

Arctic coastal and drifting ice processes and dynamics

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Environmental Impact and Mitigation

- 1) We camp out at the northern coast of Ellesmere Island and there is some generation of greywater. **Mitigation:** We will screen food scraps from the greywater so that it is less likely to attract wildlife. We dispose of greywater in a sump far from streams and lakes or on ice where it will eventually find its way to the ocean. Note that all solid waste generated from camping is removed from the site. [Ref: 08YN010]
- 2) When camping we use a generator to obtain power. There is a risk of spilling during refuelling. **Mitigation:** Spilled gasoline during refuelling will be mitigated using spill kits. Refuelling will occur over a plastic tarp. [Ref: 08YN010]
- 3) Access to the water column typically requires a hole be drilled in the ice cover for instrument access. The greatest risk with this activity is spilling fuel during refuelling of ice augers, corers and melters. **Mitigation:** Spilled gasoline during refuelling will be mitigated using spill kits. Refuelling will occur over a plastic tarp. [Ref: 08YN010]
- 4) Some of our instruments need to be installed on a firm surface such as bedrock. To do so we need to drill a hole several centimetres deep into rock and insert a bolt which will remain there permanently. **Mitigation:** We will use a little anchoring as possible to avoid marring the surface of the rock. We will reuse existing anchors whenever possible. [Ref: 08YN010, but this is a new kind of anchoring]
- 5) There is a risk that equipment, installed in the ice or through the ice gets lost if the ice melts out or breaks away. **Mitigation:** We attach several safety lines and floats on our valuable equipment to improve the chance of recovery. [Ref: 08YN010]
- 6) Occasionally some science gear gets frozen into the ice and cannot be retrieved. This can occur with ablation stakes (3 m long plastic poles, sometimes with a small temperature sensor at the top), metal supports and wires when we remove our above ice instruments. **Mitigation:** We will make a best effort to retrieve all equipment that we set out on the ice. If it cannot be removed with the means available, we will cut the above ice portions off to minimize the amount left behind. If feasible, we will also return to the site after some time has passed to remove what has melted out in the meantime. Note that the ablation stakes that we do return to regularly do eventually melt and are regularly reused. [Ref: 08YN010]
- 7) GPS satellite tracking beacons and other similar expendable scientific gear are rarely recovered. Once they fall off the iceberg or ice island they are tracking, they will either sink to the bottom of the ocean (one type) or float (another type). **Mitigation:** We will collect and reuse tracking beacons when this is feasible. We did this once with an icebreaker but we do not have the financial resources or would want to incur the environmental cost (in fuel expended) of retrieving these small beacons. We are conscious of this problem and we try to minimize the amount of disposable gear we leave out on the ice. [Ref: 09YN071]

- 8) We use helicopters and uninhabited aerial vehicles (UAVs) for surveying and mapping ice and to do this we take photos at an altitude of ~100 m for UAVs and between 610 and 1000 m for helicopters. **Mitigation:** UAVs are not very noisy and are difficult to hear from 100 m away. No surveys will be conducted at low elevation near wildlife to avoid disturbance. [Proposed activity]
- 9) It is possible that a remotely operated vehicle or an autonomous underwater vehicle will get stuck under the ice. They would then remain there until they could be freed. **Mitigation:** This very expensive equipment will normally be tethered by rope so that we can retrieve them if this should occur. Our team has experience with deployment and recovery of AUVs under ice. Having another underwater vehicle on site is helpful for recovery and we will have a hole melter to open extraction holes as required. [Proposed activity]
- 10) We use aircraft, ships, boats and snow machines for our research and are aware that, through our use of fossil fuels, we are altering the climate. **Mitigation:** We will endeavour only to use these modes of travel when necessary to meet the objectives of our research and to use other means of gathering data when we can (asking locals for help with measurements, using satellite data, etc).