How to Produce Translational Research to Guide Arctic Policy

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Integrating scientific knowledge into the formation of policy is always a challenging exercise in translation. In the Arctic, there is an urgent need to accelerate this process as the region undergoes rapid physical and environmental change—at rates faster than the rest of the globe (Kwok and Rothrock 2009, Comiso 2012). Changing temperatures, sea ice, winds, and currents already affect the complex Arctic ecosystem and will continue to do so (Post et al. 2013). But these changes are also altering the way the world is looking at the Arctic. On a grand scale, retreating sea ice is forming a new ocean, revealing opportunities for economic and political gains, including new shipping routes; new fisheries; and access to oil, gas, and mineral deposits (Laursen 2015, Kintisch 2016).

Arctic governance is adapting to these dramatic changes, but governance decisions will be steered only by the most rigorous and up-to-date scientific understanding if scientists engage in a sustained and consequential manner. For science to play a central role in the formation of robust policies, it must be part of a cyclical, iterative exchange. In the same way that pressing human-health problems require an integrative bench-to-bedside exchange, termed translational research, Arctic scientists must understand policy considerations and engage in the adaptive management stages of policy review and revision, not solely problem description and data delivery. The mode and style of engagement also matters (Gewin 2014). The publication of policy-relevant findings in scientific journals does little to ensure that such findings will inform policy. Not all scientists may wish to engage in the policy arena, but for those who do, such engagement not only increases the impact of one’s research but also exposes scientists to the policy objectives that often guide funding initiatives, increasing awareness of opportunities to fund timely and consequential research.

To accelerate translation, we (a) summarize why the need for policy engagement is particularly pressing in the Arctic right now, (b) outline key emerging policy challenges as well as scientific investigations needed to address them, and (c) offer guiding principles for turning research on the Arctic into translational research for the Arctic.

Policy engagement: A clear and pressing need in the Arctic
First, the landscape of Arctic policy is arguably more multidisciplinary than most environmental policy areas. Creating responsible management in the Arctic requires knowledge from a vast array of scientific disciplines and therefore from a vast array of scientists. Second, the multidisciplinarity and international nature of Arctic issues has created a complex and diverse set of scientific and governance bodies that make it challenging for scientists to know where to offer their expertise and for policymakers to access scientific results (refer to supplemental figure S1 for a summary of international Arctic governance bodies). The Arctic Council (AC) and the International Arctic Science Committee (IASC) have working groups dedicated to scientific assessments, but their productivity depends on the volunteer service work of governmental and academic scientists. The utility of these working-group products depends on the alignment of the questions the policymakers are asking and the questions the scientists are answering—but specific objectives and questions are not always coordinated between these groups at the outset. Third, the magnitude of Arctic change and its urgent consequences for social preparedness have created a valuable focus on long-term strategic planning within the policy realm (Stoessel et al. 2014). We argue that this focus better aligns with the timescales of research and prediction, providing an opportunity to increase scientific visibility and policy impact at a crucial time. Finally, there is a surge of activity within the policy realm to support and elevate science (box 1). Policymakers are asking how they can support and incorporate science more readily into policy processes. Scientists should ask how they can make their research most informative to decisionmakers and take action.

Emerging policy challenges and scientific needs
The scope of climatic, physical, and socioeconomic changes brings a myriad of challenges to the highest levels of political attention internationally, many of which are data poor. Here, we summarize three emerging issues that require substantial and immediate scientific research and interdisciplinary collaboration. We offer these as brief examples to demonstrate the types of information required by policymakers and the complementary research that is needed from the scientific community (figure 1).

Arctic fisheries. In 2015, Canada, the United States, Russia, Norway, and Denmark signed an Arctic Fisheries Agreement to prevent unregulated
commercial fishing in the high seas of the central Arctic until there exists sufficient scientific knowledge on which a responsible management plan can be based. Despite a lack of knowledge of the region or the economic potential of such fisheries, commercial interest is substantial. It is likely that development of an international mechanism for the regulation of commercial fishing will proceed in the coming years. Therefore, scientific information is needed on these ecosystems of interest, on fish population assessments and the population dynamics of species in the region, and on fisheries oceanography and forecasting.

Black-carbon and methane emissions. Recognizing the strong contribution of short-lived pollutants to global warming and the impact of black-carbon deposition on sea-ice melt, the AC adopted the Framework for Enhanced Action to Reduce Black Carbon and Methane in 2015 (Arctic Council 2015). The framework requires Arctic states to submit biennial reports detailing national inventories, actions to reduce pollutants, and projections when available. The framework also established an Expert Group to synthesize the national reports and propose a collective quantitative goal for year 2025 emissions. Although many countries submitted reports, national inventories were not all comparable, delaying collective accounting or goal setting (EGBCM 2016). In addition, not all countries were able to generate national projections. Therefore, critical initial steps remain, including the harmonization of emission calculations and projection methods. Beyond these foundational scientific requirements, a greater understanding of source-specific adaptation benefits and impacts of emissions on Arctic ecosystems is needed.

Arctic Ocean acidification. Of the three issues presented here, ocean acidification is the most data poor and remains in the assessment and research stage, with no concrete policy action yet developed. The AC working group, the Arctic Monitoring and Assessment Programme, published the Arctic Ocean Acidification Assessment in 2013 and is including acidification in the project Adaptation Actions for a Changing Arctic, an integrative impact assessment focused on three marine and terrestrial pilot regions (AMAP 2013). There is strong political interest in establishing pan-Arctic monitoring, the development of region-specific projections, and the integration of carbonate monitoring with other key biophysical variables. These are clear next steps for the research community to execute.

Recommendations for executing translational Arctic research

The fundamental restructuring of Arctic science policy is still ongoing. Policymakers are in the middle of discussions to evaluate existing governance structures and their suitability in light of rapid environmental change. Efforts are underway to strengthen the Arctic Council, because it is currently a nonregulatory forum, and the possibility of a United Nations Regional Seas Programme is being considered as a management tool for the Arctic Ocean. Given these transitions and the multitude of Arctic governance structures and Arctic scientific bodies that exist, we do not recommend the creation of a new forum, nor do we wish to propose overly ambitious policy prescriptions. Rather, we offer three concrete principles that scientists can readily implement in their professional capacities to help the scientific community produce translational research to affect policy decisions in the immediate future.

The first principle addresses scale of research effort and investigation. As Arctic researchers are well aware, the cost of each observation is high, and resource demands are often too vast for any one nation (Arctic Council SAO 2015). Moreover, the most pressing environmental issues and the most urgent ones for policymakers are equally transboundary in nature (Kintisch 2015). Consequently, the recently negotiated legally binding ad referendum Agreement on Enhancing Arctic Scientific Cooperation was a top priority for the Arctic Council and...
stands to positively affect scientists’ ability to collaborate internationally for decades to come (supplemental table S1). Although international cooperation agreements are hard won in the policy realm, especially regarding the creation of shared international funds, international science cooperation is now commonplace (e.g., international coauthorship has increased over 400 percent between 1985 and 2007; Hormats 2012). When policy conversations stall because of national agendas, scientific progress can often continue, making international research collaborations a critical diplomatic tool for political and scientific progress. With policymakers promoting international scientific coordination, it is crucial that scientists continue to work with colleagues across both Arctic and non-Arctic nations.

The second principle focuses on a logistical hurdle in Arctic research. There is an increasing need for data harmonization to leverage individual contributions into more cohesive international assessments and studies. This idea is not new: At the close of the first International Polar Year (1881–1884), scientists remarked on this same problem, reflecting that a greater synchrony of measurements would lead to more robust understanding (Kintisch 2015). Although harmonization should be feasible today given the prevalence of digital data platforms, the absence of harmonization continues to delay and depress the potential value of the collective research and monitoring efforts in the region, as was
recently demonstrated by the lack of comparability between national black-carbon inventories (EGBCM 2016). Although data sharing among governments is often nonnegotiable because of national security concerns, scientists must advise and implement data harmonization and coordination from collection to deposition. There already exist various national and international data portals and networks focused on Arctic monitoring and research available for scientists to facilitate coordination (table S1). In addition, the outcomes of the White House Arctic Science Ministerial in 2016 should provide further data-sharing mechanisms in the coming years (table S1).

We encourage scientists to consider the potential synchrony of their own data collection with that from across the Arctic, even from the early stages of proposal writing, for both the academic and societal benefits such harmonization could produce.

The third principle that may aid the production of translational research is one of process. Whereas most global environmental problems have been targeted by top-down, integrated approaches (e.g., the United Nations Framework Convention on Climate Change), a growing body of literature suggests that negotiations in the face of uncertainty are better accomplished through decentralized approaches that foster on-the-ground problem-solving and iterative exchange (Parson 2005, DeBurca et al 2014, Sabell and Victor 2015). For example, the Montreal Protocol, frequently cited as one of the most successful global environmental treaties, was effective because of a close connection between technical assessments and regulatory systems (Parson 2012). The negotiation process involved iterative goal setting, repeated review, and the modification of policies, which led to the reduction of uncertainty regarding the environmental impact of regulations and enabled agreement at global levels (Parson 2012).

We posit that a pivotal element of such an approach is the opportunity to collaboratively reframe questions in real time with both decisionmakers and researchers present. These two sets of practitioners inherently ask questions in different ways. In broad terms, scientists wish to know function and mechanisms—framing questions with why and how, whereas policymakers need information to assess trade-offs—questions that begin with what and when. If the lexical and pedagogical differences that exist between these groups are not compensated by increased interaction and exchange, the information delivered is not always the information needed for decisionmaking and solution implementation. Consequently, we urge scientists to engage directly and iteratively with policymakers so that the questions asked, the format of the information delivered, and the potential for review and modification can help reduce uncertainty in the development and international adoption of sound policies for the Arctic.

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Supplemental material
Supplementary data are available at BIOSCI online.

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