

International Review of the Discovery Grant Program

Response by the Canadian Society for Ecology and Evolution

1. To what extent is the philosophy of the Discovery Grants program suited to the Canadian context and the country's needs for research results and highly qualified people (HQP)?

We consider the Discovery Grant program to be soundly based for the conduct of scientific research in general, and appropriately configured for the Canadian context.

- First, the best measure of the efficiency of a funding program is the marginal scientific return on investment. In most cases, research output and training of HQP is a nonlinear function of funding level. Above some minimal level (below which no useful work can be done) output rises at a diminishing rate because any laboratory has a limited capacity for making progress. This will occur, if for no other reason, because it is often impossible to plan the next project or experiment before the results of the current one are known. Thus, the marginal return on investment will fall with funding level, so that the second ten thousand dollars above the minimal level adds less value than the first, the third ten thousand less than the second, and so forth. It follows that the optimal average level of funding for successful applications will be greater than the minimal level but will not be very large. The overall return on investment is therefore greater for a large number of modest grants.
- Secondly, a modest but consistent level of funding is less wasteful than boom-bust cycles engendered by grant systems with lower success rates. Many labs in the USA have expensive equipment that was bought on previous grants but is not

currently supported and therefore lies idle. Unfortunately, a shortage of DG funding may tend to create a similar situation in Canada for expensive equipment bought on CFI grants.

- Finally, the DG program creates a highly distributed system of expertise that supports research and the training of HQP throughout the country, including small universities and remote regions. A much smaller number of large grants would inevitably create an “academic imbalance” between universities and between regions.

For these reasons, we conclude that the Discovery Grants program serves Canada well by ensuring a high national level of research activity while supporting a substantial research and training capacity in all regions of the country. Having said this, **the current average funding in GSC18 (about \$29K) is clearly much closer to the minimum than to the optimum.** In most areas, Discovery Grants of less than \$40K will not allow applicants to realize their potential in terms of research productivity and training of HQP. Moreover, funding levels are tending to decline. This year, returning applicants in GSC 18 received on average 10% less than what they had before. Given that most obtained their previous grant 4-5 years ago, they faced a 20-25% decrease in purchasing power in inflation-adjusted dollars. This shortfall must be corrected for the program to be fully effective.

2. What should be an appropriate balance between the following two objectives of the Discovery Grants program: “promoting and maintaining a diversified base of high-quality research capability in the natural sciences and engineering in Canadian universities” and “fostering research excellence”?

We do not consider these objectives to be contradictory; indeed, we see them as being complementary. Our reasons for thinking this are as follows.

- First, the unpredictability of future research strength. The system of peer review is the best that can be contrived, but it is nevertheless imperfect. The most serious

flaw is a failure to recognize outstanding researchers early in their careers. This is a grave drawback in funding systems with low success rates, where an unknown but perhaps substantial number of promising researchers are not supported and who therefore never realize their potential. This can happen even in our system: it is notorious that a Herzberg laureate initially received a very modest award. This was, thankfully, enough to establish what was to become a world-famous program; in a more stringent system this scientist would never have had the opportunity to develop.

- Secondly, future research directions and needs are inevitably unpredictable. We can identify areas where progress is likely to be rapid and fruitful only when the outcome of the research we are currently doing has pointed the way, and this outcome evidently cannot be predicted with confidence, otherwise it would not be necessary to do the research. A diversified research program, such as Discovery Grants, is inherently flexible, and can respond very rapidly to the most recent advances. Centrally directed science runs the risk of freezing in place yesterday's themes, creating institutions that are poorly placed to shift direction and take advantage of emerging results and ideas. Our more entrepreneurial system ensures that the community as a whole has the capacity to take up new advances very quickly and deploy resources to investigating them further.
- For similar reasons, emerging problems are more easily dealt with when some basic research has already been done. In recent years, our ability to respond to problems such as mountain pine beetle, West Nile disease, SARS and cyanobacterial blooms has depended on a pre-existing research program. In a less diversified system no such base would exist, and attempts to understand, control or regulate an emerging problem would inevitably be delayed.

In short, we conclude that the diversified base of research capability provided by the DG program helps to foster research excellence by providing a highly flexible and manoeuvrable system able to adapt rapidly to new research priorities.

3. To what extent is NSERC successful in supporting the best researchers at a world-class level through its full suite of programs?

In most fields, but not in all, the funding opportunities offered by NSERC allow scientists to operate at world-class levels. There are two reasons for this.

- The more obvious is the availability of funding through NSERC programs other than the DG program. These offer many opportunities for supporting ambitious research programs. Their main drawback is that in most cases (not all) they are restricted to targeted projects that are intended to lead directly to a specific application. This is clearly a justifiable strategy for the use of public funds, but may lead to a shortfall in the funding of some types of basic research. The introduction of the Discovery Accelerator Program will alleviate this problem to some degree, and we hope that it will be carefully monitored to ensure that advanced basic research in areas that require exceptionally high funding levels will be adequately supported.
- The way in which research funding is organized in Canada, however, provides a second and less obvious source of support. For example, graduate students and postdoctoral fellows often bring their own stipends to the lab rather than drawing on their supervisor's funds. Furthermore, the salaries of university researchers normally cover the whole year, rather than the 9 months that is often the case elsewhere. Indirect and overhead costs are also less a burden on NSERC grants than on the grants provided by similar agencies in other countries. However, there are several ways in which current practices might be revised in order to increase the effectiveness of Discovery Grant funding. For example, the practice of awarding scholarships directly to students is unusual, and it might be more productive and more cost-effective to distribute them directly to researchers, who are in the best position to evaluate applicants to their laboratories.

Having said this, there are some areas where the minimal cost of research is so high that it may deter, or even preclude, setting up world-class research programs. These include large-scale field experiments, some aspects of oceanographic research, and projects in northern areas that require expensive logistical support. It is also a cause for concern that using modern molecular techniques in evolution and ecology is becoming increasingly difficult at current funding levels. There are, therefore, some areas where higher funding levels would release research potential that is currently under-utilized. Large-scale ecological projects in arctic and subarctic sites are perhaps the most obvious at a time of rapid environmental change.

The way in which research facilities are provided has changed considerably in the last twenty years, and in particular institutional support has greatly declined. The common services that were formerly provided by departments have almost completely disappeared, throwing the burden of providing them onto the individual researcher. One way of enhancing the value of research grants might be to ensure that the funding of the indirect costs of research is channeled more directly to researchers.

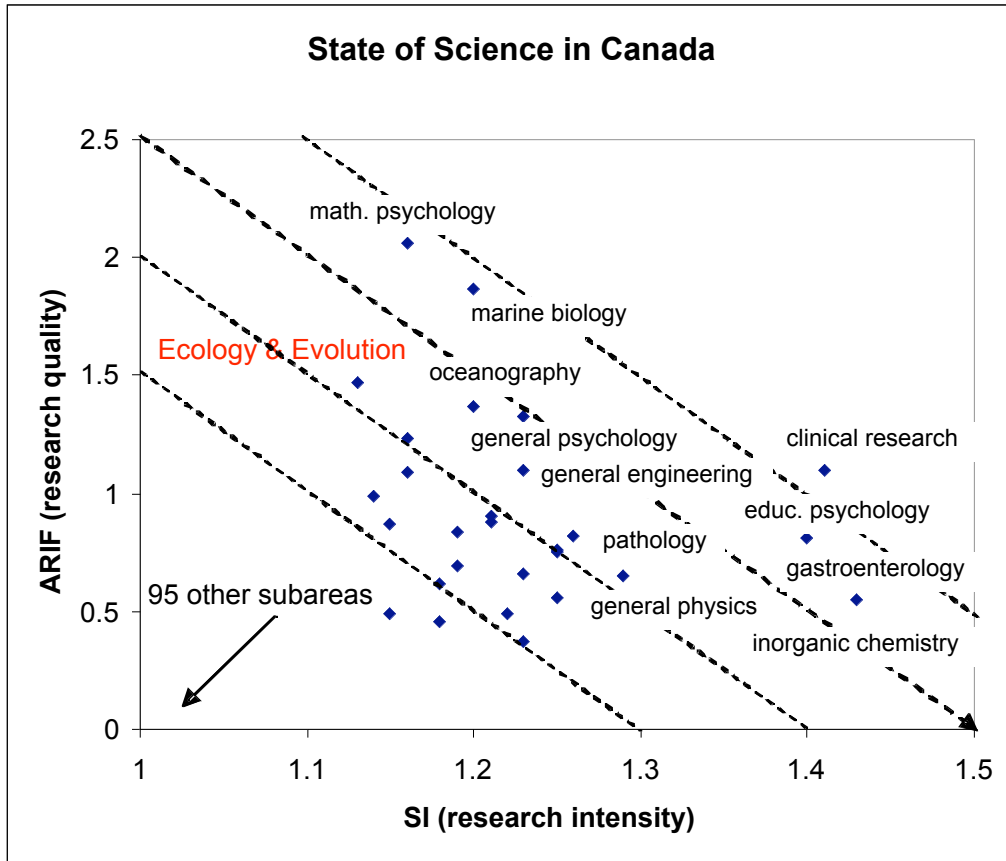
4. In the discipline or field of your membership, to what extent is the research funded through the Discovery Grants program having an impact on the international scene?

Two quantitative assessments of the productivity of Canadian research in ecology and evolution have been published. The first ranked Canadian research relative to other developed countries, while the second ranked research in ecology and evolution relative to other fields within Canada.

- The first was by Peters et al. (1996 *Can J Fish Aquat Sci* 53, 670), who found that rates of publication and citation were very high relative to the level of funding. Over all the fields funded by NSERC, Canada ranked as the 6th most cited nation. In ecology-environment and in aquatic sciences, however, Canada was the 2nd most cited nation, behind the U.S.A. but ahead of the U.K., Germany, France and

Japan. This was achieved despite funding levels that were appreciably less than those in any of these other countries. Peters et al comment: “Although typical Canadian grants were less than half the size of those in other countries, available indices of national achievement in evolution and ecology place Canadian research among the world’s best. From 1981 to 1992, Canada was the second most active nation in the fields of environment, ecology, and aquatic sciences in terms of both publications and citations.”

- The second document was the Report on the State of Science and Technology in Canada, which was issued by the Council of Canadian Academies in 2006. It evaluated more than a hundred different domains with respect to the quantity and quality of publication – essentially the same criteria as used in Peters et al (1996).



This confirmed that ecology/evolution had maintained its position as one of the strongest fields in Canadian science. Taking quantity and quality together, the diagram above, prepared from the data in this report, shows how the research supported by GSC18, together with the related fields of oceanography and marine biology, surpasses almost all other areas of science and engineering. This is particularly true for the quality of research.

These two objective assessments make it clear that Canadian researchers in ecology and evolution have had an enormous impact on the international scene for at least the last twenty years. Indeed, with the exception of certain specialized technical areas (such as oil sands technologies) it can be argued that ecology and evolution has the highest international profile of all the major fields funded by NSERC. This is in large part attributable to the Discovery Grants program, which has supplied more than 50% of the funding received by most researchers. An informal survey of *Ecology* and *American Naturalist* (two of the top journals in our field) showed that 76% of papers published in 2005 – 2007 with first authors residing in Canada acknowledged NSERC support. Our historical pre-eminence may be under threat today, however, partly as a victim of its own success. The level of funding has failed to keep pace with the rapid expansion of research activity in recent years, and consequently real funding rates per capita are falling. As they were already well below those in comparable nations ten years ago, this is a matter for concern.

Respectfully submitted,

Graham Bell
President, Canadian Society for Ecology and Evolution
31 August 2007