

# Evaluation of the Strategic Network Grants (SNG) Program

## *Final Summary Report*

**Prepared for:**

Natural Sciences and Engineering Research Council (NSERC)

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# Acronyms & Abbreviations

AAPN	Agile All-Photonics Network
BL-NCE	Business-Led Networks of Centres of Excellence
CAISN	Canadian Aquatic Invasive Species Network
FY	Financial Year
GEWEX	Canadian Global Energy and Water Cycle Experiment
HQP	Highly Qualified Personnel
MAGS	Canadian Mackenzie GEWEX Study
NCE	Networks of Centres of Excellence
NECTAR	Network for Effective Collaboration Technologies through Advance Research
NPV	Net Present Value
NSERC	Natural Sciences and Engineering Research Council
PBCA	Partial Benefit-Cost Analysis
PY	Publication Year
R&D	Research and Development
RP	Research Partnerships
S&T	Science and Technology
SENTINEL	The Canadian Network for the Development and Use of Bioactive Paper
SNG	Strategic Network Grants
SPI	Strategy for Partnership and Innovation
TBS	Treasury Board of Canada Secretariat

# Executive Summary

## Objectives, Scope and Methodology

The SNG program, which was created in 1996, is situated within the Natural Sciences and Engineering Research Council's (NSERC) suite of research partnership programs. The program funds large-scale multi-disciplinary research projects in areas determined to be of national importance that requires a network approach and that involve collaboration between academic researchers and Canadian-based industry or government partners. The research networks funded by this program are intended to enhance Canada's economy, society, and/or environment within the next ten years. At least one Canadian partner (government or industry) must be involved at all stages within each SNG network.

Grants are awarded through annual competitions for a duration of up to five years for a maximum of up to \$5 million. On average, annual SNG program grant expenditures were valued at \$17.2 million between 2001-02 and 2009-10. During the time period under study (2008-09 to 2012-13)<sup>1</sup>, 38 networks were funded by the program.

This evaluation was undertaken to inform program management and delivery personnel, as well as to comply with Treasury Board *Policy on Evaluation* (2009) and *Financial Administration Act* regarding evaluation coverage. The evaluation adhered to the Policy on Evaluation and its associated Directive and Standards relating to the core evaluation issues of relevance and performance.

Seven methods were employed for the evaluation of the SNG program by a hybrid evaluation team composed of the NSERC Evaluation Division and an external consultant: document review; program file review; administrative data analysis; web-based surveys with SNG (and comparator networks) researchers, partner organizations and highly qualified personnel (HQP); case studies of four SNG funded networks, a partial cost-benefit analysis, and a bibliometric study.

This report is a summary of the SNG Program Evaluation Technical Report, which was submitted under separate cover and includes a more fulsome presentation of evidence and data.

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<sup>1</sup> While the period under evaluation covered the years 2008/9 to 2012/13, some networks whose funding ended as early as 2005 were included in the study in an effort to explore longer-term impacts of the program.

## Key Findings

### Relevance

The evaluation confirms the continued need for the SNG program. Demand for the program has remained strong with a stable number of applications for funding over the study period. According to the literature, there are many advantages to the research network approach, which has been found to foster synergies and unique solutions to complex research problems that could not be achieved by individual researchers working in isolation. There was no evidence of problematic duplication with other funding programs; the SNG program occupies a specific niche in the NSERC suite of funding programs distinguished by its focus on medium to longer-term research initiatives for complex programs in areas of national importance that require collaborative efforts among researchers and partners. The research networks and projects funded by the networks are unlikely to have occurred in the absence of the SNG program.

The SNG program was found to be consistent with government priorities that highlight the ongoing federal commitment to R&D and innovation as key drivers of prosperity. The 2014 ST&I Strategy signals the continued federal role and priority for these investments, and underscores the SNG program's specific role in supporting the government's ST&I core principles as well as its research priorities. The program also aligns well with the strategic outcomes of NSERC and its Strategy for Partnerships and Innovation.

### Effectiveness

The evaluation evidence indicates that the SNG program through the achievements of its funded networks is achieving or making progress toward achieving intended outcomes.

**Research, development and innovation.** The entities established by the SNG have created networked approaches to research and development through the engagement of many researchers and partners from various sectors. The SNG networks that were examined in the evaluation were seen to meet or exceed their research goals. The network approach facilitated, among other benefits, significant contributions of in-kind resources from partners that aided research. SNG researchers' annual scientific output

increased significantly from an average of 2.39 papers per year before they had received support from the program to 3.72 during the period in which they were supported by the SNG program. The increase in SNG researchers' output was comparable to researchers that received other types of NSERC research funding. However, the study also indicates citations increased for SNG researchers after program support ended. Research excellence was confirmed by external awards and distinctions won by SNG scientists. Many networks significantly increased the visibility and reputation of Canadian researchers both in Canada and internationally. A strong majority of SNG partners and researchers indicate network research projects are leading to the creation or extension of knowledge.

**Multidisciplinary, multisectoral and international collaborations.** SNG networks were very successful in facilitating multidisciplinary collaborations in various areas of expertise and research strength within the natural sciences and engineering domain. On average, SNG network-funded research projects involved collaborations with six organizations, drawn from a wide variety of organizations and sectors, including universities, the private sector, government and not-for-profit organizations; collaboration between SNG researchers and government partners was particularly high as compared to other network funding programs such as the NCE or BL-NCE. According to surveyed researchers, their research collaborations often involved a mix of new and existing partners and were generally viewed as successful. According to many partners, their involvement in the network seeded continued interest in academic-industry partnerships. International collaborations are taking place; in some cases SNG networks are leading international research collaborations while in other cases the network participants are expanding current or creating new international collaborations.

**Meeting partner needs.** SNG guidelines are in place to foster partner engagement, such as mandatory involvement of partners on management boards and Science Advisory Committees. There was also evidence of network-created supplementary engagement activities. Universities lead most phases of SNG network research projects; private sector and government partners play a more prominent role during the mobilization stage (use/application of knowledge and/or technology). Networks are equally seen to be meeting business needs as public and non-profit needs.

**Impacts on HQP.** The SNG program has a positive impact on the training of HQP. Virtually all SNG-funded projects within the networks involve HQP, and the networks have put in place varied engagement, research funding and training and development opportunities to enhance HQP research and professional skills. Key distinguishing features of network HQP training include opportunities to interact with university

researchers and other HQP, to enhance job readiness, to participate in exchanges/internships, to conduct multidisciplinary and multisectoral research and to conduct research relevant to the private sector. Researchers and HQP approve of the quality of research and training opportunities. Of HQP who were employed at the time of the survey, a significant proportion is employed by industry. Case studies indicate that the employment outcomes for network HQP were very positive and network partners often hired network-trained HQP.

**Knowledge and/or technology mobilization by partner organizations.** The SNG networks demonstrate broad dissemination of network research through traditional media (publications, conferences) and researchers and partners agree that the networks accelerate the exchange of these results. KT activities are actively pursued (though some opportunities for improvement in this area were noted by some) and there is evidence of a significant amount of commercialization activity, including the execution of non-disclosure or confidentiality agreements and patent applications. SNG researchers who are mobilizing their research results are working primarily with universities, and secondarily with the private sector and the Canadian government; SNG researchers are much more likely than all other comparator networks to indicate they are mobilizing results with public sector partners. Some challenges relating to the engagement or receptivity of receptor communities were uncovered and surveyed partners recommended improvements related to engagement of partners and a stronger link between the research and partner needs/goals.

**Impacts on partner organizations and the user sector.** Increasing the knowledge base of network organizations is the most common impact of network research according to SNG partners and researchers; SNG partners and researchers also cite impacts on the R&D of network organizations and on products and/or services of network organizations. Numerous tangible results for partner organizations and the user sector were identified, including the creation of prototypes/pilots, new processes/products/services, improved processes/products/services, knowledge applied toward policy/regulations and new spin-off companies.

**Long-term economic, social, health and environmental benefits to Canada.** The contributions of SNG networks to long-term benefits is challenging to measure. However, there is evidence of SNG network-funded research that has led to a variety of impacts such as regulatory changes to reduce environmental and economic impact and improved environmental forecasting, monitoring and management. As well, within the benefit-cost analysis, evidence of research that has led to or will likely lead to quantifiable long-term economic and environmental benefits was identified.

## Efficiency and Economy

The SNG program is delivered efficiently, with a low and relatively stable administrative cost: total administrative costs of the program are estimated at an average of 5.1 cents per \$1 of grants awarded over the study period; there was a notable decline in the operating ratio from 6.3 cents in 2008-09 to 4.7 cents in 2012-13.

Program stakeholders are generally pleased with the delivery of the SNG program and perceive many of the elements of the program to be well-executed; satisfaction with governance guidelines was markedly higher for SNG participants than for all other comparator research networks. SNG researchers and partners were also more likely than their comparator network counterparts to be satisfied with financial administration guidelines. While management of IP was cited as an issue by some, NSERC introduced an IP policy (2009) which provides guidance to networks on this issue. SNG researchers and partners across various lines of evidence cite strong leadership as a key factor in facilitating network success; some issues were raised in regards to finding researchers/network managers with appropriate management skills.

## Recommendations

- 1. The SNG program is relevant and is achieving its key intended immediate and intermediate outcomes, as well as demonstrating progress towards meeting its long term outcomes. It should therefore be considered for continued support at the federal level to continue to foster research and innovation.** The SNG program is addressing a continued need using a network approach that has been shown to have many advantages; the program also supports the federal government's R&D and innovation goals and is delivered in an efficient manner.
- 2. Best practices in the area of industry engagement and KT among SNG and other research networks, including tools and resources, should be shared broadly among the networks to embed and maximize translation of network research to meet partner needs. Consideration should be given to including KT resource allocation minimums or greater specificity in the KT approach in applications for funding.** The experience of the case study networks suggested that where challenges were encountered, these often occurred in the mobilization of research results and the engagement or receptivity of receptor communities. Surveyed partners also recommended improvements related to greater breadth and more meaningful engagement of industry. Several networks have developed resources or had successful experiences in mobilization which could be beneficial to share and adopted by other networks.



3. **The program should examine ways to improve capture and reporting of performance metrics at the program level that would indicate the outputs and outcomes of networks based on common indicators of research outcomes (e.g., publications, mobilization of research, commercialization).** While a common network reporting template was introduced in 2005, the ability to report on results at the program level remains limited.
4. **The program may wish to explore how to provide increased guidance and identification of best practices to improve network leadership and to ensure that the requisite administrative and oversight skills of the network management team are in place to create a well-functioning and cohesive network.** Across the various lines of evidence, strong leadership was identified as a key factor in facilitating network success. This important, yet demanding function was identified as a challenge for some networks that impacted their success. Increased support of leadership skills development or best practices in management recruitment could contribute to improved network functionality and success.

# 1.0 Introduction

The purpose of this document is to present the findings from the summative evaluation of the Strategic Network Grants (SNG) program. The evaluation contributes to meeting the coverage requirements of Treasury Board's Policy on Evaluation (2009) and the requirements of the *Financial Administration Act*.

## 1.1 Program Description

The SNG program, which was created in 1996, is situated within the Natural Sciences and Engineering Research Council's (NSERC) suite of research partnership programs. The program funds large-scale multi-disciplinary research projects in areas determined, through consultation between NSERC and partners/industry, to be of national importance and that require a network approach involving collaboration between academic researchers and Canadian-based organizations. The research networks funded by this program are intended to enhance Canada's economy, society, and/or environment within the next ten years. Currently, the program is accepting applications in four target areas: Environmental Science and Technologies; Information and Communications Technologies; Manufacturing; and Natural Resources and Energy.

The expected results of the SNG program are to create knowledge/technology to strengthen Canada's industrial base, generate wealth, create employment and/or influence Canadian public policy; increase the number of HQP in the areas targeted; foster the increased participation of Canadian-based companies and/or government organizations in academic research; and result in the transfer of knowledge/technology and expertise to Canadian-based companies or to government organizations<sup>2</sup>.

Grants are awarded through annual competitions for a duration of five years for a maximum of \$5 million. On average, annual SNG program grant expenditures were valued at \$17.2 million between 2001-02 and 2009-10. During the time period under study (2008-09 to 2012-13), 38 networks were funded by the program.

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<sup>2</sup> Strategic Network Grants Program. Online: [http://www.nserc-crsng.gc.ca/Professors-Professeurs/RPP-PP/SNG-SRS\\_eng.asp](http://www.nserc-crsng.gc.ca/Professors-Professeurs/RPP-PP/SNG-SRS_eng.asp).

**Exhibit 1.1: Strategic Networks Funded During the Study Period**

<b>Network Name</b>	<b>Funding Period</b>
Canadian aquatic invasive species research network	2005-2011
Canadian Bovine Mastitis Research Network	2005-2011
Green Crop Network	2005-2011
Canadian Network for the Development and Use of Bioactive Paper (SENTINEL)	2005-2010
Solar Buildings Research Network	2005-2010
The Canadian Barcode of Life Network (BOL.ca)	2004-2010
ForValueNet - NSERC Strategic Network on Forest Management for Value-Added Products	2007-2012
NSERC Canadian Healthy Oceans Network (CHONe)	2007-2013
NSERC EmbryoGene Network	2007-2013
NSERC Magnesium Network (NSERC MagNet)	2007-2012
NSERC Solid Oxide Fuel Cells Research Network	2007-2013
NSERC Internetworked Systems Security Network (ISSNet)	2007-2012
NSERC Wind Energy Strategic Network (WESNet)	2007-2013
20/20 NSERC Network for the development of advanced ophthalmic materials	2008-2014
BiopSys: NSERC Strategic Network for Bioplasmonic Systems	2008-2013
Healthcare Support through Information Technology Enhancements (hSITE)	2008-2014
NSERC Canadian Pollination Initiative (CANPOLIN)	2008-2014
NSERC Canadian Seismic Research Network (CSRN)	2008-2014
NSERC Hydrogen Canada (H2CAN) Strategic Research Network	2008-2013
RES'EAU-WaterNet	2008-2014
The NSERC Canadian integrated multi-trophic aquaculture network (CIMTAN) for the development of responsible aquaculture	2008-2013
NSERC Bioconversion Network	2009-2014
NSERC Canadian Capture Fisheries Research Network	2009-2014
NSERC Canadian network for research and innovation in machining technology (NSERC-CANRIMT)	2009-2014
NSERC Digital Surface Software Application Network (SurfNet)	2009-2014
NSERC Green Fibre Network	2009-2014
NSERC Photovoltaic innovation network	2009-2014
NSERC Strategic Network Grant on Value Chain Optimization	2009-2014
NSERC Strategic Network for the production of single-type glycoform monoclonal antibodies (Mabnet)	2009-2014
NSERC Strategic Network on Innovative wood products and building systems	2009-2014
NSERC biomaterials and chemicals strategic research network	2009-2014
NSERC network for innovative plastics materials and manufacturing processes (NIPMMP)	2009-2014
NSERC's HydroNet: A national research network to promote sustainable hydropower and healthy aquatic ecosystems.	2009-2014
NSERC/Business Intelligence Network	2009-2014

## 1.2 Objectives and Scope of the Evaluation

This evaluation was undertaken to inform program management and delivery personnel, as well as to comply with Treasury Board *Policy on Evaluation* (2009) and *Financial Administration Act* regarding evaluation coverage. The period under evaluation covered the years 2008-09 to 2012-13, however some networks whose funding ended as early as 2005 were included in some lines of evidence in an effort to explore longer-term impacts of the program (e.g., GEWEX, Phase 2, included in case studies).

The evaluation adhered to the *Policy on Evaluation* and its associated Directive and Standards relating to the core evaluation issues:

- **Relevance:** The extent to which the Program addresses a continued need, is aligned with federal government priorities and departmental strategic outcomes, and is aligned with federal roles and responsibilities; and
- **Performance:** The extent to which the Program has achieved its expected outcomes, and demonstrates efficiency and economy.

Five evaluation questions covering Treasury Board's five core issues under the *Policy* were defined for the SNG evaluation. The evaluation questions are presented in Exhibit 1.2.

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### Exhibit 1.2: Evaluation Questions

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1. To what extent is there a continued need for the SNG program to fund a network approach to research, development and innovation?

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2. To what extent has the SNG program enhanced research, development and innovation in the areas of funded networks?

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3. What impact has the SNG program had on the attraction, training, retention and employment of highly qualified personnel (HQP)?

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4. To what extent has the SNG program resulted in long-term economic, social, health and environmental benefits to Canada?

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5. To what extent are efficient and effective means being used to deliver the program?

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## 1.3 Lines of Evidence

A total of seven lines of evidence completed between 2011 and 2014 were examined for this evaluation of the SNG program. Evidence was gathered by a hybrid evaluation team composed of the NSERC Evaluation Division and external consultants and

included:

- **Document Review.** A review of internal program documents, publically materials, and literature (completed in 2014);
- **SNG Program File Review:** A review of the final reports of 11 networks funded between 2001 – 2011 (2011);
- **Administrative Data Review:** Analysis of financial and other program data. (2014);
- **Web-based Surveys:** Surveys were conducted with SNG researchers, partner organizations and highly qualified personnel (HQP) as well as with their counterparts in comparator networks funded by the tri-agencies<sup>3</sup> and by the SSHRC<sup>4</sup> (2014);
- **Case Studies:** Four case studies with SNG networks with high-impact potential were conducted of: the Canadian Network for the Development and Use of Bioactive Paper – SENTINEL; Canadian Aquatic Invasive Species Network – CAISN; Agile All-Photonics Network – AAPN; and Canadian Global Energy and Water Cycle Experiment – GEWEX (Phase 2). The case study methodology included document and administrative data review, key informant interviews with network management, researchers, and HQP as well as with representatives from partner organizations. (2011);
- **Partial Cost-benefit Analysis:** A Partial Benefit-Cost Analysis (PBCA) intended to provide evidence on the socio-economic impacts of two networks<sup>5</sup> (2011); and
- **Bibliometric Study:** A bibliometric database was created that retrieved all scientific publications authored by 17,456 NSERC-funded researchers during the study period to examine scientific output for the suite of NSERC research funding programs (2014).

The evaluation of the SNG program is based on a multiple lines of evidence approach that included internal and external perspectives, gathered using a mix of quantitative and qualitative methodologies. The focus of the evaluation was on immediate and intermediate outcomes, as it is difficult to measure these outcomes aggregated at a program level and to monetize through a PCBA. It should be noted that the lines of evidence for the study were implemented over a three year period (2011-2014) and thus cover slightly different time periods and different study issues. There was a limited number of survey responses collected from HQP using a ‘snowball approach’

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<sup>3</sup> Comparators programs included the Networks of Centres of Excellence and Business-led Networks of Centres of Excellence funded by NSERC, the Social Sciences and Humanities Research Council (SSHRC) and the Canadian Institutes of Health Research. Comparisons across the network programs are presented in more detail in the SNG evaluation technical report.

<sup>4</sup> SSHRC comparator programs included the Major Collaborative Research Initiative (MCRI) and the Community University Research Alliance (CURA) programs.

<sup>5</sup> Although limitations to this analysis impacted the extent to which PCBA conclusions could be drawn, numerous findings were uncovered that were applicable to performance evaluation.

through contacts with researchers and, therefore, the representativeness of the survey responses could not be assessed. Finally, there were some inconsistencies across the networks in recording some performance measures and limited performance measures of research outcomes available at the program level.

## 2.0 Key Findings

### 2.1 Relevance

#### 2.1.1 Continued Need

***Key Finding: All lines of evidence support the continued need for the SNG program and its niche in funding mid-size research networks to foster innovation which, in turn, drives competitiveness and quality of life. The SNG research network approach is consistent with literature on the efficacy of research collaborations. The SNG network structure generated numerous advantages for network teams, including economies of scale and resource leveraging/sharing which allowed networks to address more complex research than could be done through individual grants. Interest in the program is healthy and has been stable during the period under study.***

#### *The R&D and Innovation Environment*

Innovation has been recognized by the federal government as being critical to productivity growth which, in turn, drives the long-term competitiveness of businesses and the quality of life of Canadians<sup>6</sup> and R&D “is increasingly recognized worldwide as a critical contributor to citizens’ social and economic well-being”<sup>7</sup>. However, Canada’s R&D record is mixed. While investments in higher education R&D compare favourably to other countries and have increased since the early 2000s, commercial outcomes such as patents and licensing have not risen in tandem, suggesting that the productivity of technology transfer may be weak and declining.<sup>8</sup>

NSERC’s Research Partnerships (RP) programs fosters collaborations between

<sup>6</sup> Government of Canada (2011). Innovation Canada: A Call to Action: Review of Federal Support to Research and Development – Expert Panel Report. Retrieved August 27, 2013 from: [http://rd-review.ca/eic/site/033.nsf/vwapj/R-D\\_InnovationCanada\\_Final-eng.pdf/\\$FILE/R-D\\_InnovationCanada\\_Final-eng.pdf](http://rd-review.ca/eic/site/033.nsf/vwapj/R-D_InnovationCanada_Final-eng.pdf/$FILE/R-D_InnovationCanada_Final-eng.pdf).

<sup>7</sup> Association of Universities and Colleges of Canada (2008). Momentum: The 2008 Report on University Research and Knowledge Mobilization. Retrieved August 28, 2013 from: [http://www.aucc.ca/wp-content/uploads/2011/05/momentum\\_2008.pdf](http://www.aucc.ca/wp-content/uploads/2011/05/momentum_2008.pdf).

<sup>8</sup> Council of Canadian Academies. The State of Industrial R&D in Canada. The Expert Panel on the State of Industrial R&D in Canada, 2013. OECD (Organisation for Economic Co-Operation and Development). OECD Economic Surveys: Canada. Paris, France: OECD, 2012.

university researchers, colleges and other sectors (including government and industry) in order to develop new knowledge and expertise, and transfer it to Canadian-based organizations. The SNG program is a key program within the Strategic Partnership program category of RP. SNG research networks are intended to enhance Canada's economy, society, and/or environment within the next ten years by funding networks in specific targeted areas of strategic national importance.

### *Advantages of the Network Approach*

Documentary evidence collected to support evaluations of other research network funding programs suggests that the research network approach that is a distinguishing feature of the SNG program has many advantages. The 2011 *Review of Federal Support to Research and Development*, for example, notes that collaboration among businesses, governments and the higher education sector can contribute importantly to the conception and successful introduction of new products and processes. Strategic partnerships of this kind are noted to be useful for a number of reasons such as increased knowledge exchange, R&D risk-sharing, human resources skill-sharing, commercialization and improved access to new markets.<sup>9</sup> The literature on R&D and innovation commonly cites linkages between the business, government, non-profit and higher education sectors as a fruitful area of effective research collaboration and important drivers of social change.<sup>10</sup> A network approach to research is seen to allow for reduced financial risks for universities and businesses, greater research opportunities for university faculty and staff, better understanding of skills development by the private sector, and greater access to cutting edge research by bringing the diversity of experience and perspectives necessary to address complex and multi-dimensional problems and maximize resources, reduce inter-institutional fragmentation, reduce duplication and increase overall engagement.<sup>11</sup>

The SNG program file review and case study evidence confirms that the network approach generated numerous advantages for network teams, including increased scientific collaboration and cross-fertilization of ideas and methods, and synthesis of findings to achieve scientific objectives. Overall, for academic scientists, as reported in the case studies, the network R&D programs were more strategic and multidisciplinary than would be the norm for discovery grant research; for industry

<sup>9</sup> Government of Canada (2011). Innovation Canada: A Call to Action: Review of Federal Support to Research and Development – Expert Panel Report. Retrieved August 27, 2013 from: [http://rd-review.ca/eic/site/033.nsf/vwapj/R-D\\_InnovationCanada\\_Final-eng.pdf/\\$FILE/R-D\\_InnovationCanada\\_Final-eng.pdf](http://rd-review.ca/eic/site/033.nsf/vwapj/R-D_InnovationCanada_Final-eng.pdf/$FILE/R-D_InnovationCanada_Final-eng.pdf).

<sup>10</sup> Nichols, N., Phipps, D.J., Provençal, J. & Hewitt, A. (2013). Knowledge Mobilization, Collaboration, and Social Innovation: Leveraging Investments in Higher Education. *Canadian Journal of Nonprofit and Social Economy Research*, 4(1), 25-42.

<sup>11</sup> Ibid.

and government partners, the R&D was longer-term.. SNG networks also provided the benefits of leveraged resources and economies of scale that were able to overcome restrictions often inherent in smaller, separate research projects, bringing diverse researchers and partners together in pursuit of common and strategic goals that had both scientific and practical relevance. Finally, SNG networks were seen to foster closely knit groups of scientists and graduate students fostering connections that are anticipated to support and enhance future collaborations, impacting positively on Canada's research landscape.

### ***Interest in the Program***

Data suggests that there is sufficient interest in the SNG program within Canada's R&D community. Funding competition announcements have generated a significant number of Letters of Interest (LOIs): a total of 93 during the study period (2008-2013), not including another 13 LOI generated through special forestry, fisheries and manufacturing focused funding made available between 2008 and 2010.

### ***Overlap/Duplication***

***Key Finding: The SNG program is distinguished in terms of the focus on national priority areas in the natural sciences and engineering fields, and in that it permits complex problems to be addressed. The reports of researchers and case studies of SNG networks suggest that the research networks and projects funded by the networks are unlikely to have occurred in the absence of the SNG program.***

In addition to the SNG program, the research funding landscape in Canada includes other programs that fund research networks. NSERC, along with SSHRC and CIHR (the tri-agencies) fund other programs that provide grants to multi-disciplinary and multisectoral research networks, and there are other examples of network or sector-focused federal and provincial-level research programs (e.g., Fonds de recherche du Québec). The SNG program is different from these programs in that the program only provides funding for research networks in national priority areas within the natural sciences and engineering fields. The case studies of SNG networks indicate that the nature and complexity of the problems that are the focus of the program's networks are of a scale requiring a network approach to link diverse or widely-distributed areas of expertise, but appropriately addressed within the somewhat smaller resources and shorter timeframes of SNG (compared to tri-agency Networks of Centres of Excellence programs). SNG funding also provides support for strategic research efforts that require significant input from external partners to help set research directions and participate in the projects, and that enable partners to gain early access to research



findings, and benefit from hiring HQP trained in the networks.

Across the SNG networks included in the case studies, there was agreement amongst those involved that a similar network would not have formed and operated in Canada in the absence of SNG. At the level of network-funded projects, the vast majority of funded SNG researchers (92%) indicated that if funding had not been available for their project, it would have had a major negative impact on their project. Specifically, researchers (72%) most often indicated that the project would not have proceeded at all.

## 2.1.2 Necessary Role for Federal Government

***Key Finding: Documentary evidence supports the importance of the federal role in funding research and development to foster innovation and economic growth. The relevance of government's role in providing SNG program funding is confirmed by the alignment of SNG expected results with federal ST&I investment priorities.***

Canada's most recent and thorough examination of the federal role in research funding programs such as the SNG is the *Review of Federal Support to Research and Development* (2011). This report calls for the establishment of a "clear federal voice for innovation" and makes a number of recommendations on the suite of federal supports for business and commercially oriented research and development. The report notes the distinction between solution-driven research and basic discovery research supported by research granting councils such as NSERC, and the need to fund both types of endeavours adequately (and to evaluate using appropriate and relevant metrics).

Since the publication of the *Federal Review*, the federal government recently released an updated Science, Technology and Innovation Strategy in December 2014 to guide federal investments and priorities: *Seizing Canada's Moment: Moving Forward in Science, Technology and Innovation 2014*.<sup>12</sup> The Strategy builds on the 2007 framework *Mobilizing Science and Technology to Canada's Advantage*, signaling a continued federal role and commitment to "keep science, technology and innovation at the forefront of government policy" in the coming years and to build on the Canadian legacy of innovation and scientific breakthroughs. The updated Strategy continues to emphasize the importance of partnerships, calling for action among players in the Canadian innovation system (research and business communities, different levels of government) "to work together to achieve the goal of making Canada a scientifically

<sup>12</sup> <http://www.pm.gc.ca/eng/news/2014/12/04/canadas-science-technology-and-innovation-strategy>

and technologically innovative nation capable of leading the world”. Among the Strategy’s tangible commitments is “the enhancement of established networks and the fostering of new collaborations among post-secondary institutions, researchers and companies, as well as government scientists and engineers”, matching SNG program goals.

### 2.1.3 Alignment with Federal Priorities

***Key Finding: The objectives of the SNG program are consistent and aligned with federal government priorities and NSERC strategic outcomes.***

#### *Alignment with Federal Government Priorities*

The 2007 S&T Strategy, released as a blueprint to achieve the R&D goals outlined in the federal government’s 2006 strategic economic plan, *Advantage Canada: Building a Strong Economy for Canadians*<sup>13</sup>, aimed to foster three distinct Canadian S&T advantages: an Entrepreneurial Advantage, whereby knowledge is translated into commercial applications that deliver benefits to Canadians; a *Knowledge Advantage*, whereby Canadians are on the cutting edge of knowledge development and acquisition; and a *People Advantage*, which involves Canada’s attractiveness as a destination of choice in the modern global economy<sup>14</sup>. The 2014 Strategy builds on the 2007 framework, retaining the *People* and *Knowledge* pillars from the earlier framework, and broadening the *Entrepreneurial* pillar to encompass *Innovation*.

Through investments in R&D, training of HQP and knowledge mobilization the SNG program contributes to the Knowledge, People and Entrepreneurial / Innovation Advantages outlined in the 2007 and 2014 Strategies to varying degrees. Notably, the SNG program target areas align well with the updated research priorities identified in the 2014 Strategy which added a fifth priority, advanced manufacturing (an NSERC strategic target area), to the previously established priorities of natural resources and energy, health and life sciences, information and communications technologies and the environment priority (all of which are NSERC strategic target areas, with the exception of health and life sciences).

Successive Speeches from the Throne have reiterated the federal priority on R&D and

<sup>13</sup> Department of Finance (2006). *Advantage Canada: Building a Strong Economy for Canadians*. Retrieved August 28, 2013 from: <http://www.fin.gc.ca/ec2006/pdf/plane.pdf>

<sup>14</sup> Government of Canada (2007). *Mobilizing Science and Technology to Canada’s Advantage: Summary*. Ottawa: Public Works and Government Services Canada

innovation which are aligned with the objectives of the SNG program. Federal Budgets have underscored that priority: in 2010 the Budget acknowledged that improvements were still needed in the translation/commercialization of research discoveries<sup>15</sup> and increased the annual budgets of the tri-agencies by an additional \$32 million per year. Budget 2013 stressed the importance of strengthened industry-academic collaboration, a key tenant of the SNG program<sup>16</sup>. Budget 2014 further confirmed the government's commitment to "world-leading research" and outlined investments in advanced research and innovation among other economic initiatives<sup>17</sup>.

### ***Alignment with NSERC Strategic Outcomes***

The SNG program is a key instrument within NSERC's Strategic Partnerships program. Within NSERC's current Program Alignment Architecture, SNG contributes to NSERC's strategic outcome 1.3 Innovation: Research Partnerships, Sub-program 1.3.1: Research in Strategic Areas. 3.0 Innovation; "Productive use of new knowledge in the natural sciences and engineering."

In December 2009, NSERC launched its Strategy for Partnerships and Innovation (SPI) which is a blueprint for action to increase Canada's benefits from its investments in R&D. The goal of the SPI and subsequent Budget investments in 2010 and 2011 is to accelerate innovation in Canada by helping businesses of all sizes and in all sectors connect and collaborate with the research strength in Canada's post-secondary institutions to find the competitive edge they need to excel. NSERC's Research Partnership programs, including the SNG, respond to the needs of receptor communities by fostering interactions and partnerships between academic researchers and the user sectors in order to generate new knowledge and develop new expertise, and to transfer this knowledge and expertise to Canadian-based organizations to promote innovation.

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<sup>15</sup> Government of Canada (2010). Budget 2010: Leading the Way on Jobs and Growth. Retrieved August 27, 2013 from: <http://www.budget.gc.ca/2010/pdf/budget-planbudgetaire-eng.pdf>.

<sup>16</sup> Government of Canada (2013). Budget 2013: Jobs, Growth and Long-term Prosperity Retrieved August 27, 2013 from: <http://www.budget.gc.ca/2013/doc/plan/budget2013-eng.pdf>

<sup>17</sup> Government of Canada (2014). Economic Action Plan 2014. The Road to Balance: Creating Jobs and Opportunities. Retrieved February 18, 2015 from: <http://www.budget.gc.ca/2014/docs/plan/pdf/budget2014-eng.pdf>

## 2.2 Effectiveness

### 2.2.1 Enhanced R&D and Innovation

***Key Finding: SNG network-funded research is leading to the creation or extension of knowledge, confirmed by scholarly publications and citations and networks that were examined in the evaluation were effective in producing research that met or exceeded network goals; SNG-funded researchers increased their visibility and reputation in Canada and internationally.***

A total of 472 researchers were identified as being involved in the 35 SNG networks that were included in the survey conducted for this evaluation. Almost all SNG researchers indicated that their network project resulted in the creation of new knowledge (85% stated that their project resulted in or was likely to result in this outcome) or extension/application of existing knowledge (78%). The creation of new knowledge is corroborated by the bibliometric study of SNG-funded researchers: the scientific output of the SNG researchers increased significantly from an average of 2.39 papers per year before they had received support from the program, to 3.72 during the period in which they were supported by the SNG program. The study also assessed the scientific impact of supported researchers, determined by average of relative citations. Although it indicates that the scientific impact of the SNG-supported scholars' papers decreased very slightly during support (almost all other programs researchers decreased more significantly<sup>18</sup>), it also indicates citations increased for SNG researchers after program support ended: 2.97 against 2.67 for Collaborative Research and Development Grants and 2.88 for Strategic Project Grants.

Case study evidence also indicates that all four networks studied were successful in meeting and/or exceeding their research goals.

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<sup>18</sup> The slight decrease in citations during the program period could be attributable to increased volume of research activity during the period, leading to less stringent oversight of the quality of the output on the part of the researchers leading to a slight reduction or stagnation in the impact of the resulting output.

Three-quarters of surveyed SNG researchers (75%) indicated that their SNG-funded project increased the visibility and reputation of researchers involved in the project a benefit of the program echoed also in the case studies and file review which further pointed to the many awards and distinctions won by network scientists for the quality of their work. Reported factors in the case studies that assured research excellence included the national scope of the networks, the stability of relatively large and long-term funding bolstered by significant in-kind resources from partners, effective network management, and clear project review and reporting mechanisms.

LITHOPROBE's unique combination of collaborative research and multidisciplinary studies has earned high international regard and is considered by many to be the best Earth Science program in the world.

The SENTINEL network has significantly increased the visibility of Canadian researchers and has generated significant interest internationally. The network has received about 100 inquiries across the globe about new SENTINEL technologies. SENTINEL is well known in countries such as China, Australia, Finland and Sweden.

Canada is now considered a world leader in aquatic invasive species (AIS) research as a result of work done by the Canadian Aquatic Invasive Species Network (CAISN). Canadian researchers contribute half of the world's research publications in AIS.

## 2.2.2 Collaborations

***Key finding: SNG was effective in facilitating multidisciplinary and multisectoral collaborations; SNG networks were more likely than other comparator program networks to involve government partners. There is evidence that many SNG collaborations involved organizations that had not worked together previously. Collaborations are generally viewed as successful, leading to closer connections between research and industry needs, new directions in scientific inquiry and leveraging of partner contributions. There is some evidence of international collaborations and impact.***

Two-thirds of surveyed SNG researchers (65%) and three-quarters of SNG partners (75%) indicated that their network project / they network they were involved in resulted in *multidisciplinary* research collaborations. The vast majority of SNG researchers identified themselves as working primarily at a university (92%) and most indicated their research domain as natural sciences and engineering (94%). The case studies give a more detailed picture of the different disciplines involved in the selected networks, and indicate that SNGs were very successful in facilitating multidisciplinary collaborations in various areas of expertise and research strength within the natural sciences and engineering domain. Examples of fields that were represented in these networks included biology, veterinary medicine, earth sciences, ecology and evolutionary biology, mathematical and statistical sciences, fisheries and aquatic sciences, and ocean sciences. Involvement of individuals from disciplines outside of

natural sciences and engineering was less frequent, although, health sciences and social sciences were represented among the SNG researchers (6% and 8%) and partners (16% and 6%).

Most SNG partners (59%) indicated that the network resulted in *multisectoral* collaborations; four in ten researchers (38%) agreed. On average, SNG network-funded research projects involved collaborations with six organizations (though there is a significant range based on the nature and size of the project), drawn from a wide variety of partner organizations and sectors. Almost all surveyed SNG researchers indicated that the types of organizations involved in their collaboration included universities (96%), while approximately half indicated there were private sector (51%) and/or Canadian government (federal, provincial or municipal) (46%) partners. SNG networks involved significantly more Canadian government partners than NCE (36%) or BL-NCE (16%) networks. The case studies and bibliometric study provide supporting evidence for multisectoral collaborations within SNG networks through, for example, increases in the number of jointly authored publications with government partners during and after SNG funding.

There is also evidence of significant *new* partnership development; half of surveyed SNG researchers indicated that they had worked with only some of their project partners previously (49%), and approximately one-quarter indicated they had not worked with any of their partners previously (23%). While less prevalent than multidisciplinary or multisectoral collaborations, case studies point to several projects that increased the visibility and reputation of Canadian researchers internationally, leading, in some cases, to international collaboration.

The majority of surveyed SNG researchers indicated that their collaborations with partner organizations were successful. The quality of collaborative relationships between researchers and partners within the case study networks was seen to be superior than would have been possible outside the network. These increased and better quality collaborations reportedly resulted in academic research being better informed by the needs and expertise of industry and/or regulatory partners, which in turn meant increased relevance of the science in the real world. New strains of scientific inquiry were also developed through collaborations specific to network projects. For example, MAGS developed hydroclimatology, bringing together the fields of hydrology and climatology – a scientific field of inquiry now offered as training in some universities.

Finally, within the networks included as case studies, strong partnerships also reportedly led to the leveraging of cash and in-kind support from partners to the research program, and to spin-off collaborations outside of the network and beyond the funding period between researchers, and between researchers and industry.

### 2.2.3 Meeting the Needs of Partner Organizations

***Key Finding: SNG networks actively sought mechanisms to engage with partners by including them in their research projects in innovative and meaningful ways. Universities lead most phases of SNG network research projects; private sector and government partners play a more prominent role during the mobilization stage. Networks are equally seen to be meeting business needs as public and non-profit needs. When there were specific challenges to meeting partner needs, SNG networks most often found ways to address them.***

Case study and file review evidence indicates that SNG networks actively sought mechanisms to engage with their partners in order to meet their needs and maximize their impact within the network: there was evidence of compliance with SNG program guidelines designed to foster partner engagement, such as mandatory involvement of partners on management boards and Science Advisory Committees, as well as evidence of network-created supplementary engagement activities including the implementation of data sharing policies, conducting demonstration projects to show how network results could benefit stakeholders, and holding research reviews at partner facilities. Across the 35 SNG networks that were included in the survey of partners, there were 287 unique organization named as network partners.

SNG researchers indicate that the university is the lead partner for most SNG-funded project phases with the exception of the dissemination and mobilization phase, when private sector and Canadian government partners, as well not-for-profit organizations and, to a lesser extent, health providers, play a more prominent role. SNG partners confirm that they play comparatively greater involvement in the very early planning stages, as well as in the latter phases of the project (dissemination and, to a lesser extent, mobilization).

Just over half of surveyed SNG partners (55%) and approximately three-quarters of surveyed SNG researchers (72%) agree that the network addresses significant research challenges that meet business needs; a similar proportion of SNG partners (54%) and researchers (77%) indicate the network addresses research challenges that meet the needs of public or not-for-profit organizations.

About one in four SNG partners (38%) indicate the network has met the needs of their organization to a great extent and another 22% say the network has somewhat met the needs of their organization (e.g., by addressing technical challenges, providing opportunities for collaboration/networking, producing skilled graduates, providing access to latest research advances).

Among surveyed partners who indicated their needs had not been met, the reasons most often cited were due to lack of relevance or utility of network research (not aligned to interests, too general, network didn't meet objectives, too slow for competitive market) or weak or delayed engagement/communications by the network with partners.

Case study evidence indicates that the networks studied were mostly successful in meeting the research and technology needs of their industry and government partners. The networks provided an extension of the partners' own research facilities at a reduced cost compared to building equivalent internal R&D capability. Furthermore, the networks provided value-added training and access to HQP, which according to some was perhaps more significant for network partners than the research knowledge itself.

## 2.2.4 Impact on HQP

### *Participation of HQP*

***The SNG program has supported the training of thousands of HQP, typically at the Master's and PhD level. Virtually all SNG-funded projects involve HQP, and the networks have put in place varied engagement, research funding and training and development opportunities to enhance HQP research and professional skills. Researchers and HQP approve of the quality of research and training opportunities within the SNGs.***

Within the SNG program, virtually all researchers (97%) indicated that their project had resulted in the training of HQP. There is evidence that training opportunities for thousands of HQP have been either partially or fully supported by SNG funding: in the program file review, with information from 11 networks, a total of 717 HQP were fully supported, and another 1,714 HQP were partially supported by the SNG grant. According to survey data, the majority of SNG HQP were Master's (40%) or Doctoral (43%) students, while one in 10 was a Post-Doctoral Fellow (12%). Almost all SNG HQP were drawn from the natural sciences and engineering domain and, reflecting the



gender distribution of NSE disciplines, there was a higher proportion of survey respondents who were men.

SNG network researchers reported that the SNG program, in comparison to other projects they have been involved in, offers superior HQP training opportunities to interact with university researchers and other HQP (66%), and to enhance job readiness (60%). Approximately half of SNG researchers indicated superior HQP training opportunities were also available to participate in exchanges/internships (54%), conduct multidisciplinary and multisectoral research (49%), and conduct research relevant to the private sector (49%).

Case studies and the file review indicated that SNG networks sought to add significant value to HQP training by providing them with a wide variety of opportunities outside the realm of basic research, including opportunities to work in more than one laboratory (including those of partners) which exposed them to different research projects, environments and approaches. Some HQP were also given opportunities to participate in entrepreneurial training workshops that included an introduction to the commercialization of products; others were able to attend national and international conferences to build their personal networks, in some cases presenting research findings at those forums.

Most SNG HQP were very positive about the quality of their research experience, rating it to be of excellent (52%) or very good (32%) quality. Most also rated the quality of the training provided to be of excellent (40%) or very good (37%) quality. Six in ten reported that the quality of the networking opportunities was excellent (41%) or very good (26%), and more than half rated the quality of cutting edge technology/research facilities they were able to access to be excellent (30%) or very good (24%).

### *Acquisition of Skills and Experience*

***Key Finding: Through their training with the SNG networks, HQP were able to participate in numerous activities that developed their research and knowledge translation skills; notable opportunities were related to interactions with other students and network partners, and participation in research and multidisciplinary collaborations. Many HQP indicate that their participation in SNG-funded projects is leading to the creation of new knowledge.***

SNG HQP were asked what specific experience they gained through participation in their network project. Approximately three-quarters indicated they worked with other

students or Post-Doctoral Fellow researchers in the network (76%) and other academic researchers in the research network (73%).

Most SNG HQP indicated that their training resulted in the participation in projects leading to the creation of new knowledge (83% rated this factor 4 or 5 on a 5-point scale). Approximately two-thirds indicated they participated in projects leading to the extension/application of existing knowledge (77%).

SNG HQP were also asked to indicate the extent to which their experiences with the research network allowed them to gain specific skills. Almost all SNG HQP (91% rated this factor 4 or 5 on a 5-point scale) indicated that their participation in an SNG network project allowed them to interpret research findings and to develop research skills (88%). HQP also reported gaining skills in the data collection/research implementation phase (84%) and undertaking knowledge translation/mobilization activities (papers, final reports, presentations, theses, commercialization, and non-typical dissemination activities) (84%).

### *Employment*

***Key Finding: Of HQP who were employed at the time of the survey, a significant proportion is employed by industry. Most are using the skills acquired through their SNG research project, and those skills were seen to assist them in finding employment. Case studies indicate that the employment outcomes for network HQP were very positive and network partners often hired network-trained HQP.***

Approximately one-third of SNG researchers (35%) and partners (36%) indicated that their project (researchers) or the network (partners) had resulted in HQP being hired by network organizations. Among SNG HQP who were no longer working on their SNG network project, 48% were employed full-time and 10% part-time. Of those, the majority were working for the private sector (44%) or with a university or affiliated institution (35%). Thirteen percent were working for government, almost twice as many as in all three comparator networks.

Six in ten SNG HQP indicated that they are working in an area addressed by the research network to a great (27%) or some extent (34%) and about one in ten were working for one of the research network's partners. Among SNG HQP who are currently employed, 53% indicated that they use the skills acquired through their participation in the research network project in their current position.

The HQP interviewed for the SNG case studies confirmed that the skills they obtained through the network directly contributed to their ability to obtain their current employment. These HQP were in high demand and were quickly hired by partners or their competitors in Canada that were involved in related activities. Some industry partners were able to recruit HQP in Canada who were trained through SNG networks rather than seek them from abroad.

A large number of NECTAR HQP went on to work for high-tech companies. NECTAR's two primary industry partners, SMART Technologies and Microsoft, hired a total of 12 HQP. According to the NECTAR final report, 14 HQP were hired by partner companies, 30 were hired by other organizations in the user sector, 20 were employed as faculty in academia and 10 were hired by government.

### 2.2.5 Mobilization

***Key Finding: SNG researchers mobilize knowledge using refereed and non-refereed publications. Survey results and file report evidence indicate many publications are co-authored by researchers and government and industry partners. Case studies point to numerous KT activities taking place, although some networks experience challenges in fostering visibility and uptake of research results.***

Virtually all SNG researchers and indicate that network research results are being shared and most (91% of researchers and 77% of partners) agree that the SNG network with which they are affiliated accelerated the exchange of research results among members of the network. Sharing of network research results occurs through a broad array of channels: SNG researchers are most likely to share results with other network members through an annual conference/general meeting, meetings, presentations and informal discussions or correspondence (all mentioned by approximately 9 in 10 researchers). SNG partners are most likely to say that sharing of network research results occurs through meetings, annual conferences, informal discussions and reports. Case study and file review evidence indicated that SNG networks often used technology to help them share research results, such as network-wide databases and/or comprehensive data management systems that could include a data policy, data management tools, a data manager/specialist and websites or electronic newsletters.

Almost all SNG researchers indicate that network research results are being mobilized in some way (only 6% of researchers said their research had not (yet) been mobilized). Refereed publications are by far the most often mentioned means of mobilization for SNG researchers (87%), followed by non-refereed publications (51%) and joint refereed publications by academic and private sector participants (32%). One in ten SNG researchers says their research is also being mobilized through social media.

Among the SNG partners who are sufficiently engaged and aware of mobilization activities, like SNG researchers, they most often named refereed publications as a means of research mobilization (72%), followed by joint refereed publications (54%), non-refereed publications (49%), and network agreements regarding intellectual property (32%).

SNG researchers who are mobilizing their research results are working primarily with universities (91% indicate they are working with this type of organization to mobilize results). Almost half are working with the private sector (45%) and the Canadian government (44%). SNG researchers are much more likely than all other comparator networks to be mobilizing results with the Canadian government. The SNG program file review reported 5,140 dissemination activities based on the 11 networks included in the review: 1,870 refereed publications, 1,240 conference presentations (invited), 917 conference presentations (not-invited), 713 non-refereed journal articles, and 400 technical reports. Interestingly, 848 papers and 473 presentations were co-authored by networks' (10 of 11 reporting) industry and government partners.

## 2.2.6 Impacts on Partners

***Key Finding: The SNG program is having a positive impact on the knowledge base of partner organizations, as well as R&D receptivity, capacity and investment. There is some evidence SNG knowledge has led to regulatory changes, new products and services, and patent applications.***

Among partners, survey responses indicate that the most common impacts of the strategic networks is on the increased knowledge base of partner organizations (65% of partners indicate their network resulted in this outcome and another 12% say this is likely to happen). Half of strategic network partners indicated the network impacted the R&D of network organizations (50% has happened and another 16% say likely to happen), while 4 in 10 indicated the network impacted network organizations' processes and/or practices (37%). Approximately one-third indicated the network impacted network organizations products and/or services (30%).

The review of final reports of 11 of the SNG networks funded over a 10 year period provided a number of examples of the use of research results for several of the networks, including new processes/products/services (71 in total), the creation of prototypes/pilots (34), knowledge applied toward policy/regulations (28), improved processes/products/services (10), and new spin-offs (12). In terms of commercial outcomes, the SNG program files noted that 4 patents were filed by the Canadian

Research Network on Swine Infectious Diseases and 2 patents were filed by NECTAR.

Case studies also demonstrated numerous mobilization activities, including development of and partner utilization of prototypes, research influence on government and industry policy (some that had specific ramifications in mitigating negative economic impacts to Canadian industry), and improved models for a variety of environmental management issues.

### 2.2.7 Long-term Benefits

***Key Finding: While longer-term benefits are challenging to measure, case studies and the partial cost-benefit analysis point to SNG research which has led or will likely lead to long-term economic and environmental benefits for Canada.***

The contributions of SNGs to long-term benefits is often challenging to measure. However, two of the four SNG case studies provide examples of SNG network-funded research that have led to a variety of impacts related to regulatory changes to reduce environmental and economic impact (CAISN) and improved environmental forecasting, monitoring and management (MAGS) that will have major implications for the prediction of the ecological, economical and social impacts associated with water resources.

**CAISN** researchers were successful in influencing both government and industry policies. CAISN contributed to inform the policy surrounding the creation of the aquatic invasive species (AIS) regulatory proposal (Department of Fisheries and Oceans). CAISN research on ballast water discharge also influenced Transport Canada regulations: the research showed that ships subject to minimal regulation (because it was thought they were low risk) were actually posing the highest threat of spreading aquatic invasive species (AIS).

CAISN contributed to inform the policy surrounding the creation of the aquatic invasive species (AIS) regulatory proposal. By knowing more about pathways related risks and probabilities of invasions, Fisheries and Oceans Canada was able to create regulatory tools for AIS management that will allow for adequate response should an invasion occur. More importantly, the research done through CAISN will allow jurisdictions using these tools to focus their efforts where the greatest risk exists and where there are greater chances of eradication/management success.

In its Regulatory Impact Analysis Statement published in the Canada Gazette<sup>19</sup>,

<sup>19</sup> Canada Gazette, Aquatic Invasive Species Regulations, Vol. 148, No. 49 — December 6, 2014, <http://www.gazette.gc.ca/rp-pr/p1/2014/2014-12-06/html/reg1-eng.php#archived>

Fisheries and Oceans Canada stated: “The total projected costs arising from damages caused by AISs are difficult to estimate as they include direct and indirect costs and are reflected in market and non-market variables. Nevertheless, AISs have been demonstrated to have significant environmental impacts and economic costs for humans. An examination of three published studies<sup>20</sup> that included over 100 species suggested that the average costs associated with each invasive species within North America ranged from \$14 million to \$39 million annually. Associated costs included the control and management of the invasive species, losses in biodiversity and intrinsic ecosystem values, and economic costs associated with commercial and industrial activities that are dependent on water and aquatic ecosystems (e.g. fishing, tourism, hydroelectricity, marine transportation)”.

CAISN research also contributed to Transport Canada’s *Ballast Water Control and Management Regulations*. While regulation of ballast water discharge imposes costs on government (for inspection) and to ship owners and operators, the benefits were found to outweigh the costs of not acting to prevent AIS: the ongoing costs of AIS, such as the zebra mussel in the Great Lakes was estimated at over \$1 billion for the region<sup>21</sup>. As a result, TC revised the Ballast Water Control and Management regulations under the Canada Shipping Act to reduce the threat posed. In addition, the Shipping Federation of Canada used that same information to order ships identified as high risk to flush their ballast water. This approach was subsequently adopted by regulators in the US.

Moreover, within the benefit-cost analysis, some potential (and even likely) quantifiable economic benefits were identified.

The benefit-cost calculation for NECTAR and CBMRN examined the likelihood that the networks would achieve economic benefits (e.g., from marginal profits, cost savings, value of hiring HQP) in line with the NSERC research investment. The results showed that in order for NECTAR to cover its direct network costs, only about a 4% chance of success of achieving its projected industrial sales estimates was required. For CBMRN, about a 14% chance of success of achieving its cost savings goals for the Canadian dairy industry was required in order to cover the anticipated direct network

<sup>20</sup> Pimental, D., Lach, L., Zuniga, R., Morrison, D. (2000), Environmental and Economic Costs of Nonindigenous Species in the United States. *BioScience* 50(1), 53–65.

Pimental, D., Zuniga, R., Morrison, D. (2005), Update on the environmental and economic costs associated with alien-invasive species in the United States. *Ecological Economics* 52, 273–288.

Colautti, R., Bailey, S. A., van Overdijk, C. D. A., Amundsen, K., MacIsaac, H. J. (2006), Characterized and projected costs of nonindigenous species in Canada. *Biological Invasions* 8, 45–59.

<sup>21</sup> Canada Gazette, Ballast Water Control and Management Regulations, Regulatory Impact Assessment Statement, 2005 [http://www.puntofocal.gov.ar/notific\\_otros\\_miembros/can129\\_t.pdf](http://www.puntofocal.gov.ar/notific_otros_miembros/can129_t.pdf)

costs. The analysis concluded that, given NECTAR's existing sales achievements, and CBMRN's renewal and extensive industry outreach, the likelihood of successfully achieving a positive benefit-cost ratio was within reach for both networks.

## 2.3 Efficiency and Economy

**Key Finding:** *The SNG program is delivered efficiently, with a low and relatively stable administrative cost.*

Efficiency and economy of the SNG program were examined using analyses of administrative efficiency and perceptions of surveyed program stakeholders about the efficiency and effectiveness of the delivery of the programs.

### 2.3.1 Administrative Efficiency

The ratio of operating expenses relative to the total amount of grants is a common method to evaluate the operational effectiveness of grant programs. This ratio represents the cost to deliver one dollar of grant funds awarded. Funding agencies have also commonly calculated their operating expenses as a percentage of total program expenditures.

Exhibit 2.1 summarizes the estimated operating expenses under the SNG program for fiscal years 2008-2009 to 2012-2013. The actual operating expenditures of the SNG program are not available because some expenses, such as common administrative services for NSERC (e.g., finance, human resources and IT) cannot be provided at the program level. These costs and were estimated using the ratio of total SNG grant funds to total NSERC grant funds. It should be noted that the estimation of administrative costs only takes NSERC's costs into account. For example, the value of the volunteer time selection panel members spend on the competition process is not accounted for in the estimation.

Data on various expenditures and annual ratios for SNG from 2008-09 to 2012-13 are presented in Exhibit 2.1 below. Program data indicate that the funds available for SNG are \$173,802,623 for the funding period 2008-2009 to 2012-2013. For the same period, the administrative costs of the program are estimated at \$8,423,633 for an operating ratio of 5.1 cents per \$1 of grants awarded. Note that over the period under study, there was a notable decline in the operating ratio from 6.27 cents per \$1 of grants awarded in 2008-09 to 4.7 cents per \$1 of grants awarded in 2012-13.

**Exhibit 2.1: Estimated Operating Expenditures of the SNG Program**

Expenditures (in \$)	2008-09	2009-10	2010-11	2011-12	2012-13	Total
Total Direct	\$806 050	\$1 025 983	\$752 347	\$849 751	\$826 513	\$4 260 645
<i>Direct Salary</i>	<i>\$502 120</i>	<i>\$730 188</i>	<i>\$653 073</i>	<i>\$743 920</i>	<i>\$733 050</i>	<i>\$3 362 352</i>
<i>Direct Non-Salary</i>	<i>\$303 930</i>	<i>\$295 795</i>	<i>\$99 274</i>	<i>\$105 831</i>	<i>\$93 463</i>	<i>\$898 293</i>
Indirect + Direct Non-Attributable	\$609 540	\$742 358	\$874 906	\$986 768	\$949 417	\$4 162 989
Total Admin Cost	\$1 415 590	\$1 768 341	\$1 627 252	\$1 836 519	\$1 775 930	\$8 423 633
Grant Funds Awarded	\$22 594 184	\$31 889 508	\$33 542 042	\$39 592 207	\$37 761 048	\$165 378 989
<b>Total Program Expenditures</b>	<b>\$24 009 774</b>	<b>\$33 657 849</b>	<b>\$35 169 294</b>	<b>\$41 428 726</b>	<b>\$39 536 979</b>	<b>\$173 802 623</b>
<i>Operating Ratio (¢:\$1) Expenditures to Grant Funds awarded</i>	<i>6.27¢</i>	<i>5.55¢</i>	<i>4.85¢</i>	<i>4.64¢</i>	<i>4.70¢</i>	<i>5.09¢</i>
<i>Operating Expenditure as a percentage of Total Program Expenditure</i>	<i>5.90%</i>	<i>5.25%</i>	<i>4.63%</i>	<i>4.43%</i>	<i>4.49%</i>	<i>4.85%</i>

Exhibit 2.2 shows the comparative operating ratios and percentage of administrative costs to program expenditures for the SNG, NCE and BL-NCE programs. The operating ratio for SNG (5.1 cents per \$1 of grants) is low and similar to those of NCE and BL-NCE which amounted to 3.3 cents and 5.5 cents per \$1 of grants respectively. Operating expenditures of the SNG program (4.8% of total program expenditures) are also low and similar to NCE and BL-NCE which amounted to 3.2% and 5.28% of total program expenditures respectively. (It should be noted that the NCE program overhead, which appears to be comparatively lower, is reflective of the size of the overall program and of the size and frequency of grant awards.)

**Exhibit 2.2: Comparative Data NCE, BL-NCE and SNG Programs**

Program	Administrative expenditure (in \$)	Grant Expenditures (in \$)	Total Administrative and Grant Expenditures (in \$)	Operating Ratio (¢:\$1)	Operating Expenditure (in %)
NCE	\$12,373,996	\$371,939,990	\$384,313,986	3,3¢	3,2%
BL-NCE	\$2,661,004	\$48,162,343	\$50,823,347	5,5¢	5,2%
SNG	\$8,423,633	\$165,378,989	\$173,802,622	5,1¢	4,8%





### 2.3.2 Perceptions of Efficiency and Effectiveness

***Key Finding: Program stakeholders are generally pleased with the delivery of the SNG program; SNG researchers and partners are more satisfied with program governance and financial administration guidelines than their NCE and BL-NCE counterparts. SNG researchers and partners cite strong leadership as a key factor in facilitating network success.***

Based on results of the networks to date, 71% of SNG partners consider the network they are affiliated with to be successful to a great or good extent and most SNG researchers (90%) consider their project to be successful to a good or great extent.

Most SNG partners (83%) and researchers (75%) indicated they were satisfied with SNG governance guidelines, such as network and funding agreements; satisfaction with governance guidelines was markedly less for all other comparator networks. SNG researchers (77%) and partners (68%) were also more likely than their comparator network counterparts to be satisfied with financial administration guidelines such as eligible and non-eligible expenditures. Two-thirds of SNG researchers (67%) and approximately eight in ten SNG partners (78%) indicated they were satisfied with the programs reporting requirements.

Similar to other funding programs, less than half of SNG researchers were satisfied with the guidelines for the management of intellectual property (42% indicated they were satisfied with that aspect of the program) while approximately two-thirds of SNG partners indicated they were satisfied with guidelines for the management of intellectual property (64%) (this was the lowest rated aspect of the program). Note that many of the researchers and partners in the SNG are unlikely to have experience with a new policy on intellectual property introduced by NSERC in 2009 which provides requirements for IP agreements.

According to surveyed SNG researchers, the factor that best facilitated the performance of the network was network leadership (81% rated this factor 4 or 5 on a 5-point scale); approximately seven in ten also indicated network governance structure (72%), network design (72%), network project selection process (69%) and access to equipment and facilities (68%) facilitated the performance of the network. The ratings of SNG partners were consistently lower than those of researchers, but they similarly rated leadership, network governance structure, network design and access to equipment and facilities as key facilitating factors. Consistent with the program satisfaction ratings presented above, management of intellectual property was least apt

to be rated a facilitating factor by researchers (20%) and partners (15%).

Case study evidence echoes the survey responses; case study participants were satisfied with network management and administration, and indicated that their time and resource investments in their SNG network were worthwhile. Specific success factors included strong and proactive leadership; strong, effective, goal-oriented and coordinated management by the network's scientific lead (PI), Board of Directors and Scientific Advisory Committee; rigorous review of proposed projects to determine whether they could effectively contribute to the network's overall objectives; and economies of scale, particularly in sampling activities, as a result of collaboration among researchers.

According to the case studies and review of program files, where the networks encountered challenges, these often had to do with technical or scientific problems, management problems such as long term planning, personnel problems and partners leaving the network prematurely or encountering financial difficulties. Typically, the networks were able to resolve these problems with minimum impact on the scope and scale of network research or training activities.

Some challenges relating to the engagement or receptivity of receptor communities were also noted: not all partners understood the value of university research, and not all industry partners had the capability and capacity to use the knowledge that was being generated. There were also examples of a lack of focus on and/or resources dedicated to KT. Some partners recommended improvements related to industry engagement.

Case study participants highlighted several areas for improvement, including more information sharing (specifically in progress reports and by improving the network meeting and conference structure) (echoed by the file review), more tracking of HQP post-network involvement in order to assess the effectiveness of network training, and training for network managers in areas in which they have specific deficiencies depending on their background (conducting meetings, financial issue management). Some surveyed SNG researchers (between 6% and 11%) suggested improvements could be made to communications and project selection criteria, and that funding periods could be longer. Some surveyed SNG partners (between 2% and 7%) mentioned: improve link between results and application, including greater industry engagement and meaningful involvement in network projects; less administrative red tape/reporting requirements; stable/longer funding and more communications/clarity. Suggestions for improvement by SNG HQP included more events/workshops for networking (11%).

## 3.0 Conclusions and Recommendations

Following are the conclusions and recommendations based on the findings from the evaluation of the SNG program.

### 3.1 Relevance

The evaluation confirms the continued need for the SNG program. Demand for the program has remained strong with a stable number of applications for funding over the study period. The network approach to research funding that is the basis of the SNG and other network programs was found in the review of literature to have many advantages, particularly to address complex problems that require efforts of widely dispersed and multidisciplinary and multisectoral teams. There was no evidence of problematic duplication with other funding programs; the SNG occupies a specific niche in the NSERC suite of funding programs distinguished by its focus on medium to longer-term research initiatives for complex programs requiring collaborative efforts among researchers and partners. The research networks and projects funded by the networks are unlikely to have occurred in the absence of the SNG program.

The federal government role in funding research and development to foster innovation and economic growth was found to be important and relevant. The SNG program was found to be consistent with government priorities that highlight the ongoing federal commitment to R&D and innovation as key drivers of prosperity. The 2014 ST&I Strategy signals the continued federal role and priority for these investments, which includes programs such as the SNG. The program also aligns well with the strategic outcomes of NSERC.

### 3.2 Effectiveness

The evaluation evidence indicates that the SNG program through the achievements of its funded network is achieving or making progress toward achieving intended outcomes.

**Research, development and innovation.** The entities established by the SNG have created networked approaches to research and development through the engagement of many researchers and partners from various sectors. The SNG networks that were examined in the evaluation were seen to meet or exceed their research goals. The network

approach facilitated, among other benefits, significant contributions of in-kind resources from partners that aided research. SNG researchers' annual scientific output increased significantly during the period in which they were supported by the SNG program compared to the period before research funding, and the increase in SNG researchers' output was comparable to researchers that received other types of NSERC research funding. Research excellence was confirmed by external awards and distinctions won by SNG scientists. Many networks significantly increased the visibility and reputation of Canadian researchers both in Canada and internationally. A strong majority of SNG partners and researchers indicate network research projects are leading to the creation or extension of knowledge.

**Multidisciplinary, multisectoral and international collaborations.** SNG networks were very successful in facilitating multidisciplinary collaborations in various areas of expertise and research strength within the natural sciences and engineering domain. On average, SNG network-funded research projects involved collaborations with six organizations, drawn from a wide variety of organizations and sectors including universities, the private sector, government and not-for-profit organizations; collaboration between SNG researchers and government partners was particularly high as compared to other network funding programs such as the NCE or BL-NCE. According to surveyed researchers, their research collaborations often involved a mix of new and existing partners and were generally viewed as successful. According to many partners, their involvement in the network seeded continued interest in academic-industry partnerships. International collaborations are taking place; in some cases SNG networks are leading international research collaborations while in other cases the network participants are expanding current collaborations or creating new international collaborations.

**Meeting partner needs.** SNG guidelines are in place to foster partner engagement, such as mandatory involvement of partners on management boards and Science Advisory Committees. There was also evidence of network-created supplementary partner engagement activities. Universities lead most phases of SNG network research projects; private sector and government partners play a more prominent role during the mobilization stage (use/application of knowledge and/or technology). Networks are equally seen to be meeting business needs as well as public and non-profit needs.

**Impacts on HQP.** The SNG program has a positive impact on the training of HQP. Virtually all SNG-funded projects within the networks involve HQP, and the networks have put in place varied engagement, research funding and training and development opportunities to enhance HQP research and professional skills. Key distinguishing

features of network HQP training include opportunities to interact with university researchers and other HQP, to enhance job readiness, to participate in exchanges/internships, to conduct multidisciplinary and multisectoral research and to conduct research relevant to the private sector. Researchers and HQP approve of the quality of research and training opportunities. Of HQP who were employed at the time of the survey, a significant proportion is employed by industry. Case studies indicate that the employment outcomes for network HQP were very positive and network partners often hired network-trained HQP.

**Knowledge and/or technology mobilization by partner organizations.** The SNG networks demonstrate broad dissemination of network research through traditional media (publications, conferences) and researchers and partners agree that the networks accelerate the exchange of these results. KT activities are actively pursued (though opportunities for improvement in this area were noted by some) and there is evidence of a significant amount of commercialization activity, including the execution of non-disclosure or confidentiality agreements and patent applications. SNG researchers who are mobilizing their research results are working primarily with universities, and secondarily with the private sector and the Canadian government; SNG researchers are much more likely than all other comparator networks to indicate they are mobilizing results with public sector partners. Some challenges relating to the engagement or receptivity of receptor communities were uncovered and surveyed partners recommended improvements related to more active engagement of partners and a stronger alignment between network research and partner needs/goals.

**Impacts on partner organizations and the user sector.** Increasing the knowledge base of network organizations is the most common impact of network research according to SNG partners and researchers; SNG partners and researchers also cite impacts on the R&D of network organizations and on products and /or services of network organizations. Numerous tangible results for partner organizations and the user sector were identified, including the creation of prototypes/pilots, new processes/products/services, improved processes/products/services, knowledge applied toward policy/regulations such as improved models for environment management issues and new spin-off companies.

**Long-term economic, social, health and environmental benefits to Canada.** The contributions of SNG networks to long-term benefits is challenging to measure. However, there is evidence of SNG network-funded research that has led to a variety of impacts such as regulatory changes to reduce environmental impact and improved environmental forecasting, monitoring and management. As well, within the benefit-cost analysis,

evidence of research that has led to or will likely lead to quantifiable long-term economic and environmental benefits was identified.

### 3.3 Efficiency and Economy

The SNG program is delivered efficiently, with a low and relatively stable administrative cost: total administrative costs of the program are estimated at an average of 5.1 cents per \$1 of grants awarded over the study period; there was a notable decline in the operating ratio from 6.3 cents in 2008-09 to 4.7 cents in 2012-13.

Program stakeholders are generally pleased with the delivery of the SNG program and perceive many of the elements of the program to be well-executed; satisfaction with governance guidelines was markedly higher for SNG participants than for all other comparator research networks. SNG researchers and partners were also more likely than their comparator network counterparts to be satisfied with financial administration guidelines. While management of IP was cited as an issue by some, NSERC introduced an IP policy (2009) which provides requirements as to what must be included in IP agreements. SNG researchers and partners across various lines of evidence cite strong leadership as a key factor in facilitating network success; some issues were raised in regards to finding researchers/network managers with appropriate management skills. Other facilitating factors cited by researchers and partners included governance structure, network design, network project selection process (researchers only) and access to equipment and facilities. Case study evidence points to a deficiency in details provided in researchers' progress reports and a need for reporting templates, which has since been implemented by the program.

### 3.4 Recommendations

1. **The SNG program is relevant and is achieving its key intended immediate and intermediate outcomes, as well as demonstrating progress towards meeting its long term outcomes. It should therefore be considered for continued support at the federal level to continue to foster research and innovation.** The SNG program is addressing a continued need using a network approach that has been shown to have many advantages; the program also supports the federal government's R&D and innovation goals and is delivered in an efficient manner.
2. **Best practices in the area of industry engagement and KT among SNG and other research networks, including tools and resources, should be shared broadly among**

**the networks to embed and maximize translation of network research to meet partner needs. Consideration should be given to including KT resource allocation minimums or greater specificity in the KT approach in applications for funding.** The experience of the case study networks suggested that where challenges were encountered, these often occurred in the mobilization of research results and the engagement or receptivity of receptor communities. Surveyed partners also recommended improvements related to greater breadth and more meaningful engagement of industry. Several networks have developed resources or had successful experiences in mobilization which could be beneficial to share and adopted by other networks.

3. **The program should examine ways to improve capture and reporting of performance metrics at the program level that would indicate the outputs and outcomes of networks based on common indicators of research outcomes (e.g., publications, mobilization of research, commercialization).** While a common network reporting template was introduced in 2005, the ability to report on results at the program level remains limited.
  
4. **The program may wish to explore how to provide increased guidance and identification of best practices to improve network leadership and to ensure that the requisite administrative and oversight skills of the network management team are in place to create a well-functioning and cohesive network.** Across the various lines of evidence, strong leadership was identified as a key factor in facilitating network success. This important, yet demanding function was identified as a challenge for some networks that impacted their success. Increased support of leadership skills development or best practices in management recruitment could contribute to improved network functionality and success.