Supporting a Culture of Safety in Arctic Science

Workshop Report: Arctic Field Safety Risk Management

Renée Crain, Kristina Creek, and Helen Wiggins, Editors

Bear tracks, Barrow, Alaska
Photo by John Bleidorn

Acknowledgments

The workshop and this report were supported by a generous grant from the National Science Foundation Arctic Research Support and Logistics Program under Cooperative Agreement No. PLR-1304316. Opinions, findings, and conclusions in the report do not necessarily reflect the views of NSF.

An organizing committee of NSF employees and contractors developed the workshop vision and agenda. Renée Crain and Patrick Haggerty from the Arctic Research Support and Logistics program, along with Jim Karcher from the Polar Environment, Safety and Health section, led the effort; Mike McKibben, Brad Stefano, Alan O'Bannon, and Kim Derry from CH2M HILL Polar Services and Dr. Jennifer Mercer from ALEX-Alternative Experts made valuable contributions to organizing the workshop. Dr. Mercer made essential contributions to the data presented in this report.

We thank all attendees for their time, ideas, expertise, and energy during the workshop. We especially appreciate all who gave time to contribute to the creation of this report.

We also thank CH2M HILL Polar Services for their work and expertise in planning the workshop and its discussions, as well as their assistance in developing this report.

Editing, design, and production by APL-UW Communications & Information Services.

Citation

Renée Crain, Kristina Creek, and Helen Wiggins, eds. *Supporting a Culture of Safety in Arctic Science. Workshop Report: Arctic Field Safety Risk Management*. Fairbanks, Alaska: ARCUS, 2015. 39 pp.

Supplemental Online Materials

Workshop plenary presentations, breakout charges, original breakout worksheets, and completed breakout worksheets are available at http://rslriskworkshop.com/workshop-notes.

On the covers

Photos by Erich Osterberg

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Outfitted with the proper safety equipment, Craig Beals works his way to the top of the Swiss Tower, Summit Camp, Greenland.
Photo by Craig Beals
Courtesy of ARCUS

EXECUTIVE SUMMARY

As interest in the Arctic increases, so too does the need for information about this area of the world. Scientists, policy makers, industry, non-profits and federal agencies require greater access to the Arctic and more data to address questions of national and global importance. Despite the use of remote sensing and autonomous technologies, the need to conduct field research in the Arctic in remote locations and under extremely cold and otherwise dangerous conditions cannot be avoided. Rather than avoid the risk of arctic fieldwork, it is incumbant upon all parties — researchers, industry, federal agencies, non-profits and others — to manage and mitigate risks of fieldwork. The field of safety risk management, when applied to arctic fieldwork, reduces the risks of fieldwork to acceptable levels.

The National Science Foundation (NSF) Arctic Research Support and Logistics (RSL) program held a workshop in February 2014 to discuss improvements in arctic field safety risk management. The workshop brought together 53 logistics support providers, researchers, risk management experts, and agency representatives to:

- Discuss current NSF and RSL program risk management policies and procedures
- Explore other federal agency and personal field risk management approaches
- Increase research community engagement in risk management, including participation at the research institution level
- Initiate a *Community of Practice* for arctic field safety risk management

The workshop covered an array of risk management topics including past incidents and trends, identifying risks, planning for and mitigating risks, the institutional role in risk management, available resources and training, firearms safety, research vessel safety, and physical qualifications for arctic research. Through two days of plenary discussions and breakout groups, recommendations and best practices emerged within the following categories:

- **Risk Identification and Assessment**
  Implement a simple, flexible process to identify and assess risk that can be used by all disciplines and institutions
- **Institutional Risk Management Office (RMO)**
  Encourage communication between RMOs and researchers/research teams to make use of their expertise and tools, such as 24/7 emergency call lines, insurance, and tools for assessing and managing risk
- **Crisis Communication**
  Develop a clear communications plan before embarking on research, including emergency contacts and determining who calls family members in the event of an emergency
- **Incident Reports**
  Develop an easy reporting system that enables quick, efficient write-ups of incidents and near misses, then share these widely so that others may learn
- **Training and Mentorship**
  Implement mechanisms for experienced scientists to train and mentor early career researchers
- **Community of Practice**
  Develop and sustain a network of people among the many arctic institutions and agencies to share knowledge, experience, and best practices

This report includes several additional, more specific recommendations within these topics. In addition, over the course of the discussions, two consistent themes emerged:

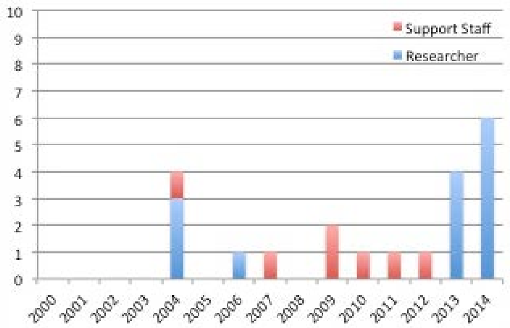
- Risk management needs to be fully integrated within the arctic research culture. Researchers should consider risk management an integral part of the research process, starting at the proposal stage and continuing throughout the life of a project. Processes and protocols should be adopted only if they make concrete improvements in the field. This report explores options to ensure that changes are not just cosmetic, but rather includes ways to work through potential risks prior to and during fieldwork.

- There is a wealth of safety risk management information and knowledge already available throughout the community. Researchers and those who support research need improved systems to share this information, particularly between experienced field scientists and early career researchers. It is essential that researchers learn from the mistakes and successes of others.


Photo by Erich Osterberg

Returning safely is a primary focus of those leading research teams into the field, though this receives little attention compared to the goals of research. This workshop report provides a framework for the discussion of field safety risk management. The workshop website and several others listed as references provide tools and focal points for the ongoing discussion about managing risks in the field to appropriately support a culture of risk management in the Arctic without becoming a distraction from the research.

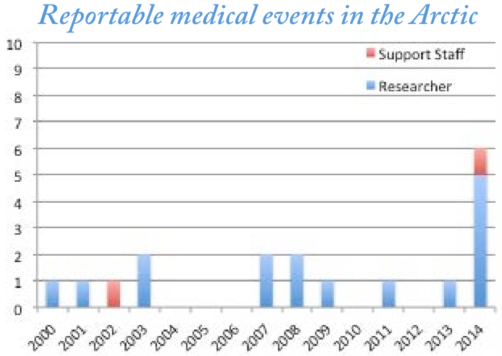
Reportable injuries in the Arctic



Approx. 1/3 of injuries occurred in Alaska, 1/3 at Summit Station in Greenland, and 1/3 elsewhere in Greenland.

- Helicopter crashes—two fatalities, three minor injuries
- Two crevasse falls
- Bug bites
- Slips, falls, pinches, lacerations
- Broken tooth
- Cold exposure

Reportable medical events in the Arctic



Medical events were equally split between Greenland and Alaska; a few occurred in other arctic locales.

Numerous unreported altitude issues at Summit Station, Greenland prior to 2014 are not included in these data.

NSF's operational entities are called upon for approximately one search and rescue (SAR) assist per year for non-NSF-program personnel (e.g., tourists).

- Four cardiovascular events—one fatality (not a researcher)
- Appendicitis
- Dental issues
- Altitude sickness at Summit Station

Data collected by CH2M Hill Polar Services

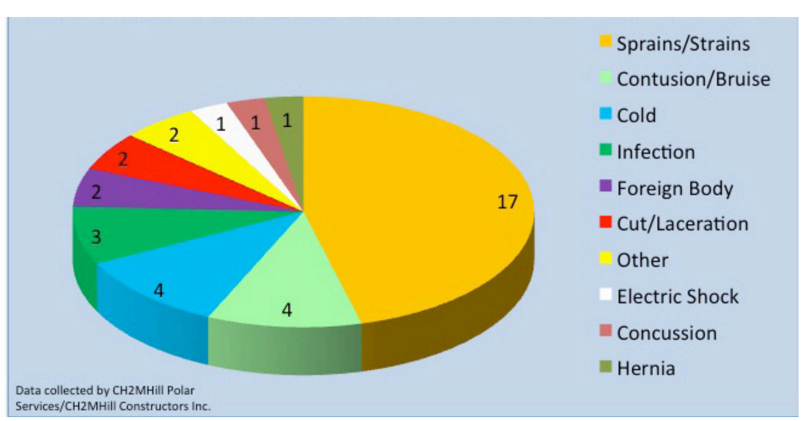
INTRODUCTION

Arctic field researchers work in an inherently risky area of the world. The Arctic's remoteness and natural hazards present many opportunities for accidents, injuries, and illnesses, and therefore many challenges in terms of safety risk management. We are familiar with safety risk management in an area such as transportation, where standards are set and enforced by policy. Seatbelt laws and speed limits are meant to reduce injuries and fatalities in the event of an accident. Such policies are the result of data on the likelihood of an accident occurring and the severity of the injuries, where seatbelts and slower speeds significantly improve the outcomes of an accident. In arctic field research increased dialogue about risk management will help reduce the likelihood of some incidents and improve the outcomes when accidents happen.

Risk management is a decision-making process undertaken before, during, and after field expeditions. Risk is the product of the likelihood of an event and the impact of its occurrence. The process of risk management includes identifying risks and estimating the likelihood of their occurrence, understanding a person's or organization's tolerance for risk, and reducing, mitigating, or accepting risk. Following a field season it is important to review near misses and areas for risk management improvement, and to suggest, if supported by data, procedures or policies that standardize risk management so that others can benefit from the process.

In the Arctic more than one hazard or risk is likely to be present at a time. Cold, remoteness, and bad weather, when taken together, may increase the likelihood of someone becoming hypothermic and getting frostbite while also delaying their rescue. Because of the complex interplay of risks and the variety of options to reduce, mitigate, or avoid risk, risk management is most effective when people work together through the process. In some cases the risk management process is documented, with the analysis, evaluation, and elimination of risk written into a risk reduction plan. The field of risk management and our collective expertise and experiences can offer many approaches that, if applied systematically, may reduce the frequency and impact of field incidents.

Types of injuries in the Arctic, 2010–2013



About the Workshop

To support discussion of arctic field safety risk management, the Arctic Research Support and Logistics program funded a workshop held 3–4 February 2014. RSL program managers Renée Crain and Patrick Haggerty organized the workshop in coordination with the NSF Polar Environment, Safety and Health section and the RSL services contractor, CH2M HILL Polar Services (CPS). The 53 participants (Appendix A) were selected to represent researchers from a broad cross-section of disciplines, career stages, and institution types; support providers; safety and risk management experts; university risk managers; and agency representatives. The workshop focused on four goals:

- Discuss current NSF and RSL program risk management policies and procedures
- Explore other program and agency field risk management approaches
- Increase research community engagement in risk management, including participation at the research institution level
- Initiate a *Community of Practice* for arctic field safety risk management

The agenda (Appendix B) included topical plenary presentations, focused breakout groups, and a facilitated tabletop activity to build and share knowledge in the field of risk management. After an introduction to NSF and RSL risk management policies and strategies, the workshop began with a presentation by Matthew Sturm on "Common Sense and Sanity in Safety in Arctic Field Research." Stanley Love of NASA shared the perspective of managing risk in human space flight, which opened the door to discussing the culture of risk management and the importance of sharing incidents or near misses (injuries that nearly occurred but did not) so that others may learn. Jim Karcher of the NSF Polar Environment, Safety and Health office shared statistics on the rates and types of accidents and injuries that occur in the Arctic and Antarctic programs. Robert "Max" Holmes shared his experiences with a medevac from his project in the Russian Far East.

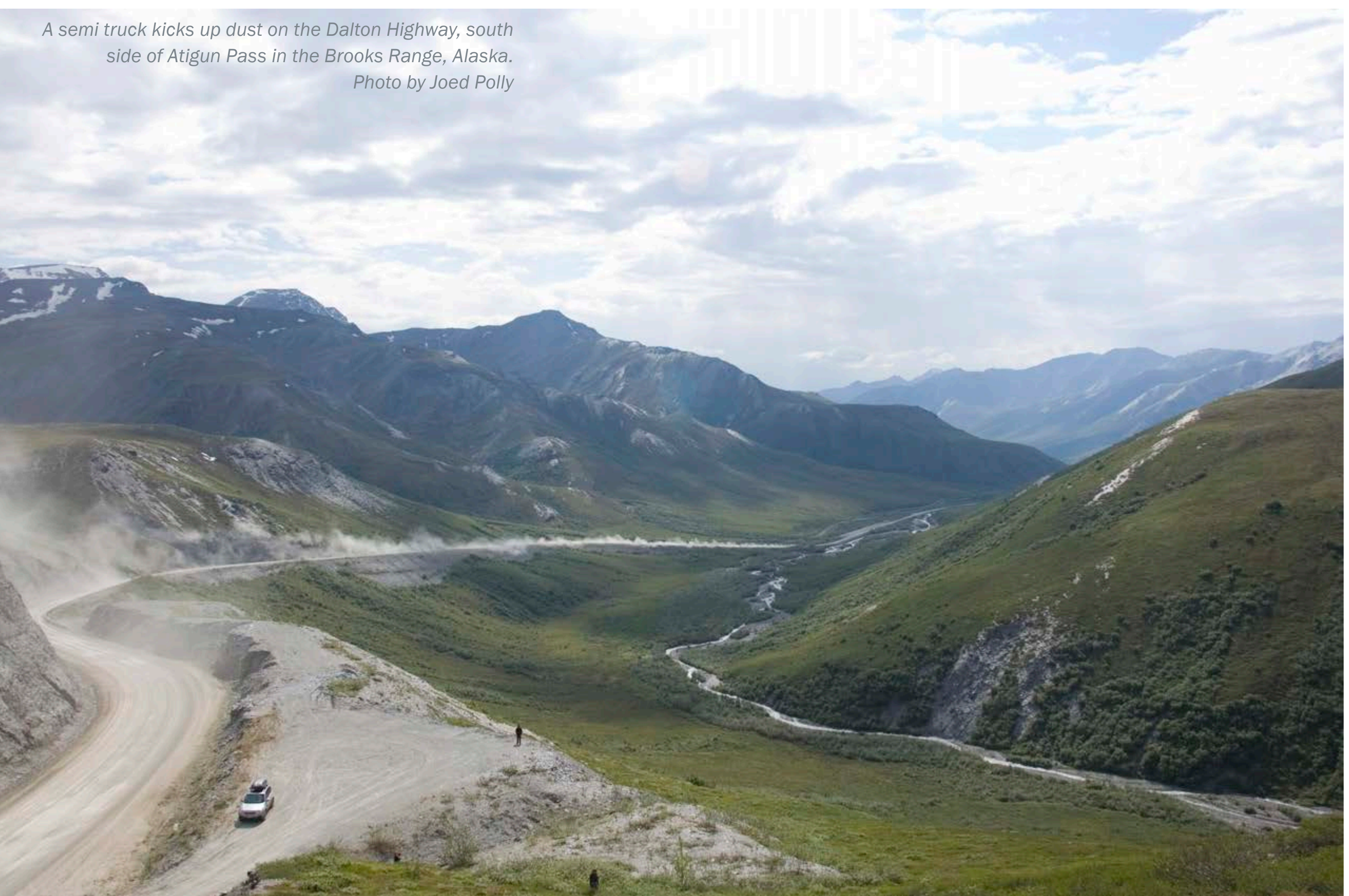
Near Misses (incidents with no injuries) in the Arctic since 2000

- 3 aircraft incidents
- 2 crevasse falls
- 6 bear incidents
- 4 truck incidents
- 3 boat incidents
- 5 snowmobile/ATV incidents
- 4 unintended camps
- 2+ unsafe conducts
- Several fire incidents

Workshop participants heard about firearm safety, risk management on research vessels, and risk management at NOAA and NASA. One presentation explored the importance of researchers involving their institutional risk management offices in the development and execution of their field plans. The agenda moved on to identifying and analyzing hazards in arctic field research, managing the highest risks before, during, and after fieldwork, the roles of the PI, team members, and support organizations in risk management, and communication. Presentations and discussions then focused on responding to situations — the tools and resources of the field team, support providers, sponsoring institutions and the role of the funding agency. A tabletop activity facilitated by John Gookin of the National Outdoor Leadership School (NOLS) allowed participants to work through an incident, practicing and sharing their skills. NSF presented the policy on requiring researchers to qualify physically for field research, and the CPS health and safety team presented a review of the risk management tools and training available through the program.

How This Report is Organized

This report documents the salient workshop discussions for those who were not able to attend and provides a reference point for future discussions. The report presents current practices and policies in arctic field safety risk management, identifying and assessing risk, utilizing institutional risk management offices, crisis communication, incident reporting, training and mentorship, and a community of practice. Furthermore, this report is intended to serve as a basis for further discussion and progress on risk management for arctic research. Though the workshop and report were funded by NSF, the improved safety risk management practices discussed and reported here are applicable to any program with research endeavors in the Arctic.



A semi truck kicks up dust on the Dalton Highway, south side of Atigun Pass in the Brooks Range, Alaska. Photo by Joed Polly

ARCTIC FIELD SAFETY RISK MANAGEMENT

Current Practices and Policies

Safety risk management is the practice of evaluating potential problems before they occur in order to plan ways to circumvent the situation altogether or, if it is unavoidable, mitigate potential consequences as much as possible.

The possible risks in arctic research are numerous, and include field safety risks for individuals (e.g., crevasse falls or cold temperatures), risks for organizations (e.g., liability or personnel loss), risk to the environment (e.g., fuel spills or damage to tundra), and risks for science (e.g., equipment failure or data loss). The workshop focused on field safety risks to individuals and how this relates to organizational risks.

Risk = Probability x Impact

Risk management — the identification, assessment, and mitigation of risk — is an inherently imperfect practice, but can be highly effective when approached systematically. This requires the right stakeholders (e.g., researchers, field experts, risk management personnel) providing an analysis of risks or hazards present and evaluating how to reduce them, avoid them, and what level of risk to accept. The dialog should start during the planning stage of the project, continue during fieldwork, and follow up afterward to highlight any lessons that can be applied in the future.

Risk management is an iterative process, because situations and conditions change. No one person sees all risks and approaches to managing risk. Not all individuals have the same tolerance for risk. Therefore, risk management is better done collaboratively to include the experience and expertise of many people through the planning, execution, and closing of the project.

The right time to engage in risk management is all the time. During project planning, risks and strategies to avoid or manage them should be identified. In the field, risk management is commonly performed daily as team members receive or review their tasking for the day. In many disciplines the plan of the day is discussed in the morning before work begins. The plan is reviewed and in some instances risk is assessed by the group using a scoring or rating technique for specific activities. There should be an assessment at the end of a project to gather information from team members about activities that seemed risky or resulted in accidents or near misses.

A single, rigidly structured risk management process will not fit all situations. The process works best when its affiliated rules and requirements are flexible enough to accommodate the broad array of situations, field programs, and remote sites. The wide diversity of arctic science requires adaptable methods for safety risk management that do not result in undue burden on the research community.

USING A SMALL BOAT: A HYPOTHETICAL RISK ASSESSMENT IN THE FIELD

To conduct a risk assessment for using a small boat, the first step is to capture the identifiable hazards in a list (weather, size of the swells, experience of the operator, experience of the team, and landing conditions, etc.). The team meets to consider these risks in the context of the operation, including factors such as the impact of an accident, the time to rescue, and the distance to medical care.

The team leader then goes down the list one at a time, and all team members rate both the likelihood and potential severity of each hazard with a score of 1–5 (low to high risk). This can be done either vocally or by holding up fingers. The leader takes the highest risk number (not the average or the median) for the likelihood, and the highest risk number for the potential severity, and adds them together. People can then speak briefly about why they assigned that rating. This is not a time to argue, but to capture the risk assessment information.

After each hazard has been scored, they are all added together to get the total risk number for the activity (in this case, a small boat voyage). The total is then compared to an established risk score, such as a GAR (Green, Amber, Red), where a total score of 5–10 may be Green, 11–18 Amber, and 19–25 Red. Based on the GAR score, the group can accept the risk, choose to mitigate the risk (for example, by assigning a more experienced boat operator, choosing to land in a less difficult location, or postponing the activity until the weather is more favorable), or, in a worst-case scenario, cancel the planned activity.

This type of systematic risk assessment can be applied to many activities in arctic research, from tower climbing to tundra walking, from glacier travel to sea ice operations. Researchers can talk with their institutional risk management offices, experienced safety experts, and support providers to work through this type of analysis tool for specific field activities.

A back deck safety meeting with all of the science parties aboard the R/V Nathaniel B. Palmer in the South Atlantic Ocean. Photo by Katie Pena (PolarTREC 2008/2009) Courtesy of ARCUS

Safety Risk Management at NSF

NSF policy is clear that risk management and the activities performed under a grant are the responsibility of the grantee institution.[1] At the same time, the NSF Arctic RSL program strives to provide researchers with the tools and knowledge needed to work effectively in extreme environments. One of the goals of the RSL program is to improve safe access to the Arctic.

The RSL program funds a service contractor to support NSF-funded researchers in the field, including providing risk management services and tools to the NSF-funded arctic research community. For contractors, the responsibility for risk is shared between NSF and the contractor and is governed by contract language.

The current contractor, CH2M HILL Polar Services (CPS), provides a variety of tools and services. Resources specific to risk management are available on their website. Offerings include "Know Before You Go," a short list to help scientists plan the administrative side of fieldwork (e.g., standards of practice for taking students into the field, emergency notifications, financial responsibility for search and rescue). Compiled by NSF RSL managers and CPS field risk experts, "Know Before You Go" helps field leaders and PIs plan beyond field gear and science instruments. Scientists can download related documents such as the "Field Emergency Action Plan" to prepare for emergencies. The CPS site also describes field training courses offered by CPS and other parties. It includes resources such as environment-specific clothing lists; suggestions for what to pack in survival bags, medical and first aid kits; and information on boating safety, making weather observations, avoiding bears in the field, and more. CPS adds information and resources as they are discovered or requested, and is always open to ideas from the arctic community.

CPS engages with researchers during field planning and works with the research team leaders to identify risks and potential mitigation strategies. A risk assessment is included in the field season plan for projects supported by CPS. This plan should be circulated among all the field team members, from senior personnel to undergraduates, to ensure that everyone on the team is aware of the risks and mitigation measures. CPS also provides communication devices, access to a telemedicine service, medical kits, and other tools for use during the field expedition. Following the field season, CPS requests information about risks the project encountered, incidents or near misses, and input on whether these things could be avoided in the future.

National Science Foundation Arctic Research Support and Logistics:

http://www.nsf.gov/geo/plr/arctic/res_log_sup.jsp

http://www.arcus.org/logistics

CH2M Hill Polar Services:

http://cpspolar.com

contact: FieldRisk@polarfield.com

[1] National Science Foundation. "Award and Administration Guide," *Proposal and Award Policies and Procedures Guide*. Washington, D.C.: National Science Foundation, 2014.

Why Arctic Researchers Get in Trouble

- *Lack of field experience*
- *Pushing the limits*
- *Being complacent or cavalier*
- *Dumb bad luck*

–presented by Matthew Sturm and amended by workshop participants

A WET SNOW MACHINE ON THE TOOLIK RIVER

We were snowmobiling on a remote section of the Toolik River in late November 2001. It was dark and about –40°F. The day was closing and we were tired and wanted to get to a spot we thought was going to be a good camp. I was leading, and came to a curving cutbank with lots of snow-covered shrubs hanging over the riverbank. Just below this was some open water that was perhaps 6" deep. Not wanting to get my track wet and icy, and not thinking, I stayed on the outside corner, in the deeper snow on ice. But right under the willows there was no ice, and the rear of the snowmobile dropped into about 4 feet of water. Thankfully, the skis hung up on a thick ice edge.

So at this point, we have a big screw up due to a) rushing, and b) not stopping to camp when we were already worn out and brain dead. The embarrassing thing is that I am an expert on the insulation properties of snow. I should have known that under that bank with its deep snow, the ice was going to be thin.

For the rest of the event we did the right thing: I jumped off the machine and cut my pack (and sleeping bag) from the back of the machine before they got wet. We told one of our cohorts to get a lantern going right away and start making camp, and we slid on our stomachs up to the skis and were able to ascertain that they were on pretty solid ice. Then we rigged a series of ratchet strap come-alongs and ever so gently winched the machine up until the track engaged...then drove the machine while winching until it was out of the hole. Lastly we sunned the track for about 20 minutes to clean out all the slush and ensure that the next morning the machine would not be frozen up solid.

The prime mistake: Trying to push too far, too fast, with dark approaching
The contributing mistake: Probably day-dreaming and fatigue

— Matthew Sturm, PhD
Geophysical Institute, University of Alaska Fairbanks

IDENTIFYING AND ASSESSING RISK

Different Perspectives on Risk

People on the project are both its greatest asset and its greatest vulnerability. Human error is often to blame for catastrophic events. At the same time, the experience and attitude of field team leaders and members are the best tools for managing risk during all stages of the project. Different team members will have unique experiences, expertise, comfort levels, and approaches in terms of risk management. The most experienced team member is not necessarily the safest and the least experienced is not necessarily the riskiest. There are vulnerabilities at any stage — early career scientists may not have enough first-hand knowledge to warrant proper caution, while late career researchers may be complacent or worse, cavalier. Often the questions asked by newer members of the team will remind the senior members about the risks involved. Including all team members in the assessment and management of risk is the best way to ensure that all concerns are addressed.

Risk Assessment at the Research Proposal Stage

Identifying and assessing the risks of a given project should begin at the proposal stage and continue through each step of field research. There is no substitute for a research team's in-depth safety risk management discussions. Participants recommended that safety risk management be a mandated, formal part of the proposal approval process that continues throughout the development of the project. A risk management plan could be included as a separate supporting document similar to the data management plan or postdoc mentoring plan. The initial risk assessment could be described in the main body of the proposal with the description of the field research to be conducted. Including this step in the proposal process encourages researchers to put specific thought into the issues of field safety. It ensures that the proposer is developing a plan and accepts that part of the planning process, and that execution of the project includes managing field safety risks for all team members.

WORKSHOP PARTICIPANTS RECOMMENDED THAT SAFETY RISK MANAGEMENT BE A MANDATED, FORMAL PART OF THE PROPOSAL APPROVAL PROCESS THAT CONTINUES THROUGHOUT THE DEVELOPMENT OF THE PROJECT.

THE NATIONAL SCIENCE FOUNDATION OR CH2M HILL POLAR SERVICES COULD CONSIDER PROVIDING A SIMPLE CHECKLIST OF SAFETY RISK MANAGEMENT PLANNING TOOLS AND THEIR COSTS.

Also at the proposal stage, researchers should ensure that the proposal budget contains any costs involved in safety risk management. These costs may include training/education; shakedown expeditions — practice runs with equipment to ensure the necessary type, quantity, and familiarity with use; reconnaissance visits to the field; compliance; permissions; foreign clearances; insurance; and communications devices. NSF or CPS could consider providing a simple checklist of safety risk management planning tools and their costs, if any.

Mitigating the concerns of individual team members is best achieved by approaching the process of risk management as a group. Workshop participants utilized this technique during the first breakout session, working together to assemble a list of the hazards and risks associated with various research platforms (Table 1). It is imperative that risk management not fall to just one person. The entire research team must be involved in the process of examining the project to assess all of the potential hazards. Though each individual is responsible for their own safety, each team member is also responsible for the other team members. This is particularly true when novice researchers who may not have extensive experience or adequate education and training in fieldwork are involved. In these cases, the responsibility for the safety of the team falls more heavily on the PI and other experienced team members. A realistic risk management approach may lead to members seeking out training or adding and/or changing team members to meet the needed skill sets.

Table 1. Results of breakout session #1. Participants divided by research platform and worked together to list each platform's associated hazards and risks. Risk score is on a 1–5 (least – greatest) scale and reported as probability/severity. The table presents representative examples from each breakout group. Complete results are available as supplemental online materials.

Platform	Hazard	Description	Risk Score	Risk Assessment Justification
Aviation	Remote landings	Aircraft sometimes land places they wind up not being able to take off from, forcing an unintended camp	3/5	Happens fairly regularly; small hazard to people but moderate to property and mission.
Remote & Foreign Field Sites	Medical	Injuries, illness, food poisoning, cold-related dangers, altitude sickness	4/3–5	There are frequently minor injuries or illnesses while in the field, which can be exacerbated when in remote or foreign locations.
Marine & River	Swamping	Small boats filling with water, often accompanied by fog and rain (difficult navigation)	5/5	This is a common accident with potentially serious outcomes including death.
Glaciers & Ice Sheets	Crevasses	Encountering large cracks in ice into which personnel and/or gear can slip and fall	4/5	Encountered frequently, usually without incident but an actual incident is most often quite severe.
Terrestrial	Driving	Many potential problems — collisions, driving while fatigued, mechanical failures	5/2–5	Occurs frequently and can range in severity from minor delays to reducing the project scope to serious injury or death.
Cross-platform	Behavioral issues	Staff may disregard safety procedures, or poor morale may lead to behavioral problems	4/4	Issues in long field campaigns can arise, especially in remote areas. Causes various risks to both science and personnel.
Cross-platform	Weather, natural disaster, geographic	Environmental conditions that cannot be controlled, e.g., storms	5/3	Highly likely to occur; generally not too severe unless teams are inadequately prepared for changing conditions.
Cross-platform	Firearms	Necessary in some areas for protection again bears and other wildlife	1/1–5	Incidents are rare, but lack of proper training and experience can result in misfires, improperly kept equipment, or accidents.

GENDER DYNAMICS AND SENIORITY IN RISK MANAGEMENT

When you look back on an incident or near-miss, usually you can find a moment when someone could have spoken up and stopped the chain of events that followed. There are a variety of reasons people don't speak up. Groups have dynamics and sometimes feeling too junior, succumbing to machismo, or not wanting to be the 'wet blanket' plays a role. Each of us, especially in science, is a trained observer and each of us therefore must share our observations with others for the good of the group if we notice something is not right.

I was boating with two friends, both male, one summer day in Alaska. Both were very experienced in the Alaskan outdoors. I was in a dry suit and a kayak. They were in a canoe. At our lunch stop, someone did not re-seal the dry bag with the spare clothes for the two canoeists. When their canoe overturned during the afternoon paddle, both canoeists and their spare clothes were soaking wet. We were still some distance from our take-out, where one vehicle was parked to shuttle back to the put-in. As soon as we righted the canoe and got on the road side of the river, I made the decision to stop paddling and hike to the road.

In my view, both people were headed toward hypothermia and another hour on the river would be fraught with more mistakes, the kind you make when you're cold and tired. Neither canoeist seemed like they were going to make that suggestion, though they did not disagree once I said it out loud. I took two lessons away from this experience: sometimes the person who is not wet and cold has the clearest head, and sometimes people who are suffering from cold, discomfort, and other stressors don't want to be perceived as giving up.

Maybe we only avoided a miserable and cold paddle downstream, or maybe we avoided a call to search and rescue. There are times when ending an activity is better than pushing through to the finish line. After a short portage and retrieving the trucks and boats, we enjoyed a hot drink and lived to paddle again. Speak up when you see or sense that a situation may head in the wrong direction. Fieldwork in the Arctic is a team effort and each person — no matter their level of experience, age, gender, or role on the team — can and should speak up.

— Renée Crain
NSF Division of Polar Programs, Arctic Research Support and Logistics Program

ALL RESEARCH TEAM MEMBERS SHOULD BE INCLUDED IN THE INITIAL PRE-FIELDWORK RISK ASSESSMENT PROCESS AND ENCOURAGED TO SPEAK UP WHEN CONCERNS ARISE WHILE IN THE FIELD.

Risk Assessment as a Group Process

The PI and the more experienced team members should strive for a process that is both transparent and inclusive. The best risk management occurs when all team members, including "rookies," feel free to come forward regarding safety concerns. All members should be included in the initial pre-fieldwork risk assessment process and encouraged to speak up when concerns arise while in the field. This kind of team building also serves to bring out and communicate the strengths and weaknesses of individual team members, which is valuable information for risk management, and ensures that all participants are fully aware of potential risks involved with fieldwork. This discussion is also a good time for a conversation regarding behavioral expectations, such as alcohol consumption or other recreation during downtime or emphasizing the overall culture of safety in the team. Depending on the group, it may be useful to have each member sign a statement agreeing to these expectations. Often field team members are not selected until just prior to going to the field. Even one meeting pre-deployment can communicate the risk management approach, expectations for behavior and outline the safety risk roles and responsibilities of everyone involved. The importance of using a collaborative, group process to manage risks cannot be overstated.

Rules of Risk Management

1. **Own it**—Everyone must be responsible for their own safety
2. **Know your enemy**—Don't focus on the wrong hazards
3. **Forget technology**—Technology is an important tool, but batteries die and coverage is sparse; be prepared to depend on self-reliance and resourcefulness
4. **Take it easy**—Don't push the limits
5. **If in doubt, check it out**—Don't ignore the signs of a potential problem
6. **Embrace the craft**—You must master the requisite skills to survive in the Arctic; learning those skills should not be considered an impediment
7. **Elder speak**—Learn from the experts who have gone before you
8. **Profit from the misfortunes of others**—Learn from others' mistakes and do your best not to duplicate them
9. **Acceptance**—Embrace the knowledge others have to pass on
10. **Full bore mentoring**—It takes many years to be competent and safe in the field; pass along your knowledge

–presented by Matthew Sturm and amended by workshop participants


Baffin Island
Photo by Jason Briner


Climbing Mt. Dundas
Photo by Kurt Burnham, High Arctic Institute

Specific Hazards and Risks

After identifying a comprehensive set of risks, the research team should then examine each risk individually. Regardless of the particular hazard, the approach to risk evaluation and management should be the same. There are different variations on the process, but fundamentally the team must address the following:

- Assign an owner to each risk — the person or people most responsible for avoiding a given risk
- State the potential costs — the losses sustained should the incident actually happen
- Explore whether the hazard can be avoided
- Explore whether the hazard can be mitigated

Photo by Pat Smith

Consider what can be done pre-fieldwork to mitigate the hazard, and then also discuss what to do in the field in the event that it happens anyway. Contingencies should be developed for multiple scenarios. Consider the options if any individual person on the team is injured, or any piece of equipment breaks down. Which team members will be assigned to what roles in the event of an emergency? How would the team respond if the communications person is unconscious or the medical lead is injured? What scenarios would require extraction or cancellation of the field season? Which scenarios can be managed by the group without outside help?

Considerations when identifying hazards:

- Have the right attitude about risk. Identifying risks and discussing their mitigation is not done to fulfill a point on a bulleted list, but is instead a crucial part of a successful field campaign.
- Do not waste time on imagined risks. Perceived risk is rarely equal to actual risk. Personal fears and concerns must be separated from the consideration of potential hazards. An example of a perceived risk is the threat of encountering a violent person while on expedition. While it can happen, it is not among the main risks that should be planned for.
- Recognize the potential problems of the environment or equipment and areas where humans are prone to error. Fatigue, dehydration, and cold exposure can reduce a person's ability to make rational risk management decisions. The tendency toward groupthink when discussing risks can lead to faulty decision-making. These impediments can be recognized and addressed while in the field, especially if the group discusses them in risk management scenarios.
- Consider agency regulations, institutional policies, international laws, best practices, and other guiding principals.
- Risk management is not synonymous with liability avoidance. The focus should be on how to make fieldwork safer rather than how to avoid blame and financial costs.
- The initial discussion is not the endpoint. As the project continues through the planning stages and especially during the actual fieldwork, risks must be identified and reassessed continually.

In the second breakout session, workshop participants went through the process of planning how to manage the highest risks (Table 2). They examined potential hazards and considered how to plan for potential hazards before and during fieldwork and the roles of various team members.

Table 2. Results of breakout session #2. Each high-risk hazard identified during the first breakout session was carried through a hypothetical risk assessment/management process by a breakout group. Each group discussed how the hazard should be assessed prior to fieldwork, as well as what would happen and who should handle which responsibilities should an incident actually occur. The table presents representative examples from each breakout group. Complete results are available as supplemental online materials.

Platform Hazard	Before Fieldwork	During Fieldwork	Role(s) of the PI	Role(s) of the Field Team	Role(s) of Support Providers & Station Operators
Aviation Remote Landings	• Aviation training from pilot • Recon/maps, remote images/field experience • Expected hazards (plan what to expect) • Preplanning hazard and risk assessment • Meet with pilot prior to flight to troubleshoot possible problems with landing • GPS w/ waypoints prior to flight • PI and pilot should be aware of one another – strengths, weaknesses, experience levels • Plan to be stranded	• Contingency plan (from pre-flight meetings) is followed pending conditions • Keep eye on pilot and changing weather	• PI not just a scientist • Don't confuse science with safety • Planning from contingencies • Meeting with pilot pre-flight to troubleshoot before flying to site • Make sure a team member can also lead • Pilot may have limited regional experience compared with PI – may need to mentor pilot (e.g., crevasse safety)	• Aim for organizational redundancy • Make sure that aviation protocols communicated by pilot are adhered to strictly • Be prepared to be stranded (in camp/field) • Be responsible for own safety (problem for the inexperienced)	• Contractor may have role in choosing pilot with appropriate experience — this may not always be possible • Be flexible with requirements of pilot (scheduling, weather) and communication with pilot is essential • Accommodate changes in plan due to conditions
Remote & Foreign Field Sites Medical	• Self-report medical history v. medical exam and release • Conditioning • Medical/first aid training of team members • Develop response procedures	• Medical supplies and training • Emergency plan • Means of communication and training • Safety orientation • Clear and concise instructions • Frequent practicing • Fallback procedures in field at the base • Field/food/flight plan	• Complimentary of team members • Distribution of information • Proper preparation • Delegation of tasks • Monitoring status	• Assign team leader • Taking ownership • Checks and balance • Aware of surroundings	• Information provider • Season plan • Training • Maintain availability • Risk assessment/review
Marine & River Swamping	• Safety training education • Safety equipment on board • Boat maintenance and inspection (get military PM lists) • Compliant safety regulations • Pre-deployment shakedowns • Develop checklist • Assign responsibility • Understand team members' strengths	• Stick to the plan ("flight" plan) and adjust as necessary • Follow checklists for operations • Continue boat maintenance (use PM lists) • Constant reassessment of conditions (situation awareness) • Open communication	• Clear line of responsibility between "shipper" and PI • Sharing responsibility — use team member strengths • Realistic expectations for the boat and the crew • Balance physical limitations with intellectual desire • Assign a first mate who has responsibilities — rotate jobs • Have clear briefs/debriefs	• Obligation to speak up if you see a problem • Take care of themselves — remain healthy/high functioning team member • Pitch in and help others do their job • Understand expectations or ask for clarification • Cross train to learn other jobs	• Provide reliable gear • Provide training • Set clear expectations • Open communications • Rescue plan • Daily communications plan
Glacier & Ice Sheet Crevasses	• Are they present? • Where are they? • Training and equipment necessary? • Audience and rescue plan?	• Pre-action safety review and equipment checklist and weather report	• Discuss daily lessons learned • Team building • Leadership, including delegation	• Everyone is empowered to stop work and call out safety issues • Know your job and equipment	• Help vet PI experience and provide training • Help PIs own safety
Terrestrial Driving	• Arctic training course • ID/background check for driver • Insurance • Develop policy to prevent fatigue (e.g., driving schedule) • Have a plan before going into the field • Safety gear • Back-up equipment • Have contact numbers • Develop SOP for vehicle operations and go/no-go • Environmental checklists	• Follow the regulations and policies and SOP and if there is a prescribed check-in place • Area familiarization • "How I Road" — clean lights/windows • Keep an eye out for wildlife • Know communications gear, test it • Make sure you have a survival bag/gear • Wear your seatbelt	• The PI is the responsible party for the field team • Foster a good culture of safety • Disseminate and enforce the safety policy and information • Make sure vehicle is insured, licensed, registered • Take action for anything • Stop unsafe practices • Make sure field team has field safety training and knows how to use survival gear • Wear seatbelt	• See something, say something, do something • Follow procedures • Report potential hazards • Responsible for individual safety • Stop unsafe practices • Keep an eye out for animals • Wear seatbelt	• Keep vehicles in safe operating conditions • Maintenance • Driver certification • Local intel/checklist • Daily/regular radio check-in • Functional back-up plan for broken vehicles — rescue system in place • Provide training requirements, SOP, policy • Provide survival gear/bag
Cross-platform Behavioral Issues	• Group training/team building • Discussion of expectations • Explain rules/regulation of consequences	• Nip problems in the bud by addressing issues right away	• Manage adequate work assignments • Manage rest and morale • Make decision to send problem person home	• Express concerns to PI • Maintain health through well-being/take care of oneself	• Meals • Resources to address problems

Photo by Jason Briner

Tools for Identifying Risks

- The CPS risk assessment template.[2] Workshop participants highlighted a need for the documentation currently available to be developed into a process that engages research teams with useful, thoughtful risk assessment tools.
- The NASA process for identifying, categorizing, and assessing risks.[3]
- Experienced field professionals who are available for consultation and facilitation of safety risk management discussions.[4]

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[2] CH2M HILL Polar Services. *Field Risk Assessment Table: Example for Researchers*. July 2013. http://cpspolar.com/wp-content/uploads/2013/07/Field-Risk-Assessment-Table-Example-for-Researchers-2.pdf

[3] National Aeronautics and Space Administration. *NASA Risk Management Handbook*. Hanover, MD: November 2011.

[4] CH2M HILL Polar Services. *Third-party Field Training*. 2015. http://cpspolar.com/for-researchers/risk-management/wilderness-first-aid-training

UTILIZING INSTITUTIONAL RISK MANAGEMENT OFFICES

The workshop included a targeted discussion about the involvement of university risk management offices (RMOs) in arctic field research. While RMOs focus on campus risk management and possibly overseas travel, they are an untapped resource, providing many important services for arctic field researchers. Many researchers at the workshop were unaware of the RMO at their institution, and others who were aware that it existed were wary of approaching the office due to concern that a conflict in priorities might delay or cancel the planned research.

RMOs and researchers will inherently approach risk management from different perspectives, with different tolerances for risk. The RMO is responsible for protecting the institution and employees from unacceptable risk while the researcher is responsible for executing the funded research within budget while avoiding unacceptable risk. Keeping in mind that universities and institutes depend on the success of grantees, RMOs can be expected to seek a way to perform the research with acceptable levels of risk. At NSF, field safety risk management is considered, though not expressly evaluated, during the proposal review process by the reviewers, program officers, and logistics providers prior to award. Therefore, RMOs are unlikely to become involved in funded projects with unacceptable risks that cannot be avoided or mitigated.

Safety risk management can be considered from two key points of view — legal and ethical. Legal risk management includes the steps taken to make sure that the PI and institution are protected in the event of litigation. Ethical risk management refers to the steps taken to protect the research team and project from unnecessary risk. Workshop participants agreed that ethical consideration of risk management should be the priority, noting that if the ethical considerations of avoiding harm to the research team are addressed, that often also addresses legal considerations. The RMO can be expected to review both types of risk in their assessment. The greatest risk of litigation is when no formal risk assessment and management process exists. Beyond the immediate risk to the health and safety of people in the field, risk management helps avoid the cost of a rescue, lost research time, and damage to the researcher's reputation. Safety risk management support from the university or institution is designed to help researchers develop risk

> You should do everything you can so that you can sleep comfortably at night knowing that these people are well cared for, and if you do that then you'll generally find that the legal bases are covered.
>
> *–John Gookin, National Outdoor Leadership School*

PIs SHOULD ARRANGE AT LEAST ONE MEETING WITH THEIR RISK MANAGEMENT OFFICE. GET TO KNOW YOUR RMO.

management plans that further scientific goals while meeting both the ethical and legal requirements of risk management. Projects should be pushing the limits of science without pushing the limits of safety risk.

Working openly with the RMO may help alleviate potential problems. During the proposal process, the PI(s) should arrange at least one meeting with their RMO, and go to the meeting prepared with a list of questions, concerns, and considerations to discuss. The offices may have resources unknown to the scientist, and can often assist with items that the research team may not have considered.

Resources and Expertise Available Through RMOs

- Insurance for costly field equipment
- Education, training, and personal protective equipment for team members
- Environmental permitting
- Proper handling and shipping of hazardous materials
- Safety of all personnel on project
- Project demobilization in compliance with permits and stewardship
- Evacuation plans for field teams
- Insurance for workman's compensation, medical evacuation, repatriation, and other travel services
- Emergency phone line staffed 24 hours per day, 7 days per week
- Engagement of safety and risk management professionals to aid with developing a comprehensive risk management plan
- Trained emergency responders to manage a crisis, contact family members, and engage other emergency responders as needed

Photo by Erich Osterberg

Baffin Island
Photo by Jason Briner

CRISIS COMMUNICATION

Part of developing a risk management plan is establishing a chain of command for communication and decision-making. The chain should include information on who should be contacted by whom and when in the event of an emergency. Communication in the face of a crisis is vital. People in the field should know that they can get in touch with a point of contact for assistance at any time.

In a crisis, individuals (or teams with leaders, depending on the group) should be assigned specific tasks with clear expectations, roles, and responsibilities for all team members, including anyone at a base station or the home institution. Ideally one person should serve as liaison between all parties (field team, institution, authorities, family, etc.) to reduce confusion and ensure consistent messages. That person should not be integral to responding to the crisis at hand, but a close secondary team member. Each team member should have an up-to-date laminated card that details the contact protocol (phone numbers, frequencies, times) in the event of an emergency. In addition, in the planning phase, team members should address:

- Who needs to be contacted? Determine the necessary contacts and the order of priority: institutional contacts, medication assistance, insurance representatives, family, government, etc.
- How should they be contacted? Largely determined by location and accessibility, it is generally best to have one individual responsible for tracking communications among all parties involved in the situation.
- How and under what circumstances should a medical evacuation be initiated?
- When and how will the media be notified?

Decisions will always depend on the specific situation, but be prepared to recognize the transition between an annoyance, which requires a problem-solving thought process, and threat, which requires a survival thought process.

Avoid common traps of crisis management. It is each individual's responsibility to point out possible pitfalls such as groupthink, where people are in general agreement and thus no longer working on alternative solutions, or a 'nothing we can do' mindset where people have stopped trying to improve the situation.

Stay ahead of an annoyance that may develop into a threat. Reach out through your communication chain of command early to pre-emptively alert the chain of an evolving situation rather than waiting for a crisis. Ensure they will be by the phone to receive regular reports and in turn they can provide updated weather and real-time assessments of search and rescue capabilities to inform the field team's decision-making.

Camping on the Ikpikpuk Delta, Alaska
Photo by Leslie Pierce (TREC 2005)
Courtesy of ARCUS

A MEDICAL CLOSE CALL IN AN ANTARCTIC FIELD CAMP

I participated in the 2012–2013 Antarctic Search for Meteorites (ANSMET) expedition. Our party of eight meteorite hunters spent six weeks in remote field camps, about 400 miles from both McMurdo Station and the South Pole. Late in the field season, we had a medical emergency. The occasion was a 30-mile snowmobile traverse across potentially crevassed terrain to a new work area. Early in the traverse a team member started behaving erratically. We halted, and the team leader called McMurdo using a satellite phone. The physician there couldn't positively identify the problem, but because the possible causes included stroke, the physician called for a medical evacuation. We decided to return to the camp site we had just left, which had a safe place for an aircraft to land. Throughout the episode, the victim claimed to be feeling fine and resisted the change in plan.

Back at the camp site, we set up a tent for the victim and lit a stove for warmth. Two team members stayed in the tent and cared for the victim while others rebuilt the camp and retrieved equipment that had been left on the traverse route in order to transport the victim. The team leader called McMurdo every 30 minutes with updates on the local weather (for the rescue aircrew) and the victim's status (for the physician).

A ski-equipped Twin Otter from the South Pole, carrying the Pole's only physician and an emergency medical technician, arrived about five hours after the episode began. By then the victim's symptoms were beginning to resolve. They took the victim to McMurdo, and the victim remained there until the next available flight to Christchurch, New Zealand, which was two days later. By that time the illness had resolved completely. After a medical workup, the cause of the illness was found to be an accidental overdose of prescription medication.

The overdose might not have happened if the label on the medication had been unambiguous about the minimum interval between dosing. We might have responded to the problem sooner and better if the victim had complied with ANSMET policy by providing a list of his prescriptions to team leaders before the season. On the positive side, given the remoteness of the field camp and the limited numbers of aircraft and doctors in Antarctica, the rescue was commendably fast. The physician on the rescue flight praised the field team for its handling of the situation.

— Stanley G. Love, PhD
Astronaut Office, NASA Lyndon B. Johnson Space Center, Houston, TX

DEVELOP A COMMUNICATIONS PLAN COMPLETE WITH CONTACT NAMES AND NUMBERS.

Recognize where good decision-making can improve the outcome even though it may be at the risk of science. It is better to send a team member out or leave the field early than to press on and put people's health and safety at risk.

Workshop participants recommended that research teams develop a communications plan complete with contact names and numbers. Each team member should keep a copy of this plan with them at all times.

Missy Holzer poses wearing her dry suit, Longyearbyen, Svalbard, Norway. Photo by Missy Holzer (PolarTREC 2008) Courtesy of ARCUS

INCIDENT REPORTING

No matter how well a team manages risk, accidents and close calls will occur. Incident and near miss reporting is an essential part of risk management for two reasons. It offers the team members, their institutions, and associated groups an opportunity to evaluate the incident and make corrective actions. Reporting allows others to learn from the incident or near miss to avoid similar issues.

The workshop participants and NSF voiced support for a culture of openness to share incidents and near misses in the Arctic. Sharing accounts of incidents and near miss situations provides the research community with case studies for examination. The purpose is to improve the practice of field safety risk management in the Arctic, not to cast blame. Reporting incidents and near misses is a service to the community by helping others avoid similar circumstances. Researchers and service providers should feel able to share their own experiences or anything they observe that will improve risk management in the Arctic without fear of recriminations.

NSF supports open reporting of incidents and near misses. In some cases, NSF will conduct an incident investigation through one of several mechanisms. The staff of the Polar Environment, Safety and Health section are experienced with incident investigations. Alternatively, NSF may convene a mishap analysis board of outside experts to examine the evidence and provide recommendations. The purpose is not to assign blame, but to ensure a thorough and impartial examination of the circumstances, decisions, and processes followed to improve processes, policies, and procedures and to inform decision-making in the future. As with other organizations, such as the U.S. Coast Guard and the National Transportation Safety Board (NTSB), if the mishap analysis board discovers information that suggests negligence, a poor command climate or other performance errors, the mishap analysis can lead to further investigation by the organizations involved.

The workshop participants note that an outcome of an incident investigation — the legal perspective on incidents — can be the assignment of blame. It is important that organizations recognize that facilitating a culture of openness is one of the greatest defenses against risk. Sharing information openly about incidents and the outcomes of mishap review boards, as well as implementing lessons learned without retribution will build trust over time and eventually lead to better incident reporting, an increased safety culture, and ultimately reduce incident rates.

Effective incident reporting starts with a minimal amount of paperwork to avoid creating a deterrent to reporting. Initial data collection must include who, what, when, and where. How the incident occurred – the causation – and how the response was carried out, are most relevant to promote learning from an incident or near miss.

An incident report template should be developed and made available to all projects funded by the Division of Polar Programs.

There should be an online submission option for incident reporting.

An annual report should be produced for some or all the incidents and near misses in the arctic program. Its format should promote discussion and examination without assigning blame.

Out-briefings or post-fieldwork discussions should be required of all research teams.

Workshop participants recommended developing an incident reporting template, to be made available to all projects funded by the Division of Polar Programs. The process should continue to be voluntary. As a first step, outreach from NSF requesting that people submit this form on a voluntary basis might encourage participation. Developing an online submission option is also highly recommended, as it allows for real-time (or as timely as possible) reporting. Keeping the required documentation and reporting brief and focused on the causation and aftermath of the incident itself rather than extraneous details, will further encourage participation by busy researchers.

The NSF Arctic RSL contractor will continue to out-brief research teams following the field season where they request information on any incidents or near misses that could prompt corrective actions aimed to improve fieldwork going forward. The workshop highlighted the importance of producing an annual report of some or all of the incidents and near misses in the arctic program in a format that promotes discussion and examination without assigning blame. This will help promote the culture of openness and focus the discussion on field safety risk management. Again, it is essential that the researchers reporting on specific incidents not be subjected to judgment or punitive measures. The National Aeronautics and Space Administration (NASA) has developed a format they call the 'Safety Confessional' that may serve as a good model for other risk management programs.

Additionally, out-briefings or post-fieldwork discussions for the people involved in a particular project or campaign do not always happen, but they ought to be required of all research teams. The best way to learn about risk management and safety is to acknowledge, as a group, what went well, what went wrong and how it was handled, and what might have gone better with different preparation.

The CPS Field Incident and Near-Miss Reporting Form:

http://cpspolar.com/new-field-incident-report/

More for Researchers:

http://cpspolar.com/for-researchers/risk-management

TRAINING AND MENTORSHIP

Policies, plans, and checklists are useful tools, but personnel are the greatest resource in assessing and managing risk. Though there is no substitute for experience, training and mentorship can improve the development of researchers into successful field leaders and risk managers. Through the proposal process, new researchers with very little field experience can end up in charge of expeditions. Lack of experience in new researchers and the loss of experience in retiring researchers were two key concerns of workshop participants. As a corollary, experienced scientists receive very little credit for mentoring newcomers in field craft, a process that can quickly consume both time and resources.

An integral part of risk management is ensuring that researchers receive proper training, and that knowledge is passed from experienced to early career researchers. The training made available by NSF to the research community should be promoted as an important resource. Other training is available through organizations like Learn to Return and the National Outdoor Leadership School. Researchers should work with their university to request training for themselves or their students, they should discuss training needs with their NSF program officer as a part of their grant proposal, and they should explore possibilities for students to work with the outdoor recreation or similar programs at their institution to practice certain field skills. Safety risk management should be taught while in the field, led by senior researchers with a great deal of experience. Early career researchers need many opportunities to learn from their predecessors and other experts. Though there is no curriculum, one could be developed as a long-term goal for the RSL program. Mentorship starts with training in essentials of fieldwork and risk management and continues through long-term mentorship to develop the next generation of experienced researchers.

RECOMMENDED GENERAL TRAINING FOR ALL ARCTIC FIELD RESEARCHERS

- *Satellite phone*
- *VHF Radio*
- *Relevant communications*
- *CPR*
- *Basic first aid*
- *Navigation / GPS*

Stream crossing near Lake Linne, Svalbard, Norway
Photo by Robert Oddo (TREC 2005)
Courtesy of ARCUS

Recommendations:

- Facilitate a process to pair new scientists with senior researchers and field operators
- Include graduate students in the planning, purchasing, and organizing of field trips to prepare them for arranging their own expeditions in the future
- Have students propose safety and risk management posters and/or talks to present at conferences
- Help institutions develop programs focused on fieldwork skills and risk management as accredited courses for students and required training for new employees
- Encourage early career researchers and/or graduate students to formally interview late-career scientists with a lot of fieldwork experience, concentrating on their lessons learned regarding risk management

Tools to assist with training and mentorship include several organizations that offer courses or certifications in different skill sets. It is important to note that resources are only helpful when they can be utilized — researchers and institutions need funds and salaried time so that people can take advantage of training and mentoring opportunities.

Research via helicopter, somewhere between Raven Bluff and the Chukchi Sea, Alaska
Photo by Karl Horeis (PolarTREC 2010)
Courtesy of ARCUS

Small boat training
Photo by Matt Irinaga

"Even though the CCGS Louis S. St. Laurent follows just one mile behind us, we often can't see the Louis at all through the fog. When visible it is often just an outline in the haze, kind of like a ghost ship."

— *Bill Schmoker, aboard the USCGC Healy*

Photo by Bill Schmoker (PolarTREC 2010)
Courtesy of ARCUS

COMMUNITY OF PRACTICE

One approach to developing, communicating, and sharing risk management tools and practices is to develop a *Community of Practice* — a group with a common interest that works on common approaches, making new strategies and lessons learned easily visible to the group and others.[5] Since the workshop, the RSL program has continued the discussion of arctic field safety risk management through infrequent emails to the initial members of an Arctic Field Safety Risk Management CoP. The goal of this CoP is to advance field safety risk management in arctic research. The CoP will continue work on the ideas started at this workshop and serve as a platform for further discussion as the need arises. All participants at the workshop were included in the initial CoP, which is expected to grow and take shape in the years to come.

The CoP can be whatever its members lead it to be. It can serve as a starting point to include early career researchers in risk management discussions, and nurture new experts. Anyone in the CoP can initiate activities or discussions, though in this case a great deal of leadership will likely come from the RSL program to take action on many of the suggestions made during discussions. The CoP provides the forum for an ongoing dialog and idea exchange about risk management approaches and lessons learned and develops best practices. A CoP recognizes the value of different perspectives. By sharing knowledge throughout the arctic research community, the endeavor of risk management is improved.

Subsequent meetings, ideally on an annual basis, can be convened to keep the community in regular contact regarding risk management and safety. These issues are not afterthoughts and should be brought regularly to the forefront in terms of time and consideration. The release of an annual report on incidents and near-misses is an opportunity to convene an online meeting to keep the CoP active. An in-person component is preferred, but any form of regular contact is essential for the development of a CoP.

In addition to research institutions and organizations, multiple agencies must be included in the CoP. Risk management in arctic research is not a concern singular to NSF. Interagency communication is essential, and an interagency approach to risk mitigation can be developed. The arctic programs at NSF, NASA, NOAA, the Department of the Interior, the Department of Defense, and others can share experiences, solutions, and lessons learned as well as problems and areas of concern. This may be facilitated best by the IARPC (Interagency Arctic Research Policy

DEVELOP A COMMUNITY OF PRACTICE — CoP

The CoP should convene annually.

The CoP must include multiple agencies.

The Interagency Arctic Research Policy Committee Logistics Working Group may facilitate an inter-agency CoP.

Develop a consistent risk management approach across funding agencies.

Photo by Erich Osterberg

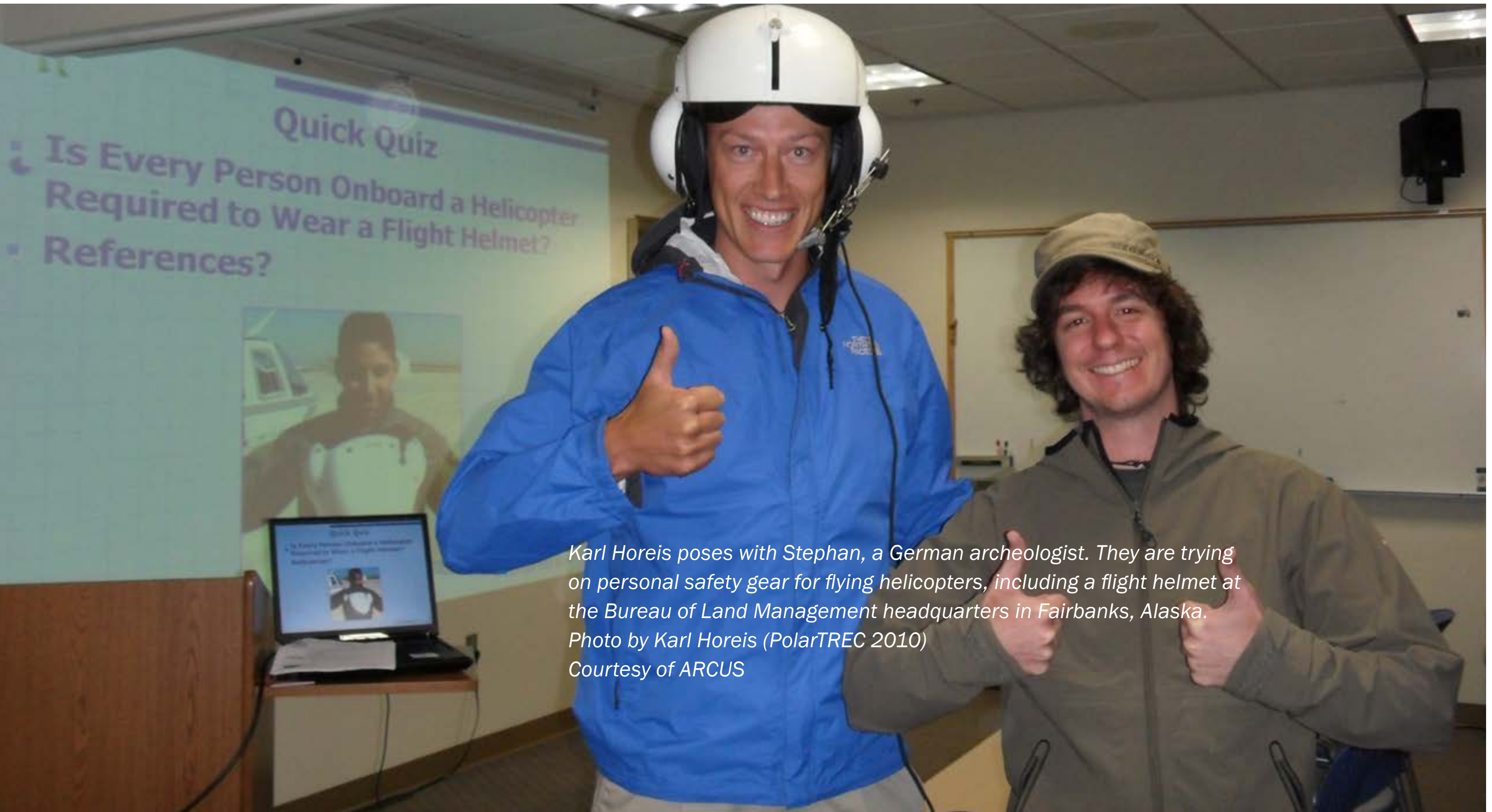
[5] Wenger, Etienne. *Communities of Practice: Learning, Meaning, and Identity.* Cambridge University Press, 1998.

Committee) Logistics Working Group to coordinate with other agencies on logistics and risk management.

CoP discussions should focus upon and recommend development of a consistent risk management approach across funding agencies, so that all researchers handle the planning and execution of risk management similarly and all change and adapt as better solutions are found and shared with the research community.

Information about the Arctic Field Safety Risk Management CoP is occasionally circulated via *ArcticInfo* and *Witness the Arctic*.

To join the CoP, email Renée Crain rcrain@nsf.gov or Pat Haggerty phaggert@nsf.gov



Karl Horeis poses with Stephan, a German archeologist. They are trying on personal safety gear for flying helicopters, including a flight helmet at the Bureau of Land Management headquarters in Fairbanks, Alaska. Photo by Karl Horeis (PolarTREC 2010) Courtesy of ARCUS

CONCLUSION

After two days of productive, thought-provoking discussions, the participants of the Arctic Field Safety Risk Management Workshop successfully met the goals of assessing current risk management and suggesting ways forward for improvement. Major themes and specific recommendations emerged:

- Expand the current risk management policies and procedures in ways that are both flexible and valuable; avoid implementing additional forms or paperwork that do not serve a distinct, constructive purpose
- Establish a CoP to widen the arctic risk management discussion by broadening the scope of agencies and institutions involved in the conversation
- Instill a culture of risk management ownership in the arctic community, and encourage an open channel of communication and reporting so that researchers, particularly those in early stages of their careers, can learn from the experiences of others

Risk management approaches change from project to project, and must be adaptable on a case-by-case basis. Flexibility throughout the process is key, as is separating the risks to science from the risks to people — research projects need to be risky with science, but not risky with how science is conducted.

The program managers in the NSF Arctic Research Support and Logistics program are strongly supportive of an atmosphere of openness in the ongoing discussion of safety risk management. This report provides a framework for continued discussions on development of best practices and furthering a safety culture in arctic research. The suggestions and examples herein can serve as a basis for improved safety risk management, and the various materials from the workshop are available for reference for future conversations.

NSF has already taken action based on the workshop discussions and will continue to going forward. An active CoP will ensure continued progress and improvement in arctic field safety risk management. Risk management is best improved through coordination and collaboration among its many interested parties. Researchers, funding agencies, support providers, institutional risk management offices, and safety experts all have valuable perspectives they can contribute to ensure that arctic field research is as safe as possible.

Before anyone else can go on the sea ice, someone must first "fly" to the floe to test for thickness and safety. Kevin Bakker and Katarina Abrahamsson are lifted from the Oden to the floe by crane. Photo by Jeff Peneston (PolarTREC 2008/2009) Courtesy of ARCUS

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Photo by Erich Osterberg

APPENDIX B. AGENDA

Day 1. 4 February 2014

8:00	Breakfast	
8:30	Welcome and Introductions	
	- Participants Introduce Themselves	Renée Crain, NSF
	- Introduction to Facilitators from NSF and NOLS	Pat Haggerty, NSF
9:00	Charge to the Workshop and RSL Program Perspective on Arctic Field Safety Risk Management	Renée Crain, NSF Pat Haggerty, NSF
9:30	Common Sense and Sanity in Safety	Matthew Sturm, UAF
9:50	Past Incident Review and Trends in RSLS and USAP	Jim Karcher, NSF
10:10	Field Safety Risk Management in the Russian Far East	Robert 'Max' Holmes, NSF
10:30	BREAK	
10:45	Breakout One: Identifying Risks - Aviation - Ships and Boats - Bears and Firearms - Physical Qualifications and Health/Medical Risk - Glaciers and Cold Temperatures	
11:30	Report Out and Discussion	
12:00	Lunch Provided	
12:30	Fieldwork Firearms Safety	Mike Abels, UAF
1:00	Staying Safe in a Dangerous Place: Managing Risk in Human Space Flight	Stanley G. Love, NASA
1:40	Breakout Two: Planning for and Managing Risks - Before the Fieldwork - During the Fieldwork - Role of the PI and Field Team - Role of Support Providers (ship, contractor, field station)	
2:20	Report Out and Discussion	
2:45	BREAK	
3:00	Earth System Research: Managing Field Safety in the NOAA Atmospheric Watch Program	Brian Vasel, NOAA
3:20	Institution Role in Mitigating Field Risks	Frances Isgrigg, UAF
4:00	Safety Risk Management on Research Vessels	David O'Gorman, OSU
4:20	Arctic Field Safety Program Review & Resources and Training Offered by CPS	Brad Stefano, Allen O'Bannon, Kim Derry, Kim McAllister, CPS
4:40	Physical Qualifications for Arctic Research	Renée Crain, NSF
5:00	Plenary Wrap-up Discussion	Lauren Strange, SRA
5:30	Adjourn to Front Page Restaurant for Reception	

Day 2. 5 February 2014

8:00	Breakfast	
8:30	Opening Remarks and Recap from Day 1	NSF
9:00	Tabletop Exercise: Hands-on Response to Situations	John Gookin, NOLS Allen O'Bannon, PFS
12:00	Lunch Provided	
12:00	A Practical Approach to Hazard Identification and Assessment for Field Campaigns	Dan Hodkinson, Sigma Space Corporation
1:00	Breakout Three: Responding to Situations	
1:40	Report Out and Discussion	
2:20	Plenary Discussion: Draft Workshop Report Outline	Lauren Strange, SRA
4:00	Adjourn	

Several scientists work on the sea ice getting a core as the Coast Guard safety swimmer watches from nearby. From aboard the USCGC Healy on the Bering Sea. Photo by Robyn Saup (PolarTREC 2007) Courtesy of ARCUS

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