POLAR RESEARCH, EDUCATION, OUTREACH AND COMMUNICATION DURING THE FOURTH IPY

How the 2007-2008 International Polar Year contributed to the future of education, outreach and communication

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EXECUTIVE SUMMARY

One hundred and twenty-five years after the first International Polar Year (IPY), the fourth IPY (2007–2008) represented the most ambitious polar research programme in history, and included for the first time a full range of physical, biological and social science projects. IPY 2007–2008 set out to engage members of the general public in active polar science endeavours on a global scale. Overall, the education, outreach and communication (EOC) efforts carried out during the latest IPY were successful. With tens of thousands of scientists, and more than 14 million people in 70 countries touched by outreach events, the fourth IPY was the largest and most comprehensive international science programme. **Several factors contributed to the overall success of IPY EOC:**

1. EOC was integrated into the larger science IPY programme from the beginning.
2. The EOC efforts engaged and involved experts in both science and communication.
3. A central office encouraged and coordinated EOC efforts throughout the IPY.
4. The EOC programme was branded and inclusive.
5. Advocacy maintained EOC momentum throughout the IPY period.
6. Polar issues were timely and topical.

Based on their collaborative and successful experiences of EOC during IPY, both the research and outreach communities have developed new expectations for future science programmes. Namely, both research and EOC are integral to science programmes, should be given equal importance, and EOC must be built in from the initial project planning stages. In general the public wants to be involved in the process of science, and scientists need recognition for their EOC efforts. In order to move science EOC beyond simply being produced and delivered to audiences without assessment, formative evaluation needs to become integrated into science outreach programmes. By doing so, **ongoing assessment, reflection and adjustment can ensure outreach programmes are effective. Since this approach is different from most current practices, it will require a major reorientation with a number of necessary steps, including the following:**

- Acceptance within the scientific community and from the funding agencies that EOC is an essential component of research projects, and that all people involved (scientists, educators, communicators, public and media) can and should learn from each other.
- Specific budget items and dedicated trained EOC staff are needed for EOC to be effective.
- Communication training with educators/communicators needs to be part of the professional development of all scientists.
- Professional recognition, publication and career advancement opportunities for people doing EOC activities need to become part of the scientific community's expectations.
- Continued integration of EOC at science conferences, meetings and workshops is needed.
- Support for EOC networks is needed to ensure continued communication between scientists and outreach projects and partners.

Like many science initiatives, IPY relied on the efforts and energy of early career researchers (ECRs) in both research and outreach programmes. Developed in concert with the IPY, the Association of Polar Early Career Scientists (APECS) enhanced the roles early career professionals play in international research and provided opportunities to gain the additional skills needed for successful careers. APECS has been recognized by the IPY sponsors, the

International Council of Science (ICSU) and the World Meteorological Organization (WMO), as the organization that, together with other partners (e.g., IASC and SCAR), will carry forward the momentum of polar research, education and outreach in the years to come (ICSU & WMO 2010). The lessons learned from creating APECS can now serve as a model for how other initiatives can include and recruit ECRs in a meaningful and lasting way.

A number of factors were imperative to the success of APECS during and beyond IPY:

1. The energy, momentum and desire required for early career programmes to be successful must come from the ECRs themselves.
2. True support from organizations and partners that are willing to engage young researchers is integral to having meaningful involvement for ECRs.
3. Direct involvement of established scientists alongside ECRs is needed to bridge knowledge gaps and develop mentorship programmes.
4. The governance and management of the ECR associations and projects need to be driven by ECRs; they also need to be designed for a quick turnover rate in order to maintain momentum and energy in the face of changing personnel and to assure that ECRs have time to concentrate on their research while being active in leadership roles.
5. Dedicated coordination staff and funding can create a lot of synergies and activities, and are critical for building and maintaining institutional memory.
6. ECR programmes need to offer services and activities that go beyond home institutions and national boundaries to ensure interdisciplinary and international collaborations.

Post-IPY APECS continues to grow and expand, and is now an integral and necessary player in shaping the both the present and future of polar research. Over the next decade the polar regions will undergo many changes, and polar researchers will be continually challenged as these changes impact the people, infrastructure and ecosystems. It is imperative that ECRs trained during the IPY stay connected to and engaged in polar topics. Continuing to support APECS and providing the infrastructure to retain the skills, knowledge and capacity built during IPY is critical. Without this support, much of the energy and enthusiasm created during the IPY will dissipate and be lost by the polar community and to science and society as a whole.

Through the strong EOC component and ECR involvement several practical lessons can be drawn from the experiences of IPY outreach efforts. These lessons are important to consider when designing other science outreach and communication programmes:

- The public, students, teachers, media, artists and musicians want to be actively engaged in science.
- Professionals in science and communication, at junior and senior levels, expressed frustration at the limited professional recognition for outreach activities.
- Small-scale outreach projects benefit greatly by being linked to larger outreach initiatives.
- Formal outreach assessment is still lacking in most programmes and needs to be prioritized in order to gauge the effectiveness of such programmes and to adapt accordingly.
- In many cases, science EOC has moved beyond the traditional poster or pamphlet, but more needs to be done to ensure that outreach efforts are reaching target audiences.
- Institutions and organizations with long-term programmes should house and maintain networks that link scientists and communicators, creating legacies and sustaining outreach efforts past short-lived projects.

- Science outreach efforts should involve partners such as teachers, media and science centers that already have EOC capacity and an audience.
- Archival capacity for outreach programmes needs to be planned from the beginning to ensure that resources created, such as videos and curricula, are available beyond the projects' lifespan.
- Multi-year science events are more likely to attract partners for outreach efforts as funding cycles and institutional programming agendas often do not naturally coincide with science planning.

With the many challenges facing society today, public outreach and communication can no longer afford to be a low priority within the scientific community. Science outreach efforts must be given an equal standing to research and an important role within scientific programmes to ensure that key audiences such as teachers and professional communicators have the resources and networks to access relevant and current science information. The many lessons learned from the IPY EOC efforts can help inspire science outreach efforts to improve planning, enhance self-evaluation and expand on the current elevated interest in public outreach programmes.

INTRODUCTION

Science Education, Outreach and Communication and the Fourth International Polar Year

Science Education, Outreach and Communication

Historically, much of scientific research has occurred without substantial involvement of the general public (Brush 1989). As a result, the public has had little knowledge of science in general and some have even grown skeptical of science, leading to disenchantment and cynicism (Baron 2010). As science becomes more pervasive in daily life and decision-making, it is now widely recognized that science can no longer afford to be conducted behind closed doors and away from the public eye, and that scientists need to prioritize communication (Lubchenco 1998, Baron 2010).

The International Council for Science (ICSU) aims to promote science education as part of its central mission to strengthen international science for the benefit of society (ICSU 2010). Recently, an ICSU Ad Hoc Panel on Science Education formed to review science education on a global scale and determine what role ICSU can play in encouraging science education. In general the panel found that many people are eager to expand their knowledge and grapple with the complex issues investigated by researchers (ICSU 2010). This public desire to be engaged, coupled with new tools which make it easy to communicate effectively to a global network, are driving a greater need for the integration of education, outreach and communication (EOC) and science at every level.

Beyond the growing desire for more contact with relevant science projects, there is also an increasing recognition that science literacy is a critical component in promoting public awareness of science advancements and current events, such as climate change, and in enabling the public to make decisions based on scientific findings (Barbour et al. 2008). There is also a strong link between science literacy and economic development and sustainability. Now more than ever before the need for science literacy has become important as the pace and scope of science continues to increase, leading to a wide array of innovations permeating everyday life as discussed by Lubchenco:

> *The new and unmet needs of society include more comprehensive information, understanding, and technologies for society to move toward a more sustainable biosphere—one which is ecologically sound, economically feasible, and socially just. New fundamental research, faster and more effective transmission of new and existing knowledge to policy- and decision-makers, and better communication of this knowledge to the public will all be required to meet this challenge. (Lubchenco 1998, pg 491)*

In order to effectively share experiences and results with the public, scientists, educators and communicators must approach science projects as a team and make EOC a part of the overall research strategy. A number of programmes that have been successful in integrating research and EOC objectives can be used as models as the science community moves forward in planning for future science outreach initiatives. This report examines the latest International Polar Year (IPY) 2007–2008 for important lessons in planning and conducting science EOC.

The International Polar Year

The distinctiveness of the polar regions has attracted the attention of explorers, adventurers, storytellers, researchers and students for centuries. While the Antarctic has attracted mostly explorers, whalers and scientists over the past decades, over three million people call the Arctic home and have developed strong cultural ties over thousands of years. The unique landscapes and animals found in these regions have appealed to people for some time but, due to the remoteness of the Arctic and Antarctic, few people from non-polar areas have had the opportunity to visit these areas.

While there had been numerous previous expeditions to study the polar regions, the first IPY (1882-1883) - an idea

brought forth by the Austro-Hungarian naval officer, Karl Weyprecht - was one of the first multi-national collaborative efforts undertaken in science (Krupnik et al. 2011). A second IPY followed in 1932-33, with the International Geophysical Year (IGY) in 1953-54. One hundred and twenty-five years after the first IPY, the fourth IPY (2007–2008) entailed the most ambitious polar research programme to date and included for the first time a wide range of physical, biological and social science projects. Unlike previous IPYs, the latest effort also made communication of the science results a priority (Krupnik & Hik 2011). Officially 63 countries and tens of thousands of scientists and students participated, but IPY also set out to involve members of the general public in active polar science endeavours on a global scale (Krupnik & Hik 2011). This integration of science and outreach resulted in millions of people learning about the polar regions through IPY scientists and educators.

Figure 1: Radio engineer William MacPherson and electronics technician Cliff Dickey, two of eighteen men who spent the 1957 IGY winter at the South Pole.

Photo courtesy of Cliff Dickey and the National Science Foundation.

IPY and EOC

In total, the latest IPY's EOC programme represented one of the largest international science education coordination efforts ever attempted. From the initial planning stages in 2003 to the closing ceremony in 2010, EOC was included, encouraged and prioritized (Salmon et al. 2011). Within the IPY Joint Committee (JC), the EOC Subcommittee coordinated international events, developed a framework for international IPY outreach and assisted national committees to plan their own activities (Zicus et al. 2011). The action plan of the EOC Subcommittee created a high-impact global campaign that increased awareness of polar issues by target audiences and defined EOC as (Zicus et al. 2011, pg 482):

> Education [is used here to] refer to efforts designed to promote the development of programmes, infrastructure and resources needed to improve knowledge of polar-focused science, technology and humanities. These formal educational efforts mainly occur within classrooms. Formal education is not necessarily limited to curricula, but ranges from teacher training to classroom science experiments.
>
> Outreach, sometimes called informal education, is used here to refer to experiences for learning outside of formal classroom environments through stimulating media, exhibits and community-based programmes. Examples of outreach activities include field trips, museum exhibits, zoo exhibits, lecture series, computer software, school competitions, quizzes and essay writing.
>
> Communication is used here to identify interactions with the print, television, radio, internet and film media.

Established in 2005, the IPY International Programme Office (IPY IPO) prioritized EOC by playing an important role in promoting and fostering hundreds of global EOC efforts (Salmon et al. 2011). In addition, numerous independent science outreach programmes capitalized on the momentum of IPY to create polar-themed outreach opportunities, with the IPY IPO as a central hub of information (Salmon et al. 2011). Thus, IPY EOC not only encouraged those within the scientific community to actively plan for science EOC, it also engaged education and communication experts to develop polar activities and become involved in the larger IPY momentum.

Due to the efforts of scientists, students, educators, communicators, media personnel and many others, IPY helped to create and support science EOC programmes on a global scale that went beyond standard science EOC initiatives. As a result the IPY education programme represents, in microcosm, a wealth of practical and real-world information from which many lessons can be learned that address shared IPY and ICSU questions regarding science outreach. These include what happened in science EOC during the IPY, which external factors contributed to the success of the IPY EOC programme, and what should happen next for polar EOC and in the future for a variety of other science outreach programmes.

Why an assessment was needed, and what can be learned

The 2007–2008 IPY was a success in both the science and outreach that spanned almost a decade from the initial planning stages in 2003, through the official launch of the IPY in 2007, and on into 2011 when many IPY projects were in the final stages of data analysis. Overall, hundreds of EOC projects were undertaken as part of science projects, as independent outreach programmes, and IPY-inspired EOC projects that wanted to be a part of this global science effort. Yet no single or comprehensive overview was planned to assess IPY EOC on an international scale or to inventory the many EOC efforts that occurred during the IPY time period, to try to understand what worked or did not work within the IPY EOC effort.

Recognizing an opportunity to learn from the IPY EOC experiences, the Association of Polar Early Career Scientists (APECS) proposed to undertake an initial assessment of IPY EOC, supported by the International Arctic Science Committee (IASC), the Scientific Committee on Antarctic Research (SCAR) and at the time the IPY IPO. In 2010 this assessment was timely as it coincided with the official end of the IPY, and the closing of the IPY IPO and many national IPY offices. It also proved necessary to record and account for the immense efforts of EOC activities and programmes as well as to learn how IPY EOC was successful, what made certain areas more effective, how these successes can be applied to other science programmes and initiatives, and what can be learned from the failures.

To address these questions, Dr. Jenny Baeseman (APECS) and Dr. David Carlson (at the time IPY IPO), worked with SCAR and IASC to propose to ICSU an initial IPY EOC assessment project with the following goals:

- Conduct an inventory and begin planning for a general assessment, from an international viewpoint, of EOC strategies, programmes, and networks active during IPY;
- Identify key target groups that need to be continually informed about the latest polar (and general scientific) research;
- Determine key activities to sustain the dissemination of polar research (science information) to target groups;
- Identify the factors and mechanisms by which IPY successfully stimulated and inspired the enthusiastic involvement of early career and future scientists;
- Provide guidance on the incorporation of early career researchers in large-scale science planning and research;
- Construct a set of ‚lessons learned' from the IPY EOC experience relevant to engaging the public in ICSU's international science research programmes; and
- Discuss the roles of IASC, SCAR and other key partners, within and outside of ICSU, who contributed to IPY's success and who can play a role in future ICSU education programmes.

The IPY EOC Assessment Project and Committee

Funding from ICSU and others was used to hire a project coordinator to conduct, organize and manage the overall assessment and to establish a project committee. Jennifer Provencher, having experience during IPY in both science and EOC projects, was brought on to the team as the project coordinator in September 2010. The IPY EOC Assessment

Committee (from here on referred to as the committee) included educators, communicators and scientists who were involved in IPY 2007–2008. Committee members include:

- Dr. Renuka Badhe, Scientific Committee for Antarctic Research (SCAR) – UK
- Dr. Jenny Baeseman, Association of Polar Early Career Scientists (APECS) – Norway
- Jennifer Bellman, Government of Canada – Canada
- Dr. David Carlson, UNAVCO, Inc. (formerly IPY IPO) – USA
- Dr. David Hik, University of Alberta, International Arctic Science Committee (IASC) – Canada
- Louise Huffman, ANtarctic geological DRILLing (ANDRILL)– USA
- Jacinta Legg, International Council for Science (ICSU) – France
- Margarete Pauls, Alfred Wegener Institute – Germany
- Mare Pit, IASC – Germany
- Jennifer Provencher, APECS – Canada
- Sandy Shan, Polar Research Institute of China – China
- Kristin Timm, Arctic Research Consortium of the U.S. (ARCUS) – USA
- Kristen Ulstein, Research Council of Norway – Norway
- Dr. Sandra Zicus, University of Tasmania– Australia

The Online IPY EOC Assessment Inventory, Survey and Polar Outreach Catalogue

The first step of the assessment project involved inventorying all IPY EOC programmes reported to date. The project team used the following reports to create a comprehensive list of IPY outreach activities:

- Abstracts submitted to the EOC sessions at the 2008 SCAR/IASC IPY Conference in St. Petersburg and the 2010 IPY Oslo Science Conference (http://www.scar-iasc-ipy2008.org/, http://ipy-osc.no)
- US IPY Education Summary prepared by the Arctic Research Consortium of the US (ARCUS) (courtesy of ARCUS)
- Minutes and summaries from the IPY EOC meeting at the AGU 2007 (courtesy of ARCUS)
- US Project Connections summary produced by ARCUS (courtesy of ARCUS)
- The report on the Canadian IPY EOC projects (http://www.ipycanada.ca)
- Norwegian National IPY report 2011 (courtesy of the Research Council of Norway)
- National Science Foundation (NSF) IPY website (http://www.nsf.gov)
- Polar Resource Book: Polar Science and Global Climate (Kaiser 2010)
- Understanding Earth's Polar Challenges: International Polar Year 2007–2008: Summary by the Joint Committee (Zicus et al. 2011)

Although all of the above resources are useful tools in understanding IPY outreach programmes, the committee felt that a broader survey of IPY EOC programmes was needed to inventory the many efforts of people worldwide. The committee accordingly created an international IPY EOC survey (from here forwards referred to as the survey) available in 4 languages (English, Chinese, Russian and Spanish; these were identified by the committee as target areas to

Firgure 2: The IPY EOC Assessment Project Committee meeting attendees in Bremerhaven, Germany hosted by the Alfred Wegner Institute (front row, left to right - Kristen Ulstein, Jennifer Provencher, Sandra Zicus, Jacinta Legg, Kristin Timm; back row, left to right - Renuka Badhe, Jennifer Bellman, Jenny Baeseman, Margarete Pauls; absent – David Carlson, David Hik, Louise Huffman, Mare Pit, Sandy Shan)

Photo by Maike Thomsen

learn about global IPY EOC activities within our resources). The intention of the survey was to inventory IPY EOC projects and to investigate a number of questions about IPY EOC programmes related to planning, personnel, target audience, funding, EOC products, future plans and the challenges of doing science EOC. The survey was designed to allow all polar science outreach projects that occurred during the IPY to contribute, whether they were IPY endorsed or IPY inspired.

With these two types of projects in mind, the committee developed and designed the survey via email and during a face-to-face meeting in Bremerhaven, Germany on October 25–26, 2010 sponsored by the IPY IPO and ICSU and hosted by the Alfred Wegener Institute for Polar and Marine Research (AWI; Fig. 2). Upon completion, the online survey was created using Survey Monkey (access provided by ICSU) and contained a total of 31 questions (Appendix A contains a complete version of the survey). Once final the survey was available online, notice of the project and a request to complete the survey was sent to all of the IPY national committee contacts and the various IPY Networks created using Google Groups, posted on polar research listserves and disseminated widely by the committee.

The survey was online and available from November 18, 2010, and as of April 19, 2011, had a total of 250 entries, with 80% (200) of the project entries fully completed. All of the projects from the survey results, as well as project information gained from other resources, were compiled into a single inventory, the Polar Outreach Catalogue (from here on referred to as the catalogue). This catalogue is a searchable online tool currently hosted on the APECS website (APECS 2011; http://apecs.is/education-outreach/catalogue). Ultimately, this online catalogue will serve as an archive for all of the IPY EOC activities inventoried by this project. The survey remained open until August 2011 as a tool to gain further information on IPY EOC projects not yet inventoried. As of August 22, 2011, the catalogue had a total of 552 entries. As surveys and more project information summaries continued to be submitted, the catalogue was updated until the end of this project in August 2011, but the results presented here are based on the survey results as of April 19, 2011.

Although the official time period of the latest IPY was March 1, 2007, to February 28, 2009, many countries continued to have projects running beyond this, in some cases into 2011 and 2012. It is for this reason that although the fourth IPY is labeled 2007–2008, this project recognizes outreach programmes that have dates outside of this range as IPY related.

Defining the success of IPY EOC

The success of an EOC programme can be measured in several different ways. Indicators of success may include how many EOC projects were undertaken, in how many countries, how many people a programme reached, how the activity changed people's awareness of the subject matter, how many students go on to study in the field of science, etc. (Thomson et al. 2010). Although the committee recognizes that all of these questions are important and valuable to consider when examining the success of any science programme, many of these questions are beyond the scope of this project.

Therefore, to carry out an initial assessment of IPY outreach as proposed, this project uses the objectives set for outreach by IPY itself. The first meeting of the IPY Planning Committee in 2003 identified the need for IPY EOC to have an impact on a global scale that would target key audiences with important messages and themes (ICSU 2004). Thus, we consider how IPY EOC was successful 1) on a global scale, 2) at informing a wide spectrum of audiences and 3) at communicating key polar issues. The IPY EOC Assessment project examined the information submitted via the survey, project summaries from various resources and a variety of communications from the IPY EOC global community. These results are presented in the next three chapters. The first chapter examines the success of IPY EOC on a global scale; the second chapter discusses the success of engaging early career researchers in polar science; and the third chapter examines lessons learned from IPY EOC and areas of improvement needed in science EOC as demonstrated by IPY.

CHAPTER 1

The Success of IPY Education, Outreach and Communication

The success of IPY EOC

The fourth IPY set out to reach key audiences on a global scale with important themes throughout the 2007–2008 period (ICSU 2004). First, we assess the international extent of IPY EOC activities; did the IPY EOC efforts reach a global audience?

IPY stimulated National Committees or National Contact Persons in 33 countries, and the IPY Project database indicates participants from 63 countries played a part in the latest IPY (Krupnik & Hik 2011). Results from this assessment indicate that IPY EOC reached even further than these official partner and scientific participant countries, touching individuals and organizations in more than 70 countries around the globe (Fig 3; see Appendix B for a complete list of countries where IPY EOC activities were reported). These data indicate IPY outreach had widespread international exposure.

Figure 3. World map with countries where IPY outreach activities were reported indicated in blue. More than 70 nations had at least one IPY EOC activity reported during the 2007–2008 IPY.

IPY EOC projects were not only global in scope, but also international in focus. Of the projects surveyed, 32% looked beyond their national boundaries to communicate polar science to audiences in other countries (Fig. 4). International audiences were the most commonly targeted audience (local 22%, regional 17%, national 29%), again indicating many EOC programmes were international in their efforts.

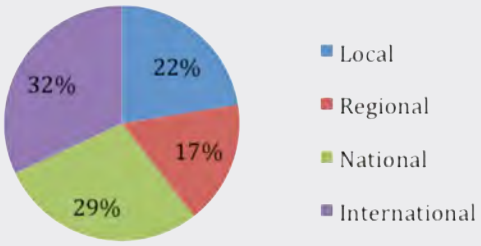

Figure 4. Percentage of audience types (local, regional, national and international) targeted by IPY outreach programmes (n = 222).

This multi-national focus is also reflected in the number of countries that had more than one nation involved in the project planning (21%, n=217) and the number of projects that had international audiences (27%, n=233) as indicated in the survey.

The survey data also permits an estimate of the number of people reached through IPY activities. Exact numbers of people touched, influenced or motivated by IPY will remain difficult to determine due to the international and diverse nature of the EOC efforts, but results from this survey suggest that IPY EOC easily reached millions of people. Although the most commonly reported average audience size for EOC projects surveyed was 100–499 people (21%; Fig 5), another 19% of the projects reached audiences of between 1,000 and 10,000 members, and 13 of the projects surveyed estimated their audiences to be over a million.

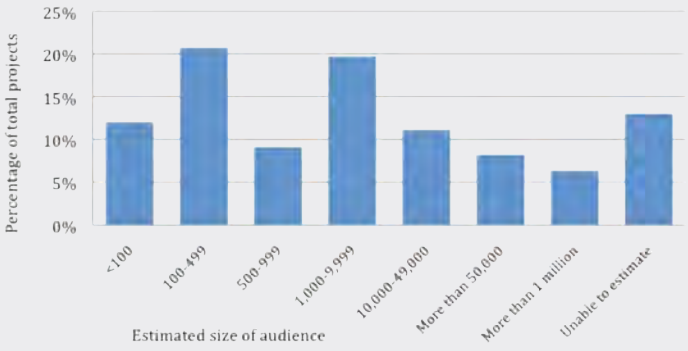

Figure 5. Estimated audience size by IPY EOC projects as a percentage of all the outreach programmes surveyed (n=211).

The 13 projects reporting audience sizes in the millions involved mostly websites and exhibits where overall numbers were based on total viewers or attendees. Assessing the effectiveness of such programmes is outside of the scope of this report but nonetheless these large programmes likely exposed millions of new people to polar topics. Taking those estimates and all others at face value and summing the lower boundary values of the ranges reported for the 211 projects that provided estimates, approximately 14 million people were reached by IPY EOC. As the catalogue has twice as many entries as the survey, and because we know the survey as of April 19, 2011, did not receive information from at least one large programme with international television components (i.e., the Tara Expedition), nor numerous activities in at least one large country (China), a more realistic estimate for IPY EOC audiences probably exceeds 20 million people. Overall, IPY EOC efforts reached millions of individuals, in over 70 countries around the world, in both hemispheres through many internationally organized and targeted outreach programmes indicating a successful international EOC effort.

The second goal, and measure of success, for IPY EOC was to communicate to several target audiences during IPY EOC that would carry on polar outreach to further audiences including the media, educators and early career researchers (ECRs) (Zicus et al. 2011). No specific numbers or goals were established by IPY , but these groups were among the most targeted groups by activity audience with 9% of all activities (n=1131) targeted towards the media, 1.5% towards teacher training, with another 8% in classroom visits by scientists and 6% of the activities targeted towards ECRs. In total, approximately a quarter of IPY EOC efforts were targeted towards these information provider groups, which then passed information on to other important audiences. This can be seen in the products and activities the provider groups went on to create, such as the number of articles in newspapers and magazines (7%; n=1131), curriculum materials (7%; n=1131) and overall EOC projects led by ECRs (9%; n=253).

The third and final goal and measure of success is how EOC efforts conveyed a broad scope of polar science topics covered by IPY science projects. Like IPY science, outreach focused on polar topics that included physical, biological and social science facets. IPY EOC used audience interest in ice, polar bears and penguins to bring polar sciences of all types into the view of the general public. Figure 5 shows a word cloud (created using http://www.wordle.net) of all the titles of EOC projects entered into the IPY EOC catalogue (n=552). The words Polar, Arctic and Antarctic are of course dominant, but the repeated appearance of other words such as students, communities and health, along with the absence of specialty terms (ex. glaciology, meteorology) show the variety of EOC programmes and how they often promote integrated and interdisciplinary research as well as outreach.

Although not explicitly laid out by the IPY JC, another important measure of programme success is how outreach will be carried on beyond the project. On this last measure of success, of the IPY EOC programmes surveyed, 48% were engaged in polar EOC prior to IPY, with an additional 28% doing polar outreach on occasion, for a total of 76% of programmes working in polar themes prior to IPY; thus 24% of the IPY EOC survey entries represented new polar outreach efforts. IPY EOC can also be examined by whether it inspired people to continue to do polar outreach beyond IPY. When asked if polar outreach would continue beyond IPY, 46% indicated that polar outreach would continue, and 44% said that some part of their polar outreach would continue suggesting, 90% of the projects plan to continue polar outreach beyond IPY. This increase from 76% of projects conducting polar outreach prior to IPY to

90% that plan to continue suggests that a number of programmes that did not offer polar outreach prior to IPY will now take on such themes and continue working in communicating polar topics to the general public. This overall increase in polar science outreach, during IPY and beyond, is yet another indicator of the success of global IPY EOC efforts.

Figure 6. Word cloud of the project titles in the IPY EOC catalogue (n=552). The larger words are the most commonly used words, with less used words in smaller print. The top 25 words are polar, IPY, Arctic, science, Antarctica, education, research, international, climate, ice, change, outreach, year, project, school, students, Canada, new, sea, network, earth, global, program, field and Norway.

As defined by the objectives laid out by IPY at the start of the 2007–2008 planning committees (ICSU 2004), IPY EOC was successful in promoting diverse polar science issues to a large number of important audiences around the world. The reasons for the success of IPY EOC efforts varies from project to project, but by examining these we can begin to understand how to build on the successes of IPY EOC and how to apply these lessons to future science initiatives. Many factors contributed to the success of IPY EOC efforts, which can be summarized into the following six categories:

1. EOC was integrated into the larger science IPY programme from the beginning.
2. The EOC efforts engaged and involved experts in both science and communication.
3. A central office encouraged and coordinated EOC efforts throughout the IPY.
4. The EOC programme was branded and inclusive.
5. Advocacy maintained EOC momentum throughout the IPY period.
6. Polar issues were timely and topical.

1. EOC was integrated into the larger science IPY programme from the beginning

The latest IPY succeeded in promoting science EOC because it was integrated into the larger science programme. During the planning stages of IPY, dating back to 2003, those interested in IPY's overall impact advocated for the establishment of a dedicated, international EOC Committee along with the other IPY committees focused on data and observations (ICSU 2004). Alongside the formation of the IPY EOC committee in 2005, a parallel application process for international science communication projects and an explicit requirement for an EOC component in every endorsed IPY science project were also established to ensure widespread science outreach efforts (Salmon et al. 2011).

This integration of EOC during IPY set the tone and the expectation that outreach was important and encouraged and enabled those working in EOC to seek and access resources needed to carry out programmes. EOC projects that were either part of a larger IPY-endorsed science project (32% of surveyed EOC activities) or a separately funded IPY EOC programme (20%) accounted for more than half of the EOC projects surveyed (52%; Fig 7, blue bars). For these IPY funded EOC activities, association with a science project or the separate but parallel endorsement as an IPY EOC Project provided the connections and resources that helped IPY EOC succeed. This direct funding and expectation of science EOC programmes contributed to the widespread and varied EOC effort worldwide, with half of the EOC projects being a direct result of IPY support or programming.

Although official support of IPY EOC funding bolstered many EOC programmes nationally, on an international level EOC projects with international components were seen to be at a disadvantage when requesting funding, as many national funding agencies mainly funded national efforts. Endorsed international EOC projects had a lower proposal success rate, by a factor of two, than endorsed international science projects, suggesting that while international focus and collaboration benefited nationally funded science projects, international outlook or partnerships hindered many EOC Projects competing for the same national funds. In the future, to ensure the success of international outreach programmes, not only does EOC need to be integrated into planning and implementation, national and international agencies need to recognize the need to fund EOC projects that are international in focus in order to ensure broad success.

Our results show that 52% of the outreach programmes during IPY were IPY-endorsed in some way, but what is perhaps more interesting is that 48% of the programmes that occurred were not a part of the IPY official efforts (Fig 7; red bars). 35% of the projects surveyed were not IPY-funded, IPY-endorsed or even in existence prior to IPY; they were simply IPY-inspired, demonstrating the power of promoting science EOC programmes widely. Although one might argue that this large non-official outreach effort indicates that targeted outreach funding is unnecessary, we suggest that these programmes in fact developed because of the dedicated outreach resources. In a large scale science event, such as IPY, it is more likely that the impacts of the funded IPY programmes spurred on others to create their own programmes and to become a part of this global event. This is also supported by the number of smaller programmes requesting links to larger programmes. Successful outreach often leads to more outreach by others being inspired and energized and thus contributing to the overall success of outreach efforts.

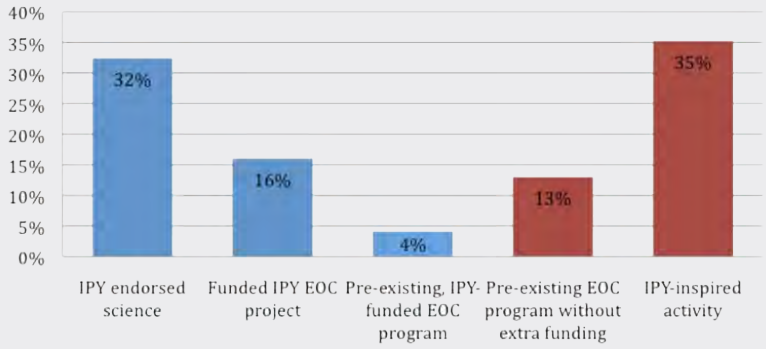

Figure 7. Percentage of IPY EOC programmes types: EOC programmes that were part of a science IPY programme, an independent IPY EOC programme, a pre-existing programme that took advantage of IPY funding, a pre-existing programme that did not receive extra funds during IPY, or simply IPY inspired programmes that were not directly endorsed or funded by IPY (n=222). Blue indicates programmes that received IPY funds and red those that did not receive IPY funding.

The successful engagement of science and scientists with outreach in this IPY was a contributing factor to the success of IPY EOC and deserves special attention. As a consequence of integrating EOC with the science and requiring a communication component from every science programme, many scientists became involved in the EOC component of their science programme, using IPY as a chance to engage teachers, educators and communicators directly. This willingness of scientists to go into classrooms and interact with students when given support and opportunity was demonstrated by classroom visits by scientists being the most popular of over 40 EOC methods among those programmes surveyed (9%; n=1131; Fig. 8).

Beyond the willingness of scientists to interact with students, it was also recognized during IPY that when encouraged and supported, time with an actual scientist was beneficial and enjoyable to both students and scientists, as explained here by a teacher and a researcher.

> Teachers and students both rank interactions with scientists as an important part of the project. Teachers highly valued both the background knowledge they gained, as well as the teacher resources for transferring that knowledge to their students.
> *- Louise Huffman, ANDRILL, USA; C2S2 Climate Change Student Summits (C2S2 is a pilot project connecting students*

studying how climate change is affecting their local regions to communities around the world)

Students were extremely interested and it was a lot of fun to go into schools!
- Dr. Torsten Sachs, Alfred Wegener Institute for Polar and Marine Research, Germany; Polar lectures and Educational Matinée (a programme that had German scientists visiting classrooms to share IPY science throughout the IPY period)

Figure 8. Dr. David Carlson, the Director of the IPY IPO during IPY, visits a primary school in Haines Junction, Yukon Territories, Canada to talk with students about how sea ice is measured.

Photo courtesy of D. Carlson

Overall, the direct involvement of scientists in EOC is mutually beneficial. Throughout IPY, scientists repeatedly reported gaining insight into their research, improving their connections with the public and communities, and having opportunities to practice their communication skills. Communities often gain a deeper appreciation of the importance and relevance of polar science to their daily lives and feel better in being able to put a face to research. For a further discussion of the factors leading to successful classroom interactions, along with a very useful guide for teachers and visitors, see the book Polar Science and Global Climate - An International Resource for Education and Outreach (Kaiser 2010).

2. The EOC efforts engaged and involved experts in both science and communication

IPY EOC engaged both communication and science experts in planning outreach programmes that met the needs of stakeholders (Salmon et al. 2011). The EOC committee recognized the need to include the skill sets of many different sectors in order to carry out a successful EOC programme and actively involved members with direct professional experience in teaching, other formal and informal education, science communication, art and journalism (Zicus et al. 2011).

In particular, the media was recognized as an important audience by both large programme offices and individual projects. Several national or project-specific communication offices and plans were established. On an individual project level, the media was also a primary target with 37% of the outreach programmes listing the media as a target audience.

Communication experts were also recognized as important partners in communicating polar research. Many professional communicators were engaged at the planning stages and included on national and international EOC committees. At the project level, 71% of the projects surveyed indicated that they had communication personnel who were responsible for EOC programmes suggesting that it was widely recognized that EOC was an IPY priority.

Even though the need to engage professional communicators was widespread, one challenge was that staff assigned to EOC responsibilities were often tasked with these duties in addition to their regular jobs and workloads. The IPY IPO identified only two IPY Science Projects in the USA as having a full-time EOC person; the other projects had EOC personnel that had other institutional or programmatic responsibilities as well. The need for professional EOC coordination was also regularly commented on throughout our survey. When asked what would have helped improve IPY EOC, several programmes listed a dedicated full-time EOC coordinator as a resource that would have been beneficial and

recognized that balancing EOC and research was not ideal.

> Outreach support personnel funding [was needed]
> *- Dr. Paul Andrew Mayewski, Climate Change Institute, University of Maine, USA; ITASE (International Trans Antarctic Scientific Expedition; an IPY science project tracking and mapping ice and snow in Antarctica)*
>
> A separate, dedicated coordinator is integral to effective outreach and communication. We did not have this and so struggled considerably with EOC in trying to balance different research needs.
> *- Dr. Gunhild Hoogensen Gjørv, University of Tromsø, Norway; The Impacts of Oil and Gas Activity on Peoples of the Arctic Using a Multiple Securities Perspective (GAPS is a multi-national, multi-disciplinary initiative that aims to examine the scope and range of human security in the Arctic)*
>
> [It was difficult] contacting schools to offer EOC, but then having to turn some interested ones down, as we can only do so much.
> *- Kim Jochum, Institute of Wildlife Research, Hannover, Germany - Introducing high school kids to polar research; Polar bear biology and historic Arctic travelers (a programme led by ECR that visited schools to discuss polar ecosystems and history)*
>
> The major challenge was funding and time to devote to development and participating in outreach activities.
> *- Isla Myers-Smith, University of Alberta, Canada; Local outreach for students (Isla visited local classrooms to share her IPY science experiences)*

Training in the field of communications (i.e. training in education, communication, public relations, etc.) was another area that IPY science and outreach programmes did well to recognize as an important component to the success of IPY EOC programmes. Of the 71% of the projects in our survey that included EOC personnel, 67% (~47% of the total number of projects) had EOC personnel that had communication training. Clearly, many projects and institutions recognized that communication training provided value and benefits outreach efforts. Although this survey is unable to test the effectiveness of programmes that had a communication person working with the project versus those that did not, a general sense of the importance of scientists and professional communicators working together emerges from many comments and from the overall quality of many activities and products.

Although communication professionals did play a large role in the success of IPY EOC, several researchers indicated that they would have liked to develop their own communication strategies further through more training during IPY.

> Information about writing for general audiences, etc. and how to communicate science/research in an accessible and interesting way [would have been helpful].
> *- Allen Pope, Scott Polar Institute, UK; General IPY Activities (Allen is an ECR that participated in a number of outreach events in schools and universities)*

Science communication training is currently offered in some institutions but is not mandatory, or even encouraged in most science disciplines and programmes. Looking beyond IPY, outreach efforts of all kinds would be bolstered by formal training opportunities and communication mentoring for early career and established researchers alike. Future science outreach efforts should build on the involvement of communication experts as used in IPY and carry this forward to extending communications training to all interested researchers.

3. A central office encouraged and coordinated EOC efforts throughout the IPY

IPY EOC was supported through a central office that was easy to access for all those interested in polar outreach. At the beginning of the IPY the IPY IPO was established as a focal point for IPY activities. This office included a full time education and outreach professional that worked to coordinate programmes and volunteers on an international scale (Dr. Rhian Salmon). As a result the IPY IPO helped administer a number of internationally based EOC activities that

drew in audiences that otherwise would not have been engaged in IPY, such as Polar Days/Weeks, a series of events organized by the IPY IPO that connected people from around the world online to learn about a polar topic, including activities such as virtual balloon launches, classroom activities and multi-lingual educational fliers (Zicus et al. 2011). This highly successful series of events involved audiences from 49 countries, with several that had little other IPY involvement such as Malawi and Uzbekistan.

Figure 9. The IPY IPO represented at the American Geophysical Union's Fall 2009 Meeting to promote the outcomes of the International Polar Year.

Photo : Mare Pit

The IPY IPO was not only the main organizing body for several international programmes; it was also the central hub for many volunteers and networks. Many IPY EOC activities were organized and carried out by a large number of volunteers worldwide who donated time and resources. These volunteers, who felt welcomed and connected to IPY, combined with the coordination from the IPY IPO, allowed many outreach efforts to have wide audiences. The success of these IPY outreach efforts thus depended to a very large extent on the ability to motivate, recruit, support, sustain and respect this volunteer community, with the IPY IPO as a critical rallying point for these volunteers. The IPY IPO was utilized by many outreach programmes and recognized as an integral resource by several projects.

> We had a lot of help from the IPY IPO and we used all the materials available online.
> *- Miriam Hebling Almeida , Colégio Puríssimo Coração de Maria, Brazil; Polar Days/Weeks (discussed above)*
>
> The support given through the IPY IPO was all very helpful, including the listserves, the website, information about conferences where IPY related activities would be held, and so on.
> *- Louise Huffman, ANDRILL, USA; ANDRILL Research Immersion for Science Educators (This programme provides science educators with a first-hand view of authentic science in action and an in-depth understanding of the process and nature of science)*

As the central contact point of the IPY for many, the IPY IPO fostered relationships through a variety of inclusive approaches. Salmon et al. (2011) provides a good discussion on the role of the IPY IPO and should be consulted for a more detailed examination of the office's activities. In summary, the IPY IPO made an effort to cover programme costs whenever possible, to communicate through effective and easy-to-use technologies, to find funding for critical face-to-face meetings and to keep volunteer activities and accomplishments visible and prominent within IPY. EOC partners were also enabled through a broad and open membership system of Google Groups, sub-committees and working groups.

The IPY IPO invited and supported members of the community to represent IPY at events; they encouraged the use of the IPY logo for events and products. Volunteers could instantly join a Google Group, sit in on a conference call, participate in community-based training in communication and achieve expanded knowledge of and access to community-developed resources, encouraging buy-in of a community of volunteers who felt connected not just to their project but to the larger IPY programme. Many of these individuals then went on to serve as hubs for further propagation across local and national networks and due to the organization and support from the IPY IPO (Salmon et al. 2011). This ownership granted through the efforts of the IPY IPO transformed these individuals from simple volunteers to ambassadors of IPY, rewarding their efforts with further connection, inclusion and support, and thus greatly adding to the success of global IPY EOC efforts. Without this central office to motivate and mobilize volunteers IPY EOC efforts would have been greatly reduced in size and scope.

Overall the IPY IPO consisted of 3 staff members, limited funds, hundreds of volunteers and lots of enthusiasm. Although many successful programmes were coordinated and supported through the IPY IPO, including several programmes that have gone on to be important legacies of IPY, such as APECS, the office was limited in time, funds and energy. Hundreds of programmes were supported, but even more programmes and ideas that would have been beneficial to IPY were not supported due to a lack of resources. The IPY IPO was a keystone in the success of IPY but was in itself limited and could have done more if resources had allowed.

4. The EOC programme was branded and inclusive

IPY EOC fostered an inclusive and branded approach to IPY, allowing people worldwide to become involved with this global initiative. The larger connection that IPY EOC volunteers and programmes offered allowed projects small and large to gain traction and be a part of a large international effort, even if their event was at a local community center with 15 participants. The inclusive approach of IPY occurred on a number of levels from using all-encompassing activity types and technologies (Section 3, above), to allowing any EOC programme to contribute and be associated with the IPY through branding and logo use.

The primary way in which IPY EOC reached out to contributors and audiences everywhere was through an open, accessible and widely advertised invitation to any and all EOC groups and teams to become formally endorsed partners in IPY. In addition and in response to the large interest, through a free and open branding policy (encouraging, for example, widespread use of the IPY logo), IPY offered a less-formal option for engagement by partners who might not have time or means to submit proposals or who started after the endorsement period closed. In combination, these formal and informal participation options allowed the media, teachers, students, artists and many others to in effect become active 'members' of a global science event rather than passive observers.

Without the open, inclusive approach to IPY EOC, a large number of EOC programmes that made great contributions to the IPY EOC efforts might not have occurred. As discussed above, 48% of the programmes reported did not have IPY funding, and without the inclusive approach of IPY many of these polar outreach programmes might not have happened. In planning science EOC programmes, the contributions of EOC programmes that do not fall within the official EOC plan must not be underestimated, and in fact should be encouraged and promoted as they have shown here to be large contributors to the overall EOC effort.

Technology choices made by the IPY IPO also favoured inclusion in using freely and easily available tools. To engage and include partners in every corner of the world in an active way, free and accessible technologies were utilized to create community events that stimulated and rewarded outreach participants (Salmon et al. 2011). Led by the efforts of the IPY IPO, numerous activities used state-of-the-art audio-, video-, web-conferencing, web portals, on-line discussions, streamed video, and internet radio. Google Earth, YouTube, Google Groups and Documents, Tagzania, Gmail, Skype, and Facebook were all used when appropriate in a variety of IPY EOC programmes (Salmon et al. 2011). In many activities, the focus was on reliability, accessibility, and minimum (toll-free) costs for international partners and audiences. In these ways, IPY reached out to many interested partners with easy and accessible tools, moving polar science outreach beyond traditionally targeted groups.

IPY EOC successfully promoted polar science to various target audience types by encouraging, promoting and supporting EOC activities in a wide range of media. More than 40 different types of EOC outreach activities were reported in the survey, varying from traditional pamphlets (2.3%) to the use of new online social networking tools (1.2%). Figure 10 illustrates the variety of IPY EOC media.

Figure 10. Word cloud of EOC resources/events/products produced during the 2007–2008 IPY by percentage of total number of resources produced (projects n=207, events/resources/products n=1131). The larger the word, the more common the medium was in IPY EOC efforts surveyed. Image produced using http://www.wordle.net/.

This variety of EOC media allowed IPY science communication to meet the varying needs of audiences across different languages, nationalities, cultures, socio-economic levels and many other factors. IPY outreach coordinators and leaders should be recognized for undertaking these ambitious and expansive EOC programmes. From live calls between Antarctic scientists in remote field camps and classrooms around the world to polar-themed inter-collegiate soccer tournaments, from travelling museum exhibits on trains to shopping mall displays to symphonies composed by musicians travelling on Arctic icebreakers—science EOC went to new heights, depths and extremes to take people to the poles and to take the poles to the people, all contributing to the success of IPY EOC on a global scale.

Although the use of new technologies and communication tools was an important component in allowing people to play an active role in polar science, some of the most traditional forms of science EOC were important components to global EOC efforts. In India, where internet connections can be slow and are often the limiting factor to communication, many audiences benefited from more traditional modes of communication such as travelling exhibits. The Indian IPY Outreach Program thus planned their outreach efforts accordingly:

> Despite the ease & accessibility of web-based EOC resources, in a developing country like India, where the internet penetration is still very low, the best way forward is to directly engage children via competitions, public lectures etc. Even if internet is available, only those who are really interested will visit an EOC website while many others may just overlook it defeating its very purpose. So we have to reach out to the students through various interactive activities.
> *- Rasik Ravindra and Manish Tiwari, National Centre for Antarctic and Ocean Research (NCAOR), India; Indian IPY Outreach Programme (The central office that coordinated many IPY outreach efforts in India)*

This example highlights an important lesson of IPY: for outreach plans to be globally successful a variety of EOC media need to be used to reach a broad set of audiences. New technologies were of great use to IPY EOC efforts, but a balanced approach by IPY outreach volunteers and staff that combined old and new techniques served IPY EOC well in engaging audiences worldwide.

IPY EOC activities were also inclusive in audience types, with outreach programmes reaching a variety of people and many targeting multiple audiences. Students were a large component of the target audiences with the most targeted audience overall being secondary students (high school students generally aged 12–18 years; Table 1, 60%). The engagement of students was not limited to secondary students, with primary school students (aged 4–10 years; 32%) and tertiary education students (post-secondary institutions, 43%) also targeted by a third of the programmes surveyed. This large involvement of students of all ages in IPY EOC demonstrates the wide range and inclusive nature of the activities.

Target Audience	
Early childhood education (generally children aged less than 4 years)	8%
Primary/elementary school students (generally aged 4–10 years)	32%
Secondary/high school students (generally aged 11–18 years)	60%
Tertiary education (university or college undergraduate students, generally aged 18+ years)	43%
Graduate and post-doctoral students	40%
Arctic community organizations and residents	24%
Community organizations	25%
General public	58%
Government	21%
Indigenous groups	18%
Media	35%
Residents of polar research area	19%
Youth groups	19%
Other	11%

Table 1. Audiences targeted by IPY EOC projects (project n=211). Values show the percentage of IPY EOC projects reported to have targeted each audience group, with many projects targeting more than one audience type, resulting in the total percentages reported being more than 100%.

The second largest group targeted was the general public, with 58% of the programmes targeting this group, suggesting that many outreach efforts were planned for general audiences and allowed for many different groups to access information. Such general and inclusive approaches are effective when communicating polar issues, given that few people have specific knowledge or experiences that connect them to the polar regions. In general the inclusive and wide-ranging audience types targeted by IPY EOC can been observed in the number of programmes that targeted different audiences within the same programme. Very few outreach programmes surveyed focused on a single audience type (13%), with the largest single audience reported being the general public, arguably a broad audience by definition.

IPY EOC was also flexible and inclusive in defining the time period that IPY covered, which added to the success of the global IPY efforts. Officially, the latest IPY carried a two-year label: "2007–2008". However, the IPY JC and IPO adopted a flexible approach, considering activities that ended or started during that time period as valid partners in IPY. IPY EOC activities therefore continued throughout this time period, even past the official 'closure' of IPY in Oslo in June of 2010. The peak of project inceptions was in 2007 (Fig 11) but as a result of this multi-year approach, many projects were able to capitalize on the momentum that IPY created, with some projects continuing to use the IPY branding, and thus linking themselves to IPY, but not starting until 2010 and 2011.

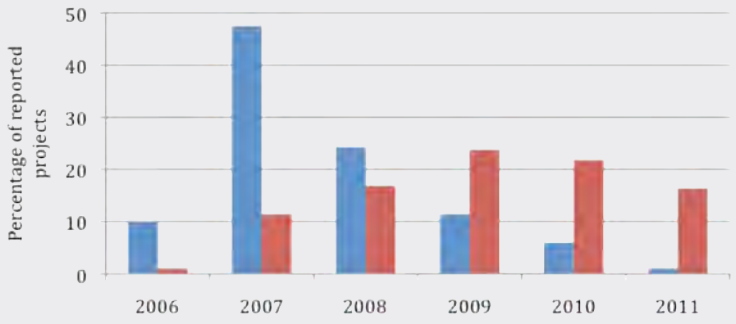

Figure 11. Percentage of IPY EOC projects with start and end dates between the years 2006 and 2011 (n=222).

This flexible approach to the timing of IPY associated projects allowed IPY to include activities that wanted to be a part of the global efforts but moved on timelines that did not coincide with IPY funding or planning.

Overall, the branding and inclusive policies of IPY EOC allowed and encouraged numerous activities to join this global science outreach event and contribute to the science outreach both within and outside of the formally funded programme. Through open invitations to participate, use of accessible technology, innovative outreach methods and flexible timing, IPY EOC encouraged and energized many individuals and activities to take part in IPY, and to become important partners in the global IPY outreach efforts.

5. Advocacy maintained EOC momentum throughout the IPY period

IPY EOC success required continued advocacy to promote and support EOC at all levels throughout the IPY. Science outreach is not a new idea; scientists and communicators have voiced the need for science EOC to promote science literacy and public awareness for decades (Sutherland 1901, Powers 1944), but for science EOC programmes to really meet their full potential, they must have champions who are willing to put in the time and energy, as IPY EOC did.

One of the ways in which the IPY IPO advocated for outreach was as a platform for communicators and educators to contribute in polar discussions and events. By working with many partners, IPY science communication activities were included prominently in numerous sessions and workshops at major international science conferences. The American Geophysical Union (AGU), the European Geophysical Union (EGU) and the World Science Forum are generally non-polar-focused science conferences, but during the IPY took on polar topics more broadly, supplying opportunities for projects to share information, experiences and to talk with potential collaborators. This occurred not just at the

conclusion of IPY, but throughout the IPY period, allowing an IPY EOC network and momentum to build with each successive meeting, session and event.

A strong EOC presence was also ensured at both IPY meetings in St Petersburg (2008) and in Oslo (2010). In particular the IPY Oslo Science Conference had a very active education and outreach component through the Polar Teachers workshop and dedicated outreach sessions in the larger science programme. The teachers workshop included 114 teachers from around the world (Zicus et al. 2011). Beyond the teachers workshop, the conference included a session entitled 'Polar Science Education, Outreach, and Communication' that received more than 250 abstracts. These EOC sessions featured educators and communicators who shared their EOC contributions. Outside of the main presentations, numerous books, festivals, events, expeditions, classroom materials, films, ECR training and other IPY science communication activities were highlighted during the Oslo conference in a variety of presentations and festivals targeted at both the visiting conference participants and the general public (Baeseman et al. 2011a). Achieving this level of prominence for EOC, even at a major IPY conference, required persistent advocacy.

Including IPY EOC in large conferences encouraged polar educators not only to attend a traditional science meeting but to participate actively. Each EOC participant demonstrated the importance of EOC to the science community and inspired educators and communicators in their EOC endeavours, as expressed one participant:

> Taking part in the IPY Oslo Teachers Workshop really inspired me with what outreach was being done in other parts of the world.
> *- Antony Jinman, Education Through Expeditions, UK; (Education through expeditions aims to encourage and share first hand experiences with students and connect classrooms with researchers in the field)*

While attending meetings and workshops IPY EOC partners were able to make connections with other communication and education experts, and meet scientists to collaborate with in the future. These focal points of IPY EOC also allowed independent IPY EOC projects to connect with the larger network of trained communication experts, again propelling and incorporating them in larger initiatives, a key ingredient to supporting and inspiring independent projects to continue in their EOC efforts. At the writing of this report, plans are being developed for the IPY Montreal 2012: From Knowledge to Action conference, which will include a polar teacher's workshop and several EOC sessions, building on the experiences from the IPY Oslo Science Conference that engaging educators broadens the science experiences for both communicators and researchers (Baeseman et al. 2011a).

IPY EOC succeeded because of maintained advocacy throughout the period of the IPY, ensuring that outreach was carried out not only when the momentum of the IPY was high, but throughout the IPY period by the many science projects active over the multiple field seasons spanning IPY. Without continued support and encouragement many of the proposed EOC components of these projects would have withered, but due to dedicated staff leading and energizing volunteers over the term of IPY, IPY EOC instead grew and expanded as new partners were identified. Such advocacy throughout the IPY was critical to the success of IPY EOC in general.

6. Polar issues were timely and topical

One of the main reasons for the success of IPY EOC, beyond planning and coordination efforts, was that it was timely. Of the EOC projects surveyed, 68% indicated that climate change was a theme used in their outreach efforts, even though it was not an explicit IPY focus (these were atmosphere, ice, land, oceans, people and space). Many IPY EOC projects were able to capitalize on the attention directed to the polar regions created by a number of events related to climate change that occurred leading up to or during the IPY. The breakup of the Larsen B Ice Shelf in Antarctica, which was widely shown through a number of media outlets, and the warmest years on record in the Arctic, including the record lows of the Arctic sea ice extent, both drew attention to the poles during the IPY period, increasing both the need and opportunity for effective science communication. The ability of IPY EOC activities to take advantage of

events that came into popular consciousness while IPY was underway undoubtedly expanded both audiences and impact. Although these polar events were beyond the control of science or EOC planning, it does demonstrate that timely and topical themes are important for programmes to gain the attention of general audiences.

A new set of expectations in science EOC

IPY exhibited how science EOC can be integrated within large- and small-scale science research programmes. It showed that audience or outreach medium does not limit EOC and that successful science EOC approaches are as varied as the people carrying them out. IPY EOC also demonstrated that making science outreach accessible to a wide range of participants is an important component of reaching a variety of people on a global scale, and it illustrated that students, teachers, community groups and the general public are eager to be included in an active way. Lastly, IPY EOC has shown that many scientists have a desire to do science EOC within the frameworks of research programmes. As we move forward beyond IPY, there is a need to consider what IPY EOC has demonstrated about science EOC, including what can be seen as new standards and goals for science outreach. Based on the collaborative and successful experiences of EOC during IPY several new expectations have developed within the science outreach community.

- Both science and EOC are integral to research programmes and need to be given equal importance with EOC built into the science programme from the initial planning stages.
- The public wants to be involved in the process of science, and scientists need recognition for their EOC efforts.
- Science EOC needs to be evaluated, just as with other programmes. Ongoing formative evaluation, reflection and adjustment need to be built into the programme budgets to ensure outreach programmes are effective.

These expectations form a reorientation for science EOC that include several new basic concepts that will need to be addressed for the lessons learned from IPY EOC to move beyond IPY. First, the scientific community and funding agencies need to realize and accept that EOC is an essential component of the success of their research projects. Specific budget line items and dedicated, trained EOC staff are needed for EOC to be effective. Second, all people involved (scientists, educators, communicators, public and media) learning from each other is integral to encouraging and promoting widespread science outreach. Communication training needs to be part of the professional development for scientists, starting at the level of early career and involving professional science communicators. Third, without professional recognition, publication and career advancement opportunities for people doing science EOC activities, the outreach capacities, networks, skills and personnel built throughout the fourth IPY will no longer be active or effective, resulting in loss of this large-scale investment. Lastly, continued integration of EOC at science conferences, meetings and workshops is needed. These new practices will need to be recognized, encouraged, and even mandated within the scientific community to ensure that the level of science EOC that was reached during IPY is carried forward and built on in the future.

RECOMMENDATIONS CHAPTER 1

Recommendations for science outreach programmes

1. **EOC must be planned and integrated into larger science plans at every level.** At the science project level, EOC efforts must have dedicated staff that are trained and have the resources to carry out effective EOC to the target audiences. At the institution and project levels, EOC must have a line item in budgets. Scientists, both early and established, must be given professional communication training, recognition and credit for their EOC efforts. At a science association/organization level, outreach should be a part of every professional meeting, workshop and conference, either integrated within the science sessions or as a standalone session.

2. **Communication experts and communication training need to become a part of the science strategy.** Scientists who are good communicators should be encouraged and supported to do EOC. Scientists who are not strong communicators should be encouraged to partner with communication teams, public relation departments or projects that do have strong EOC programmes. Communication professionals need to partner with scientists, and science organizations need to create EOC strategies that are meaning ful and appropriate for target audiences.

3. **Large EOC programmes need to be supported with resources and dedicated personnel, ideally through a central office, in order to maintain momentum.** EOC programmes need resources and personnel to be planned, carried out and adapted throughout the programmes lifespan.

4. **EOC must be advocated for in the science community.** For science projects this means addressing the communities that are impacted by their work. For science funding agencies and institutions science EOC should be an expectation, not a bonus. For science organizations and associations, EOC should not be just marketing the organization but should be educational in nature, encouraged, supported and recognized professionally within research projects and at science meetings and conferences.

Chapter 2

Involving and Engaging Early Career Researchers during IPY

Observed environmental, ecological, social and geopolitical changes in the polar regions are expected to continue at an accelerating pace, and fully understanding their global connections and impacts will require innovative, international and interdisciplinary polar research. Stimulating, nurturing and retaining the next generation of polar researchers are all crucial for achieving this goal. Along with outreach, the latest IPY set out to inspire, excite and involve the next generation of polar researchers (ICSU 2004). Through grassroots efforts and supportive mentors, early career researchers (ECRs) became engaged and involved in planning parts of the IPY, helping to ensure a legacy of continued polar education and research and a continuum of knowledge that will help build the next IPY. In this chapter we highlight examples of these efforts and discuss lessons learned in creating one of the strongest IPY legacies, the Association of Polar Early Career Scientists (APECS).

Early career researchers and the IPY

ECRs were heavily involved with the science portion of IPY with an estimated 1.5 ECRs (graduate students and/or postdoctoral researchers) per senior researcher (Baeseman et al. 2011b). These ECRs infused the IPY with their enthusiasm, energy, and creativity. They had the desire and ability to work internationally and see polar research from a fresh perspective, stimulating new research directions and collaborations that were crucial to the success of IPY.

As in most research projects, during IPY there was a focus on training graduate students in the methods of scholarship and inquiry. Beyond the traditional graduate student curriculum, a few project coordinators and IPY participants promoted activities in education and professional development that addressed the deeper challenges of preparing young researchers for an international career in polar research. In their own way, these initiatives successfully created access to professional development tools, assisting ECRs in learning the skills needed to build a successful career in science.

Several initiatives and activities exemplify ECR participation during the IPY. Throughout IPY various symposia, meetings and networks were set up as IPY projects, or took advantage of the IPY to enhance their programmes to encourage more international cooperation and a cross-disciplinary approach to science, including:

- The 2008 and 2009 Student Days of the ArcticNet Student Association. An annual meeting of the students involved in the Canadian ArcticNet research programme, which included international participants and information about developing international and interdisciplinary collaborations;
- The New Generation of Polar Researchers Symposium, a US funded, but international career development workshop;
- Combining Art and Science at the ARCTOS PhD-school took advantage of IPY momentum by including international aspects;
- The Young Researcher Network at the University of Alaska, a cluster of IPY funded postdoctoral researchers; and
- The Permafrost Young Researchers Network (PYRN), a virtual platform for young permafrost researchers to exchange knowledge and experiences.

These efforts, and many more, provided ECRs with training, networking opportunities and created optimal conditions for them to grow both professionally and personally (Baeseman et al. 2011b). The energy behind the activities of these groups demonstrated the need for a broader, more encompassing and sustained professional development

effort specifically geared towards early career scientists working in the polar regions. Through feedback and discussion from several different groups it became clear that these efforts should be led by ECRs and focus on improving science collaborations through career development.

Shaping the future of polar research - APECS

At the start of the fourth IPY, a grassroots effort led by a group of young scientists formed the International Youth Steering Committee (YSC) to ensure the inclusion of the next generation of polar researchers and the world's youth in IPY planning and activities. The group focused on outreach efforts and aimed to involve school children and young adults in polar literacy projects and strengthen the communication between students and young researchers throughout IPY.

Because the YSC was driven by IPY, its scope was limited in time and didn't look beyond the IPY. Recognizing the growing need for international collaboration and coordination of ECR activities beyond the IPY, two members of the International YSC, Hugues Lantuit (Germany) and Jenny Baeseman (USA), along with Rhian Salmon from the IPY IPO, laid the groundwork for APECS. The initial group grew quickly, acting as an umbrella organization bringing together polar-related young researcher initiatives across disciplines and nations. With the vision of recognizing the significant role that ECRs play in conducting and advancing research in polar areas, APECS filled the neglected gap of career development activities for young researchers by making strong connections to the senior leaders in the field. By creating a continuum of knowledge between early career and senior researchers, APECS explored new ways to sustain the international leadership, involvement and energy of ECRs beyond the IPY.

In order to build meaningful partnerships with professional organizations, APECS initiated discussions in 2007 with overarching senior international polar organizations, the International Arctic Science Committee (IASC) and the Scientific Committee on Antarctic Research (SCAR). These discussions and subsequent memoranda of understanding ensured major international polar science involvement and presence for ECRs in activities of the senior research community. APECS rapidly evolved to serve the diverse needs of ECRs studying the polar regions and the wider cryosphere with the mission statement "to raise the profile of polar research and stimulate collaborative projects in research and outreach by providing a continuum of leadership that is both international and interdisciplinary in focus" (APECS 2011), and defined ECRs as students and those within 5 years of completing their Masters and 7 years of their PhD.

Since its official launch in 2007, APECS has grown far beyond any young researcher group dealing with a single field of study or geographic area, and as of August 2011 is made up of more than 2600 members in 74 countries (APECS 2011). APECS represents people with a wide range of scientific expertise and interests including anthropology, atmospheric science, biology, biogeochemistry, culture and heritage studies, education, glaciology, geology, linguistics, oceanography, paleontology, permafrost, polar law, sociology and space studies. During IPY, APECS members played an active role in planning workshops, conferences, publications and outreach with over 100 APECS-sponsored events spread across 6 continents since 2006 (APECS 2011). Beyond the close of IPY, APECS continues to grow at

Figure 12 The International Youth Steering Committee (YSC) focused on outreach efforts and aimed to involve school children and young adults in polar literacy projects and strengthen the communication between students and young researchers throughout IPY.

Photo : David Hik

a rate of 1.5 new members per day (APECS 2011). Members, new and old, continue to carry on internal working groups focused on organizing research efforts, data management and international collaboration, with APECS members continuing to lead the way in polar science and outreach.

As APECS expanded, the following organizational structure was put into place to involve early career and established researchers, to ensure the transfer of knowledge and skills and maintain fresh and adaptable leadership. The structure of APECS is entirely driven by ECRs with ECRs forming the Council, the Executive Committee and the leadership consisting of a Director and President (Fig 10). The Director position is held by a 'senior' ECR, whose responsibility is to oversee the daily operations of the association and provide continuity for the organization and mentoring to the members. Together, these individuals and groups decide, manage and run the operations, projects and initiatives of APECS. Established researchers from around the world form the APECS Advisory Committee provide advice to the APECS leadership.

Figure 13. Figure 10. Leadership structure of APECS including ECR as the members, working groups, committees, council, the executive committee and the directorate, and established scientists in the role of advisory committee.

Throughout IPY, and now post IPY, APECS serves as a hub for ECRs from a variety of disciplines to communicate, network and learn beyond what is offered in the standard university setting. APECS aims to provide continuing career development for its members by:

- Facilitating workshops, panels, and web-based discussions to help ECRs share ideas and experiences and to develop new research directions and collaborations;
- Providing opportunities for members to find expert guidance for their career development;
- Developing tools and resources to assist with every aspect of polar research, such as field site information, training, networking, project management, and employment opportunities; and
- Promoting education and outreach as an integral component of research in polar areas.

Along with providing career development services for its membership, APECS also acts as a conduit for ECRs to get involved in science organizations and international science planning. Through a number of memoranda of understanding and agreements, APECS has worked with such groups as SCAR, IASC, the Arctic Monitoring and Assessment Program (AMAP), the Circum-Arctic Flora and Fauna working group (CAFF), the IPY Oslo Science Conference, the IPY Montreal 2012 Conference, several AGU meetings and many others to help these groups find ECRs to serve as members of working groups, session conveners and committee members. Previous to APECS, there was often limited knowledge of many of these international organizations and programmes by ECRs beyond internal pools of graduate students already associated with the programme, and as a result of APECS the recruitment and involvement of ECRs has provided these programmes with new ideas and energy. Now, through its wide and active membership, APECS is able to connect ECRs from a variety of backgrounds with science groups looking for ECR input, contributions and involvement.

APECS, the leadership and membership, continues to identify and develop activities and opportunities beyond its current programme to address arising needs. Members are encouraged to take on projects that will benefit the membership as a whole and represent APECS in a variety of international science meetings and conferences.

Using the APECS model for other international science efforts

In general, the science community is beginning to recognize that the coming decade may have knowledge gaps as many established researchers plan for retirement and few early and mid-career researchers are involved in science organizations and programmes in a meaningful way. As one of few successful organizations of its kind, APECS has actively tried to address this issue through its array of programmes and activities. The success of APECS during IPY has been recognized by the IPY JC, the IPY sponsors (ICSU & WMO 2010) and other APECS partners (e.g., IASC, SCAR, Arctic Council Working Groups; Baeseman et al. 2011b), and now that IPY has closed several lessons from its formation and development can serve as a model for other science groups or initiatives.

First and foremost, the energy, momentum and desire required for early career programmes to work must come from ECRs. APECS is successful because it brings together enthusiastic, energetic, talented and dedicated people. APECS' energy comes from the membership, and its leadership strives to meet the needs of its members. Without this grassroots effort and bottom-up structure, what APECS has been able to do on a global scale over the past four years would not have been possible, regardless of how much support it had from established scientists and organizations.

Second, APECS was successful due to support and recognition from IPY scientists and science organizations. Many senior scientists recognized the value that APECS and ECR bring to polar science and actively supported and advocated for APECS and its members. As a result of memoranda of understanding, APECS, IASC, SCAR and others have actively supported ECR programmes by including ECRs in working groups and committees. Without the recognition that fostering future generations of researchers is an important step in science planning for all science organizations, large and small, APECS would not have been able to flourish as it did during IPY and continues to. APECS also capitalized on this support through active participation of established polar research professionals as mentors in all of its activities. This facilitated connections between senior and junior researchers in polar research knowledge and built the camaraderie essential in forming new collaborations. These established relationships ensure knowledge transfer between generations and are an important part of carrying the momentum of polar research, education and outreach beyond IPY. At the same time, many mentors felt renewed energy and excitement from mentoring ECRs, giving a benefit to them as well as the young researchers.

The third important step to the success of APECS beyond IPY was the development of a systematic process for the annual succession of the core leadership to ensure the ongoing initiatives of the organization. Because the time commitment of young researchers needs to be limited so they can concentrate on their research goals, a plan to facilitate a timely turnover in leadership is critical. The absence of this plan for turnover is where many young researcher initiatives lose momentum and fail. Fourth, APECS is fortunate, through both in-kind and monetary support, to have a salaried Director position responsible for the day-to-day management of groups, meetings, event planning and leadership mentoring. The Director has institutional memory and developed long-term partnerships with external groups. This type of position is often difficult to fund, and the importance of institutional in-kind and monetary support cannot be underestimated. Having a funded Director position helps sustain activities, coordinate volunteers, and meet the long-term needs of the organization.

Overall, the energy and enthusiasm of ECRs is the key ingredient to the success of ECR organizations; however, this needs to be accompanied by mentoring to help young researchers learn important professional skills such as organizing events, working in groups, bridging cultural differences, setting goals and plans, leadership, etc. It is not necessary for every international science project to establish a young researcher group such as APECS, but creating activities at conferences that are funded, supported by senior mentors and run by young researchers so to address their needs and keep it on a peer-to-peer level is important and can be implemented easily. APECS has produced several template documents to plan mentor panel discussions at conferences, workshops, online activities and other events that can be used by other groups to create similar successful activities (APECS 2011).

Figure 14: Thousands of ECRs were trained throughout IPY, but without permanent positions related to polar science to transition to, many highly skilled polar ECRs will look outside the polar regions for employment.

Photo : Jenny Baeseman

Polar early career researchers and preparing for future challenges

Most research is carried out in part by the efforts of graduate students and postdoctoral researchers, and in the past this was considered as adequate training for preparing the next generation of researchers. The IPY provided ECRs opportunities in research but also provided several mechanisms through which they could gain additional skills needed for successful careers with international and interdisciplinary aspects.

With all of the challenges that current and future polar researchers face, APECS continues to grow and expand post IPY and is now arguably more important than ever before; although IPY is now officially closed, polar ECRs continue to need support. The active and growing membership of APECS suggests that APECS continues to have value for ECRs, and the ongoing formation of internationally important partnerships (e.g., with CAFF and AMAP [both working groups of the Arctic Council] in 2011) demonstrates the value of APECS within the scientific and political community. Funding and coordination support for these efforts is an essential ingredient for maintaining and expanding the global continuum of research knowledge, and the rapid growth of APECS demonstrates the need for this. Polar science organizations need to continue to support APECS as a way to foster the ECRs of today and tomorrow as these researchers will be the established researchers and mentors in the coming decades, including the fifth IPY later this century.

The polar regions are changing rapidly, and polar researchers will be continually challenged in the coming decades; thus it is imperative that the ECRs trained during the IPY stay connected and engaged in polar topics. Without such continued involvement of today's polar ECRs, the skills, knowledge and capacity invested during IPY may dissipate and be lost to the polar community (Provencher et al. 2011). Thousands of ECRs were trained throughout IPY, but without permanent positions related to polar science to transition to, many highly skilled polar ECRs will look outside the polar regions for employment. Governments and organizations need to recognize that in order to retain the ECR investment made during the IPY, full-time positions in polar science and outreach must be prioritized.

Early career researchers beyond polar science

Many of the challenges faced by ECRs extend beyond polar science with many areas of science experiencing the same challenges of knowledge gaps and problems retaining ECRs. These challenges are hard to address using traditional approaches to early career development, but through IPY's approach to ECRs many lessons can be learned, including the following:

- ECRs want to be actively involved in science planning at all levels.
- Support from established scientists and science organizations is key to the widespread success of ECR groups and professional development.
- The involvement of ECRs can be accomplished through existing working groups, committees, boards and

conferences adopting open mentoring policies.

- ECR initiatives need to be centrally organized, plan for high turnover rates and provide programmes that are lacking elsewhere in traditional training settings.
- Moving beyond training and mentoring, career transition programmes need to be put into place in order to retain skilled ECRs or these skills sets will dissipate as ECRs look elsewhere for employment.

Efforts that carry on the legacy and engagement of ECRs, such as APECS, must be sustained and further developed to continue the international and interdisciplinary momentum of IPY as well as enhancing the role of young researchers in other international science projects.

RECOMMENDATIONS CHAPTER 2

Recommendations Early Career Researcher Programme

1. **ECR programmes need to be driven by ECRs.** The energy and longevity of ECR programmes depend on the time and energy that ECRs are willing to put into the organization. Without this dedication ECR programmes will not flourish and grow or address current ECR needs.

2. **ECR programmes need the support of existing professional committees and established scientists to meaningfully engage them**. ECRs must be valued and engaged in programmes beyond the ECR group. The ECR programme should act as a hub for ECR activities, but ECRs should not be limited to acting only within this structure. Working groups, expert groups, steering committees and project boards should all actively include ECRs to help foster the skills associated with being active leaders. Large overseeing bodies should encourage, recommend and model to their membership to include ECRs in their own organizations in a similar way. In addition, ECRs need mentors to bridge the knowledge gap between generations. Science organizations should encourage and support scientists and groups to mentor ECRs, and give them professional credit and acknowledgement for doing so.

3. **The governance of ECR programmes needs to be driven by the ECRs and developed to promote participation, but supported by a central office that retains institutional memory.** The leadership of ECR programmes needs to be collaborative, so people with busy schedules can still contribute, and have built-in turnover policies that keep the leadership fresh and engaged.

4. **The ECR programme must offer a variety of activities that go beyond what is found in other educational or student support arenas.** For an ECR programme to be successful, it must offer activities that fill a gap in ECR needs. First, career development skills such as proposal writing, networking and time management are critical to the successful development of ECRs. Second, the opportunity to work with, not for, established researchers on large projects such as conferences, and expert working groups is necessary for the meaningful involvement of ECRs.

5. **The retention of ECRs beyond IPY must be facilitated to allow highly skilled ECRs to transition to mid-career responsibilities.** Science organizations must advocate for full time positions within polar science and education in order to prevent the loss of ECRs to other fields and professions. The loss of polar ECRs to other areas will not only be detrimental to the future of polar science in terms of knowledge and skills, but will represent a loss in valuable capacity and investment developed during IPY.

CHAPTER 3

Conclusions and Practical Lessons Learned from IPY EOC efforts

Along with the success of IPY in reaching key audiences around the globe, IPY EOC plans and activities reflected some broader issues that are relevant in planning future science outreach programmes. Salmon et al. (2011) identified several of the most commonly identified themes over the course of IPY that were also apparent throughout this assessment project, including the following:

1. **The public, students, teachers, media, artists and musicians want to be actively engaged in science.**
2. **Professionals in science and communication, at junior and senior levels, expressed frustration at the limited recognition for outreach activities.**
3. **Small-scale outreach projects benefit greatly by being linked to larger outreach initiatives.**

In addition to these, several other recurring themes that were apparent in the survey and other communications included the following:

- Formal outreach assessment is still lacking in most programmes and needs to be prioritized in order to gauge the effectiveness of programmes and to adapt accordingly.
- In many cases, science EOC has moved beyond the traditional poster or pamphlet, but more needs to be done to ensure that outreach efforts are reaching target audiences.
- Institutions and organizations with long-term programmes should plan to house and maintain networks that link scientists and communicators, creating a legacy of the science programme and sustaining outreach efforts past short-lived projects.
- Science outreach efforts should involve partners such as teachers, media, museums and science centers that already have EOC capacity and an audience.
- Archival capacity for outreach programmes needs to be planned from the beginning to ensure resources created, such as videos and curricula, are available beyond the projects' lifespan.
- Multi-year science events that span several years are more likely to attract partners for outreach efforts as often funding cycles and institutional programming agendas do not naturally coincide with science planning.

Audiences want to be actively engaged in science

Again and again, the public, students, teachers, media, artists and musicians involved in outreach throughout IPY expressed the desire to be actively engaged in science activities. This desire needs to be recognized and considered in all science EOC planning. Outreach projects that put audiences in direct contact with science and scientists are highly successful in involving people and in fostering further polar outreach by those participants. The Antarctic geological DRILLing (ANDRILL)[1], PolarTREC[2], Students on Ice[3], Schools on Board[4] and others provided opportunities for students, educators, artists and musicians to connect directly with science programmes and to become an integral part of them. The success of these projects can be seen in the number of presentations by their participants locally, nationally and internationally at conferences, workshops and other venues. As an example, the IPY Oslo Science Conference had more than 30 abstracts submitted (12% of the entire EOC section) by non-researchers that had a direct involvement with a science project that went on to share their experience with others.

1. http://www.andrill.org/
2. http://www.polartrec.com/
3. http://studentsonice.com/
4. http://www.arcticnet.ulaval.ca/sb/index.php

Students and teachers particularly expressed a desire to be directly involved with science projects and were motivated by working directly with scientists and researchers.

> From our experience and contact with some of the schools, students find it interesting and encouraging to be part of an important research project. They experience that the research community and the society actually find use for their work. They take a personal interest in the work they have done and they tend to instill a feeling of ownership and pride.
> *- Eldbjørg Sofie Heimstad, Norwegian Institute for Air Research (NILU), Norway; Global POP (In Global POP students follow a scientific protocol for fish sampling worldwide to help monitor contaminants in fish populations)*

Students and teachers want to actively participate in science, and outreach programmes need to foster and support this active involvement. One of the most successful aspects of IPY was not only that it brought polar science into the classroom, but that it brought polar science education out of the traditional classroom setting by engaging students in topical, relevant and current science and data collection on a global scale.

Figure 15: Students on Ice offers unique educational expeditions to the Antarctic and the Arctic and helps sstudents, educators and scientists from around the world foster a new understanding and respect for the planet.

Photo : Lee Narraway

Although more than 3% of the activities examined were of the expedition type that actively engaged teachers and students as discussed above, another 3% of the EOC materials reported were pamphlets, booklets or information sheets (Chapter 2, Fig 10). There may be some audiences where pamphlets are an effective tool for science communication but in general science needs to move beyond simply distributing information and engage audiences more actively. It is no longer sufficient for EOC to consist of passive materials that are dispersed throughout the local community. By involving students, teachers, artists, media and community members to share the journey of science programmes they become invested in the project and the outcomes, transforming them into ambassadors of the science, the ultimate goal of any science outreach programme.

Professionals in science and communication expressed frustration at limited recognition for outreach activities

One of the main obstacles that many scientists and communicators, early career and established, have voiced concern over is the limited professional recognition, and in some cases support, for science EOC activities. For ECRs inspired by IPY, this is particularly important because currently EOC is an important function of their role as scientists (Nelson & Vucetich 2009, Baron 2010). If science EOC efforts remain unrecognized in the world of professional science, as the ECRs from IPY mature and move into established positions, many will become bogged down in the activities that "count" (publications, official courses taught, etc.) as they try to move into more permanent and established research positions, causing a decline in EOC efforts.

This loss of EOC capacity also has implications to the broader public. The National Science Foundation (NSF) has recognized a decrease in importance of broader impacts (EOC impacts) is a major cause for concern in a diminishing

scientifically engaged and literate society (Boone & Marsteller 2011). Boone and Marsteller (2011) suggest that the best hope for increased public-science relations is in increasing programmes that support the next generation of researchers in outreach efforts. IPY is well situated to leave a legacy of engaged and highly skilled polar communicators. If EOC efforts are supported and recognized, this new generation of ECRs will carry their experiences of IPY EOC forward by developing more science EOC programmes and integrating EOC into their own research as they become established and contribute to public science literacy for decades to come.

Developing a conceptual framework for professional recognition within the science and academic world is outside of the scope of this report, but the IPY EOC Assessment Committee strongly recommends that such a system be developed. Several different systems exist in other professional areas allowing members to be rewarded for a variety of professional activities within their field that could be used as models in the creation of a science outreach recognition system. The Lifesaving Society of Canada uses a credit system of courses and events to maintain professional qualifications for lifeguards and instructors (Lifesaving Society of Canada 2005), as does the American Medical Association under their Physician's Recognition and Credit system (American Medical Association 2010).

Small-scale outreach projects benefit greatly by being linked to larger outreach initiatives

Many IPY EOC programmes benefitted from having a coordinating unit that acted as a hub for EOC information and planning. This is illustrated in how the Polar Days events grew to Polar Weeks (as described in Chapter 1) as people became more aware of the activities and the opportunities to bring this international event to the local level. IPY has demonstrated that a central contact point for science outreach efforts is critical in maintaining project momentum, recruiting and managing volunteers, and for continued advocacy throughout the science event timeline; it also established that a coordinating unit can lead to a project growing beyond the sum of its parts. Project participants recognized the benefits of being part of something larger, something beyond their own community event or individual science project, something bigger. This spirit of wanting to be part of a larger community is what many associate with polar science, so it is not surprising that this energy and feeling is also found in polar outreach programmes. Globally successful science outreach programmes must recognize this need for a larger connection and capitalize on it in order to gain a truly international audience.

Formal outreach assessment needs to be prioritized in order to gauge effectiveness of programmes

Although science EOC has greatly increased in quantity and importance over the past several decades, reaching a global scale thanks to the efforts of the many contributors to IPY EOC, there are several areas in which projects are not reaching their full potential. Only 27.8% of the projects surveyed conducted any type of evaluation or assessment of their EOC, suggesting many science programmes recognize the need for EOC, but are not yet evaluating their efforts in order to improve EOC programmes. Evaluation is an important part of any programme, and professional communicators should be engaged to assess and improve these efforts. A media analysis by Rueth et al. (2008), examined how the 2007 IPY launch event led to local, national and international media coverage, was one of only a few assessment projects undertaken during IPY that demonstrated how media releases by science organizations can impact global media coverage.

In general, where scientists and communicators did partner to create EOC programmes, the assessment portion of the project was not funded. Just as science needs to be examined and peer-reviewed, science EOC efforts also need to be assessed in order to refine and redirect approaches to ensure objectives are being fulfilled. As demonstrated by IPY EOC, a variety of outreach approaches and audiences are needed for a successful large-scale science EOC programme to have a high level of impact. Knowing these audiences and what works best for them is integral to reaching beyond the traditional audiences.

Moving science EOC beyond the traditional poster presentation, pamphlets and brochures

Another challenge in outreach is that EOC does not mean the same thing throughout the science community. Throughout IPY EOC there are numerous examples of researchers and educators using new technologies and innovative strategies to connect audiences, but a number of activities that were reported as EOC were focused on communicating within the scientific community. The 9th most popular EOC delivery method, of over 40 possible options, was a scientific poster delivered at a conference or within an institution (4.2%; n = 1131), and the 7th most popular was a presentation at a conference or workshop (4.3%; n = 1131). Although posters and conferences can be effective and useful communication tools among scientists, they are not ideal beyond the scientific community and generally fail to communicate to the general public.

Science programmes need to continue to support both scientists and communicators to move beyond these traditional means of science communication that are limited to the research community. Two innovative examples of this come from APECS. The APECS Virtual Poster Session takes the concept of the traditional science poster session online, broadening participation to include stakeholders and society as a whole (APECS 2011). Another example of this resulted from an APECS workshop. Several participants worked with an established researcher experienced in science outreach to create animations that could be used to communicate their science to the general public (May et al. 2011). Such projects and workshops need to become a part of the training for every ECR so that the next generations of researchers will be prepared to engage with the public in a meaningful way.

Figure 16: Sami reindeer herder, Johan Mathis Turi, discusses reindeer earmarks with Evenki herders in Northern China. Traditional foods are often the glue that binds communities together through social sharing networks abd traditional knowledge passed on to future generations.

Photo : Elna Sara

Institutions with long-term programmes should plan to sustain outreach efforts past short-lived projects

One of the most important tools in the success of the IPY EOC programme was the widespread community of polar educators, scientists and communicators that had direct access to information and to each other at all times from anywhere. Throughout IPY, educators and communicators used existing groups and created a variety of new online networks in order to communicate, share knowledge and develop new ideas. The IPY media network allowed media personnel to collaborate and share information, as did the other network established and maintained throughout IPY.

In particular the Polar Teachers Network (a Google Group that allowed emails to be sent to a subscribed group of people interested in polar education) proved successful in connecting educators from around the world who often had little to no other direct connection with scientists and researchers. The networks circulated information on conferences, workshops, professional development opportunities, science programmes and much more to educators and communicators worldwide and were important in bringing together highly motivated like-minded people.

Through these networks numerous outreach events were created, promoted and inspired as these science outreach communities learned and connected with each other. Salmon et al. (2011) outlines an interaction in which a teacher emailed the IPY IPO requesting help with teaching polar science in her classroom. Within a few hours the IPY IPO

sent this message to the IPY Polar Teachers Network. Less than 18 hours later the teacher had received numerous suggestions and ideas for teaching polar science to use in her classroom from polar scientists and educators, including help from an ECR stationed in Antarctica. This real-time response of an active network of people was critical in sharing information, and in building capacity in educators and communicators to teach polar science and in linking scientists ready to connect with interested audiences.

In other cases the IPY networks simply kept the conversation about polar outreach active, allowing many to learn and become involved in global initiatives such as Polar Days/Weeks, the Global Snowflake Network (an international programme in which students and teachers classified and studied snowflake formation) and Global POP (an investigation of environmental pollutants with the sampling done by students and teachers across the northern hemisphere).

Scientists and teachers often lack direct links to each other outside of an effort such as IPY, and ultimately science outreach is not effective if no one is using the information. Many teachers do not have the time to continually search for curricula, and researchers often do not have the tools to seek out and contact teachers interested in science outreach. Stable networks, particularly between scientists and educators, are needed. Some scientists were willing and able to do more outreach but could not find the contacts in the education system in order to make this happen. One case of this was the Frozen Five project that skied across Svalbard.

> It is not always easy to get in contact with school classes. We had the capability to do more outreach, but did not get teachers interested to invite us.
> *- Mats Björkman, Sweden / Kim Senger, New Zealand; Frozen Five (Svalbard scientific skiing expedition that prioritized polar outreach as part of their mission)*

For science EOC to reach the classroom student audience, teachers need to have connections with scientists. Programmes that connect teachers with early career and established scientists, locally and globally, were a common request throughout the IPY and this project as expressed here by one teacher:

> The most valuable lesson(s) are: 1) that science teacher(s) do need to work with scientists more often and have a direct experience of what [the] science process is and 2) teachers need to have international contacts to improve their „local" work (my rule since this experience is „Get inspired globally, act locally").
> *- Matteo Cattadori, ANDRILL progettosmilla.it, Italy; (Progettosmilla.it is a website that provides information and resources to teachers in Italy about polar science).*

One resource that has been suggested by both scientists and communicators is a matching programme that would link researchers who want to do EOC with educators and outreach personnel. This would greatly increase scientist and educator collaboration and help to increase science EOC networks.

Unfortunately, many of the IPY networks no longer have moderators or groups keeping them active now that the IPY IPO has closed. Just like IPY EOC had to be nurtured throughout the IPY period, these networks also need to be nurtured and are likely to become inactive, as members are no longer continually engaged. These groups of educators and communicators around the world are one of the legacies of the IPY EOC efforts, with the ability to continue with polar EOC beyond IPY, but without support and new information, networks will disintegrate. In the future, networks for science initiatives should either be hosted by offices with long-term programme objectives or have a successional plan to transition from the short-term science initiative programme to a larger science office or organization. Science programmes and institutions, such as ICSU, IASC and SCAR, who have a long-term standing, are in a better position to support such polar outreach communication networks as they are more stable over time, while science initiatives are more ephemeral.

Science outreach efforts should involve partners such as teachers, media, museums and science centers that already have EOC capacity and an audience

The IPY represented not only a huge investment in science but also in outreach efforts, and although some EOC programmes have funding sources that will allow them to continue beyond IPY, many do not. To extend outreach efforts and increase outreach beyond limited timelines, EOC programmes should aim to form partnerships with established communication professionals or centers. Science centers, museums, filmmakers and teachers are some of the main target audiences that should be the focus of science outreach efforts; these groups, once connected, can carry on communication strategies beyond time-limited science initiatives.

Of the 552 activities in the Polar Outreach Catalogue, 12% have a film component of some kind, 8% created curriculum materials and 14% include an exhibit component in a gallery or museum. The projects that contain the above components have some of the largest and most widespread audiences. These projects demonstrate how effective outreach efforts can be when targeted towards groups that already have built-in communication personnel and audiences.

This type of collaborative outreach effort should be promoted in any science outreach strategy as science centers, museums and galleries come with communication capacity, established audiences and may have their own independent budgets. By working with such communication centers, science programmes can maximize their outreach efforts and produce quality outreach products.

Several examples of exhibits can be found in the Polar Outreach Catalogue. First, Ice Stories, an IPY project coordinated by the Exploratorium (a science center in San Francisco) was very successful at creating interactive polar researcher blogs that were tied into exhibits. This project ran from 2007 to 2010 with the website getting millions of hits across this time period. This programme not only allowed the public to connect and follow researchers, it taught the researchers communication skills that they could take on to future projects, fostering a culture of active science outreach.

Another example of a highly successful collaboration between a science project and a museum is the Interpolar Transnational Art Science Constellation (ITASC) Catabatic Experimental Platform for Antarctic Culture (ICEPAC) project. The ICEPAC project is a South African research initiative involving a solar- and wind-powered mobile research station that can house a six-person crew for up to 30 days while collecting environmental data in Antarctica. During IPY, an exhibit was installed in two science centers in France that showed real-time environmental data collected by ICEPAC. The ICEPAC project was also a part of the second Bienal del Fin del Mundo, an art exhibition focused on weather, climate and Antarctica that took place in 2009 in Brazil, the South African Antarctic base SANAE IV and Argentina. With exhibits in four languages (French, English, Portuguese and Spanish) on four continents, the ICEPAC effort reached hundreds of thousands of people and was one of the most global IPY EOC projects.

Lastly, the Science Express exhibit combined museum resources with a mobile approach. A 16-car train carried an exhibit showcasing polar science and technology and was visited by over 2 million people during its travels through India and Germany. This traveling exhibit took advantage of professional communication experts in creating exhibits and then went the extra step to make sure that a variety of audiences were able to access it. The Science Express also brought polar outreach to thousands of people in rural communities that might otherwise not have learned about IPY, a true mark of successful EOC.

Figure 17: The Interpolar Transnational Art Science Constellation (ITASC) is a network of individuals and organisations working collaboratively in the fields of art, engineering and science on the interdisciplinary development and deployment of renewable energy, waste recycling systems and sustainable architecture to enable the production and distribution of open-format, open-source remote field research in Antarctica and the Arctic.

Photo courtesy of ITASC

These examples, along with others that occurred during IPY, should be used as models of how science projects can partner with existing communication and education centers to create effective and widespread outreach programmes.

Archival capacity for outreach programmes is needed to ensure that resources are available beyond the projects' lifespan

Archival and recording of EOC events is another area that was not planned systematically. 60% of the IPY EOC projects surveyed indicated that their IPY EOC materials have been archived, which seems encouraging, with more than half theoretically available for future use. This is a huge accomplishment, considering that hundreds of projects of various sizes were conducted around the world. Finding and accessing this material is when the challenge arises. No central archive for IPY EOC materials exists. The projects that are 'archived' are scattered on project websites, many of which have a limited lifespan. In short, there is no way to ensure that any of the projects archived will continue to be available over the coming years, which would represent a huge EOC investment loss.

In addition to the limitations of the archival EOC material, no general list of IPY EOC efforts existed until the current project. Although this project has collected information on 552 outreach projects (as of August 2011), there are inevitably still large gaps in the catalogue, which will be increasingly difficult to fill as time passes, project offices close, and staff move on to new programmes.

Significant IPY EOC products and resources may have been lost due to the lack of a central repository that was widely advertised and accessible. Teachers accessed polar resources during the IPY may now face challenges in getting material, and as a result lose the momentum of teaching polar issues when faced with general science curricula in which polar topics are not prescribed learning outcomes. Science outreach programmes should not only be tasked with carrying out EOC programmes but also with actively archiving and tracking outreach projects, with targeted funding to support this final step.

The IPY outreach catalogue, a direct product of this assessment, does begin to address the need for a comprehensive source for IPY EOC activities. Although it may not be the ideal archive format, it is a single place where teachers, educators, scientists, managers and funding agencies can review and investigate outreach projects that occurred during IPY. The catalogue is available online (APECS 2011; http://apecs.is/education-outreach/catalogue) and open for everyone to use. Visitors to the catalogue can view individual records for outreach programmes or use keywords to search for specific types of programmes, such as by nation; the catalogue will give numbers of total records for such queries. The catalogue can also be sorted by project name, audience type and type of medium, allowing users to create searches that best suit their needs.

Multi-year science events are more likely to attract outreach partners as often many agendas do not naturally coincide with science planning

Another reason for the success of IPY EOC, though not planned for directly, was the multi-year aspect. Officially the latest IPY was labeled 2007–2008, but events both official and unofficial continued on well into 2010 and 2011. Although most of the IPY EOC projects started in 2007, the majority of the projects (62%) did not end until after the official IPY timeline (Chapter 2, Fig 9). This suggests that to some degree another reason IPY EOC was successful in reaching so many audiences was the multi-year nature of the event. If IPY had been only a year long, a number of highly successful EOC programmes that did not gain momentum, funding or resources until after the initial start of IPY might not have been as successful or engaged at all in polar topics.

This long time period and continued attention allowed IPY EOC to expand and grow over time. Thus, along with advocacy a critical time period is essential in building the momentum and success of science outreach programmes. Potentially 6 to 12 months is not long enough for external science outreach programmes to buy in and become

associated with a science event; as demonstrated by IPY, these "latecomers" can represent up to half of the overall outreach effort.

The next steps in examining and assessing IPY EOC

The IPY EOC assessment committee undertook an initial assessment of global IPY EOC efforts. The results presented here include general trends and several overall lessons learned from the outreach efforts during IPY. Unfortunately, no preliminary assessment was done on polar science knowledge or EOC before IPY, but this does not mean that an in-depth assessment is no longer possible. To move beyond this initial assessment and inventory, to examine the direct and indirect impacts of IPY EOC on targeted audiences and the effectiveness of these IPY EOC efforts, this committee recommends a dedicated follow-up project(s) to undertake this task.

To assess how IPY EOC impacted the general public, how it impacted students choosing careers, and what media were the most successful in reaching different audiences, etc., a dedicated study with some type of pre- and post-IPY polar knowledge evaluation needs to be undertaken. This type of formal evaluation goes beyond what most scientists and even many educators are trained to do, and requires specialized knowledge and time. Nevertheless, such formal assessments are needed to fully understand the impact of IPY EOC. Appendix C contains several examples of projects that could be carried out to gain a better understanding of the impact of IPY EOC.

IPY EOC is a microcosm of outreach experiences, and offers a unique opportunity to ask these and other questions relating to science EOC programmes. This inventory and initial assessment of the IPY EOC efforts has provided the groundwork for much more extensive analysis to be done. This committee hopes that these initial efforts and ideas will be used to examine IPY EOC efforts further, and will benefit and inform other science and outreach initiatives.

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Appendix A

Online International IPY EOC survey

Below is the online survey completed by IPY science outreach projects and used to develop this report, as it appeared in the Survey Monkey format (access courtesy of ICSU):

As you know, the International Polar Year has now come to a close. From the very beginning, IPY education, outreach and communication activities (EOC) were recognized as important components to the overall success to the biggest IPY to date.

IPY 2007–08 defined EOC as the following:
Education – efforts to promote science literacy and improve knowledge and understanding of the polar regions and polar science, usually accomplished through schools
Outreach – proactive activities to reach out and engage audiences on polar science and research
Communication – public information and media products and activities to provide information about polar research projects

Over the last few years a number of very exciting EOC projects have produced many valuable resources and have had widespread impacts throughout the IPY and around the globe. In an effort to gather information about IPY-focused EOC efforts the international EOC assessment committee has developed a short online survey.

This survey is designed to gather information regarding all EOC activities that occurred during the latest IPY, whether they had formal, informal, funded or voluntary connections to IPY. This information will help inform the numerous funding agencies, projects and interested parties to help us continue to collaborate effectively, share resources, maintain the momentum of the IPY effort and inventory the efforts by educators, communicators, researchers and the many others to engage the public in this highly successful scientific event. The survey is project specific and is an inquiry about your project's goals, successes, challenges, resources you have generated and future plans.
Please take the time to read the questions and the following instructions carefully.

The survey will take approximately 10 to 15 minutes to complete. If you have multiple EOC projects please complete a survey for each project. When you finish the survey your information will be saved and you will be taken to the beginning to allow you to complete the survey for another project. The program saves your responses throughout the survey so you can return to complete it at a later time if needed.

If you would like to receive a copy of the final report, please provide your email address at the end of the survey.
If you encounter any problems or have concerns please contact the project coordinator at: ipy-outreach@apecs.is.

1. Project name

Project name

2. Project leader

Project leader Name (title, first, last)

Institution

3. Please provide a short description of the project.

4. What type of audience did your project focus on?

- ☐ local
- ☐ regional
- ☐ national

international

5. Please select the country(ies) in which your EOC project was organized or coordinated from.

6. Please select the country(ies) in which your EOC project is/was based. For international EOC projects, please select all countries where participants and audiences were located.

7. Project duration

Start date Month Year

End date Month Year

8. Project website address: http://

9. List of partner organizations/contributors (please use a comma to separate each partner)

10. What (if any) was the specific field of polar research that your EOC project was working with? (Please select all that apply)

- ☐ Atmosphere
- ☐ Climate change
- ☐ Ice
- ☐ Land
- ☐ Oceans
- ☐ People
- ☐ Space
- ☐ Other (please specify)

11. What geographical range did your project address?

- ☐ Arctic
- ☐ Antarctic
- ☐ Both poles
- ☐ Other

12. Was your EOC project part of a science project?

- ☐ Yes, the EOC was part of a larger science initiative
- ☐ No, the EOC efforts were an independent project

13. Which term best describes your project? (please select one)

- ☐ IPY endorsed science: I had a science project that had an EOC component.
- ☐ Funded IPY EOC project: I had a specific EOC project created and funded during the IPY.
- ☐ Pre-existing, IPY-funded EOC program: I had an EOC project prior to IPY that used IPY funding to expand or continue.
- ☐ Pre-existing EOC program without extra funding: I had an EOC project prior to IPY that used the IPY to gain momentum.
- ☐ IPY-inspired activity: I created an EOC activity that was inspired by IPY.

14. Did you have a dedicated person(s) managing the EOC project?

- [ ] Yes
- [ ] No (please go to question 16)

15. Was the EOC dedicated person(s) someone with education or communication training?

- [ ] Yes
- [ ] No
- [ ] It's complicated

16. Funding for the EOC project was provided by: (please select all that apply)

- [ ] Government agency (e.g. NSF, NSERC, NERC)
- [ ] Institution (e.g. existing institutional budget that went towards EOC)
- [ ] Foundation (e.g. Bill & Melinda Gates Foundation)
- [ ] Non-governmental organization (e.g. WWF)
- [ ] Corporate (i.e. a business or corporation supported the project)
- [ ] Personal (i.e. paid for event or transportation out of personal funds)
- [ ] Other

17. How much were the overall costs for your EOC project or activity?

18. Which of the following options best describes how your project chose its EOC activities during IPY? (please select all that apply)

- [ ] Part of an existing polar EOC program
- [ ] Part of an existing non-polar EOC program that was expanded
- [ ] Expanded an existing EOC link with an educational institute
- [ ] We/I identified an EOC gap and created a program
- [ ] Was approached by a museum/institute/facility to collaborate
- [ ] Was approached by a local classroom teacher
- [ ] Was approached by a IPY-endorsed program to collaborate
- [ ] Was approached by a non IPY-endorsed program to collaborate
- [ ] We/I approached a museum/institute/facility to collaborate
- [ ] We/I approached a local classroom teacher
- [ ] We/I approached an IPY-endorsed program to collaborate
- [ ] We/I approached a non IPY-endorsed program to collaborate
- [ ] Engaged an EOC professional to aid in EOC development
- [ ] Other (please specify)

19. Which target primary audiences took part in the different activities of your EOC project? (please select all that apply)

- [ ] Early childhood education (generally children aged less than 4 years)
- [ ] Primary/Elementary school students (generally aged 4-10 years)
- [ ] Secondary/High school students (generally aged 11-18 years)
- [ ] Tertiary Education (University or College, undergraduate students, generally aged 18+ years)
- [ ] Graduate students and Post Docs
- [ ] Arctic community organizations and residents

- [ ] Community organizations
- [ ] General Public
- [ ] Government
- [ ] Indigenous groups
- [ ] Media
- [ ] Residents of polar research area
- [ ] Youth groups
- [ ] Other (please describe)

20. Please estimate how many people you reached, overall, with your EOC project

- [ ] < 100
- [ ] 100-499
- [ ] 500-999
- [ ] 1,000-9,999
- [ ] 10,000-49,999
- [ ] More than 50,000
- [ ] More than 1 million
- [ ] I am unable to estimate how many people were reaches with this activity/event

21. Did you or any other individual or organization conduct any formal evaluation or assessment of your program with your participants?

- [ ] Yes
- [ ] No

22. What types of EOC events or resources resulted from your project? Please select all that apply to your project and the associated information for each. (For materials available in multiple languages, please use a new line for each language)

Resource or event	Language	Availability

23. Will your IPY EOC project continue after IPY?

- [ ] Yes, all
- [ ] Yes, parts of it will
- [ ] No
- [ ] It's complicated (please explain)

24. In general, will your institution/group continue to do EOC?

- [ ] Yes, all
- [ ] Yes, parts of it will
- [ ] No
- [ ] It's complicated (please explain)

25. In general, did your institution/group do polar EOC previous to the IPY?

- [ ] Yes, regularly
- [ ] Yes, on occasion or as needed
- [ ] No
- [ ] complicated (please explain)

26. In general, will your institution/group continue to do polar EOC?

- [ ] Yes, all
- [ ] Yes, parts of it will
- [ ] No
- [ ] It's complicated (please explain)

27. What were the most valuable lessons learned and challenges from your IPY EOC work?

28. What additional support could you have used to assist you with your IPY EOC project? (Please select all that apply)

- [ ] Partner meetings
- [ ] EOC related workshops/conferences
- [ ] EOC training
- [ ] Listserves/distribution lists/EOC networks
- [ ] Information on other projects
- [ ] Other (please specify)

29. Is your EOC material archived?

- [ ] Yes
- [ ] No

Not yet, I need somewhere to archive it

30. Did you present your EOC activities at the following conferences, publications or meetings? (Please select all that apply)

- [ ] Conference/workshop
- [ ] Journal
- [ ] Report required by the funding agency
- [ ] Did not present or report on our EOC

31. Would you like to receive a copy of the final report once the survey results are compiled?

- [ ] No
- [ ] Yes (please provide your email address)

APPENDIX B

List of countries where IPY EOC was reported

All of the countries listed below had at least one activity indicated in the Polar Outreach catalogue. This list was used to create a map of IPY EOC countries (can be found in Chapter 1, Figure 3) of this report.

Argentina
Australia
Austria
Bahrain
Belgium
Brazil
Canada
Chile
China
Colombia
Republic of Congo
Cuba
Cyprus
Czech Republic
Denmark
Ecuador
Estonia
Ethiopia
Faroe Islands
Finland
France
Germany
Greece
Greenland
Guatemala
Guinea-Bissau
Hong Kong
Iceland
India
Ireland
Italy
Japan
Kenya
Republic of Korea (South)
Latvia
Liberia
Liechtenstein
Luxembourg
Malawi
Malaysia
Mexico
Monaco
Morocco
Mozambique
Netherlands
New Zealand
Nicaragua
Norway
Pakistan
Palestinian Territory
Peru
Poland
Portugal
Russian Federation
Saint Lucia
Serbia
Singapore
Slovak Republic
South Africa
Spain
Sri Lanka
Sweden
Switzerland
Taiwan
Tanzania
Thailand
Turkey
Ukraine
United Kingdom
Uruguay
USA
Uzbekistan
Zambia

APPENDIX C

Project outlines for in-depth IPY EOC studies

Project A – Examining polar outreach efforts during the IPY in polar and non-polar countries

Both Portugal and Norway had extensive, documented and widespread national outreach programmes during the fourth IPY that included numerous events from classroom activities to public exhibitions. As a result of these extensive polar outreach programmes in both countries, questions that address how students and the general public were impacted by the IPY can be assessed. Surveys could be used to assess student experiences in schools where programmes were conducted and be distributed to membership lists from museums where polar exhibits were displayed. Survey results could then be used to assess how these two groups were impacted by different events and programmes. By comparing results between Norway, a polar country, and Portugal, a mid-latitude country where polar regions may be out of sight and out of mind, could inform how global science outreach efforts need to be focused in different regions.

Project B – Active versus interactive polar learning experiences

Several IPY outreach initiatives engaged students in active learning through expeditions to the poles. Students on Ice and Students on Board are two programmes that took students to the poles during the IPY not only to learn about polar topics but also to experience them first-hand. These programmes represent a large investment in hands-on learning experiences, with the limitation that these experiences are available to only a small number of students due to cost and logistics. In contrast, a number of programmes actively involved students in polar topics through live interactive events that connected classrooms with people living and working in polar regions. Although this experience is not as experiential as being there, it does have the ability to engage many classrooms from around the world at the same time, with only a fraction of the cost of an expedition. These two types of outreach activities balance cost of participation with number of participants. By comparing these types of IPY outreach programmes, one could study these trade-offs and their effects on student experience. An examination of the impacts on students who participated in these programmes could help inform science outreach managers on how to best balance outreach efforts with these two approaches.