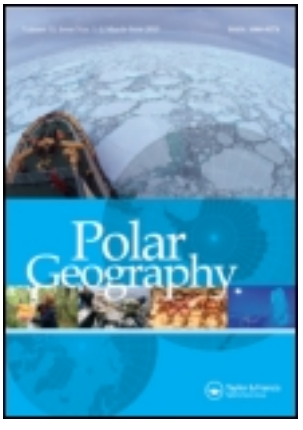


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# Measuring the economic impact of publicly funded research in Northern Canada

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This paper provides the first empirical estimate of the local economic impact of publicly funded research expenditures in the Yukon, Nunavut, and Northwest Territories of Canada between 2000 and 2009. The total dollar expenditures of northern research during this period was estimated to be $284 million and peaked in 2009 at close to $110 million. Using data acquired from major granting agencies in Canada and Statistics Canada multipliers, the economic impact of northern research on local income, Gross Domestic Product (GDP), and employment impacts were estimated. It was determined that at its peak, northern research impacted the territorial GDP by 0.04%, income by 0.09% and employment by 0.11%. While the total economic impact of publicly funded research expenditures may be small relative to other northern industries, individual communities where the field research is conducted, may experience significant income, employment and other intangible benefits. The community of Old Crow is used to illustrate the potential community-level importance of local expenditures associated with northern research.



## Introduction

In 1998, a Canadian Task Force on Northern Research was formed to assess the state and contribution of Canadian research. Funded jointly by Canada's Natural Sciences and Engineering Research Council (NSERC) and the Social Sciences and Humanities Research Council (SSHRC), the Task Force found that Canada's northern research programs were in a state of crisis, and if immediate action was not taken, Canada would fail to meet basic national requirements to monitor, manage, and safeguard the northern environment, or respond effectively to emerging social issues (Task Force on Northern Research 2000). In order to reverse these conditions, the Task Force recommended that NSERC, SSHRC, and other federal research programs rejuvenate funding support for northern research and develop new funding mechanisms that would 'augment existing research expertise, train a new generation of northern researchers, increase the amount of high-quality research being done in the north, and enhance the involvement of northern communities in research' (Task Force on Northern Research 2000, 25).

Since the Task Force made its recommendations, Canada has made a considerable financial investment in its northern and Arctic research capacity. This includes the establishment of new northern research initiatives and a reinvestment in a

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number of existing research programs, including: NSERC Northern Research Chairs; SSHRC Northern Research Development Grants, and annual Strategic Research Grants; Northern Contaminants Programs; Northern Ecosystems Initiative; Arctic-Net Network Centres of Excellence; International Polar Year; Polar Continental Shelf Programme; and the Northern Students Training Program.

While increased funding for northern research has proven beneficial in terms of scholarly and scientific advancement (their stated purpose), northern communities have voiced concern that too often the local benefits accruing from community participation in research are few. Northern communities are, by-and-large, supportive of research that may improve the social, economic, and environmental conditions of the north (ARI 2001), but they also expect to receive tangible benefits from the conduct of the research itself. This is particularly true in cases where community members contribute valuable time, knowledge, and resources to the successful completion of research projects (CCAC 2008). Researchers have thus been encouraged to consider other types of direct and indirect benefits that research projects can have within northern communities (ITK and NRI 2007). For example, researchers are asked to ensure that project budgets account for the costs associated with preproject consultation with community members, provide local employment and training opportunities, pay honoraria for local expertise, utilize local accommodations and services, and spend the necessary funds for results reporting (translation, interpretation, transcription, and in-person visits) (Gearheard and Shirley 2007). These budget considerations have in many cases become standard expenditures for researchers working with northern communities.

While it is assumed that communities are now benefiting more directly from the conduct of northern research, there has yet to be an attempt to quantify these benefits and measure the local economic impact of publicly funded research expenditures. To date, most attempts to measure the impact of publicly funded research have focussed on academic or commercial benefits of research findings (Salter and Martin 2001). For instance, academic benefits have been measured in terms of new scientific instrumentation and methodologies being created, the number of trained graduates produced, the stimulation of intellectual interaction, and increasing the capacity for scientific and technological problem solving (Smith 1998). Other attempts have measured the commercial benefits such as the number of patents registered, the adoption and application of new technologies by industry, improvements in labor productivity, and the creation of new firms (Martin 1998). Our interest, however, is not in documenting these types of impacts but rather in investigating the direct and indirect local (territorial) impacts of the expenditures incurred during the on-site conduct of the research. Northern research grants do benefit the (southern) universities or the organizations of the awardees (i.e. the cost of research administration). However, of necessity or by stipulation, northern research also involves hiring northern labor, purchasing northern transportation services, and expenditures for local accommodations, provisions, and other services.

By viewing publicly funded research as a source of local income, this paper provides the first empirical assessment of the local economic impact of northern research expenditures. This includes an assessment of the types of incomes and expenditures that are generated locally by publicly funded research between 2000 and 2009. By focusing specifically on the *conduct* of the research as a potential economic driver in the north, it is hoped that the results of this paper will contribute to a more informed and nuanced understanding of the complex nature of the

northern economy and the local face of northern research. Such considerations may be especially important as climate change, explorations regarding the extent of the continental shelf, and the related social, environmental, and jurisdictional concerns accelerate future expenditures for northern research.

## Background and methodology

In this research, the Canadian north includes the Yukon, Northwest Territories, and Nunavut. Collectively, these three territories comprise 14,275,633 $km^2$, or 40% of Canada's total land mass. The Canadian territories are, however, sparsely populated, with less than 1% of Canada's total population. Today, territorial economies are based not only on the extraction of natural resources such as oil, gas, and metal ores but also include public services, retail, construction, and the arts, each contributing in varying degrees to territorial economies. However, common to all the three territories is the significant contribution of public services. Serving as the single largest employer in all the three territories, public services include the administration of federal, territorial, local, and Aboriginal governments. For example, in Nunavut, public services have been estimated to account for 45 percent of all economic activity in the territory (Duhaime and Caron 2008).

While the economy of northern Canada has undergone considerable change over the past century, an enduring and perhaps defining feature remains the harvest of country foods and resources. Today, as in the past, residents from across the North harvest, process, distribute, and consume considerable volumes of country food annually. Collectively, these activities have come to be known as 'subsistence' and together comprise an essential component of the northern economy. Despite the predictions of its eventual demise, the subsistence economy continues to demonstrate considerable resilience and remains integral to the health and well-being of northern communities. Rather than subverting subsistence production, the wage economy, in many ways, provides an economic basis for wildlife harvesting to continue. In fact, Nuttall and his colleagues (2005, 673) suggest that, due to the complementary nature of subsistence and wage earning, the northern economy is perhaps best characterized as an economy of optimization, where households exploit a range of financial and natural resources that collectively contribute to dynamic forms of livelihood. It is in the context of economic optimization that this study first originated.

A conventional technique for tracing the direct, indirect, and induced impacts of demand shocks in the form of new/reduced expenditures or the emergence of new industry or the decline of an existing industry on a regional economy is Input–Output (I–O) analysis (Allan *et al*. 2011; Borzoni 2011; Brown *et al*. 2012; Guerrero *et al*. 2011; Kashian and Pfeifer-Luckett 2011; Lee *et al*. 2012). Such an analysis is based on the empirically estimated interdependency of each sector of the economy on every other sector and on factor inputs (e.g. labor and capital) and can be traced to Leontief's early work as well as subsequent refinements (Leontief 1936, 1970). Once all the interindustry, household, and government sector relationships have been established, the implied relationships are represented by technical coefficients that describe the 'production function' of every industry. Assuming these technical coefficients are constant over time, I–O tables are used to assess the economic impact of an incremental final demand expenditure change. That is, as a new expenditure is added to the final demand portion of the I–O table, the 'ripple' effects

through the economy can be traced using the prior empirically estimated coefficients.

I–O multipliers summarize the total impacts throughout the economy. Direct multiplier effects are those occurring in direct response to the expenditures, such as accommodation for researchers. Indirect multiplier effects are those incremental purchases made by industries based on new sales – for example, new sales in the accommodation industry will result in new demand for linen services and cleaning supplies. Finally, induced multiplier effects include the changes in household income due to the direct and indirect effects (Miller and Blair 1985).

The Canadian government has been publishing I–O tables for Canada since 1961, with the most recent being in 2007 (Statistics Canada 2010). Canadian tables, at the national and provincial/territorial levels, are derived from surveys, tax records, and other administrative sources. The economic activities documented are those by consumers (both in consuming domestic and imported goods and services), producers (both production for domestic markets and export markets), governments, and nonprofit organizations. Due to confidentiality reasons, I–O tables at the provincial/territorial level are available only at a higher level or aggregation of industries than at the national level.

Statistics Canada provides four different types of multipliers for the Territories, specifically output, Gross Domestic Product (GDP), income, and employment. Output multipliers translate actual expenditures into total output or production requirements as a result of an increase in final demand expenditures, including the inputs required to produce the output represented by the new demand. GDP multipliers represent the change in the output of all industries due to a change in final demand in terms of local value-added (Ghanem 2005). Only that portion of the value of new production that becomes territorial factor payments (wages, rents, profits, and interest) is represented, so this multiplier will always be less than one.

Income multipliers estimate the changes in territorial wages and salaries due to an increase in final demand, that is, the portion that becomes income to someone in the territories; employment multipliers represent the change in employment, and in this paper, the number of jobs created per million dollars spent on research. These four multipliers (output, GDP, income, and employment) are used to assess the territorial impact of northern research expenditures.

## Data sources

Data requirements for this analysis consist of industry-specific expenditures identified in research grant applications and industry-specific multipliers from the Statistics Canada I–O tables for the Yukon, Northwest Territories, and Nunavut. Through the Access to Information Act, detailed research expenditure data were obtained for the 2000–2009 period, in the form of ‘budget justifications’ from the Tri-Council, Sustainable Communities Initiative, Environment Canada’s Northern Ecosystem Initiative, and the Polar Continental Shelf Project. These ‘budget justifications’ identify the proposed amounts to be spent on salaries and benefits, equipment and facilities, materials and supplies, travel, dissemination, and other relevant activities necessary for the researchers to conduct their research. While these figures do not necessarily reflect the exact expenditure of research funds, they do provide a close approximation inasmuch as they are a projection at the time of application of how funds were to be used during the course of the research.

Information was also gathered from the annual reports and other online resources for ArcticNet, Northern Contaminants Program (NCP), Northern Scientific Training Program (NSTP), Arctic Infrastructure Fund (AIF), and International Polar Year (IPY), although specific expenditures were not listed for these programs, only yearly totals spent on research.

Expenditure data were organized as follows: salary and benefit costs are for students, postdoctoral fellows, and technical/professional assistants. Equipment or facility costs are broken down into purchase or rental, operation, and maintenance as well as user fees. Materials and supplies are a separate category while travel includes conferences, fieldwork, and collaboration/consultation travel costs. Dissemination costs include publication costs as well as any other costs necessary for the publication of the research results. The other categories include technology transfer activities, freight costs, or any other particulars stated in the budget justifications.

Other research expenditures data were obtained from Aboriginal Affairs and Northern Development Canada's (AANDC) NCP website from 2000 to 2006. Funds for the years 2007 and 2008 were obtained by contacting the Public Enquiries Contact Centre at AANDC. However, funds for AANDC (2009) were not provided. While the AANDC website lists each funded project, and the total funds received, expenditures (i.e. labor, materials, etc.) were not indicated (Aboriginal Affairs and Northern Development Canada 2013). Annual reports for the NSTP were available through 2006. In 2009, $85 million in government funding was dedicated for the AIF to upgrade existing key Arctic research facilities in which $55 million was spent in the territories. Funding decisions were made in March 2009 and projects were allowed to take up to two years to complete. The IPY website identifies project expenses of $150 million between April 2006 and March 2012. The 2007, 2008, and 2009 IPY funding commitment was over $100 million. In total, the northern research expenditures over the 10-year period sum to more than $284 million, peaking in 2009 at close to $110 million.

The second main data requirement is the set of industry-specific multipliers from Statistics Canada. Expenditure components of the research granting agencies were first classified into standard Statistics Canada industries for which multipliers are available. The Statistics Canada industries (NAICS code) chosen to be most closely aligned with research expenditure categories include the following: universities (GS2100); other professional, scientific and technical services (541B00); other administration and support services (561A00); operating supplies (F10100); office supplies (F10200); laboratory supplies (F10400); all other ground passenger transportation (458A00), air transportation (421000), support activities for transport (488000), traveler accommodation (721100), food services and drinking places (722000). Table 1 shows the expenditure categories most closely aligned with Statistics Canada industries. Total research expenditures in each industry were then broken down into northern expenditures and expenditures outside the region. For the northern impact analysis in this paper, only the northern expenditures portion is relevant. An examination of the details of the research budgets produced the total northern research expenditures by industry for the 2000–2009 period, shown in Table 2. Output, GDP, income, and employment impacts of these expenditures are the result of applying Statistics Canada territory/industry-specific multipliers to the total expenditures for each of the three territories in each year.

Table 1. Concordance between Statistics Canada Industries and Research Budget Categories.

| Statistics Canada categories | Tri-council, SCI, and NEI expenditures |
|---|---|
| Universities (gs2100) | Graduate student salaries |
| Other professional, scientific, and technical services (541b00) | Services rendered by research assistants, translators, elders, hunters, analysts, and scientists, user fees for labs |
| Other administration and support services (561a00) | Phone, fax, and photocopy expenditures, training, publishing |
| Operating supplies (f10100) | GIS, camping equipment and sampling equipment |
| Office supplies (f10200) | Computer equipment and photocopying machines |
| Laboratory supplies (f10400) | Slides and test tubes |
| All other ground passenger transportation (4b5a00) | Vehicle rentals, including snowmobiles and ATVs |
| Air transportation (421000) | Commercial air travel, small plane, and helicopter rentals |
| Support activities for transport (488000) | Gasoline |
| traveler accommodation (721100) | Hotel and other accommodations |
| Food services and drinking places (722000) | Food and incidentals |

SCI, sustainable communities initiative; NEI, Northern Ecosystem Initiative.



## Results

The total output impact of publicly funded northern research in the three Canadian Territories from 2000 to 2009 was estimated to be $24.8 million. Air and ground transportation accounted for 38% of the total estimated expenditures, followed by professional, scientific, and technical services (32%), research accommodations (11%), food service (7%), and other administrative services (2%).

Total GDP, income, and employment impacts resulting from northern research expenditures were estimated for each of the three territories. GDP impacts represent the total value-added impact or the northern economies, while income impacts show the total impact on personal incomes. Employment impacts are derived from the industry-specific number of jobs per million dollars of expenditure. Summing these impacts across the three territories, over the 2000–2009 period, shows total northern impacts, Table 3.

The value-added, or GDP, impact was in excess of $12 million over the entire period, varying substantially during the period with the predominance of the expenditures occurring in the last three years, 2007–2009, and the peak occurring in 2009. The composition of total research grants by source (granting agency) varies significantly by year (see Table 4). Based on total proposed gross expenditures, IPY accounted for 76% of all the research grants in 2007. This proportion increased to 77% in 2008 and then declined to 21% in 2009. In 2009, AIF accounted for 51% of total research grants and Polar Continental Shelf Program (PCSP) represented 22% in that year. While the impact attributable to particular granting agencies was not calculated, it seems reasonable that the gross value of the research grants across agencies may also be reflective of their relative importance in particular impacts such as GDP (and other) impacts. However, because the proportion spent in the north, and, therefore, the impact of research expenditures will also vary by granting

Table 2. Northern research expenditures by industry, all agencies, 2000–2009 ($).

| Expenditure categories | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Universities | Professional services | Admin services | Ground transport | Air transport | Other transport | Accommodation | Food | Total |
| 2000 | 0 | 263,131 | 0 | 5028 | 0 | 12,598 | 106,227 | 99,497 | 486,481 |
| 2001 | 0 | 191,108 | 28,161 | 157,94 | 81,482 | 0 | 405,935 | 0 | 864,627 |
| 2002 | 0 | 179,716 | 11,862 | 122,422 | 84,694 | 1142 | 84,923 | 30,212 | 514,971 |
| 2003 | 0 | 329,188 | 8234 | 108,473 | 185,725 | 0 | 83,145 | 19,093 | 733,860 |
| 2004 | 0 | 131,425 | 14,754 | 43,050 | 109,254 | 5,691 | 73,706 | 34,159 | 412,039 |
| 2005 | 0 | 120,840 | 77,064 | 132,496 | 167,014 | 758 | 109,285 | 61,350 | 668,807 |
| 2006 | 0 | 356,422 | 94,831 | 61,197 | 215,752 | 4,570 | 102,711 | 147,870 | 983,355 |
| 2007 | 159,095 | 2,711,661 | 86,207 | 204,549 | 1,729,708 | 11,541 | 307,067 | 264,034 | 5,473,869 |
| 2008 | 82,607 | 2,713,014 | 72,349 | 172,536 | 1,548,855 | 10,892 | 367,929 | 294,823 | 5,263,007 |
| 2009 | 477,999 | 657,056 | 42,466 | 180,716 | 2,886,067 | 13,957 | 384,060 | 1,177,438 | 5,819,761 |
| Total | 719,701 | 7,653,561 | 435,928 | 1,188,407 | 7,008,551 | 61,149 | 2,024,988 | 2,128,476 | 21,220,777 |

Notes: Research expenditures are summed from Tri-Council, SCI, NEI, PSCP, AIF, ArcticNet, NCP, NSTP and IPY. The column headings are the corresponding industry categories for which Statistics Canada derives multipliers from the territorial I–O multipliers.

Table 3. Total northern research impacts, 2000–2009, all territories.

| | Impacts summed 2000–2009 | | |
|---|---|---|---|
| | GDP impacts ($'000) | Income impacts ($'000) | Employment impacts |
| Universities | 0 | 0 | 0 |
| Other prof./scientific/tech. services | 5,017 | 4,810 | 132 |
| Other admin./support services | 351 | 285 | 7 |
| All other transit/ground passenger | 938 | 406 | 12 |
| Air transport | 3,211 | 1,861 | 33 |
| Support activities for transport | 38 | 21 | 0 |
| Traveler accommodation | 1,793 | 1,037 | 35 |
| Food services and drinking places | 921 | 597 | 26 |
| Total | 12,269 | 9,017 | 245 |



agency, the inference regarding the relative importance of a particular granting agency in total impacts must be made with caution.

Annual figures show the total GDP impacts of $304 thousand in 2000, just over $726 thousand in 2006, and then increasing to over $3 million, in 2007 and 2008. To put these into perspective, in 2007, for example, the territorial GDP in current prices totaled $7753 million (Statistics Canada 2008).This means that publicly funded northern research in that year at over $3 million accounted for 0.04% of the total territorial GDP.

The income impact of northern research in the three territories over 2000–2009 was estimated at over $9 million, ranging from annual values of $199 thousand in 2000 to $526 thousand in 2006, then increasing in 2007 to $2.6 million. To assess the size of the income impact in the context of the territorial economies, during 2007, for example, the average salary of a northern resident residing in the territory ($49,785.73)[1] was multiplied by the total employed (55,711)[2] to obtain the total territorial earnings ($2773 million).The income generated by northern research ($2.6 million) that year accounted for 0.09% of the total wages and salaries in the territorial economy in the peak year of research funding.

Table 4. Percentage distribution of granting agency expenditures.

| | Tri-council | SCI | NEI | PCSP | ArcticNet | NCP | NSTP | AIF | IPY | Total |
|---|---|---|---|---|---|---|---|---|---|---|
| 2000 | 4.7 | 1.0 | 2.8 | 0.0 | 0.0 | 80.1 | 10.5 | 0.0 | 0.0 | 100.0 |
| 2001 | 6.5 | 7.9 | 10.5 | 0.0 | 0.0 | 65.0 | 10.1 | 0.0 | 0.0 | 100.0 |
| 2002 | 12.4 | 5.0 | 4.9 | 0.0 | 0.0 | 69.5 | 8.1 | 0.0 | 0.0 | 100.0 |
| 2003 | 10.6 | 1.9 | 1.2 | 0.0 | 0.0 | 77.2 | 9.1 | 0.0 | 0.0 | 100.0 |
| 2004 | 9.7 | 1.1 | 1.6 | 0.0 | 32.4 | 42.9 | 12.3 | 0.0 | 0.0 | 100.0 |
| 2005 | 12.3 | 0.2 | 1.5 | 0.0 | 34.5 | 42.7 | 8.8 | 0.0 | 0.0 | 100.0 |
| 2006 | 35.5 | 0.0 | 0.9 | 0.0 | 29.5 | 34.2 | 0.0 | 0.0 | 0.0 | 100.0 |
| 2007 | 9.2 | 0.0 | 0.7 | 0.0 | 6.5 | 7.3 | 0.0 | 0.0 | 76.3 | 100.0 |
| 2008 | 10.6 | 0.0 | 0.2 | 0.0 | 4.7 | 7.3 | 0.0 | 0.0 | 77.2 | 100.0 |
| 2009 | 3.0 | 0.0 | 0.1 | 22.3 | 2.9 | 0.0 | 0.0 | 50.6 | 21.2 | 100.0 |

SCI, sustainable communities initiative; NEI, northern ecosystem initiative; PCSP, polar continental shelf program; NCP, northern contaminants program; NSTP, northern scientific training program; AIF, arctic infrastructure fund; IPY, international polar year.

The increase in the total number of jobs (full-time and part-time) was 245 for the combined three Territories over the 2000–2009 period. Again, there was considerable variation over time with the majority of the job increases occurring from 2007 to 2009. The sum of the total employment impacts in 2000 was 18 jobs, declining in 2001 and 2002, and then increasing to 61 and 62 in 2007 and 2008, respectively. Comparing these employment values with total employment in the territories (55,711 in 2007 and 56,982 in 2008), the jobs created by publicly funded research accounted for 0.11% of the total.

**Research impacts at the local level: example of Old Crow, Yukon**

While the impacts estimated above may be small in terms of total territorial GDP, income, and employment, research expenditures are not necessarily distributed spatially in the same way as the highly concentrated economic activity in general. Research expenditures may be more dispersed with a higher incidence in remote and small communities. In these cases, income and job creation may be large relative to local economies. For example, the total income impact in 2007 was $2.6 million. For a small community receiving even 1% ($26,000) of this total, the impact may be locally significant. Indeed, the money spent locally on lodging, subsistence, on research assistants, paying for translation services, providing compensation for research involvement, and other associated costs may be large, relative to the local economies, especialy where wage earning or revenue-generating opportunities may be limited. Illustrative of the site-specific effect is the community of Old Crow.

Old Crow is the most northerly community in the Yukon Territory, and the only community in the Yukon without road or marine access. Today, approximately 300 people occupy Old Crow, 270 of whom are Vuntut Gwitchin. The market economy of Old Crow is supported largely by government services, including the Vuntut Gwitchin First Nation that provides employment in seasonal construction, building maintenance, water and fuel delivery, and support services for the youth and elderly. Education and health care also provide some employment while the Northern Store employs several people from the community.

In 2006, the last year for which data are available, about half of the 15+ population had no education certificate or diploma, about 10% have a high school diploma as their highest educational achievement, and about 10% have a University degree (Statistics Canada 2007). This Statistics Canada Community Profile shows that of the approximately 200 people that are over the age of 15, 115 or more are shown as employed, for an employment rate of 58% compared with a Yukon average employment rate of about 70%. By industry, the majority (69%) is employed in 'other services' a category that includes public administration. For individuals 15+ with income, the median income was $23,936, compared with $31,352 for the Yukon as a whole. However, the share of income that was earnings, as opposed to government transfers, was about the same as the Yukon at 83%.

The cost of living in Old Crow is high. With no road or marine access, the weekly nutritional needs of a family of four cost approximately $496 per week compared to $206 per week for the same food basket purchased in the Yukon's capital city of Whitehorse (AANDC 2010). For this, and other equally important cultural reasons, community members depend largely on the harvest of country foods to satisfy much of their nutritional needs (Wesche *et al.* 2011). For example, in 2008, residents of Old Crow reported consuming country foods a median of 582 times per year, with

median and mean consumption for men and women aged 61+ and mean consumption for men 19–40 at approximately 0.5 kg\day (Schuster *et al.* 2011, 290–295). Rather than declining in frequency, the consumption of country foods in Old Crow has actually increased since the 1990s (Schuster *et al.* 2011; Wein 1995).

The Vuntut Gwitchin have long welcomed researchers to their community and territory. Since the early 1900s, the Vuntut Gwitchin have been visited by numerous researchers (see, for example, Balikci 1963; Greer 1999; Leechman 1949; Murray 1910; Netro 1973; Schweger 1989), and since 1990, have hosted no less than 34 different research projects, with 14 of those projects occurring during our research period (2000–2009). Prominent among these projects was a multiyear research program designed to address the impacts of climate change on the Old Crow Flats and the community of Old Crow (Wolfe *et al.* 2011). This research program involved researchers from across Canada with expertise in Quaternary paleontology, dendroclimatology, permafrost science, hydroecology, terrestrial ecology, wildlife biology, community health, and traditional knowledge. Initial funding of $1.7 million was secured from Canada's IPY program, yet these funds represented only a portion of the total cost required for carrying out the research. According to Wolfe and his colleagues (2011, 134), IPY funds accounted for approximately 35% of the total project costs. The remaining 65%, or $3.1 million, was secured from NSERC's Northern Research Chairs Program, the Polar Continental Shelf Program, the Northern Scientific Training Program, NSERC Strategic Project Grant, and Parks Canada and were used to cover the costs for research assistantships, local field assistants, analytical costs, travel for fieldwork, community meetings, and conferences (Wolfe *et al.* 2011).

If we consider the combined IPY and NSERC Northern Chairs program of $4.8 million, and applying the 'northern expenditure ratio' from the total research funds for the territories of approximately 11%, this would represent local expenditures of $566,400. Applying the average Yukon income multiplier (0.49) and assuming a distribution over types of expenditure consistent with that for research expenditures in the Yukon as a whole, this would represent increased income of $277,500. To put this in context, the median earnings in 2006 reported above from Statistics Canada of $23,936 for 190 individuals, implies total aggregate income of $4.5 m in Old Crow in 2006. The income impact of the identified research project ($277,500) would thus represent roughly 6% of the aggregate income received in a particular year.

While exact expenditures for this research are not known, expenditure data from another project conducted in Old Crow during this same period accounted for more than $26,000 of the direct community expenditures. Funded by the Social Economy Research Network of Northern Canada, these direct costs include salaries for a part-time local research coordinator and two summer research assistants, room accommodations for a graduate student, groceries purchased at the Northern Store, contract services paid for river transportation to and from Fort Yukon, Alaska, and gifts and gas vouchers for community members (see Table 5). Relative to the median income of approximately $24,000, the coordinator position would represent almost half the median income, and the combined expenditures would represent more than the equivalent of the median income, or an increase of one 'employed' person out of 115 (in 2006 terms), or almost 1% of full-time-equivalent employment from this single research project.

The positive experience that Old Crow has gained from collaborating with researchers in the past, undoubtedly led to Old Crow being awarded $2,044,950

Table 5. Local research expenditures in Old Crow, Yukon (2009).

| | |
|---|---|
| Local project coordinator | $10,000 |
| Local research assistant | $5000 |
| Local accommodations for graduate student | $3500 |
| Groceries | $3400 |
| Contract service for river travel | $3650 |
| Gifts for elders | $500 |
| Raffled gas coupons | $250 |
| Total | $26,300 |



from the Federal Government's AIF. These funds have been used to construct the Old Crow Research Facility that will house Old Crow Paleontological collections, artifacts, fossils, and oral and recorded data. This facility will also support the activities of visiting academic and government researchers and provide necessary space to store research and other logistical equipment. With the construction of the Old Crow Research Facility, the Vuntut Gwitchin fully anticipate attracting and collaborating with researchers in the future.

It is also important to note that other intangible impacts may be realized at the community level. For instance, by engaging with university researchers, Old Crow has developed important professional networks that can be employed to address local issues of concern (Wolfe *et al.* 2011). Local engagement in research can also help develop research capacity where community members gain the necessary experience to direct research on their own or with the support of university researchers (Wesche *et al.* 2011). This may then lead to other forms of local empowerment not readily discerned through economic analysis, for instance, the pursuit of postsecondary education among youth who have been exposed to northern research. Further, given the seasonal nature of most northern research, those community members who are directly involved as research assistants, or those who are compensated for providing other forms of expertise, can still pursue other forms of employment during other times of the year. This might involve participation in the land-based economy where income earned through research can be used to faciliate the harvesting of wildfoods (i.e. purchase necessary supplies and equipment) or may be distributed within community networks thereby allowing others to harvest country foods which are then redistributed locally. For example, the $10,000 salary paid to the part-time research coordinator in Old Crow was invested in the refurbishing of her family's fish camp the following summer. Used in this way, research revenues have an important multiplier effect as well as import substitution value when considering the health benefits associated with the harvesting of country foods.

Although Old Crow has established a remarkable community-based research program, it is not all that unique among other northern communities. Numerous communities across the territories have also been actively engaged in research projects. For example, between 2000 and 2009, the community of Igloolik (population 1538) participated in more than 48 research projects, Clyde River (population 950) was involved in 31 research projects, and Tuktoyaktuk (population 930) participated in 37 research projects (Arctic Science and Technology Information System [ASTIS] 2013).

## Conclusion

This research set out to provide the first empirical estimate of the economic contribution of publically funded research in the Yukon, Nunavut, and Northwest Territories between 2000 and 2009. Research expenditure data acquired under the Access to Information Act together with Statistics Canada I–O multipliers permitted the estimation of the territorial-wide impacts of research expenditures on output (sales), GDP, income, and employment. Since the release of the 1998 Task Force Report on northern research, public investment in research has grown considerably and is estimated to have increased the territorial GDP by 0.04%, income by 0.09%, and employment by 0.11%.

It is important to empahasize that this analysis included only those federally funded programs specifically mandated to support research. Not included were other departments such as Transport Canada, the Department of National Defense, Industry Canada, and the Department of Fisheries and Oceans who all sustain active northern research programs as part of their overall programming responsibilities. At the same time, many G7 and European Union nations have demonstrated a renewed interest in Canada's Polar Regions, and have funded their own research programs in the Canadian north. Private industry, particularly resource extraction and transportation sectors, conducts their own research and community consultations processes, for instance, research associated with environment and social impact assessments, which have additional economic effects. Unable to account for these additional funding expenditures, our findings are likely conservative.

Finally, with increased research attention on the north, there is in some cases a growing sense of 'research fatigue' among northern communities. As a result, the northern research institutes (Nunavut Research Institute, Aurora Research Institute, and Yukon Research Centre) are being called upon to articulate the tangible benefits that communities gain from participating in research. It is hoped that this research will assist the northern research institutes by providing the first economic evaluation of northern research. In a knowledge-based economy where climate change and related environmental concerns, as well as the social and environmental impacts of resource development, are gaining national importance, northern research will likely continue to be a growth industry for northern Canada.

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## Notes

1. Statistics Canada Table 281-0027 (http://www5.statcan.gc.ca/cansim/pick-choisir?lang=eng&p2=33&id=2810027).
2. Statistics Canada Table 281-0024 (http://www5.statcan.gc.ca/cansim/pick-choisir?lang=eng&p2=33&id=2810024).

## References


Aboriginal Affairs and Northern Development Canada (AANDC), 2009, *Arctic Research Infrastructure Fund* [online]. Available from: http://www.ainc-inac.gc.ca/nth/st/arf-eng.asp

Aboriginal Affairs and Northern Development Canada (AANDC), 2010, *Northern Contaminants Program* [online]. Available from: http://www.aadnc-aandc.gc.ca/eng/1100100035611

Aboriginal Affairs and Development Canada (AANDC), 2013, Backgrounder – *Arctic Research Infrastructure Fund: Project Descriptions* [online]. Available from:http://www.ainc-inac.gc.ca/ai/mr/nr/j-a2009/bk000000260-eng.asp

Allan, G., Mcgregor P., and Swales K., 2011, The importance of revenue sharing for the local economic impacts of a renewable energy project: a social accounting matix approach. *Regional Studies*, **45**(9), pp. 1171–1186.

Arcticscience and Technologyinformation System (ASTIS), 2013, Available from: http://www.aina.ucalgary.ca/astis/

ARI (Aurora Research Institute), 2001, *NWT Research Priorities Agenda Survey* (Inuvik, NWT: Aurora Research Institute).

Balikci, A., 1963, *Vuntut Kutchin Social Change: A Study of the People of Old Crow, Yukon Territory* (Ottawa: Northern Coordination and Research Centre, Department of Northern Affairs and Natural Resources).

Borzoni, M., 2011, Multi-scale integrated assessment of soybean biodiesel in Brazil. *Ecological Economics*, **70**(11), pp. 2028–2038.

Brown, J.P., Pender, J., Wiser, R., Lantz, E., and Hoen, B., 2012, Ex post analysis of economic impacts from wind power development in U.S. counties. *Energy Economics*, **34**(6), pp. 1743–1754.

CCAC (Canadian Council of Academies), 2008, *Vision for the Canadian Arctic Research Initiative: Assessing the Opportunities*. Report of the International Expert Panel on Science Priorities for the Canadian Arctic Research Initiative. Ottawa: Canada.

Duhaime, G., and Caron, A., 2008, Economic and social conditions of Arctic regions. In *The Economy of the North 2008*, S. Glomsrod and I. Aslaksen (Eds.), pp. 11–23 (Oslo: Statistics Norway).

Ghanem, Z., 2005, *The Canadian and Inter-Provincial Input–Output Models: The Mathematical Framework* (Ottawa: Industry Canada).

Gearheard, S., and Shirley, J., 2007, Challenges in community-research relationships: Learning from natural science in Nunavut. *Arctic*, **60**(1), pp. 62–74.

Greer, S., 1999, *Historic Summary: Rampart House Historic Site, LaPierre House Historic Site, Management Plan. Prepared for the Vuntut Gwitchin First Nation and Government of Yukon* (Wells, BC: Ecogistics Consulting).

Guerrero, B., Johnson, J., Amossonm, S., Johnson, P., Segarra, E., and Surles, J., 2011, Ethanol production in the southern high plains of Texas: impacts on the economy and scarce water resources. *Journal of Regional Analysis and Policy*, **41**(1), pp. 22–32.

International Polar Year (IPY), 2007, *Frequently Asked Questions* [online]. Available from: http://www.ipy-api.gc.ca/pg_IPYAPI_008-eng.html#q1.1

ITK and NRI (Inuit Tapiriit Kanatami and Nunavut Research Institute), 2007, *Negotiating Research Relationships with Inuit communities: A Guide for Researchers* (Ottawa and Iqaluit: Inuit Tapiriit Kanatami and Nunavut Research Institute).

Kashian, R., and Pfeifer-Luckett, R., 2011, The economic impact of organized camps. *Tourism Economics*, **17**(4), pp. 905–916.

Lee, B., Park, J., Gordon, P., Moore, J.E., and Richardson, H.W., 2012, Estimating the state-by-state economic impacts of a foot-and-mouth disease attack. *International Regional Science Review*, **35**(1), pp. 26–47.

Leechman, D., 1949, *The Vanta Kutchin*. National Museum of Canada Bulletin 126, Anthropological Series 33. Ottawa.

Leontief, W.W., 1936, Quantitative input and output relations in the economic systems of the United States. *The Review of Economics and Statistics*, **18**, pp. 105–125.

Leontief, W.W., 1970, Environmental repercussions and the economic structure: An input–output approach. *The Review of Economics and Statistics*, **52**, pp. 262–271.

Martin, F., 1998, The economic impact of Canadian University Research and Development. *Research Policy*, **27**, pp. 677–687.

Miller, R., and Blair, P., 1985, *Input-Output Analysis, Foundations and Extensions* (Englewood Cliffs, New Jersey: Prentice-Hall Inc).

Murray, A.H., 1910, *Journal of the Yukon, 1847–48*. Publications of the Canadian Archives, Number. 4 (Ottawa: Government Printing Bureau).

Netro, J., 1973, *A Book of Indian Legends and Stories from Old Crow, Yukon Territory* (Whitehorse: Whitehorse Star).

Salter, A.J., and Martin, B.R., 2001, The economic benefits of publicly funded research: A critical review. *Research Policy*, **30**, pp. 509–532.

Schuster, R.C., Wein, E.E., Dickson, C., and Chan, L., 2011, Importance of traditional foods for the food security of two first nations communities in the Yukon, Canada. *International Journal of Circumpolar Health*, **70**(3), pp. 286–300.

Schweger, C., 1989, The Old Crow and Bluefish basin, Northern Yukon: Development of the quaternary history. In Late Cenozoic History of the Interior Basin of Alaska and the Yukon, L.D. Carter, T.D. Hamilton and J.P. Galloway (Eds.), pp. 30–33 (Washington DC: U.S. Geological Survey Circular 1026).

Smith, V.H., 1998, *Measuring the Benefits of Social Science Research* (Washington, DC: International Food Policy Research Institute).

Statistics Canada, 2007, Old Crow, Yukon Territory (Code6001043) (Table). 2006 Community Profiles. 2006 Census. Statistics Canada Catalogueno.92-591-XWE. Ottawa. Released March 13, 2007.http://www12.statcan.ca/census-recensement/2006/dp-pd/prof/92-591/index.cfm?Lang=E (accessed April 27, 2013).

Statistics Canada, 2008, Regional gross domestic product survey, Table 384-0002. Ottawa, Ontario.

Statistics Canada, 2010, The input-output structure of the Canadian Economy 2006/2007. Ottawa, Ontario.

Task Force on Northern Research, 2000, *From Crisis to Opportunity: Rebuilding Canada's Role in Northern Research. A Final Report to NSERC and SSHRC* (Ottawa, ON: Natural Sciences and Engineering Research Council of Canada and the Social Sciences and Humanities Research Council of Canada).

Wein, E.E., 1995, Nutrient intakes of first nations people in four Yukon communities. *Nutritional Research*, **15**(8), pp.1105–1119.

Wesche, S., Schuster, R.C., Tobin, T., Dickson, C., Matthiessen, D., Graupe, S., Williams, M., and Chan, L., 2011, Community-based health research led by the Vuntut Gwitchin First Nation. *International Journal of Circumpolar Health*, **70**(4), pp. 396–406

Wolfe, B.B., Humphries, M.M., Pisaric, F.J., Balasubramaniam, A.M., Burn, C.R., Chan, L., Cooley, D., Froese, D.G., Graupe, S., Hall, R.I., Lantz, T., Porter, T.J., Roy-Leveillee, P., Turner, K.W., Wesche, S.D., and Williams, M., 2011, Environmental change and traditional use of the Old Crow flats in Northern Canada: An IPY opportunity to meet the challenges of the new northern research paradigm. *Arctic*, **64**(1), pp. 127–135.