Evaluation of the NSERC Discovery Research Program
Final Report

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NSERC CRSNG

Canada

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List of acronyms

CCV	Canadian Common CV
CFI	Canada Foundation for Innovation
CIHR	Canadian Institutes of Health Research
CITA	Canadian Institute for Theoretical Astrophysics
CTRMS	Collaborative and Thematic Resources Support in Mathematics and Statistics
DAS	Discovery Accelerator Supplements
ECR	Early career researcher
EDI	Equity, diversity, and inclusion
HQP	Highly qualified personnel
MRS	Major Resources Support
MSLC	Mathematics and Statistics Discovery Grants Liaison Committee
NRS	Northern Research Supplement
NSE	Natural sciences and engineering
NSERC	Natural Sciences and Engineering Council of Canada
RTI	Research Tools and Instruments
SAP	Subatomic Physics
SAP-IN	SAP Individual Discovery Grant
SAP-PJ	SAP Project Discovery Grant
SSHRC	Social Sciences and Humanities Research Council
ST	Ship Time

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Executive Summary

This document constitutes the final report of the evaluation of the Discovery Research Program of the Natural Sciences and Engineering Research Council of Canada (NSERC). This evaluation covers selected activities that fall within the scope of the Discovery Research Program, and covers the 2013/14 to 2017/18 fiscal years. It builds on previous evaluations of the program (or components thereof), more specifically those released in 2008 and 2014.

Discovery Research Program

As a departmental program, the Discovery Research Program includes a fairly wide range of funding opportunities which are expected to enhance the capacity of Canadian researchers to further our shared understanding of natural sciences and engineering through the production and dissemination of high quality research. It is particularly important to emphasize that the term "Canadian researchers" is meant to be inclusive, covering both emerging and established researchers and reflecting the diversity of Canadian researchers by taking into account their identity factors and regional distribution. This research is expected to be undertaken collaboratively, including joint efforts with international partners. As with all fundamental research, the body of knowledge generated with the support of the program is expected to ultimately find applications in both the private and public sectors, benefiting citizens in Canada and in other countries.

It is important to note that not all activities that fall within the Discovery Research Program are covered by this evaluation and that specific questions were prioritized to respond to current information needs within NSERC. As a result, this evaluation covers the following components of the Discovery Research Program:

- Discovery Grants: support ongoing programs of research in natural sciences and engineering, with long-term goals and are awarded to individual researchers, normally for five years.
- Discovery Accelerator Supplements (DAS): provide additional resources to Discovery Grant holders who have a superior research program that is highly rated in terms of originality and innovation, and who show strong potential to become international leaders within their field.
- Northern Research Supplements (NRS): support Discovery Grant holders who conduct research in Canada's North.
- Ship Time (ST): supports Discovery Grant holders who use a vessel for their research.
- Research Tools and Instruments (RTI): enables researchers to obtain up to $150,000 in support for research tools and instruments with a net cost between $7,001 and $250,000.
- Subatomic Physics Discovery Grants (Individual SAP-IN and Project SAP-PJ): support ongoing programs of research at the individual and project level.
- Subatomic Physics Research Tools and Instruments (SAP RTI): provides support to researchers who carry out research in subatomic physics, to assist with the purchase or development of research equipment that costs more than $7,000.
- Subatomic Physics Major Resources Support (SAP MRS): facilitates access by Canadian academic researchers, working in the field of subatomic physics, to major and unique national or international (based in Canada) experimental or thematic research resources.

- Collaborative and Thematic Resources Support in Mathematics and Statistics (CTRMS): provides support to national or international (based in Canada) thematic research resources (e.g., research institutes) in the mathematical and statistical sciences, to cover their operating and maintenance costs.
- Canadian Institute for Theoretical Astrophysics (CITA): provides support to national or international (based in Canada) thematic research resources (e.g., research institutes) that are involved in theoretical astrophysics, to cover their operating and maintenance costs.

Evaluation Questions and Methodology

In close collaboration with program representatives, the scope of the evaluation was established so as to build on previous evaluations of the Discovery Research Program and to best address the current needs of the program management group. The evaluation questions read as follows:

1. How effectively does the Discovery Research Program support excellence in research in Canada?
2. To what extent and how effectively does the Discovery Research suite of programs (supplements, RTI, Institutes and funding mechanisms) address the needs of the natural sciences and engineering research communities?
3. How does the Discovery Research Program support the new generation of researchers?
4. How do mechanisms and approaches implemented by NSERC support diversity among Discovery applicants?

Various methods were used to gather evaluation findings and to support the analysis included in this report:

- Document and administrative review: relevant documents, data, and information, either publicly available or produced for internal purposes, have been reviewed.
- Bibliometric analysis: As part of the bibliometric analysis, scientific publications were used as a proxy to evaluate Canada's position in and contribution to the world, relative to other counties, in the natural sciences and engineering, and the extent to which researchers receiving funding from the Discovery Research Program contribute to these publications.
- Survey of grant applicants: All 12,595 researchers who applied during the period of 2013 to 2017 for a grant under the program components covered by this evaluation were invited to participate in an online voluntary survey. They included researchers who secured program funding (n=10,187), as well as those who were not successful at any point during this period (n=2,408). A total of 5,314 responded to this invitation by completing the questionnaire, for an overall participation rate of 42%.
- Review of national and international awards/scientific prize recipients: An analysis of recipients of national and international awards who have a direct connection to Canada was undertaken, including an analysis of the extent to which they have received support from the program.
- Key informant interviews: A total of 53 individuals participated in semi-structured interviews to provide a wide range of insights covering all evaluation questions.

- Case studies of funded research institutes: Case studies were undertaken with the nine research institutes that currently receive funding from one of the three applicable program components (CTRMS, CITA and SAP-MRS).

Main Conclusions and Recommendations

Supporting Research Excellence in the Fields of Natural Sciences and Engineering

The Discovery Research Program is a central component of Canada's research funding ecosystem. It has a well-established record of providing Canadian researchers in the fields of natural sciences and engineering the opportunity to undertake curiosity-driven, long-term research programs with the required flexibility to pursue promising research avenues. While it is complemented by other funding sources, the program has no equivalent and remains the foundation upon which recipients can pursue meaningful research activities.

Providing this support is crucial if Canada is to remain a predominant contributor of knowledge creation and dissemination in these fields. The international dynamics of fundamental and curiosity-driven research activities are shifting, as additional countries are greatly enhancing their participation in research outputs. While this increased level of research activities brings significant benefits, such as accelerating the creation of new knowledge, Canada must maintain its competitive edge, and its capacity to grow, attract, and retain innovative minds, thereby contributing to the innovation agenda of the federal government. The Discovery Research Program cannot achieve this on its own, but in turn, these goals cannot be achieved in the absence of a strong foundation for leading-edge research. The Discovery Research Program acts as that foundation in Canadian natural sciences and engineering.

Addressing the Needs of the Research Communities

Central to the entire structure of the Discovery Research Program, the Discovery Grants component provides meaningful funding support to approximately 10,000 Canadian researchers in natural sciences and engineering. The driving principle behind the program, namely that a large number of researchers receive some grant-in-aid funding, as opposed to providing larger grants to fewer researchers, is largely supported and constitutes a significant achievement for the program. These funded researchers are more likely than unfunded researchers to explore novel and potentially transformative lines of inquiry, conducting riskier research, collaborating with other researchers in Canada or in other countries, and focusing on fundamental research.

However, experience to date confirms that the program has continually struggled to maintain a stable and consistent level of funding. The value of Discovery Grants, in constant dollars, has largely decreased over the past two decades, with periodic adjustments being made, including those that have led to some increases in the value of Discovery Grants provided over the past two years. Despite recent increases in the 2014, 2016 and 2018 budgets, continued increases in the cost of research may jeopardize the Discovery Research Program's sustained efforts to support innovative research in Canada.

The supplements (DAS, NRS and ST) and the RTI funding provide highly complementary support that greatly enhances the Discovery Research Program's ability to respond to researchers' needs. The DAS funding provides an opportunity to inject timely resources to accelerate particularly promising research programs. While some uncertainties appear to remain in the research community as to the actual

purpose and allocation process for DAS, evaluation findings provided clear evidence that the supplements recipients are, indeed, in a position to intensify the implementation of their promising research programs. While highly limited to certain research communities, the NRS and ST are directly aligned with Canada's interests in northern research and research involving oceans and other large bodies of water, and help to meet the high cost of research in these environments.

The RTI funding also highly complements funding provided by the Canada Foundation for Innovation (CFI) and other funders of equipment and infrastructure. However, when surveyed as part of this evaluation, only 55% of RTI funded respondents and 32% of non-RTI funded respondents indicated that their equipment was adequate to undertake cutting-edge research. Despite these needs, few researchers access RTI support due to the level of funding available. At the time of the evaluation, approximately 20% of applicants were able to secure RTI funding, and researchers from smaller institutions were far less successful than researchers from medium or large institutions in securing RTI funding. In this context, the RTI program is not in a position to meet the needs of the research community.

To reflect the subatomic physics, mathematics and statistics fields' specific needs and characteristics, the NSERC has set up specific funding mechanisms. The evaluation team has found that, while there is a strong support for the current SAP funding mechanism, views differ on the extent to which the funding mechanism for mathematics and statistics meets the current needs of that community of researchers.

Over time, a number of research institutes in mathematical, statistical, and natural sciences have been established in Canada. They have broadened the range of activities in which researchers, both established (ERs) and early career (ECRs), and students can collaborate, create new knowledge, enhance their skills, build their professional networks, and facilitate their transition and growth as researchers. Some of these institutes have received funding from NSERC, through various programs and, more recently, from the Discovery Research Program. There is a strong rationale for supporting the work of these institutes, as they are highly complementary to the other program components covered in this evaluation and directly contribute to research excellence in Canada. Each funded research institute is focused on expanding the range of research, collaboration, learning and career development opportunities provided to researchers, including graduate students, postdoctoral students, and ECRs. The incremental approach used to date by NSERC to support selected institutes has succeeded in providing them with fairly stable funding. However, NSERC has yet to establish a clear vision of how it intends to approach the funding of research institutes in Canada in a manner that is more sustainable in the longer term. In particular, positioning other grant support and institute funding in a zero-sum dynamic (where any increase to one side must lead to a decrease on the other side) is bound to lead to unproductive tensions. In addition, it is unclear how any growth in the number of institutes can be accommodated.

Supporting Diversity and New Generations of Researchers

Ensuring that program access and benefits are available to all qualified Canadians is a long-standing goal of the three granting agencies (CIHR, NSERC and SSHRC), which are collaborating on a joint Equity, diversity, and inclusion (EDI) action plan. The Program is implementing changes to foster engagement in the research ecosystem of underrepresented groups in all fields of natural sciences and engineering. Information collected for this evaluation can be used as baseline data in future evaluations, in order to explore issues related to barriers experienced by underrepresented groups.

This evaluation has provided an opportunity to better understand some of the challenges associated with such a strategy. Relevant data on a number of the program recipients identity dimensions are currently lacking, and the need to gather such data must be balanced with privacy considerations. For the purpose of this evaluation, this lack of information has considerably limited the scope of what could be documented. As NSERC continues to progress on the EDI front, it is particularly important to ensure that these efforts expand beyond sex and gender to include the other identity dimensions. Also, ongoing assistance is required for applicants and reviewers as they operationalize the EDI requirements.

The support to ECRs is another agency-wide priority of NSERC that directly applies to the Discovery Research Program. During the period covered by the evaluation, ECRs have had comparable access to the key program components. Concerns were raised around the level of funding being provided in order to meaningfully assist these individuals in establishing their careers.

Recommendations

In light of these findings, this evaluation team makes the following recommendations:

Recommendation 1

The Discovery Research Program is a fundamental building block of the Canadian research funding environment.

- **Considering its fundamental role and positioning in the ecosystem of research funding in Canada, NSERC should maintain the Discovery Research Program, with the goal of ensuring its sustainability and its continued adaptability to emerging dynamics in the fields of natural sciences and engineering.**

Recommendation 2

It is generally recognized that the costs of research can vary by discipline and that this may result in variations in the funding levels among different disciplines. However, at the time of the evaluation there was no publicly available information that could explain and justify the extent of these differences, and how this translates into Discovery Grant Evaluation Group budgets and the range of average grant sizes across disciplines. This has led to speculation among those consulted and questions about the fairness of the current model.

- **NSERC should explain the rationale for funding differences across disciplines, providing a clear description of the Discovery Grant funding levels and how they are established. This would reflect NSERC's commitment to ensuring a transparent management of the program, it would allow researchers to be adequately informed at the time of their application, and it would provide them with an opportunity to plan accordingly.**

Recommendation 3

The RTI funding provides critical support needed for the successful implementation of research funded by the Discovery Research Program and other NSERC programs. This funding is complementary to other infrastructure funding, notably that provided by the Canada Foundation for Innovation (CFI). However, with its current level of funding, RTI only supports one fifth of the applications submitted by the community. Moreover, only half of the funded researchers perceive that they have the equipment

required to conduct cutting-edge research. As a result, RTI is not in a position to respond to the needs of those it is intended to serve.

- **NSERC should clarify its objectives with respect to the nature and level of support it provides for research tools and instruments that enable researchers to carry out leading edge research funded by the Discovery Research Program and other NSERC programs. NSERC should revisit the RTI budget in order to enable the program to meet the needs of the community.**

Recommendation 4

The funding mechanisms for subatomic physics (SAP) and mathematics and statistics have emerged incrementally over time. The SAP funding mechanism is long-standing and reflects the nature of the research undertaken; evidence from the evaluation has demonstrated that it is serving the specific needs of this community. In contrast, the funding mechanism for mathematics and statistics was implemented more recently. Since 2014 it has had a fixed proportional relationship between the funding for Collaborative and Thematic Resources Support in Mathematics and Statistics (CTRMS) and the funding to individual Discovery Grants. This approach to funding isn't serving the community's needs.

- **NSERC should consider separating the management of the funding for individual mathematics and statistics Discovery Grants from the management of the funding for institutes provided by CTRMS.**

Recommendation 5

The currently funded research institutes in the fields of astrophysics, subatomic physics, and mathematics and statistics fulfill an important role that is highly complementary to the Discovery Grants provided by the program. However, NSERC funding is fragmented and has been implemented incrementally. The most significant gap that NSERC now faces results from a lack of a coherent vision and strategy on how to support research institutes, and to provide this funding in a manner that is consistent with the principles governing all its granting activities.

- **NSERC should clarify its vision and develop a comprehensive framework and guidelines that communicate how NSERC intends to provide ongoing support to research institutes in Canada, including the potential of expanding to other fields of research. Moreover, in order to improve accountability and assess impacts, NSERC should implement a more rigorous monitoring and reporting framework for the institutes that it supports.**

Recommendation 6

Ensuring that all qualified Canadians have access to and benefit from its programs is a longstanding goal for NSERC, and are the basis for the tri-agency EDI action plan. The Discovery Research Program is in the process of implementing changes to ensure fair access and support for underrepresented groups in all fields of NSE in the research ecosystem. Comprehensive data on a number of identity dimensions of program participants is currently lacking.

- **NSERC should pursue the implementation of its EDI principles as they apply to activities funded through the Discovery Research Program. This includes, among other things: 1) continuing to collect and analyze new, broader data to better understand the participation of all underrepresented groups; 2) continuing to provide the required support to both grant applicants and reviewers to ensure that the activities they undertake with the support of the Discovery Research Program reflect these principles.**

1 Introduction

This document constitutes the final report of the evaluation of the Discovery Research Program of the Natural Sciences and Engineering Research Council of Canada (NSERC). This evaluation covers selected activities that fall within the scope of the Discovery Research Program, and covers the period from fiscal year 2013/14 to 2017/18. It builds on previous evaluations of the program (or components thereof), particularly those evaluations released in 2008 and 2014.

The evaluation reflects the requirements of the federal government's *Policy on Results* (2016) and section 42.1(1) of the *Financial Administration Act*, which requires each ongoing federal program of grants and contributions to be evaluated every five years, with respect to its relevance and effectiveness.

The following subsections included in this introduction describe the program itself, the range of evaluation questions addressed, the methodology used to adequately address such questions, and key findings from the previous two program evaluations.

It is important to note that the evaluation does not cover all the activities that fall within the Discovery Research Program and that specific questions were prioritized to respond to current information needs within NSERC. Consequently, these subsections serve to clearly delineate the scope of the evaluation and what the remaining sections of the report are expected to address.

1.1 The Discovery Research Program

The fundamental responsibility of NSERC is to fund research and training in the fields of natural sciences and engineering, and in doing so, it aims to achieve three departmental results:

- "Canada's natural sciences and engineering research is internationally competitive;
- Canada has a pool of highly skilled people in the natural sciences and engineering;
- Canada's natural sciences and engineering research knowledge is used" (NSERC, 2019e, p. 24).

As of 2019-2020, the total NSERC annual budget stood at $1.36 billion, and its programming activities were distributed among three departmental-level programs[1], along with internal services (see Table 1 for details). One of these departmental programs is the Discovery Research Program, to which more than half of NSERC's resources are allocated.

Table 1: NSERC Program Inventory and Services, and Associated Budget for 2019-2020

Departmental Programs and Services	Budget ($)	Budget (%)
Discovery Research Program	$764,765,145	56%
Research Partnership Program	$405,378,275	30%
Research Training and Talent Development Program	$162,698,586	12%

[1] In accordance with *Policy on Results*, we must distinguish between departmental programs and specific programs or initiatives that may fall within a broader departmental program. For instance, the Discovery Research Program is a departmental program that includes a number of individual funding opportunities such as the Discovery Grants Program or the Research Tools and Instruments Program.

Departmental Programs and Services	Budget ($)	Budget (%)
Internal services	$23,998,403	2%
Total	$1,356,840,409	100%
Source: GC InfoBase (https://www.tbs-sct.gc.ca/ems-sgd/edb-bdd/index-eng.html)		

Discovery Research Program Components Covered by the Evaluation

As a departmental program, the Discovery Research Program includes a fairly wide range of funding opportunities. This evaluation specifically covers the funding opportunities described in Table 2. Appendix A includes a detailed description of the scope of the evaluation and identifies the components of the Discovery Research Program that were not included.

Table 2: Components of the Discovery Research Program Covered by the Evaluation

Components	Description[1]
Discovery Grants	This funding, often referred to as NSERC's flagship program, supports ongoing programs of research in natural sciences and engineering, with long-term goals. Discovery Grants are awarded to individual researchers, normally for five years. These grants are considered "grants-in-aid" of research, as they are expected to provide operating funds and facilitate access to funding from other programs. Grant recipients are not restricted to the specific activities described in their applications, and may pursue new research interests, provided they are within NSERC's mandate. (NSERC, 2019i)
Discovery Accelerator Supplements (DAS)	The Discovery Accelerator Supplements (DAS) provide additional resources to Discovery Grant holders who have a superior research program that is highly rated in terms of originality and innovation, and who show strong potential to become international leaders within their field. Each award is valued at $120,000 over three years ($40,000 annually) and provides recipients with additional resources that can be used to expand the recipients' research group, to purchase, or to have access to, specialized equipment, or for other initiatives/resources that would accelerate the progress of their research program, and are only valid during the active period of the Discovery Grant through which the DAS was awarded.
Northern Research Supplements (NRS)	This funding supports Discovery Grant holders who conduct research in Canada's North. Successful applicants receive a supplement to their Discovery Grant in the range of $10,000 to $25,000 per year, for the duration of their Discovery Grant. Recipients are not restricted to the specific activities described in the application, but must pursue research interests in the North, and only costs associated with working in the Canadian North are eligible expenses. (NSERC, 2019m)
Ship Time (ST)	This funding supports Discovery Grant holders who use a vessel for their research. Researchers may apply as a sole Principal Investigator or as a team with any number of Co-applicants. It applies to the Department of Fisheries and Oceans/Canadian Coast Guard vessels, undersea vehicles operated by the Canadian Scientific Submersible Facility or other similar research platforms, and any other Canadian or foreign vessels crewed in conformance with the Shipping Act. The normal duration of Ship Time grants is one year. Two-year grants will be considered in exceptional circumstances, where the project completion requires a firm commitment of funding for more than one year. (NSERC, 2019l)
Research Tools and Instruments (RTI) Grants	This funding enables researchers to obtain up to $150,000 in support for research tools and instruments with a net cost between $7,001 and $250,000. To be eligible for RTI funds, applicants and co-applicants must each hold one of the NSERC research grants listed in the on-line program description. The normal duration of the RTI grant is one year. (NSERC, 2019n)

Components	Description[1]
Subatomic Physics (SAP) Discovery Grants (Individual and Project)	Since 1991, funding for SAP has been structured through an independent funding mechanism, which reflects the specific needs of this research community and the interdependency of proposals that often involve international collaborations and laboratories. Keeping this in mind, the SAP Discovery Grants Program pursues goals similar to the main Discovery Grants Program, as it supports ongoing programs of research. The SAP Individual Discovery Grants (SAP-IN) are awarded for a period of up to five years, while the SAP Project Discovery Grants (SAP-PJ), provided to groups of researchers (referred to as SAP Collaborations), are awarded for a period of up to three years. (NSERC, 2019q; Subatomic Physics Long-Range Planning Committee, 2016)
Subatomic Physics Research Tools and Instruments (SAP-RTI) Grants	Similar to the general RTI Grants, this funding provides support to researchers who carry out research in subatomic physics, to assist with the purchase or development of research equipment that costs more than $7,000. SAP-RTI grants are divided into three categories, according to the total net cost of the equipment, and may provide funding of up to $325,000. Grants are typically one-year awards, and only in exceptional cases will multi-year requests be accepted. (NSERC, 2019p)
Subatomic Physics Major Resources Support (SAP-MRS)	This funding is expected to facilitate access by Canadian academic researchers, working in the field of subatomic physics, to major and unique national or international (based in Canada) experimental or thematic research resources (e.g., institutes or facilities), by financially assisting these resources to remain in a state of readiness for researchers to use. The funding also aims to facilitate access by Canadian academic subatomic researchers, who come together as national consortia, to major international resources located outside Canada, the equivalent of which is not available in Canada. (NSERC, 2019o)
Collaborative and Thematic Resources Support in Mathematics and Statistics (CTRMS)	This funding provides support to national or international (based in Canada) thematic research resources (e.g., research institutes) in the mathematical and statistical sciences, to cover their operating and maintenance costs. These grants target resources that have broad reach and provide significant value in advancing the state of knowledge in mathematics and statistics and related interdisciplinary research. With this support, these resources are expected to provide an environment that serves to accelerate research in the mathematical and statistical sciences, as well as to develop partnerships and interactions with different disciplines, thus fostering interdisciplinary research. (NSERC, 2013)
Canadian Institute for Theoretical Astrophysics (CITA) Support	This funding provides support to national or international (based in Canada) thematic research resources (e.g., research institutes) that are involved in theoretical astrophysics, to cover their operating and maintenance costs. Such resources are expected to provide an environment that serves to accelerate research in theoretical astrophysics, as well as to develop partnerships and interactions with different disciplines, thus fostering interdisciplinary research. One award has been made under this program. (NSERC, 2015)

[1.] The descriptions included in this table are largely lifted from the referenced websites, with adjustments where required. In case of discrepancy, the official program descriptions take precedence.

The following considerations help to appropriately situate these various programs components:

- Discovery Grant funding is the central component to which many other components are directly linked. During the fiscal year 2018/19, a total of 10,440 researchers in Canada were benefiting from a Discovery Grant, which represented an annual investment of just over $363 million.
- Access to a number of supplements is limited to researchers who hold a Discovery Grant (including the individual SAP Discovery Grant). As such, holding a Discovery Grant is a prerequisite for any researcher who wishes to access the NRS or ST supplements or to receive a DAS (other conditions apply based on each of these programs). Supplements are designed to support a small subset of Discovery Grant holders. During the evaluation period, a yearly

average of 27 researchers received NRS, 8 researchers received ST as principal investigators[2], and 125 researchers received DAS).

- Access to RTI support is not limited to Discovery Grant holders. It can also be accessed by researchers who receive funding from other NSERC programs, such as Research Partnership grants.
- For mathematical and statistical sciences, the Discovery Grants and CTRMS funding are grouped into one funding mechanism through which 81% of the funds available are directed to Discovery Grants for researchers in mathematics and statistics and the remaining 19% are directed to the CTRMS Program. This approach has been formally adopted since the fiscal year 2014/15 following a recommendation from the 2012 Long Range Plan for Mathematical and Statistical Sciences Research in Canada (2013-2018) prepared by this research community (LRP Steering Committee, 2013).
- The various forms of funding support for subatomic physics are grouped into one overarching funding mechanism, which favors a more flexible allocation of resources, reflecting the specific nature of this field of research. This mechanism covers SAP-IN, SAP-PJ, SAP-RTI and SAP-MRS. As noted in Table 2, this approach has been in place since the early 1990s, in accordance with long-range plans prepared by this research community (Subatomic Physics Long-Range Planning Committee, 2016).
- Three components currently provide financial support to research institutes in Canada: CTRMS in the fields of mathematical and statistical sciences, CITA in the field of astrophysics, and the SAP-MRS in the field of subatomic physics. At the time of the evaluation, nine research institutes were supported by one of these three components.
- Other major funding programs, such as the Canada Excellence Research Chairs program or the Canada First Research Excellence Fund, are included in the Discovery Research Program (as a departmental program for the purpose of departmental reporting and budgets), but they are not covered by this evaluation (NSERC, 2019g). Accordingly, for the purpose of the evaluation, any reference to the Discovery Research Program includes only the components described in Table 2.

Program Resources

Over the five-year period covered by the evaluation, NSERC invested just over $2 billion in the program components covered by this evaluation. Table 3 provides an overview of this investment.

Table 3: Resources assigned to each program component covered by the evaluation, per fiscal year

Components	2013/14	2014/15	2015/16	2016/17	2017/18	Total
Discovery Grants	320,227,522	322,227,522	323,489,951	333,734,006	344,870,047	1,644,549,048
NRS	1,705,270	1,911,090	2,107,390	2,110,620	2,108,850	9,943,220
ST	1,000,000	700,378	1,075,433	991,279	975,217	4,742,307
DAS	15,150,000	15,360,000	15,000,000	15,160,000	15,200,000	75,870,000

[2] These statistics refer to the number of researchers who received funding, but do not include their co-applicants. The average number of co-applicants on Ship Time supplement is 2.24.

Components	2013/14	2014/15	2015/16	2016/17	2017/18	Total
RTI	17,513,838	27,069,570+	26,149,418	30,191,711	25,615,103	126,539,640
CTRMS	4,140,889*	4,191,309**	4,205,162***	4,212,500	4,337,726	21,087,586
CITA	1,100,000	1,100,000	1,100,000	1,100,000	1,100,000	5,500,000
SAP Funding Mechanism						
SAP-IN	5,452,200	5,431,700	5,883,270	5,710,470	4,203,220	26,680,860
SAP-PJ	14,271,948	13,907,000	14,628,000	15,652,400	17,673,700	76,133,048
SAP-RTI	613,893	1,057,961	285,285	564,875	35,000	2,557,014
SAP-MRS	2,294,500	2,283,500	2,389,444	2,337,207	2,444,173	11,748,824
Total	383,470,060	395,240,030	396,313,353	411,765,068	418,563,036	2,005,351,547
Source: Internal financial data derived from the Financial Approval Memos of each respective Fiscal Year, including Federal budget increases in 2014 and 2016						

+ $2M used to fund additional awards in previous year RTI competition
* In 2013, funded in full by other NSERC program (prior to CTRMS)
** In 2014, 1/4 of CRM, Fields, and PIMS funded by other NSERC program; BIRS fully funded by other program
*** In 2015, BIRS funded by other NSERC program

Program Management and Delivery

NSERC's Research Grants and Scholarships Directorate manages the various components of the Discovery Research Program covered by this evaluation. A large number of expert scientists and engineers are also involved in the actual review. The following briefly summarizes the application review and funding recommendations processes under each applicable funding opportunity:

- For Discovery Grants: The review and merit assessment of applications are done using an annual conference model peer review structure (NSERC, 2019b, p. 7).[3] At the time of the evaluation, there were 12 Evaluation Groups structured along the various disciplines in natural sciences and engineering covered by the program (see Figure 1), as well as a separate group for Subatomic Physics (discussed below). The Evaluation Groups are responsible for assessing each application, based on the following three criteria: the researcher's scientific or engineering excellence, merit of the proposal, and contribution to the training of highly qualified personnel (HQP) (NSERC, 2019i). Applications are then grouped into funding bins, each bin representing a level of funding that reflects the scores of the applications grouped into it. The final recommendations for the allocation of the Discovery Grants' budget are made by

Evaluation Groups

- Biological systems and functions
- Civil, Industrial and Systems Engineering Biological
- Chemistry
- Computer Science
- Electrical and Computer Engineering
- Evolution and Ecology
- Genes, Cells and Molecules
- Geosciences
- Materials and chemical engineering
- Mathematics and Statistics
- Mechanical Engineering
- Physics

Figure 1

[3] The review of Discovery Grant applications involves multiple steps, including internal and external reviewers, which are not described in this brief program overview. Detailed information on each of these steps can be found in the Discovery Grants Peer Review Manual, which is updated annually (NSERC, 2019b).

the Research Grants and Scholarships Directorate staff in consultation with each of the Evaluation Group executive committee (NSERC, 2019b, p. 29).[4]

- For the DAS grants: Discovery Grants Evaluation Groups are also tasked with making recommendations for the DAS grants. It should be noted that individual researchers do not apply for a DAS grant. Instead, as part of the review of Discovery Grants applications, members of the Evaluation Groups first nominate and then vote on potential recipients, based on the quality and relevance of the proposed research program. Then, from this assessment, each Evaluation Group executive committee nominates the applicants who best meet the objectives of the DAS program. A quota of DAS awards is allocated to each Evaluation Group (NSERC, 2019b, pp. 27–28).
- For the SAP components (SAP-IN, SAP-PJ, SAP-RTI and SAP-MRS): NSERC has established a Subatomic Physics Evaluation Section responsible for conducting peer reviews of submissions and making funding recommendations.
- For the other supplementary components (NRS and ST) and RTI: NSERC has established specific committees that are tasked with reviewing the proposals for which they provide funding recommendations.
- Finally, for the CTRMS and CITA components: NSERC has used expert review committees that are charged with assessing applications and making recommendations based on the set of selection criteria.

To assist with the overall strategic direction of the Discovery Research Program, NSERC established the Committee on Discovery Research. The Committee provides advice to the Council and the Vice-President of Research Grants and Scholarships on funding opportunities that support discovery, and related policy issues, in accordance with specific decisions and any other guidelines provided by the Council (NSERC, 2019h).

Program Logic

Appendix B includes a detailed description of the Discovery Research Program logic model. To summarize, the range of activities undertaken through the program is expected to enhance the capacity of Canadian researchers to further our shared understanding of natural sciences and engineering through the production and dissemination of high quality research. It is particularly important to emphasize that the term “Canadian researchers” is meant to be inclusive, covering both emerging and established researchers, and reflects the diversity of Canadian researchers by taking into account their identity factors and regional distribution. This research is expected to be undertaken collaboratively, including joint efforts with international partners. As with all fundamental research, the body of knowledge generated with the support of the program is expected to ultimately find applications in both private and public sectors, benefiting citizens in Canada and in other countries.

[4] The process has somewhat evolved during the period covered by the evaluation. The description included in this report reflects the process used at the time that this report was prepared.

Previous Evaluations

The Discovery Grants Program, and some of the other funding opportunities associated with it (particularly DAS), have been periodically evaluated, with each evaluation focusing on specific dimensions of the program. The following insights emerged from the last three of these evaluations:

- In 2006, NSERC carried out an evaluation focused specifically on the Discovery Grants Reallocation Exercise (NSERC, 2006a) which had been recommended by the Committee on Research Grants and by Council in 2002. In brief, the reallocation exercise was a process that NSERC introduced in 1991 to "redistribute a portion of the Discovery Grants budget among the various NSERC Grant Selection Committees" (NSERC, 2006a, p. 1). This was done through community input and peer reviews. Partly as a result of the considerable time and effort required to conduct such operations and the lack of perceived benefits accrued, the report recommended that this process be replaced by an approach more integrated into the ongoing management of the program. NSERC agreed to terminate the reallocation exercise, and base future allocation of funding on discipline dynamics (number and type of applicants per discipline) and the cost of research (NSERC, 2006b).
- In 2008, NSERC mandated an International Review Committee to evaluate the Discovery Grants Program (NSERC, 2008b). The goal was to determine whether the program achieved the right balance between supporting a large base of researchers and fostering research excellence. The Committee concluded that the high success rate of the program did, in fact, encourage a high degree of research excellence and that, overall, the program was "an exceptionally productive investment and thus deserves additional funding to ensure that the value of its grants keep with the growing opportunity" (NSERC, 2008b, p. 40). The Committee provided some recommendations to improve the program, particularly as it relates to the assessment of applications and the structure of the selection committees (now known as the Evaluation Groups). As a result, the conference model, the binning system and the two-step review process (i.e., merit review followed by funding allocation) were introduced. The Committee also recommended doubling the number of DAS recipients (from 100 to 200). NSERC agreed with the overall direction of these recommendations, and implemented changes to the program accordingly (NSERC, 2008a). However, as previously noted in the DAS description, the number of recipients remained at 125 per year for the period of the current evaluation for budgetary reasons.
- Finally, in 2014, NSERC mandated an International Review Panel to evaluate the relevance, design and delivery, effectiveness, and efficiency and economy of the Discovery Grants program (NSERC, 2014a). The panel confirmed the relevance of the program and noted that "Discovery Grants continue to be Canada's most important support mechanism for foundational research and should be fully recognized for this importance" (NSERC, 2014a, p. 28). Moving forward, the panel recommended improvements to the program related to DAS, to the process for the first renewal for early career researchers and to the review process itself. NSERC agreed to these recommendations and implemented a number of changes, especially in relation to better supporting the participation of early-career researchers in the program (NSERC, 2014b).

1.2 Evaluation Scope and Methodology

While it provides an opportunity to revisit and update certain themes covered by previous evaluation reports, this evaluation differs in at least two dimensions:

- First, its scope is wider and more emphasis is placed on the supplements (DAS, NRS, ST), on RTI, on the funding mechanisms used to support SAP and Mathematical and Statistical Sciences, and on the support provided to research institutes.
- Second, this evaluation is also focused on assessing the extent to which program activities covered within its scope support horizontal priorities of NSERC as they relate to new generations of researchers, and the involvement of diverse groups of researchers, including women, Indigenous people, persons with disabilities, and visible minority groups.

Keeping these considerations in mind, this evaluation primary objective was to assess a publicly funded program that supports research in Canada. This particular field of program evaluation is now fairly well established (Coryn & Scriven, 2008) and the experience gained to date allows for a better understanding of the best practices applicable to this type of evaluation and the challenges to be anticipated. For instance, progress in research is "usually unpredictable and the translation of research into societal outcomes occurs through complex processes that involve many actors downstream" of the funded program (AEA Research, Technology & Development TIG, 2015, p. 5). Also, researchers typically receive funding from a number of sources and yet, data often come from a single source that does not integrate these other forms of support.

These aspects informed the methodology used to evaluate the Discovery Research Program, and must equally be kept in mind when reviewing the evaluation findings that have emerged from this process. Simply put, the very nature of research, particularly fundamental research, is such that no evaluation methodology can claim to mechanically measure the achievement of all expected program results. However, sufficient experience gained to date supports the claim that this type of program can be meaningfully evaluated in such a way as to provide solid evidence that can inform its ongoing management.

Evaluation Questions

In close collaboration with program representatives, the scope of the evaluation was established in such a way as to build on previous evaluations of the Discovery Research Program, and to best address the current needs of the program management group. These questions are included in Table 4.

Table 4: Evaluation Questions Addressed by the Current Evaluation of the Discovery Research Program

Evaluation questions
1. How effectively does the Discovery Research Program support excellence in research in Canada?
2. To what extent and how effectively does the Discovery Research suite of programs (supplements, RTI, Institutes and funding mechanisms) address the needs of the natural sciences and engineering research communities?
3. How does the Discovery Research Program support the new generation of researchers?
4. How do mechanisms and approaches implemented by NSERC support diversity among Discovery applicants?

Methodology

Appendix C includes a detailed description of the various methods used to gather evaluation findings and to support the analysis contained in this report. It also contains further information on the limitations of the methodology and on the strategies to mitigate them. The following briefly summarizes the components of this methodology.

Document and administrative review	Relevant documents, data, and information, either publicly available or produced for internal purposes, have been reviewed. They provided important descriptive, contextual and performance information that inform all evaluation questions. More specifically, a detailed review was undertaken of the relevant administrative data contained in NSERC's Administrative Databases. This information covered the evaluation period (2013 to 2017 inclusive), and provided particularly helpful information on outputs for each program component, including program reach and activities along discipline groupings, gender, size of institutions, and regional locations.
Bibliometric analysis	As part of the bibliometric analysis, scientific publications were used as a proxy to evaluate Canada's position in and contribution to the world, relative to other counties, in the natural sciences and engineering, and the extent to which researchers receiving funding from the Discovery Research Program are engaged in these publications. A variety of bibliometric indicators were used, based on Canada's and other countries' publication outputs and on the citations they received from other publications and from patents. The analyses focused on the last five years (2014–2018), and on NSERC supported researchers (in contrast to unsupported applicants).
Survey of grant applicants	All 12,595 researchers who applied during the period of 2013 to 2017 for a grant under the program components covered by this evaluation were invited to participate in an online voluntary survey. This included researchers who secured program funding (n=10,187), as well as those who were not successful at any point during this period (n=2,408). A total of 5,314 responded to this invitation by completing the questionnaire, for an overall participation rate of 42%. These findings cover a wide range of insights and perceptions on all components covered by the evaluation.
Review of national and international awards/ scientific prize recipients	An analysis of recipients of national and international awards who have a direct connection to Canada was undertaken, including an analysis of the extent to which they have received support from the program.
Key informant interviews	A total of 53 individuals participated in semi-structured interviews to provide a wide range of insights covering all evaluation questions. These interviews involved program officials and NSERC senior management (n=9), members of the various Evaluation Groups (n=21), as well as recipients of national and international awards who also received program support at one point in their career (n=23).
Case studies of funded research institutes	Case studies were undertaken with the nine research institutes that currently receive funding from one of the three applicable program components (CTRMS, CITA and SAP-MRS). Available documentation and data were reviewed, and interviews were conducted with representatives from these research institutes. The purpose of these case studies was not to assess the individual performance of these institutes, but rather to assess the extent to which these three program components support the institutes and provide added value to researchers.

Limitations

While the evaluation benefited from multiple lines of inquiry, there are some limitations to the evaluation data.

- Overall, there were high levels of participation from the research community in several lines of inquiry throughout the course of the evaluation. Some lines of inquiry, however, relied on self-reported data and may reflect a slight bias towards reporting positive results. The evaluation addressed this limitation by triangulating the findings, thus facilitating data analysis through cross verification using two or more sources. More specifically, by collecting data on the same evaluation questions from multiple lines of inquiry, the evaluation team was able to improve the validity of the evaluation findings, thereby minimizing the impact of any potential bias.
- The scope of the evaluation was wide and more emphasis was placed on the supplements (DAS, NRS, ST), on RTI, on the funding mechanisms used to support SAP and Mathematical and Statistical Sciences, and on the support provided to research institutes. In order to limit the burden of the evaluation instruments, choices were made to reduce their length, which may lead to emerging questions that could not be addressed.
- Because some supplements support a relatively small number of researchers, the ability to conduct statistical tests was limited and allowed for descriptive statistics only. The same limitation applies to some communities or researchers. The ability to establish counterfactual groups was limited by multiple factors, including the small sample size of some communities or researchers supported by supplements; the high success rate of some communities, coupled with their small size; the lack of a control/comparison group for funding that researchers do not directly apply for (i.e., the Discovery Accelerator Supplement); and finally, the lower response rate from unfunded researchers, particularly when coupled with the previously described factors. In order to mitigate some of these issues, a non-response analysis was conducted on survey data, and survey responses were weighted to account for differences in response rates by variables including researcher type, evaluation group/community, success rate, institution size, province, and level of funding received. This statistical correction helped to limit non-response bias, and to ensure that the survey sample better reflected the true population of funded researchers and research communities.
- For RTI funding, the analysis presented in this report is limited to RTI recipients who also hold a Discovery Grant, even if the RTI funding is also available to researchers holding funding other than Discovery Grants.
- Funded institutes were evaluated as part as their own funding mechanisms. However, the performance of each institute was not part of this evaluation, which again may lead to specific questions that could not be addressed.
- Some communities may be larger than what appears in this evaluation. As an example, the number of applications for Ship Time may be ‘’artificially“ limited by the budget allocated to this supplement and may not reflect the reality of this community, the same can be said for RTI.

2 Evaluation Findings

This section of the report synthesizes the evaluation findings. The analysis is based on information that emerged from all lines of evidence. It begins with an assessment of the extent to which the various funding opportunities covered by the evaluation succeed in addressing the research communities' needs and in supporting research excellence. It also explores the extent to which the Discovery Research Program contributes to agency-wide priorities related to diversity and early career researchers.

2.1 Overall Contribution of the Discovery Research Program

Summary of findings: In Canada, the Discovery Research Program is a pillar of the research funding ecosystem in natural sciences and engineering. In an international context where an increasing number of countries engage in fundamental and curiosity-driven research, the program enhances Canada's capacity to remain competitive, and to train, attract, and retain innovative researchers. Since a large portion of the funding provided through the program is ultimately used to engage highly qualified personnel, the program directly contributes to a central goal of NSERC, namely to ensure the long-term renewal of qualified researchers in Canada.

The Relative Contribution of Canada to Research Creation and Dissemination

All researchers share the ambition of advancing knowledge in their respective fields. Historically, and despite its relatively small population base, Canada has honoured that principle and made a significant contribution to scientific knowledge creation and dissemination. Among other things, it has stood among the 10 most productive countries in the world in terms of sheer volume of scientific publications (Naylor, 2017, p. 38).

A better understanding of how Canada performs in knowledge creation and dissemination in the specific fields of natural sciences and engineering provides contextual information that can be meaningful to the evaluation of the Discovery Research Program. However, it must be stressed that any assessment of Canada's performance in those fields, either positive or negative, cannot be systematically attributed to the Discovery Research Program. At a minimum, one would need to take into account the results from the entire research funding ecosystem in those fields to determine the extent to which the system as a whole is performing well. University support, provincial funding programs, other federal, NSERC or Tri-Agency initiatives (such as the Canada Research Chairs Program, the Canada Excellence Research Chairs Program, the Networks of Centres of Excellence, the Canada First Research Excellence Fund, or the New Frontiers in Research Fund), and the support provided by the Canada Foundation for Innovation are all drivers that shape Canada's research performance. In addition, international shifts are constantly reshaping the overall environment in which research is being undertaken. A handful of western countries (including Canada) has experienced decreasing trends associated with scientific publications in the last decade, likely influenced by emerging countries such as China, Iran, India, South Korea, and Brazil, which have rapidly increased their share of world output in scientific publications over the last decade or so (Naylor, 2017, p. 37) (Naylor, 2017, p. 37).

Keeping these considerations in mind, the bibliometric analysis undertaken in this evaluation provides helpful and updated information on Canada's overall performance in natural sciences and engineering

research. The following insights appear particularly relevant for the purpose of this evaluation (all trends and statistics are specific to the fields of natural sciences and engineering):

- For the 15-year period between 1999 and 2014, the number of Canadian publications[5] has steadily increased, with the majority of the increase accounted for by academic-related publications. Since 2015, however, the overall number of Canadian publications is following a downward trend, and, in 2018, stood at 34,000 publications (compared to 37,000 in 2014). Importantly, this decrease is primarily associated with other sectors (government, private, and other), the academic sector remaining above the global level. During the same period, since 2002, the Canadian share of international publications has been gradually decreasing, from 3% in 2005 to 2% in 2018.
- Looking more specifically at the data relating, for the most part, to the period under review (2014 to 2018), most countries traditionally leading in publications, such as the United States, Germany, Japan, the United Kingdom, France or Italy, have all seen their share of worldwide publications decrease, whereas countries such as Russia, India, Iran, Poland, Brazil, China, Turkey and South Korea have all experienced some growth in their worldwide share of publications.
- Canadian researchers tend to engage in international collaboration quite frequently, ranking 8th out of the top 20 countries. In fact, just over half (55%) of Canadian publications are co-authored with at least one researcher located in another country.
- Compared to the world average (1.00), Canadian publications tend to be cited more frequently. During the evaluation period, the relative citations (ARC) average for Canadian publications stood at 1.21. Since 2009, however, Canada's performance in that regard has slightly declined.

During the evaluation period, 62% of all Canadian publications from the academic sector in natural sciences and engineering involved researchers who received a Discovery Grant. This reflects the wide reach of the program where, at any point in time, roughly 10,000 Canadian academic researchers in these fields are receiving Discovery Grant support.

Along the same lines, statistics show that, during the evaluation period, practically all researchers (95%) who received a Discovery Grant have successfully published in their respective fields. When compared to unfunded researchers, researchers who received program support tended to be less involved in international co-publications or interdisciplinary publications. This does not mean, however, that funded researchers did not engage in international co-publications or interdisciplinary publications. In fact, funded researchers had an international co-publication rate (ICR) of 50% and an 8.7% share of interdisciplinary papers, compared to unfunded researchers who had an ICR of 64% and a 9.9% share of interdisciplinary papers. Interestingly, the opposite trend was visible in the survey results for international co-publications, with funded researchers (63%) being significantly more likely to report collaborating with researchers outside of Canada compared to unfunded researchers (49%).

Finally, the bibliometric analysis indicates that early career researchers (ECR) who receive program funding generally outperformed unsupported ECRs. Funded ECRs had significantly higher scores related

[5] "Canadian publications" refers to publications made by Canadian researchers affiliated to different sectors—namely, the academic, government and private sectors.

to publication output, including international co-publication output, as well as for highly cited publications when compared to unfunded ECRs.

The Foundational Nature of the Discovery Research Program

Expectedly, one would struggle to envision the Canadian research funding ecosystem in the fields of natural sciences and engineering without the Discovery Research Program. In one form or another (and under various labels), the program has stood as a pillar of fundamental research funding ever since NSERC was first established in 1978 (NSERC, 2008b, p. 13). More than four decades later, the unique positioning of the program comes in large part from the fact that it simply has no equivalent. It remains the only national program whose fundamental purpose is to allow a relatively broad base of researchers in natural sciences and engineering to pursue long-term, curiosity-driven research programs. As such, this evaluation is about assessing one of the pillars of Canada's research funding ecosystem.

While many views persist on what constitutes the best strategy to adequately support curiosity-driven research, there is a fairly large consensus on the actual need for such research activities to occur and on their many benefits that can be expected to accrue over time. In 2017, the Advisory Panel for the Review of Federal Support for Fundamental Science issued a strong plea in favour of adequately supporting curiosity-driven research activities in Canada, noting that "basic research is the upstream source of the foundational building blocks for innovations of transformative importance to the world" (Naylor, 2017, p. 21). The Advisory Panel urged governments to "give researchers the support and freedom to pursue their very best ideas, any one of which holds the potential to result in a discovery or insight that is the seed of a future innovation or industry" (Naylor, 2017, p. 25). This view was systematically echoed by the consulted stakeholders. They shared a fundamental view that any creative, innovative, and solution-driven society must be in a position to rely on a balanced research environment where fundamental research paves the way for a wide range of applications.

The previous evaluation of the Discovery Research Program's largest component, the Discovery Grants, conducted in 2014, concluded that these grants "serve Canada well and appear to be unique worldwide in their design in supporting programs of research rather than specific projects. The program is highly valued, it is believed by the Panel to be envied in other countries, and it is widely seen within the Canadian research community as a credential of excellence" (NSERC, 2014a, p. 7).

Findings gathered as part of this evaluation align with these conclusions. When considering its fundamental purpose, the Discovery Research Program, as a building block of the Canadian research funding environment, is unique. Of note, the survey conducted with Discovery Grant applicants (both successful and unsuccessful) indicates that funded researchers are significantly more likely than unfunded researchers to report that they are exploring novel and potentially transformative lines of inquiry, conducting riskier research, collaborating with other Canadian researchers, collaborating with researchers outside Canada, and focusing on fundamental research. In addition, while unfunded recipients do pursue their research programs, they generally indicate that not having a Discovery Grant has had a particularly negative impact on their progress rate, the scope and breadth of their research

program, the number of highly qualified personnel (HQP)[6] they involve, and the degree to which they can undertake fundamental research.

As such, the Discovery Research Program does support research excellence, but as further elaborated in the following subsections, this outcome can only be achieved if other components of the research funding ecosystem allow researchers to further elaborate on what the program funding has facilitated in the first place. In other words, research excellence is supported by funding such as that offered through the Discovery Research Program, but it is unlikely to be achieved solely through this program.

The "grant-in-aid" nature of the funding provided

The Discovery Research Program offers "grants-in-aid". On this matter, the program's documentation is unequivocal. In particular, "Discovery Grants are considered 'grants-in-aid' of research, as they provide long-term operating funds and can facilitate access to funding from other programs, but are not meant to support the full costs of a research program" (NSERC, 2019i). But as previously stated, when it comes to supporting curiosity-driven fundamental research, the funding provided through the Discovery Research Program is also considered, in terms of design and flexibility, to be unique in Canada. Therefore, the extent to which researchers can successfully secure other funding to carry out their research programs becomes particularly critical if the program is to achieve its expected results.

While strategies to secure additional funding vary among disciplines, types of researchers (new or established), institution size or regional distribution, researchers who benefit from the program will normally obtain complementary funding from other sources to pursue their research programs. The 2014 evaluation of the Discovery Grants Program noted that Discovery Grants typically represent about a quarter of the total funding secured by researchers. At that time (in 2014), the average annual Discovery Grant stood at about $35,000, and the total research support obtained by researchers averaged $130,000 (NSERC, 2014a, p. 12). While the same measurement has not been conducted as part of the current evaluation, evaluation findings from interviews confirm that, typically, researchers cannot solely rely on the funding they obtain through the Discovery Research Program to successfully implement their research programs. For one thing, the average annual Discovery Grant had slightly decreased to $33,243 by 2017 (NSERC, 2019c, p. 14). Consequently, funded researchers have had to secure complementary funding from their own institutions, from other public or private partners, or from provincial or federal research funding.

In this context, it is safe to assume that, for the foreseeable future, the funds provided through the Discovery Research Program will continue to be a "grant-in-aid". This, in turn, reinforces the fact that any grant holder performance evaluation must systematically acknowledge that the performance does not solely reflect the program funding, but rather multiple factors, funding or otherwise, that impact the success of Canadian researchers in the fields of natural sciences and engineering.

HQP Hiring

A well-established measure of success in fostering excellence is a research community's ability to meaningfully hire HQP, ensuring the long-term renewal of qualified researchers in Canada. Through the

[6] Training supported by NSERC includes undergraduate, master's and PhD's students, postdoctoral researchers, research associates and technicians.

funding they secure through the Discovery Research Program and other funding sources, program recipients do build research teams that involve HQP. Evaluation findings, particularly survey results, indicate that researchers receiving program funding tend to have a higher number of HQP involved in their research activities, when compared to unfunded applicants. More precisely, and as indicated in Table 5, Discovery Grants funded researchers have reported a median of 8 HQP per team, compared to 6 HQP for unfunded researchers.

The number of HQP involved in research teams varies among Evaluation Groups, reflecting the nature of research activities associated with each one. For example, funded researchers in mechanical engineering report the largest teams (median = 11), whereas funded researchers in mathematics and statistics report the smallest teams (median = 6). When comparing funded and unfunded researchers, the table shows that the largest differences were found among civil, industrial and systems engineering researchers (median = 10 vs. 5) and among chemistry researchers (median = 9 vs. 4).

Table 5: Median number of HQP broken down by Evaluation Groups

Evaluation Groups	Unfunded median	Funded median	Difference	Unfunded n	Funded n
All Evaluation Groups	6	8	2	675	4,308
19 - Subatomic Physics	--	7		5	117
1501 - Genes, Cells and Molecules	6	7	1	112	561
1502 - Biological Systems and Functions	6	9	3	103	620
1503 - Evolution and Ecology	7	9	2	41	294
1504 - Chemistry	4	9	5	33	297
1505 - Physics	3	7	4	29	278
1506 - Geosciences	5	8	3	55	278
1507 - Computer Science	7	8	1	70	310
1508 - Math. and Statistics	2	6	4	33	430
1509 - Civil, Industrial and Systems Eng.	5	10	5	51	335
1510 - Electrical and Computer Eng.	7	10	3	60	270
1511 - Materials and Chemical Engineering	7	10	3	39	240
1512 - Mechanical Engineering	7	11	4	44	278
Source: 2019 survey for the evaluation of the Discovery Research Program					

While a direct and measurable causal link between receiving program funding and building larger teams cannot be assumed (a range of other factors could also explain that difference), the fact remains that resources allocated by the program are, in fact, used to engage HQP. As illustrated in Figure 2 and considering the 2013-2017 period, just over half (52%) of the reported Discovery Grants' expenses were, on average, directed towards salaries for students and postdoctoral fellows. As for the non-salary expenses, they cover material (19%), travel (13%) and equipment (4%).

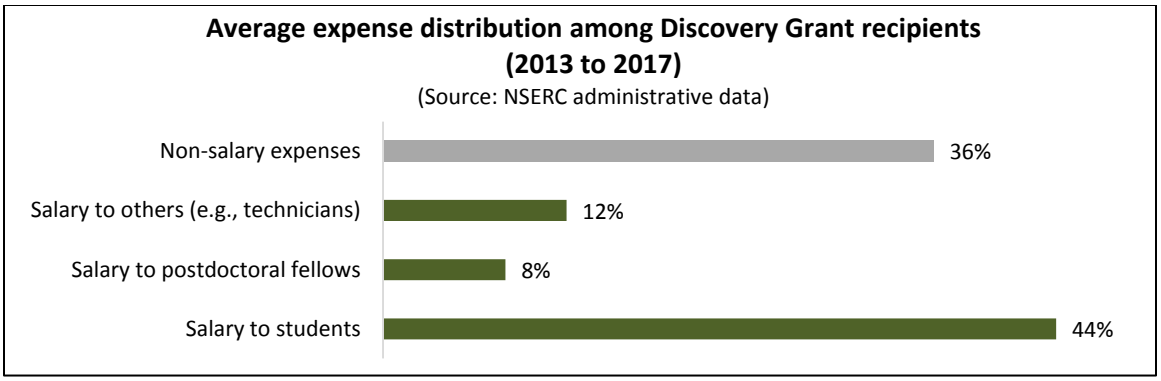


Figure 2

Overall, evaluation findings confirm that funding provided through the Discovery Research Program is predominantly used to hire HQP in research programs, and as such, it is part of the overall support structure that allows future generations of researchers to engage in meaningful research activities. Interviewed national and international research prize winners have repeatedly emphasized how pivotal the funding they obtained through the Discovery Research Program had been, particularly in the early stages of their career, in building research teams with a capacity to match their ambitious research programs.

Looking at the funding provided through the Discovery Grants more closely, it should be noted that the portion of the grants dedicated to salaries (including stipends) has been slowly but steadily increasing over a 15-year period, between 2002 and 2017, for all Evaluation Groups and HQP categories. This is all the more true for the share of Discovery Grants allocated to student salaries. Back in 2002, it represented 27% of the funding, as opposed to 48% in 2017.[7] The interviewed stakeholders offered some possible explanations, the predominant one being that, while the value, in constant dollars, of the average Discovery Grant has been progressively decreasing over the review period, student salaries had to be adjusted to the inflationary curve. As previously noted, because researchers typically operate with multiple sources of funding in support of their research programs, they had to rebalance the distribution of salaries versus non-salary expenses among these various sources of financial support.

Finally, the survey conducted as part of this evaluation provided additional insights on the benefits for the HQP, perceived to be associated with the support provided by the Discovery Research Program. Funded researchers indicated, in particular, that the program funding has enriched the training environment, supported the acquisition of material and supplies needed for research in which HQP are engaged, facilitated the participation of HQP in conferences, and broadened the areas of research to which HQP are exposed.

[7] The portion of Discovery Grants assigned to postdoctoral fellow salaries increased from 4% in 2002 to 8% in 2017. Salaries to others decreased from 15% in 2002 to 12% in 2017.

2.2 Discovery Grants

Summary of findings: The Discovery Grants component provides meaningful funding support to approximately 10,000 Canadian researchers in natural sciences and engineering. The fundamental logic of the program – whereby a large base of researchers receives a meaningful grant-in-aid – is sound and responds to a well-documented need to sustain curiosity-driven research in Canada in these fields of research. The program delivery is supported by a strong peer-review process, constantly adjusted to reflect emerging best practices. Historically, the program's main challenge is to manage, over time, inflationary pressures in order to continue providing meaningful support. However, while the cost of research is expected to vary among disciplines, at the time of the evaluation, no publicly available information could explain and justify the magnitude of these variations, and how they are reflected in the Discovery Grant Evaluation Group budgets and in the range of average grant sizes across disciplines.

This subsection focuses on the Discovery Grants, and covers issues related to their current design, as well as their direct impacts on funded researchers. It should be noted that SAP Individual Discovery Grants (SAP-IN) are not included in this analysis, as they are covered in subsection 2.5 on the funding mechanism for subatomic physics.

Overview of Program Activities

As previously noted in the program description, at the time of this evaluation, approximately 10,000 researchers were supported by a Discovery Grant. As these grants are typically allocated for a five-year period, it means that approximately 2,000 researchers are awarded grants every year. Table 6 provides further information on Discovery Grant yearly competitions for the period covered by the evaluation, including overall success rates.

Table 6: Statistics on Yearly Allocations of Individual Discovery Grants

Competition years	Funded (n)	Not Funded (n)	Total (n)	Success Rate (%)
2013	1,997	1,401	3,398	59%
2014	2,033	1,101	3,134	65%
2015	2,059	1,100	3,159	65%
2016	2,094	1,073	3,167	66%
2017	2,154	1,086	3,240	66%
Total	10,337	5,761	16,098	64%

Source: NSERC administrative data

A few additional characteristics of Discovery Grants recipients are worth noting:

- The average annual grant amounts vary among the Evaluation Groups. As illustrated in Figure 3, and as per the five-year review period for this evaluation, recipients in the fields of mathematics and statistics received the lowest average annual grant amount ($20,639), while researchers in the field of chemistry received the highest average annual grant amount ($51,253).
- During the five-year period, the highest success rate was found in the field of physics where 76% of applicants received funding, while the lowest success rate (56%) was found in the field of genes, cells and molecules.

- Limited information is available concerning the sex of grant recipients, as 20% of these individuals have opted to not indicate their sex. Of those who did identify their sex, 21% of funded recipients indicated female and 79% indicated male.
- The vast majority of grant recipients (85%) were established researchers, while the remaining 15% were early career researchers (individuals who have held an independent academic position for 2-3 years or less).[8]
- The vast majority of grant recipients (76%) were from large institutions, while 15% were associated with medium institutions and the remaining 9% came from small institutions.[9]

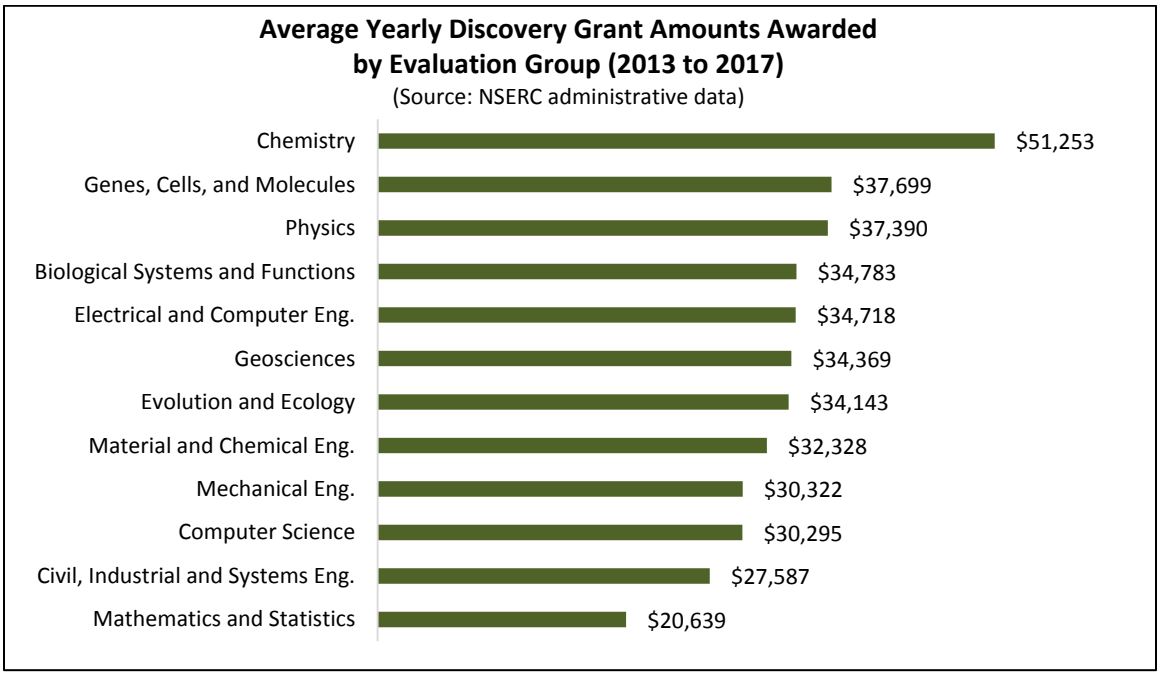


Figure 3

Balancing Success Rates and Levels of Funding

Arguably, no other aspect of the Discovery Research Program raises stronger and more passionate views than the level of funding currently offered through individual Discovery Grants and, by extension, the current success rates. Offering a relatively modest contribution (grant-in-aid) to a fairly large group of researchers is the defining feature of the Discovery Grants component.

Previous Perspectives

This specific issue was at the core of the 2008 International Review Committee's mandate. After careful consideration of all evidence presented as part of that study, the Committee concluded that, while

[8] The early career researcher eligibility window was extended from two to three years starting with the 2017 competition for Discovery Grants. Beginning in the 2019 competition, it was further expanded to five years.

[9] NSERC divides institutions into three categories, according to the amount of total annual NSERC funding they receive (based on 3-year rolling average for the last three fiscal years). In 2018, small institutions received less than $3,885,252, medium institutions received between $3,885,252 and $15,541,008, and large institutions were received more than $15,541,008. These numbers are adjusted on an ongoing basis.

improvement opportunities existed, the Discovery Grants Program generally strikes an appropriate balance between fostering excellence and maintaining a diversified base of research capability across the NSE fields (NSERC, 2008b, p. 32). The Committee added that

> "there may be considerable misunderstanding about the role and nature of the Discovery Grants Program. The evidence reviewed by the Committee demonstrates that any perception that the DGP is flawed because of a 'high success rate and low grant value' is an inaccurate reading of the actual situation." (NSERC, 2008b, p. 32)

This issue was also addressed by the International Review Panel that evaluated the Discovery Grants in 2014. The Panel concluded that "the current balance between supporting a broad base of researchers and institutions and supporting excellence is generally very appropriate", and added that "Discovery Grants provide the core 'grant-in-aid' funding for most researchers' investigations and form a base upon which considerable amounts of additional research funding can be built (often called 'leveraging') for foundational research in NSE" (NSERC, 2014a, p. 28).

In its 2017 report, The Advisory Panel for the Review of Federal Support for Fundamental Science weighed in on this issue, and expressed some concerns about the current approach adopted by the Discovery Grants Program:

> "The Panel supports high success rates for ECRs, but has mixed views on the DG approval rates that start and remain so high across the life cycle of NSERC researchers. (…) The obvious concern is that these success rates could lead to funding of a higher-than-usual proportion of lower-quality research and are certainly a factor in the unreasonably low per grant funding levels. A further concern is that the DG program not only reflects but also strongly reinforces a one-scientist-one-grant model, at a time when multi-investigator and multidisciplinary teams are becoming more important in many areas of science." (Naylor, 2017, p. 87)

In the end, however, the Advisory Panel noted that striking the right balance between the funding level for individual grants and the approval rates was not easy to determine and, consequently, it limited itself to recommending that all three granting agencies harmonize their funding strategies, with the view of monitoring and adjusting this balance point as required (Naylor, 2017, p. 89).

Evaluation Findings

During the reference period, the levels of funding and success rates remained fairly stable. Figure 4 provides further details for each year covered, but overall, the level of annual funding averaged $33,681 and the success rates averaged 64%. Considering that the average Discovery Grant stood at a little more than $30,000 back in 2006 (NSERC, 2008b, p. 39), there is no doubt that the program has struggled to maintain the actual financial value of the support it provides, which in fact, when considered in constant dollars, has been consistently decreasing during from 2001 to 2015 (Naylor, 2017, p. 87).

While it extends beyond the evaluation period, it is worth noting that a series of new investments in research funding were announced by the federal government in 2014, 2016 and 2018, which increased the overall budget of the Discovery Grants component. During the period from 2015/16 to 2019/20, the

Discovery Grants' budget increased by 19% or $69.2 million (NSERC, 2019a, p. 2)[10] and the impact of these announcements is already being felt.

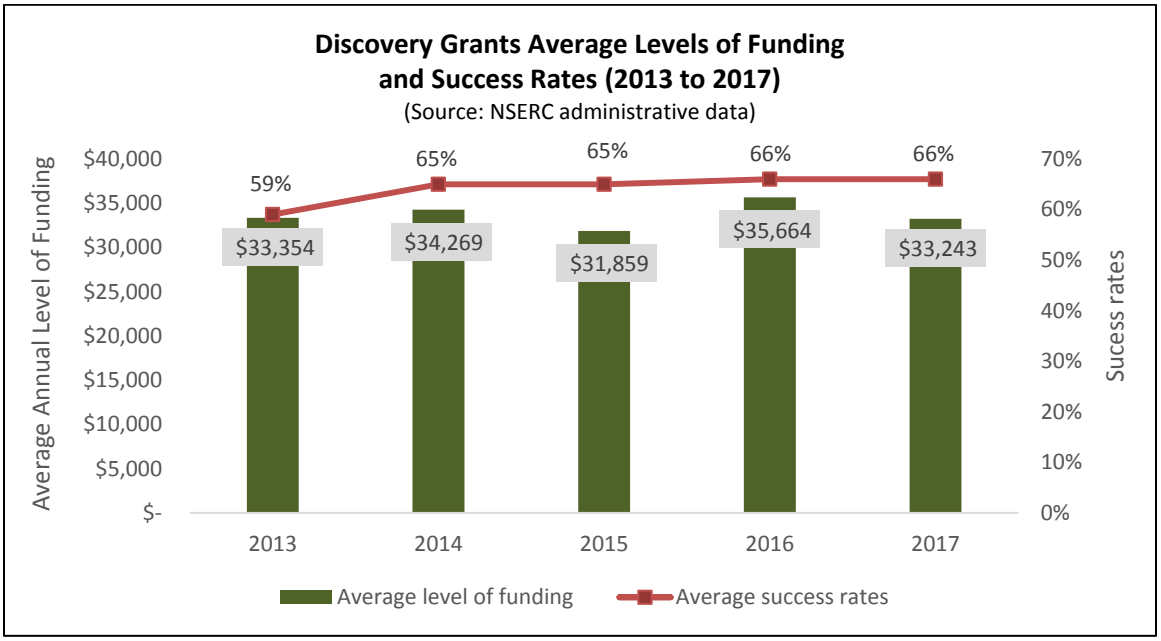


Figure 4

The central issue for this evaluation is the extent to which the program is sustainable. Findings strongly support the view that the program's fundamental logic – whereby a large base of researchers receive a meaningful grant-in-aid – is sound and responds to a well-documented need to sustain curiosity-driven research in Canada in the fields of natural sciences and engineering. However, and while it may run counter to the vision of some stakeholders, it also appears necessary to emphasize the fact that there is simply no plausible avenue that would lead the Discovery Grants to be anything but a "grant-in-aid". For the vast majority of program recipients, their research programs will always require additional funding that will need to come from other sources.

On that basis, and in order to continue providing a *meaningful* grant-in-aid, the Discovery Grants must somehow manage inflationary pressures. At the time of the evaluation, it remained unclear how this could be achieved in a predictable and sustained fashion. Adjustments to the level of Discovery Grants have continued to be dependent on variables over which the program has limited or no direct control, such as the number of applicants and the overall budgetary envelope available for distribution. As the program is expected to remain a central component of Canada's research funding ecosystem, this issue of sustainability is bound to remain a challenge.

Distribution of Funding Among Evaluation Groups

As already noted and illustrated in Figure 3 (page 18), average Discovery Grants vary considerably among the Evaluation Groups. The average grant for chemistry is more than twice the average for mathematics and statistics. As noted throughout the interviews held as part of this evaluation, there is

[10] This statistic includes DG, as well as DAS, SAP DG and the new Discovery Launch Supplement (not included in this evaluation).

an intuitive logic that undertaking research in chemistry is more expensive than pursuing research in mathematics. Costs associated to laboratories, equipment or material would logically be higher.

As such, it is generally recognized that the costs of research can vary by discipline and that this may result in variations in the funding levels among different disciplines. However, at the time of the evaluation no publicly available information could explain and justify the magnitude of these variations, and how they are reflected in the Discovery Grant Evaluation Group budgets and in the range of average grant sizes across disciplines. This has led to speculation among the stakeholders consulted and raised questions about the fairness of the current model. Among other things, it was noted that the cost of undertaking research is constantly evolving, driven in part by technological innovations. In the absence of any available documentation, one can only speculate as to the appropriateness of the current differences noted among Evaluation Groups.

Other Considerations Relating to the Program

Interviews with Evaluation Group members and national and international research prize winners, as well as the applicant survey provided more conceptual insights about the impact of the Discovery Grants program. The following paragraphs summarize the key findings.

There is a shared perception that the Discovery Grants program serves as a powerful statement about Canada's philosophical approach to supporting research. Comparisons were regularly made with approaches adopted in other countries, most notably in the United States, where success rates are substantially lower. As one researcher noted during their interview: "When a program that supports fundamental research operates with success rates of 10% or 15%, it sends the wrong message. I cannot believe that 85% or 90% of researchers out there are not worth supporting." Other researchers emphasized that, following postdoctoral fellowships or experiences as faculty members in foreign universities, they purposely came back to Canada in great part because of the funding provided by the Discovery Grants, which, they argued, supports a far more collegial and healthier environment in which to conduct long-term and meaningful research.

The flexibility that Discovery Grants offer was also unanimously praised. Combined with five-year funding cycles, it creates a solid base upon which research programs (as opposed to research projects) can be undertaken. It genuinely allows researchers to take risks, shift directions, and essentially follow the unexpected path that curiosity-driven research requires.

In addition to being a grant-in-aid from a purely financial perspective, the so-called "NSERC seal of approval" that comes from securing a Discovery Grant also facilitates access to funding from other sources. Resulting from an extensive peer-review process, a Discovery Grant further establishes the credibility of a researcher, particularly an emerging one, which in turn helps to secure the needed funding to fully undertake their research program. Here again, many researchers who were interviewed emphasized how critical this initial step had been in carving the early stepping stones of their academic career.

The impact that a Discovery Grant may have in terms of establishing one's career was also echoed in the survey results. When comparing funded and unfunded applicants, survey results indicated that funded researchers were significantly more likely to be part of organizing committees for major international

conferences, to receive a provincial, national or international award or prize, and to be invited to participate in the peer review process.

Operational Processes

With over 3,000 funding applications being submitted annually, NSERC has developed a robust peer-review process that is constantly being modified and adjusted to reflect emerging best practices and feedback received from those engaged in this process. Of note, the 2008 program evaluation focused on this process, and provided recommendations that led to fairly significant changes, including the decision to move from 28 Grant Selection Committees to the current 12 Evaluation Groups structure and the establishment of the conference model (NSERC, 2008a, p. 3).

The very fact that, annually, more than 400 Canadian and international researchers from academia, governments and the private sector agree to volunteer a significant amount of their time to participate in the 12 Evaluation Groups attests to the level of commitment the Discovery Grants Program enjoys (NSERC, 2012). This evaluation provided an opportunity to, once again, take stock of the program's perceived strengths and shortcomings.

Perceptions of Applicants

Generally speaking, researchers who apply for a Discovery Grant appear to be knowledgeable about the peer review process. In total, 76% of the survey respondents indicated that they are adequately informed. Perhaps not surprisingly, applicants who were successful tended to report a higher level of satisfaction (78%) compared to applicants who did not secure funding (67%). In fact, the more successful and experienced researchers are, the more comfortable they are with the peer review process.

However, some applicants believe that the current process, as it stands, does not provide Evaluation Group members with all the required information to make well-informed reviews:

- Overall, 59% of survey respondents consider that the information available to Evaluation Group members is sufficient.
- The expected split between successful and unsuccessful applicants is confirmed: 64% of successful applicants indicated that sufficient information is provided compared to 38% among unsuccessful applicants.
- Over time, there is also a downward trend in the perception of applicants. Specifically, 63% applicants who submitted applications in 2013 reported they believed the information available to Evaluation Group members is sufficient, compared to only 55% of applicants who submitted their applications in 2017.

Perceptions of the Evaluation Group Members

Members of the Evaluation Groups who were interviewed as part of this evaluation generally held a positive perception of the review process. They systematically referred to it as being well structured, fair, transparent, rigorous and adaptable. On numerous occasions, Evaluation Groups' members also praised the sustained and professional support they received from NSERC officials throughout the entire review process.

The extent to which they have sufficient information to make well-informed decisions was not raised by Evaluation Group members as being particularly problematic. In fact, the current workload of Evaluation

Group members is perceived as being quite significant, leading some to note that additional documentation that may be added to applications (e.g., published articles) is seen as not being particularly helpful as they are unlikely to be read. Where Evaluation Group members expressed more concerns is around the Canadian Common CV (CCV), which is meant to offer a standardized curriculum vitae that applicants can eventually use when applying to any of the three granting agencies. As it currently stands, the CCV is perceived as being challenging to navigate in order to extract the relevant information. Evaluation Group members have indicated that the CCV is, in fact, slowing down the review process as opposed to making it more efficient.

In terms of improvement, Evaluation Group members who were consulted first noted that NSERC has an ongoing process that allows them to provide feedback to program officials and the experience to date indicates that this feedback does lead to adjustments and improvements to the process. Keeping this in mind, the interviewees pointed to the following potential areas of improvement:

- Modify the CCV to make it more relevant to the Discovery Grants review process;
- Facilitate greater exchanges among the various Evaluation Groups chairs and co-chairs to ensure consistency in the application of the evaluation criteria;
- Further support the role of chairs and co-chairs. While a detailed peer review manual is available for Evaluation Group members, it was noted that additional information could be provided on the specific role expected from chairs and co-chairs (best practices, terms of reference, roles and responsibilities, potential issues to flag during deliberation, etc.);
- Manage workload of Evaluation Group members. The high volume of applications is placing significant pressures on Evaluation Group members, leading some chairs to be concerned about reviewer fatigue, and the ability to recruit new members. While many perceive the role of Evaluation Group member as a recognition from peers of one's contribution to his or her field of research, it remains a demanding task undertaken on a volunteer basis.

2.3 Funding Supplements

Summary of findings: The funding supplements (DAS, NRS and ST) provide highly complementary support that greatly enhances the Discovery Research Program's ability to respond to researchers' needs. The DAS funding provides an opportunity to inject timely resources to accelerate particularly promising research programs. While highly targeted to certain research communities, the NRS and ST are directly aligned with the interests of Canada in northern research and research involving oceans and other large bodies of water, and help to meet the high cost of research in these environments.

Compared to Discovery Grants, funding supplements provided to program recipients are far more directed. The following paragraphs summarize evaluation findings concerning DAS, NRS, and ST. As noted in the program description, access to these supplements is limited to researchers who also hold a Discovery Grant.

The Discovery Accelerator Supplement (DAS) Program

As per the program structure, a total of 125 researchers were selected per year, for a total of 625 researchers who received DAS support over the five-year evaluation period. All awards had an equal value of $120,000 over three years ($40,000 per year) and were distributed among all Evaluation Groups

and SAP. Overall, 94% of DAS awards were allocated to established researchers and the remaining 6% to early career researchers. The vast majority of these researchers were in large institutions (83%), as opposed to medium (13%) or small (4%) institutions. (NSERC, 2019c, p. 27)

The 2014 Discovery Grants program evaluation covered the DAS, and noted that its actual intent had somewhat shifted over time, which had not been clearly communicated. The panel also noted that the selection process was lacking transparency (NSERC, 2014a, p. 15). As for the actual results achieved through DAS, the panel concluded that it was too early to assess them.

Findings from this evaluation echo some of these concerns, but do provide greater insights on this supplement's impacts.

As for effectively communicating the precise intent of the supplement and the selection process used to allocate DAS funding, evaluation findings confirm that it remains somewhat of a challenge. Interviews with Evaluation Group members show diverging views, with some praising this supplement for its timely support to promising and innovative research activities, while others remained uncertain as to the actual need for such an additional support, particularly in light of the bin system that already provides additional funding for higher ranked proposals. Moreover, since researchers do not apply for DAS funding and the recommendation to allocate this support is purely internal to each Evaluation Group, it appears likely that some uncertainties around the allocation process will persist.

Survey results left no doubt, however, as to the impact reported by those who benefit from the supplement. They consistently noted that having this additional support has allowed them to accelerate their research, explore new lines of inquiry, improve their international competitiveness, increase their international visibility, hire additional new HQP, conduct high-risk research, and conduct more collaborative and interdisciplinary research to some or to a great extent.

Reports provided by funding recipients provided further illustrations of the range of impact that DAS funding may have. For instance, one recipient noted:

> "In addition to the financial advantages, DAS really made a difference for my recognition at my university and in the Canadian scientific community in my field. My colleagues and the staff at the faculty publicized my award and it did help me to obtain tenure."

Another recipient noted the immediate impact that the funding had on the research undertaken:

> "The accelerator supplement was instrumental in allowing me to immediately hire several HQP and to train them within the framework of our research program. The majority of the accelerator supplement was used for salaries. (…) While the accelerator did not fully financially support all the HQP until the end of their degree, it allowed me to acquire publishable results that could attract other funding and that could contribute to the finances of my research laboratory."

Finally, it is worth noting that the bibliometric analysis showed that, during the core review period, DAS recipients systematically outperformed non-DAS recipients in research outputs, except for the share of highly interdisciplinary papers. This does not assume a causal impact, but rather illustrates the fact that DAS recipients do pursue promising research activities that can be expected to lead to greater intensity in publications.

The Northern Research Supplement (NRS)

As part of their individual Discovery Grant application, applicants can also apply for an NRS supplement. During the review period, a total of 229 individual Discovery Grant applications included an NRS application. Of those, 181 were successful DG applicants which made them eligible for the NRS supplement. Of the 181 successful DG applicants, a total of 134 researchers were successful in receiving NRS during the five-year period, for an average of 27 recipients per year. The average success rate stood at 74%. However, when considering the global pool of NRS applications, the average success rate was 58%. The vast majority of the funded researchers (90%) came from the fields of geoscience, and evolution and ecology. While 70% of these researchers worked in large institutions, 17% worked in small ones, with the remaining 13% working in medium institutions. (NSERC, 2019b, p. 28)

As noted during interviews, conducting research in the North is costly, and a researcher's Discovery Grant can rapidly be spent on basic travelling and accommodation expenses associated with arctic research activities. Yet, the Canadian North is of strategic importance to Canada. As a result, NSERC has established a number of funding opportunities that focus on Northern research, such as the NRS or the Northern Earth System Research call for proposals issued as part of the Discovery Frontiers program (NSERC, 2010, 2019k).

Through the survey, Discovery Grant recipients who focus on northern research expressed strong opinions on the relevance of the NRS. Those who were able to secure funding emphasized the positive impact it has had at multiple levels, such as covering added costs that are unique to research in the North, improving the quality of the training they provide to students engaged in Northern research, collaborating with other researchers, engaging with northerners, and leveraging other funding. Not receiving the requested support is also reported to have had a direct negative impact in the same areas. In the absence of NRS funding, survey findings indicate that some researchers were able to secure funding from other sources, such as other federal research grants, their provincial governments, or their universities. However, evaluation findings did not allow for a comparison between the NRS funding and these other sources of funding, particularly in relation to the level of funding provided.

During interviews, it was noted that the NRS places particular emphasis on engagement with communities in the North. In that sense, NRS was seen as being complementary to other measures that pursue a similar goal, such as the Northern Scientific Training Program currently offered by Polar Knowledge Canada, which directly supports Canadian university students who are engaged in northern studies and conducting thesis research in Northern regions (Polar Knowledge Canada, 2018).

The Ship Time Supplement

With a total of 38 principal investigators[11] who received the Ship Time supplement during the five-year period, for an average of eight awards per year, this is the smallest component of the Discovery Research Program being evaluated. The average success rate during the evaluation period stood at 75%. Just like NRS, the vast majority of the funded researchers (84%) came from the fields of geoscience, and evolution and ecology.

[11] The average number of co-applicants on Ship Time supplement is 2.24.

As a result of the limited number of applications for this funding, the range of insights gathered as part of the evaluation is limited. Survey results indicate that those who have secured Ship Time funding have, in fact, succeeded in accessing vessels, undersea vehicles or other similar research platforms in support of their research programs. They have also used that funding to leverage other funding. As a result, support for ship time has contributed, among other things, to the quality of their research, of the training they provide to HQP, and of the collaborations they have engaged in with other Canadian researchers.

During interviews, it was again emphasized that while the Ship Time component may be highly targeted, it remains critical for a country such as Canada where research on large bodies of water is of scientific, political, and commercial interests. In that sense, the same logic that drives the relevance of the NRS also applies to Ship Time.

2.4 Research Tools and Instruments (RTI) Funding

Summary of findings: The RTI funding complements support provided through the CFI and other funders of equipment and infrastructure. At the time of the evaluation, a significant portion of researchers in the fields of natural sciences and engineering did not have access to equipment that was adequate to undertake cutting-edge research. Despite their needs, few researchers access RTI support due to the level of funding available for RTI. In this context, the RTI Program is not in a position to meet the needs of the research community.

RTI funding is not limited to individuals who also receive Discovery Grants. However, for the purpose of this report, statistics only include researchers who have, in fact, received both Discovery Grants and RTI funding. Keeping this in mind and considering the five-year evaluation period, an average of 214 RTI per year were awarded (see Table 7). It should be noted that each grant may support a number of researchers (applicant and co-applicants).

Table 7: Statistics on Yearly Allocations of RTI Grants among Discovery Grant Recipients

Competition Year	Funded (n)	Not Funded (n)	Total (n)	Quotas (n)	Success Rate (%)
2013	249	852	1,101	n/a	23%
2014	163	255	418	500	39%
2015	204	413	617	700	33%
2016	199	421	620	700	32%
2017	254	586	840	800	30%
Total	1,069	2,527	3,596		30%

Source: NSERC administrative data

To help manage the intake of applications, NSERC established quotas for the number of applications that could be received during four of the five years covered by the evaluation. The implementation of these quotas necessarily had a direct impact on the success rates of applicants. Statistics included in Table 7 must therefore be considered accordingly. In 2018, NSERC ceased to use quotas and, during the 2018 and 2019 competitions, NSERC received approximately 1000 applications for each of those years, and success rates stood at approximately 20% (NSERC administrative data). While all Evaluation Groups applied and received RTI funding, the following groups received the greater share of the funding:

- Civil, industrial and systems engineering
- Biological systems and functions
- Chemistry
- Genes, cells and molecules

During the review period, the vast majority of RTI grants went to large institutions (85%), while medium institutions received 11% of the grants and small institutions received 4% of the grants. The average amount awarded was $111,090, with a standard deviation of $43,649. The minimum amount awarded was $7,732 and the maximum was $150,000 (NSERC, 2019c, p. 46).

The Perceived State of Research Equipment

The survey conducted as part of this evaluation provided an opportunity to gather the views of researchers on the actual condition of their equipment. Respondents indicated that most of their equipment was in good or very good condition. More specifically, 84% of respondents who received RTI funding indicated that their equipment was in good or very good condition, whereas that level stood at 76% for non-RTI funded respondents.

However, having equipment in good condition does not necessarily mean that it is adequate for the nature of the research being undertaken. Simply put, inadequate equipment may well be in perfect condition. In that regard, survey results painted a more troubling picture. Only 32% of non-RTI funded respondents and 55% of funded respondents indicated that their equipment was adequate to undertake cutting-edge research. Worse still, only 25% of respondents from small institutions indicated that their equipment was fit for cutting-edge research.

Funding Options

Natural sciences and engineering tend to require complex laboratories and other types of research equipment. And even within these fields of research, requirements vary considerably. In order to secure the funding needed to purchase the necessary equipment, researchers turn to a variety of sources. Respondents to the survey offered insights on the main funding sources (other than RTI). Results are presented in Figure 5.

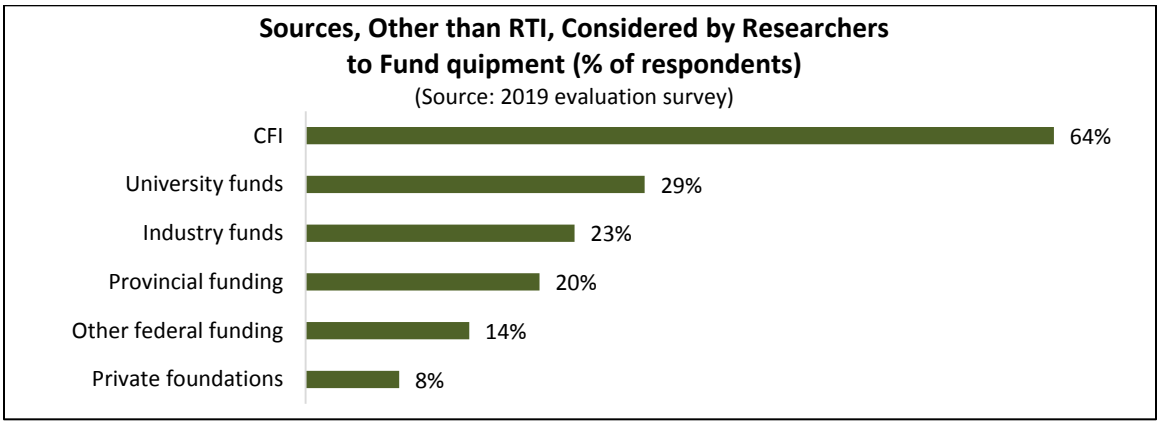


Figure 5

The CFI stands as another pillar of Canada's research funding ecosystem, focusing specifically on the infrastructure needed to carry out high-quality research. Since its inception in 1997, the CFI has

operated on a cost-share basis, typically funding up to 40% of project costs for research infrastructure, which may include equipment, laboratories, databases, specimens, scientific collections, computer hardware and software, communications linkages, and buildings necessary to conduct leading-edge research (CFI, 2019a). To date, the CFI has funded close to 11,000 infrastructure projects, representing an investment of over $8 billion (CFI, 2019b). Most matching contributions come from provincial governments, but also from universities, colleges, businesses and charities (Naylor, 2017, p. 126). Of note, the CFI only funds projects submitted by institutions, not by individual researchers, and it generally funds projects that are much larger than those funded by RTI.

The Relative Contribution of the RTI Funding

In this broader context, and as reflected in the interviews, some concerns were expressed relating to the actual niche of the RTI program and potential overlaps with other sources of funding, such as the ones offered by the CFI.

Evaluation findings indicate that, in fact, the RTI funding has a meaningful contribution to make, distinct and complementary to other funding sources. These same findings also indicate that the RTI program, as it currently operates, is falling considerably short of meeting the needs it is meant to address.

As previously noted, once quotas on applications were eliminated, the recent program history shows that only 20% of applicants succeed in securing RTI funding. The data covering the evaluation period (which include quotas for most years) also indicates that researchers from small institutions are far less successful in their applications when compared to colleagues operating in medium and large institutions (see Figure 6). While one may expect large institutions to secure more grants and more funding, the fact that their researchers would register success rates that are double those of researchers in small institutions is far more concerning and point to a systemic challenge in program access.

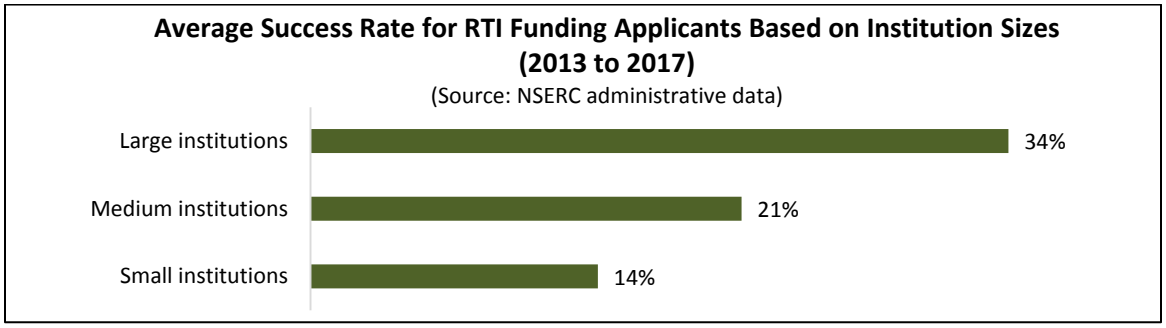


Figure 6

Globally, evaluation findings indicate that a large portion of Canadian researchers in natural sciences and engineering are not operating with the equipment required to engage in cutting-edge research and that this issue is particularly felt by researchers from small institutions. While the RTI program does provide some support, highly valued by funding recipients, it does not address the needs of most applicants who are simply unable to secure funding. For various reasons, it appears that other sources of funding are not filling that gap. In particular, the critical support that the CFI provides is of a different nature and operates at the institutional level (typically on a five-year cycle), not at the researcher level.

Moreover, and from an operational perspective, it was noted during interviews that the funding envelope for RTI resulted from some baseline funding from the Discovery Research Program to which unused funds from other NSERC programs were added, creating some level of uncertainty as to the

overall resources available from one year to the next to support the achievement of the RTI's expected outcomes.

2.5 Funding mechanisms

Summary of findings: To reflect the specific needs and characteristics of the fields of subatomic physics, as well as mathematics and statistics, NSERC has established specific funding mechanisms. The evaluation has found that, while there is a strong support for the current SAP funding mechanism, views diverge on the extent to which the funding mechanism for mathematics and statistics meets the current needs of that community of researchers.

The Discovery Research Program includes two funding mechanisms that provide specific funding frameworks for subatomic physics, and for mathematical and statistical sciences. This subsection covers each of them individually.

The SAP Funding Mechanism

As noted in the description of the Discovery Research Program, funding for the Subatomic Physics (SAP) suite of programs has been made through an independent funding mechanism since 1991. It covers SAP-IN, SAP-PJ, SAP-RTI, and SAP-MRS[12], and involves a SAP Evaluation Section that supports the overall planning and allocation of SAP funding. This comprehensive approach reflects recommendations made by the community in consecutive editions of the 5-yearly Canadian Subatomic Physics Long Range Plan, the most recent of which was published in 2016 (Subatomic Physics Long-Range Planning Committee, 2016). It is expected to meet the special needs of the SAP research community, given the complexity and interdependency of many proposals, which are often parts of international programs and collaborations, and involve many universities and national laboratories. The SAP Evaluation Section makes recommendations on funding across the components of the SAP funding mechanism to allow for planning and stability in the execution of large scale and long-term projects while maintaining a balance between large projects and the smaller research efforts that are essential to individual research programs.

SAP Individual Discovery Grants

Per year, an average of 18 researchers in subatomic physics received SAP Individual Discovery Grants during the evaluation period, with a high success rate, reaching 94% in 2017. Further details are included in Table 8.

[12] As a reminder, SAP-IN refers to SAP Individual Discovery Grants, SAP-PJ to SAP Project Grants, SAP-RTI to SAP Research Tools and Instruments, and SAP-MRS to SAP Major Resources Support.

Table 8: Statistics on Yearly Allocations of SAP Individual Discovery Grants

Competition Year	Funded (n)	Not Funded (n)	Total (n)	Success Rate (%)
2013	18	5	23	78%
2014	11	5	16	69%
2015	23	2	25	92%
2016	20	2	22	91%
2017	16	1	17	94%
Total	88	15	103	85%
Source: NSERC administrative data				

The average amount awarded (based on all 5 years considered for the evaluation) is $57,828 (Std. Deviation = $27,115). This level of funding is slightly higher than what is found under the general Discovery Grants among the Evaluation Groups (see Figure 3 on page 18). During the period covered for this evaluation, the minimum annual amount awarded was $6,000 and the maximum annual amount awarded was $172,700. The average length for a SAPIN is 4.3 years. The normal length is 5 years, but some researchers terminated theirs early.

Just like the general Discovery Grants, SAP Individual Discovery Grants were predominantly provided to established researchers (86%) as opposed to early career researchers (14%). These grants were also predominantly received by large institutions (73%), while medium institutions received 16% of the grants and small institutions received the remaining 11%.

SAP Project Discovery Grants

Groups of researchers in subatomic physics (SAP collaborations) may jointly submit an application to receive SAP project grants. Typically, researchers receiving support from SAP project grants do not also hold a SAP individual Discovery Grant. These collaborations reflect the long-range planning principle to ensure impact by concentrating SAP community efforts on certain projects. Many SAP projects are long-term, international collaborations and NSERC funding are often co-ordinated with CFI. As indicated in Table 9, a total of 96 such applications were submitted during the evaluation period, with an average success rate of 89%.

Awards made under the SAP Projects' component are usually 3 years in duration; however, these are often long-standing projects– much longer than the scope of this evaluation. Applicants, who can change over time, reapply to SAPPJ to maintain ongoing funding for their project. With this in mind, in order to give a measure of the average size of a project funded under this program, we have taken the average annual instalment for a SAP Project. The total funding provided to each project during the evaluation period averaged $385,218 (Std. Deviation = $775,124), with a minimum annual amount of $20,000 and a maximum annual amount as high as $6,000,000.

The majority (59%) of the SAP Project Discovery Grants went to large institutions, whereas medium institutions received 34% of these project grants, and small institutions received 7%.

Table 9: Statistics on Yearly Allocations of SAP Project Discovery Grants

Competition Year	Funded (n)	Not Funded (n)	Total (n)	Success Rate (%)
2013	18	1	19	95%
2014	14	4	18	78%
2015	18	2	20	90%
2016	16	2	18	89%
2017	19	2	21	91%
Total	85	11	96	89%
Source: NSERC administrative data				

SAP-RTI

To support the purchase of research equipment and installations in the field of subatomic physics, the SAP-RTI has been providing an average of five grants per year during the period covered by the evaluation (see Table 10). Just like the general RTI funding, the success rate has been fairly low, averaging 36%, with important fluctuations between 16% and 55%.

Table 10: Statistics on yearly allocations of SAP-RTI grants

Competition Year	Funded (n)	Not Funded (n)	Total (n)	Success Rate (%)
2013	3	16	19	16%
2014	9	9	18	50%
2015	3	7	10	30%
2016	4	8	12	33%
2017	6	5	11	55%
Total	25	45	70	36%
Source: NSERC administrative data				

The amount of funding provided through each SAP-RTI grant varied between $14,099 and $575,000, with an average of $115,681.

SAP-MRS

The Subatomic Physics Major Resources Support Program (SAP-MRS) is expected to facilitate the effective access by researchers in the field of subatomic physics to major and unique national or international (based in Canada) experimental or thematic research resources, by financially assisting these resources to remain in a state of readiness for researchers to use (NSERC, 2019o).

Between 2013 and 2017, 18 applications for SAP-MRS were submitted, of which 16 were funded (success rate of 89%). As SAP-MRS grants can have varying durations, the average amount awarded is based on the total sum awarded over the duration of the grant. The average amount awarded for a SAP-MRS is $811,583 (with a standard deviation of $1,006,148). The minimum amount awarded was $145,000 and the maximum was $3,340,000.

Among these grants, some were used to fund institutes such as the Institute of Particle Physics and the Canadian Institute of Nuclear Physics, which are discussed in subsection 2.6.

Views on the SAP funding mechanism

Researchers in subatomic physics who participated in the evaluation survey strongly endorsed the current SAP funding mechanism. They almost unanimously agreed that this structure is valuable for the field, that it effectively supports the implementation of the strategic priorities contained in the SAP Long-Range Plans (Subatomic Physics Long-Range Planning Committee, 2016), and that the current distribution of funding among the various SAP components does reflect the priorities of this community.

As noted during interviews, the specific research on neutrinos undertaken by Dr. Arthur McDonald provides a good illustration of how the SAP funding mechanism can be flexible to meet specific research program requirements. Over an extended period of time (1991 to 2019), over $29 million in SAP funding has been allocated to the research led by Dr. McDonald and involving a wide range of other researchers (NSERC, 2019f). This led to remarkable discoveries that earned international recognitions, including the 2015 Nobel Prize in Physics (The Nobel Prize, 2019).

The Mathematics and Statistics funding mechanism

The Mathematics and Statistics funding mechanism includes the budget for Discovery Grants for the Evaluation Group 1508 (Mathematics and Statistics), as well as the budget for the Collaborative and Thematic Resources Support in Mathematics and Statistics (CTRMS), through which six research institutes are currently supported by four awards.

The concept of combining these two funding opportunities under a single funding mechanism was recommended in the Long Range Plan for Mathematical and Statistical Sciences Research in Canada 2013–2018 (LRP Steering Committee, 2013). When NSERC established this mechanism in 2014, each of the two components maintained the same level of funding committed at that time, which meant that 81% of the funding under the mechanism was directed to Discovery Grants for 1508 while the remaining 19% was directed to supporting research institutes (formally under the Major Resources Support Program and now under the CTRMS). While the amount of funding for this mechanism has fluctuated, the distribution between the two funding opportunities (81% and 19%) has been maintained during the review period.

NSERC has also established the Mathematics and Statistics Discovery Grants Liaison Committee (MSLC), which has a mandate to advise on budget allocation principles and on the management of the NSERC Mathematics and Statistics funding mechanisms as a whole.

Views on the Mathematics and Statistics mechanisms

The survey conducted as part of this evaluation provided an opportunity to assess the perspectives of some of the Canadian researchers involved in mathematics and statistics as to the relevance of the current funding mechanism. Overall, a fragmented picture emerged from these findings:

- A large majority of respondents (72%) have indicated that the current funding mechanism has proven to be valuable to the mathematics and statistics research community.
- Half of the respondents agreed that the decision to divide the funds awarded through the Mathematics and Statistics funding mechanism in the ratio of 81% to Discovery Grants and 19% to CTRMS was appropriate. The support for this distribution was higher (63%) among those receiving

larger grants (from the highest bin groups), and much lower (19%) among those receiving smaller grants (from the lowest bin groups).

- Given the same budgetary envelope, the majority of respondents (67%) were of the opinion that NSERC should prioritize Discovery Grants over the funding for research institutes.
- Finally, half the respondents were of the opinion that the current funding mechanism in mathematics and statistics should be restructured to meet the current needs of the community.

2.6 Research Institutes

Summary of findings: A number of research institutes in mathematical, statistical, and natural sciences have been established in Canada. They have broadened the range of activities in which researchers, both established and ECRs, and students can engage to collaborate, create new knowledge, enhance their skills, build their professional networks, and facilitate their transition and growth as researchers. Some of these institutes have received funding from NSERC, through various programs and, more recently, from the Discovery Research Program. There is a strong rationale for supporting the work of these institutes, as they directly contribute to research excellence in Canada. The incremental approach used to date by NSERC to support these institutes has succeeded in providing them with fairly stable funding. However, NSERC has yet to establish a clear vision of how it intends to approach the funding of research institutes in Canada in a manner that is more sustainable in the longer term.

Needs Addressed by the Funding for Institutes

General Findings

Research institutes have a long history in Canada, dating back to the 1960s. Their emergence reflects international trends whereby research in some fields of natural sciences and engineering rely particularly heavily on collaboration and co-creation, which research institutes are meant to facilitate.

Regardless of the specific fields in which they specialize, each research institute is focused on supporting the creation of new knowledge, enhancing interdisciplinary and multidisciplinary research, and expanding the range of learning and career development opportunities provided to researchers, including graduate students, postdoctoral students, and ECRs. Activities undertaken by research institutes include research funding, conferences, workshops, summer schools, and other research collaboration opportunities.

Over time, NSERC has provided funding for some of these institutes, particularly through its Major Facilities Access (MFA) Program and, starting in 2006, its Major Resources Support (MRS) Program. These two programs' primary goal was to facilitate the access of Canadian researchers to major regional, national, or international (based in Canada) experimental and thematic research resources by financially assisting these resources to remain in a state of readiness for researchers to use. The MRS Program also aimed to assist Canadian researchers, who come together as consortia, in accessing major resources located abroad and whose equivalent is not available in Canada. In the case of the subatomic physics community, SAP-MRS replaced the SAP-MFA component within the SAP funding mechanism.

In 2012, the Government of Canada placed the MRS Program under moratorium, and it was subsequently phased out (NSERC, 2016). For theoretical research institutes holding MRS grants, NSERC stated its intent to continue providing a peer review and funding framework outside the MRS Program.

The communities holding these MRS supported research institutes worked with NSERC to develop their own unique funding frameworks. In response to long-range plans in subatomic physics (Subatomic Physics Long-Range Planning Committee, 2016), the SAP-MRS continued within the SAP funding mechanism. In response to the 2012 long-range plan in mathematical and statistical sciences (LRP Steering Committee, 2013), NSERC established the CTRMS Program. Once the MRS program had been phased out, NSERC established the CITA component to facilitate the access to major and unique national or international thematic research resources in the field of theoretical astrophysics for Canadian academic researchers. Only CITA has received funding under this program.

At the time of the evaluation, and as indicated in Table 11, a total of nine institutes were supported through the Discovery Research Program. In the meantime, other research institutes, such as the Canadian Institute for Ecology and Evolution or the Pacific Centre for Theoretical Physics, have been operating without such funding.

Table 11: Research Institutes Funded through the Discovery Research Program

Institutes	Funding mechanism
Atlantic Association for Research in Mathematical Sciences (AARMS) *	Collaborative and Thematic Resources Support in Mathematics and Statistics (CTRMS)
Banff International Research Station (BIRS)	
Canadian Statistical Science Institute (CANSSI) *	
Centre de recherches mathématiques (CRM)	
Fields Institute for Research in Mathematical Sciences (Fields)	
Pacific Institute for the Mathematical Sciences (PIMS)	
Canadian Institute of Nuclear Physics (CINP)	SAP – Major Resources
Institute of Particle Physics (IPP)	
Canadian Institute for Theoretical Astrophysics (CITA)	CITA
* Funded indirectly through contributions from CRM, PIMS and Fields institutes.	

Evaluation findings indicate that funded institutes carry out activities in line with the fundamental objectives of the Discovery Research Program, particularly when it comes to supporting knowledge creation and dissemination, and providing a stimulating environment for researchers, including emerging or new researchers.

Along the same lines, and as applicable among the various fields of research, the funding to research institutes complements individual and SAP Discovery Grants (and, as applicable, the supplements provided) offered through the Discovery Research Program. It adds a new layer of development by engaging HQP in activities that allow them to access national and international research leaders in their fields, participate in thematic conferences and workshops, build their professional networks, and in the case of postdoctoral students, facilitate their transition towards academic or other research-oriented careers.

The funding provided to research institutes also responds to a need to ensure some degree of regional fairness in the range of research opportunities provided to researchers and students involved in the

fields of research that rely on institutes. The natural dynamics of large urban centres are such that the ability universities located in outlying areas have to attract international experts or to offer advanced training opportunities in these fields is limited. The funding provided to research institutes, particularly those located in smaller centres, mitigates, in part at least, these disparities.

Impact of Funded Activities

Reach of the Funded Institutes

Not all researchers engage with funded research institutes, but those who do report a range of benefits that have furthered their careers.

As an indication of reach, close to a quarter (24%) of researchers who participated in the evaluation survey indicated that they have had some interaction with at least one of the funded research institutes. Not surprisingly, as these institutes focus on specific fields of research, the level of engagement varies considerably among discipline groupings:

- 94% of survey respondents from the fields of subatomic physics indicated that they interacted with one of the institutes. Similarly, for mathematics and statistics, 93% of survey respondents in these fields indicated that they had interacted with research institutes.
- Those receiving Discovery Grant funding reported a higher level of interaction (26%) compared to unfunded applicants (16%).
- Finally, established researchers reported a higher level of interaction (25%) compared to ECRs (19%).

Looking more specifically at those survey respondents who reported no interaction with any research institutes (funded or not funded by the Discovery Research Program), the vast majority (89%) indicated that their research did not align with what the institutes are offering, whereas a small portion of respondents (13%) did not see the added value of being involved with an institute.

Perceived Benefits for Researchers

The range of activities that funded institutes deliver varies and reflects a number of factors such as the fields in which these institutes are involved in, their history, their geographical locations, and the specific needs they wish to address. Some institutes reach larger audiences (including, in some cases, students in primary and secondary schools), while other institutes target researchers who wish to collaborate in knowledge creation and dissemination (such as collaborative research groups), or individuals who are transitioning from graduate studies or postdoctoral fellowships towards faculty positions or other types of formal research career paths. Some institutes offer the majority of their activities onsite, while others operate largely virtually.

Keeping this in mind, most funded research institutes organize activities that directly engage established and emerging researchers, as well as students, particularly but not exclusively graduate students. Workshops, conferences, competitions, or summer schools are some of the activities offered that engage students, as well as other researchers. Statistics provided by the funded institutes indicate that their activities (conferences, workshops, summer schools, etc.) may engage anywhere between 100 to close to 2,000 students annually per institute, depending largely on the location of the institute and the nature of the activities.

Postdoctoral fellows and ECRs represent also a significant group of beneficiaries for the activities offered by the institutes. In fact, all funded institutes organize activities that serve these individuals. In addition to the activities already mentioned, such as conferences and workshops, several institutes offer postdoctoral fellowships or provide opportunities for ECRs to join established researchers as part of collaborative research groups and other activities. In the case of postdoctoral fellowships, the number of holders may vary between five and 15 holders per institute.

Findings from the evaluation survey echoed these observations. Respondents who have engaged in the institutes' activities indicated that their participation, among other benefits, had enhanced their visibility and recognition within the field, led to the creation of new knowledge, enhanced research dissemination, and facilitated inter and multidisciplinary research. Of note, almost two thirds (62%) of survey respondents who had interactions with an institute reported that they engaged in collaborations as a result of this participation.

Efficiency of the Current Funding Provided to Research Institutes

While programs used to support research institutes have evolved and changed, the support itself has proven to be fairly stable. This is seen as an important achievement, since research institutes have used this NSERC support to systematically leverage other funding. From a programmatic perspective, however, the incremental nature of the funding arrangements implemented to date does raise some fundamental issues. At the time of the evaluation, the overall program framework was the following:

- Of the six institutes funded through CTRMS grants, two of them, namely CANSSI and AARMS, are only indirectly receiving funding from NSERC, since they are receiving funding from PIMS, CRM and Fields. While several factors may explain this situation, it is hardly a sustainable approach moving forward.
- Two institutes involved in particle and nuclear physics are receiving funding.
- CITA is the sole applicant and recipient of the CITA program.

In addition, the current funding framework is such that funding for all institutes, except CITA, is largely positioned in relation to other grant funding. For mathematics and statistics, their funding is established t in relation to individual Discovery Grants, whereas for subatomic physics, it is positioned in relation the other components of the SAP funding mechanism (SAP-IN, SAP-PJ, and SAP RTI). In the context of a fixed overall budget, if the funding mechanism were to operate as planned, any increase provided to these institutes would reduce the funding available for the other grants. This situation has arguably contributed to the fact that the level of funding provided to institutes has remained largely the same for several years, despite the expected rise in costs for delivering many of the activities they offer.

Evaluation findings indicate that the most significant gap that NSERC is facing at this point results from its fragmented vision and strategy on how to globally, consistently and fairly support research institutes that are engaged in fields related to the NSERC mission, and to provide its funding in a manner that is consistent with the principles that govern all granting activities undertaken by NSERC.

Finally, in terms of accountability, assessing the impact of the funding provided by NSERC to research institutes requires activities to be properly monitored by these institutes. To date, institutes have been providing annual reports to NSERC, which include helpful information. There is, however, a need to ensure greater consistency in the manner in which some of the data is being reported. For instance, it

remains unclear at times whether reported data refer to the number of participants, the number of users, the number of discrete researchers, etc. As the overall performance of NSERC funding must be properly documented (as opposed to what each institute delivers individually), the consistency in reported information and data becomes particularly important.

2.7 Supporting Agency-Wide Priorities

Summary of findings: Ensuring that program access and benefits are available to all qualified Canadians is a long-standing goal of the three granting agencies (CIHR, NSERC and SSHRC), which are collaborating on a joint equity, diversity and inclusion (EDI) action plan. The Program is implementing changes to foster engagement in the research ecosystem of underrepresented groups in all fields of natural sciences and engineering. Supporting ECRs is another agency-wide priority of NSERC that directly applies to the Discovery Research Program. During the period covered by the evaluation, ECRs have had a comparable access to the key program components. However, concerns were raised around the level of funding being provided in order to meaningfully assist these individuals in establishing their careers.

This last subsection explores the extent to which the Discovery Research Program contributes to agency-wide priorities, particularly in terms of EDI, and the support provided to ECRs.

Equity, Diversity and Inclusion (EDI)

In 2017, NSERC issued a statement on EDI in which it committed itself to identifying and addressing systemic barriers that may limit its ability to equitably serve all Canadians who wish to engage in natural sciences and engineering (NSERC, 2017). Among other things, NSERC formally acknowledged that challenges remained in engaging some groups of Canadians in natural sciences and engineering, such as women, visible minorities, Indigenous peoples, people with diverse gender identities and people with disabilities. Since then, NSERC has collaborated with the Canadian Institutes of Health Research (CIHR) and the Social Sciences and Humanities Research Council (SSHRC) to advance these goals. At the time of the evaluation, the three agencies were planning the release of a joint action plan on EDI (NSERC, 2019j). In the meantime, NSERC has proceeded with the implementation of its Framework on Equity, Diversity and Inclusion that, among other things, requires applicants and selection committees to systematically consider EDI in developing their applications or in assessing these proposals (Government of Canada, 2017).

For the purpose of this evaluation, it is worth noting that the bulk of activities concerning EDI have taken place after the current period covered by the evaluation (2013/14 to 2017/18). Keeping this in mind, the evaluation did gather some opinions and insights that should support NSERC's efforts in implementing its EDI goals. This is particularly important considering the Discovery Research Program, and more specifically the Discovery Grants component, significant reach. Moreover, NSERC is in the process of implementing changes to foster engagement of underrepresented groups in all fields of natural sciences and engineering in the research ecosystem. Information collected as part of this evaluation can be used as baseline data in future evaluations to explore issues related to barriers experienced by underrepresented groups so as to facilitate their participation in the research funding programs.

Collecting the Relevant Data

A lack of relevant data is NSERC's current main challenge when it comes to better understanding the extent to which the Discovery Research Program is successful in removing systemic barriers to participation. Over the whole evaluation period, 20% of applicants to the Discovery Grants elected to not indicate their sex (NSERC, 2019c, p. 10). Moreover, the current set of administrative data for the evaluation period contains no information on participation levels among visible minorities, Indigenous peoples, people with diverse gender identities or people with disabilities.

The EDI initiatives planned by the three granting agencies are expected to address these challenges and will explore strategies that can accommodate both the voluntary nature of disclosing identity-related information among program applicants and the information program managers need to reach EDI goals.

In the meantime, findings gathered as part of this evaluation point to an important need to shift the predominant perception of EDI as being essentially centred on sex or gender. During interviews conducted for the evaluation, the importance of EDI for NSERC and the federal government as a whole was broadly acknowledged, but rarely did the discussion address barriers for Indigenous researchers or researchers with disabilities.

A Cultural Shift

Individuals involved in the Discovery Research Program selection committees and administration noted that full integration of EDI in the management of the program continues to be a "work in progress" and that further support is required. For instance, representatives from Evaluation Groups noted that, while the principle of EDI is widely recognized, it remains difficult to operationalize in terms of reviewing and rating applications.

Additionally, interview findings indicate that applicants also need to learn how to fully integrate EDI considerations into their applications. To this end, NSERC has published an EDI guide for applicants (NSERC, 2019d), but the interviewed stakeholders indicated that ongoing support for applicants will be required as NSERC continues to implement its EDI strategy.

Supporting Early Career Researchers (ECR)

Assisting ECRs in establishing their careers is a long-standing goal of the Discovery Research Program and particular attention has been given to this group as part of the ongoing management of the Discovery Research Program. For instance, while all Discovery Grants applicants (established researchers or ECRs) are evaluated using the same merit indicators, special provisions are included to take into account ECRs more limited training record (NSERC, 2019b, p. 26).

Administrative data indicates that, during the period under review, 15% of Discovery Grant recipients and 6% of DAS recipients were ECRs (no administrative data is available on the career status of RTI recipients). While ECRs represent a small portion of program recipients, the relevant question, for the purpose of this evaluation, is whether they have equitable *access* to the program. On that point, evaluation findings indicate that the DAS appears to be performing well. A relevant indicator in that regard is the success rate of ECRs. As illustrated in Figure 7, during the reference period, the success rates of ECRs applying to both the Individual Discovery Grants and the SAP-Discovery Grants (SAP-IN and SAP-PJ) were slightly higher than those of established researchers. Only for specific funding supplements (NRS and ST) were the success rates of ECRs lower than established researchers.

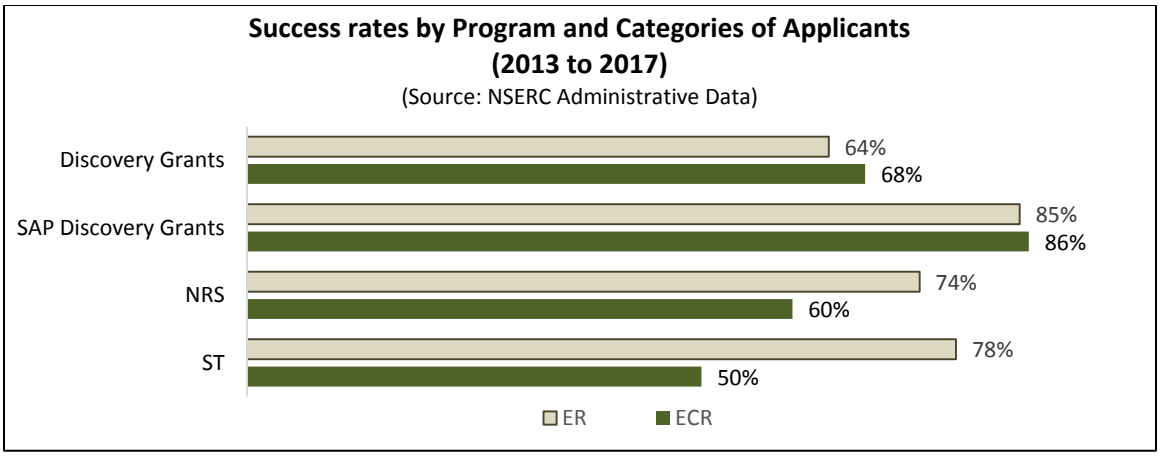


Figure 7

The level of funding provided to ECRs raised some concerns as almost three quarters (71%) of ECRs who participated in the survey were of the opinion that the Discovery Grants component does not provide sufficient funding for ECRs. This opinion was equally shared by 62% of the established researchers who participated in the survey.

Interview findings emphasized another important dimension, which is the support provided to ECRs as they apply to Discovery Grants or other related program components for the first time. In particular, it was noted that ECRs operating in larger institutions are more likely to benefit from the experience and support provided by more established colleagues, compared to ECRs operating in smaller institutions.

3 Conclusions and Recommendations

Supporting Research Excellence in the Fields of Natural Sciences and Engineering

The Discovery Research Program is a central component of Canada's research funding ecosystem. It has a well-established record of providing the opportunity for Canadian researchers in the fields of natural sciences and engineering to undertake curiosity-driven, long-term research programs with the required flexibility to pursue promising research avenues. While it is complemented by other funding sources, the program has no equivalent and remains the foundation upon which recipients can pursue meaningful research activities.

Providing this support is imperative if Canada is to remain a predominant contributor of knowledge creation and dissemination in these fields. The international dynamics of fundamental and curiosity-driven research activities are shifting, as additional countries are greatly enhancing their participation in research outputs. While this increased level of research activities offers a wide range of benefits, such as accelerating the creation of new knowledge, Canada must maintain its competitive position and its capacity to grow, attract and retain innovative minds, therefore contributing to the innovation agenda of the federal government. The Discovery Research Program cannot achieve this on its own, but in turn, these goals cannot be achieved in the absence of a strong foundation for leading-edge research. The Discovery Research Program acts as that foundation in Canada's natural sciences and engineering fields.

Addressing the Needs of the Research Communities

Central to the entire structure of the Discovery Research Program, the Discovery Grants component provides meaningful funding support to approximately 10,000 Canadian researchers in natural sciences and engineering. The driving principle behind the program, namely that a large number of researchers receive some grant-in-aid funding, as opposed to providing larger grants to fewer researchers, is largely supported and constitutes a significant achievement for the program. These funded researchers are more likely than unfunded researchers to explore novel and potentially transformative lines of inquiry, conducting riskier research, collaborating with other researchers in Canada or in other countries, and focusing on fundamental research.

However, experience to date confirms that the program has continually struggled to maintain a stable and consistent level of funding. The value of Discovery Grants, in constant dollars, has largely decreased over the past two decades, with periodic adjustments being made, including those that have led to some increases in the value of Discovery Grants provided over the past two years. Despite recent increases made in the 2014, 2016 and 2018 budgets, continued increases in the cost of research may jeopardize the Discovery Research Program's sustained efforts to support innovative research in Canada.

The supplements (DAS, NRS and ST) and the RTI funding provide highly complementary support that greatly enhances the Discovery Research Program's ability to respond to researchers' needs. The DAS funding provides an opportunity to inject timely resources to accelerate particularly promising research programs. While some uncertainties appear to remain in the research community as to the actual purpose of the allocation process for DAS, evaluation findings provided clear evidence that those who receive supplements are, indeed, in a position to intensify the implementation of their promising research programs. While highly limited to certain research communities, the NRS and ST are directly aligned with the interests of Canada in northern research and research involving oceans and other large bodies of water, and help to meet the high cost of research in these environments.

The RTI funding also highly complements funding provided by the CFI and other funders of equipment and infrastructure. However, when surveyed as part of this evaluation, only 55% of RTI funded respondents and 32% of non-RTI funded respondents indicated that their equipment was adequate to undertake cutting-edge research. Despite these needs, few researchers access RTI support due to the level of funding available for RTI. At the time of the evaluation, approximately 20% of applicants were able to secure RTI funding, and researchers from smaller institutions were far less successful than researchers from medium or large institutions in securing RTI funding. In this context, the RTI program is not in a position to meet the needs of the research community.

To reflect the subatomic physics, mathematics and statistics fields' specific needs and characteristics, NSERC has set up specific funding mechanisms. The evaluation has found that, while there is a strong support for the current SAP funding mechanism, views differ on the extent to which the funding mechanism for mathematics and statistics meets the current needs of that community of researchers.

Over time, a number of research institutes in mathematical, statistical, and natural sciences have been established in Canada They have broadened the range of activities in which researchers, both established and ECRs, and students can engage to collaborate, create new knowledge, enhance their skills, build their professional networks, and facilitate their transition and growth as researchers. Some

of these institutes have received funding from NSERC, through various programs and, more recently, from the Discovery Research Program. There is a strong rationale for supporting the work of these institutes, as they directly contribute to research excellence in Canada in a manner that is highly complementary to the other program components covered by this evaluation. Each funded research institute is focused on expanding the range of research, collaboration, learning and career development opportunities provided to researchers, including graduate students, postdoctoral students, and ECRs. The incremental approach used to date by NSERC to support these institutes has succeeded in providing them with fairly stable funding. However, NSERC has yet to establish a clear vision of how it intends to approach the funding of research institutes in Canada in a manner that is more sustainable in the longer term. In particular, positioning other grant support and institute funding in a zero-sum dynamic (where any increase to one side must lead to a decrease on the other side) is bound to lead to unproductive tensions. In addition, it is unclear how any growth in the number of institutes can be accommodated.

Supporting Diversity and New Generations of Researchers

Ensuring that program access and benefits are available to all qualified Canadians is a long-standing goal of the three granting agencies (CIHR, NSERC and SSHRC), which are collaborating on a joint EDI action plan. The Program is implementing changes to foster engagement in the research ecosystem of underrepresented groups in all fields of natural sciences and engineering. Information collected during this evaluation can be used as baseline data for future evaluations in order to explore issues related to barriers experienced by underrepresented groups.

This evaluation has provided an opportunity to better understand some of the challenges associated with such a strategy. Relevant data on a number of identity dimensions of program recipients is currently lacking, and the need to gather such data must be balanced with privacy considerations. For the purpose of this evaluation, this lack of information has considerably limited the scope of what could be documented. As NSERC continues to progress on the EDI front, it is particularly important to ensure that these efforts expand beyond sex and gender to include the other identity dimensions. Also, ongoing assistance is required for applicants and reviewers as they operationalize the EDI requirements.

The support to ECRs is another agency-wide priority of NSERC that directly applies to the Discovery Research Program. During the period covered by the evaluation, ECRs have had a comparable access to the key program components. Concerns were raised around the level of funding being provided in order to meaningfully assist these individuals in establishing their careers.

Recommendations

In light of these findings, this evaluation team makes the following recommendations:

Recommendation 1

The Discovery Research Program is a fundamental building block of the Canadian research funding environment.

- **Considering its fundamental role and positioning in the ecosystem of research funding in Canada, NSERC should maintain the Discovery Research Program, with the goal of ensuring its sustainability and its continued adaptability to emerging dynamics in the fields of natural sciences and engineering.**

Recommendation 2

It is generally recognized that the costs of research can vary by discipline and that this may result in variations in the funding levels among different disciplines. However, at the time of the evaluation there was no publicly available information that could explain and justify the extent of these differences, and how this translates into Discovery Grant Evaluation Group budgets and the range of average grant sizes across disciplines. This has led to speculation among those consulted and questions about the fairness of the current model.

- **NSERC should explain the rationale for funding differences across disciplines, providing a clear description of the Discovery Grant funding levels and how they are established. This would reflect NSERC's commitment to ensuring a transparent management of the program, it would allow researchers to be adequately informed at the time of their application, and it would provide them with an opportunity to plan accordingly.**

Recommendation 3

The RTI funding provides critical support needed for the successful implementation of research funded by the Discovery Research Program and other NSERC programs. This funding is complementary to other infrastructure funding, notably that provided by the Canada Foundation for Innovation (CFI). However, with its current level of funding, RTI only supports one fifth of the applications submitted by the community. Moreover, only half of the funded researchers perceive that they have the equipment required to conduct cutting-edge research. As a result, RTI is not in a position to respond to the needs of those it is intended to serve.

- **NSERC should clarify its objectives with respect to the nature and level of support it provides for research tools and instruments that enable researchers to carry out leading edge research funded by the Discovery Research Program and other NSERC programs. NSERC should revisit the RTI budget in order to enable the program to meet the needs of the community.**

Recommendation 4

The funding mechanisms for subatomic physics (SAP) and mathematics and statistics have emerged incrementally over time. The SAP funding mechanism is long-standing and reflects the nature of the research undertaken; evidence from the evaluation has demonstrated that it is serving the specific needs of this community. In contrast, the funding mechanism for mathematics and statistics was implemented more recently. Since 2014 it has had a fixed proportional relationship between the funding for Collaborative and Thematic Resources Support in Mathematics and Statistics (CTRMS) and the funding to individual Discovery Grants. This approach to funding isn't serving the community's needs.

- **NSERC should consider separating the management of the funding for individual mathematics and statistics Discovery Grants from the management of the funding for institutes provided by CTRMS.**

Recommendation 5

The currently funded research institutes in the fields of astrophysics, subatomic physics, and mathematics and statistics fulfill an important role that is highly complementary to the Discovery Grants provided by the program. However, NSERC funding is fragmented and has been implemented incrementally. The most significant gap that NSERC now faces results from a lack of a coherent vision

and strategy on how to support research institutes, and to provide this funding in a manner that is consistent with the principles governing all its granting activities.

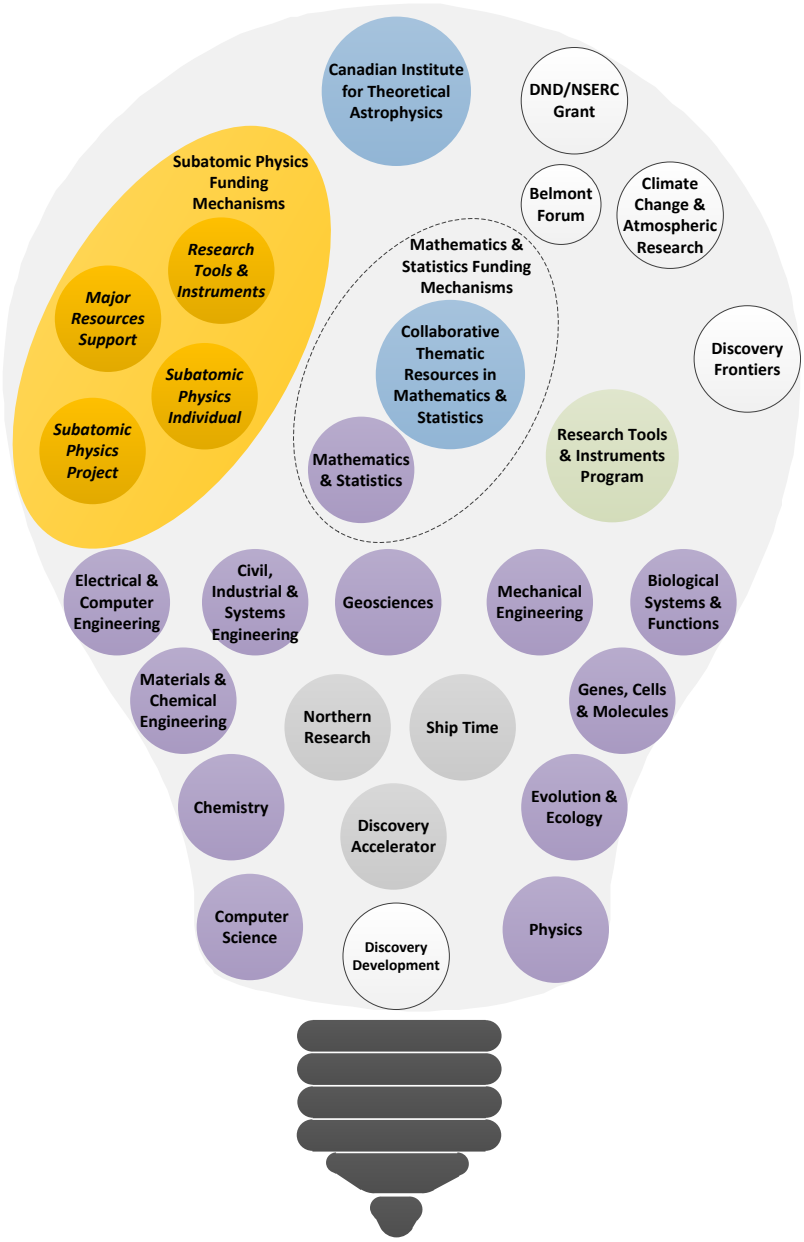
- **NSERC should clarify its vision and develop a comprehensive framework and guidelines that communicate how NSERC intends to provide ongoing support to research institutes in Canada, including the potential of expanding to other fields of research. Moreover, in order to improve accountability and assess impacts, NSERC should implement a more rigorous monitoring and reporting framework for the institutes that it supports.**

Recommendation 6

Ensuring that all qualified Canadians have access to and benefit from its programs is a longstanding goal for NSERC, and are the basis for the tri-agency EDI action plan. The Discovery Research Program is in the process of implementing changes to ensure fair access and support for underrepresented groups in all fields of NSE in the research ecosystem. Comprehensive data on a number of identity dimensions of program participants is currently lacking.

- **NSERC should pursue the implementation of its EDI principles as they apply to activities funded through the Discovery Research Program. This includes, among other things: 1) continuing to collect and analyze new, broader data to better understand the participation of all underrepresented groups; 2) continuing to provide the required support to both grant applicants and reviewers to ensure that the activities they undertake with the support of the Discovery Research Program reflect these principles.**

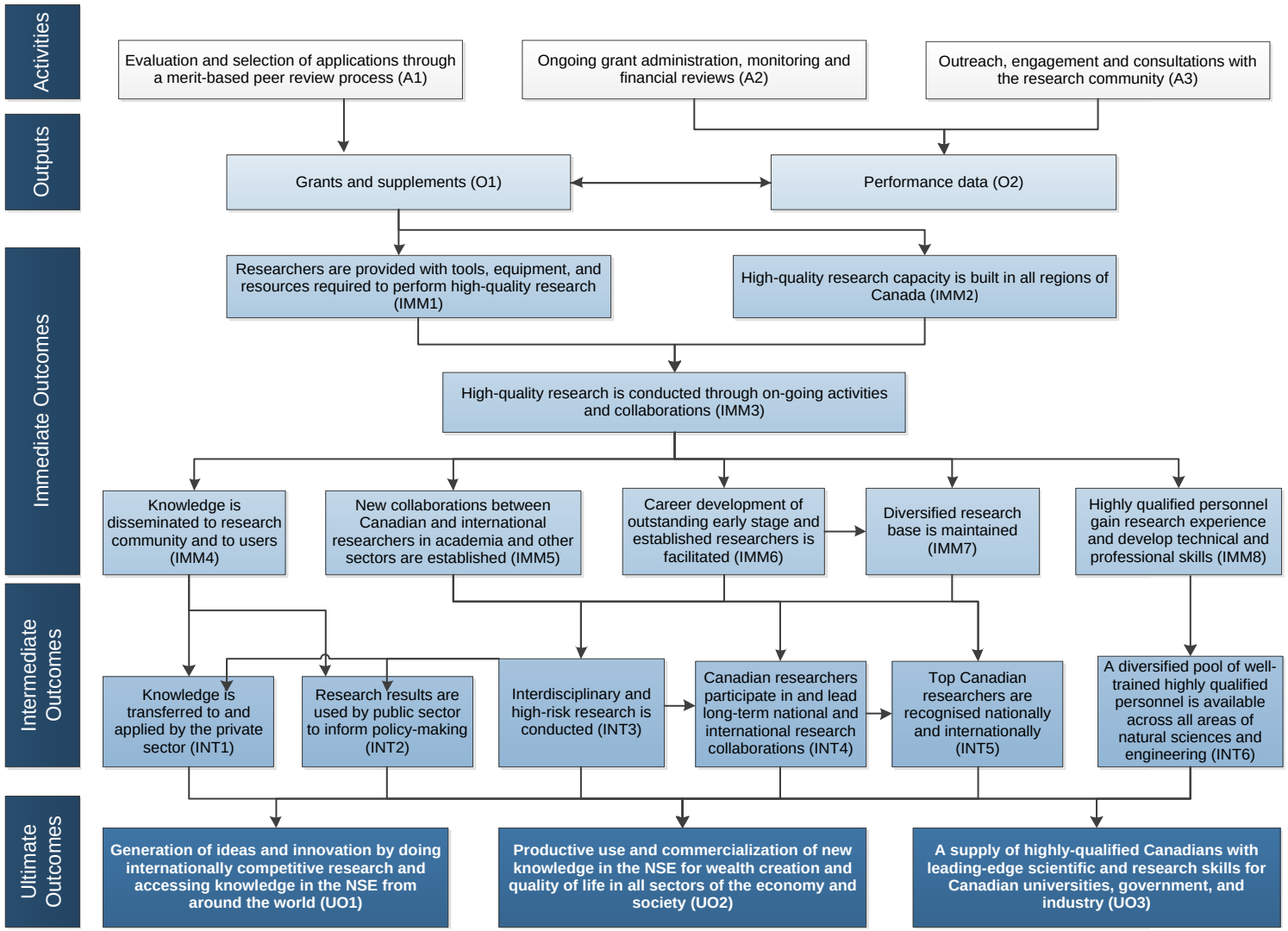
Appendix A: Evaluation Scope



EVALUATION SCOPE - EXCLUDED

- Belmont Forum
- Climate Change & Atmospheric Research (evaluated in 2016)
- Discovery Development Grants (currently at pilot stage)
- Discovery Frontiers
- DND-NSERC Grant (administered by DND)

Appendix B: Logic Model for the Discovery Research Program



Appendix C: Evaluation Matrix

Question	Indicator	Admin data	Bibliometric	Stats - Corp. Plan	Survey	Prizes	KI interviews
	1.1 : Distribution (over time) of Discovery Research grants and supplements within the research community: – type of supplements, – discipline, – seniority, – gender, – location/province, – host institution size, – language, – amounts allocated, – success rate (taking into account the ability to receive multiple times the grant – e.g.: Ship Time).	√					
	1.2 : Ranking in the per capita output of publications in the natural sciences and engineering vs. G20 countries.			√			
	1.3 : Ranking in the number of natural sciences and engineering publications vs. G20 countries.		√	√			
	1.4 : Ranking in terms of average relative citation factor of Canadian publications in the natural sciences and engineering vs.G20 countries.		√	√			
	1.5 : Types of research contributions attributable, at least partially, to the Discovery program (e.g., new knowledge, lines of inquiry and/or research fields, publications in peer-reviewed journals; participation in conferences [national or international]; etc.) (Logic model - IMM4-IMM5)				√		
	1.6 : Types of socio-economic impacts attributable, at least partially, to the Discovery Research (e.g., start-up/spin-off companies; patents and licenses; projects involving knowledge and technology transfer; policy-making; regulation, public good; etc.)				√		
	1.7 : Number of HQP (students and postdocs) supervised by researchers who are/were receiving training, at least partially, as part of their supervisor's Discovery Research as well as the quality of their training.	√			√		
	1.8 : Number and percentage of applicants using tools, equipment, and resources required to perform fundamental research				√		

Question	Indicator	Admin data	Bibliometric	Stats - Corp. Plan	Survey	Prizes	KI interviews
	provided through the Discovery Research						
	1.9 : Measures of scientific production – Measure of the volume of scientific production (Number of publications) – Measure of the quality of scientific production (Average Relative Impact Factor; Average of Relative Citations) – Measure of the collaborative processes involved in scientific production (International collaboration) – Disciplinary classification (Average Interdisciplinarity Index; Average Interdisciplinarity Relative Index)		√	√			
	1.10 : Prizes and Awards received by Canadian researchers funded by Discovery Research program					√	
	2.1 : Nature and level of use of the Discovery Research suite of programs (supplements, RTI, Institutes and funding mechanisms) by the community – User and usage profiles – Nature (types of tools, equipment, and resources) and the importance of the needs that the program meets – Nature and importance of the program's unmet needs – Overall level of satisfaction with the mechanisms				√		√
	2.2: Advantages (benefits and value added) and disadvantages related to receiving funding from the Discovery Research grants and supplements, as perceived by the community (discipline, host institution size, mechanism)				√		√
	2.3 : Funding from other sources (amounts and sources) available to research communities (those receiving funding from the Discovery Research program including supplements and those not receiving funding from the Discovery Research program) – per discipline – province – seniority	√			(√)		
	2.4: Types of expenditures paid from the Discovery Research program (use of funds by discipline)	√					
	2.5: Perceptions of stakeholders regarding application and review processes for the Discovery Research program				√		√
	2.6: Perceptions of applicants regarding access to and satisfaction with program information				√		

Question	Indicator	Admin data	Bibliometric	Stats - Corp. Plan	Survey	Prizes	KI interviews
	3.1: Trends in the number of applicants to and recipients of Discovery Research program by ECRs and compared to ERs and non-NSE disciplines, if available	√					
	3.2: Perceptions of ECRs regarding the ease to apply for and receive Discovery Research				√		
	3.3: Perceptions of applicants regarding the extent and nature of barriers/facilitators to participation in the Discovery Research program				√		
	4.1: Number and percentage of applicants broken down by the following categories and compared to distribution in the overall population in NSE/non-NSE disciplines, if available: – Women – Aboriginal peoples – Persons with disabilities – Members of a visible minority group	√			√		
	4.2: Success rates for applicants identifying with the following categories compared to the total group of applicants, as well as distribution in the overall population in NSE/non-NSE disciplines, if available: – Women – Aboriginal peoples – Persons with disabilities – Members of a visible minority group	√			√		
	4.3: Perceptions of applicants regarding the extent and nature of barriers/facilitators to participation in the Discovery Research program				√		

Appendix D: References

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