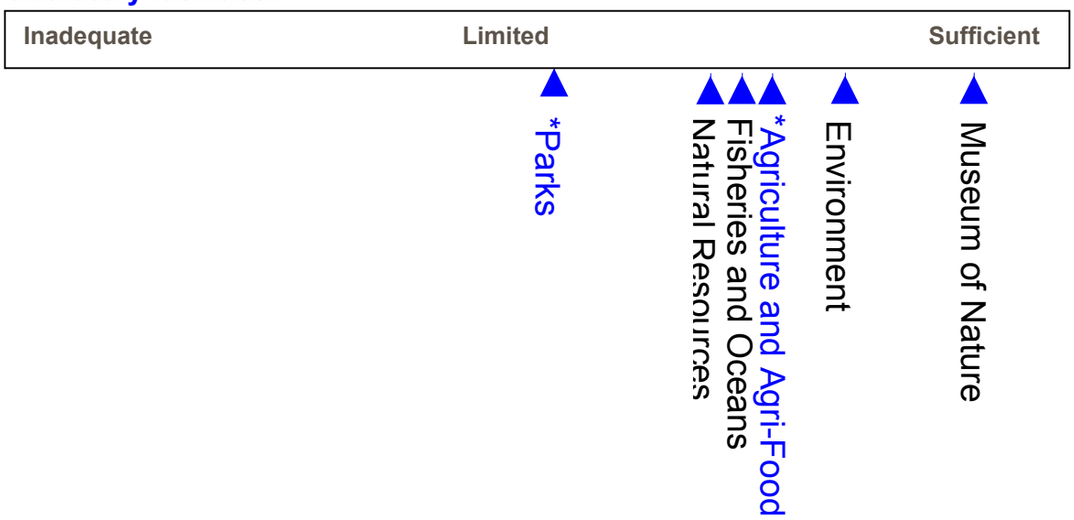
Research Assets

Office space for resident or visiting researchers?

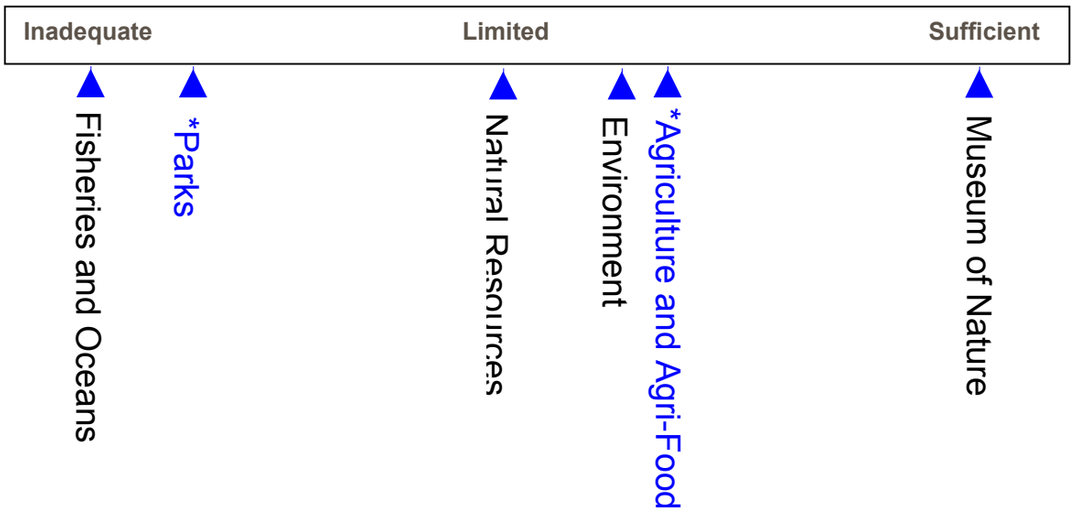


* Draft: to be confirmed

Laboratory facilities?

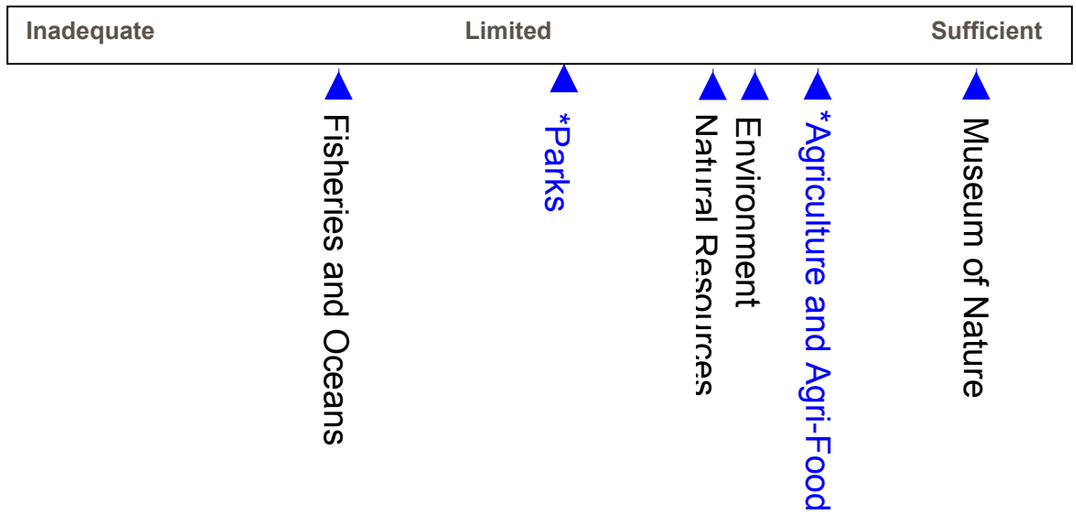


Collections storage space?

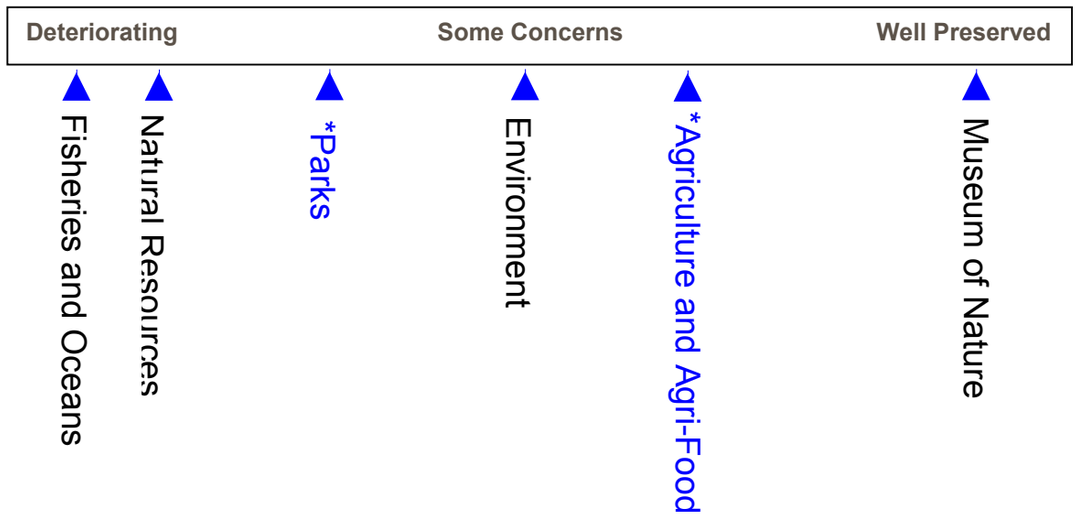


* Draft: to be confirmed

Extent of **specimen collection** relative to mandate?



Condition of collections?



* Draft: to be confirmed

ANNEX D

List of Interviewees

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Robert Anderson, Project Leader, Issues in Biodiversity, Canadian Museum of Nature
Wade Bowers, Director, Corner Brook Research Division, CFS/NRCan
Peter Delorme, Environmental Assessment Division of the PMRA
Kathy Dickson, Senior Waterfowl Biologist, Environment Canada
Jean-Marc Gagnon, Director, Collection Services, Canadian Museum of Nature
Peter Frank, Chief Registar, Information Services, Canadian Museum of Nature
Mark Graham, Director, Research Services, Canadian Museum of Nature
Peter Hall, Executive Director, Biodiversity Network Initiative, AAFC
Ole Hendrickson, Scientific Advisor, Biodiversity Convention Office, EC
Lee Humble, Entomologist, Pacific Forestry Centre, CFS / NRCan
Ed Hurley, Forest Health Unit Leader, Atlantic Forestry Centre, CFS/NRCan
Keith Marshall, Chief Wildlife Toxicology, Environment Canada
Sue Martin, National Database Manager, Atlantic Forestry Centre, CFS/NRCan
Ben Moody, Scientific Advisor - Science Programmes Division, CFS/NRCan
Albert Simard, Director, Knowledge Management, Natural Resources Canada
Darlene Smith, Senior Advisor, Biodiversity Science Branch, DFO
Janice Smith, Biologist, National Water Research Institute, Environment Canada
Larry Speers, Database Manager, Biodiversity, Agriculture and Agri-food Canada
Robert Waller, Chief, Collection Conservation, Canadian Museum of Nature