A Network Approach to Addressing Strategic Fisheries, Aquaculture, and Aquatic Sciences Issues at a National Scale: An Introduction to a Series of Case Studies from Canada

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ABSTRACT: *Traditional funding programs for fisheries, aquaculture, and aquatic research provide short-term support for an individual or small research team to test a specific hypothesis, often having only limited spatial applicability. To tackle more complex issues existing at larger spatial scales (national or continental), other approaches are necessary. In Canada, the Natural Sciences and Engineering Research Council has developed the Strategic Network Grants (SNGs) program that enables multi-institutional teams of academics (typically 10 to 20 co-principal investigators) to work with industry and government partners on large-scale, multidisciplinary research projects in targeted research areas. The network model is intended to create unique training opportunities and enable researchers to study problems at spatial and temporal scales that could not be addressed with traditional funding. Currently, six of the 30-plus SNGs in Canada are focused on fisheries, aquaculture, and aquatic sciences issues, namely, impacts of hydropower on fish and fish habitat, capture fisheries, integrated multitrophic aquaculture, healthy oceans, and the spatial ecology of aquatic vertebrates in coastal waters. Here we introduce five case studies that will examine the motivation, scientific research objectives, and operation of networks in detail. In addition, we explore the perceived benefits and challenges with the research network–funding model with specific reference to the advancement of large-scale studies in fisheries, aquaculture, and aquatic sciences.*

Introduction

In Canada the traditional model for granting programs (i.e., Natural Sciences and Engineering Research Council of Canada; NSERC) has focused on awarding monies to individuals or small groups of researchers studying a common issue (Table 1),with funds being tenured for relatively short periods of time (3–5 years). This model for dispensing public funds for scientific research results in sums of money being granted to many scientists carrying out important fundamental science and training highly qualified individuals but often leads to researchers working in relative isolation on specific scientific questions that maybe criticized for their reductionism. Typically those questions are not of a national or international interest. Nevertheless, the questions can be of great importance for the advancement of knowledge and the explanation of novel phenomena. Though we tend to believe that the research and training funded by autonomous grants are vital to the development of science, science may also benefit from more holistic approaches to funding that enable larger collaborative, interdisciplinary, and integrative research projects. By altering the way in which some public funds are distributed among scientists, governments may be better equipped to solve, or mitigate, pressing large-scale and complex environmental issues such as climate change, collapsing fisheries, and invasive species.

Natural Sciences and Engineering Research Council of Canada large-scale network-type grants have existed since the 1980s, when they were called "collaborative special projects," later morphing into "research networks." In 2006, the NSERC decided to link research networks to strategic target areas; thus the program became known as "strategic network grants." Identified target areas had high potential to improve Canada's economy, society, and/or environment within 10 years. Funds for the networks would also contribute toward the research and training of highly qualified personnel in areas of key national importance (e.g., hydropower impacts on fish habitat), thereby improving the pool of skilled individuals available for solving the next generation of scientific and technical problems. In general, it was envisaged that the focus of the networks would entail funding critical science to find solutions to problems with strategic importance on a national scale.

The Strategic Network Grant (SNG) program requires that the problem be of importance at the national scale and that industry be explicitly and actively involved (Table 1). Grants have been awarded to networks with topic focuses rooted in fundamental science (e.g., the Canadian Barcode

TABLE 1. A comparison of NSERC discovery grant and strategic network funding

	Discovery grants	NSERC Strategic Network Grants
Research	Incremental research that builds toward a stated long-term objective as defined by the researcher. Projects must fall within the limits of funding body portfolios and may relate to either theoretical or applied problems	Research must fall within predefined strategic target areas (e.g., environment and health) considered to be of national importance
Spatial scale	Can be any scale but often practically limited to regional or local scales by funding	Typically regional to national
Temporal scale	Typically 3–5 years	Typically 5-year grant with possibility of re-application at the end of the 5 years
Number of institutions	Typically one	Industry and/or government end-user partnerships required
Type of partners	Not required	In first 5-year terms, no partner cash required, only in-kind contributions and support. If re-applying for a second 5-year term, end-user partners must provide a minimum of $1 for every $3 from NSERC

of Life Network) and applied science (e.g., sustainable energy initiatives like the NSERC Wind Energy Strategic Network) and to programs designed to enhance business competiveness in Canada (e.g., the Business Intelligence Network). Because Canada is a nation with abundant water and seafood resources, a number of fisheries, aquaculture, and aquatic sciences networks have been funded. These networks include programs aimed at studying the effects of hydropower on fish and fish habitat (NSERC HydroNet), the impacts of capture fisheries (NSERC Canadian Capture Fisheries Research Network), the development of integrated multitrophic aquaculture systems (NSERC Canadian Integrated Multi-Trophic Aquaculture Network), the implementation of an ocean tracking network (Ocean Tracking Network Canada), and the development of scientific guidelines for the conservation and sustainable use of marine biodiversity resources (Canadian Healthy Oceans Network). To date these networks have garnered over $30 million in NSERC support and each consists of 10-plus academic researchers and additional government and industry scientists. Each network is guided by a highly qualified, mid- or late-career scientist supported by an administrative structure that includes a research management committee to oversee the scientific research program being carried out by the network and a board of directors that draws on external business and administrative experience to ensure the efficiency and relevance of network activities. In following issues of *Fisheries*, the scientists leading these networks will explain the objectives, scope, research activities, and future directions of these multidisciplinary research programs.

Benefits and Challenges of Networks

The use of a network approach has its benefits and challenges, and the associated change in the allocation of research funds has attracted positive and negative comments. With that in mind, we explored the perceived benefits and challenges of the network funding model to advance large-scale studies in fisheries, aquaculture, and aquatic sciences (Table 2). We polled the leaders and key personnel involved with each of these five SNGs and have summarized the benefits and challenges reported. One obvious benefit of the approach anticipated in the program name is networking for the lead researchers and students involved. All networks consist of over 10 researchers, who come from a variety of institutions and disciplinary backgrounds. The mix of skills provides obvious possibilities for synergistic research interactions that might not otherwise come about because of the isolation associated with individual granting and study. For students, the network provides opportunities to be involved in multidisciplinary research likely to increase their understanding of the complexity of large research questions. Such understanding can help students to appreciate the passively invoked *ceterus paribus* of traditional research and to actively consider how other disciplinary experience may be used to solve the research problems they are working on. Students are also presented with opportunities to actively participate in the planning of meetings and workshops that form a core of network activities. Furthermore, students are able to deal directly with the network partners, and that experience with industry and government scientists provides direct experience with real-world project development and implementation. The mix of top-down driven determination of national-level research priorities and bottom-up responses in the form of network grant applications exposes both university researchers and students to and engages them in the development and implementation of science policy. Thus, these networks have the potential to produce more well-rounded science graduates with an appreciation of the social relevance of their research and what science may be needed to address as critical needs in the future in Canada and elsewhere.

TABLE 2. Benefits and challenges of the strategic network approach

Benefits	Challenges
Interdisciplinary networking possibilities	Administrative obstacles associated with network start-up that delay actively addressing identified research questions
Facilitates research synergism among participating disciplines	Administrative burden and consumption of funding resources to meet accountability requirements and to ensure that the network achieves its overarching goals
Improved opportunities for student involvement with applied science problems	Coordination with end-user partners required to ensure common vision
Improved opportunities to tackle large-scale problems	Scale of research questions encouraged may exceed ability of available funding to be successfully addressed
Exposure to the science–policy and science–commercial interfaces	Maintaining a unity of purpose among a diverse set of researchers more used to individual research projects
Increases Canada's international reputation in the funded fields of research	Management steering committee and scientific advisory committee in place to ensure that the network achieves its overarching goals

As is the case with most large-scale granting opportunities, there are challenges. The size and multiparty nature of the grant structure necessarily involves a lot of administrative setup. The intellectual rights of researchers to publish must be balanced with concerns about proprietary information that may be supplied by network partners. Detailed research agreements outlining the duties and responsibilities of all participants need to be written, reviewed, and signed. Accountability demands that each network establish internal review processes and have decision structures in place to ensure that they meet their stated objectives. All of these controls come at a cost and invariably involve the use of funds and time for other than direct research costs. Thus, though network grants may appear large, not all funds received are available for actual research. In contrast, the reporting for individual grants does not entail the construction of resource-consuming parallel bureaucracies (~15% of funds are allocated to network administration and management costs, such as meetings, communications, etc.). The demands of internal bureaucracy should not be underestimated. Network leaders can easily become subsumed in the details of running the network organization and quickly lose their ability to functionally carry out their individual research projects in the network. Although most universities offer secretarial staff and administrative assistance to deal with the monetary side of grant administration, leaders and members of the various research management committees are left to deal with the day-to-day scientific administration, which can require a considerable time commitment.

In addition to the time commitment involved in grant administration, there is an inherent challenge of solving the "big questions" posed by the network. Big questions often have many unknowns, involve the study of highly variable phenomena, and require difficult and costly experimental designs. The requirement to tackle problems at the largest scale can require resources that outstretch the capacity of even the most effective research team. Furthermore, the need to involve multiple partners requires time be spent explaining the necessity and benefit of complex science methods to groups often more focused on the short-term performance and applied approaches. However, these end-users are an essential part of the networks because they are ultimately responsible for the use and implementation of the network outcomes.

Outline of Canadian Strategic Grant Networks Series

In the coming months, *Fisheries* will present five case studies that will examine the motivation, scientific research objectives, and operation of fisheries, aquaculture, and aquatic-related networks in detail. This project is sponsored by the Canadian Aquatic Resources Section of the American Fisheries Society and is intended to highlight these prominent national research initiatives that are attempting to address large-scale problems. The five case studies are based on the following five networks: HydroNet is focused on a national research network designed to promote sustainable hydropower and healthy aquatic ecosystems; Ocean Tracking Network Canada is focused on understanding the movements and spatial ecology of continental shelf marine animals relative to environmental variability, change, and human activities; the Canadian Integrated Multi-Trophic Aquaculture Network is focused on developing balanced production systems for complementary cultured species for environmental sustainability, economic stability, and social acceptability; the Canadian Capture Fisheries Research Network is focused on ensuring that Canadian commercial fisheries are sustainable; and the Canadian Healthy Oceans Network is focused on providing biodiversity science for the sustainability of Canada's three oceans. The networks are at various stages of maturity and thus some will be able to report on research plans and preliminary results, whereas others will be able to summarize research output and, in some cases, how their findings have already informed management or led to technological innovations that have improved the Canadian environment and economy. Although decidedly Canadian in

geographic focus, the case studies we will present address issues that are also of global significance. Transfer and dissemination of information is an important goal of these networks, and this series will contribute to reaching that goal. The individual case studies will address the benefits and challenges of this new approach to funding. It is our hope that these case studies will be of broad interest to the readership of *Fisheries*.

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