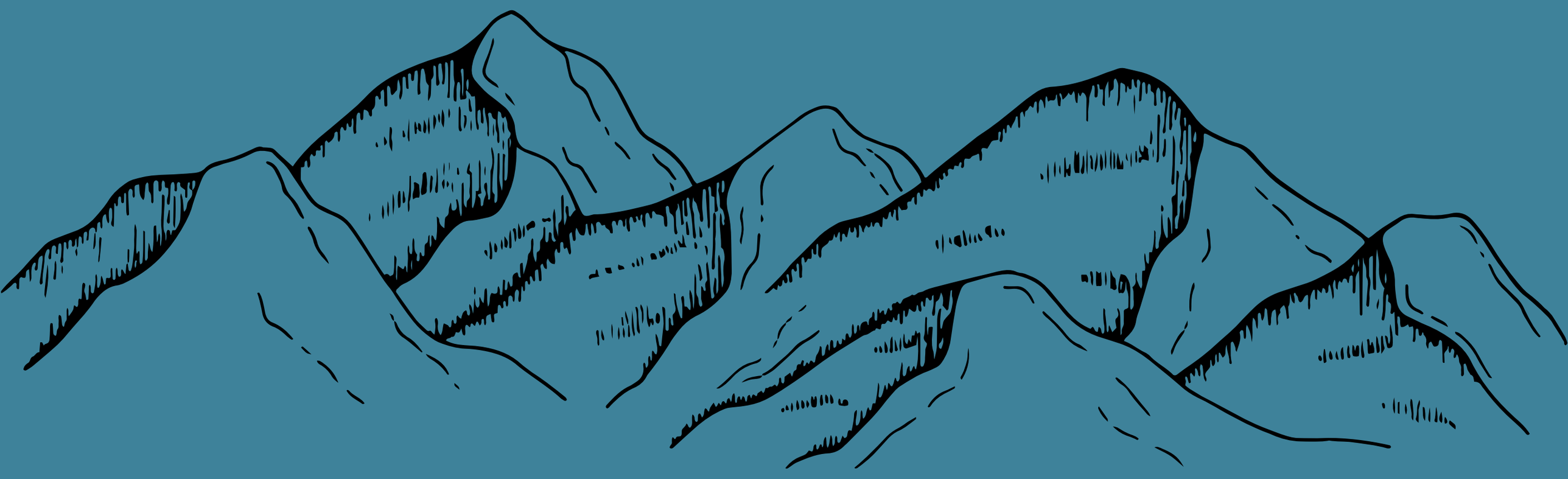
WHERE THE BODY MEETS THE MOUNTAIN

An Exploration of the Convergence of Wilderness Medicine and Ethics



Adventure, Risk, and Rescue
2023-2024 Final Praxis Lab Report
University of Utah Honors College

Honors Ethics and Wilderness Medicine: Adventure, Risk, And Rescue was one of two 2023-2024 University of Utah Honors College Praxis Labs. Professors Margaret P. Battin, MFA, PhD and Trahern W. (“TW”) Jones, MD taught the class. The students who contributed were Lily Halberg, Stephanie Horvath, Harper Howe, Rachel Muhlestein, Zev Katz, and Savannah Romney

INTRODUCTION FROM THE PROFESSORS

In 2023, the U.S. National Park system recorded over 325 million recreational visits, an increase of 13 million from 2022, and quite nearly on par with the record highest year in 2016, when the park system recorded over 330 million visits.[1] Moreover, similar trends in outdoor recreation show increasing numbers of higher-risk activities in the country's wild spaces. In the U.S., the number of self-reported rock climbers has risen from 6 million to 10 million in the past two decades, while skiing and snowboarding continue to grow in popularity each winter, and the overall outdoor industry now represents a nearly 680-billion-dollar economy in itself.[2,3] Our social media are filled with images of outdoor recreation to emulate, ranging from hiking, canyoneering, and backpacking, to diving, mountaineering, paragliding, and caving. The spirit of adventure is alive and well, it would seem, and glorified to boot.

Impressive as this spirit is, adventure is not only defined by its positive attributes but also by the bodily risks it poses. Though modern safety technology has mitigated the dangers of climbing sheer faces of granite or plunging down a whitewater river, participants must still face the possibility of serious injuries or death. The clinical field of wilderness medicine has grown up around the realization that such hazards require specific training for emergency treatment and evacuation in often remote and dangerous environments.

Thus, there is now a flourishing medical field taught in many medical schools and with extensive online information. Outdoor participants can now seek certification in Wilderness First Responder and Wilderness Emergency Medical Technician training. Physicians around the world can gain medical education credits by attending conferences, and the Wilderness Medical Society publishes new case reports, scientific research, and management guidelines in its flagship journal, Wilderness and Environmental Medicine.

However, little formal attention has been given to the ethics of managing such risks and adventures. How do we choose acceptable levels of risk when planning our encounters in the wild? How do we mitigate the risks we choose? And what decisions do we make when our priorities turn from fun to survival? Moreover, what motives and attitudes guide our own approaches to adventure in the first place? Here, the philosophical subfield of bioethics is supremely adapted to address such issues, moving beyond its original orbit of hospital care and biological research to many new areas of ethical challenge.

Fortunately, we have reasoned, pairing the academic field of Bioethics with the clinical field of Wilderness Medicine is an as-yet-untapped opportunity for reflection, study, and renewed engagement with the thrills and risks of adventure in the world's wildlands something applicable to situations

everywhere around the globe. During the Fall 2023 semester, we presented and discussed such topics with our undergraduate Honors and Honors Praxis Lab students. In order to address the ongoing gap in scholarship and public perceptions of these concepts, our students recognized the need for a foundational book in this new area, ethics and wilderness medicine. Hence, Where the Body Meets the Mountain was born.

Undertaking the construction of an original book in an as-yet-unexplored field is no small feat, but with a plan, instructor guidance, and countless hours of writing, rewriting, revision, editing, and more writing, our students have laid the cornerstone for a truly exceptional and exciting book. We are privileged to join them in their presentation of what could well establish a new academic field, bioethics and wilderness medicine.

– Margaret P. Battin and Trahern W. Jones

1. National Park Service. About Us. February 22, 2024. Accessed April 30, 2024. https://www.nps.gov/aboutus/visitation-numbers.htm
2. Statista. Number of Participants in Climbing in the United States from 2006 to 2021. April 22, 2024. Accessed April 30, 2024. https://www.statista.com/statistics/191233/participants-in-climbing-in-the-us-since-2006/
3. Outdoor Industry Association. State of the Outdoor Market, Fall 2022. Accessed April 30, 2024. https://outdoorindustry.org/wp-content/uploads/2022/12/OIA-State-of-the-Outdoor-Market-Report-Fall-2022.pdf

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MEET THE CREW

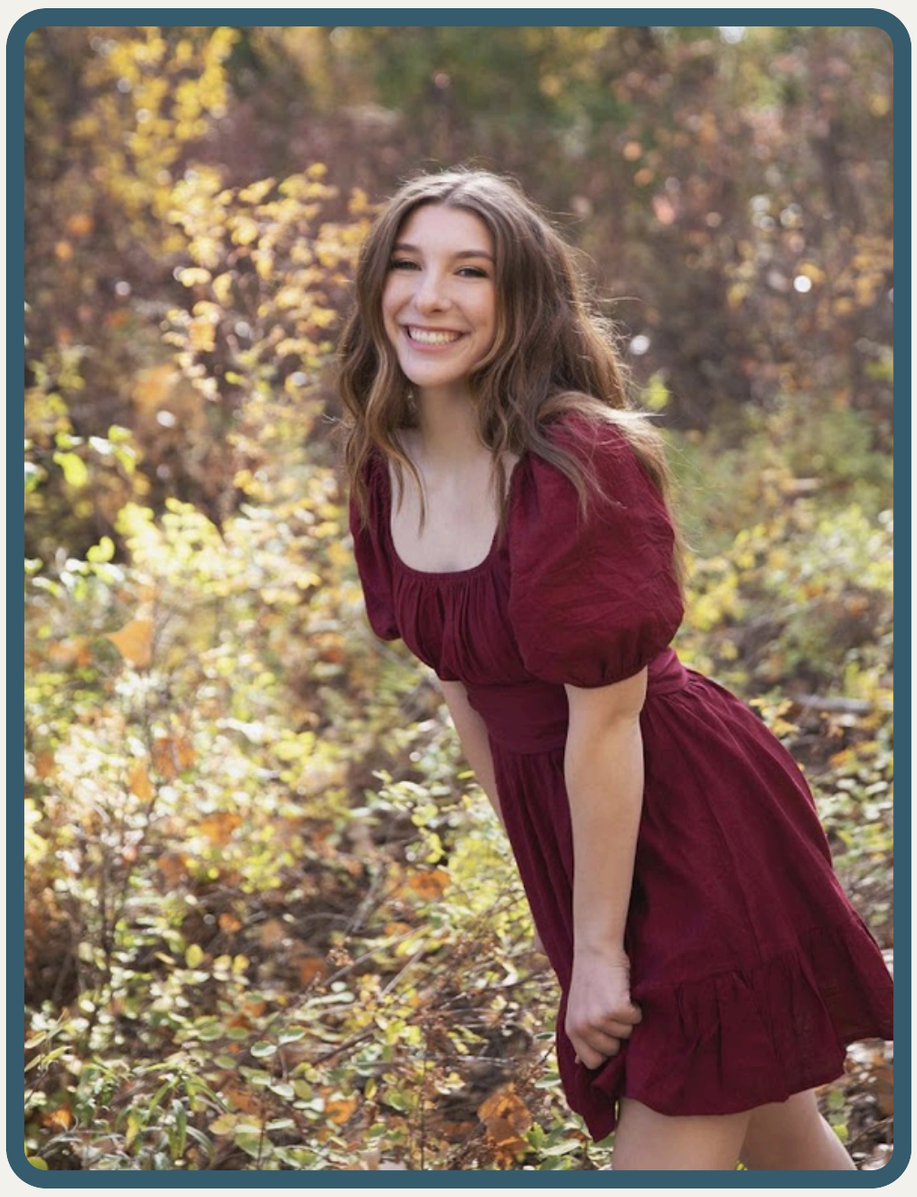
Lily Halberg

Hello! My name is Lily, and I'm a third year undergraduate studying Plant Biology. I love spending time outdoors in nature. Spring is the best time of the year, especially when all the flowers are in bloom. After graduation I hope to pursue a Masters or PhD in biology. I am especially interested in Pharmacology and Toxicology.

Stephanie Horvath

Hello! I I am an upcoming 3rd year here at the University of Utah pursuing my undergrad in an Honors degree and a bachelors in Civil Engineering. I am currently pursuing my passion for engineering and construction through a summer interning with Mortenson, a general contracting firm in Salt Lake City. I came to Utah two years ago from Colorado for school, and have enjoyed exploring Salt Lake and the surrounding areas thus far. My parents taught me how to ski when I was two, and I have loved it ever since. Some of my other favorite activities include mountain biking, hiking and adventuring into the outdoors as much as I can. After I graduate, I plan on working at an engineering or construction firm and continuing my education at a graduate program.

Harper Howe

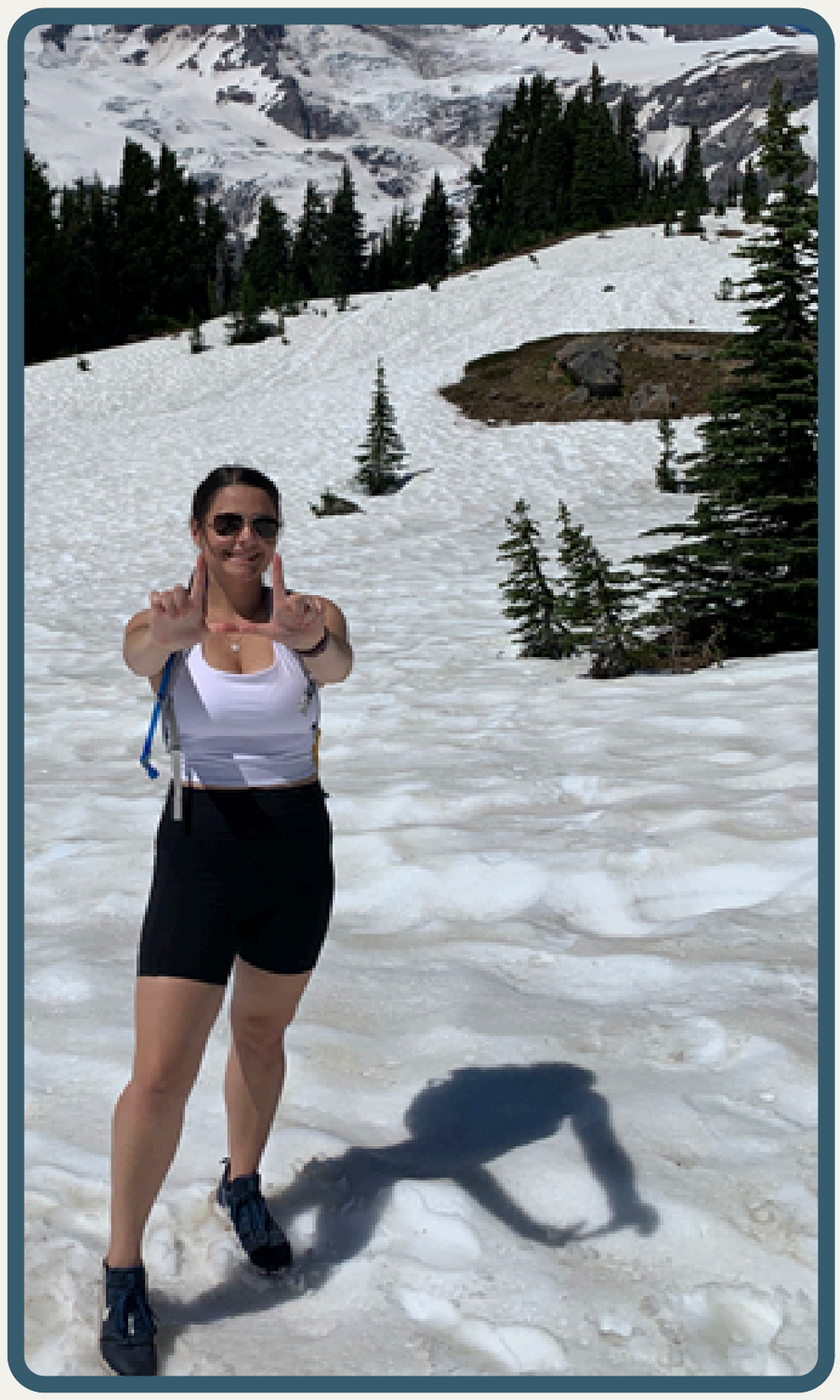


Heyo! I am an upcoming 3rd year here at the University of Utah aspiring to graduate with an undergraduate Honors degree in Earth and Environmental Science with an emphasis on ecosystem science and a minor in Modern Dance. For a couple of years after undergrad, I would like to travel and dance around the world and then go to graduate school for Conservation Biology. I plan to design conservation and/or restoration projects to restore wastelands into natural habitats helping combat climate change and further environmental education. Currently, I am the Education Intern for PBS Kids Utah, working on educational outreach within the Utah youth community. My interests include skiing, anything outdoors, dancing, music, and being as adventurous as possible.

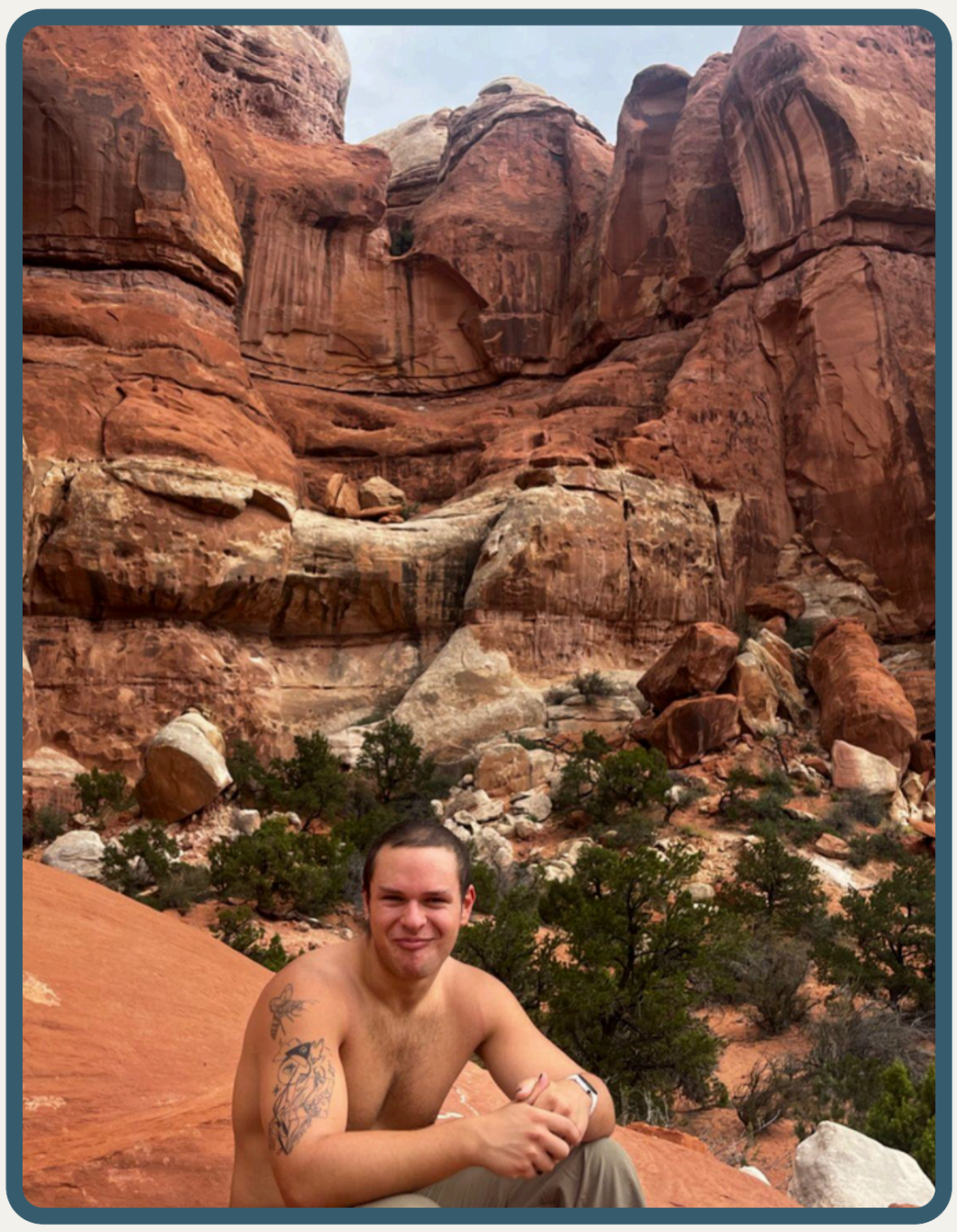
Rachel Muhlestein

Hello! My name is Rachel and I am from Lehi, Utah. I am a third-year undergraduate student pursuing an honors double major in biochemistry and biomedical physics. I love being outdoors and I spend most summer weekends camping in Utah and surrounding states. My favorite outdoor activity is canyoneering. I plan to complete an MD/PhD program after graduating to eventually work in medical research.

Savannah Romney



My name is Savannah Romney, and I am a third-year student studying biology with an emphasis on genetics/genomics and a minor in chemistry. I hope to attend medical school to become a primary care physician. I am passionate about preventative medicine and women's health, so a career in obstetrics and gynecology seems probable. I am a certified Emergency Medical Technician and love thinking on my feet. Being prepared for medical emergencies has always been important to me, and wilderness medical knowledge has been a great addition to what I already know. Bioethics is relatively new to my studies but has become
a major interest of mine throughout this year. Growing up in Utah, I have spent ample amounts of time in the outdoors, whether that be in the mountains or national parks. My favorite national park to date is Mount Rainier National Park in Washington!



Zev Katz

Hey, I am Zev a current 3rd year at the University of Utah pursuing a double major in applied math and physics. I was born and raised in Salt Lake City growing up exploring the Wasatch Mountains by foot, bike and skis. After graduation, I hope to utilize the knowledge I learned throughout this course by spending a couple of years as an outdoor guide either on a raft or by bike.

MEET THE PROFESSORS

Margaret P. Battin, MFA, PhD

Distinguished Professor of Philosophy and Adjunct Professor of Internal Medicine, Program in Medical Ethics and Humanities, at the University of Utah.

I love writing books. I've authored, co-authored, edited, or co-edited at least twenty so far (I think I've lost count), including works on philosophical issues in suicide, case-puzzles in aesthetics, ethical issues in organized religion, two collections of essays on end-of-life issues, The Least Worst Death and Ending Life; I've been the lead for two multi-authored projects, Drugs and Justice and The Patient as Victim and Vector: Ethics and Infectious Disease, brought out again by OUP with a new Preface on Covid-19; and I've won the University of Utah's Distinguished Research award and received the Rosenblatt Prize, the University's most prestigious award. But it's continuing projects that seem important to me: a huge sourcebook, The Ethics of Suicide: Historical Sources, published by Oxford University Press, coupled with an online Digital Archive at ethicsofsuicide.lib.utah.edu; Living in What-If Land, exploring real-life thought experiments with normative force, a book still in draft. Then there's the slide talk Nuevo Favela: How to live in an Italian hill town and still get to Walmart, about urban design for maximal environmental benefit. Currently appearing is Sex and the Planet: What Opt-In Reproduction Could Do for the Globe, published May 28, 2024, by The MIT Press. This is a book on large-scale reproductive problems of the globe, including population growth and decline, teen pregnancy, abortion, and male roles in contraception, religious opposition to contraception, and the costs that this immense thought experiment might involve. Of course, there's hardly ever enough time to address all the problems one might want to take on, but big new make-the-world-a-better-place ideas seem to me what it's all about.

Trahern W. (“TW”) Jones, MD

Dr. Jones is an Assistant Professor of Pediatrics at the University of Utah School of Medicine. He is a husband, father, physician, and lifelong climber and adventurer. He has almost three decades of experience in the alpine throughout the United States, with summits in the Alaska Range, Cascades, Tetons, Rockies, Sierra Nevada, and, more locally, the Wasatch. He primarily practices as a subspecialist in pediatric infectious diseases at Primary Children’s Hospital, where he also teaches the principles of pediatric medicine to medical students, residents, and fellows.

COURSE OVERVIEW

The Praxis lab began with a semester-long course called "Ethics and Wilderness Medicine: Adventure, Risk, and Rescue." This class was taught by faculty members Dr. Peggy Battin, MFA, PhD and Dr. TW Jones, MD.

On the first day of class, students were posed an ethical dilemma. In 1985, Joe Simpson and Simon Yates were on an alpine climbing expedition on the West Face of the Siula Grande. On the adventure's descent, Joe fell on an icy cliff and broke his leg. Simon was then tasked with getting both Joe and himself off the mountain. In a stroke of bad luck, Simon lowered Joe into a crevasse. The gap between the two men was too large to communicate, and Simon had no idea how far off the ground Joe was. Impending weather looked dangerous and a night on the mountain would cause probable hypothermia for both men. At this point Simon had a choice: does he cut the rope and let Joe fall an unknown distance or does he not cut the rope and risk them both dying? Students recorded their responses to the question and the votes were tallied. Nearly 60% of students chose to cut the rope, while 40% did not. While there is no right or wrong answer, students discussed their approach to making a decision.

With students from PHIL5520, PHIL6520, HONOR2710, and HONOR3700 meeting in this conglomerate course, our classroom was filled with students from diverse backgrounds and varying areas of expertise. We had graduate and undergraduate philosophy students, STEM students, Honors students, and many wilderness enthusiasts. The course's unique structure allowed for lively discussions about ethical dilemmas in wilderness settings. We consider whether or not there could be a right or wrong answer or if a right or wrong answer is even needed.

Wilderness Medicine topics were presented by TW Jones each week. The medical topics covered in the course were as follows:

Human Endurance and Survival

Heat Illness and Dehydration

Nutrition and Starvation

Water Travel and Drowning

Safety Around Wildlife

Dive Medicine

Children and Families

UV Radiation and Sun Protection

International Travel and Tropical Medicine

Weather and Climate Change Hazards

Acute Mountain Sickness and Altitude Medicine

Avalanche Hazards

Philosophy concepts were presented by Dr. Battin or Philosophy students each week. The ethical concepts covered in this course included:

Consequentialist vs. Non-Consequentialist Theories
Individualism and Rights
Paternalism and Autonomy
Egoism
Scarcity, Rationing, Conservation, and Speciesism
Altruism
Competence
Justice
Insurance
Contract Theory
Risk Assessment

Each class generally included information on, or related to a type of outdoor activity. Among others, these included:

Climbing and Mountaineering
Canyoneering
Canoeing and Kayaking
Backcountry Skiing
Caving

As an example, one day of the class consisted of a medical lesson on avalanches, an ethical lesson on risk assessment, and an analysis of skiing-related case studies. Andy Rich attended our class as a guest lecturer and discussed avalanche conditions. His presentation included information on a mountain's slope, the snowpack, and the surrounding terrain and weather. It also described how these factors can be used to assess the likelihood of an avalanche occurring given specific conditions. We also discussed how avalanches are triggered and what someone can do to prevent and/or prepare for avalanches in the outdoors. Next, we discussed risk assessment concerning decision-making in outdoor activities. We asked questions like: When does an activity become too risky to participate in? How can one prepare for potentially hazardous conditions? What drives someone to participate in a high-risk activity? Finally, we discussed cases that related to skiing. The case studies were integrated into the avalanche presentation.

Each student in the course was required to complete the Associate in Wilderness Medicine certification through the University of Utah. This certification proves competency in wilderness medicine topics including basic wilderness life support, backpacking medicine, search and rescue, and travel medicine.

To finish the course, our Praxis lab group was asked to give a presentation to the class about our project plans for the Spring 2024 semester. Through collaboration and planning from our team, our Praxis lab chose to write a book analyzing the intersection of bioethics and wilderness medicine for our project.

PROJECT OVERVIEW

Partway through the first semester, the Praxis Lab students started to debate on what our project should be and look like. Through learning in class and conversation, the group discussed a variety of ideas to combine bioethics and wilderness medicine into one project to leave an impact on our school and society. Some ideas included educational videos, collaborating with other clubs and organizations on campus to provide medical expertise and advice when going into the outdoors, making a website to educate and bring information to the public about bioethics and its impact on everyday recreation, and a book: shaped similar to our class. While each proposal seemed engaging and fun for us to work on, through extensive research, we found that there were no books or books that combined wilderness medicine and bioethics together into one seminar. Thus, we became captivated in creating the first-ever book (that we knew of) that combined these topics together: and our project was born.

Although we had finalized what our project would be, we now had to figure out how to write, organize, and make a book, which none of us had completed before besides our professors. Thankfully, through this entire year, they have provided expert advice and support as we have worked together to make this project come to life. It took several weeks for us to find which topics we wanted to include in our book, and how we wanted to present them. Our first draft of chapters and an outline of the chapters was presented to our class during our final, and included separate chapters on: ethical theories, general first aid, snow sports, mountaineering, climbing, caving, backpacking, water recreation, and other sports. While this was a good start on the topics that we wanted to include, through additional work, our chapters changed continuously throughout the next semester to a finalized list of the following:

1. **Medical and Ethical Introduction**
2. **Climb if you will:** Ethical Frameworks and Their Applications
3. **Lines, Aspects, and Avalanches:** Risk Assessment in the Wild
4. **Descending Into the Abyss:** An Exploration of Caving and Justice Ethics
5. **The Mountains Know:** Rescue, Recovery, and Other Professionals in the Wilderness
6. **Moments of Perfection:** The Perceptions of Risk and Gender in the Outdoors through the Lens of Egoism, Altruism, and Altitude Sickness
7. **Sandstone and Paperwork:** Paternalism, Autonomy, and the Limits to Recreations in the Wild
8. **Screw Your Head On:** Newcomers, Children, and Social Justice in the Backcountry"

Other potential topics that have not been written, (but will be covered over the summer, including the creation of titles) include:

Water Travel and Drowning

Backcountry Travel, Endurance and Nutrition Medicine, and Survival Psychology

Hunting, Fishing, and Wildlife Medicine and Ethical Considerations

Since this was a massive project for a group of six undergraduate students, we split the work in an even way to allow all team members a chance to work on what they wanted to specialize in and to allow for all members to work on an even amount of the book so that it wouldn't be as overwhelming. The chapter, "Lines, Aspects, and Avalanches: Risk Assessment in the Wild," was first started during the end of the Fall 2023 semester and completed during the beginning of the Spring 2024 semester. During December of 2023, the group decided to split the remaining chapters within the group, so that each team member could write their own chapter on a chosen topic. Once the list was finalized on the topics, each team member worked on their respective chapter throughout the Spring semester with the guidance and support of Professor Battin and Professor TW.

The chapters were spread accordingly to the following:

1. Medical and Ethical Introduction – **Professor Battin and Professor Jones**
2. Climb if you will: Ethical Frameworks and Their Applications – **Stephanie Horvath**
3. Lines, Aspects, and Avalanches: Risk Assessment in the Wild – **Entire Group**
4. Descending Into the Abyss: An Exploration of Caving and Justice Ethics – **Savannah Romney**
5. That Others May Live, Recovery, and Other Professionals in the Wilderness – **Lily Halberg**
6. Narrow Moments of Perfection: The Perceptions of Risk and Gender in the Outdoors through the Lens of Egoism, Altruism, and Altitude Sickness – **Harper Howe**
7. Sandstone and Paperwork: Paternalism, Autonomy, and the Limits to Recreation in the Wild –**Rachel Muhlestein**
8. Screw Your Head On: Newcomers, Children, and Social Justice in the Backcountry – **Zev Katz**

Other roles too help finalize the book have been subdivided into the following:

Line editing – Savannah Romney
Coherence editing – Harper Howe and Rachel Muhlestein
Graphics Editing – Zev Katz and Stephanie Horvath
Fact-checking editing – Lily Halberg
Interview editing – Zev Katz
Backgrounds editing – Stephanie Horvath
Philosophy editing – Peggy Battin
Medical editing – TW Jones

The three potential chapters will be split evenly, according to interest, and availability throughout Summer 2024. By doing this, the team members will be able to work on our project continuously throughout the summer to complete the book in a timely manner and to perfection. Throughout the year, the group was able to continuously learn and grow from lectures, books, independent study, and interviews that were presented during and after class hours, providing new insights about bioethics and wilderness medicine alike.

Throughout the first semester, case studies were presented to our class, focusing on a person or group of people who were caught in an accident or tough situation. With the help of our professors, we worked through each case study, finding large ethical questions, and learning wilderness medicine. Thus, the Praxis Lab group decided to educate the readers through case studies presented in each chapter. While the outline of each chapter is unique, they each include two to four case studies, exemplifying dangers in the outdoors, ethical concerns, and how to stay safe while having fun. Additionally, each chapter includes an interview with a professional or outdoor enthusiast in their respective outdoor field for the audience to gain more knowledge and experience through the book. While we understand that it is difficult to exemplify a classroom setting through a book, we believe that by looking at each case study individually, readers can still gain value and insight into something they may not have thought of before.

As such, we are excited to continue working on this project through the remainder of the Spring 2024 school year and look forward to the development and completion of it throughout the summer by looking for publishing options to finalize our hard work. Throughout the past year, we have worked hard to find a way to show our learning in an impactful way, and we cannot wait to see where this book culminates in several years from now.

TIMELINE OF COURSE AND PROJECT

August 2023: The HONOR 3700 course commences, introducing us to topics related to adventure, risk, and rescue.

October 2023: Recognizing the need for a comprehensive resource exploring the intersections of wilderness medicine and ethics, our group decided to write a book encompassing the topics we've studied throughout the fall semester.

December 2023: We present our plans and findings to students from graduate philosophy classes and another honors course in a final presentation for the Fall 2023 semester.

January 2024: Work on our book begins.

February 2024: The first draft of our first chapter is completed.

March 2024: Our group meets with the Oxford University Press to propose our book for publication.

April 2024: With the first drafts of seven chapters now completed, our group presents our progress at the Praxis Lab Summit during the Honors College Showcase.

May 2024: Work on our book continues as we push our book towards publication

SAMPLE CHAPTER

"Lines, Aspects, and Avalanches: Risk Assessment in the Wild"

Backcountry Skiing and Snowboarding: Avalanches, Hazards, and Risk Assessment

When encountering risk in the backcountry, we have to make decisions on whether the risk is worth taking based on the unknowns and the knowns. Understanding avalanche danger and other hazards, equipment familiarity, and assessing peril will mitigate risk in the backcountry. Backcountry skiing and snowboarding can be a high-risk, high-reward experience but without the right knowledge, fitness, and preparation how much is the risk worth it? In this chapter, we will explore three case studies of accidents that transpired during back-country skiing expeditions, examining the role of risk assessment principles in each instance

Background

For many millennia, overland winter travel has posed difficulties for human beings in the alpine, arctic, and subarctic regions of the world. In many regions in winter, snowpacks can achieve a consistency and depth that makes the simple act of walking exhausting or even impossible. Moreover, footwear may become soaked in snow, and prolonged exposure to cold temperatures due to inefficient locomotion becomes a risk for hypothermia. To meet these limitations of winter travel, Indigenous groups of the north historically developed numerous solutions to winter travel, ranging from sleds, sled dogs, and snowshoes, to skis.1-3 However, avalanches in high-angle terrain have always posed a serious threat in the backcountry, and only recently has technology caught up to mitigate this deadly risk to winter alpine travel.

Skiing was originally developed as a transportation technology in the austere conditions of Northern Russia and Scandinavia nearly 8000 years ago, where it allowed hunter-gatherer groups to cross woodlands and taiga deeply drifted in winter snows while searching for wild game or migrating between regions. Throughout the ensuing centuries it was an essential survival tool for peasants, woodsmen, and traditional hunters of the far north. Over time this folk technology was gradually employed in military applications among the national armies of Scandinavia, particularly in Norway, where the first recorded army competition took place in the 1760s. Featured events included skiing down slopes, around trees, across flat plains, and while shooting rifles. Gradually, the leisure and entertainment opportunities of the technology became more apparent, and its use was extended into civilian recreation and competition. From its epicenter in Norway, skiing in its most popular manifestations - Nordic or cross-country skiing, and Alpine or downhill skiing - was brought to mainland Europe and North America.

Backcountry skiing—the act of climbing uphill to ski down again, usually away from groomed slopes and without the benefit of a chairlift or other permanent infrastructure—embodied the original spirit of downhill skiing. Historically, downhill skiing necessitated traveling to an appropriate slope, walking up with one's skis on the shoulders, or skinning up with animal skins attached to the bottom of the skis, and then attaching the skis to one's boots and riding down again. While downhill ski competitions in the United States have existed since at least the 1860s, and many ski schools date from the early 1900s, the first tow rope was not invented until 1934 in Vermont, while the first chairlift was not invented until 1936 in Idaho. Truly, the concept of "Earn your turns" was not the maxim of a disciplined few, but rather the uniform reality of any skiing enthusiast of the early 20th century.

Nowadays, as ski resorts have proliferated across the landscapes of nearly every major cordillera in six out of seven continents in the world (indeed, even Africa with its tropical and subtropical latitudes claims resorts in the Atlas mountains of Morocco and the high peaks of Lesotho and South Africa), five backcountry skiing and snowboarding have evolved into their signature sports. Indeed, due to the risk of

avalanches and complex terrain, these activities serve as an excellent highlight of concepts in risk assessment and management.

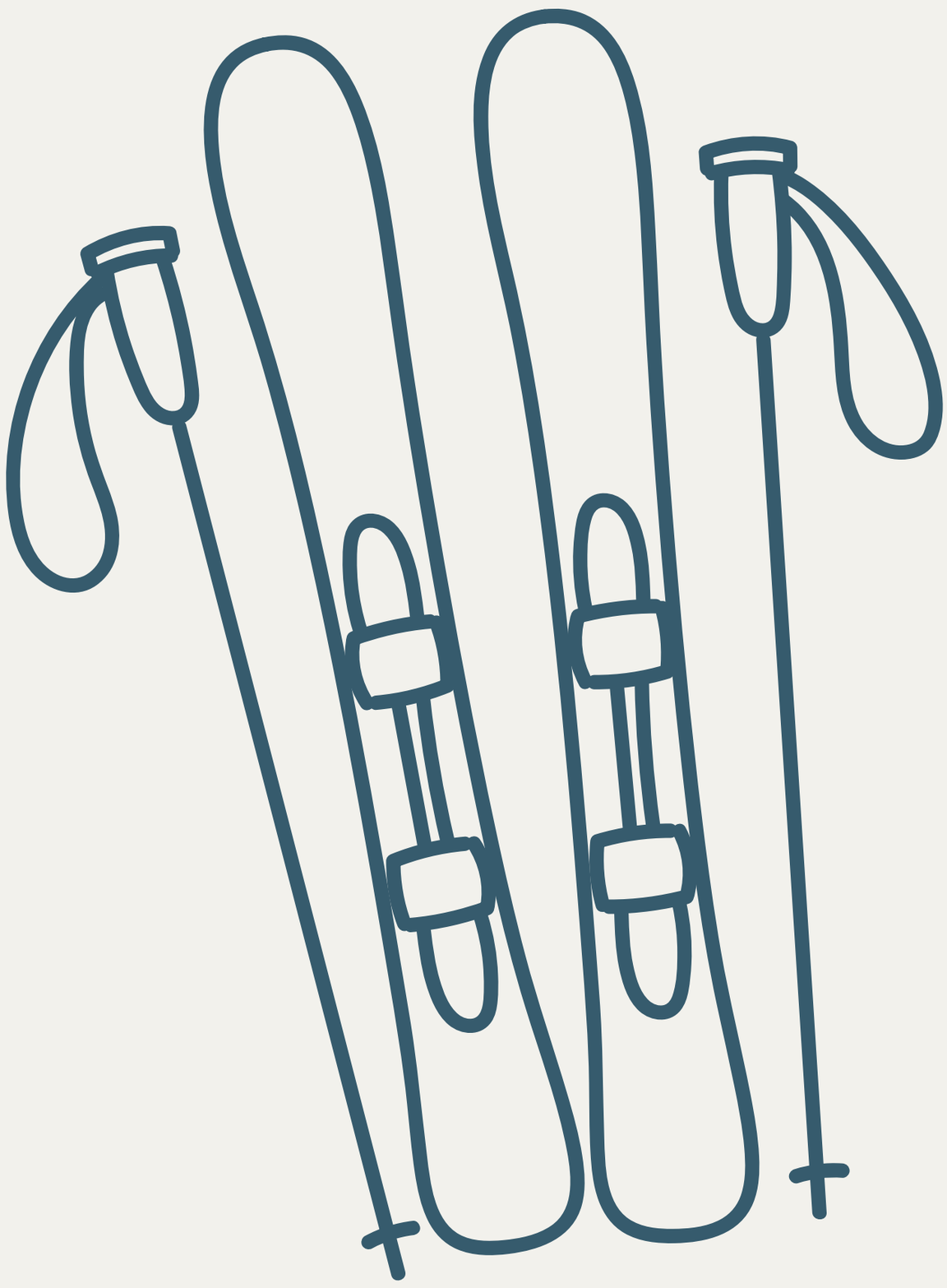
Modern backcountry skiers typically employ lightweight skis with specialized bindings and boots that allow for two methods of travel—uphill or downhill. Special "skins" are attached to the undersides of the ski with reusable glue and clip-on tabs during uphill travel. These skins are covered in nylon hairs oriented in one direction, and the name "skin" itself is literally derived from seal and horse furs used historically for this purpose. The unidirectional orientation of the fibers or hairs allows the ski to move freely forward while preventing the skier from sliding backward. Backcountry snowboarding is often accomplished by using a "split board"—a specialized snowboard that splits into two short skis for uphill travel, which are then reattached for downhill riding. In an average day of backcountry skiing, a pair or group of skiers or boarders may ascend and descend thousands of vertical feet of complex terrain in and across a given landscape.

Avalanche risk assessment and mitigation while backcountry skiing or snowboarding is a major component of such activities. Avalanche hazards were only very poorly described or understood before the twentieth century. Numerous stories of avalanche burials in the 1800s abound—victims were found among mountain travelers, railroad workers, miners, recreationists, and, in some cases, entire trains or towns were historically buried by avalanches. As it was, knowledge of avalanche terrain was so poor, yet the need for mountain travel and infrastructure was so great, that the destruction of property and lives became increasingly routine into the early twentieth century. This pattern of thoughtless human intrusion into alpine winter conditions and subsequent tragedy reached its crescendo on December 13, 1916, when both civilians and mobilized Austrian and Italian forces fighting in the southeastern Alps during World War I were caught in a succession of massive avalanches throughout a single day. "White Friday," as it became known, may have claimed as many as 10,000 avalanche fatalities in a single 24-hour period, which stands as the greatest loss of human life to avalanches in recorded history.

With such lessons learned from alpine military operations, as well as the increasing civilian and industry access to the high mountains of Western North America, avalanche science, mitigation, safety, and forecasting have become new tools in the service of the backcountry traveler. Governmental regulation and oversight have relocated essential infrastructure to lower hazard zones, or else ensured that high-risk roads and train lines are covered in avalanche "sheds," to prevent vehicles and trains from becoming buried. Release and mitigation technologies have evolved from railroad workers tossing rocks onto loaded slopes from precarious positions, to artillery technology and the application of specialized explosives by Forest Service and ski patrol professionals. Meanwhile, typical backcountry skiers now employ sophisticated transceivers or "beacons" to help locate themselves or their friends in the event of a burial, which reduces life-threatening delays in rescue. Avalanche forecasting offices can now be found in most mountainous western states and provinces, often employing full-time staff responsible for assessing the backcountry, providing detailed reports of accidents, and educating the public about navigating

avalanche risk and reducing accidents in the mountains.

While backcountry skiing, riding, and avalanche science have evolved dramatically in the past century, the problem of the epistemology of risk remains central to all decisions made in the backcountry. How can the risk of hazardous terrain be measured? How do humans interpret the risks that are present? What are the limitations to human knowledge that may limit these interpretations?



Case 1.1. Jackson Hole, WY - 2016

In 2016, three advanced skiers, David Hannagan, 46, Michael Gehl, and Catherine Grimes, 36, entered Jackson Hole Resorts backcountry.9 Earlier that day, two members of the group explored a popular out-of-bounds line called Rock Springs. Later in the afternoon, they decided to take on the southeastern-facing slope called Ralph's Slide. Assuming the danger and conditions would be similar to Rock Springs, they ignored the caution signs at the gate. Ralph's Slide has an elevation of 9,900 feet. with a slope angle of 36 degrees along with a 350 vertical foot drop to the base of the line. The avalanche conditions were listed as moderate but it was forecasted that backcountry travel could trigger windblown, unstable, deep avalanche slabs. The three skiers entered the out-of-bounds area of Jackson Hole with no transceivers or guide even though they were inexperienced in the backcountry of the Grand Tetons.

Hannagan, Gehl, and Grimes were side-stepping up and away from the Ralph's Slide cliff band when they triggered an avalanche. Hannagan and Grimes were swept off their feet and sent over a 100-foot cliff while Gehl managed to grab hold of a tree. Hannagan and Grimes died of trauma before being buried by the avalanche. Gehl called for help, and Search & Rescue was activated before 2:30 p.m. and responded immediately. They found Hannagan buried under three feet of snow at 3:20 p.m. and 15 minutes later found Grimes under one foot of snow, both pronounced dead at the scene.

Case Study 1.1 Discussion

Throughout this case study you can recognize the limitations they faced and the ethical issues at hand. A lack of understanding that avalanche danger can change throughout the day and not having or using proper avalanche safety equipment played a role in the fatal outcome; could knowing these risks in advance have affected the outcome of the run? These risks could have been mitigated by understanding the many dangers that backcountry skiing can hold. This case study helps recognize that anyone can be at risk in the backcountry no matter if you are near a hometown resort, with your most trusted friends, or just did that run earlier in the day.

Painful ethical issues are also raised by cases like these. Is anyone to blame for the tragedy? How was the decision to ski Ralph's Slide that day made? Did all three skiers agree? Did they equally recognize the risks? Did one perhaps say to the others that the risks were trivial and egg the others on? Or did they instead decide to stick to a plan they had already formed without reconsidering the risks under the particular circumstances that day? And why didn't they carry transceivers or other safety equipment? It may seem disrespectful to raise such questions in the face of tragedy, but the issues they raise are ethically relevant and of importance to other future backcountry skiing parties.

Alpine Skiing

A form of skiing downhill that takes place recreationally or competitively. A technical version of the sport was introduced in the 1936 Olympics starting with downhill and slalom race courses. Alpine skiing can be done in the backcountry, sidecountry, and front country.

Backcountry

Refers to any skiable area not highly regulated by an outside entity.

Frontcountry

Any skiable area that is controlled and regulated by an outside entity.

Sidecountry

Out of bounds terrain that you can access vis ski lift but is not avalanche regulated.

Case 1.2. Mt. Washington, NH – February 1, 2021

On Monday, February 1, 2021, Ian Forgrays (54) decided to go backcountry skiing alone on the west side of Mt. Washington in New Hampshire.10 He texted friends about where he planned to ski, the Ammonoosuc Ravine, and that he wanted to take advantage of the low-rated avalanche danger before a larger winter storm was forecasted to take place later that evening. Around nine in the morning, Forgrays reached the tree line on Mt. Monroe. A little before noon, he reached the summit of Mt. Washington before starting his descent. The week before his descent, only four inches of snow fell on Mt. Washington's summit with reported low wind speeds. Although several wind slabs were created from wind loading, the temperatures for the prior week were consistent so the slabs and apparent avalanche danger remained small. Forgrays, an experienced backcountry skier, had skied Mt. Washington hundreds of times and knew the area and conditions that would take place.

Regardless of his prior experience in the backcountry, Forgrays did not return that afternoon, nor the next. Two days after his initial departure, his friends contacted the Mt. Washington Avalanche Center to help locate the missing skier. Around ten in the morning Wednesday, Forgrays' vehicle was found next to the Ammonoosuc Ravine trailhead. Due to the considerable avalanche danger, small teams of three to four were sent to start searching for Forgrays. Avalanche debris including broken trees was found slightly up the drainage stopping due to an infamous terrain trap of an overhanging rock buttress, with a span of about 25 feet across and 40 feet down. At 4:30 p.m. a beacon signal was found below the largest west-northwest-facing slope of Ammonoosuc, with the signal a little less than 13 feet below the debris. Later, an autopsy confirmed asphyxia was the cause of death.

The size of the debris and weather factors suggest a small wind slab avalanche (D1)11 occurred above the terrain trap on the skier's descent down Mt. Washington. Due to the avalanche occurring on an overhanging rock buttress, the snow piled up beneath the rock wall, causing the avalanche to be more deadly than a regular D1 avalanche. Forgrays checked that the avalanche danger was low before leaving on his ultimately fatal trip. Even though he had skied in the backcountry hundreds of times, there was always a risk when going into unpatrolled and unmonitored terrain. The same is true for anyone hoping to participate in any high-risk outdoor activity. It is uncertain whether a partner could have saved Forgrays' life due to the terrain trap. However, it would have increased his chance of survival significantly

The Epistemology of Risk and its Impact on Ethical Decision-Making

The word "Risk" is semantically used in a variety of applications, ranging from the colloquial to the technical. For example, the following statement utilizes "risk" as a negative outcome that may or may not occur.

Getting caught in an avalanche is a risk of winter backcountry travel.

Alternatively, "risk" is sometimes defined as a probability (either quantitative or qualitative) that the negative outcome in question may occur, such as the following:

The risk of setting off an avalanche today is extreme.

Numerous other technical definitions are utilized in business, engineering, and other fields. Within philosophy and bioethics, "risk" is generally used in the first sense mentioned here; that is, a negative outcome that may or may not occur.

Fundamentally, the concept of risk depends upon the unknown, or more specifically, unknowable outcomes. For example, drawing a card from a deck has an unknown outcome: will you draw a Jack, a Queen, an Ace, or something else entirely? Knowledge about risk is best conceived of as knowledge regarding the likelihoods of the unknown outcome, or else simply knowledge of what is unknown about the situation. To continue the example regarding a deck of cards, you may know that the probability of drawing a Jack in a standard deck of playing cards should be 4 out of 52, but you cannot know the exact outcome until the card is drawn. Additional knowledge (or acknowledgment) of unknown factors adds further complications: do you know if the deck was shuffled? Do you know if the deck was "stacked" by a cheating player? Do you know if this is even a standard playing card deck?

The example of playing cards is helpful, but in application in the outdoors, risk can rarely be quantified, only estimated in qualitative terms. While knowledge of snow science, this season's snowpack, current ambient conditions, and the terrain at hand is very helpful in estimating the relative risk of an avalanche on a particular slope, even the most advanced avalanche specialists would be unable to state a precise percent probability of whether an avalanche will occur if one chooses to ski down the feature in question. This is, of course, because so many other physical constraints and variables are at play in the system beyond the factors just listed: the size and shape of a given rock in the slope, the microclimates created by the curvature of a ridgeline, the unusual pocket of wind-loaded snow at just the right place—all of these variables, and many thousands more, create complex systems that ensure any given human being's estimate of risk is always necessarily limited.

These problems in assessing human knowledge of the real world are all broadly encompassed by the philosophical discipline of "Epistemology." Pertinent epistemological questions are frequently directed at skeptically evaluating one's mental model of the world. For example:

How do I know that an avalanche is unlikely here?

Is a perfectly valid epistemological question. Rather than conceiving the facts and opinions in one's mind as perfectly true, it questions how human beings imperfectly try to understand reality around them. Most of us have experienced something of an epistemic shock when we mistakenly believe there is still milk in the refrigerator, but we are shocked to find the jug is actually empty, and we have just poured a large bowl of cereal for breakfast. Likewise, a similar discordance between reality and our mental models can lead to severe consequences in avalanche terrain. A slope that was believed to be under 30 degrees (and thus low-risk for an avalanche) was, in fact, 32 degrees due to an error in human perception. As a result, tragedy may follow from a flawed mental model.

The epistemology of risk—the study of our knowledge of the knowns and unknowns that could lead to a negative outcome—becomes even more complicated when combined with the downstream ethical consequences of our decision-making.

Consider the scenario in which a skier is deciding to descend an avalanche-prone face above another party traveling uphill. Ordinarily, ethical theories such as utilitarianism, egoism, Rawlsian justice, etc. would analyze such an event in terms of given or certain outcomes, and with the general assumption that all parties have excellent knowledge of the consequences of their actions, and generally act with certainty. In this case, the skier deliberately triggers an avalanche above the victims, killing them. Different ethical theories would go on from here to weigh the intentions and rights of the skier, the intentions and rights of the party below, the greater social ramifications of murder by avalanche, etc.

Now consider the same scenario beset instead by the uncertainties and probabilities of the epistemology of risk—an incautious skier, unaware of a party below, and without taking the time to assess the avalanche hazard of the slope, begins a ski cut across the face, placing himself and others at serious risk. This is a much more realistic scenario, and, of course, a much more difficult situation to analyze ethically. In fact, the probabilistic nature of risk and the vast, epistemological uncertainty of our interactions in the backcountry may multiply the ethical implications of our actions to a degree that is impossible to analyze.12 For example, the unwitting skier may indeed accidentally trigger an avalanche, but what if nobody below was caught and carried? What if the unwitting skier triggers an avalanche, nobody is caught and carried, and his foolish actions instead alert the uphill travelers that today is too dangerous for skiing, and they retire to their cars, thereby saving them from some later, unspecified doom?

Such imaginative exercises quickly spiral into the outrageous, but to some degree inform discourses regarding risk-taking in the outdoors. While difficult, different ethical theories have been used to try to analyze moral decision-making with

probabilities in mind. Utilitarianism attempts to weigh the moral "utility" of different outcomes with their attendant probabilities.12 For example, a rescuer arrives on the scene of an avalanche and discovers two individuals who are partially buried, but breathing. They are seriously injured, bleeding to death, and require immediate evacuation—somehow you are aware that the probability of them dying in the next thirty minutes is about 50% per individual. They also tell you there is an additional partner missing, likely buried under the runout zone fifty yards away. Likewise, you are aware that there is a 100% chance of death if this person is not found and extricated in the next 30 minutes. To a utilitarian, the choice is simple: the two injured individuals deserve to be rescued first, as the "moral utility" of saving their lives, weighted by the percent probabilities, outweighs that of the buried individual in the limited time you have available. While this makes a tidy math problem, it does not necessarily reflect how most individuals would choose to proceed in such a situation, and of course, it is exceptionally rare that any probabilities, especially ones with mortal implications, can be accurately estimated in complex environments.

Rights-based ethical theories are trickier when considering the probabilistic nature of risk. Generally speaking, rights-based theories would assert that an individual has a right not to be exposed to a particular harm by another individual (e.g. to not be murdered by an avalanche triggered from above). However, these theories have a more difficult time when analyzing situations in which probabilities are introduced. Sometimes, it is asserted, just as an individual has a right not to be exposed to a particular harm, they also have a right to not have the probability of a harm increased. This works well for large probabilities—but what about very small ones? Does a low-risk day (but not a no-risk day) mean that any slight increase in the risk of an accident is forbidden?

Contract theories are another method of encountering and navigating the probabilities of risk in the backcountry. In general, contract theories are focused on the concept of agreement and consensus between competent adults. In situations like our hypothetical imposition of risk by skiing on avalanche terrain above another group, the vagaries of risk become more palatable if all involved parties have the opportunity to come to a consensus on a reasonable level of risk. Note, importantly, that this does not mean they agree to a low level of risk—rather, they agree to a level of risk merely acceptable to their own outlooks.

Assessing Risk

The way risk is assessed differs for each individual. Hazards encountered in the backcountry will be judged to different degrees of severity. This is due to cognitive bias, or an individual's tendency to create a subjective reality based on their interpretation of outside stimuli. Therefore, the behavior of each person is influenced by their own created perception of the world.

Forgrays' decision to ski in the backcountry that day was influenced by many outside factors. He received objective inputs regarding the conditions on the mountain that day, such as the weather and low avalanche risk. Using previous experience in skiing and the information gathered, he decided that the risk of skiing this run was low, and therefore he went through with his plans. Another skier may have drawn different conclusions with the same information, depending on their perception of the situation.

Over the years, dozens of cognitive biases have been identified. In the frame of risk-taking in the outdoors, there are three that are most pertinent. Identifying and realizing these subconscious biases can help in safer travel in the outdoors.

Examples of Cognitive Biases:

1. **Status quo bias:** Humans have this innate desire to keep stability. Because of this, individuals are hesitant to make decisions that may disrupt the stability of the group or situation. This can be detrimental when assessing risk in the backcountry since important observations or opinions may be dismissed to keep the status quo.

2. Anchoring effect: A phenomenon where individuals will base their decisions on an already known reference point. Each member in a group is likely to make and communicate decisions based on their own personal "anchor," which can lead to inadequate information being shared among the group, and therefore bad decisions.

3. Group polarization: The tendency of a group to make heightened decisions. For example, a group of individuals who trend towards making risky decisions individually will make more extreme, risky decisions when together.

The risk matrix is a technique that can be utilized to mitigate cognitive biases when in a risky situation. The risk matrix is an objective assessment of risk by identifying the category of likelihood against the severity of the consequence. Figure 1.1 shows an example of what a risk matrix may look like.

Likelihood	Harm severity			
	Minor	Marginal	Critical	Catastrophic
Certain	High	High	Very high	Very high
Likely	Medium	High	High	Very high
Possible	Low	Medium	High	Very high
Unlikely	Low	Medium	Medium	High
Rare	Low	Low	Medium	Medium
Eliminated	Eliminated			

Figure 1.1 Risk Matrix table depicting the likelihood and impact of potential risks used to facilitate risk assessment and mitigation strategies (X1AS).

Interview with Dr. Russ Costa

Dr. Russ Costa PhD is a skier, mountaineer, and professor of cognitive science at Westminster University in Salt Lake City, Utah. He has a wealth of knowledge about the mountains and works intimately with the Utah Avalanche Center. He also has a particular interest in cognitive fatigue and how it applies to the decisions that people make when they are in high-risk situations. In an interview with Dr. Costa, the following questions were asked:

***How do you define "risk" in your field? Are there multiple interpretations out there*?**

Bayesian probability updating is the most common way that risk is defined, with a base level of risk and other factors causing greater risks. Dr. Costa said that he typically tries to avoid using the term "risk" due to the ambiguity of it.

What do you see as the most common cognitive biases when backcountry skiers, climbers, etc. attempt to evaluate risk?

While it depends heavily on each individual and their respective cognitive biases, the group dynamic is an equally important factor to assess. The overconfidence effect is really common with experts because they're so familiar with the sport, that they tend to make quicker decisions and put themselves in riskier situations without thinking. The halo effect is very clearly seen in groups with a guide. Many people will assume that there is less risk when traveling with a guide, which can often lead to incidents.

What is the best advice you have for people who want to start backcountry skiing?

The clear first answers are to take an avalanche class and to not ski alone. When choosing a partner to ski with, pick someone based on the skills you want. Friends are not always the best skiing partners and romantic partners can often be worse. Your first ski tour with a partner should be like a first date; ski in a low-risk area to get a feel for how they operate in the backcountry. It's also important to not become overconfident with certifications. Risk homeostasis says that people will take greater risks if they feel more protected by their equipment or certifications. People who take an avalanche course are statistically more likely to die in an avalanche. As Dr. Costa said, "The snow doesn't care about your certification".

Do people risk more or less due to the information that is available these days?

There are a lot more people today getting into the backcountry than there have ever been, but gear is also constantly improving. For example, there is 20 times more traffic on the Utah Avalanche Center website today than there was 20 years ago. Due to the higher volume of people in the backcountry, more people are getting into trouble, however, the fatality rates are relatively constant. Based on these statistics, people are individually more safe in the mountains now than they have been in the past.

Why do you ski and climb? Why not pickleball?

Dr. Costa simply gave us a quote in response to this: "New vision of the world earned through hardship".

Case 1.3 Canwell Glacier, AK - 2016

On March 26, 2016, an introductory mountaineering class from the University of Alaska Fairbanks embarked on their final project on the Canwell Glacier in the Eastern Alaska Range. Their goal was to plan and execute a safe climb up the northwest face of Callum Peak. The class comprised one lead instructor, three volunteer assistant instructors, and nine students. All members had had 12-15 hours of avalanche training, including experience in the field. Two of the instructors had an Avalanche (Avy) 2 certification, and three of the students had taken an Avy 1 class in the past.

Ten days before the final project a storm brought 27.5 inches of fresh snow to the area. An advanced Avalanche course relayed detailed information about snow conditions in the mountains. The students decided the conditions were high risk for avalanches above the treeline. To mitigate this risk it was decided they would travel in low-risk areas only. On the day of their final project, the group left early in the morning. Everyone wore a helmet and carried a working beacon, shovel, and probe (along with camping and climbing equipment). The temperature was around 24°F along with clear skies and 5-15 miles per hour winds.

Ultimately the students led this expedition, which resulted in challenging and tedious progress. The group traveled along the south side of the Canwell glacier, where they ended up straying from the trail. When the students realized they should be on a large bench 200 feet above them, they decided that instead of hiking back one and a half miles to find the correct trail route, the group would find a way up the moraine slope. This decision was reinforced by the lack of danger observed by the group. They followed a snow ramp up along a shallow rock band that led up most of the slope. When reaching an open snow portion of the hill, the group made their way up in a staggered formation. It was about 20 feet from the top when the lead climber triggered a wind slab that encompassed the whole party. Two people in the front traveled only a short distance down, five people were carried downslope on top of the snow, four were partially buried, and two were buried close to the surface. Fortunately, everyone recovered and only minor injuries were sustained, such as a leg and face laceration. After the incident, it was decided by the group to turn back and return to their cars.

Case Study 1.3 Discussion

The incident report outlines five main mistakes made by the group in a reflection by the lead instructor and an outside third party. They are as follows:

1. **Poor decision-making and communication as a group:** The group failed to follow S.T.O.P (Stop, Think. Observe, Plan), and therefore there was a failure to acknowledge that they had moved into an avalanche danger zone.

2. Poor group management: A universal rule in avalanche safety is to have only one person cross the danger zone at a time. This lowers the chance of triggering an avalanche, and in the case that the individual is caught in the onslaught of snow, then the rest of the group will be able to rescue them. This class had everyone crossing the zone at once. The lead instructor acknowledges that they should have exposed a smaller group to danger at a time.

3. Not being flexible enough with the trip plan: The group decided to continue with the trip despite knowing the risk of avalanches. The decision to simply avoid dangerous areas might not have been safe enough, instead, they might have considered changing the ultimate goal or moving the dates.

4. Avalanche blindness: It was thought that the group got too comfortable during the journey and failed to remember the magnitude of the hazard.

5. Time constraints: The planned duration of the trip was short, so it was likely the group felt pressure to complete the expedition within that day. More flexible plans could have been considered. In addition, formalizing systemic practices of risk assessment and group communication may have alleviated the mental fatigue they experienced from making numerous decisions within a limited time frame. This could involve the development of a risk matrix for their trip beforehand, outlining the acceptable risk levels based on the likelihood of occurrence and the severity of potential consequences.

The goal of this expedition was to successfully navigate avalanche territory to reach and climb Callum Peak, but the question arises of why. What is the purpose of journeying into the backcountry in dangerous terrain? Why would an individual go through the effort of traveling through a snowy mountain range to climb the side of a mountain? What do they get out of the experience? What might they lose? This expedition was supposed to be the conclusion of a training course, presumably, a course intended to instruct students in the realities and dangers of mountaineering. Should that make a difference in our ethical evaluation?

Avalanches

Avalanches are a common risk to those who participate in winter activities. Although several factors can help indicate the risk of an avalanche on any given day, there is never a definitive way to avoid them. Three components are involved when assessing avalanche danger: the terrain, the snowpack, and a trigger.

The primary consideration of the terrain is the steepness or slope of a snow-covered mountain. An angle measurement between 30 and 45 degrees is considered prime avalanche terrain. While avalanches can occur below 30 degrees and above 45 degrees, it becomes less likely for an avalanche to occur but it is still possible. In perfect avalanche conditions, there is about a 3% chance a slide could occur under 30 degrees. An avalanche could be triggered on the mountainside and find its way into the valley, where the perceived avalanche danger was originally low. Figure 1.2 shows the percent of all avalanches and is gathered from a Swiss dataset that collected avalanche data from 170 participants who analyzed ten avalanches from January 1, 2022, through December 31, 2022, across the world.

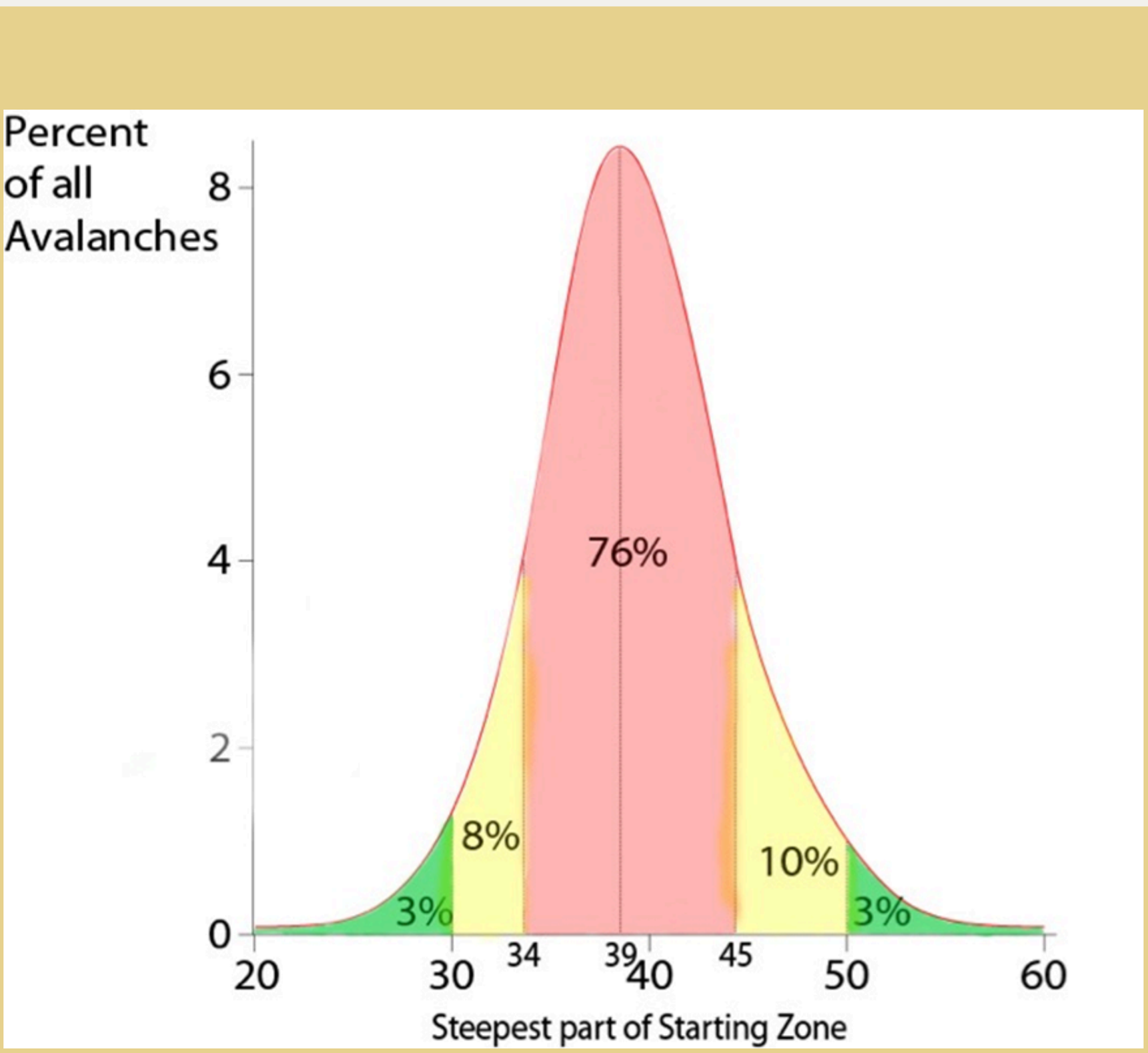


Figure 1.2 Percentage of avalanches that occur at various slope angles (Swiss dataset citation that collected avalanche data from 170 participants who analyzed ten avalanches from January 1, 2022, through December 31, 2022, across the world).

In addition to terrain, snowpack is another consideration when assessing the risk of avalanches. Avalanches are probable when specific snow conditions exist. These conditions include a bed surface of snow, a weak layer, and a strong layer. The bed surface is the layer directly interacting with the ground and can be many things including hard, old snow, or anything stronger than the weak layer. Most of the time, the middle, weak layer is directly below the strong layer. As denoted by its name, the weak layer is not stable. It is extremely susceptible to sliding, causing an avalanche because the weak layer of snow was unable to bond correctly with the layer below and above it. This could be caused by a variety of factors, most notably due to drastic changes in temperature or a large snowfall. Figure 1.3 shows a prime example of the layers of a slab avalanche. Additionally, the snow interface can easily be disrupted, causing the strong layer to release and commence an avalanche.

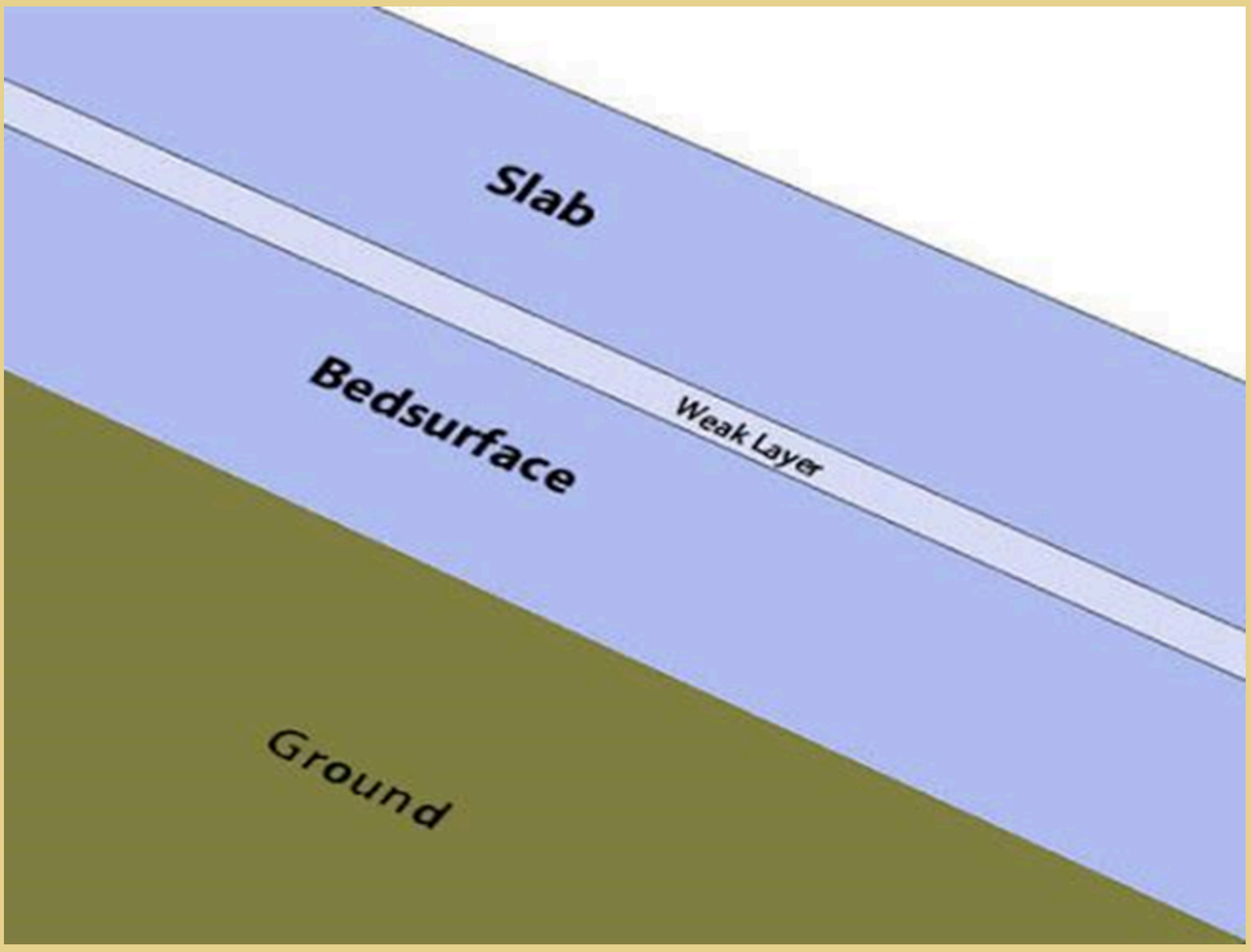


Figure 1.3 Illustration of snow layers with the potential to trigger an avalanche. The unstable weak layer can undergo shifting, causing avalanche initiation (citation).

Moreover, a “trigger” must be present for the avalanche to proceed. A trigger can be anything that disrupts the stability of the snowpack, including rapid warming, temperature gradients, human interaction, rain, wind, and areas near natural impediments such as rocks and trees. While some avalanches can be caused by humans skiing on top of the snow that collapses and starts an avalanche, avalanches can also be triggered from afar. These are denoted as remotely triggered avalanches. These remotely triggered avalanches are extremely dangerous because they can be triggered from anywhere on an adjacent slope where a crack was present in the snow. Thus, a skier touring on flat ground could trigger an avalanche in an area that is above them and may be outside of their immediate vicinity.

To help skiers and Search & Rescue teams alike, avalanches are placed on two scales, showing size and destruction abilities. The first is called the Destruction Force Scale grades avalanches into five separate categories, D1, D2, D3, D4, and D5. This scale accounts for the destruction potential that a given avalanche can create: D1 avalanches being smaller avalanches, enough to usually only partially bury a person, D2 being enough to severely injure or kill a person, and D3 avalanches carrying a destruction capability enough to destroy a car and uproot small trees. D4 and D5 avalanches are much more destructive, with their ability to destroy an oversized truck or destroy an entire village, respectively. The second scale, called The Size-Relative to the Path Scale, accounts for horizontal extent, depth of fracture, volume, and runout distance. This scale grades avalanches into five categories, R1, R2, R3, R4, and R5. Similarly to the Destruction Scale, the Size-Relative to the Path Scale starts with the smallest avalanches (R1) and goes up to R5, which has the most major avalanches with respect to size.

In addition to the Destruction Scale and the size relative to the Path Scale, the North American Public Avalanche Danger Scale (NAPADS) was created to help adventure experts and adventure enthusiasts predict the potential danger of avalanches in each area. While it may be updated and determined slightly differently depending on the state or region, it is usually updated every morning and shows the avalanche danger on a scale from one to five. One, meaning the avalanche danger is low and it is generally safe to travel in, and five, showing the avalanche danger is extreme and very large avalanches could occur in many areas. Below is the North American Public Avalanche Danger Scale that is used in the United States of America to depict the avalanche danger in a given area.

North American Public Avalanche Danger Scale

Avalanche danger is determined by the likelihood, size, and distribution of avalanches.
Safe backcountry travel requires training and experience. You control your risk by choosing when, where, and how you travel.

Danger Level	Travel Advice	Likelihood	Size and Distribution
5 - Extreme	**Extraordinarily dangerous avalanche conditions.** Avoid all avalanche terrain.	Natural and human-triggered avalanches certain.	Very large avalanches in many areas.
4 - High	**Very dangerous avalanche conditions.** Travel in avalanche terrain not recommended.	Natural avalanches likely; human-triggered avalanches very likely.	Large avalanches in many areas; or very large avalanches in specific areas.
3 - Considerable	**Dangerous avalanche conditions.** Careful snowpack evaluation, cautious route-finding, and conservative decision-making essential.	Natural avalanches possible; human-triggered avalanches likely.	Small avalanches in many areas; or large avalanches in specific areas; or very large avalanches in isolated areas.
2 - Moderate	**Heightened avalanche conditions on specific terrain features.** Evaluate snow and terrain carefully; identify features of concern.	Natural avalanches unlikely; human-triggered avalanches possible.	Small avalanches in specific areas; or large avalanches in isolated areas.
1 - Low	**Generally safe avalanche conditions.** Watch for unstable snow on isolated terrain features.	Natural and human-triggered avalanches unlikely.	Small avalanches in isolated areas or extreme terrain.

Figure 1.4 North American Public Avalanche Danger Scale used to caution backcountry travelers of avalanche risk.

While all three of these factors influence the risk of an avalanche, there is no infallible way to ensure safety in the backcountry. Avalanches can occur in almost any terrain, and as such it is important for skiers to understand the risk vs reward of going backcountry skiing or snowboarding on a given day. For every person, the value of going out in the backcountry will come down to personal choice. For some, it is their way to relax and exercise without having to deal with the hassle of the touristy ski areas, and for others it allows them to challenge themselves in new ways they have never experienced before. No matter the reason, it is important for all parties involved to be aware of and accept the present risks and dangers of every day and be ready in case of an emergency.

To increase the risk of survival if an avalanche occurs, backcountry skiers and boarders alike usually carry a beacon, probe, and shovel and travel with at least one partner. A beacon, an electronic device that transmits signals from one beacon to another, signals how far away other beacons are from the searcher if an avalanche occurs (X1AL). To work properly, it must be worn the entire tour and as close to the body as possible. This ensures that the signal is accurate when turned on. Additionally, an avalanche probe is carried to be used once a signal of the buried person is found one meter or less away. Various techniques are used to probe; however, the main process is placing the signals down into the snow, to sense the buried victim below the packed snow and differentiate between rocks, tree trunks, and other debris. Once the person is found below the debris using the probe, the rescuer uses their shovel to dig out the victim as fast as possible. However, for a buried victim of an avalanche to have the highest chances of survival, they must be traveling with a partner they trust. All parties involved place their lives in the hands of their partners and must examine the risks involved in doing so. This involves trusting your partner's risk assessment capabilities and decision-making skills alike.

Essential Avalanche Gear

Rescue Beacons: Also known as locators or transceivers, beacons are the only tool that enables a rescuer to find a buried person with the speed necessary to save their life. Practicing with a beacon is essential to becoming competent enough to save a partner's life, should it be necessary. Many different companies make beacon. However, they all operate on the same frequency so there shouldn't be any issues if two people have different brands. Beacons do need to be manually switched on, so it's extremely important to make sure they are charged and ready prior to entering the backcountry.

Avalanche Probes: Once an avalanche victim's general location is found, probes allow a rescuer to find their precise location. Probes are extendable metal poles that can be pushed into the snow so one doesn't waste their time digging only to miss the victim altogether.

Shovels: These are critical, not only for uncovering a buried victim, but they are immensely useful in assessing snowpack and digging out a car or snowmobile if necessary.

Medical Considerations

Avalanche burial victims are at risk of suffering life-threatening medical complications. The two most common causes of death among avalanche victims are asphyxiation and trauma. Asphyxiation causes nearly 75% of deaths in avalanche burials, while trauma is responsible for 24% of avalanche-related deaths in Canada, but this distribution can vary based on geographical location.

Asphyxiation occurs in individuals who do not inhale enough oxygen and ultimately stop breathing. There are several types of asphyxia seen in avalanche fatalities. The first occurs when an individual inhales snow that occludes the upper airway. Since oxygen cannot pass through the blocked respiratory tract, oxygen will not effectively diffuse into the bloodstream and circulate to the rest of the body. Compression asphyxia occurs when the volume of snow covering an avalanche victim puts pressure on the chest cavity and compromises chest expansion. When chest expansion is restricted, the body cannot effectively move oxygen into and out of the lungs. Lastly, asphyxiation can occur when an avalanche victim becomes buried beneath a layer of snow without an air pocket. An air pocket is a space near the victim's airway that does not have snow, allowing for adequate ventilation. When an air pocket is absent, an avalanche victim rebreathes the air from their exhalations. As a victim breathes over an extended period, the content of carbon dioxide increases. A high presence of carbon dioxide can ultimately lead to hypoxia, defined by insufficient oxygen levels in body tissues.

Time is of the essence during an avalanche burial. Rescue within the 15 to 20 minutes following an avalanche is known as the 'survival phase.' If rescued within the first 20 minutes of burial, an avalanche victim has nearly a 90% chance of surviving the incident. With each passing minute, the chance of recovering an avalanche victim alive significantly decreases. Quick action is critical to optimize burial victim survival.

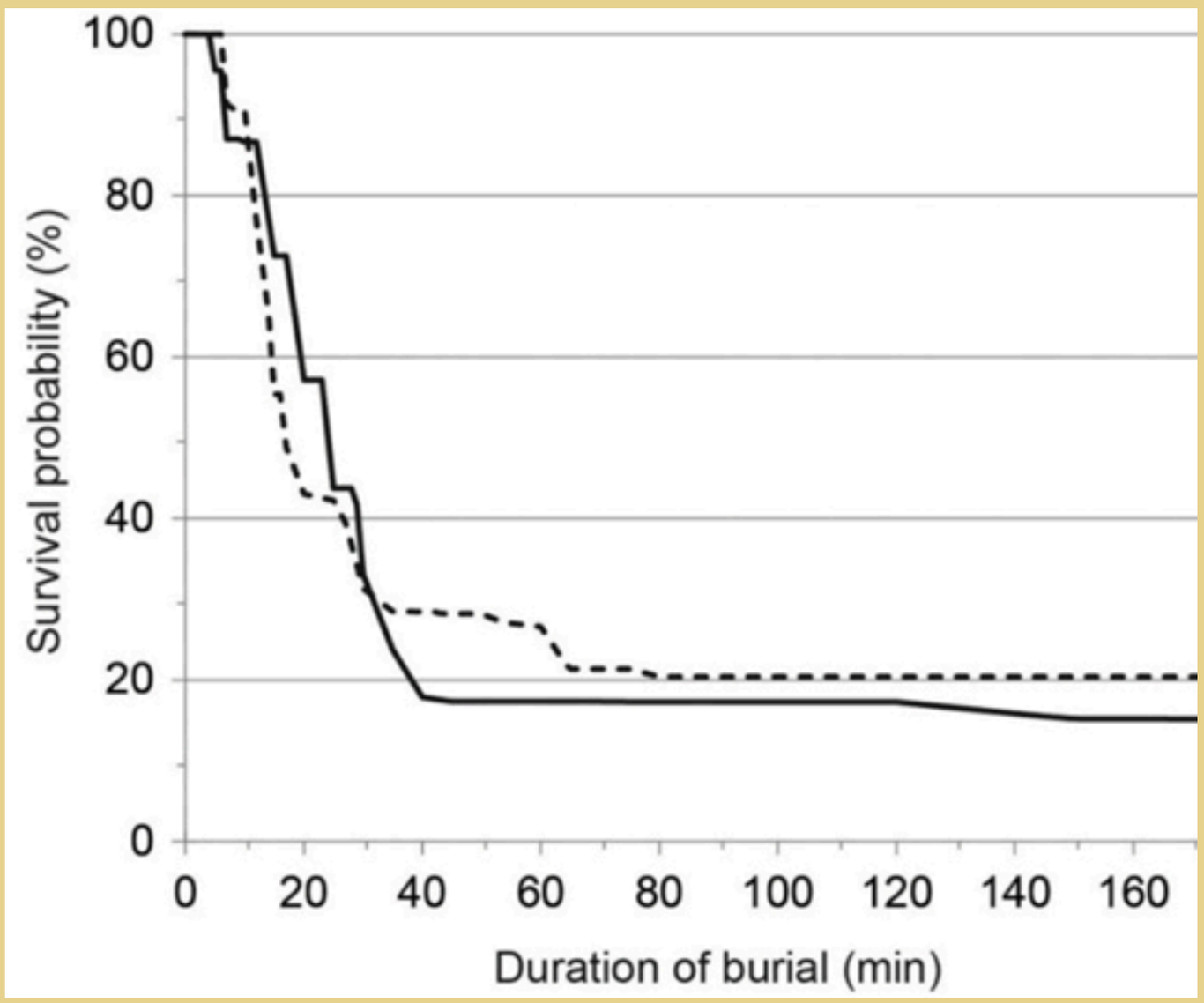


Figure 1.5 Graph depicting the relationship between avalanche victim burial longevity and survival probability.

Conclusion

The exploration of these case studies underscores the importance of risk assessment within the realm of backcountry skiing and snowboarding. Each tragic incident serves as a poignant reminder of the critical need for thorough understanding, preparation, and conscientious decision-making when venturing into unpredictable natural environments.

The ethical dimensions of risk assessment extend far beyond personal accountability; they encompass a collective responsibility to prioritize safety, informed decision-making, and mutual support within outdoor recreational communities. The ethical imperative lies in recognizing and respecting the inherent risk associated with backcountry activities, as well as the profound impact of our choices on both individual lives and broader societal perspectives.

Moreover, these case studies compel us to reflect on the ethical implications of our motivations and objectives in pursuing high-risk endeavors. Participants in back-country skiing and snowboarding must interrogate not only the technical aspects of risk management but also the underlying values and motivations that drive our engagement with such activities.

Ultimately, an ethical approach to risk assessment in backcountry pursuits may demand a commitment to continual learning, self-awareness, and collective responsibility. By embracing these principles we can strive to cultivate a culture of safety, respect, and ethical conduct regarding the risk that honors both the inherent challenges and the profound rewards of outdoor adventure.

Discussion Questions

1. Reflecting on the case studies presented, what were the commonalities and differences in the factors contributing to each accident?

2. What ethical principles should guide decision-making in these high-risk outdoor adventures like back-country skiing and snowboarding?

3. In light of the accidents described, what strategies can individuals and groups employ to enhance safety and minimize risks in the backcountry?

4. How do personal motivations and group dynamics influence decision-making and risk-taking behaviors in outdoor recreation?

5. Consider the role of education and training in preparing individuals for backcountry activities. What are the ethical responsibilities of participants and instructors in promoting safety and risk awareness?

6. Discuss the concept of "acceptable risk" in the context of backcountry skiing and snowboarding. How do individuals and groups navigate the tension between adventure and safety?

7. Explore the notion of accountability in backcountry accidents. To what extent are individuals responsible for their own safety, and what obligations do they have to their fellow adventurers?

8. Reflect on the broader societal implications of backcountry accidents. How do these incidents shape public perceptions of outdoor recreation and influence policies and regulations?

9. Discuss the concept of the risk matrix in backcountry skiing and snowboarding. How can this tool be utilized to assess and prioritize risks? What factors should be considered when developing a risk matrix for outdoor excursions?

10. Reflecting on your own experiences or observations, how have you seen risk assessment principles applied (or neglected) in backcountry skiing and snowboarding? Share specific examples and discuss the outcomes.

INTERVIEWEES

Russ Costa:
Dr. Russ Costa, PhD is a professor of cognitive science at Westminster University in Salt Lake City, Utah. He is an avid skier and mountaineer, which led him to have a special interest in avalanches, the way people prepare themselves for being in avalanche territory, and the decision-making that happens when lives are at risk.

Pete Zabrok:
Pete Zabrok, also known as “Pass the Pitons Pete,“ is a world-renowned climber and insurance salesperson from Ontario, Canada. Known to many in the climbing community, Zabrok has climbed El Capitan in Yosemite National Park over 68 times and completed 63 different routes on the mountain. Climbing hundreds of mountains, Zabrok provides a wealth of knowledge and experience to the climbing community, with extra insight on aid climbing.

Ben Eder:
Ben Eder is an architecture student at the University of Utah, a Salt Lake County Sherriff’s Office Search and Rescue squad member, and an avid climber. In August of 2022, Eder attempted to complete the Grand Traverse in Grand Teton National Park, one of the most notorious routes in North America. Along the way, Eder misstepped and fell over 300 ft. before being taken to a hospital by helicopter, where he spent over two weeks in a coma. He lost some cognitive functioning and the ability to climb but was able to rehabilitate himself well enough to run a marathon within a year of his accident.

Tom Jones:
Tom Jones is a former climber and the founder of Canyoneering USA, a website dedicated to making canyoneering a more accessible activity for people exploring the deserts of Utah. The site lists the major canyoneering regions in the state and outlines a series of ways each route is evaluated. Considering the tremendous amount of time Jones has spent in southern Utah, he has spent a while talking with rangers and knows a lot of stories.

Mark Hudon:
Mark Hudon is a distinguished big wall climber who spent much of his adult life in Yosemite National Park. He has been on the scene since the 1970s and was recently featured in a film with young climber, Jordan Cannon made by Arc'teryx. The unlikely pair chose to free climb the route Free Rider on El Capitan, with Cannon attempting to complete it in a day and Hudon seeking to claim the title of oldest free ascent. Obviously, this was an ambitious task, made more stressful by the addition of a film crew following their progress.

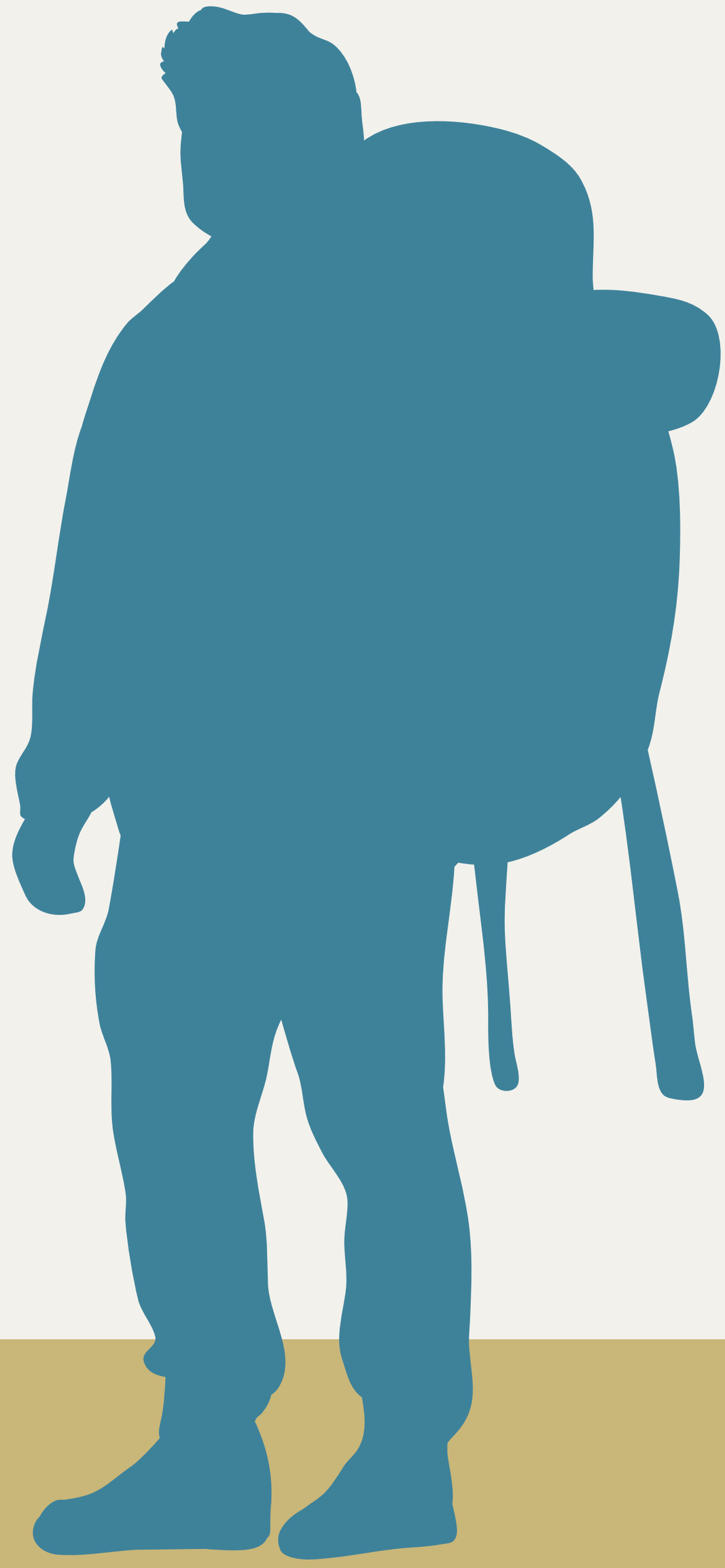
Lynn Hill:
Lynn Hill is one of the most famous female climbers of all time; renowned for being the first person to free climb The Nose on El Capitan in one day and today the only other person who has completed that task is Tommy Caldwell. She started climbing at 14 and it quickly consumed her life as she became capable of climbing many of the top standards in the 1970s. Hill has broken so many barriers as a strong female climber and continues her athletic lifestyle in Colorado.

Lone Peak Hotshots:
The Lone Peak Hotshots are a fearsome crew of 23 firefighters working to prevent and mitigate forest fires near Draper, Utah. The team upholds core values of safety, teamwork, self-discipline, and family as they spend countless hours protecting the natural environment. There is a lot to be learned from them regarding firefighting procedures, managing priorities, and keeping members of their squad happy and healthy.

Ryan Clerico:
Ryan Clerico is the Assistant Commander of the Salt Lake County Sherriff's Office Search and Rescue squad. Working as a volunteer, Clerico has been a part of the team for over a decade and was first on the scene during the infamous Wilson Glade avalanche that was triggered in February of 2021. He has a wealth of experience rescuing along the Wasatch front and was able to discuss rescue procedures and ethics that have come up in his tenure.

Ashley Saupe:

Ashley Saupe is the creator and host of The Sharp End Podcast, which discusses backcountry accidents to prevent future mishaps. Saupe loves adventuring and uses her podcast to dissect near-misses from real people, helping unburden them and find takeaways from the accidents.



STUDENT REFLECTIONS

Savannah Romney:

This year, as a Wilderness Medicine and Bioethics Praxis lab student, I gained a new appreciation and respect for the outdoors. Unpredictable incidents in the wilderness are inevitable, and properly training and preparing for adventures is essential. I also recognize that, before an expedition, it is important to look at environmental conditions to ensure that well-informed decisions can be made. At the same time, many ethical perspectives shape how people interpret risk and proceed with risky activities. While there are no right or wrong answers in many of these situations, this course has given me the necessary tools to analyze situations and make informed decisions. I have grown a lot as a student, peer, and collaborator this semester

Rachel Muhlestein:

I decided to enroll in this course rather spontaneously before the Fall semester began. From the first class, however, I was hooked and I knew that this course would stand out as one of the most enjoyable and instructive experiences of my undergraduate degree. This course challenged questions that are always in the back of my mind as a participant in outdoor activities. What do we do if something goes wrong? Is this a wise or justifiable decision? Will this risk seem worth it if something does go wrong? Why am I doing any of this in the first place? This course has confirmed my passion for outdoor adventure, solidified my interest in medicine, and provided me with a deeper understanding of the ethical considerations inherent in outdoor pursuits. We've learned to critically examine the rationale behind our actions, both in the wilderness and in everyday life. I've learned that the study of ethics is essential because it provides a framework for navigating complex situations with clarity and integrity. Applying ethical principles to outdoor activities equips us with the tools to make informed, intentional decisions, even in high-stress environments. I am very grateful for the work and guidance of Dr. Jones and Dr. Battin, as well as the time spent by our guest speakers and interviewees throughout the past two semesters. Their insights have broadened my perspective and deepened my appreciation for the natural world and those who work to maintain it and our safety within it. I'm excited for the opportunity to continue working with this group as we explore the intersections of wilderness medicine and ethics and work to make this course of study more accessible to everyone

Lily Halberg:

My time during this Praxis lab was enriching. In the past, I took part in outdoor recreational activities with the thought that nothing bad could happen to me. It is an easy mindset to fall into, and I found that the Wilderness Medicine and Ethics class has opened my eyes significantly. I learned a lot about how to be safe in the outdoors, but I also learned about the serious repercussions that could happen if unnecessary risks are taken in the wilderness. Working in this Praxis Lab also forced me to step outside of my own comfort zone and to work well in a group. I found that I could trust my group members, and I really enjoyed working with people who have different insights and experiences. I learned valuable skills like overcoming conflict and compromising without giving up my visions for the project.

Zev Katz:

It has been such an incredible experience working on this project. The things I have learned have altered how I think, impacted my life, and how I experience the outdoors. I hope the work we have done so far (and will continue to do) will ripple out and make a difference in others' lives as well. The nature of bioethics concerning wilderness medicine is much more nuanced than most think and I want that to be demonstrated clearly in our finished product.

Stephanie Horvath:

Last year when I was looking for an honors class to take, I wanted something that was going to be valuable to me and that would challenge me into thinking in new ways. So, when I read the description of this praxis lab, I knew that it would be an interesting course. Growing up in the mountains in Colorado, I was always outside. Whether my family was skiing, hiking, mountain biking, climbing, or taking part in water sports, I always felt content and peaceful being with my family. As I got older, I loved the adrenaline rush of finding a new line down a mogul field skiing or seeing how much air I could get from the downhill mountain bike trail behind my house. While these experiences allowed me to assess my endurance and physical limitations, I never thought about the fatal repercussions that I place myself in while doing these intense sports: I just did it. On the first day of class, we saw a case study that forced each of my classmates to decide if they were willing to sacrifice their climbing partner's life to potentially save themselves. It shook me: I had never thought about what would happen if something went wrong on a particular day that I decided to go outside and have some fun.

Throughout the rest of the first semester, I became enriched by each case study we talked about, and how the outcome not only affected me, but everyone and everything around me. Suddenly, I realized why my parents insisted they have my ocation when I went mountain biking by myself, or why my dad made me learn how to fix all different parts of my bike and learn basic first aid. While I was fortunate to grow

I up with parents that were supportive of my own adventurous spirits and were willing to teach me these life skills, not everyone has access to knowledge on how to fix things, wilderness medicine, or bioethics. This year, I have gained so much value to why I and others enjoy the outdoors, and how to make every adventure as safe as possible. For example, this class pushed me into signing up for an Avy 1 course this past winter. While I did my best previously to pick days that were of low avalanche danger and carry the necessary equipment when going out into the backcountry, I didn't necessarily think about the risks that backcountry skiing and snowboarding includes, and how it could affect me on a given day my friends and I decide to go.

Therefore, I am so grateful to have been a part of this class and lab this past year. Not only did I learn about different philosophical ideals and wilderness medicine, but I learned how I can apply it into my own life and share it with others through our project. For me, and much of our lab group, this project was more than just creating a cool project to bring into the community; it was an experience that allowed us to work together to solve complex day-to-day issues and emergencies that we may see in our lifetime. And for that, this class may be one of the most influential courses I will take while at the University of Utah, and I am eternally grateful for this opportunity and experience that this praxis lab has given me.

Harper Howe:

Throughout the Adventure, Risk, and Rescue Honors Praxis lab I have learned an immense amount of information involving bioethics, philosophical perspectives, wilderness medicine, and how to interpret case studies. I found a lot of value in connecting these complicated topics because it helped me understand my risk assessment while facing the outdoors. The first-semester class taught me a new way of thinking about problem-solving and finding solutions while the second-semester class taught me how to implement this new way of thinking. Before taking this class, I have always been defensive about taking risks in the outdoors, specifically, skiing. This came from not trusting my skills and the fear of getting hurt. But as I learned about risk assessment throughout this course my thought process changed. This ski season I took more risks than ever before, learning so much more about my abilities and reaching goals I never thought I would accomplish. I give credit to my new understanding and knowledge of bioethics and wilderness medicine I studied throughout this course. The most challenging thing I have faced throughout this project would be, writing about a subject I am not fully an expert on. But on that note, the most valuable part is constantly absorbing new information and striving to learn more to become well-equipped with the correct information needed to write about the allotted subject. Working with a new group of people with different styles of writing and thinking for a prolonged period changed my views about teamwork and commitment. I saw a positive change in the way I navigated different ideas and work ethics which gave me patience and understanding. This experience has been a positive influence on the trajectory of my college career and I am thankful for the skills and knowledge it has brought me and will continue to bring me.

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Tom Jones and Canyoneering USA

Ashley Saupe and The Sharp End Podcast

Jack McManus

Dr. Russ Costa

Pete Zabrok

Lynn Hill

Ryan Clerico