



ARTICLE

What to Do About Number Two? Insights from Decades of Human Waste Research and Management on Denali

Denali National Park & Preserve (<https://www.nps.gov/dena/>)

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The West Buttress climbing route on Mt. McKinley is, during the short climbing season, the most crowded backcountry location in Denali National Park and Preserve. Here, climbers dig into snow shelters at 14,200' before ascending the steeper upper mountain.

NPS/Tucker Chenoweth

For the National Park Service (NPS), top challenges in the management of visitor use often revolve around trash and human waste. This is true in developed frontcountry environments along roads and developed areas, but in the

backcountry and wilderness environments of parks with large natural areas the challenges are often greater. Traditional frontcountry tools like trash cans, dumpsters, outhouses, and restrooms are infeasible in many backcountry settings. What's more, the logistics of transporting waste out of the backcountry can be expensive and complicated. And yet the aesthetic and hygienic expectations of backcountry users are arguably even higher: wilderness visitors expect "pristine" environments and, at the same time, are more vulnerable than frontcountry users—due to limited washing facilities—to the risks posed by unmanaged waste.

The challenges of backcountry waste management extend, in unique ways, to glacial environments. Historically, most mountaineers climbing or trekking on glaciers simply tossed their trash and human waste into the snow or a nearby crevasse (a deep crack on the glacier surface). This practice was perhaps at the time consistent with the lower expectations historically prevalent in other backcountry environments, and it was perceived as having little practical consequence on remote glaciers visited rarely, if at all, by others. It also seemed intuitive that crevassed waste just "goes away" because in the upper reaches of a glacier annual snowfall exceeds annual melt. This pattern assures that anything left in a crevasse—or even on the glacier surface—will in due time be buried by additional snowfall, encased in ice, and slowly carried away as the glacier flows interminably down valley. But the waste does not, of course, truly disappear. We now know that downstream—in the glacier's ablation zone where summer melt exceeds annual snowfall—buried and transported waste will someday emerge at the glacier surface.

The emergence of crevassed trash and human waste is perhaps like the unwelcome sight of dog poop melting out of the snowpack in our backyards each spring during breakup: a gentle reminder that things don't just go away. But what if instead of just the family dog, we're running a kennel back there?

On Mt. McKinley (Denali)—North America's highest peak—the most straightforward way up the mountain is via the West Buttress climbing route. Each year during peak climbing season, from early May to mid-June, over 1,000 aspiring mountaineers arrive via ski-equipped bush plane at a busy glacier landing strip and spend an average of 17 days each climbing the route on the upper Kahiltna Glacier. The crowded climbing route presents a stark contrast with the rest of the backcountry in Denali National Park and Preserve, where visitor numbers (mostly backpackers) are strictly limited by quotas of 4-12 daily users per backcountry zone. Waste management is also easier in those zones, because (1) backpackers typically generate less trash to "pack out" because their trips are shorter, and (2) backpackers are generally able to shallowly bury their human waste in organic-rich soils where it will effectively biodegrade within a short time. In contrast, on the Kahiltna Glacier, for example, each climber starts with about 3 weeks of food and by trip's end will have generated 17 days of trash and, more importantly, 17 days of solid human waste weighing (by a very conservative estimate—individual results will vary) about 4 1/2 pounds (2 kg). Since the early 1990s, when climber numbers first surpassed 1,000/year, that amounts to over two metric tons of human fecal waste per year. As of 2023, we estimate that at least 88 metric tons of human waste have been generated by mountaineers on the West Buttress since the route was first climbed by Bradford Washburn in 1951 (Figure 1). Here we describe the history and potential consequences of the National Park Service's efforts to manage that waste and summarize existing research informing best contemporary practices.

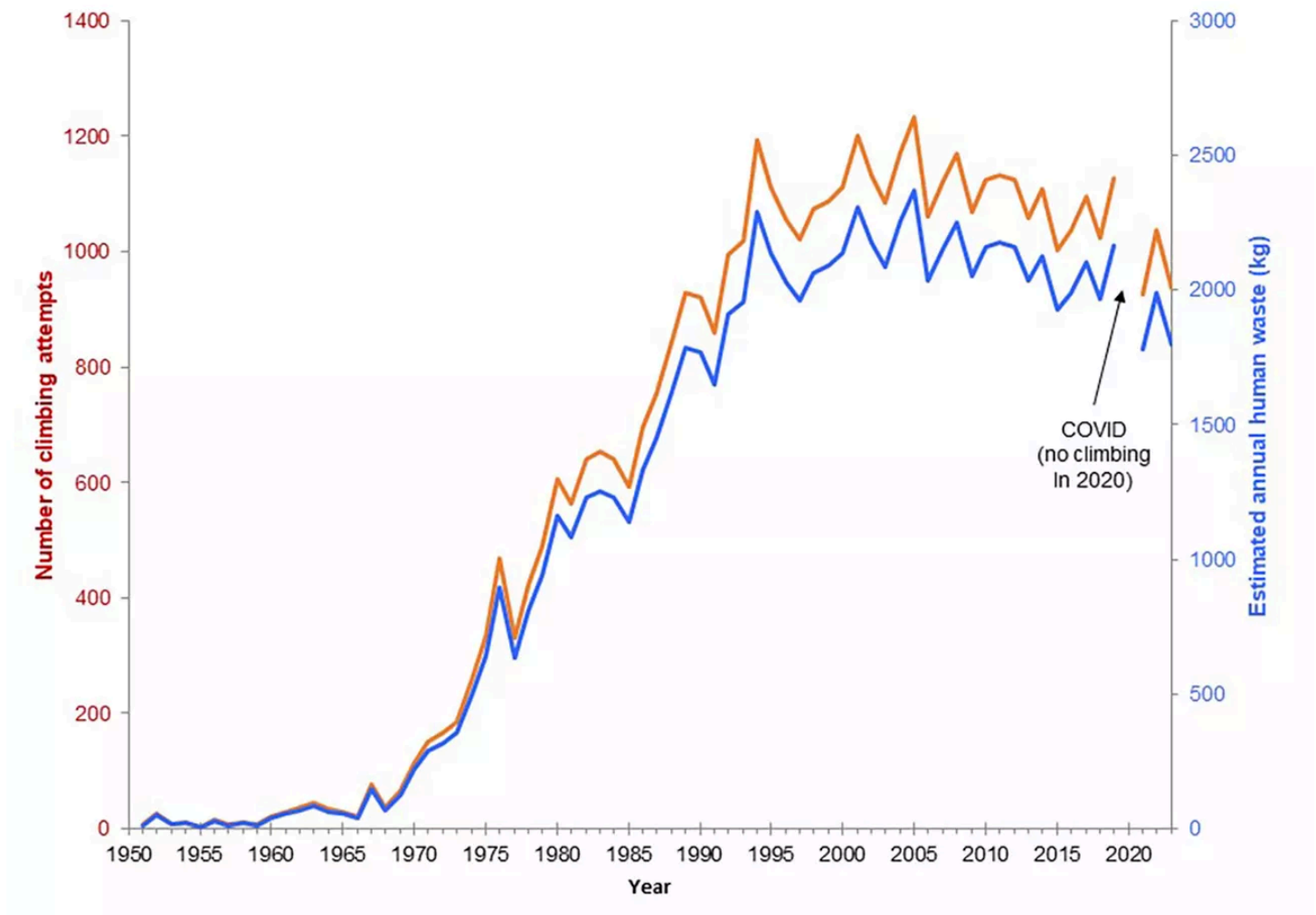


Figure 1. Numbers of climbers on Mt. McKinley's West Buttress climbing route by year (red line) with an estimate of associated annual human waste generation (blue line). Note that climbing on the Kahiltna Glacier was prohibited during 2020 due to the COVID-19 pandemic. Waste estimate assumes 17 days per climber with 113 g average stool weight per day. Based on the stool weight chosen, we calculate that in the last 73 years climbers have generated at least 88 metric tons of human waste on the Kahiltna Glacier.

Keeping the Mountain Clean

Trash and human waste management has evolved over the 70+ years of climbing on Kahiltna Glacier, which is now widely recognized as one of the cleanest high-use mountains (Mt. McKinley is one of the coveted "Seven Summits") in the world. The dedicated mountaineering ranger staff, and especially now-retired ranger Roger Robinson, played a large role in this evolution, starting in the late 1970s and early 1980s with efforts to clean up existing trash and discourage further littering through education and enforcement. Trash was managed quite simply: climbers were expected to carry all trash off the mountain and non-compliance was punished with a citation. Early efforts to manage human fecal waste were two-pronged: climbers were encouraged to dump their feces in deep crevasses, and, for areas without easy access to crevasses, latrines (over deep holes dug in the snow) were installed during the climbing season at high-use areas, especially high on the mountain. These efforts were mostly successful at keeping the glacier surface along the climbing route clean, but concerns grew about surface contamination at the highest camps and about the increasing quantities of feces going straight into the glacier.

In the early 2000s, Denali ranger staff began the first experimental use of Clean Mountain Cans (CMCs—small-lidded plastic tubs specifically designed to receive and transport human feces and toilet paper during climbing expeditions) for temporary waste storage and removal. The rangers also solicited scientific help in understanding the trajectory and fate of crevassed human waste so,

beginning in 2007, we teamed up with Alaska Pacific University graduate student Katie Goodwin and others to conduct a series of studies (Goodwin et al. 2012, Loso et al. 2013), the findings of which can be summarized as follows:

- Once buried in snow/ice, human waste remains intact and biologically active for a very long time (certainly decades and probably centuries),
- Crevassed waste will not be “ground up” in the glacier, but rather will emerge downstream on the glacier surface within roughly 50-200 years, depending on the specific location of burial, and
- No emergent waste has yet been found on the glacier surface, but low levels of *E. coli* are present in the Kahiltna River where it emerges from the glacier, suggesting that englacial waste may already be contaminating meltwater.

By the time those studies were completed, NPS had abandoned the use of pit latrines and required the use of CMCs by all West Buttress climbers. These changes helped to further clean up the glacier surface, especially at high elevation and high use camps, but at that time it was still permissible to dump CMC contents (bagged feces and toilet paper—but not baby wipes or other trash) into large crevasses along the climbing route so that most waste still remained on the mountain.

Partly in response to the studies referenced above, the recent management trend has been to further restrict locations where CMC dumping is permitted. As of this writing, most climbers are allowed to crevasse waste in only one location at a large crevasse below the 14,200’ Camp, and a substantial fraction of the feces they generate on the lower portion of the climbing route ends up being flown off the mountain. Additionally, several guiding companies volunteered in 2019 to begin “full packout” trips where they do no crevasse dumping and all solid waste is removed from the mountain. Because of these changes, a substantial fraction of the human waste now generated by climbers on Denali is ultimately carried on their backs or in their sleds back to the glacier airstrip and flown to Talkeetna at the end of their trip (Figure 2).



Figure 2. Clean Mountain Cans (“CMCs”) that have been returned from Kahiltna Glacier to the ranger station in Talkeetna, where they are typically stored until picked up by a contractor to be emptied and cleaned at a municipal waste management facility.

These particular CMCs took a different path and were intercepted for return to the glacier as part of the experiment described in this article (Goodwin et al. 2012).

Downstream Consequences of Past and Ongoing Waste Burial

What will become of the large volume of human waste already deposited in the glacier? It is difficult to be certain until it finally emerges, but a recent anecdotal observation and a simple experiment provide some insight. In 2020, we used a helicopter to closely

observe a very large ice cliff that drains glacial accumulation from Genet Basin, home of the 14,200' Camp. The cliff (Figure 3) is important because it sits about half a mile (1 km) downstream of the single large crevasse where human waste can still, as of 2023, be dumped by climbers. Our expectation that buried waste will emerge intact and predominantly undeformed by englacial transport was confirmed by a bright object we saw during that 2020 flight. Enlargement of photos taken that day show the object was yellow and orange nylon fabric (part of a tent?) and an apparently undamaged plastic compass. We don't know the story behind the burial of these items but infer from their location about 250 feet (75 m) below the glacier surface that a climber (illegally) dumped them in a crevasse some years or decades prior. In the dark, consistently cool englacial environment there is no reason to expect that a plastic bag of human feces would emerge any less intact and recognizable.

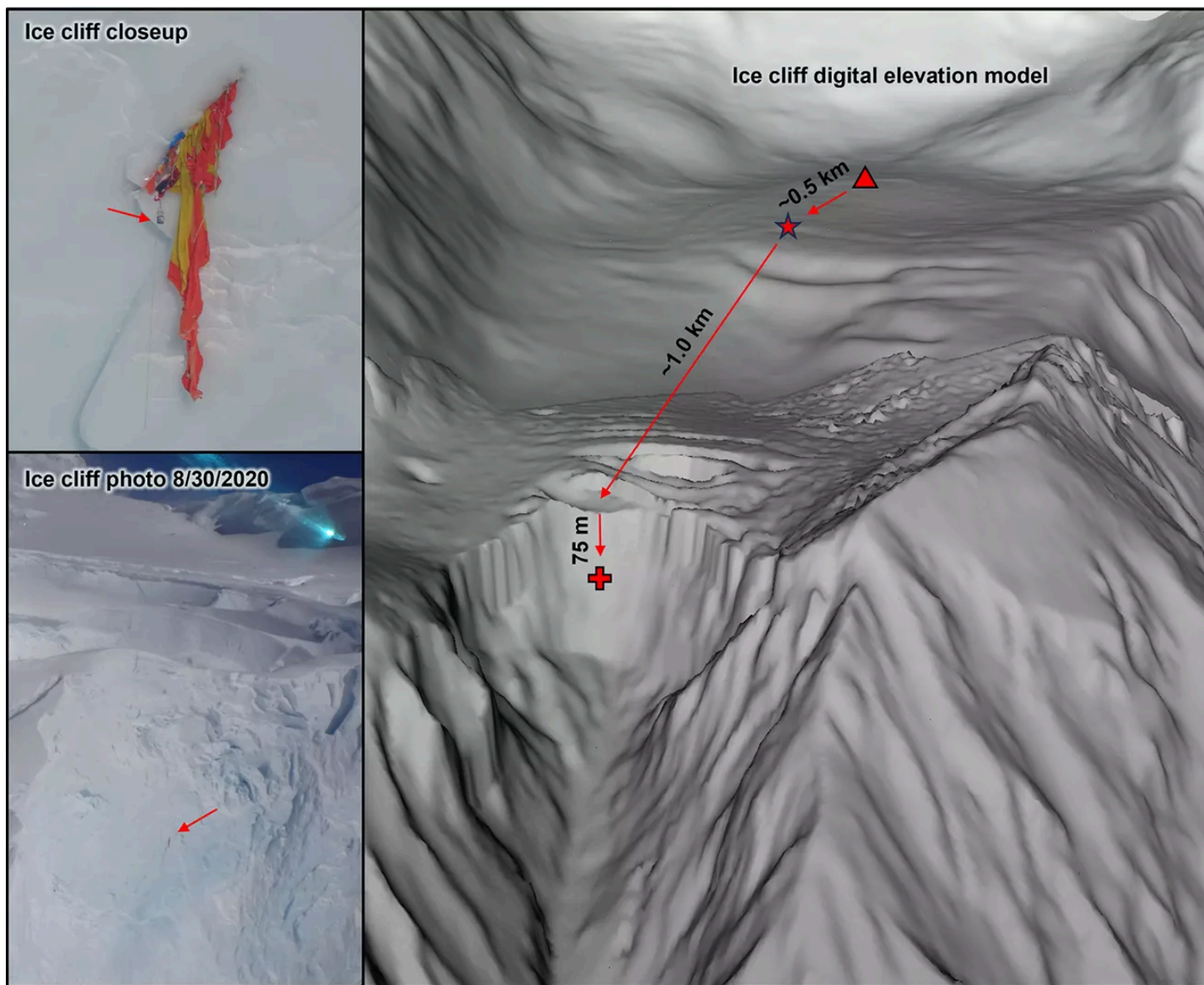


Figure 3. Photographs at left, taken from a helicopter on 8/30/2020, show an ice cliff just downstream from the 14,200' Camp in Genet Basin (red triangle in digital elevation model at right). Just visible in the ice cliff (red arrow in lower photo) is a yellow and orange nylon object (trashed tent). Red cross in the digital elevation model shows the location of the ice cliff and compass, and their relationship to the crevassed glacier upstream. Red star shows the one crevasse designated by park management as suitable for disposal of human waste.

We know from our earlier research that large volumes of that intact, crevassed waste will start to melt out on the comparatively moderate terrain of the lower glacier in coming decades. What then? In what is likely a first (and last!) for the Denali climbing program, in 2016 we began a multi-year experiment in which we randomly selected several full CMCs from the Talkeetna ranger station and flew them to the lower Kahiltna Glacier, near the Pika Glacier tributary ("Little Switzerland") at about 3,600 feet (1,100 m) elevation. There, we dug a hole in the seasonal snow

and deposited the CMC contents at the ice surface where crevassed waste would sit after melting out naturally. We then monitored the waste (Figure 4) and the local microclimate (Figure 5) for the following four summers.



Figure 4. Natural degradation of experimentally deposited human waste on the surface of Kahiltna Glacier from 2016 to 2019. Waste was sourced from used CMCs and buried each winter by snowfall. Photographs depict the comparatively rapid degradation of the poop and biodegradable bags, and also the persistence of embedded trash, including baby wipes.

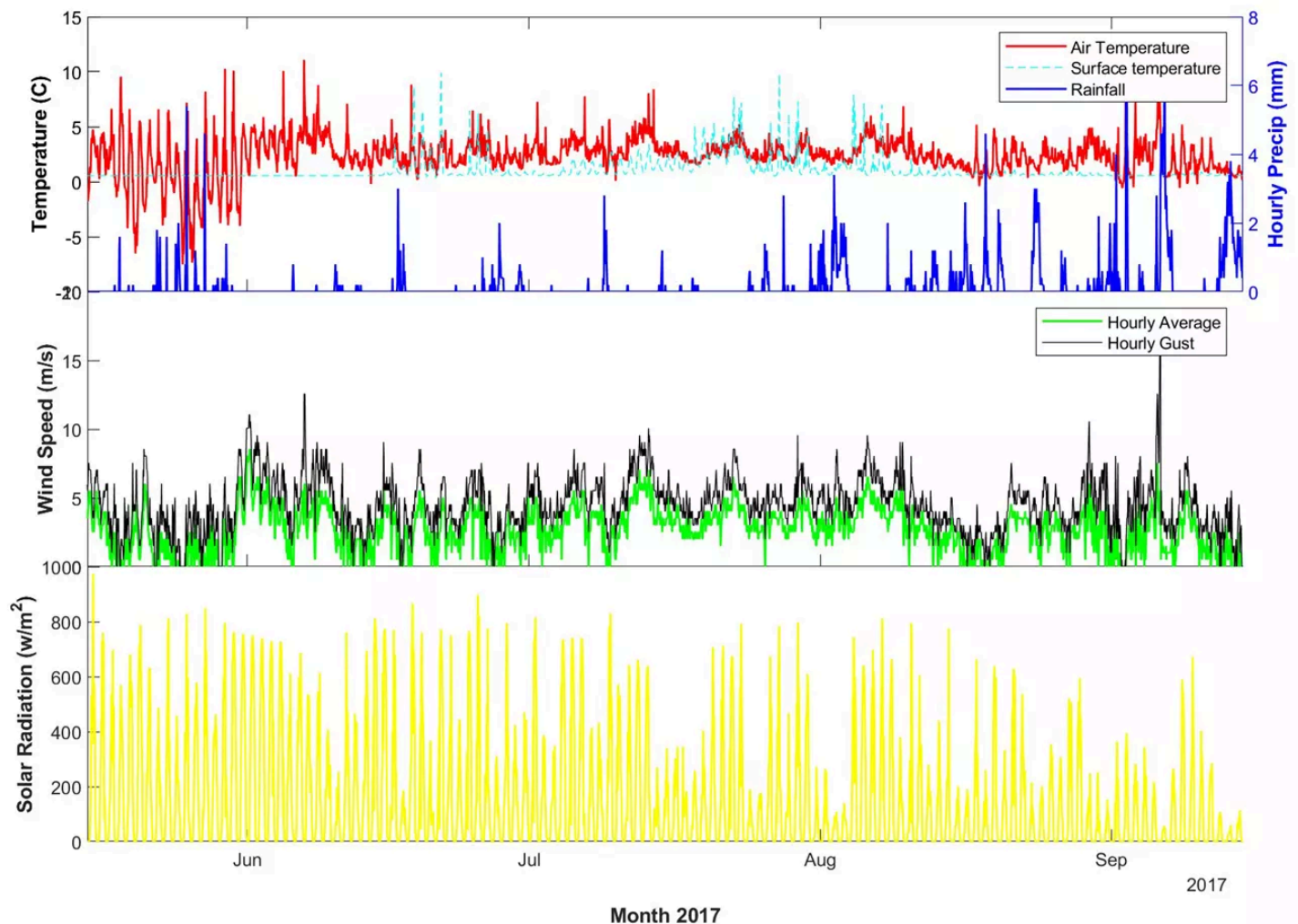


Figure 5. Typical climatic conditions during the 2017 melt season at the waste degradation experiment on Kahiltna Glacier (~1,100 m elevation). Upper panel shows air temperature, rainfall, and the ice surface temperature (which in early and late season is buried by seasonal snow). Middle panel shows hourly average and maximum windspeeds. Lower panel shows incident solar radiation. Maximum seasonal snow depth at this site (not shown) was 1.17 m in winter 2016-17, and averaged 1.90 m over the four years of the experiment.

What we found is that the volume of waste within the initially full biodegradable bags was notably diminished within two summers (Figure 4) and that what had initially smelled terrible was by that time almost completely non-odorous. This is most obviously the result of the very different microclimate on the lower glacier surface. Compared with the dark, cool, steady environment within the glacier, recorded weather conditions at the glacier surface (when snow-free during the summer months, Figure 5) are mostly above freezing, windy, and exposed to substantial solar radiation and rainfall. By the end of the fourth (final) summer, almost all visual evidence of the bagged feces was gone. What remained at the end of this informative qualitative experiment was:

- Trash (not much, since it's against policy to place trash in the CMCs, but there were nonetheless some small items including a conspicuous Lufthansa boarding pass),
- Baby wipes (perhaps not technically trash, but definitely not biodegradable on the timeline of this experiment), and
- Detectable high levels of *E. coli* in small supraglacial meltwater streams immediately downstream of the experiment.

Consistent with previous research, new rounds of water quality testing in terminus area streams once again suggest that the Kahiltna River is already carrying measurable quantities of *E. coli* that are likely sourced from englacial human waste. Using techniques described more thoroughly in Loso et al. (2013) and implemented with substantial

effort by Denali Visitor Use Assistant Becca Stenerson, Figure 6 shows average concentrations of *E. coli* in Kahiltna River and tributaries during the summers of 2016, 2017, and 2018. Values shown are most probable number (MPN) for *E. coli* during an average of 4.4 measurements/site. Results confirm the previously documented pattern of higher concentrations of *E. coli* in the Kahiltna River than in small tributaries, which are the only plausible alternative source (besides englacial human waste) of such contaminants. As before, however, the absolute values of *E. coli* are very low: in all cases well below the EPA recreational waters threshold of 100 colony-forming units (cfu)/100 ml (Figure 6; those units are approximately equivalent to the MPN units used in our tests).

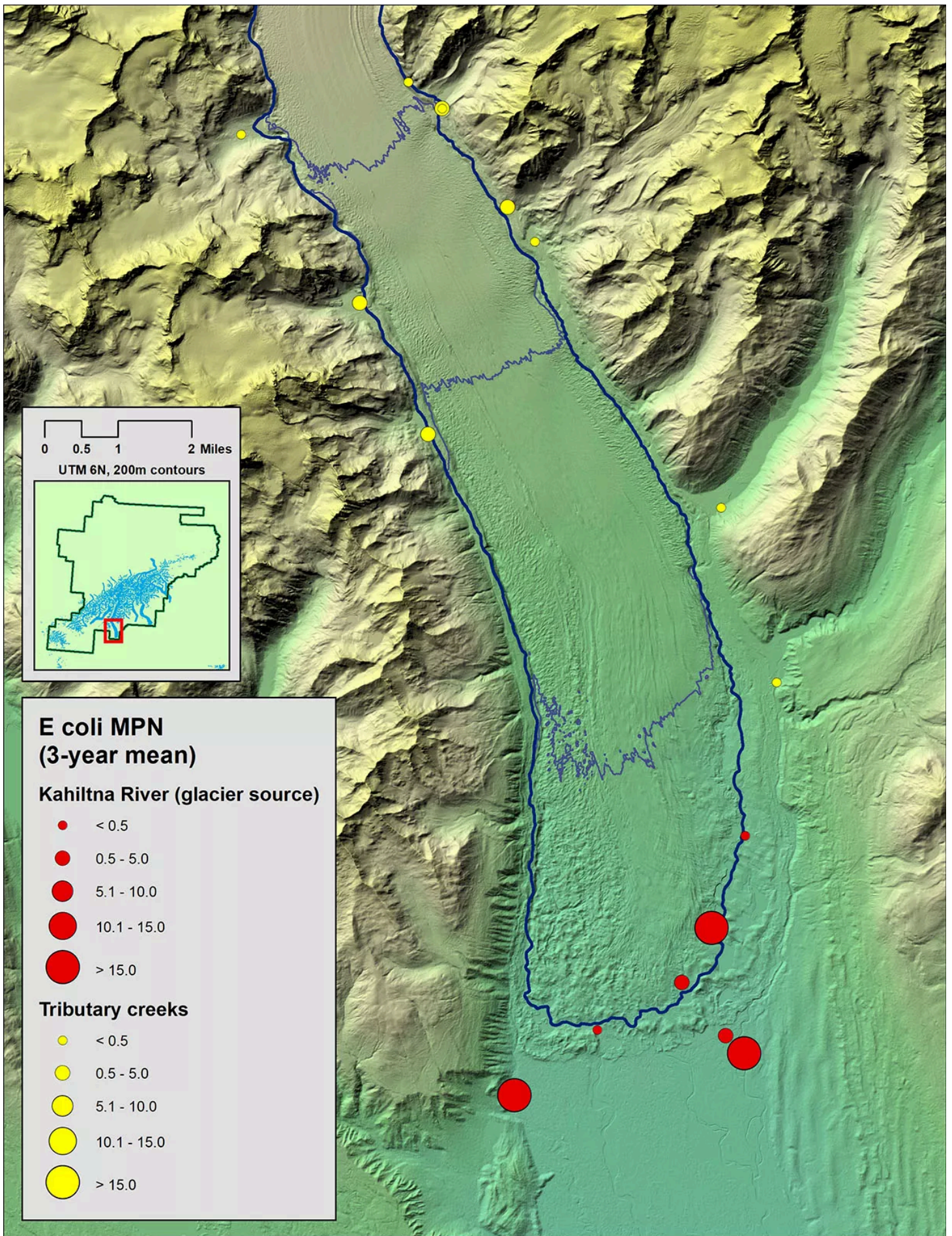


Figure 6. Most Probable Number (MPN) of *E. coli* (mammal/human-sourced fecal bacteria) measured in surface streams near Kahiltna Glacier between 2016 and 2018. Values shown are the average MPN from all samples (average $n=4.4$) collected during distinct visits to each site. Red circles indicate streams that carry subglacial outflow from Kahiltna Glacier, while yellow circles indicate non-glacial tributary streams. Circle size indicates average MPN.

In summary, here's what we now know, with reasonable confidence, is happening with respect to human fecal waste on Mt. McKinley:

1. Crevassed waste (mostly feces and toilet paper, but including some trash) will emerge in coming years mostly unscathed by downstream glacial transport onto the less frequently visited lower Kahiltna Glacier.
2. While buried, human waste remains biologically active and is contaminating meltwater (albeit at levels well within EPA standards for recreational rivers) that ultimately discharges into the Kahiltna River.
3. Once emergent at the glacier surface, unsightly piles of human waste will efficiently biodegrade within 1-several years, leaving behind a longer (decade-plus?) residue of contaminated supraglacial streams and non-degraded trash, including baby wipes.

Owing to the decadal-scale timeline for transporting previously crevassed waste to the lower glacier through gradual flow, it is outside the scope of present managers to substantially alter these conditions in the next few decades. But over a longer timescale, conditions on the lower Kahiltna Glacier and in the downstream Kahiltna River will be determined by decisions made now about the policies for trash and, especially, human waste disposal.

What Next?

The existing waste management program on Mt. McKinley is by most measures a success. Human waste is rarely encountered on the glacier surface; an increasing amount is being carried out by the climbers, less human waste than ever is disposed of in crevasses; abandoned trash is uncommon; there are few outbreaks of communicable illness; and climbers (especially those accustomed to international climbs on popular mountains) commonly remark on the cleanliness of the mountain. None of this is an accident: it has taken years of concerted and coordinated efforts by climbing rangers, guiding services, independent climbers, scientists, and park management to get to this point. But this success is not without cost. Education and enforcement efforts by the Denali National Park and Preserve South District rangers are expensive. NPS pays for purchasing and cleaning CMCs. The life cycle of a CMC—which includes fabrication and shipping, getting repeatedly flown onto and off the mountain, and being trucked down to a waste disposal facility—has a carbon cost that contributes non-trivially to the already significant carbon footprint of a Mt. McKinley climb. And climbers on the mountain, especially including the guide services that have committed to a complete pack-out strategy, can attest that carrying CMCs up and down the mountain is, at best, difficult and unpleasant. Sometimes the added weight of a full CMC might arguably push exhausted climbers into dangerous travel conditions.

Meanwhile, the historic and diminished but ongoing practice of crevassing human waste on Denali has real impacts. The very low levels of microbial contamination in Kahiltna River present a minor but measurable impact. The river is not regularly used as drinking water by any downstream communities, and even for occasional recreational use the contaminant levels are low enough to be considered safe. Nonetheless, the river is demonstrably carrying bacteria from crevassed waste and we cannot rule out the potential for negative impacts of that contamination on fish or other aquatic species. Emergent waste surfacing on portions of the lower glacier will someday soon present an unsightly aesthetic impact on wilderness character, and continued exposure of new piles will negate the otherwise good news that feces breaks down promptly on the glacier surface. To the rare backcountry traveler that encounters these piles many kilometers downstream from the standard climbing routes, the waste will give a very negative impression that undermines some of the wilderness character otherwise so exceptionally embodied in this designated wilderness on the remote south side of the Alaska Range. And to those same uncommon visitors, the locally high levels of contamination in nearby supraglacial streams will pose a potentially significant health hazard. Most persistently, trash and baby wipes inadvertently or illegally deposited with the crevassed waste may progressively accumulate on the lower glacier, resisting degradation and leaving a more distinct mark

of human carelessness on the landscape.

NPS management will have to weigh the foregoing factors when considering any further changes in waste management practices on Mt. McKinley. Climbers no longer question the need to pack out all their trash, but the requirement to pack out some or all human fecal waste remains a contentious issue on such a long expedition. Should *all* climbers be required to pack out an entire expedition worth of solid waste (both trash and feces)? Or conversely, would it be okay to backtrack a bit and allow for the crevassing of human waste in a few more locations so that climbers can travel a little more freely and, perhaps, safely? The new scientific results presented here, in combination with previous research and the hands-on experience of the ranger staff, provide some guidance.

If continued education and enforcement can further discourage the inclusion of trash and baby wipes in CMCs, it may be that a persistent zone of biodegrading human waste on lower Kahiltina Glacier is an acceptable consequence of well-managed human waste disposal on the West Buttress climbing route. In most parks, human waste management strategies generally involve the removal of waste (whether through plumbing, pumped vaults, or subsurface burial) to waste processing facilities where breakdown can proceed without compromising the health, safety, or enjoyment of park visitors. The argument could be made that Kahiltina Glacier does the same thing, albeit imperfectly, for crevassed human waste. Weighing opportunities for a safe mountaineering experience against the persistent impact of emergent waste on downstream wilderness character remains a challenge for management of high-use glacierized mountains worldwide, and Denali National Park and Preserve remains a leader in the field.

Acknowledgements

We thank the Denali South District mountaineering rangers whose efforts, over many years, have contributed to the maintenance of such a clean, safe, and rewarding climbing experience for visitors to one of the world's busiest and most sought-after mountaineering routes. In particular, thanks to ranger Roger Robinson, who worked tirelessly during his long career to highlight and address challenges in the human waste disposal process on Mt. McKinley and elsewhere. Thanks also go to researchers and field assistants who have contributed to this program over the years: especially Katie Goodwin who did the seminal work on this problem while pursuing an MS degree at Alaska Pacific University and Becca Stenerson, who did much of the field and lab work associated with the more recent round of water sampling. Thanks also to Guy Adema, Anthony Arendt, Rob Burrows, Adam Bucki, Matthias Braun, Dustin English, Scott Gende, Andy Hermansky, Chad Hults, Rich Johnson, Adrienne Lindholm, Joe Reichert, Dave Schirokauer, Haley Williams, and Joanna Young.

References

Goodwin, K., M. G. Loso, and M. Braun. 2012.

Glacial transport of human waste and survival of fecal bacteria on Mt. McKinley's Kahiltina Glacier, Denali National Park, Alaska. *Arctic, Antarctic, and Alpine Research* 44(4), 432–445. doi:[10.1657/1938-4246-44.4.432](https://doi.org/10.1657/1938-4246-44.4.432) (<https://doi.org/10.1657/1938-4246-44.4.432>).

Loso, M. G., K. E. Goodwin, H. Williams, R. Johnson, D. English, and M. Braun. 2013.

Glacial transport of human waste and survival of fecal bacteria on Mt. McKinley's Kahiltina Glacier, Denali National Park, AK. Natural Resource Technical Report NPS/AKR/NRTU-2013/784. National Park Service, Fort Collins, Colorado.

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